Lecture No 1

Structure of the course:

Teaching of General science to Grades K-8

- Composing of 45 lectures which are organized into 4 units/components.
- Unit 1: In the first unit we will explore what is science and why do we need to teach it?
- Unit 2: Children's ideas about science and their importance in planning and teaching.
- Unit 3: Learning planning and teaching science- the major part of the course.
- Unit 4: Conclusion-Review of the salient features of the course and the road ahead.

This lecture will start with the unit 1. This is the "start of the journey to develop Pedagogical Content Knowledge".

Pedagogical Content Knowledge

What is pedagogical content knowledge?

- An in depth understanding of the content of the discipline they are teaching i.e. ideas and concepts, skills and practices associated with that discipline
- An understanding of how students learn that subject, what is hard and what is easy for them and what examples, processes and activities will help them to learn i.e. appropriate pedagogy adapted to the different development levels and interests of the learner.
- They need to know how children's understanding of core ideas in science builds across K-8, not just at a given grade or grade band.
- They need to learn about the conceptual ideas that students have in the earliest grades and their ideas about science itself.
- They need to learn how to assess children's developing ideas over time and how to interpret and respond (instructionally) to the results of assessment.

What is science or the nature of Science?

- Science constitutes an organized body of knowledge about the natural world and the processes/practices whereby this body of knowledge is established and is continuously being extended, refined and revised.

Nature of Scientific knowledge

1. **Scientific theory:**

- ❖ A scientific theory (e.g. theory of electromagnetism or theory of Newtonian mechanics or atomic/molecular theory or plate tectonic theory) is an explanation of observed phenomena and natural objects which can command widespread acceptance and significant testing. Through those tests and the resulting refinement, it takes a form that is a well-established description of phenomena in a particular area and provides a coherent conceptual framework that is consistent with a body of facts that are currently known.
- ❖ In addition a theory is valued if it can make testable precise predictions for as yet unmeasured or unobserved effects; it is unlikely that new data within that area will totally discredit a well-established theory instead it can be modified and revised to take into account new evidence.

2. **Aim of Science:**

- The aim of science is thus to establish explanations for the behavior of natural objects and phenomena that are supported by data/evidence – in other words finding out how the natural world works.

Nature of Scientific practices

Scientific knowledge is acquired through a series of practices/abilities which together constitute scientific inquiry. These include:

- **Conducting observation**
- **Raising questions**
- **Developing tentative explanations or hypotheses of observed phenomena**
- **Making predictions base on the tentative explanations or hypotheses**
- **Planning and carrying out empirical investigations**
- **Collecting, interpreting, analyzing data and evaluating knowledge claims**
- **Communicate findings to larger peer group for critical review**

Essential characteristics of Science

- **Data and evidence hold a primary position in deciding any issue.**

What is Data/evidence?

Data/evidence refers to observations or measurements made in the natural environment (such as a forest or river) or in the laboratory. In some circumstances scientists can control conditions deliberately and precisely to obtain their evidence; in some cases they have to conduct observations over long periods of time and shift through data or look for "historical" evidence.

- **A process of argumentation and logical reasoning that relates data/evidence and theory**

This includes evaluation of data quality, examining the connection between evidence and claims/tentative explanations. It is made of logical discourse whose goal is to tease out the relationship between ideas and the evidence---- for example, to decide what a theory or hypotheses predicts for a given circumstance, or whether a proposed explanation/conclusion is consistent or not with some new observation.

- **Modifying or altering scientific knowledge in the light of accurate and reliable data/evidence**

When well established data, from experiment or observation, conflict with a theory or hypotheses then that idea must be modified or abandoned and other explanations must be sought that can incorporate or take account of the new evidence.

- **Identifying and avoiding Uncertainties and Bias**

Scientists have to be aware of the possible sources of uncertainty or bias associated with the investigator, instruments and method. One way of avoiding bias is having many investigators working on the same area of study.

To be proficient in Science means

- Understanding some aspects of science content i.e. knowing and applying scientific concepts and explanations associated with natural phenomenon.
- Develop the abilities to conduct scientific inquiry i.e. engage in scientific practices that generate the scientific knowledge
- Understanding the nature of scientific knowledge and how it is developed

It includes students' reflection on the status of their own knowledge. More specifically students must recognize that there may be several explanations of the same phenomena. They must understand that explanations become increasingly valuable when they account for the available evidence more completely, and as they generate new productive research questions.

- Understanding and participating in science as a social activity.

Scientific knowledge is the product of community not of an individual. Findings reported by an individual must survive an institutional checking and testing mechanism, before being accepted as scientific knowledge.

Participation in scientific practice and discourse in the classroom helps students engage in the construction of scientific evidence, explanations; advance their abilities to argue scientifically. This includes social norms for conducting and presenting a scientific argument and engaging in scientific debates. It also includes habits of mind, such as adopting a critical stance and being skeptical; a willingness to ask questions and seek help and value team work.

Why teach Science

- We teach science to nurture future scientists, technologists and engineers.
- We also teach science to increase the number of "scientifically literate" adults in society and hence improve a public understanding of science. Science education is essential for all students if they are to participate fully in a society/world that places increasing reliance on science and technology.
- We teach science to equip students with skills that are useful across disciplines such as evidence base reasoning, critical thinking, problem solving and specialized ways of social interaction.

Goal of K-8 Science Education

The goal of K-8 Science Education is to develop a strong base of scientific knowledge and practices that enable students to engage in a deeper understanding of science in higher grades or use their evaluation and analytical skills effectively in other subject areas.

Arguments for Promoting a Public understanding of Science or science literacy

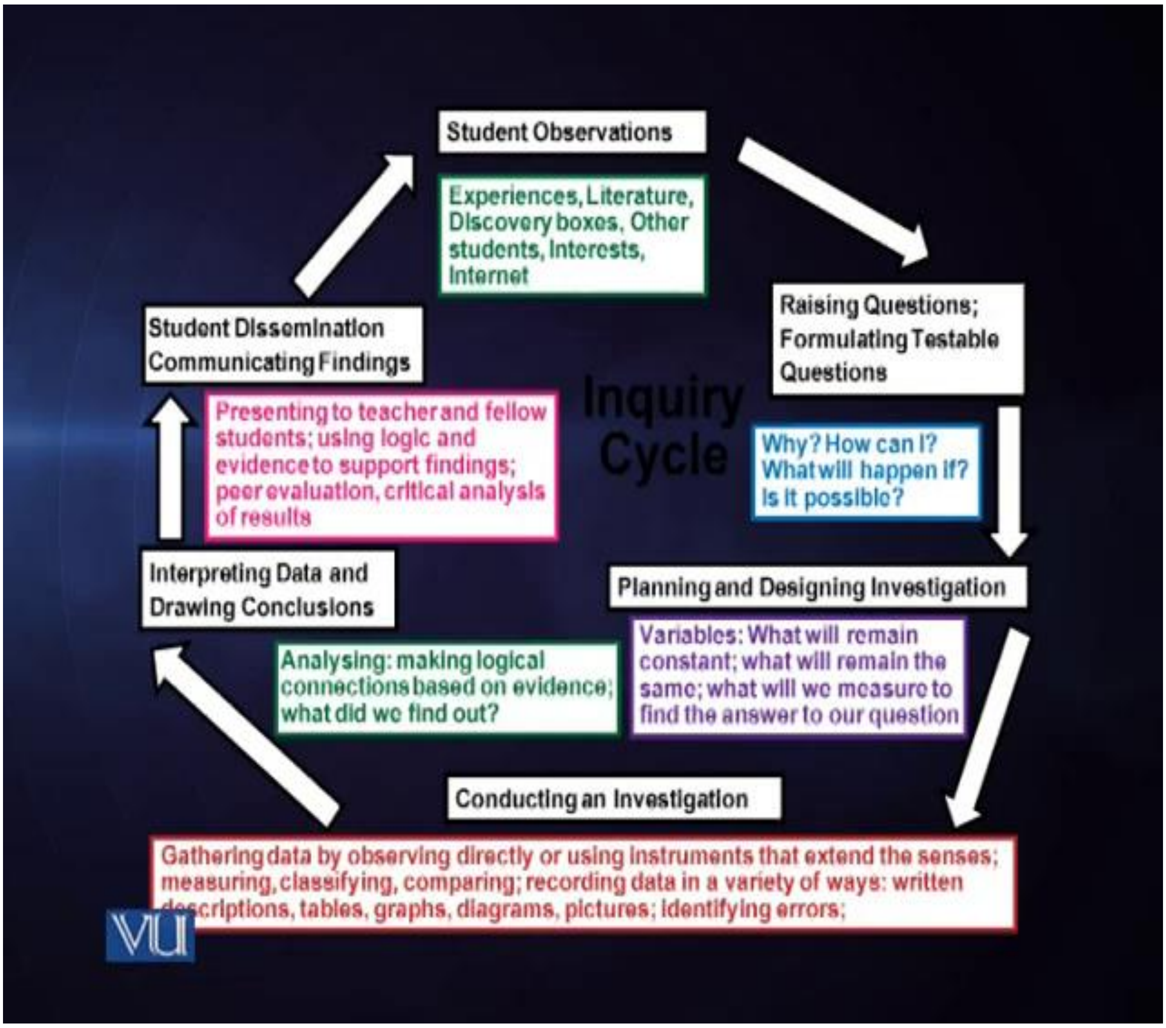
1. The economic argument: we need a supply of qualified scientists/technologists to develop the industrial processes/agricultural practices on which national prosperity depends.
2. The utilitarian argument everyone needs to understand some science to manage the technological objects and processes they encounter in everyday life making practical use of scientific knowledge involves and understanding for the grounds of confidence in that knowledge and in the sources of that knowledge and some skills in evaluating the information one receives and some understanding of scientific reasoning.
3. The democratic argument: in a democracy, it is desirable that as many as possible participate in decision making---- many important issues involve science and technology often there is consensus about the basis science related to the issue but there is dispute how lab findings relate to the complex and messy real world situation. Tied up with uncertainties about the reliability of some of the data available or the relevance of data in a new context; may extend to questioning the basic scientific understanding involved,.
4. The cultural argument: science is a major cultural achievement; everyone should be able to appreciate it. An appreciation of the elegant and powerful structure of ideas developed for understanding natural phenomena, the major figures and events in the history of science;
5. The moral argument: that the practice of science embodies norms and commitments which are of wider value.

Lecture No 2

Nature of Scientific practice/Skill

Scientific knowledge is acquired through a series of practices/abilities which together constitute scientific inquiry. These include:

- Conducting observations
- Raising questions and
- Developing tentative explanations or hypotheses of observed phenomena
- Making predictions based on the tentative explanation or hypotheses\planning and carrying out empirical investigations
- Collecting, interpreting, analyzing data and evaluating knowledge claims.
- Communicate findings to larger peer group for critical review



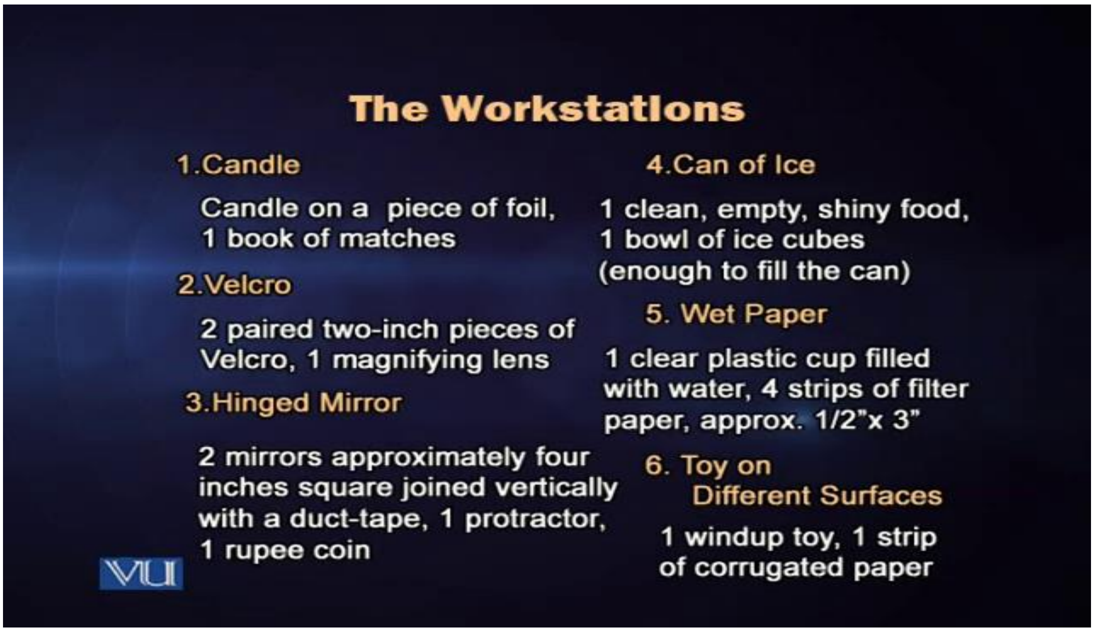
(Scientific inquiry diagram)

Exploring Process Skills

From the Professional Development Curriculum, Institute of Inquiry, Exploratorium, There are 7 process skills which we will identify through our experiments.

- **Observing**
- **Questioning**
- **Hypothesizing**
- **Predicting**
- **Planning and Investigating**
- **Interpreting and Analyzing data**
- **Communicating**

All above are the practical demonstrations of process. We will explore these with six steps study or our six types of experiments that are given below:



First the name of the experiment is listed, then there are instructions for conducting the experiment and at the end the process skills are identified in the findings.

1- **Candle:**

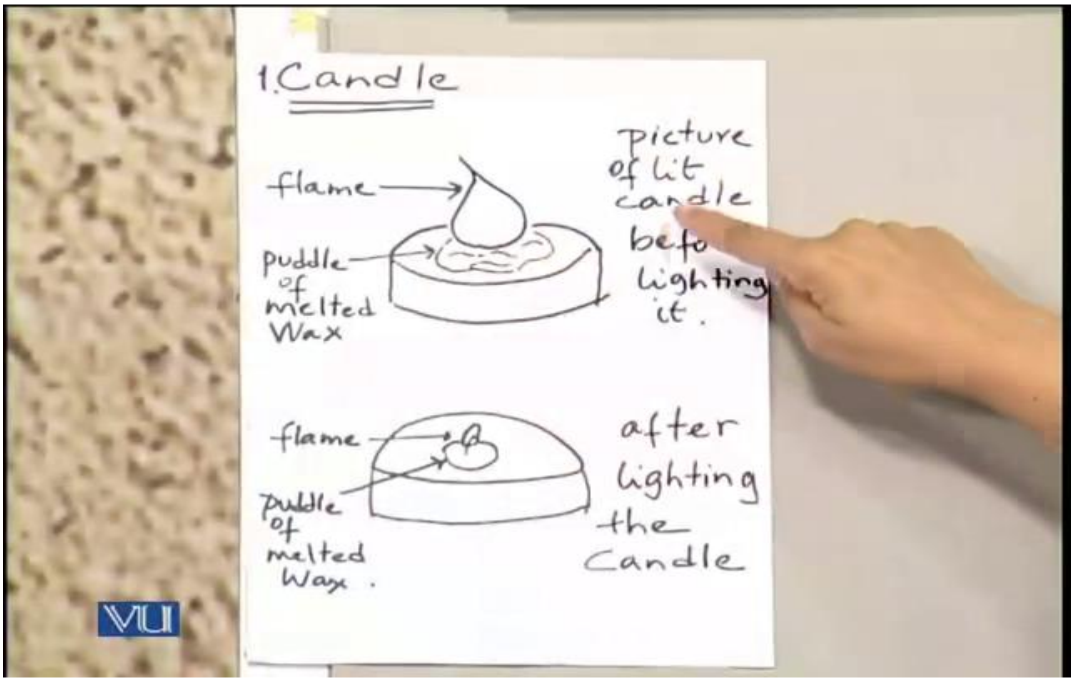
What process skill would you use to carry out the directions in the underlined sentences?

Draw what you think the candle will look like when it's lit. Put labels on your drawing.

Now light the candle.

Draw it again. What's different from your first drawing?

Are there any details in this drawing that were not labeled in the first drawing?



In this experiment we will use the **observation skill** as it is the test of the observation skill. Because we are sharing the information, we are also using **communication skill**. We are also forecasting the information before the experiment so predicting skill is also being used.
Below is the checklist, at the top the activities are mentioned and at the side column there are skills which we want to observe in the experiments.

The skills that were used in the candle experiment are checked in the Practice/Process Skills Identification form below:

Practice/Process Skills Identification

Practice /Process Skill	1. Candle	2. Velcro	3. Hinged A	Mirrors B	4. Can of Ice	5. Wet Paper	6. Toy/ Surfaces
Observing	✓						
Questioning							
Hypothesising							
Predicting	✓						
Planning and Investigating							
Interpreting							
Communicating	✓						

The skills used in the first experiment of candle are:

Observing:

Observing can be defined in many different ways like:

- To take notice;
- To make a comment or remark after looking;
- To watch carefully without participating actively.

Predicting:

A **prediction** or **forecast** is a statement about the way things will happen in the future, often but it is not always based on experience or knowledge.

Communicating:

Communicating means to have an interchange, as of ideas or to express oneself in such a way that one is readily and clearly understood.

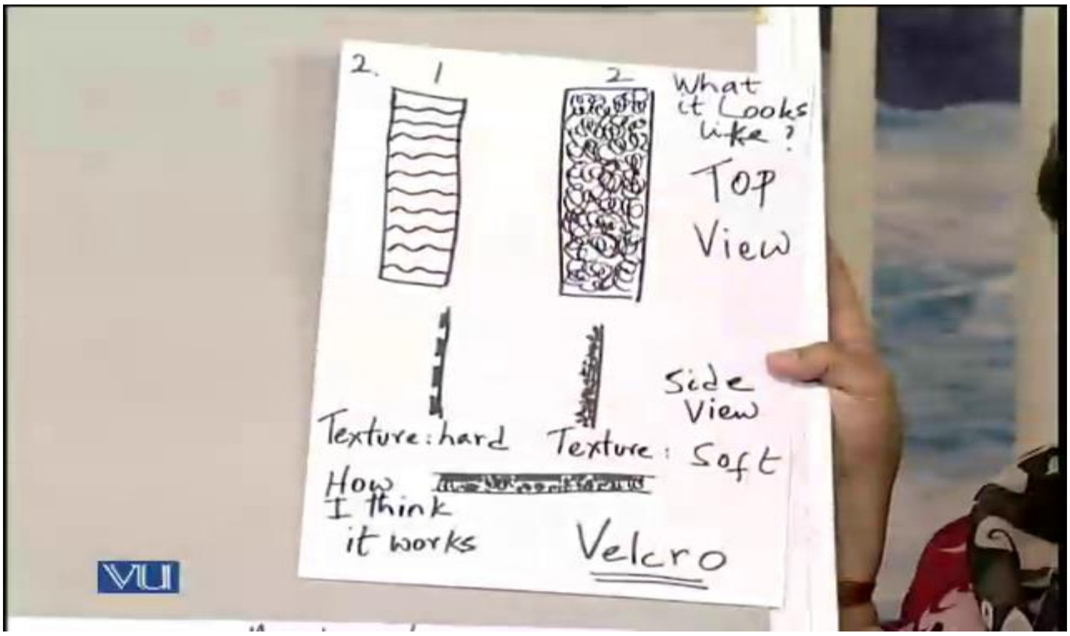
Now the second experiment is explained along with the skills used in the experiment.

1. **Velcro:**

Please mention the process skill that you would use to carry out the directions in the underlined sentences.
Put two piece of Velcro together.
Try to part them.
Try putting the pieces reversed, then crossways.

Make a series of drawings to show your ideas and findings about how Velcro works.

After doing the experiment it was found that both Velcro have different structures. This was also shown in the drawings. Communication skill was used in this experiment to share the findings. The Velcro pieces were observed by eyes and magnifying glasses. The drawings showed how Velcro works. We observed the phenomena of how Velcro works, so we made a hypotheses about its working.



The checklist of this experiment was:


Practice/Process Skills Identification

Practice /Process Skill	1. Candle	2. Velcro	3. Hinged Mirrors A	B	4. Can of Ice	5. Wet Paper	6. Toy/ Surfaces
Observing	✓	✓					
Questioning							
Hypothesising		✓					
Predicting	✓						
Planning and Investigating							
Interpreting							
Communicating	✓	✓					

The new skill introduced in the second experiment is hypotheses.

Hypotheses:

In very simple words we can say that a hypothesis (plural *hypotheses*) is a proposed **explanation** for a **phenomenon**.

2. **Hinged mirror:**
   Please write the process skills that you would use to answer the underlined questions.

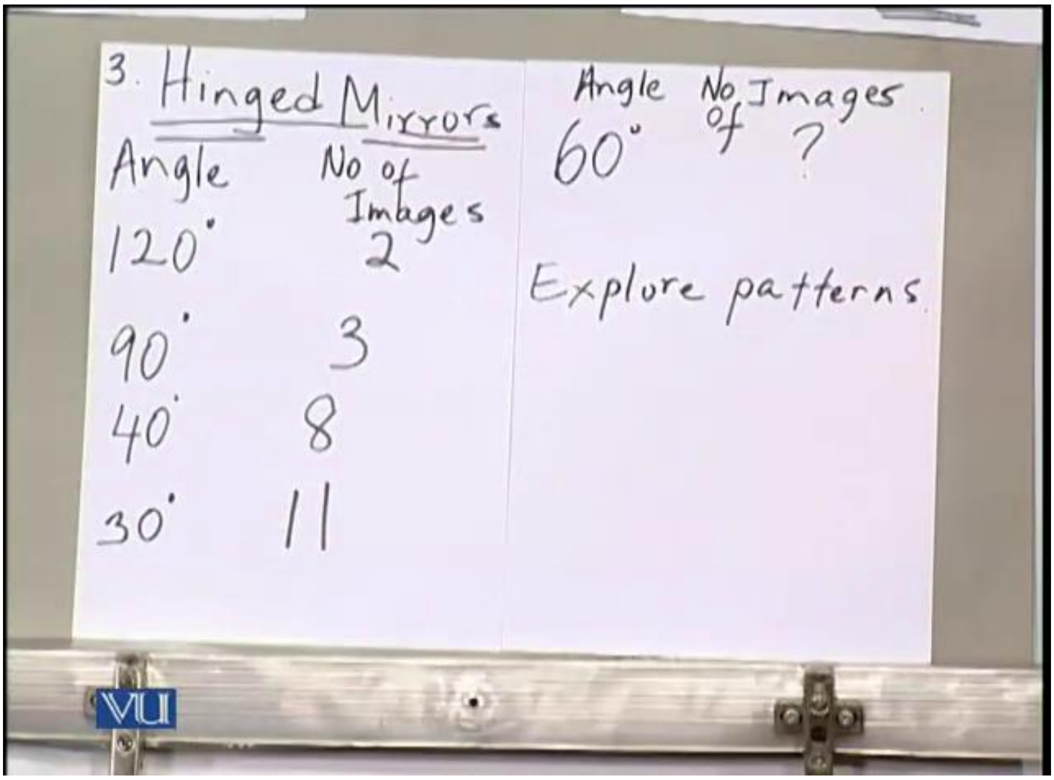
Activity:

Place a penny between the hinged mirrors so that the reflections of the coin can be seen. Adjust the angle to 120 degrees and count the reflections. Repeat for angles of 30 degrees and 40 degrees.

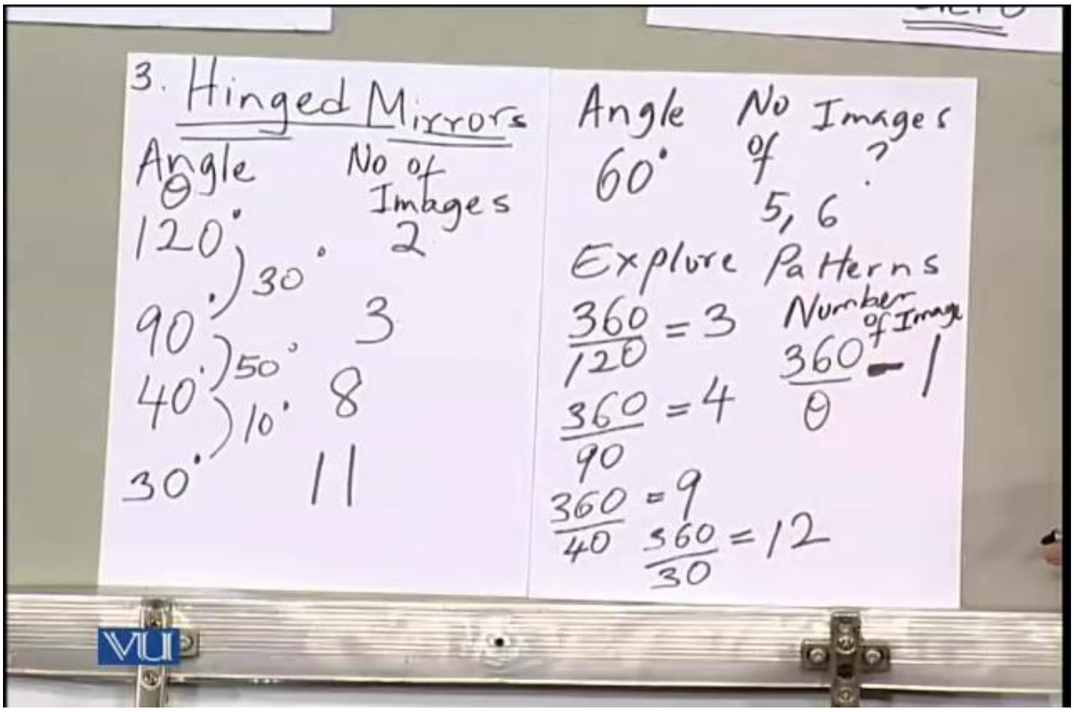
A: Can you identify a pattern in the relationship between images and angles? If so, what is it?

B: Based on the patterns you observed, how many images would you expect to get at 60 degrees?

After doing the experiment the images of coin were seen in the mirror. At the angle of 120 there were 2 images, at the angle of 40 there were 8 and at the angle of 30 there were 11 images.



We have to find out the number of images for 60 degrees. In the beginning, we can make an educated guess that because 60 comes in between 40 and 90 so the number of images may also be between 3 to 8. But the standard method is that in order to find the images we divide 360 degree with the angles and the answer will be subtracted from1. So the formula will be as shown below:



By using this formula we will get the answer of 5 images at 60 degrees. We can also prove this by doing the experiment.

<u>Interpreting</u>

Interpretation is the act of explaining, reframing, or showing your own understanding of something. A person who translates one language into another is called an interpreter because they are explaining what a person is saying to someone who doesn't understand.

Lecture No 3

<u>Process skills/Practices</u>

This lecture is the continuation of the lecture no 2.

Review of the practices we are exploring

- **Observing**
- **Questioning**
- **Hypothesizing**
- **Predicting**
- **Planning and investigating**
- **Interpreting and Analyzing Data**

- **Communicating:**

We have done the experiments on the candle, Velcro and hinged mirror in lecture no 2. In this lecture we will explore further practices through three more experiments. (see the experiments in video lecture for more understanding of the following skills).

Process skills

Definitions and Examples

1. **Observing:**

When observing, learners are:

- Using the senses and extending the senses by using tools or instruments as necessary.
- Distinguishing from many observations those which are relevant to the problem at hand.
- Identifying differences and similarities between objects and materials.

Definition

Using the senses and appropriate tools to gather information about an object, event or phenomena is called observing.

Subskills

Subskills include collecting evidence, identifying similarities and differences, classifying, measuring and identifying relevant observations.

Example

Listing the similarities and differences of a cube of ice and a ball of ice.

2. **Questioning:**

When questioning, learners are:

- Readily asking a variety of questions about phenomena
- Recognizing differences between questions that can and cannot be answered by investigation.

Definition

Raising questions about an object, event or phenomena is called questioning.

Sub-skills

Sub-skills include recognizing and asking investigable questions; suggesting how answers to questions can be found; and turning a non-investigable question into a question that can be acted upon.

3. **<u>Hypothesizing:</u>**

When hypothesizing, learners are:

- Attempting to give explanations which are consistent with evidence or with ideas from prior experiences

4. **<u>Predicting:</u>**

When predicting, learners are:

- Making use of evidence from experience or a possible explanation (hypothesis) in forecasting the outcome of a specific future event.
- Using patterns in information or observation in forecasting outcomes of specific events that go beyond the data.

Definition

Forecasting the outcome of a specific future event based on a pattern of evidence or hypothesis (an explanation). A prediction based on a hypothesis can be used in planning a test of that hypoyhesis.

Note: A prediction is not a wild guess.

Sub-skills

Subskills include justifying a prediction in terms of a pattern in the evidence, and making a prediction to test a hypothesis.

<u>Planning and investigating:</u>

When planning and investigating, learners are:

- For a fair test, identifying the variable that has to be changed, the things that should be kept the same and what to look for or measure to obtain a result in an investigation.
- Comparing what they actually did with what they planned

Definition

Designing an investigation that includes procedures to collect reliable data. Planning includes devising a way to test a hypotheses.

Note: planning is not always formal.

Sub-skills

Includes identifying and controlling variables and using measuring instruments.

Example

Deciding to put a teaspoon of salt on one ice cube and a teaspoon of sugar on another identical ice cube; setting them side by side and observing their relative melting rates in order to determine if one melts faster than the other.

(from the Professional Development Curriculum, Institute of Inquiry, Exploratorium)

5. **<u>Interpreting:</u>**

When interpreting, learners are:

- Discussing what they find in relation to their initial questions
- Identifying patterns or trends in their observations or measurements and noticing related changes

Definition

Considering evidence, evaluating and drawing a conclusion by assessing the data: in other words, answering the question, “ What do your findings tell you?” Finding a pattern or other meaning in a collection of data.

Sub-skills

Include interpreting data statistically, identifying human mistakes and experimental errors, evaluating a hypotheses based on the data and recommending further testing where necessary.

6. **Communicating:**

When communicating, learners are:

- Using drawings, writing, models and paintings to present their ideas and using tables, graphs and charts to record and organize results
- Choosing forms for recording or presenting results that are appropriate for the type of information collected and presented and appropriate for the audience.

Definition

Representing observations, ideas, theoretical models or conclusions by talking, writing, drawing, making physical models and so forth.

Sub-skills

Include talking with a more knowledgeable person, using secondary sources, presenting reports, constructing data tables and creating charts and graphs.

Example

Describing the relationship between the melting time of an ice cube and amount of salt sprinkled on the cube by writing about it or by constructing a graph.

(from the Professional Development Curriculum, Institute of Inquiry, Exploratorium)

Use of Process skills/Practices

- Process skills are not practiced discretely. Someone who is observing, for example, may be doing some predicting and hypothesizing and possibly even interpreting, virtually simultaneously. Pulling the skills apart and distinguishing them from one another can prove tricky.
- In actual practice, what we call process skills are not individual skills but combinations or blends of several skills. But, as teachers, we need to address the skills

separately so that we can identify where students are in their development of each skill in order to focus on helping them strengthen particular skills.
(from the Professional Development Curriculum, Institute of Inquiry, Exploratorium)

- Students use process skills to build a conceptual understanding of science content.
- Students of all ages use all of the process skills. Each skill can be practiced at simple and increasingly complex levels.

Lecture No 4

Review of Pedagogical Content Knowledge

What is pedagogical content knowledge?

- An in depth understanding of the content of the discipline they are teaching i.e. ideas and concepts, skills and practices associated with that discipline.
- An understanding of how students learn that subject, what is hard and what is easy for them and what examples, processes and activities will help them to learn i.e. appropriate pedagogy adapted to the different development levels and interests of learners.
- Teachers need to learn about the conceptual ideas that students have in the earliest grades and their ideas about science itself.

Building upon prior knowledge is a very important part of teaching and learning.

Prior knowledge and learning

Prior knowledge affects how the learner perceives new information. There is widespread agreement that prior knowledge influences learning, and that learners construct concepts from prior knowledge(Resnick, 1983; Glaserfeld, 1984).

Prior knowledge affects how a student organizes new information. The goal of learning is to incorporate new information into the existing organization of schema. A student uses that existing structure to assimilate new information.

Importance of Children's Prior ideas

This lecture represents the role of prior knowledge in learning. The prior knowledge of students affects their learning therefore educators must keep this in mind when they design a lesson.

Teachers need to be aware of children's prior or existing ideas, of the learning goals and the nature of the difference between the two when they are planning and teaching so that they can take appropriate steps to bridge the gap. Children develop ideas, based on their everyday experiences, about natural phenomena before they are taught Science in school.

Some of these ideas of students are in agreement with scientific views and can act as resources for developing a more extensive and solid understanding of science concepts and their ability to engage in scientific investigations e.g. characteristics of familiar animals and learning about classification of animals into mammals, birds, fish, reptiles etc. But sometimes children's intuitive understandings contradict scientific explanations and these can pose as an obstacle to science learning. For example ideas about forces and motion.

Different forms of conceptual change

Conceptual change is a process of transition from ordinary ways of perceiving, directing attention, conceptualizing, reasoning, and justifying. Slowly learners transform prior knowledge to accommodate new scientific ideas (Posner, Strike, Hewson, & Gertzog, 1982).

Concepts that are relatively easy to understand

- These concepts are consistent with students' initial understanding of this concept.

For example the concept of friction is easier for the students to understand as they experience it own life. They throw the ball it stops at a certain point and they slip on a wet floor because of the laws of friction.

Concepts that are difficult to understand.

- These concepts call for fundamental revisions to children's initial structure.

For example, the students do not see a book resting on a table as involving balanced forces (i.e. the force of the book on the table is equal and opposite to the force of the table on the book) instead, they think that only the book is pressing on the table, or that it is pressing down more than the table pressing up hence, the book stays down. In fact they often do not think of a table as the sort of thing that can apply a force and it is conceptualized as a passive resistance or support.

Teachers and curriculum developers should be aware of these different levels of difficulty and appropriately modify their methods of teaching when confronting different types of cases.

Pedagogical approaches to Restructuring Existing Ideas

Traditional science instruction and simple discovery learning alone have failed to bring about a fundamental change in children's ideas and reasoning. Making these changes is facilitated when students reflect about or learning and dissect/valuate their experiences.

Some ways of encouraging students to reflect/examine their beliefs

- Teaching of scientific concepts and ideas in the context of an organizing theme or bigger picture. Making children aware that all the components/small pieces of scientific knowledge will be pieced together to understand/explain the unifying scientific concept or phenomena.
- Investigating and gathering data that expose students to discrepant events i.e. irregularities or disagreements in data; sharing of ideas to resolve the discrepancy – there can be many reasons for the anomalous data: a fluke result, poor data collection technique, a faulty hypothesis.
- Lots of opportunities to strengthen their understanding of new ideas through extended application and collective reflection. A reflective component to learning not only speeds up the time it takes to learn, but also makes it possible to learn things that one might never figure out through trial and error.

Lecture No 5

Approaches to Teaching Science

Some important points for teachers to consider are:

1. Teachers must assess students' prior learning before starting the lecture. Instruction must be based on what children already know.
2. Teacher must understand that science is not a collection of knowledge but it seeks to explain how the world works. Therefore the teaching approach of teachers must change also.
3. Teachers must use the textbook in the context of inquiry. Textbook is not the only information to be given to students, it be linked with inquiry.
4. Teacher should not be only person explaining correct answers; we must give the opportunity to the students for collective brainstorming and discussions.
5. Teachers must help students to construct the ideas themselves. Teacher's role is that of a facilitator or a guide who helps the students to arrive at the right answer themselves.
6. Teachers must use different technologies meaningfully. We must train our students as well as our teachers in order to keep pace with the world. For example, teachers should learn to use internet for research. There are a lot of scientific simulations on internet and these will be helpful for the students as well as the teachers.

Guided inquiry

In the guided inquiry the teacher's role is that of a facilitator. So instead of telling the answers to students the teacher helps the students to find the right answer by giving scaffolds or clues to students.

Traditional vs. Inquiry Approach

Learning progression describes what children know and learn about a topic/strand as they move from one grade to another. It focuses on concept building as concepts become more difficult in higher grades. Learning progression is basedon benchmarks for that particular topic.

The benchmarks can be taught to the students through traditional teaching approach or through inquiry based approach. A comparison of the traditional and inquiry based practices for teaching of science is listed below:

1) In the traditional approach content is taught before doing any activity hence activities confirm the content. But in inquiry based curricula, activity leads to the content or to the discovery of content.
2) In the traditional approach information is given to students when they are taught content but in inquiry based approach the focus is on building concepts of students.
3) In the traditional classroom students do not have any role in planning the lesson or activity but in the inquiry classroom students are involved in the lessons.

4) Traditional approach is teacher directed but in inquiry approach students are involved in activities and directions are given by the teacher.
5) The focus of the traditional approach is on obtaining the right answers and inquiry approach focuses on the process of learning that students undergo during the investigative process.

Teaching To Support Practices of Science

Teachers need to develop the following skills in students when teaching Science:

a) Helping Children Observe

Teachers help children to explore their prior knowledge and the concepts that underlie the observation activity. In this process material should be selected carefully so that children are clearly able to see the salient features, similarities and differences and put events in a proper sequence. Teachers must also give time to the students to observe. Children should observe in small groups (2 to 4 children) so that they can share their ideas.

The role of the teacher as a facilitator is that he/she must ask such questions that focus the attention of the students towards the salient features under observation. Teachers must also help the students to ask questions.

b) Helping Children to Ask Questions

Teachers must practice and improve their questioning style so that it provides a model for children to emulate. To develop this skill engage with your immediate environment --- home and school and start raising question; identify which questions are testable and which are not; try converting questions into testable questions; look for samples on the internet etc. Teacher must choose material for interaction in class that will stimulate children's curiosity.

Teacher should encourage children to form and discuss their own questions. This can be done by putting up a "question board" in the classroom on which children should record their questions and it should be examined every week.

c) Helping Children To Hypothesize

Before children can hypothesize or give a tentative explanation, they should be provided with many opportunities to deepen their observational skills and conduct investigations.

d) Helping Children To Plan and Conduct Investigations

Children should be asked to dissect/deconstruct investigations that have been designed for them and then later plan investigations themselves. During the experiment children should use a variety of practices like managing material, observing including measuring, recording data, keeping track of difficulties etc.

Organize children in small groups and ask them to develop plans for a fair test. Children should share their plans collectively so that they can be fine tuned through discussion with their peers. After the experiment when collective sharing of findings takes place it is essential to compare the plan and the actual experiment to identify sources of error and other stumbling blocks. Teachers should also discuss ways of modifying and improving the experiment to get more reliable results.

e) Helping Children to Interpret and Analyze

After an observation or investigation a collective discourse or brainstorming session is essential for the learning process to take place. Children share and interpret their findings. The teacher has to be a skillful facilitator. If students were working in groups then a representative from each group (ideally chosen by the children) will share their findings.

Typically there is variation in the data that different groups share. If the differences are glaring then ask different groups how they conducted their observations, encourage children to explore reasons for discrepancies. This will help them to developa deeper understanding of the topic being investigated as they resolve these differences. Teachers should create an atmosphere where children can freely express themselves.

f) Helping Children to Communicate

Teachers should encourage the students to speak. They can repeat what students say and rephrase it if needed so that it is more coherent by using appropriate vocabulary. Then students will be asked them if the teacher has represented their ideas correctly.

Feedback on their written work is essential as well as on their diagrams and pictures. Draw their attention to the salient features that they have not considered and suggest them to examine it as well. Encourage them to label their drawings.

Lecture No 6

Properties of Objects

In this lecture we will develop a sequence of learning for science content associated with the structure of matter strand for grade level 2.

Teacher will ask the questions to the students to know their understanding about object and material.

Properties of object and material

1. Objects are made of specific material.
2. There is a lot of variety of material.
3. The same kind of object can be made of different materials.
4. Students must know the basic properties of object and materials.

5. Materials can be changed.

Children prior knowledge

To know the children prior knowledge about materials, we have designed the assessment procedure. It includes four inquires. Teachers asked the questions about papers, drinking utensils, measuring length or volume in these four inquiries.

Perceptions of children about matter

Children tend to think that any rigid material as a solid and any non-rigid material such as plastic or cloth as in between a solid and liquid. They think that the powders are closer to liquids. Grinding a solid into powder may result in loss of mass or weight. Or melting and dissolving are the same.

Learning Goals

We want children to learn not only the content but scientific skills also. Children will learn about the world through raising questions and seeking answers by making careful observations. They can acquire it through measurements. They could know the facts by interpreting the data and communicating or sharing with others.

According to this background we will make a teaching strand of ten lessons for Grade level 2.

Sequence of Learning Template

Phase A: Assessing prior knowledge

Phase B: Developing a background

Phase C, D, E etc.: Main content of the unit/topic

Final phase: Applying their skills and knowledge

According to this template we will make our sequence of learning. Our topic is "Exploring the properties of solids and liquids".

Phase A is related to assess the prior knowledge of children.

It includes the understanding and identifying some common properties about materials and objects. In this phase children learn to describe commonly available objects and materials.

They develop an operational understanding of property by identifying common properties such as color, shape, size, texture and weight. First phase is divided into 6 periods.

Phase B is about to know the understanding and exploration.

Phase b is exploring solids and liquids. For example in this phase children compare the characteristics of a wooden block and water and construct beginning understandings of the characteristics of solids and liquids. They also work with a variety of liquids for understanding their properties. We also develop the skill of classification in this phase.

Phase C is about to know the skills.

Third phase is consists of the changes such as dissolving and solidifying. They also extend their properties word bank and further hone their observational skills.

We will observe this phase through the example of jelly. Making Jelly , investigating physical changes and conducting fair tests.

Working in groups they prepare jelly. Encounter mixtures and dissolving. They document all the steps in writing and through drawings.

The set jelly is observed (including tasting). The word dissolving and solidifying are added to the children's word bank.

Phase D is related with applying the skills or with practical explanations.

In this phase children will learn to apply their skills.

The students apply two inquiry activities:

1) Describing a solid and a liquid by listing their properties
2) Investigating two mixtures- solids with water, Predicting, testing their predications and making drawings of their mixtures.

Now we breakdown sequence of learning into lessons

Phase A that is related to the prior knowledge consists of the following lessons.

Lesson 1: Students will describe the properties such as exploring color, shape, pattern, size texture.

Lesson 2: Another property that is weight and measuring weight with a pan balance is described by the students.

Lesson 3:students will describe the Light related properties.

Phase B that is related with exploration will have the lessons:

Lesson 4: Exploring the difference between solid liquid and gases

Lesson 5: Describing and classifying liquids

Phase C that is related with skills would have the lessons:

Lesson 6: Making Jelly I: Eliciting prior knowledge and observing jelly crystals

Lesson 7: Making Jelly II: Mixing Jelly crystals with hot water, allowing jelly to set in the fridge- observing/ recording the steps

Lesson 8: Making Jelly III: Observing and eating jelly

Lesson 9: Exploring fair test by looking at the effect of temperature and grain size ion dissolving

Phase D that is related to the application of the skills will have the lesson:

Lesson 10: Applying their skills and knowledge- assessment

Total number of lessons =10

Each lesson comprises of 2 periods

Each period of 40 minutes duration

Time needed for conducting activities/ investigations, observing, recording, making meaning and applying learnt skills and knowledge in new situations.

Lesson Plan template

1) **Over view:**
2) **Learning Objectives:**
   a) Concepts
   b) Skills/Practices

c) Attitudes

3) **Background:**

Evaluate yourself and improve you skills before you enter the classroom

You must have sufficient knowledge about the content of lecture.

4) **Children's ideas:**

Discuss the topics with children and try to explore their idea about different topics of lecture.

Also try to teach the concepts at the students' level of learning.

5) **Materials:**

It is the major component of lesson planning. As you have to provide it to students for learning purpose. The materials should be easily available and cheap in price. The material should be available:

a) For each child

b) For each group

c) For entire class

6) **Preparation**

7) **Procedure /Methodology**

8) **Home work**

9) **Assessment**

Lecture No 7

What are properties? Describing some Common properties of Materials and Objects

Overview of lecture:

- Children develop an operational understanding of property by identifying common properties such as color, shape, size and texture and recording them in properties word bank. Children draw pictures and label the salient features.
- Operational understanding means to understand a phenomena through practice and activity.

Learning objectives

- Concept
- Skills/abilities
- Attitudes

Concepts:

Students understand

- That a property is a characteristic used to describe an object
- Some properties used to describe objects are color, shape, size and texture.
- Some properties describe the material the object is made of such as color and texture and some properties describe the object as a whole such as shape and size.

Skills/Abilities:

Students are able to

- Observe objects using their senses particularly seeing and feeling
- Identify common properties such as color, shape, size and texture
- Understand and use appropriate words to describe properties of objects
- Record properties of an object in table

- Draw objects that correctly portray some of the features being describe participate in a collective discussion, share ideas, listen to others, agree and disagree
- Make connection with their immediate environment

Attitudes:

- Develop an interest in and enthusiasm for exploring and investigating properties of materials and objects.
- Learn to work in a team, sharing materials, interacting and discussing

Materials:

Materials that are used in the lesson:

For each student

An observation sheet to record the properties and drawing of an object

For a group of four students

A tray containing 7 items: a can, a scouring or cleaning pad, a marble, some cotton wool, a button, an eraser and a small magnet

For the entire class

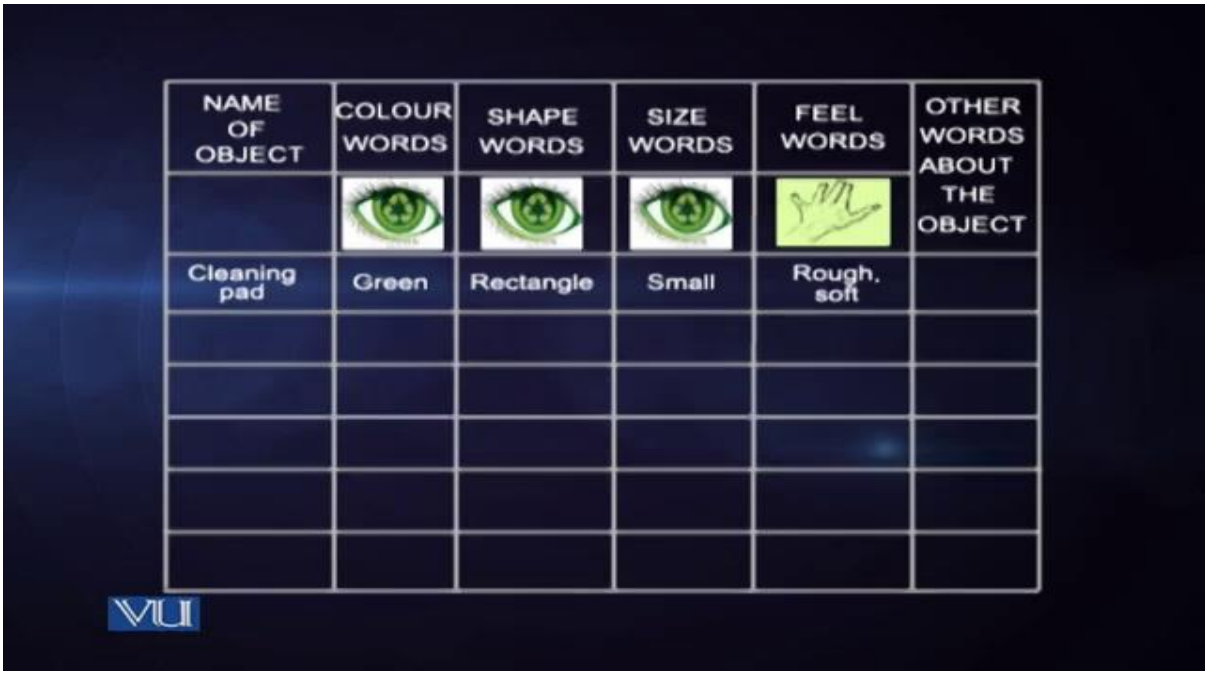
1 chat with pictures of shapes and colors

Second chart will be the property bank chart

Activity:

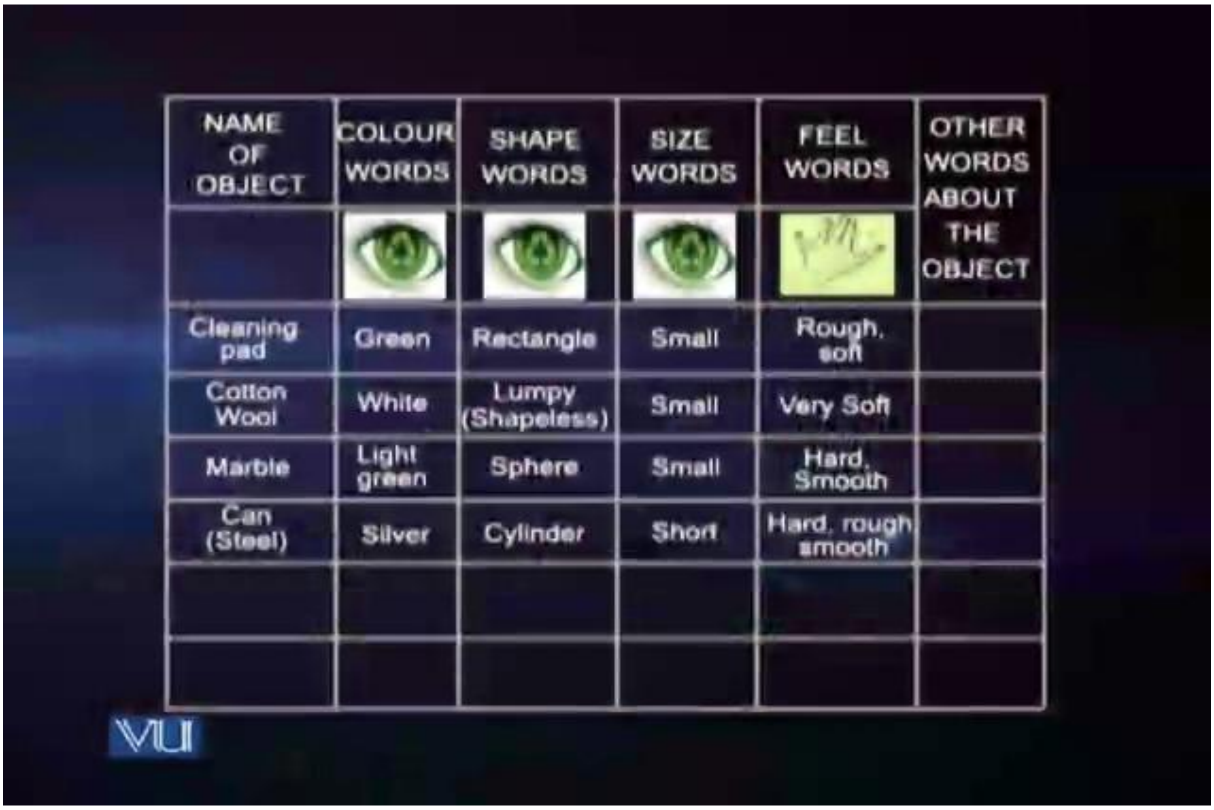
Teacher started the lecture with an activity by introducing the word **Property** to the class. Teacher explained this word by the example of ruler. She asked the students that what is this? Somebody said that it is made of steel. Another student said that its color is silver. Someone said that it has numbers on it. At the end teacher concluded that all these are the properties of ruler. Through property we can identify something. Color, material etc. are all the examples of properties. A student also mentioned that property is something which we own. To avoid the confusion teacher must clarify that property can be the quality of something and can also be something which we own.

Teacher showed the chart of shapes to the students. Teacher gave the tray to the students with different objects and told them to look, observe and feel the objects. Teacher encouraged them to discuss these with their friends. She also introduced the property chart to the students. After giving them some time teacher started asking about the objects. A student said that cleaning pad is soft as we can fold it. It is also rough when we touch it with our hand. This was the collective brainstorming session. Teacher entered this information in the table.



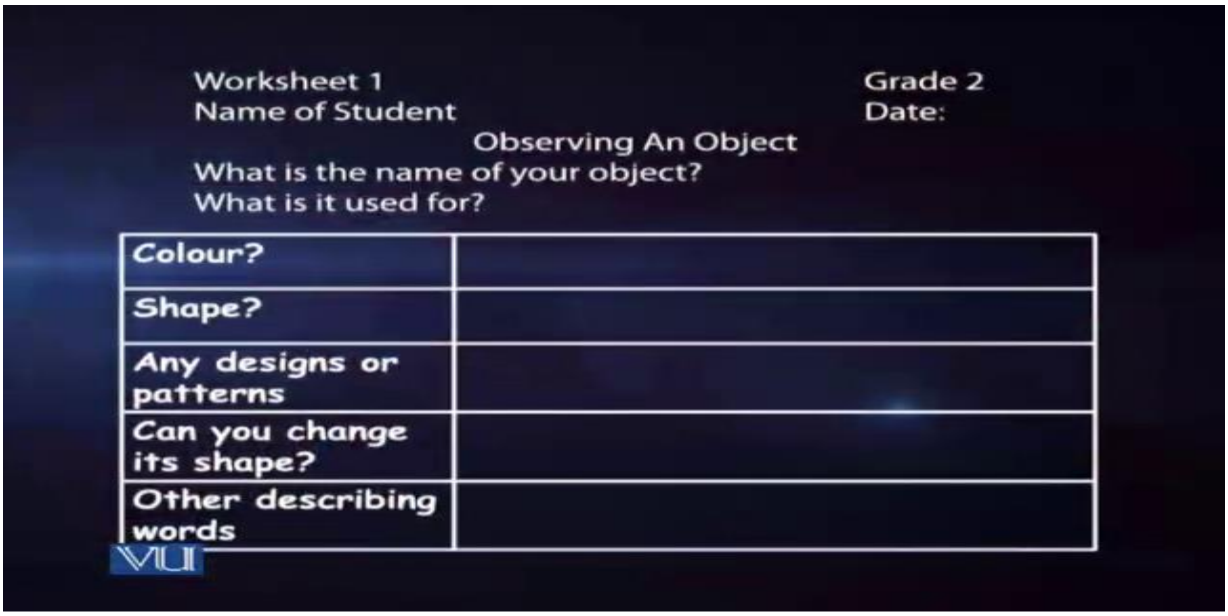
NAME OF OBJECT	COLOUR WORDS	SHAPE WORDS	SIZE WORDS	FEEL WORDS	OTHER WORDS ABOUT THE OBJECT
Cleaning pad	Green	Rectangle	Small	Rough, soft	

Teacher asked about cotton. Students shared their ideas that its color is white, it is cotton wool, it is softer than the cleaning pad. And it is also shapeless. A student said that cotton is smooth. Teacher respond that if we feel it, it has lumpy texture so it can not be smooth. Teacher made this clear with the example of table that this is a smooth surface. Teacher entered all this information about cotton wool in the table. Same method is repeated with all the objects in the tray and all information in the table. Below is the table with information:



NAME OF OBJECT	COLOUR WORDS	SHAPE WORDS	SIZE WORDS	FEEL WORDS	OTHER WORDS ABOUT THE OBJECT
Cleaning pad	Green	Rectangle	Small	Rough, soft	
Cotton Wool	White	Lumpy (Shapeless)	Small	Very Soft	
Marble	Light green	Sphere	Small	Hard, Smooth	
Can (Steel)	Silver	Cylinder	Short	Hard, rough smooth	

At the end teacher compare all her objects with the things around the students in the class and also with her chart of shapes. After student' s observation teacher gave them worksheet to analyze their individual understanding.



Worksheet 1 Grade 2

Name of Student Date:

Observing An Object

What is the name of your object?

What is it used for?

Colour?	
Shape?	
Any designs or patterns	
Can you change its shape?	
Other describing words	

Lecture No 8

Exploring the property of "Weight"

Overview

- Children will explore the property weight as a measure of how heavy or light objects are.
- Children will learn to use a pan balance to measure the weight of some common objects using 3 types of wooden blocks as weight measures and record their measurements in a table.
- At the end children will share and evaluate their findings.

Learning objectives

Learning objectives are divided into three categories:

1) Concepts
2) Skill/Abilities
3) Attitudes

In the concepts students will understand that weight is a property of an object which is a measure of how heavy or light an object is. Students will also understand the fact that weight can be measured and compared. Moreover they will learn that weight depends on the size of the object and the material of which it is made of.

Students will learn the skills to use a pan balance and non standard weights to measure the weights of common objects. Students will record the data in a table and share their evaluations in a collective discussion.

In attitudes, students will learn to work in a team, sharing materials, interacting and discussing.

Materials for experiments:

Material that are needed to do experiments with the students.

For each student an observation sheet to record the weight of 6 objects.

For a group of four students.

A tray containing 6 items, a can, a board marker, a marble, some cotton wool, a roll of clay.A pan balance with a set of non standard weights which can be blocks or marbles or paper clips etc.

Students did different experiments with all above objects under the supervision of the teacher. They experienced to balance two pans by putting different objects in them. And they wrote their observations or findings in a table. Teacher started her experimentation. She used a toy instrument with two plastic pans hanging with a thread. Teacher started putting some blocks in the pans. She had three colors (red, green, blue) blocks with different sizes. She started putting the blocks in the pans and made the both pans balanced.

In conclusion to her experiments she examined that one red block was equal to two green blocks and five blue blocks. Then she measured the can with the blocks. One can was equal to two red blocks and one green block. Teacher would make a data sheet along with her experiments. Teacher gave a lot of time to the students to be familiar with the new objects and properties. Teacher started her activities with the grade level two. She involved the whole class to the activity. She taught them how to balance the objects.

When the teacher elaborated the whole concept, he or she allowed the students to do activities themselves. Students worked in cooperation and shared their ideas with each other as well as with the teacher.

Teacher provided the worksheets to every group of students to collect the data. She asked the questions to the students about balancing randomly. Students wrote their data in their data sheets and at the end of the lesson teacher commented on the collective data. Teacher did not criticize the students directly because she wanted them to self learn through activity. Evaluate the data is a critical skill and an important scientific practice and also the necessary portion of the lesson.

Lecture No 9

Types of Solids

In this lesson children explored that materials are of three types.

Transparent

Materials are transparent if everything can be seen through them clearly.

Translucent

Materials are translucent if blurred or vague outlines can be discerned or the color of things when viewed through such materials is changed.

Opaque

Materials are opaque if nothing can be seen through them.

Learning objectives

a. In this lesson students observed the objects primarily using their sense of sight.
b. Students categorized materials as opaque, translucent or transparent.
c. Students participated in a collective discussion, share ideas, listen to others, agree and disagree.
d. Students recorded their findings in a table.
e. Students developed an interest and enthusiasm for exploring and investigating properties of materials and objects.
f. Students learned to work in a team, sharing materials, interacting and discussing.

The teacher introduced opaque, transparent and translucent objects to the students. Each student was given an observation sheet to categorize objects as opaque, translucent or transparent. A group of four students was given a tray containing the following items: a red lid, a plastic spoon, small plastic jar, and a plastic cup. Teacher prepared three charts with the headings of opaque, translucent and transparent.

First teacher explained the word property and students were asked about the properties of different objects. Teacher wrote the information on the charts. Color, shapes and structure of objects were written down. Then teacher told the students that they have to classify all objects into three categories. She told the definition of transparent objects and put all transparent objects on the chart. Things through which we cannot see are opaque. For example the lid of a jar, teacher put the lid on the chart labeled for opaque objects. Things which have the blur images are called translucent. Objects were than classified into three categories and were placed on the respective chart papers.

Lecture No 10

Exploring Solids, Liquids and Gases

In this lesson we focused on the properties of solids, liquids and gases.

Overview of the lecture

- Children compared the characteristics of solid and liquids to develop beginning understandings of the properties of solids and liquids.
- Students inflated and deflated balloons and inferred the properties of gases.
- Students identified solids, liquids and gases they encountered in their lives.

Learning objectives

Concepts:

Students understood that a solid had a distinct shape which did not change when it was placed in different containers; solids were dry and many solids were hard i.e. their shape did not change easily when they were pressed. They learnt that a liquid had no distinct shape of its own but took the shape of the container it was in; liquids flew and could be poured; liquids were wet. Gases like liquids did not have a shape of their own and took the shape of a container they were in; they usually could not be seen, but could be felt; some gases had a distinct smell; gases could flow or could be blown.

Skills:

Students observed objects/materials using their senses particularly seeing, feeling and in some cases smelling. Students could easily identify observable properties of solids, liquids and gases. They learnt to use appropriate words to describe properties of solids, liquids and gases. Students participated in a collective discussion, shared ideas, listened to others, agreed and disagreed. Students identified liquids and gases found in their immediate environment.

Attitudes:

Students developed an interest in and enthusiasm for exploring the world around them. They developed a beginning appreciation for the importance of social interactions in science.

Materials that were used for the experiments:

For each student teacher used a science journal or notebook and a balloon.

For a group of four students, teacher used a tray containing the following items; a wooden block, a transparent plastic glass containing water, an empty transparent plastic cup or bowl. For the entire class, the teacher prepared three charts with the headings of solids, liquids and gases. There were balloons for each student.

Teacher started her experiments by asking about the block's color and shape. She also reviewed the properties of materials to see if the material was opaque, transparent or translucent. For the solids identification she asked about the properties of blocks and marker and wrote the properties in the chart of solids. She taught them that solids do not change their shapes even if we put them in the water. Students observed their surrounding and identified the solids around them. For example they told the teacher that the table, cupboard, map, door and fan in their classroom are all solids.

Than teacher gave two different cups to the students with different shapes and size, then she put some water into one cup. She told the students to carefully observe the shape of water. Then she told them to pour that water into another cup with a different shape. Now the students observed that water changed its shape according to the shape and size of the cup. The teacher differentiated between solids and liquids as solids do not change its shape while liquids change their shape according to the shape and size of the object in which it is poured. She also told them that liquids flow while solids do not. Students gave the examples of water, juice and milk as liquids.

Then teacher told the students to blow the balloons and constantly observe its shape. All the students blew the balloons and then they felt the air coming from the balloon when they spared it. Now the teacher told them the properties of gases. She told them that we cannot see the gases but we can feel them. Gases also take the shape of the objects in which it is poured. We can also smell the gases.

In this way through different experiments the teacher told the students about the properties of three states of matter.

Lecture No 11

Exploring Liquids

Overview of the lesson

- Children worked with a variety of liquids, identified their proprieties and learnt to classify them.
- Children began to develop classification schemes of their own.

Learning objectives

Concepts:

Students understood that all liquids share some properties; they took the shape of the container, they flew and they were wet.

Students understand that there is a diversity of liquids--- thick and thin, flowing slowly or rapidly, transparent, translucent or opaque, having different colors and textures.

Students understood that things/materials could be grouped into classes using some property they shared in common.

Skills/Abilities:

Students were able to deepen and extend their observation skills to include classification. They learnt to classify liquids at different levels (from simple to complex).

1. For example simple step of classification was matching liquids using a known property or matching liquids using a secret property.
2. The example of complex step was to classifying the liquids into two and three groups.

Students developed the skill to interpret their observations/findings and identified the similarities and differences of a pair of liquids.

They participated in a collective discussion, shared ideas, listened to others, agreed and disagreed and constructed new understandings.

Attitudes:

Students learnt to work in a team, especially allocation of roles e.g. a writer or recorder of data, sharing and asking for ideas; discussing and critiquing in a positive way. They also developed a beginning appreciation for the importance of social interactions in science especially those involving connecting claims with evidence.

Materials used for class activity:

For group of four students a piece of news print or half a chart paper for recording similarities and differences of a pair of liquids. A pair of liquids in clear plastic bottles. For the entire class 28 to 32 clear plastic bottles/jars (200ml) containing a variety of liquids. 3 chart papers/old newspapers.

Class activity:

Teacher started introducing the concept of classification to the students. Teacher took 2 charts with the named group 1 and group 2. She told the students that according to some property we classify the liquids. Teacher had about 30 bottles with different liquids. She called students one by one and asked them to choose the liquids for grouping. Students came one by one and classify all the liquids into groups according to a secret property. Then she asked about the secret property to the students, what it should be? Different students had different opinions, yet one student answered that in group 1, bottles were half filled and in group 2, bottles were full filled.

In the second step she told the students to think themselves about some property. They suggest thick and thin. Then the students classified the liquids according to the property of thick and thin. She did another activity with the property of transparent, translucent and opaque. She prepared three charts with all three properties and classified all the liquids according to these categories.

Lecture No 12

Assessment

What is Assessment?

Assessment is the process of gathering and discussing information from multiple and diverse sources in order to develop a deep understanding of what students know, understand, and can do with their knowledge as a result of their educational experience the process culminates when assessment results are used to improve subsequent learning.

Characteristics of assessment

1. Assessment does not take place only after learning. Assessment can be done at any time during instruction (at beginning, at during as well as at the end).
2. To find out the learner's ideas at the start of a topic is also a part of assessment.
3. Written responses or answers are not necessary for assessment to take place. Assessments can be based on observations, conversations and on other information such as drawings.
4. Assessment involves gathering information, making a judgment about it and using that information. What we do with that information will determine the purpose of that assessment.

Types of assessment

We focus on the type of assessment when we examine children's learning goals during instruction and ask ourselves, are we attaining our learning goals? If that is not happening what should we do to achieve those learning goals (that are children's deep understanding of content and skills).

The type of assessment we usually focus on in our schools, is testing the students to assign grades and evaluate them for promotion. Even the grades of monthly tests count towards the annual grades. We do not use the information from such an assessment to examine changing the teaching approaches to deepen children's understanding.

There are two types of assessment:

1. Summative assessment

Summative assessment takes place after the learning has been completed and provides information and feedback that sums up the teaching and learning process. Typically, no more formal learning is taking place at this stage, other than incidental learning which might take place through the completion of projects and assignments.

Examples of summative assessment:

- Examinations (major, high-stakes exams)
- Final examination (a truly summative assessment)

- Performances
- Student evaluation of the course (teaching effectiveness)
- Instructor self-evaluation

2. **Formative assessment**

Formative assessment provides feedback and information during the instructional process, while learning is taking place, and while learning is occurring. Formative assessment measures student progress but it can also asses our own progress as an instructor.

Examples of formative assessment

- Observations during in-class activities; of students non-verbal feedback during lecture
- Homework exercises as review for exams and class discussions)
- Reflections journals that are reviewed periodically during the Semester
- Question and answer sessions, both formal—planned and informal—spontaneous
- Conferences between the instructor and student at various points in the semester
- In-class activities where students informally present their results
- Student feedback collected by periodically answering specific question about the instruction and their self-evaluation of performance and progress

Formative assessment and inquiry

Different stages of inquiry that can be an entry point to assess the student learning are:

- Observing- interacting with the material
- Talking to each other
- Raising questions
- Sharing or communicating the findings

Each of the above stages of inquiry is an entry point for the teacher to carry out assessment that will provide information on how students understand science concepts, and on how effectively they are using the skills of science.

The teacher can then use this information to determine what next steps students need to take in order to increase their understanding of science concepts and improve their ability to use the process skills of science. The teacher can then guide students in ways that will help them take next steps in learning.

Inquiry based teaching provides continuous opportunities for formative assessment. While formative assessment is essential when teaching science through inquiry, this powerful teaching strategy can also be applied effectively to all science teaching approaches – traditional book centered learning and paper and pencil tests.

Comparing formative and summative assessment:

- Both formative and summative assessments begin with goals, student activities and collecting activities related to the goals.
- In summative assessment all students are evaluated according to common criteria so results can be compared; the resulting information is used to report what has been learnt up to a particular point in time.

Indicators for assessing process skill development

In "observing" skill teacher assess that:

1. Are the students succeed in identifying obvious differences and similarities between objects and materials?
2. Are the students able to use several senses in exploring objects and materials?
3. Are they able to identify the features of the objects they are examining?
4. Are they able to classify the objects based on a common characteristic?

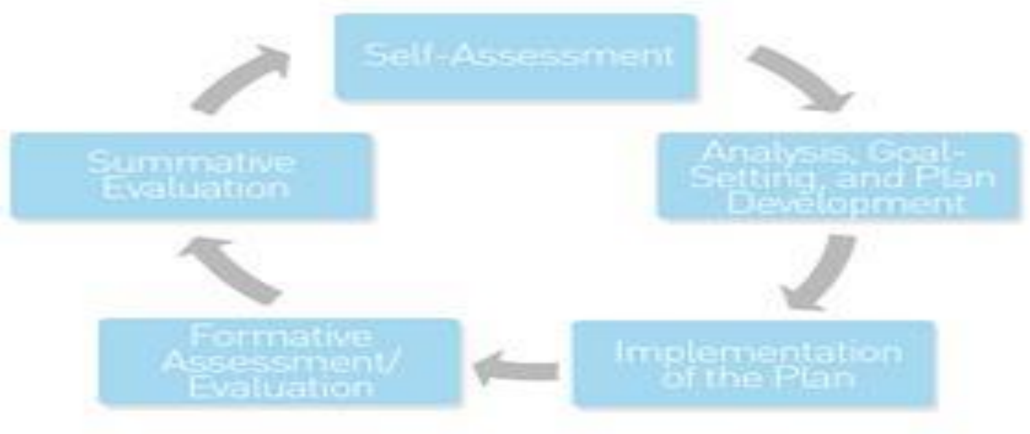
In "communicating" skill teacher assess that

Do the students:

1. Talk freely about their activities and the ides they have?
2. Listen to others ideas?
3. Record observations in writings or drawings?
4. Use tables and charts to record an report results when these are suggested?
5. Regularly and spontaneously use information from books (or other resources) to check and supplement their investigations?

Formative assessment cycle

A formative assessment occurs mid-cycle provides feedback that informs an educator's practice, showing where she/he stands relative to standards and goals, and what she/he can work on next. The formative assessment and the summative evaluation use the same format in the Educator Development and Feedback System. A formative assessment can be used to change an educator to a more or less directed plan if concerns have emerged or performance has improved significantly.



Example of Formative assessment (Lesson 1 Teaching of General Science)

For example in Lesson 1 of teaching of general science. We did experiments with candle, cotton and other objects. Students observed theses objects and describe their properties. The goal of our lesson was also that students must be able to describe all the objects, use the two or three dimensional shapes and define their properties. Teacher assessed the student's prior knowledge first.

Stage 1: Goals

Our goals were to understand that property is a characteristic used to describe an object and observed the objects and described them in terms of their color, shape, size and texture. Also developed the related vocabulary.

Stage 2:

Teacher collected evidence of student thinking related to the property.

Stage 3:

Teacher interpreted evidence of student thinking that students could not differentiate between a square and rectangle, or rectangle and a cuboid.

Stage 4:

Teacher referred to the shapes chart which she had made for student's understanding of the shapes. She had put the chart on the board. Than she placed the cleaning pad against to the shapes of square and rectangle and asked to the students which shape is identical to the cleaning pad.

Stage 5:

Teacher asked reflective questions such as “make a choice – which shape does your cleaning pad resemble?” she also talked about the difference between a square and rectangle. All sides of square are equal; only opposite pair of sides of a rectangle are equal.

Lecture No 13

Observing jelly crystals and sharing children’s prior ideas about Jelly

Main Idea of the Lesson

The central idea of the lesson is to develop the observation skills of the students. And to extend their senses of seeing, feeling, smelling and tasting. Teacher enables the students to identify the shape, color and texture of the objects.

Overview of lesson

- Children shared their prior ideas about jelly, the making of jelly and the properties of jelly.
- Children observed the jelly crystals with the help of magnifying glasses, felt, smelled and tasted it and recorded their observations.

Learning objectives

Concept :

- Students understood that materials were made of many small parts e.g. jelly powder was made up of tiny particles.
- They learnt that magnifying glasses made the small parts look bigger and enabled them to see details that they cannot see with the naked eye.
- They also understood that different sense organs were used to identify different properties.

Skills :

- Students were able to observe the objects using all their senses: seeing, feeling, smelling, tasting and hearing.

- They used magnifying glasses to extend their senses.
- They identified properties such as color, shape, texture, smell and taste.
- They recorded properties of jelly crystals in a table.
- Students participated in a collective discussion and shared their ideas.

Attitudes:

- Students developed an interest in and enthusiasm for exploring and investigating properties of familiar edible materials.
- Students worked in a pair for the activity.

Materials used for the activity were:

- For each student there was an observation sheet to record the properties of jelly powder/crystals. For a pair of students there were a magnifying glass and a transparent cup containing two tea spoons of jelly powder/crystals.

Preparation:

There were 16 pairs of children in the class so 16 magnifying glasses and 16 transparent plastic cups were available before the lesson. There were three different flavors of jelly. Teacher ensured that if two pairs were sitting at the same table each pair got a different flavor of jelly. There were two types of charts. One was prior ideas chart with the heading of "Our ideas about jelly" and the other two charts were with the heading of "Observing Jelly Powder". All charts were put up on the board before the lessons.

Class activity:

First step of the activity was related to finding out the prior knowledge of students. Teacher introduced the magnifying glass to the students and how it works. She told the students that it was used by the scientists. Teacher tested the student's prior ideas about jelly by asking, do you know what is jelly? and how can we make it? Students answered according to their understanding about jelly. One student told the procedure of making jelly. Teacher wrote all the ideas on the chart of prior knowledge.

In the second step the teacher told the procedure to the students. She told the student that they would observe the jelly powder with their eyes and then with magnifying glasses. After that they would feel, smell and taste the jelly and wrote their ideas in the worksheet provided to them.

Then the teacher gave one cup of jelly powder to each pair. And also gave the work sheet to the students. First they saw the jelly powder with naked eyes and then they saw it with magnifying glasses. After seeing or observing, students felt the jelly powder with their hands. Then they smelled and in the end they tasted the jelly powder. Teacher extended the observation skills of students on this stage.

Teacher explained to the students that for observing we need our senses like seeing, hearing, smelling and tasting. The teacher said to the students that there should never be any fight on the flavor or the color of the jelly.

At the end of the lesson students and teacher shared their observations. Students told that jelly grains were cube and sphere. Its color was light green, pink, orange and red. They felt the jelly powder rough, it was like grains. It smelt like fruits such as banana, strawberry and mango. And it tasted sweet and sour. This data was written in the worksheet by the students at the end of the lesson.

Lecture No 14

<u>Making jelly, observing and recording different stages of jelly</u>

Central ideas of the lesson

The main idea of this lecture is to enable the students to differentiate between dry jelly powder and the liquid jelly. Teacher explained the concepts of melting and dissolving to students. Solid melt when it is taken out of the fridge or it is given heat. For dissolving, solids need to be mixed into the liquids. For example, when we mix sugar or salt into water it disappears.

Overview

- Children worked in pairs, made jelly by adding hot water to jelly crystals, stirred the mixture and finally put it in the fridge.
- They compared the jelly crystals with the liquid jelly. They carefully observed the liquid as jelly crystals dissolved.

- They shared and recorded their findings by drawing pictures and by writing observations.

Learning objectives

Concepts:

- Students understood that when a solid is dissolved in a liquid it “disappeared” – it was spread evenly and was no longer visible.
- A solid melted or changed into a liquid when it was heated.
- Some properties of solids and liquids changed when they were mixed together and some stayed the same.

Skills/ Abilities:

Students were able to:

- Handle materials and simple equipment.
- Observed carefully using most of their senses: seeing, feeling, smelling and tasting.
- Identify the changes.
- They put the events into current order.
- Identify properties such as appearance texture, smell and taste.
- Use the appropriate words to describe properties of jelly liquid. They extended their scientific vocabulary.
- Students participated in a collective discussion and constructed new understanding.
- Keep record of their exploration in pictures and words.

Attitudes

- Students wrote details while writing about the observations.
- They kept the records of their findings.
- They developed an interest in and enthusiasm for investigating properties of materials.

Materials for the activity

- For each student teacher provided an observation sheet to record the different stages of making jelly.

- And for pair of student a transparent plastic cup, 4 plastic teaspoons and tissue papers. Three flavors of jelly powder for16 cups of jellies. And supply of hot water.

Class activity

Teacher gave a cup of jelly powder to each pair of students and pour hot water in their cups. She asked them to mix the jelly powder in the water and carefully observed what happened. Students started stirring the powder into the water and observed that jelly crystals were disappeared.

At this stage the teacher explained that jelly powder was dissolved into the water. She told the students about melting and dissolving. She said that melting and dissolving both are different phenomena. She gave the example of ice, that it melts when we put it out of the fridge or heat it.. On the contrary, solids dissolved when we mixed them with liquids.

After observing the whole activity teacher gave the worksheets to each student to test their observation skills. Students wrote their names and date on the sheet. There was a column of word bank on the sheet, where the teacher had written all the words in English and Urdu. Teacher discussed all the vocabulary with the students. There was also a column for the students where they had to draw the pictures of jelly crystal before and after it dissolved based on their observations. Students wrote their ideas about the shape, color, smell and taste of jelly on the worksheets and at the end of lesson discussed it with the teacher..

Lecture No 15

Observing jelly---- the final stage

Central idea of the lesson

The main idea of the lesson is to assess that on which level the learning objective “to develop the observation skills of students” is achieved. Students shared their ideas about the shape, color, taste, smell and texture of the jelly.

Overview

- Children ate the jelly, observed it and identified its properties using all their senses.
- Children extended their world bank and recorded their findings in words and pictures.
- Children deepen their experience of collective discussions in a science classroom. The statements were supported by the evidences.

Learning objectives

Concepts

Students understood that when a liquid was cooled some of its properties changed and some stayed the same. And if it was cooled for sufficient time it became a solid.

Skills/abilities

- Students observed carefully using most of their senses: seeing, feeling, smelling and tasting.
- Students identified properties such as appearance texture, smell and taste.
- Students used appropriate words to describe properties of jelly and extended their scientific vocabulary.
- Students kept a record of their exploration in pictures and words.

Attitudes

- Students developed honesty in representing observations. It is the core value of science.
- They kept the records of their findings.
- They developed an interest in and enthusiasm for investigating properties of materials.
- They repeated the observations to verify claims.

Material used for activity

- For each student an observation sheet to record properties of set jelly.
- For a pair of students 2 plastic tea spoons, a cup of jelly, piece of tissue papers.
- For the entire class, 2 charts for recording ideas about jelly.

Preparation

- All the cups of prepared jelly with the children's names on them were taken out of the fridge just before the lesson.
- The charts were given the heading "our ideas about made jelly".
- Charts were put up on the board before the lesson.

Class activity

Teacher gave the jelly cups to the students. She told the students to observe it, whether it was solid or liquid. Whether it was opaque, translucent or transparent. What was its color and texture and how it felt? Students ate the jelly, they were evolved as observers. They tasted and smelled the jelly. Then all shared their ideas as below:

The observations were that jelly was solid looking. It had different colors like pink, green and orange. It was translucent. When the students tasted the jelly it was like the flavors of fruits (banana, mango and strawberry). Jelly tasted sweet and a little sour. When students felt it with hands it was jumpy and sticky. It also smelled like the fruits.

At the end of the lesson teacher looked at the work sheets of the students for formative assessment to know whether the learning goals of the lesson were achieved or not. Most students had great observation and they gave the correct views about the shape, color, taste and smell of the jelly.

Lecture No 16

Conducting fair tests and learning some more properties of Jelly

Overview

- Children explore the effect of adding hot and cold water to jelly crystals.
- They observe the hot and cold liquid jelly mixtures and compare their properties.

Learning objectives

Concepts

Students understand that:

- Solids such as jelly crystals dissolve faster in hot rather than cold water.
- Some properties of warm liquid jelly are different from cold liquid jelly.
- An investigation is fair, that is its results are reliable, provided only one quantity is changed and the rest are held constant.

Skills/abilities

Students are able to

- **Identify the salient features of a scientific investigation:**

i. What they are investigating?
ii. What is kept constant or same through out the experiment?
iii. What is changed and varied in the experiment?
iv. What are the findings?

- **Handle materials and simple equipment**: mix solids and liquids exercising care.
- **Observe carefully using most of their senses**: seeing, feeling, smelling and tasting.
- **Identify properties such as appearance texture, smell and taste**.
- **Understand and use appropriate** words to describe properties of jelly liquids **extend their scientific vocabulary.**
- **Participate in a collective discussion,** share ideas, listen to others, agree and disagree and **construct new understanding.**

Attitudes

- **Working in a team** involves **fair play** and **sharing.**
- **Patience is** required **to make careful** and **reliable observations.**
- **Keeping a record of findings** is a very important scientific practice.
- **Honesty in representing observations is a core value of science.**

Materials

- **For each student**

  An observation sheet to record their experiment/fair test
- **For a group of 4 students**

  2 cups, 2 spoons, 2 jelly packets of jelly powder
- **For the Entire class**

Supply of hot and cold water

1 chart for recording their fair test

1 chart for recording words in English/Urdu and additional observations

Preparation

- There are 8 groups of 4 children in the class so 16 plastic spoons and 16 transparent plastic cups were available before the lesson.
- Three different flavors of jelly powder sufficient that each group gets a packet.
- Sufficient supply of hot and cold water was arranged before the lesson.
- The “Fair Test Chart” was prepared according to the given template.

Template of Fair Test

- What is our experiment we were investigating?
- What are we changing?
- What are we keeping the same?
- What do we find out?

Teacher’s demonstration

It is important for the teacher to do experiment himself and carefully observe the situation before going to the class. Teacher demonstrated the experiment herself before the class activity. She took two transparent plastic cups of same size. She wrote the word hot on one cup and cold on the other with the black marker. She opened a jelly powder packet. She poured half powder in one cup and remaining half in the other cup. The amount of jelly powder was same in both cups. She poured hot water in one cup and cold water in the other. The amount of water was also same in both cups. Then she mixed the jelly crystals in the water.

She observed that:

- **In hot water jelly crystal dissolved quickly while in cold water they were not fully dissolved.**
- **The cup of hot water was translucent while the cup of cold water was opaque**.
- **The color of jelly in both cups was also different**.
- **The cup of cold water had the suspension but the cup of hot water was clear.**

Class activity

In the class room teacher repeated the same activity with the students. She gave cups to the students with equal amount of jelly powder. She instructed student to work in the cooperation. Teacher poured the hot and cold water in the cups. Students started mixing the powder in the water. Students observed and identified that jelly crystal were not fully dissolving in the cold water. Cold water jelly was smooth. Hot water jelly was lumpy. In hot water jelly started setting. In cold water there was only liquid.

Conclusions were that:

- ✓ Jelly was being made in hot water. In cold water there was no solid jelly.
- ✓ Hot water jelly was thick while cold water jelly was thin.
- ✓ Hot water banana jelly was light green and cold water banana jelly was dark green.
- ✓ In cold water there were more grains of jelly powder than the hot water.

Teacher wrote all her findings on the chart paper with the help of the students.

Lecture No 17

<u>Concept of Dissolving</u>

Learning objectives

Students understood that sugar powder dissolved faster in water than the sugar grains. Hence some properties of solids change when the size of the particles/grains it is made up of is changed.

Materials

Two plastic cups, two spoons, sugar (solid grains and also in powder form), water

Teacher demonstration

Teacher labeled one cup with powder sugar and the other with grain sugar. She poured an equal amount of water into the cups. She started mixing sugar in both the cups. She observed that sugar powder was quickly mixed while the grains were not fully mixed. Everything else was same in both the experiments, the only difference was in the form of sugar used.

Class activity

- Teacher gave two plastic cups and spoons to the students.
- She poured the powder sugar in one cup and sugar grain in the other.
- Before adding water she made the students identify or differentiate between the sugar grains and powder.
- Then the teacher added the same amount of water in both the cups.
- Students started stirring.
- After some time teacher stopped them and they put both cups together and observed.
- Teacher started writing their findings in fair test template which she had written on the chart.

Fair test template

Fair test template had four points.

1. **What was the experiment?**

Teacher asked the students about their investigation and got responses from the students.

2. **Which variable was changed in the experiment?**

In the second step teacher asked the students about one thing that was changed in the experiment. Student answered that two types of sugar was used in the experiment.

3. **Which variables were kept the same in the experiment?**

Students told that the amount of the cold water used was the same, and the amount of sugar used was also the same.

4. **What are the findings?**

The finding was that sugar powder completely dissolved in the water but sugar grains did not dissolve completely.

Teacher wrote all her findings on the chart paper with the help of students at the end of the lesson.

Lecture No 18

Summative Assessment

Overview of Summative Assessment

The type of assessment we will consider today after the teaching of ten lessons is *summative assessment.*

This is done to determine students' levels of achievement:

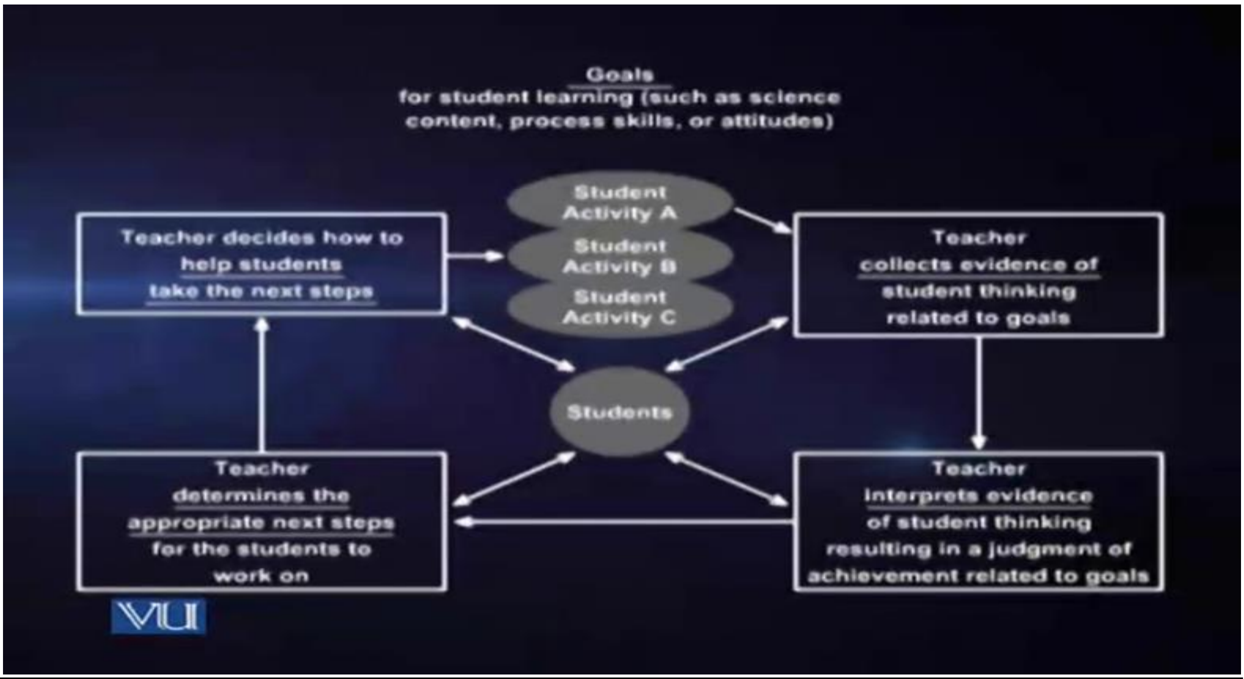
To see to what extent the concepts and skills were acquired i.e. the learning goals associated with a particular topic or curriculum were attained and move on to other topics or areas of the curriculum or make decisions about promotions.

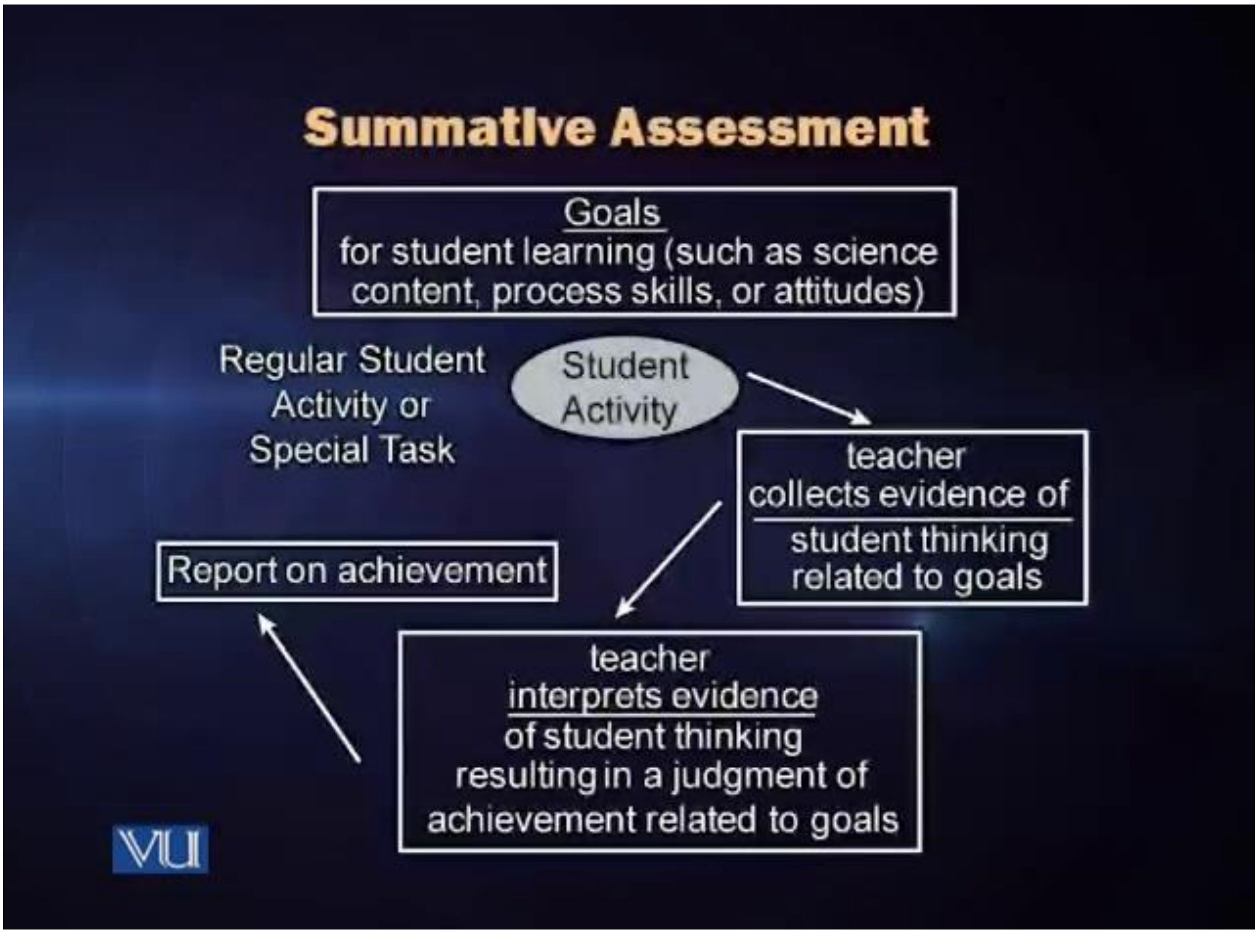
Overview of Formative Assessment

1- **Formative Assessment**

Is done continuously before a lesson and during a lesson

Using a variety of ways: conversing with children, examining their written work, their drawings and observing them when they are engaged in explorations using their skills during this continuous assessment teachers also determine how well students are progressing towards the learning goals of the lesson and if need be to modify/design learning experiences for the purpose of helping students get closer to learning goals.





Some Do's and Do not's for evaluating student's work

1. Don’t give judgmental comments, and above all scores or symbols (such as B+ or 8/10) - especially when they are still constructing/ developing their concepts and skills. Giving double stars ** , saying great work, well done brings a closure to their efforts to learn/figure things out. They feel they have achieved their learning goals.

2. Do by all means acknowledge and encourage effort and progress, but not in a way that diverts attention from how to improve and move ahead.Comment on the specific work they have done well

Some Do’s and Don’ts of Evaluating Student Work

3. Do identify one or two important aspects for comment and review, which are related to the planned learning goals.

4. Don’t pose rhetorical comments like “This needs improvement”, “This is below standards” or “This is good” because that does not inform the student about the nature of work expected from her/him.

We shall demonstrate the specific comments that should be made about children’s work

Some Do’s and Don’ts of Evaluating Student Work

5. Do Pin point weak aspects, such as misuse of a technical term, i.e. in a constructive way

6. Don’t become to obsessive about the use of words or assertions the students may have made since they are in the process of building their understanding and abilities

Some Do’s and Don’ts of Evaluating Student Work

7. Do give students time to read, reflect and respond to feedback/ comments. This can be done collectively – involving the entire class or individually on a one on one level.

8. Do indicate the next steps clearly to the students.

Developing a Marking Scheme associated with Summative Assessment

First identify expectations from children or student learning objectives

Second assign numbers or scores to students based on the extent they fulfil these expectations i.e. who shall be awarded the highest scores /numbers, less than that or the middle range and finally the least scores/numbers.

You can see the sample of developing assessment rubric for grade level 2 in the video lecture.

Lecture No 19

Review of what is Pedagogical Content Knowledge

What is Pedagogical Content Knowledge?

- An in depth understanding of the content of the discipline they are teaching i.e. ideas and concepts, skills and practices associated with that discipline.
- An understanding of how students learn that subject, what is hard and what is easy for them and what examples, processes and activities will help them to learn i.e. appropriate pedagogy adapted to the different development levels and interests of learners.
- They need to know how children's understanding of core ideas in science builds across K-8, not just at a given grade or grade band.
- They need to learn about the conceptual ideas that students have in the earliest grades and their ideas about science itself.
- They need to learn how to assess children's developing ideas over time and how to interpret and respond to the results of assessment.

Traditional vs Guided inquiry Approach

- In traditional inquiry content comes before an activity.
- In guided inquiry activity leads to content.
- In traditional inquiry little student involvement or role in planning and learning.
- In guided inquiry some or greater student role in planning and learning.

Teaching Grade 5

Developing a Sequence of Learning for Science Content Associated with the Structure of Matter **Strand**

Structure of Matter Strand

Benchmarks or Learning Goals for 3 - 5

What are things made of and how can we explain their properties?

• Objects are made of matter that takes up space and has weight. Solids, liquids, and air are forms of matter and share these general properties; There can be invisible pieces of matter (too small to see).There are many different kinds of materials.

• Objects have properties that can be measured and explained. Three important properties are mass, weight, and volume.

• Material kinds have characteristic properties that can be measured and explained; these properties are independent of the size of the sample.(Extends properties to thermal and electrical conductivity and possibly in flammability)

What changes occur when things are transformed?

Physical Changes: Materials can be changed from solid to liquid to gas (and vice versa) by heating (or cooling) but the kind of material stays the same.

Mass is conserved during physical and chemical changes*

Water as a case study: mass is conserved during a range of transformations e.g. melting, freezing, dissolving

*Chemical Changes: Combining two or more materials can produce a new material with properties different from those of the initial materials

How do we know? What are the skills we use to find out?

- Conducting Observations
- Raising Questions and
- Developing tentative explanations or hypotheses of observed phenomena
- Making predictions base on the tentative explanations or hypotheses
- Planning and carrying out empirical investigations
- Collecting, interpreting, analyzing data and evaluating knowledge claims.
- Communicate findings to larger peer group for critical review

Our focus in Second Grade:

- Observing
- Communicating
- Interpreting and drawing conclusions
- Exploring the structure of a "Fair Test"
- Structure of Matter Strand

Benchmarks or Learning Goals for 3 - 5

The Skills and Abilities that help us find out i.e. How do we know?

We will learn about the world through focusing on all the skills but especially

- Planning and conducting investigations. Controlling variables; identifying independent and dependent variables
- making measurements; using thermometers, stopwatches and electronic balances; understanding that although measurements are more reliable than common sense impressions,

measurements can be more or less precise and there is always some measurement error. (error in instruments also especially calibration of thermometers)

• Using interactive computer simulations where direct observations are not possible

• Communicating/sharing with others through pictures, writing and orally; modeling phenomena through graphs

• Children's Prior Knowledge

Findings of the Assessment

Inquiry 1: Describing Matter

Children were given 3 different types of matter:

i) A rock

ii) Shaving foam and

iii) Water

Question 1: Describe each of the substances in as much detail as possible

Question 2: Do you think that either A, B or C is a pure substance? Give reasons for your choice.

• Children's Prior Knowledge

Findings of the Assessment

Inquiry 1: Describing Matter

• Children gave detailed descriptions which were accurate

• Excellent observational skills

• From a scientific point of view a pure substance is not a mixture (the rock and shaving foam are mixtures of two or more chemicals) – only water with definite physical and chemical properties is pure. All the children interpreted "purity" as a substance which was a "pure" solid or liquid hence they characterized granite – a solid and water – a liquid as pure.

• Children's Prior Knowledge

Findings of the Assessment

Inquiry 2: Measuring Volume and Weight/Mass

• Children had never seen a measuring cylinder used to measure volumes of liquids and irregular solids

• Children had not used an electronic balance either for measuring mass/weight

- No exposure to decimal fractions e.g. mass/weight of object placed on electronic balance read as 16.5 grams children interpreted that as 165 grams
- No experience of temperature measurements i.e. using a thermometer or measuring time intervals using a stop watch
- Children's Prior Knowledge

Findings of the Assessment

Investigating Changes or Transformations of Matter

Focusing on physical changes and properties i.e. materials may change appearance but the substances in them stay the same.

e.g. Do children understand that as water melts (ice/solid to liquid water) or boils (liquid to gas) it remains the same substance?

- Children's Prior Knowledge

Findings of the Assessment

Inquiry 3: Making Mixtures (physical changes)

by adding water to a) Baking Soda and b) salt stirring and observing the two mixtures

Findings

- Observations/descriptions were good
- Not encountered the words "Solution" and "Suspension" to classify the mixtures
- No experience of separating the solids from water e.g. salt from water by evaporation and baking soda from water by filtration
- Children's Prior Knowledge

Findings of the Assessment

Inquiry 4: Adding Vinegar to Salt and Baking Soda (exploring chemical changes)

by adding a few drops of vinegar to a) Baking Soda and b) salt and observing what happens

Findings

- Observations/descriptions were good especially that bubbles were formed when vinegar was added to baking soda
- No recognition that a change had taken place in which new substances were formed (bubbles are carbon dioxide gas)
- Children's Prior Knowledge

Findings of the Assessment

Overall Conclusion

Comparing Findings with Benchmarks which tell us what understandings and abilities children should acquire by the end of Grade 5 (with reference to the structure of matter strand) Considerable work needed to be done in a variety of areas

- What should we teach fifth grade to deepen your pedagogical content knowledge?

- Two Options/Possibilities

Option 1: Explore physical and chemical properties of familiar household chemicals such as corn-flour, baking soda, sugar etc.

Option 2: Focus on changes of state – melting, boiling, freezing and evaporating using water as the classic case study

- What should we teach fifth grade to deepen your pedagogical content knowledge

One option:

Explore physical and chemical properties of familiar household chemicals such as corn-flour, baking soda, sugar etc.

- Appearance, texture, smell etc. Making their mixtures with water and identifying solutions and suspensions; discovering ways to recover the solids from these mixtures through filtration and evaporation;

- Heating them; adding other chemicals such as vinegar, iodine and red cabbage juice

What should we teach fifth grade to deepen your pedagogical content knowledge

We want you to be able to

- identify pedagogical strategies or teaching approaches in a classroom environment

- See how pedagogical or teaching approaches are altered/changed when children find certain concepts/skills difficult

- See how unexpected response/reactions of children are handled in the classroom

- What should we teach fifth grade to deepen your pedagogical content knowledge

Second option:

Focus on changes of state – melting, boiling, freezing and evaporating using water as the classic case study

- Heating ice, measuring temperature, observing and recording changes carefully, identifying characteristics of change of state;

- Measuring mass when change of state occurs; investigating evaporation; constructing beginning explanations of changes of state in terms of a particulate model of matter

Skills Developed in this Unit

Experiencing Structured and Guided Inquiry

Greater challenges for teaching and learning; hence greater opportunities for dissecting pedagogical practices and using new approaches e.g. computer simulations

- Children's Prior Knowledge
- Research on what children know

Children tend to think that

- Changes of state are not related to a particular temperature
- Increasing the heat when boiling a substance increases the boiling point i.e. tend to think that heat and temperature are the same i.e. both concepts confused with each other
- Water always boils at 100 ^{0}C
- A loss of mass or weight occurs when matter changes state i.e. solid changing into a liquid or liquid changing into a gas
- Water disappears when it evaporates
- Approach to Designing the Unit
- Looking at the Benchmarks i.e. What understandings/abilities children are expected to have acquired by end of fifth grade
- Assessed their prior/previous knowledge/skills to find out what they already knew and what they needed to learn
- Offer opportunities to deepen pedagogical content knowledge especially altering/ adjusting teaching strategies to respond to children's issues
- Sequence of Learning Template

Phase A: Assessing Prior Knowledge

Phase B: Developing a Background

Phase C: Main Content of the

D-E etc. Unit/Topic

Final Phase: Applying their skills and knowledge

Two Different Types of Assessments

1-Formative Assessment 2- Summative Assessment

The final phase assessment is Summative Assessment

In which teachers examine and evaluate students' knowledge and skills and assess how close they are to their learning goals determine grades/marks, compare levels of achievement, and usually make decisions about promotion—in this case we shall share achievement levels with you.

Formative Assessment will be an on-going part of our teaching experience

In which teachers examine and evaluate students' knowledge and skills and assess how close they are to their learning goals. Teachers use the information they gather about student work to determine what students need to do next that will help them progress toward the goals of the lesson/unit.

- Sequence of Learning for the Unit: Changes of State

Phase A: Staging Activity - Initiating a research project on properties of materials by focusing on a common "manufactured" object.

Students are introduced to their research project which they will work on in tandem with exploring changes of state.

- Working in pairs students select an object of common use and identify the materials with which it is made

- They research – using the internet – about the properties of these materials, how some materials are manufactured etc. and why these materials were selected for the object. The goal is for students to make connections between the materials from which an object is made and the function of the object

- As a case study they observe a bicycle identify its major parts and have a discussion about the materials each part is made from especially their suitability for the function they are to perform.

- They are given a structure their project, what to focus on during their research and a timeline. They are given four weeks to complete and present their project working on the main unit "changes of state" at the same time.

Time taken to launch the research project: 3 periods

- Sequence of Learning

Phase B: Developing Background for Investigating Changes of State

Students are taught how to use thermometers, stopwatches and plot coordinate graphs.

(1) Students understand how liquid in glass thermometers work through a simple demonstration; are introduced to the Celsius and Fahrenheit scale, clinical and laboratory thermometers. They learn to interpret the temperature scale and proceed to take temperature measurements.

(2) They are introduced to coordinates, plot points and finally plot line graphs using data sets. They learn to interpret graphs.

They are introduced to the digital stopwatch and time simple events.

6 periods

Phase C: Observing Changes of State by Heating Ice; Exploring the effect of Change of State on Mass of Substances; Understanding Evaporation

The core concepts of the unit are developed in three stages or parts.

Part 1: Students discuss what they already know about changes of state; observe changes of state as ice is heated; measure the temperature of ice and water as it is heated; record the data plot a graph of measurements taken and interpret the graph and other observations in terms of changes of state. Through collective reflection they will find out that change of state requires the gain or loss of heat energy; identify the characteristics of the melting and boiling processes

4 periods

Part 2: Students discuss the effect of change of state on the mass of substances i.e. explore the effect of freezing and melting on the mass of water.

Part 3: Students share their prior ideas about evaporation and boiling. They conduct guided inquiries to investigate evaporation and explore the effects of surface area, temperature and air movement on the rate of evaporation. Through these experiences they develop important skills/abilities associated with inquiry

6 periods

Phase D: Applying their skills and knowledge

In part one student will conduct a short inquiry involving application of heat and temperature measurements;

Part two will comprise of multiple choice and a short structured questions related to the skills and concepts taught to the students.

4 periods

- Sequence of Learning for the Unit:

<u>Changes of State :</u>

Phase A: Staging Activity - Initiating a research project on properties of materials by focusing on a common “manufactured” object (Prior Knowledge already assessed)

Phase B: Developing Background for Investigating Changes of State-Students are taught how to use thermometers, stopwatches and plot coordinate graphs.

Phase C: Observing Changes of State by Heating Ice; Exploring the effect of Change of State on Mass of Substances; Understanding Evaporation

Final Phase: Applying their skills and knowledge

- From Cookbook Science to Inquiry

<u>Four Stages:</u>

Traditional/Cookbook Science: Students confirming previously learnt material through activities

Structured Inquiry: Students are given the questions and procedure but collect their own data and make evidence based conclusions.

Guided Inquiry: Students are given the questions but they plan the investigation, collect and organize their own data and make evidence based conclusions.

Open Inquiry: Students generate their own questions, plan the investigation, collect and organize their own data and make evidence based conclusions.

Lecture No 20

<u>Research Project</u>

Initiating a research project on properties of materials by focusing on a common “manufactured” object

Overview

- Students are introduced to their research project which they will work on in tandem with exploring changes of state. The goal is for students to make connections between

the materials from which an object is made and the function of the object and experience project work.
- As a case study they observe a bicycle identify its major parts and have a discussion about the materials each part is made from especially their suitability for the function they are to perform.
- Student form pairs and are asked to take a week to select a sample object and give a reasons for their choice. They are given a project schedule and a research guideline (part of project structure). They are given four weeks to complete and present their project.

Learning Objectives

Concepts

Students understand:

- That the choice of materials that make-up a manufactured object is partly determined by the characteristic properties of the matter that makes up the material.
- Manufactured objects are often made from a variety of materials.
- Raw materials usually undergo processing before they are suitable for use in manufacturing.
- Connection between science and technology: changing/shaping materials to suit us better.
- Changes in the use of materials have accompanied advances in materials and changes in the design of objects.

Skills/Abilities

Students are able to:

- Select a simple manufactured object
- Explain the function of the object
- Identify the major materials that make-up the object
- Identify the properties of the materials that make them suitable for use in the object
- Identify the raw materials that make-up one of the materials and the refining process that makes them usable in the object.
- Conduct research using the internet
- Communicate by creating an xibit and giving an oral presentation
- Raising questions/critiquing the findings of their peers using logical reasoning and examining one’s own work critically.

Attitudes

- Develop an interest in and enthusiasm for exploring and investigating properties of materials and objects that are relevant to their lives.
- Learning to collaborate and take responsibility for different tasks, interact with team members listening to and sharing ideas.

- Develop an interest in the productive use of technology i.e. internet to enhance their knowledge and understanding about the physical and natural world – make interesting discoveries.

Materials

For each student

A worksheet on what are bikes made of and why a project research guideline is needed.

For the entire class

1 chart with a list of possible objects to select for research.

1 chart to be used as a word bank especially Urdu and English versions of relevant words.

1 bicycle.

Preparation

- The charts giving a list of objects and project schedule should be prepared
- A bicycle should be arranged and brought into class just before the start of the period.

Project Based Science

Elements of a project

- A driving question relevant to students' lives
- Student centred learning
- Collaboration/Team Work
- Use of technology for investigations
- Interdisciplinary/Cross disciplinary inquiry
- Production of artefacts
- Extended time frame
- Performance based assessment or evaluation
- Leading to some form of activism
- Project Based Science

Project Plan

- Project Question
- Methods or Procedure

- Materials/Technology required
- Timeline
- Identification of roles and responsibilities
- How will the project be assessed or evaluated?

List of Possible Objects to Research I

- Ball point pen
- Battery
- Light bulb
- Item of clothing e.g. shirt, jeans, jacket etc.
- Shoes e.g. joggers
- Toys
- Item of jewellery e.g. bangles, necklace etc.
- Hair accessories e.g. clips, hair bands etc.
- List of Possible Objects to Research II
- Toothbrush
- Marker
- Jogger
- Diaper
- Toys
- An Item of Furniture
- Project Research Guideline
- Function of your object or an accurate description of what your object does or what it is used for.
- Major Materials –an accurate description of the major materials that make up your object
- Why these materials were chosen which should include the properties of these materials which make them suitable for use in the object

- Origin of one of the materials – (a) the raw materials from which the material is made, (b) the processes the raw material undergoes to become the refined material used in your object
- History of your object – (a) the person or persons who invented your object, (b) when and where it first appeared and (c) how the original designs and choice of materials differ from those in use today
- Picture or photograph of your object – if your object is small enough you can even tape it along with the picture.
- along with the picture.

Project Starter Activities

Activity 1

Short Paragraph naming your object and reason for choosing it.

Deadline: 1 week later

Activity 2

An outline of the information you will research and the sources – books and internet sites – you will use.

Deadline: 2 weeks later

Lecture No 21

Case Study of Bicycle

Developing Thinking Tool for Research Project

Using a bicycle as a “research object” to model observations and establish a baseline related to what they know already and what needs to be researched.

Acknowledgement

The resource we have used for the

1. Entire research project and
2. Observing changes of changes of state by heating ice water

These are the properties of matter.

Learning objectives:

Concepts

Students understand:

- Function of different parts of a selected object i.e. bicycle.
- The function determines the choice of materials that make-up the various parts.
- Manufactured objects are often made from a variety of materials.

Skills/Abilities

Students are able to observe a bicycle and

1. Identify and explain the function of different parts of bicycle.
2. Identify the major materials that make-up the object.
3. Identify the properties of the materials that make them suitable for use in the object.
4. Learn to make connections between structure of different parts, the material they are made of and their functions using logical reasoning and evidence.

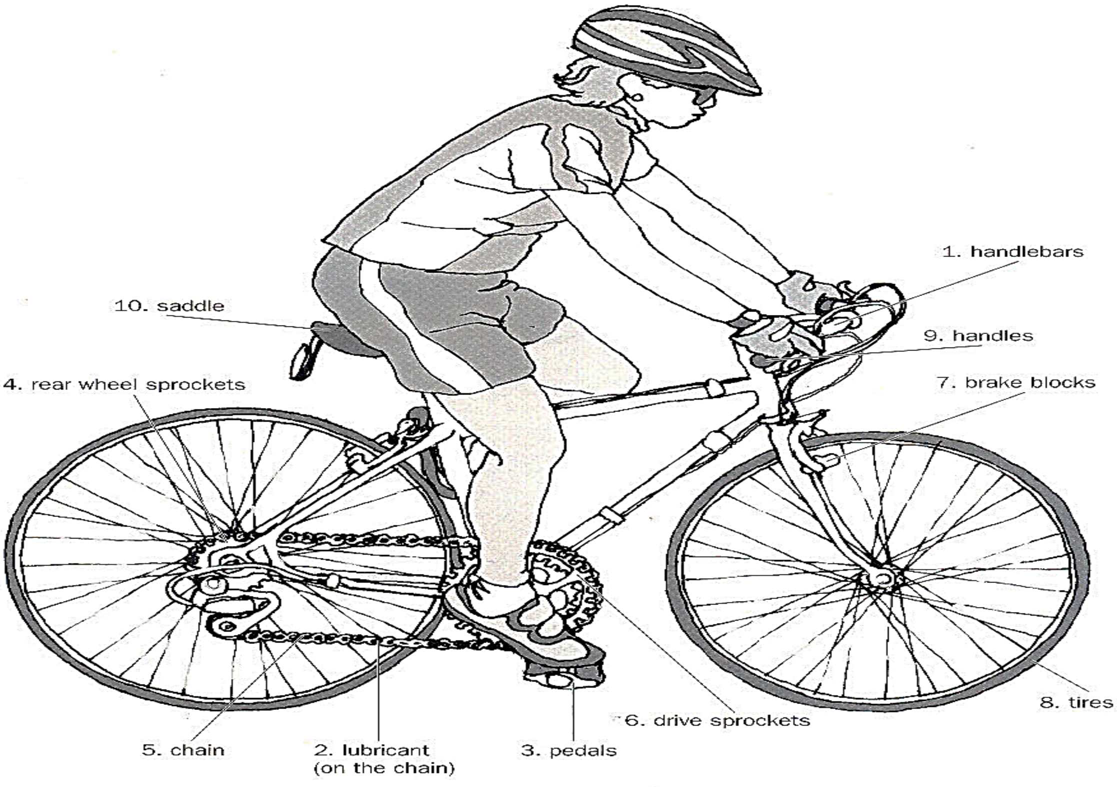
Attitudes

- Learning to take initiative when observing and handling objects.
- Develop an interest in and enthusiasm for exploring and investigating properties of materials and objects that are relevant to their lives.
- Collaborate and interact with team members listening to and sharing ideas.

Bicycle parts

Name of Part	What Does It Do?	What Type of Material Is It Made from	Why Was This Material Chosen?
1.Handlebars			
2. Lubricant			
3. Pedal			
4. Rear wheel sprockets			
5. Chain			

6.Drive sprockets			
7. Brake blocks			
8. Tyres			
9. Handles			
10. Saddle			



Teacher presented a bicycle in the class. She used bicycle as the object of case study. She gave the work sheets and picture of bicycle with the name of its parts. Students observed them firstly. And then teacher explained all the parts one by one to the students. Students saw the parts of bicycle themselves and record their observations on worksheets.

Lesson No 22

<u>Developing a Tool Kit for Measuring the Temperature</u>

This lecture is about the explanation of the changing of states. Students must know to measure and record the temperature. The main objective is to enable student to measure the temperature.

Overview

Students investigate liquid in glass thermometer. They explore what happens to air and water when they are heated and hence understand how a liquid in glass thermometer works. They are introduced to the Celsius and Fahrenheit scales and learn to measure temperature using alcohol in glass thermometers.

Learning Objectives

Concepts

Students understand

- The liquids and gasses expand when they are heated.

- This property is used in liquid in glass thermometers to measure temperature or degree of hotness.
- That to develop temperature scales numbers have to be assigned to represent temperatures at which two distinct phenomena take place – melting of ice and boiling of water.
- Measurement involves repeating a unit until all the measurement space is filled up i.e. the length of a liquid column in the thermometer.

Skills/ Abilities

Students are able to:

- Make careful observations and draw inferences/conclusions.
- Give tentative explanations or hypotheses about what they observe.
- Make connections with evidence and claims and explore how valid the connections are.
- Measure temperature using a liquid in glass thermometer.

Attitudes

Students are able to:

- Develop a beginning appreciation of the importance of evidence in science and logical reasoning to justify claims.
- Collaborate and continually revisit the importance and role of the team.
- Understand that scientific measurements can be uncertain and their reliability can be improved through better observational techniques and using better quality of instruments.

Materials

For each student

A worksheet for recording temperature of different objects or children can be given a template and they can record in their science note books.

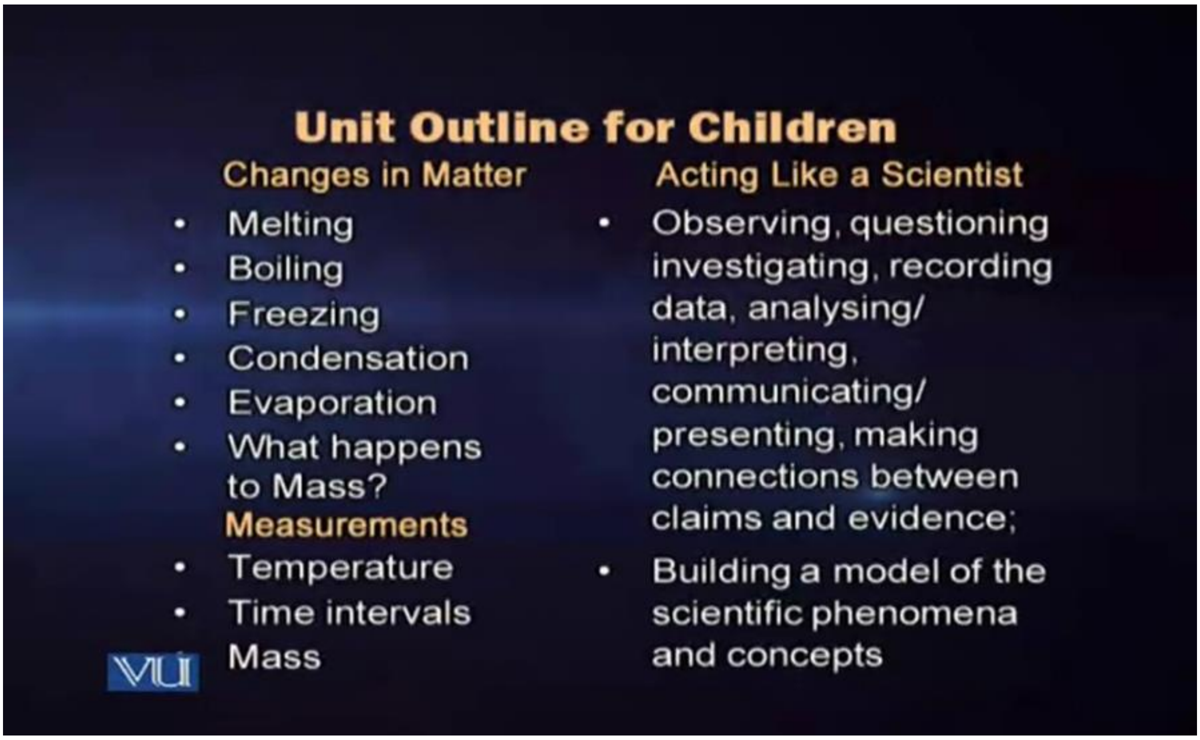
For groups of three students

- 1 Alcohol in glass laboratory thermometer
- 1 beaker containing tap water
- 1 chart depicting the Fahrenheit and Celsius scales (optional)
- 1 chart with a table for recording temperature
- 1 one – liter empty plastic bottle to which a ballon is attached.
- 1 plastic or glass bottle e.g. empty bottle of Shezan works out best one third filled with colored water with a straw in it, not touching the bottom and sealed/held in place from the top by using modeling clay.
- A basin or pans of Aluminium foil
- Supply of hot water

Preparation

- The chart depicting the Celsius and Fahrenheit scales should be prepared; the chart depicting the table for recording temperature can be prepared in class to model for the children
- The bottle with ballon, bottle with colored water and straw should be prepared/tested and supply of hot water arranged before class.
-

Teacher explained that they were going to experience the changes in the states. She told the students that they have to develop certain measuring skills.

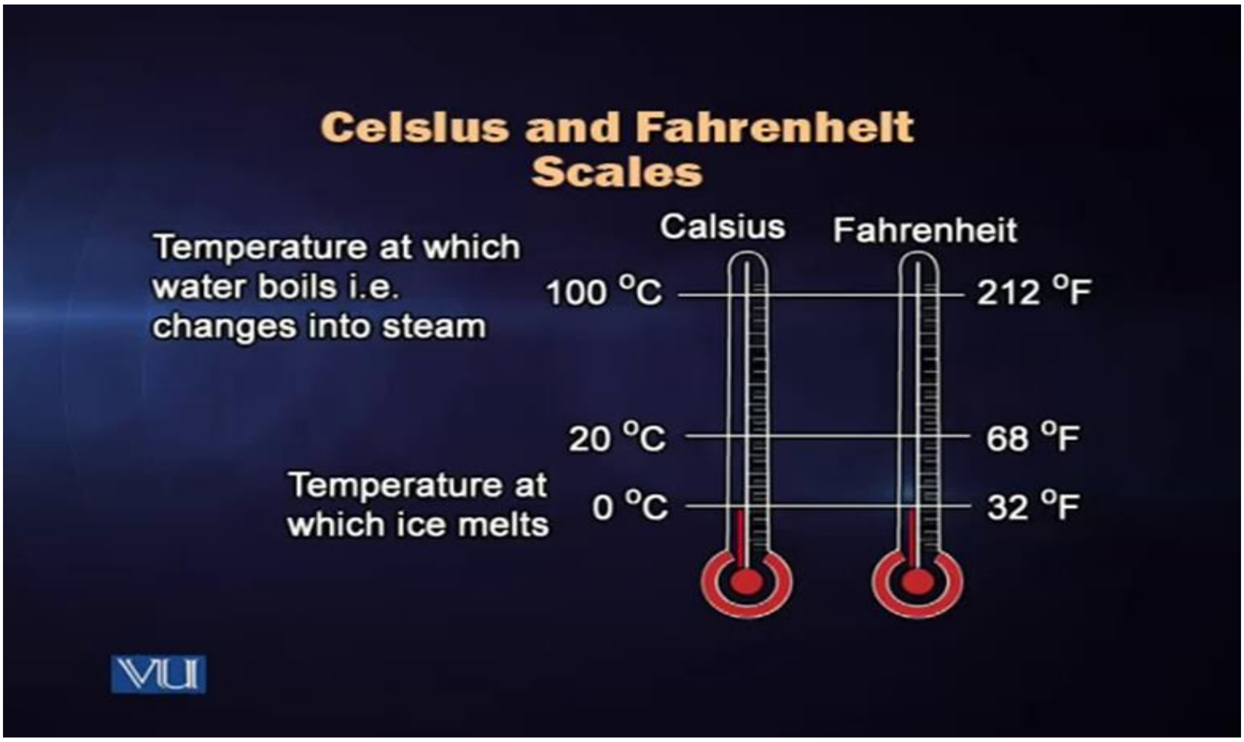


Class demonstrations focused that "fluids expand with heating".

In the first demonstration teacher poured the extreme hot water into the small tub. She took a plastic empty bottle and placed a balloon on it. She put the bottle with balloon in the hot water. After few seconds the balloon started inflating. Teacher told the students that it was because of the steam.

Second demonstration was done by liquids. It was very important because thermometer also has the liquid and it expands with temperature. Teacher poured the hot water in a tab or pan. Then she put a glass bottle with a straw and colored water in the tab. With the heat the colored water started arising in the straw.

After these experiments students had a clear vision about how to use a thermometer. Now teacher introduced a glass thermometer to the students in the class. Teacher told the students that silver liquid in the thermometer was called mercury. Teacher told the students that we measured the temperature in C^o and F^0scales (Celsius and fahrenheit scales).



Before using any measurement tool we must know how to read the measurement scales on that tool. There are different scales in different thermometers. Students measured the temperature in different situations and with different things and record their data in their worksheets and shared it with the teacher in the class.

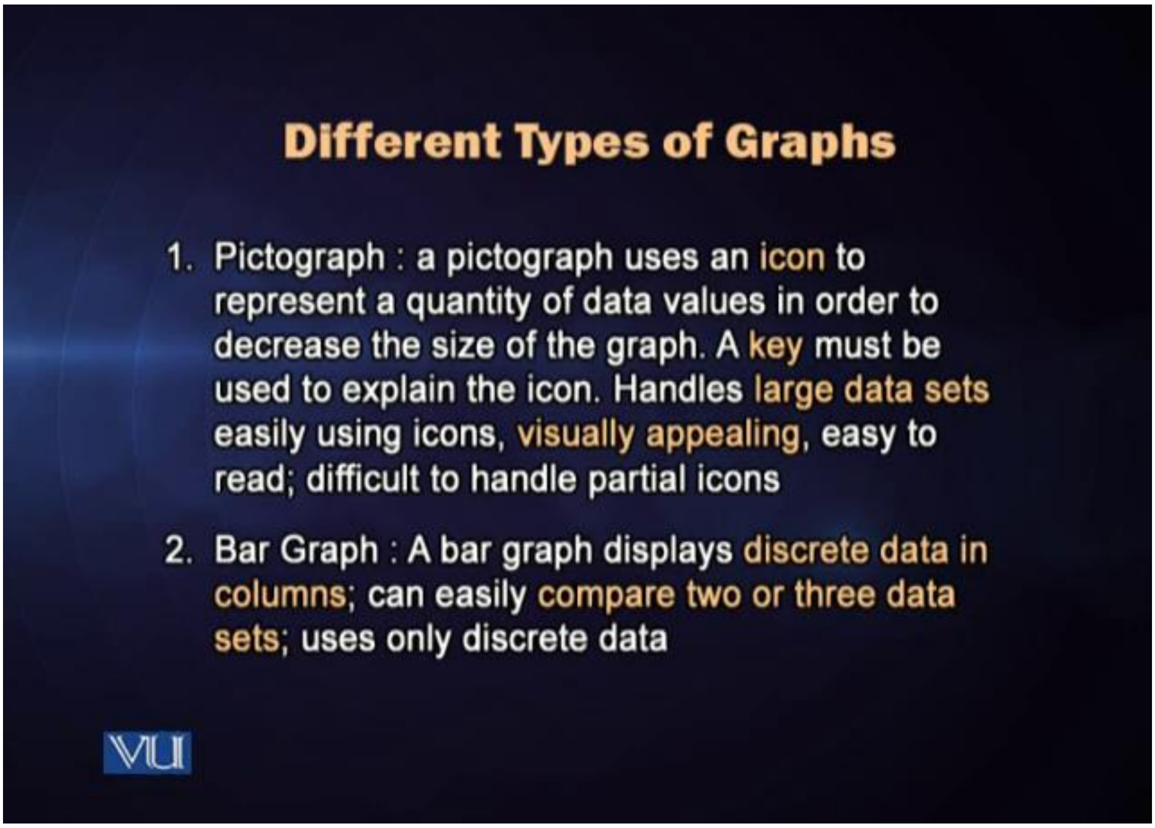
Lecture No 23

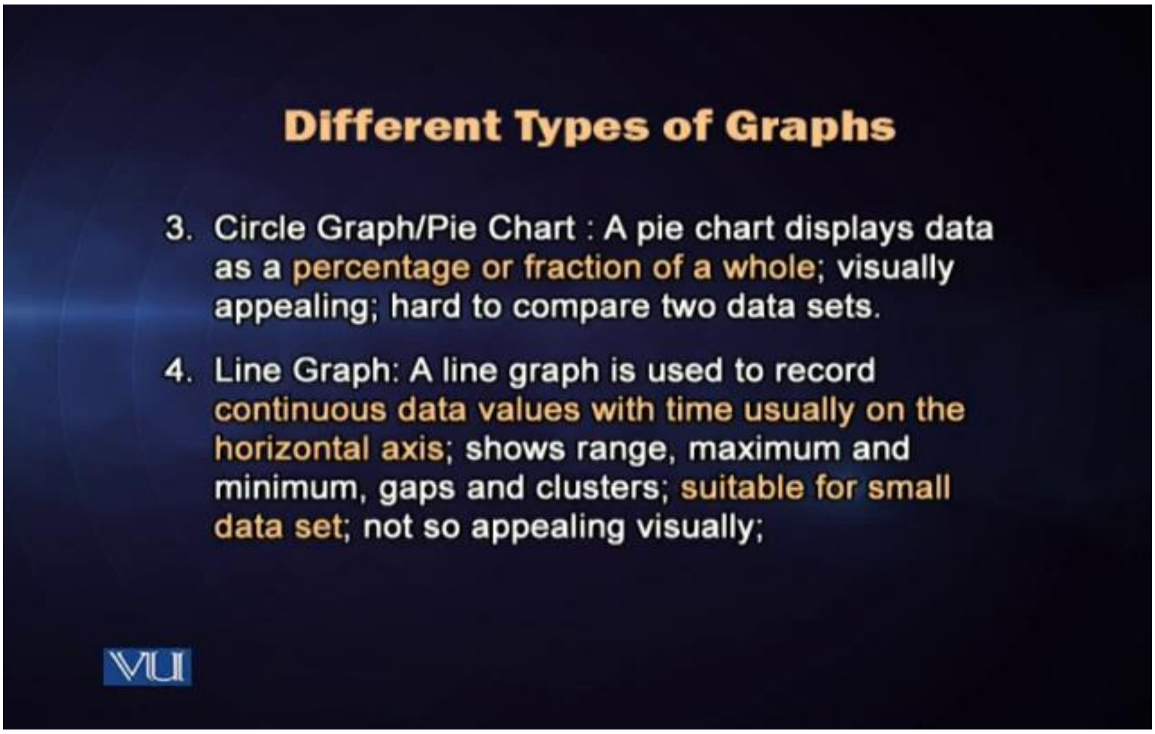
Types of Graphs

In this lecture we are developing the tool kit of the students. Our focus is on changes of states. But also we want to develop their measurement skills. In the first part of compiling a tool kit students learnt to use a thermometer. In the second stage students will learn graphing and time measurement through stop watch.

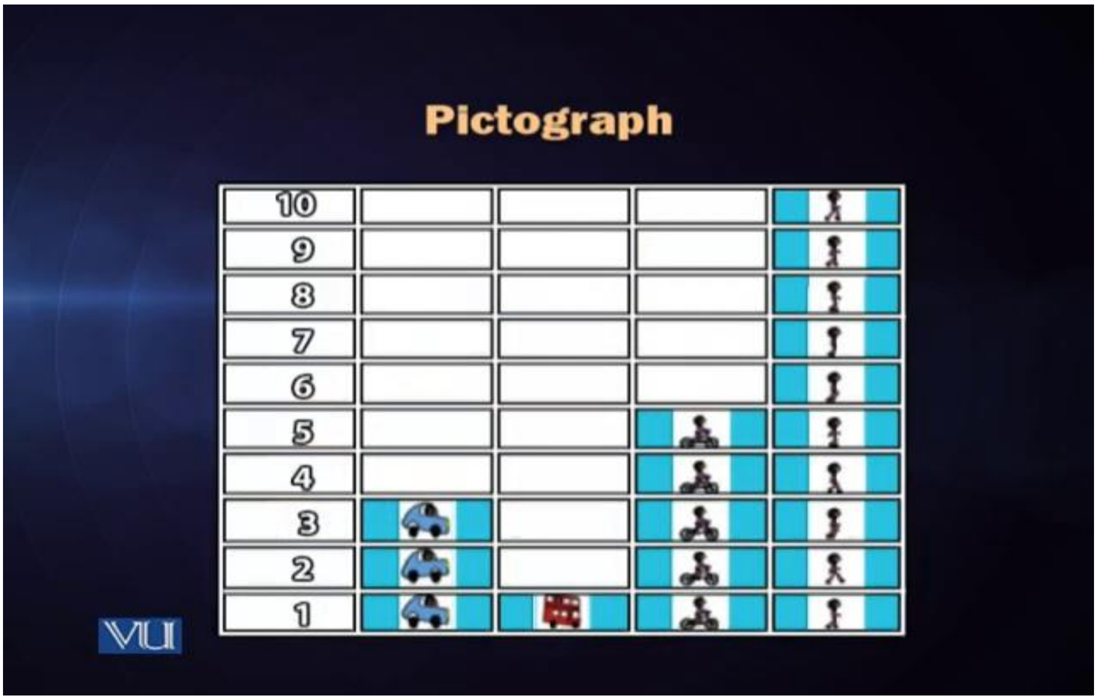
Why we are introducing the skill of graphing in 5th grade

Usually the problem in our curricula is that we do not integrate the subjects. Students are studying science and mathematics separately. While Mathematics is the language of Science. Many mathematical tools are powerful communication tools. Graphing is included in this. In this information age the data collection is the most important component in every field. It is also an important branch of mathematics and we will focus on this component. For example the data which is collected by the students can be represented through graphing. If we will focus on our math curricula, even in the kindergarten the much emphasis is on data handling. Graphing is a branch which is sadly neglected. So our purpose is to understand the importance of graphics and how can we get the information through this tool. Firstly we will see different types of graphs.



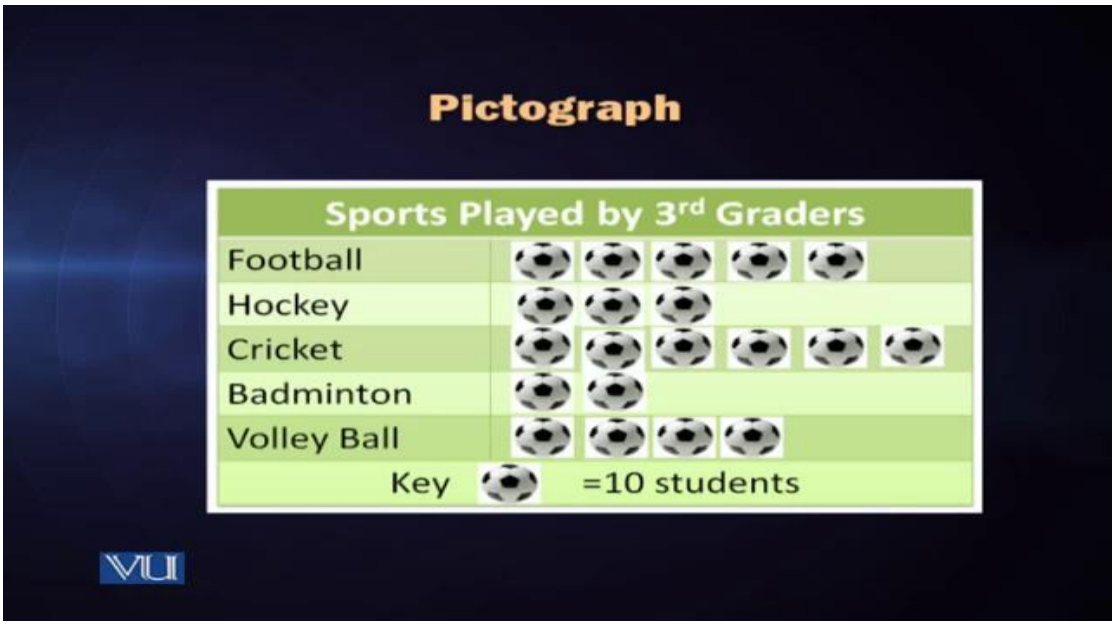


Sample of a pictorial graph for first grade



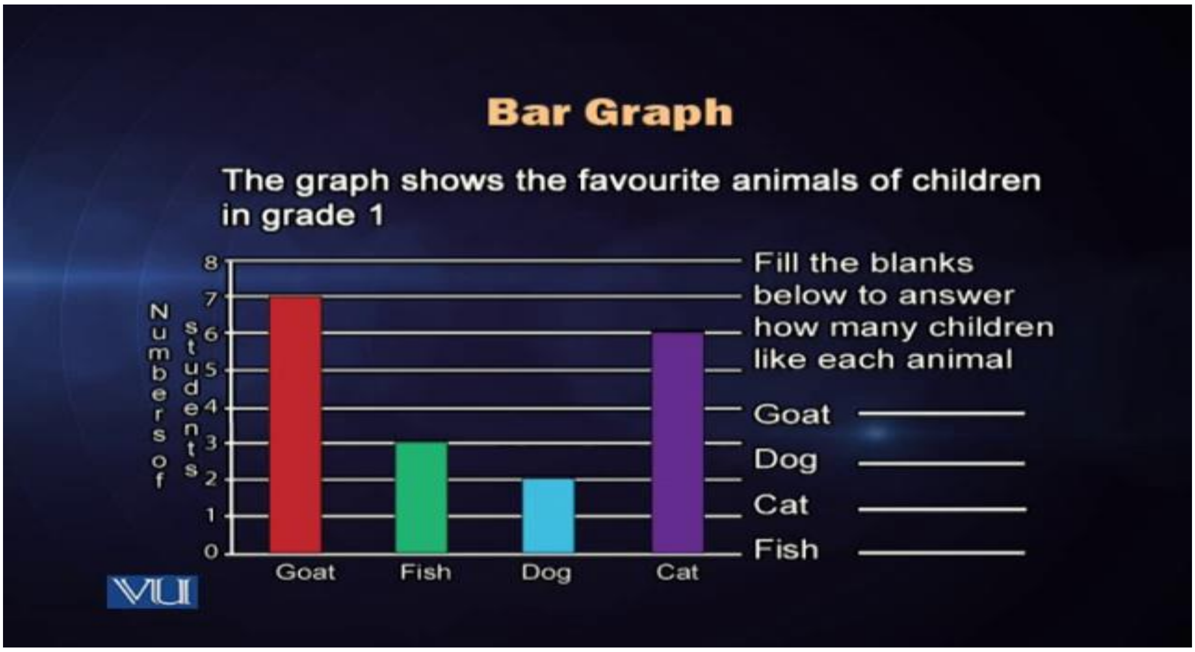
This is a simple graph which can be used in the first grade. There is simple information that there are three cars, one bus, five cycles and so on. Children can count and give comparisons immediately through this type of graph. For example children can interpret that the number of cars are more than the bus.

Sample of pictorial graph for third grade

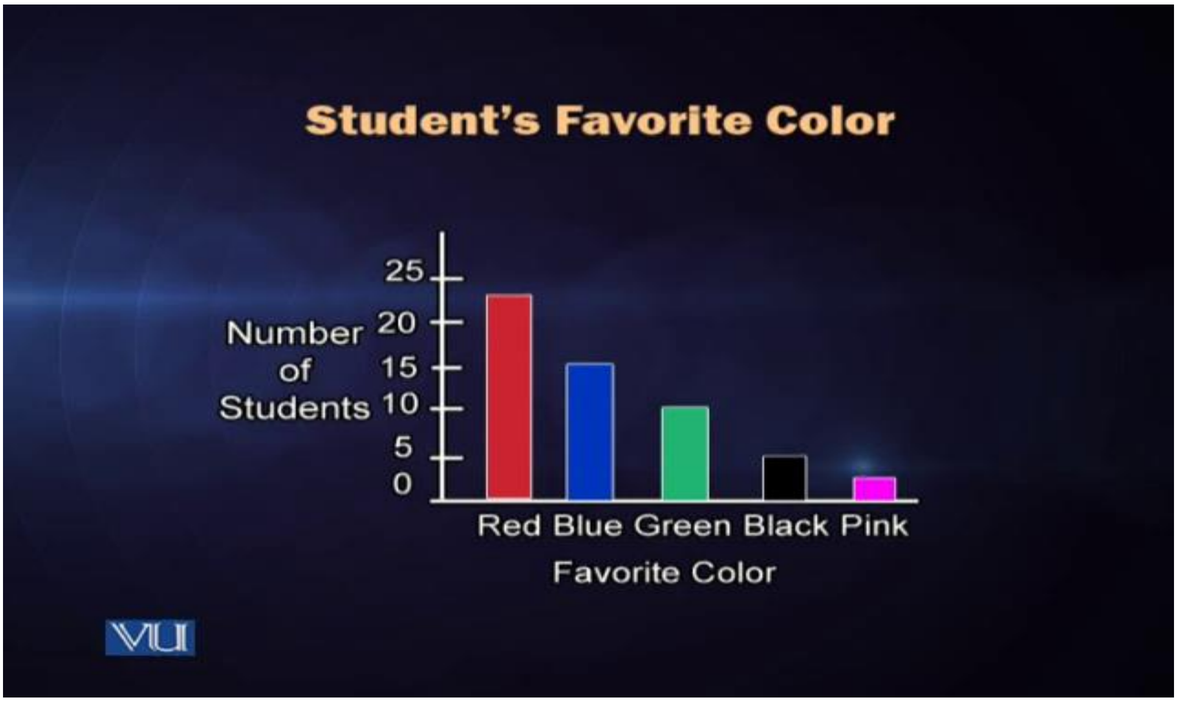


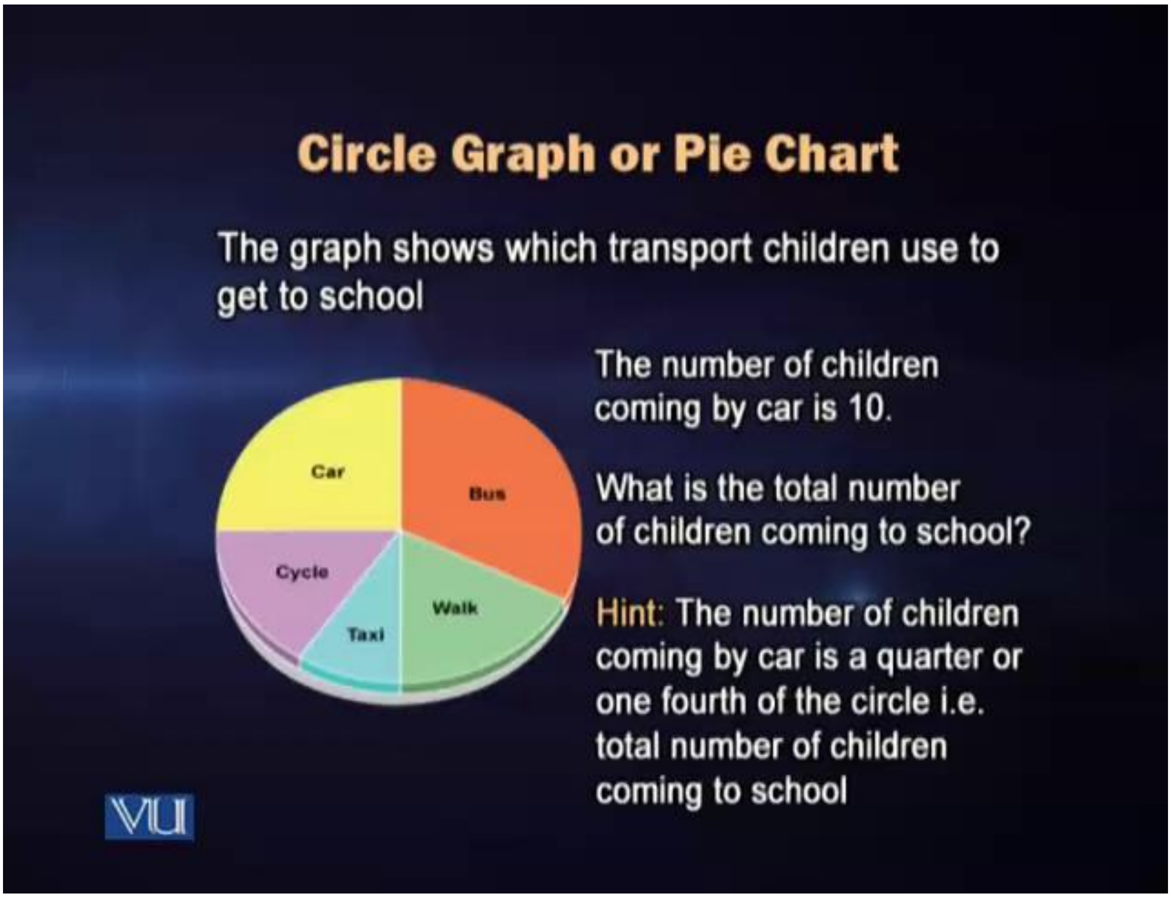
Teacher encourages the third grade students to not only analyze this type of graphs but also develop some graphs on their own. Pictograph is visually attractive and they are easy to interpret.

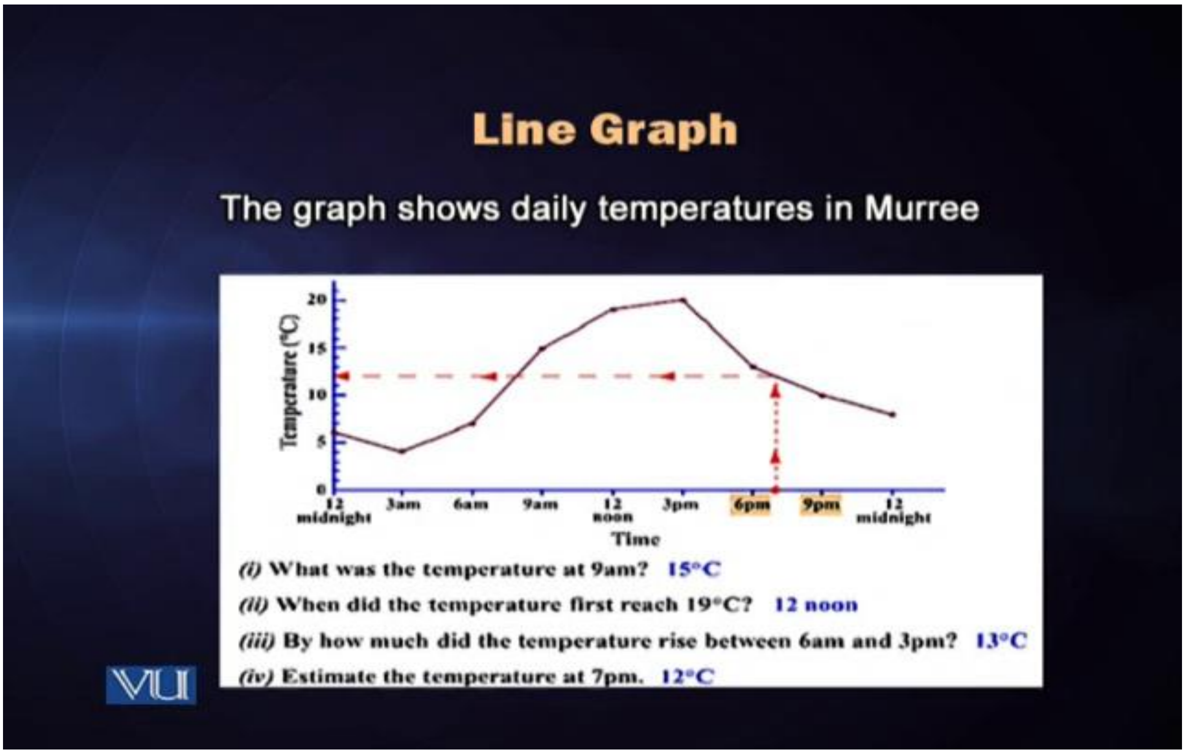
Sample of Bar graph



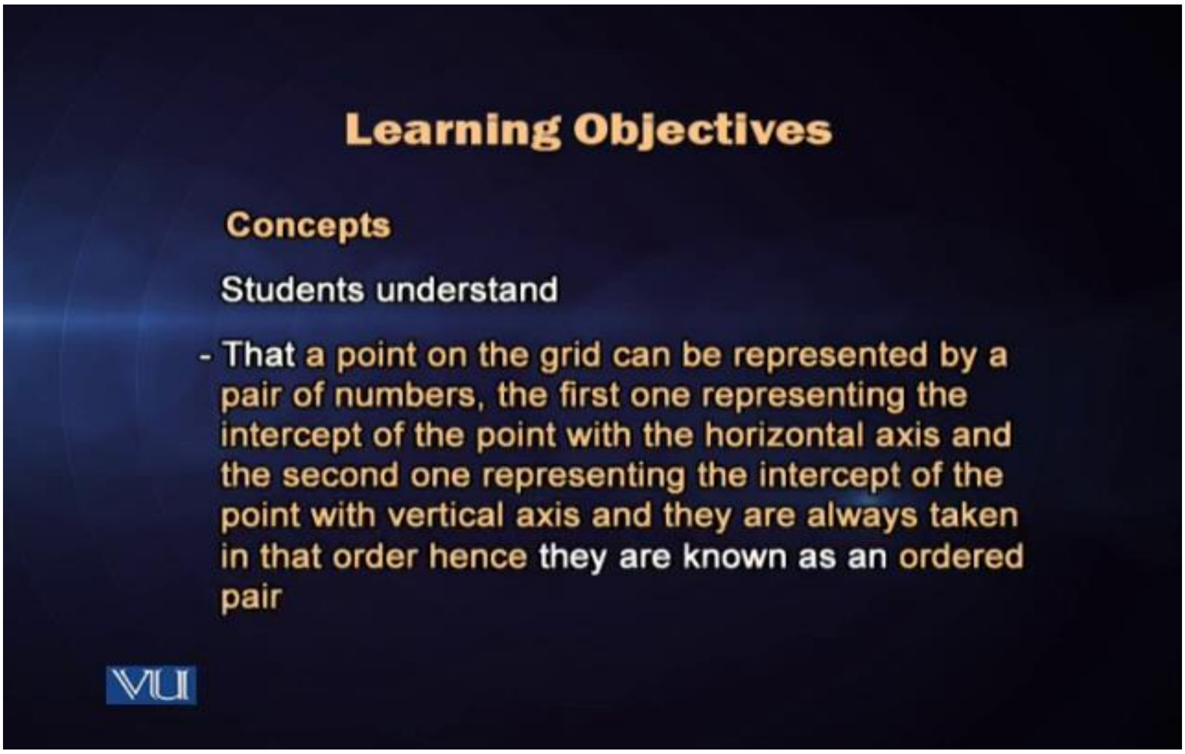
In this type of graph we represent the quantity of given information or data in terms of columns. The above bar graph is about the favorite animals of the students. We have four types of animals and the graph shows the number of the students liking each animal.

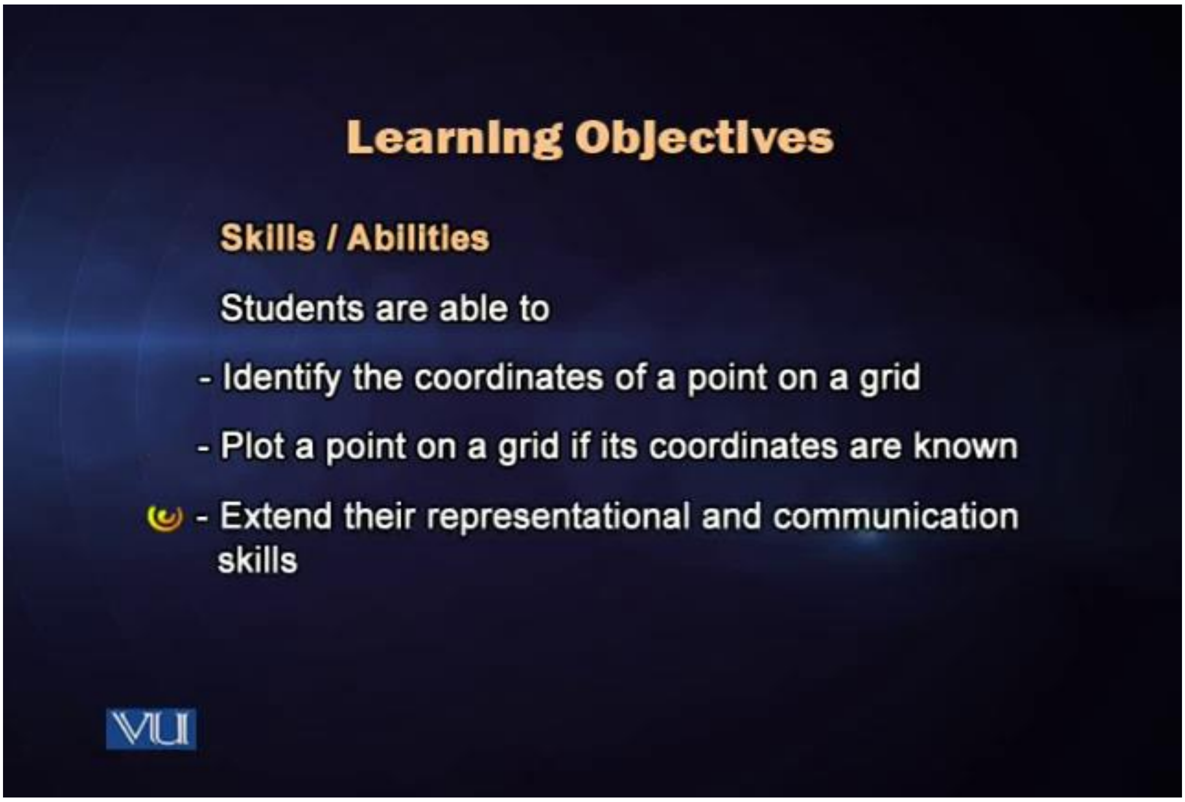

Student's Favorite Color
Number of Students
25
20
15
10
5
0
Red Blue Green Black Pink
Favorite Color
VU

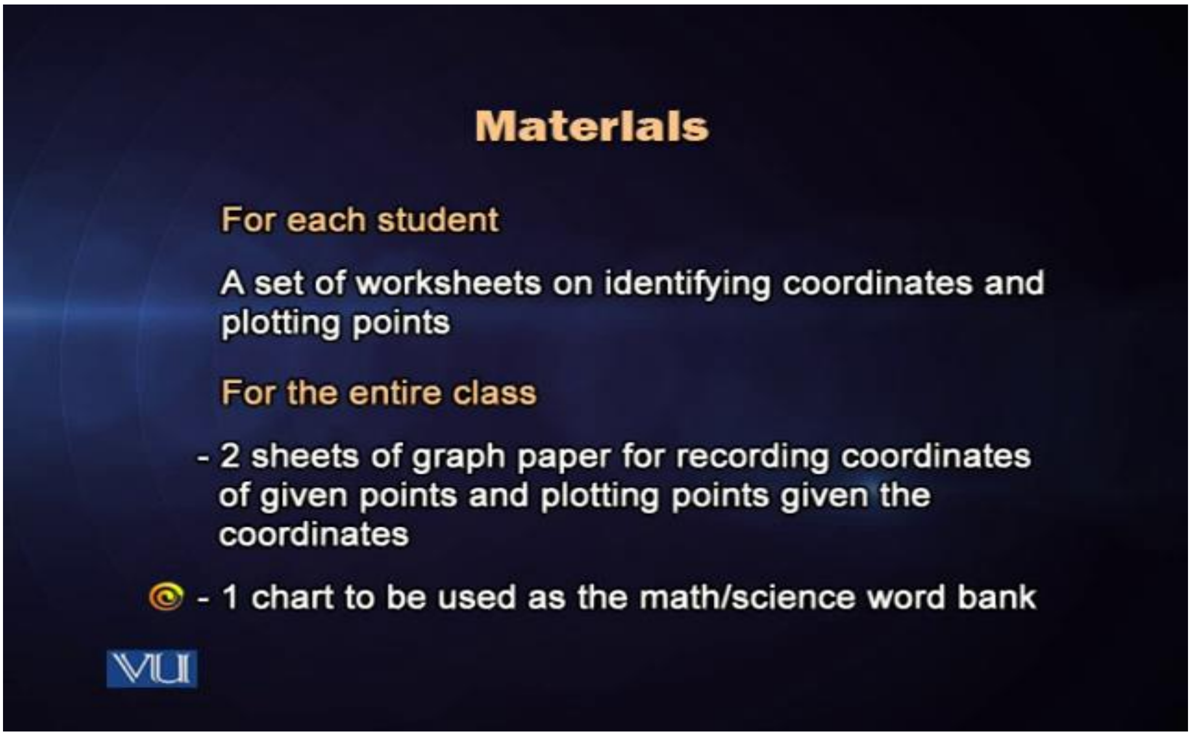

Circle Graph or Pie Chart
The graph shows which transport children use to get to school
Car
Bus
Cycle
Taxi
Walk
The number of children coming by car is 10.
What is the total number of children coming to school?
Hint: The number of children coming by car is a quarter or one fourth of the circle i.e. total number of children coming to school
VU

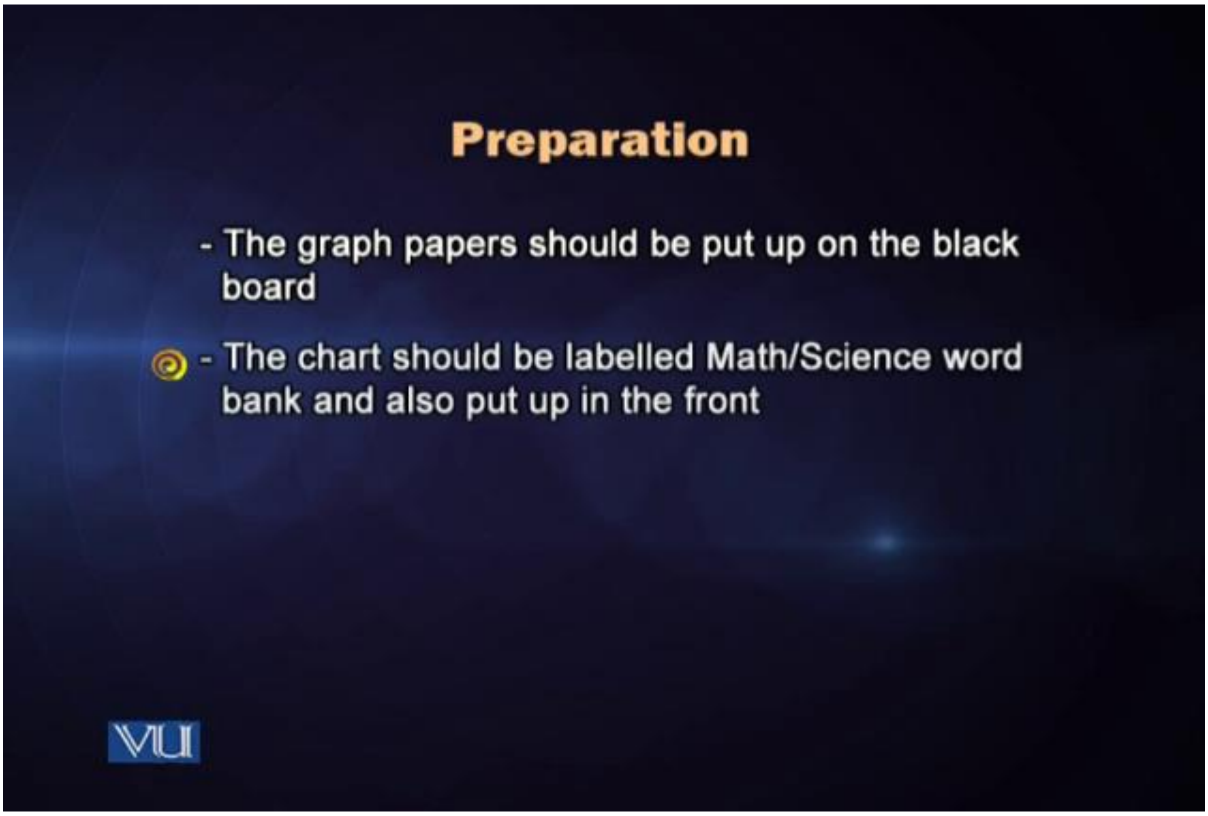


To show the quantity which vary with time we use line graph.

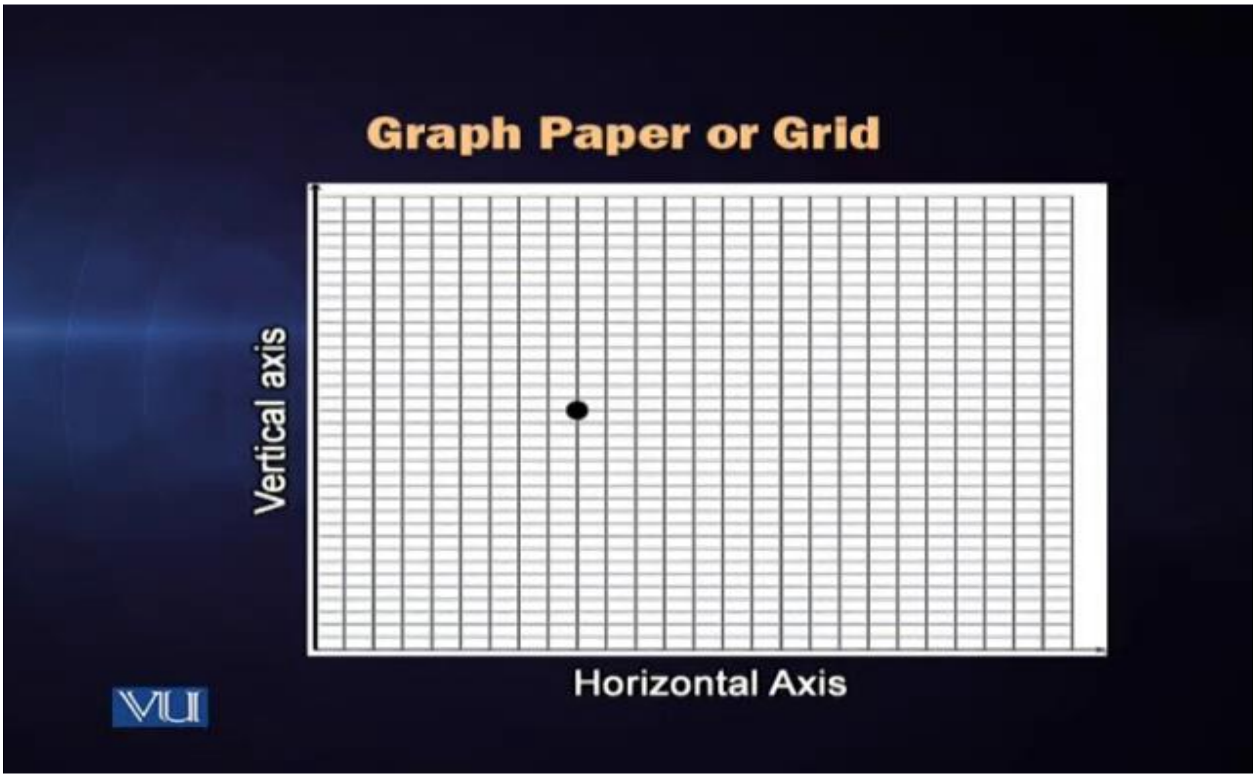

Learning Objectives
Concepts
Students understand
- That a point on the grid can be represented by a pair of numbers, the first one representing the intercept of the point with the horizontal axis and the second one representing the intercept of the point with vertical axis and they are always taken in that order hence they are known as an ordered pair
VU


Learning Objectives
Skills / Abilities
Students are able to
- Identify the coordinates of a point on a grid
- Plot a point on a grid if its coordinates are known
- Extend their representational and communication skills
VU

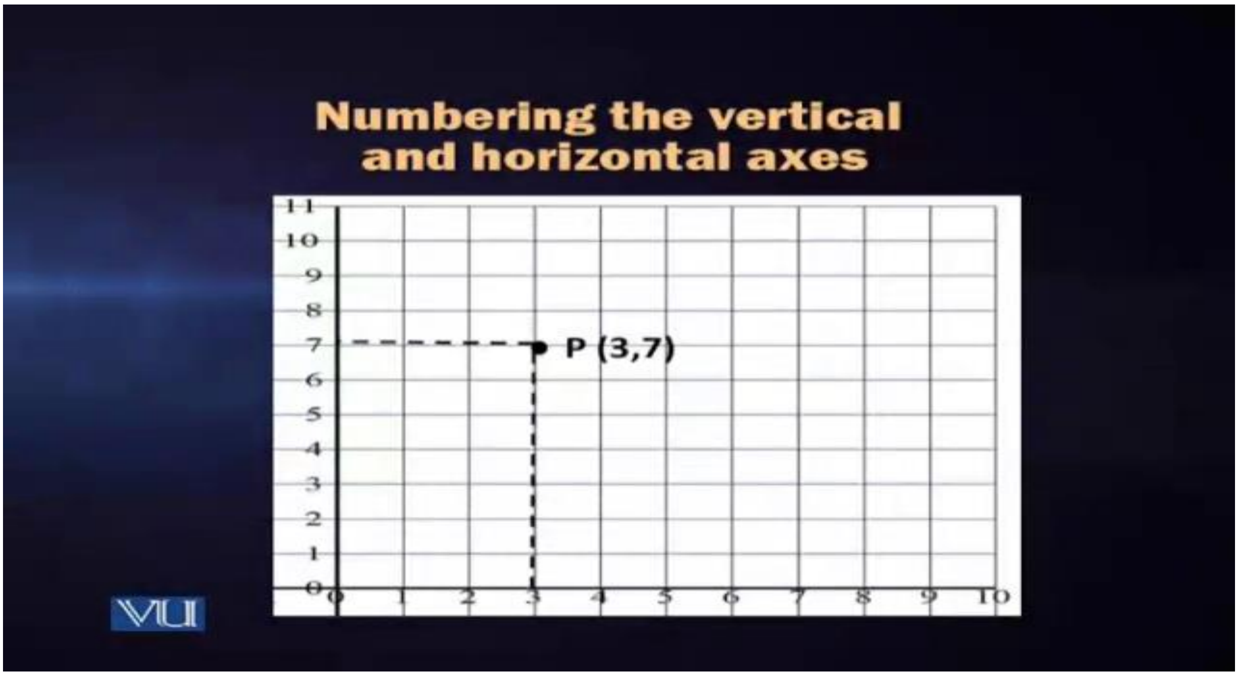

Materials
For each student
A set of worksheets on identifying coordinates and plotting points
For the entire class
- 2 sheets of graph paper for recording coordinates of given points and plotting points given the coordinates
- 1 chart to be used as the math/science word bank
VU


Preparation
- The graph papers should be put up on the black board
- The chart should be labelled Math/Science word bank and also put up in the front
VU

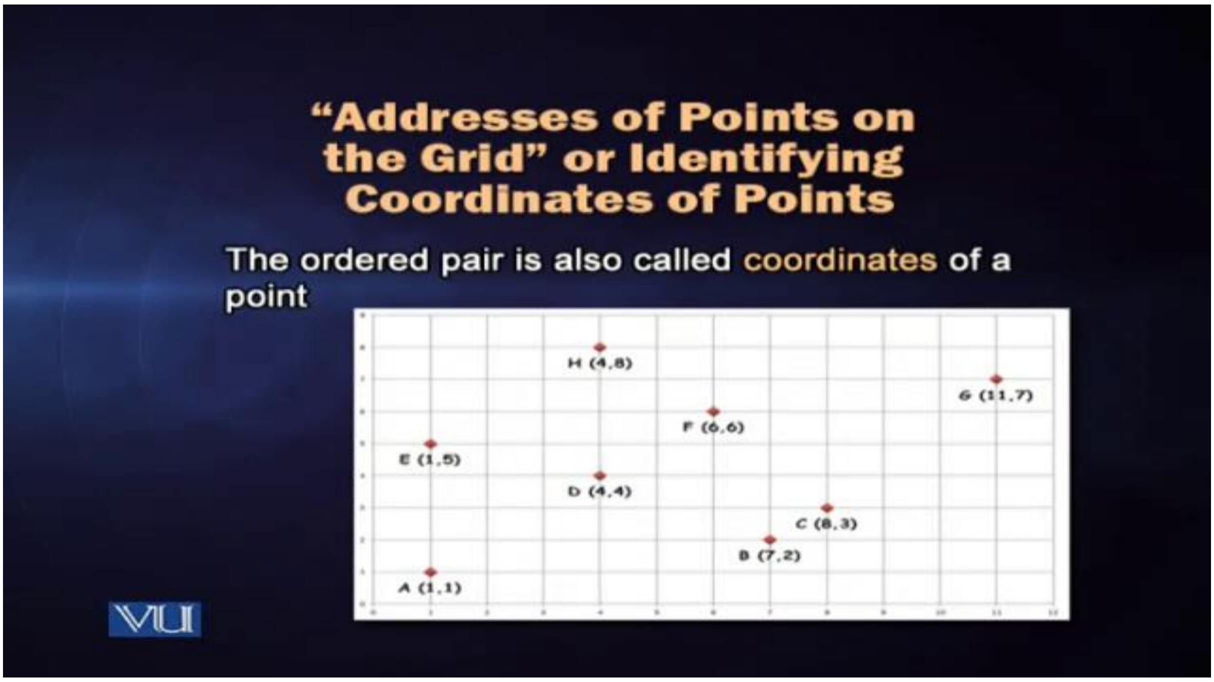
In the class activity firstly, teacher tells the students that they will develop the tools that are needed to understand the changes of states. Making graph is very important skill in science. It is one of the most powerful ways of putting information down and shares it with people. For understanding the graph paper, firstly we want to know about the vertical and horizontal lines. Line coming from top to down is vertical and going from left to right is called horizontal line. When there are a lot of equal blocks of vertical and horizontal lines it is called a “grid”. Sample of Grid is given below



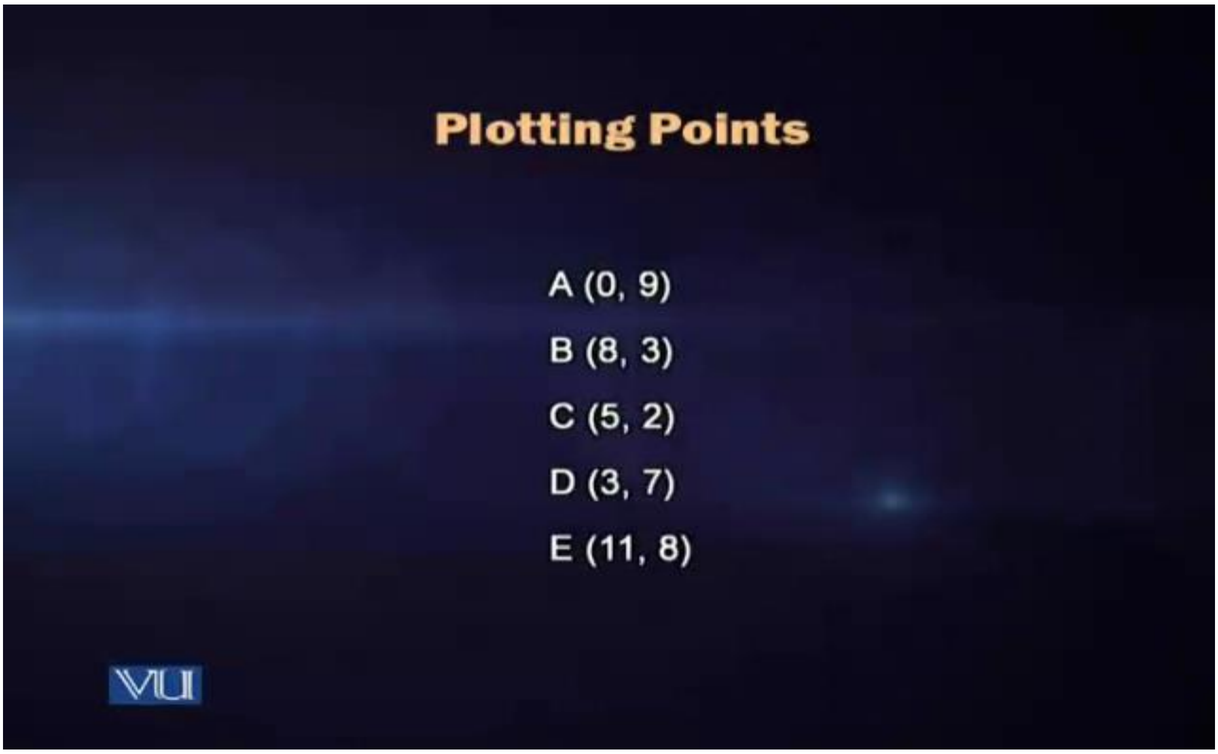
The next step is to show the information on this grid. The vertical and horizontal lines are called “axis”. These are also called the coordinate axis. Teacher will write the words of grid and axis in the words bank chart and revisit these words because these are new for the students. On both sides of axis the numbers are written. Next step is numbering the vertical and horizontal axis.



Pair of number that we show on our axis is called an ordered pair because it always comes in some order. The number on horizontal axis always come first and the number on vertical axis always come after. The ordered pair is also called the coordinates of points. Teacher will practice the coordinate points with the students. "Coordinate pairs are means of putting the point on the grid".



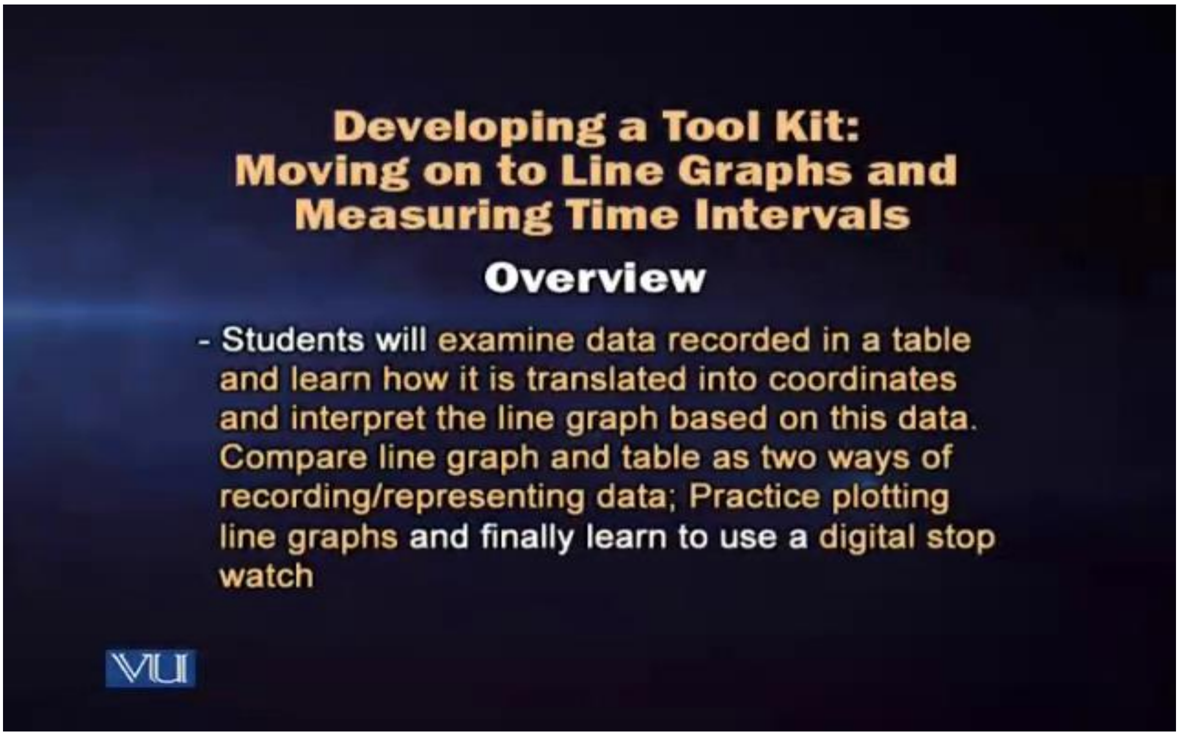
At last teacher will write the plotting points. And the students will fill their work sheets.

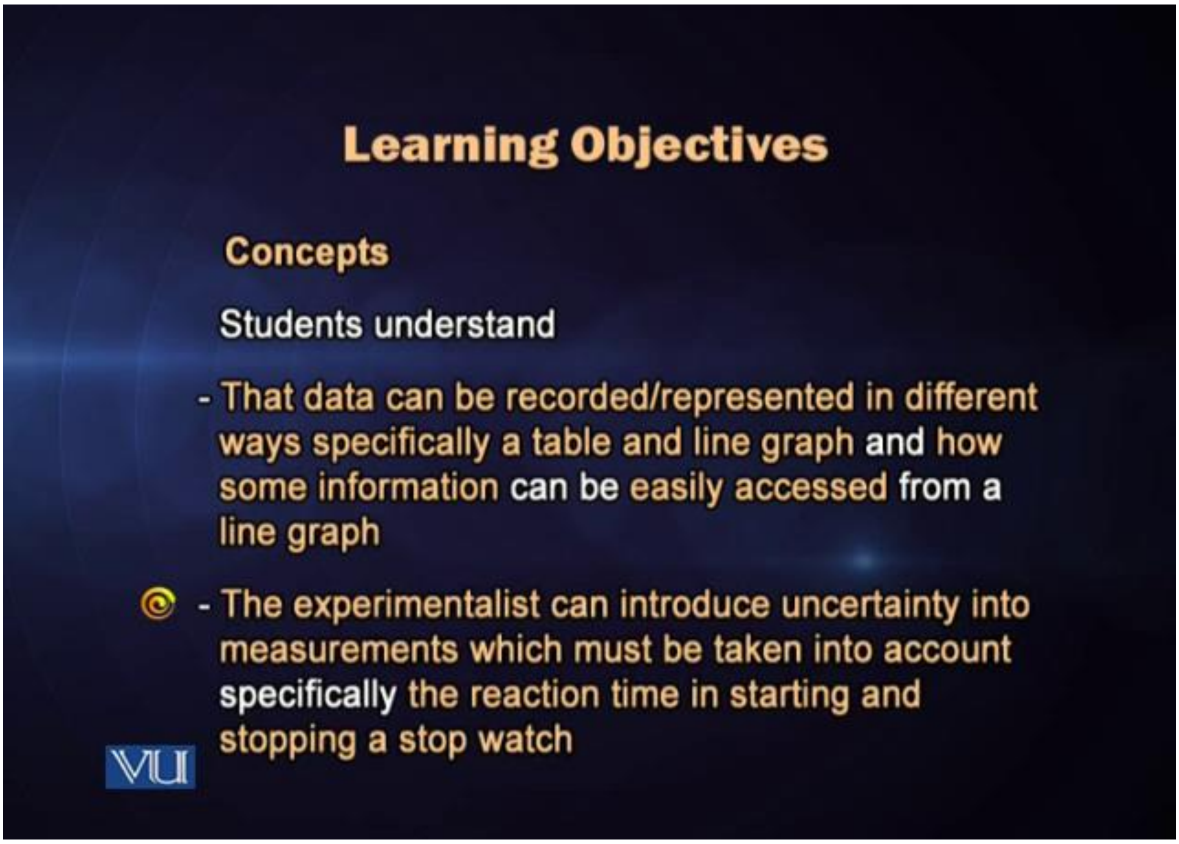


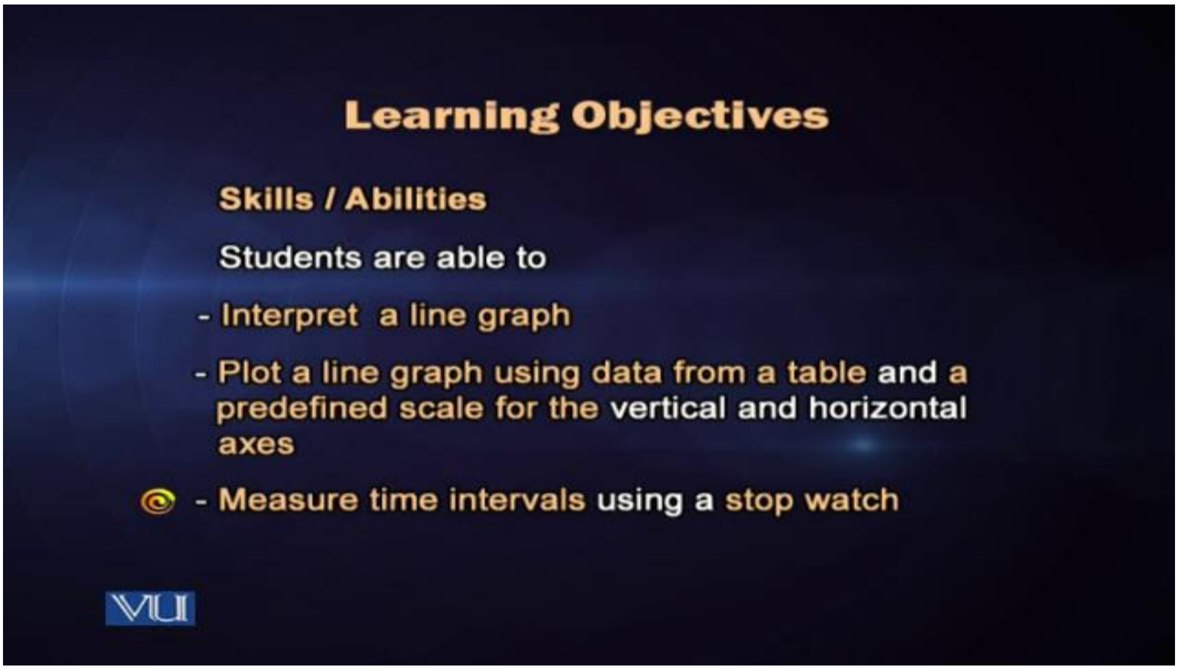
Teacher will call the students on the board and tell them to plot the points on the graph.

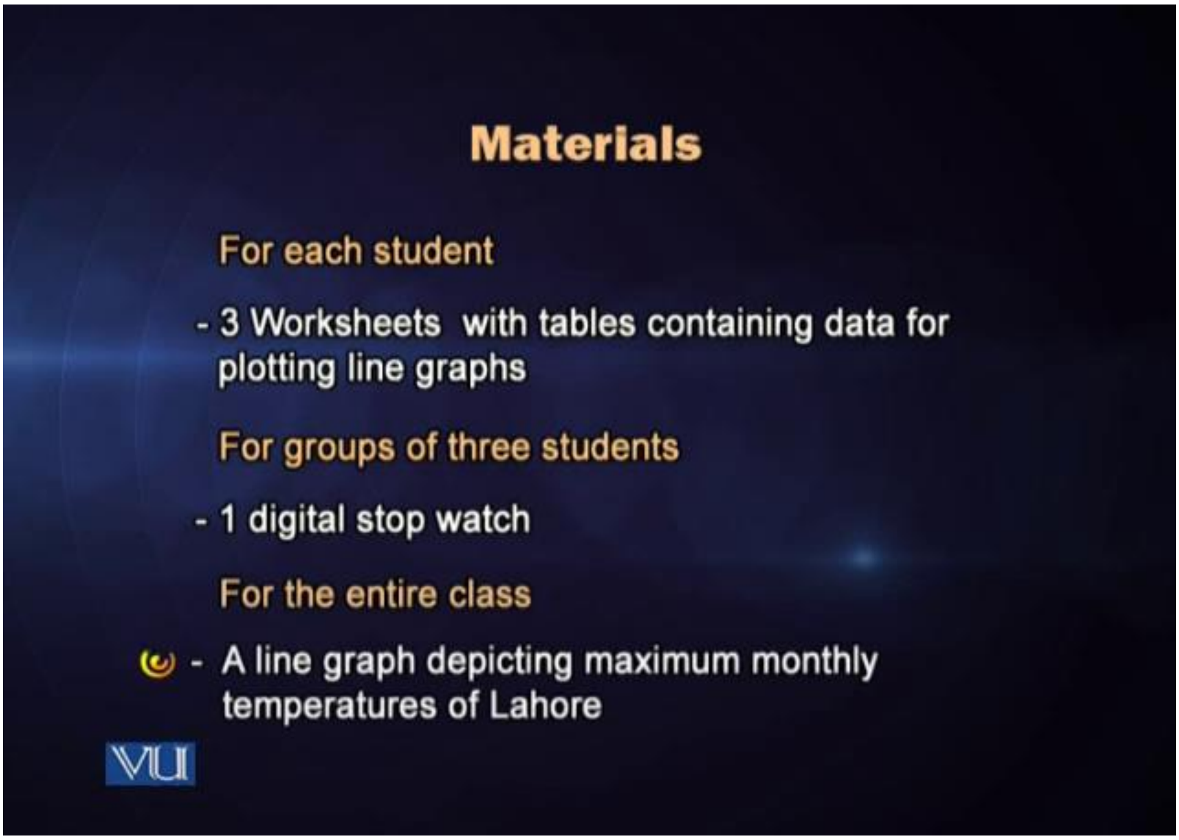
Lecture No 24

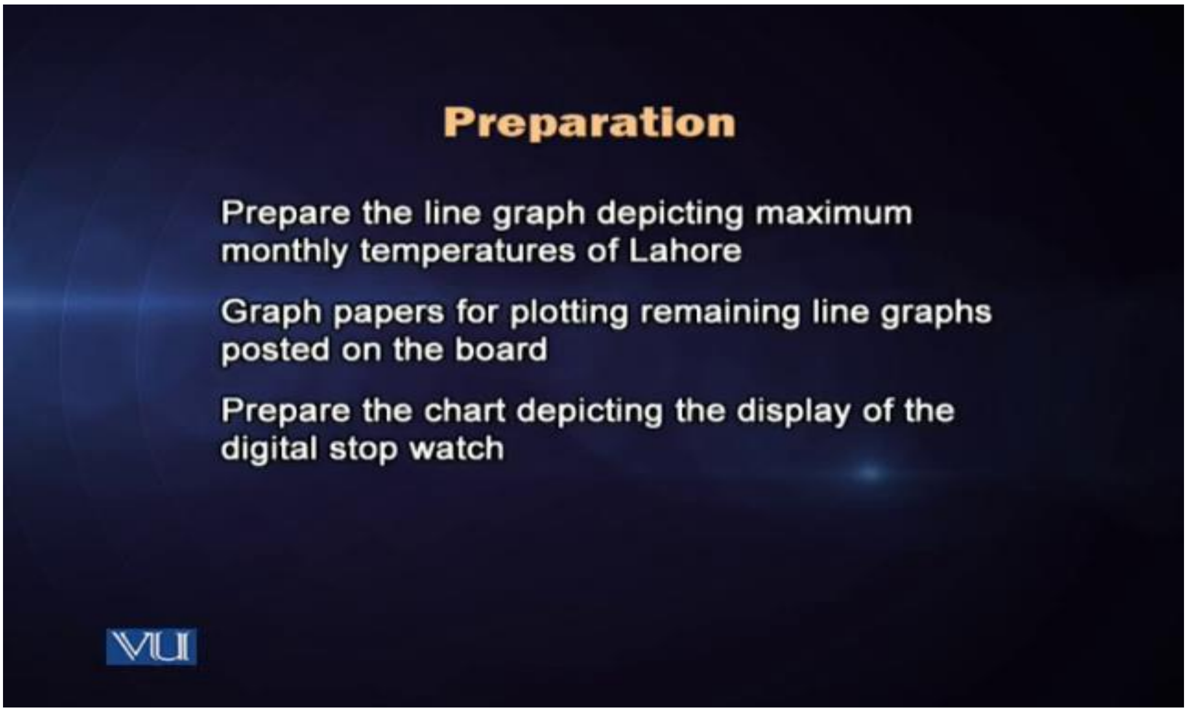
Developing a Tool Kit for measuring the Time Interval






Learning Objectives
Skills / Abilities
Students are able to
- Interpret a line graph
- Plot a line graph using data from a table and a predefined scale for the vertical and horizontal axes
- Measure time intervals using a stop watch
VU


Materials
For each student
- 3 Worksheets with tables containing data for plotting line graphs
For groups of three students
- 1 digital stop watch
For the entire class
- A line graph depicting maximum monthly temperatures of Lahore
VU



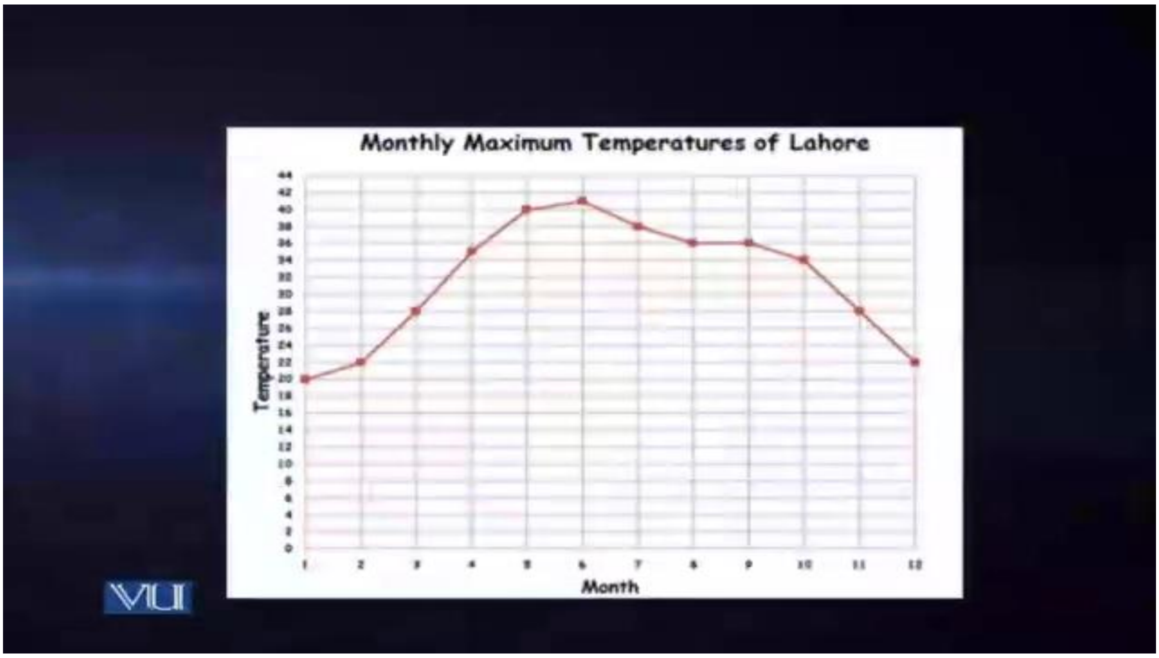
In the class activity teacher told the students that there were two columns in their worksheets one was of months and the other was of temperature. One way of getting the information is a table.

For example:

Monthly Maximum Temperatures of Lahore

Month	Temperature °C
1 (January)	20
2 (February)	22
3 (March)	28
4(April)	35
5(May)	40
6(June)	41
7(July)	38
8 (August)	36
9 (September)	36
10 (October)	34
11 (November)	28
12 (December)	22

Then teacher focused on the information on the axes. Horizontal axes represented the months and the vertical axes represented the temperature. Teacher told the students to point the ordered pairs in the graph. Then they drew a line with these points. It took a form of a curve. The top most point of the curve had the maximum temperature. If there was a flat line on the graph it shows that there are same numbers. For example in the above table August and September had the same Temperature so in the graph they would have the flat line.

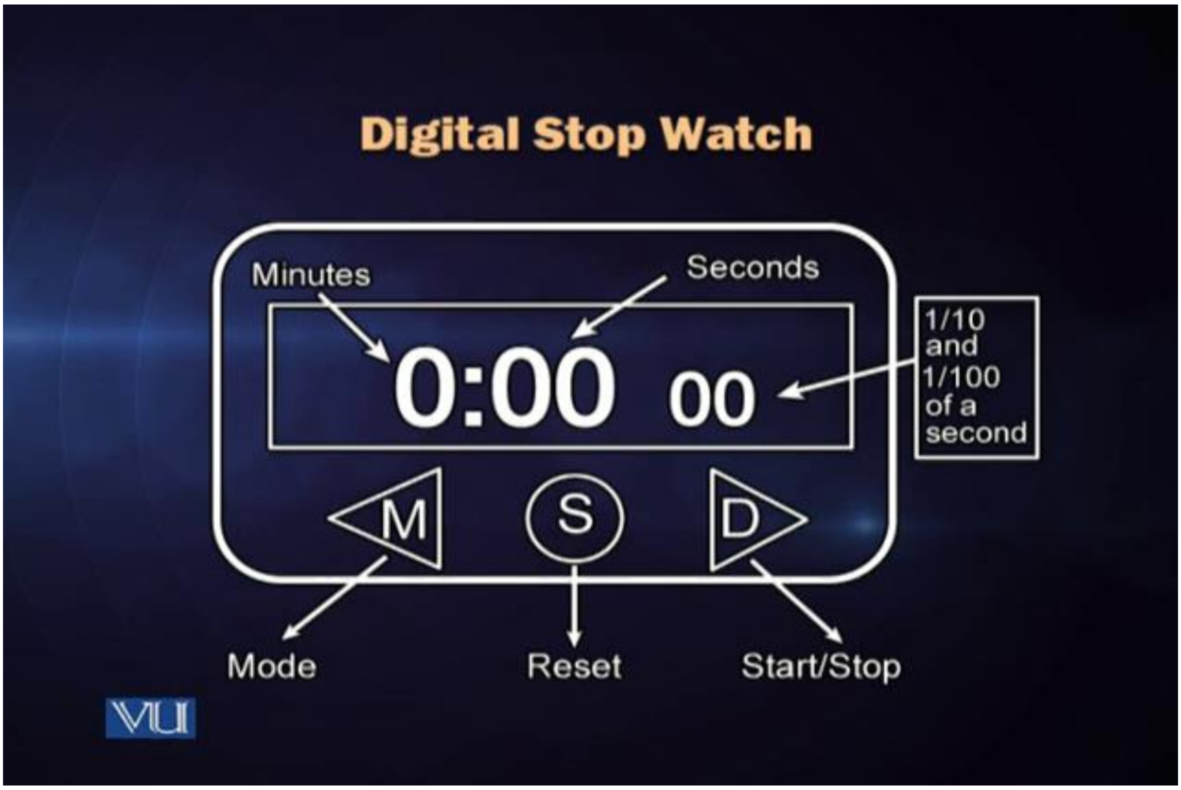


Uses of Line graph

- We can understand the information by seeing the line graph easily.
- Children will be able to identify the coordinate points through line graph.
- We can immediately assess the maximum and minimum points through line graph even without focusing the numbers.
- We can also see the variation through line graph.

Teacher gave them some situations related to their lives. And students draw the line graphs on their worksheets.

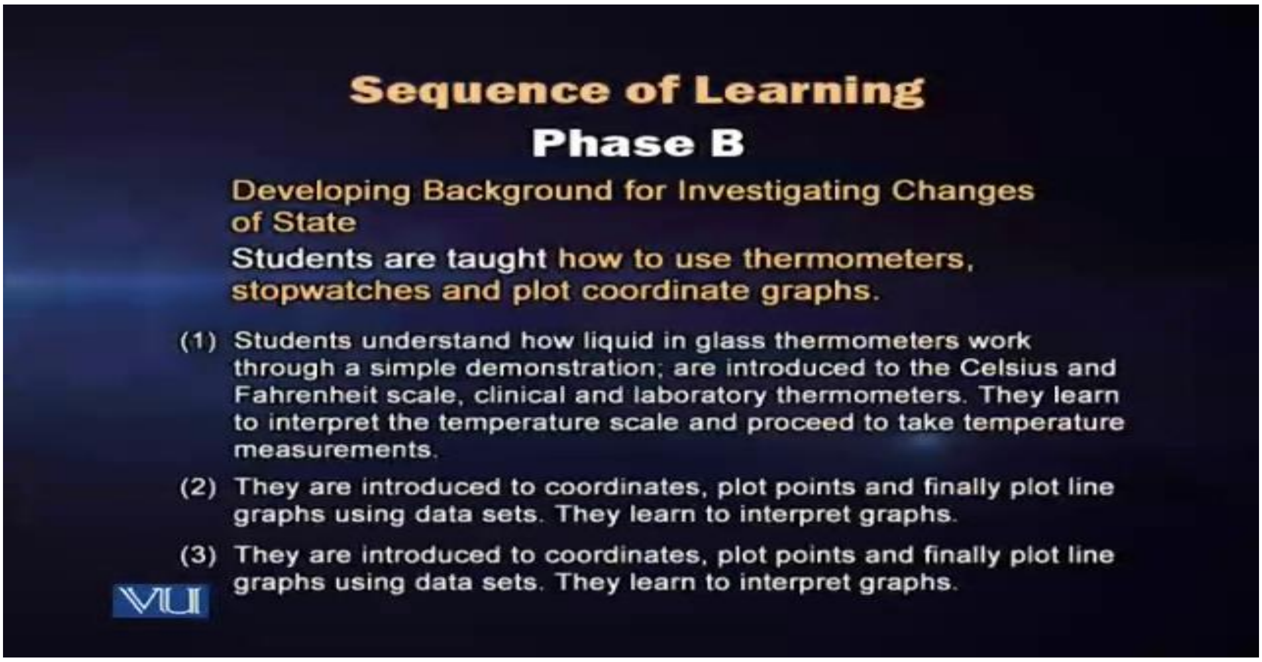
Then the teacher started teaching the use of stop watch. Teacher showed them the display of watch first.

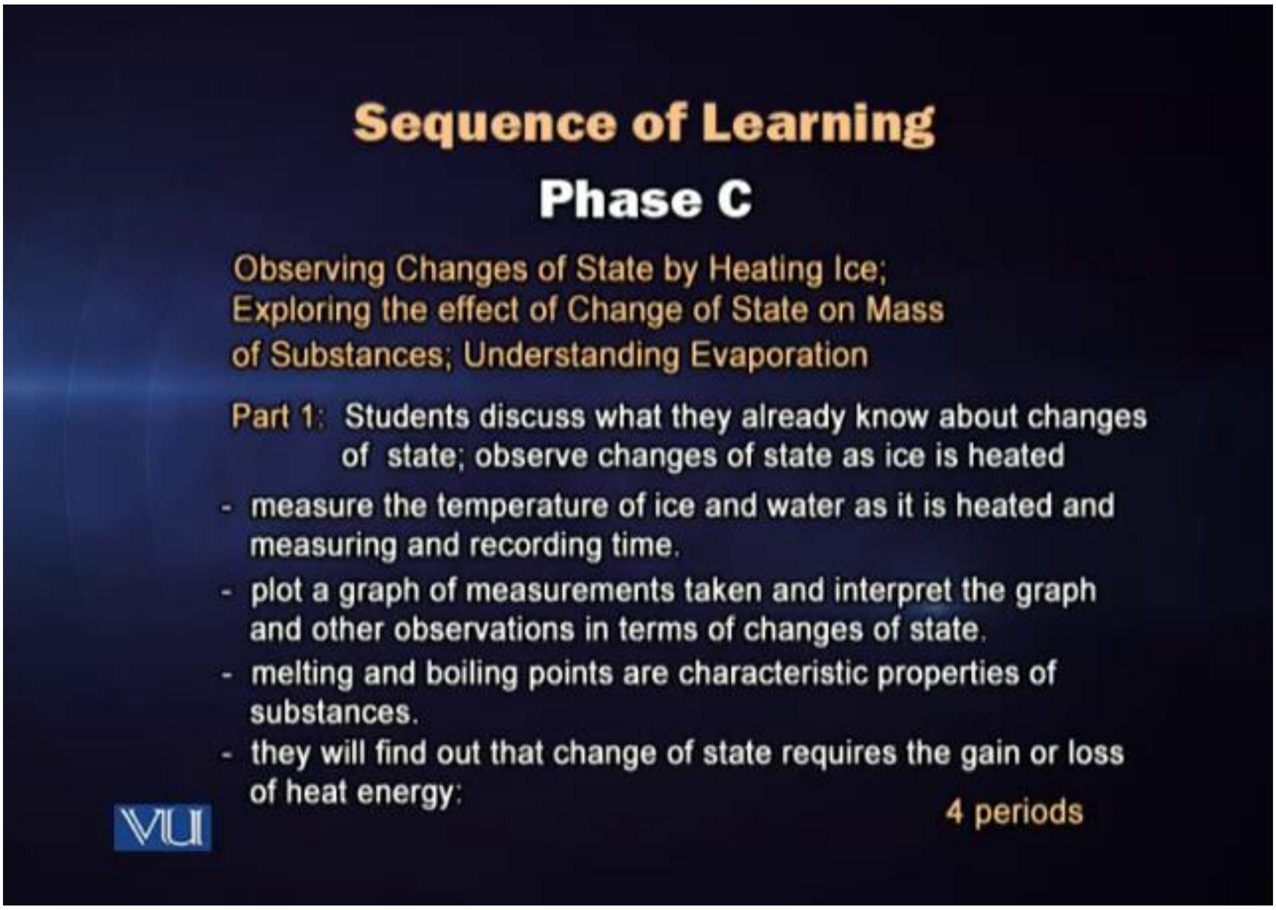


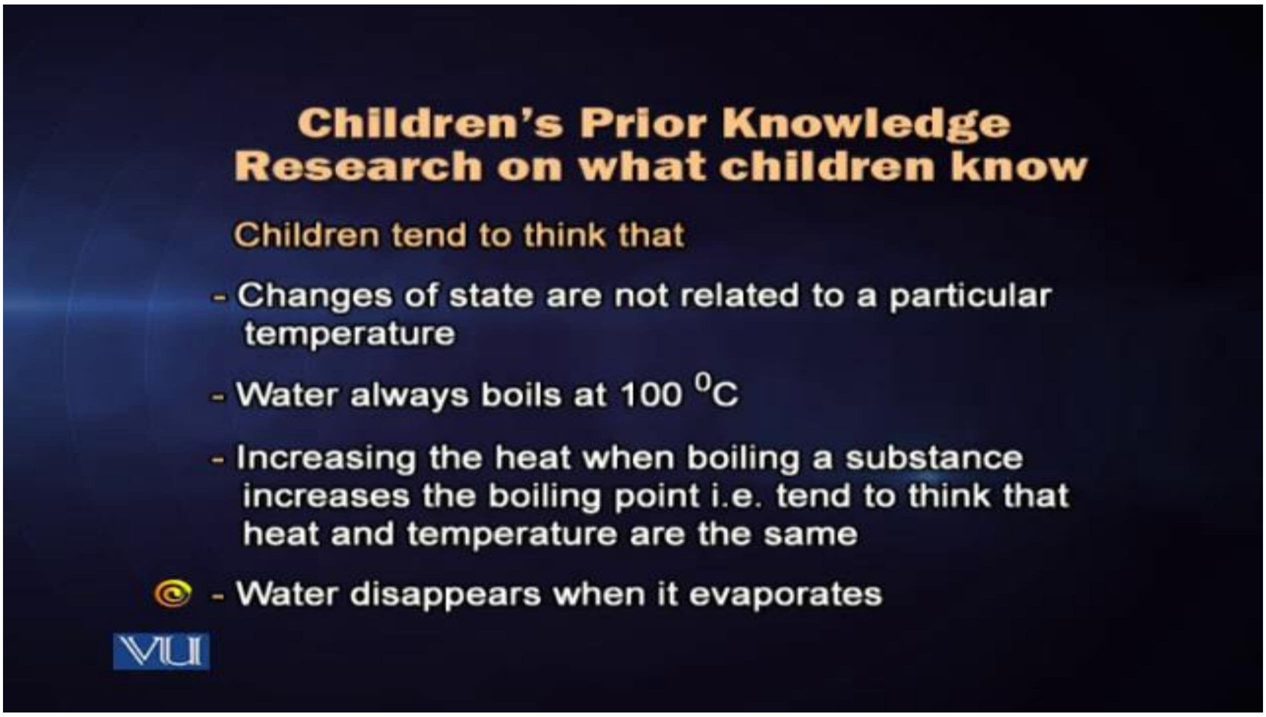
Teacher taught the students all above features of stop watch and how to use it.

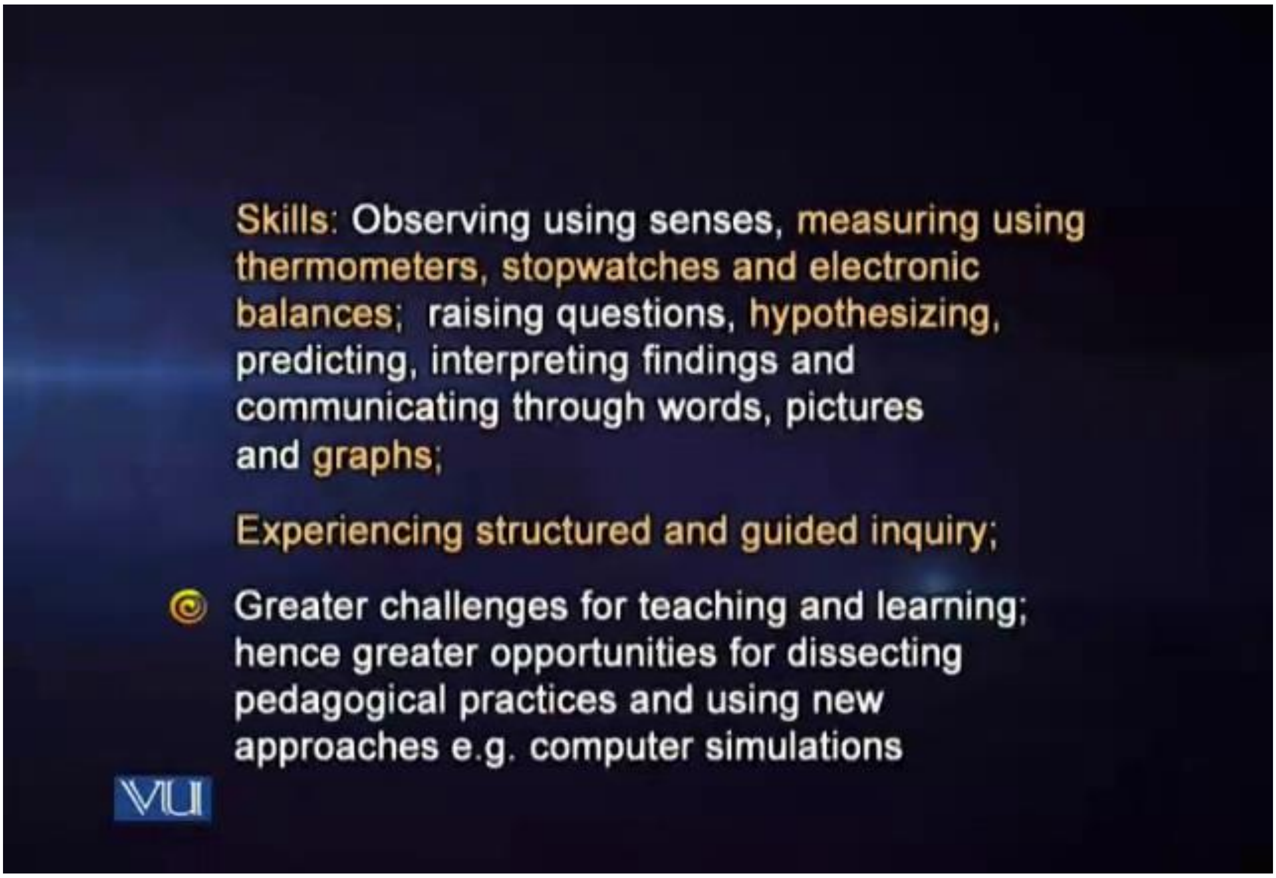
Lecture No 25

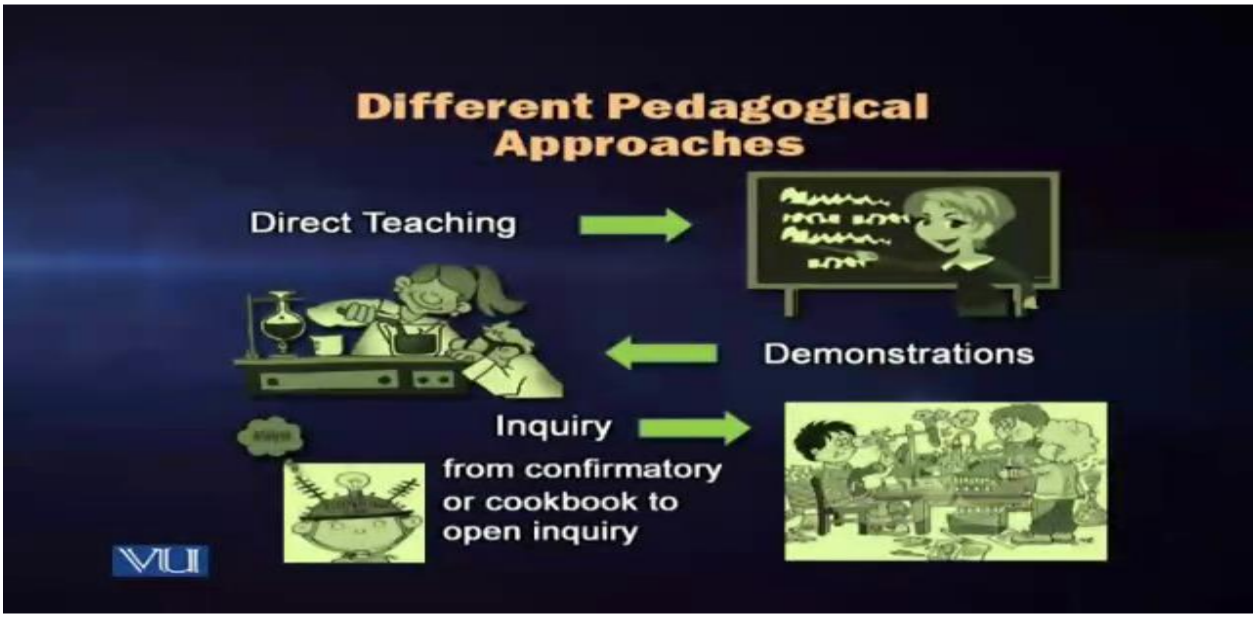
Observing changes of state by heating Ice 1





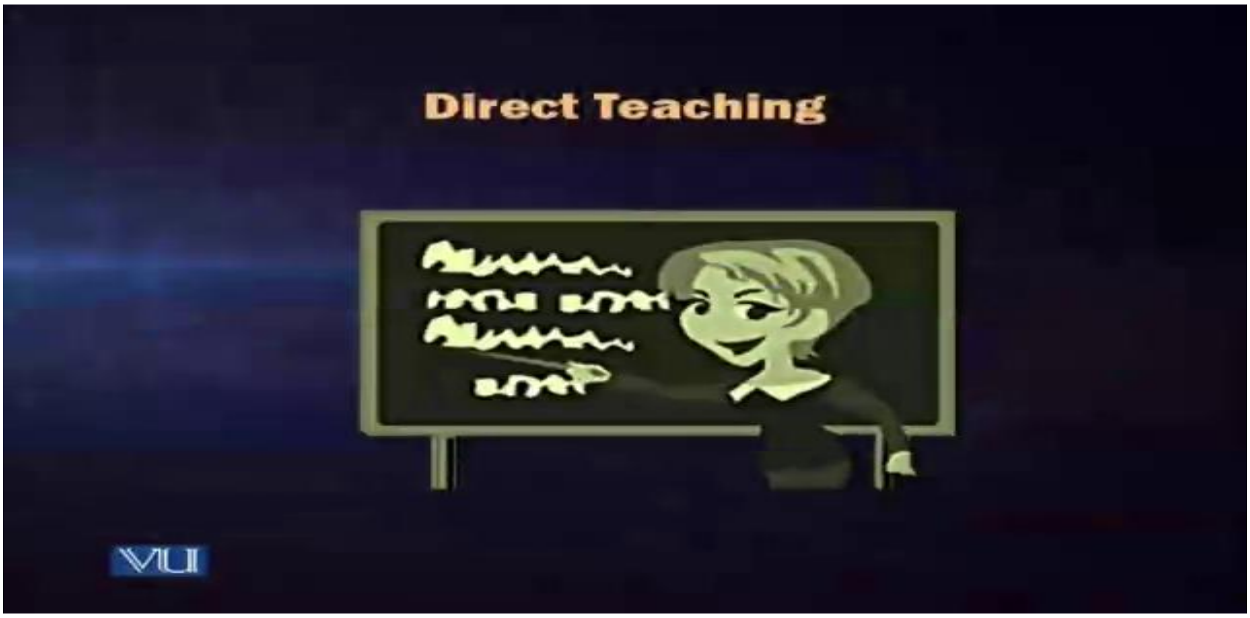

Children's Prior Knowledge
Research on what children know
Children tend to think that
- Changes of state are not related to a particular temperature
- Water always boils at 100 ^{0}C
- Increasing the heat when boiling a substance increases the boiling point i.e. tend to think that heat and temperature are the same
- Water disappears when it evaporates
VU


Skills: Observing using senses, measuring using thermometers, stopwatches and electronic balances; raising questions, hypothesizing, predicting, interpreting findings and communicating through words, pictures and graphs;
Experiencing structured and guided inquiry;
Greater challenges for teaching and learning; hence greater opportunities for dissecting pedagogical practices and using new approaches e.g. computer simulations
VU



Direct Teaching

Direct teaching is teacher centered approach. In this approach teacher helps the students to acquire the skills. For example teaching the students how to use a stopwatch or a thermometer, teacher uses the direct instruction method. In direct instruction teacher not only gives the information but also try to engage the students constantly. Direct teaching must not be only giving the lecture but also teacher must know whether the students are understanding the facts or not.

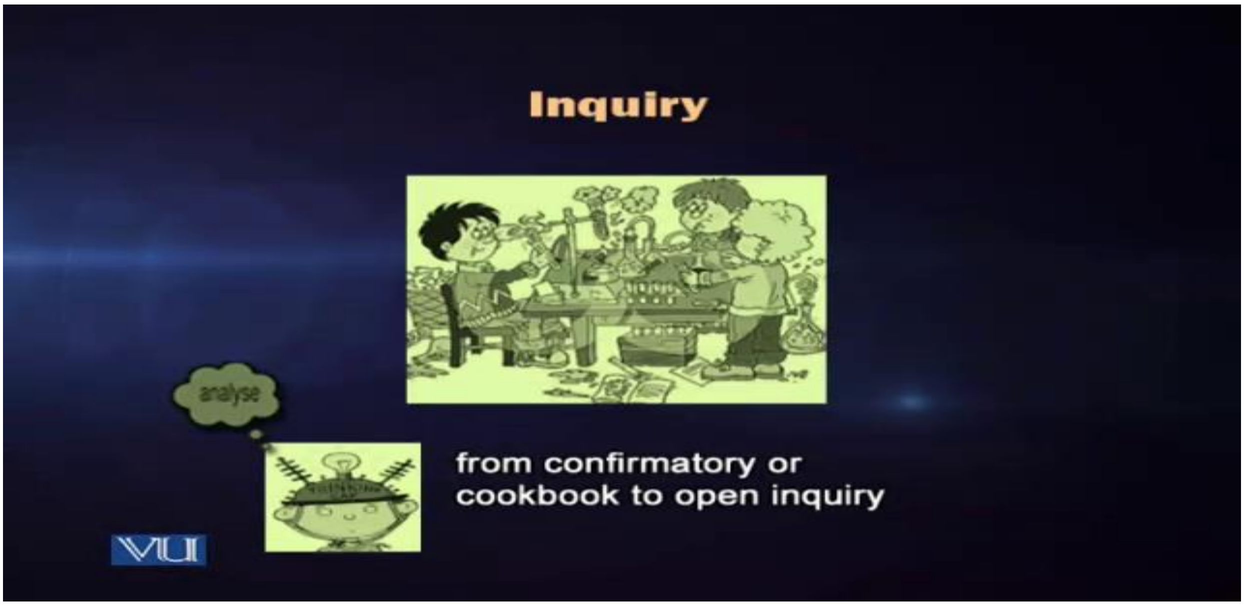


Demonstration

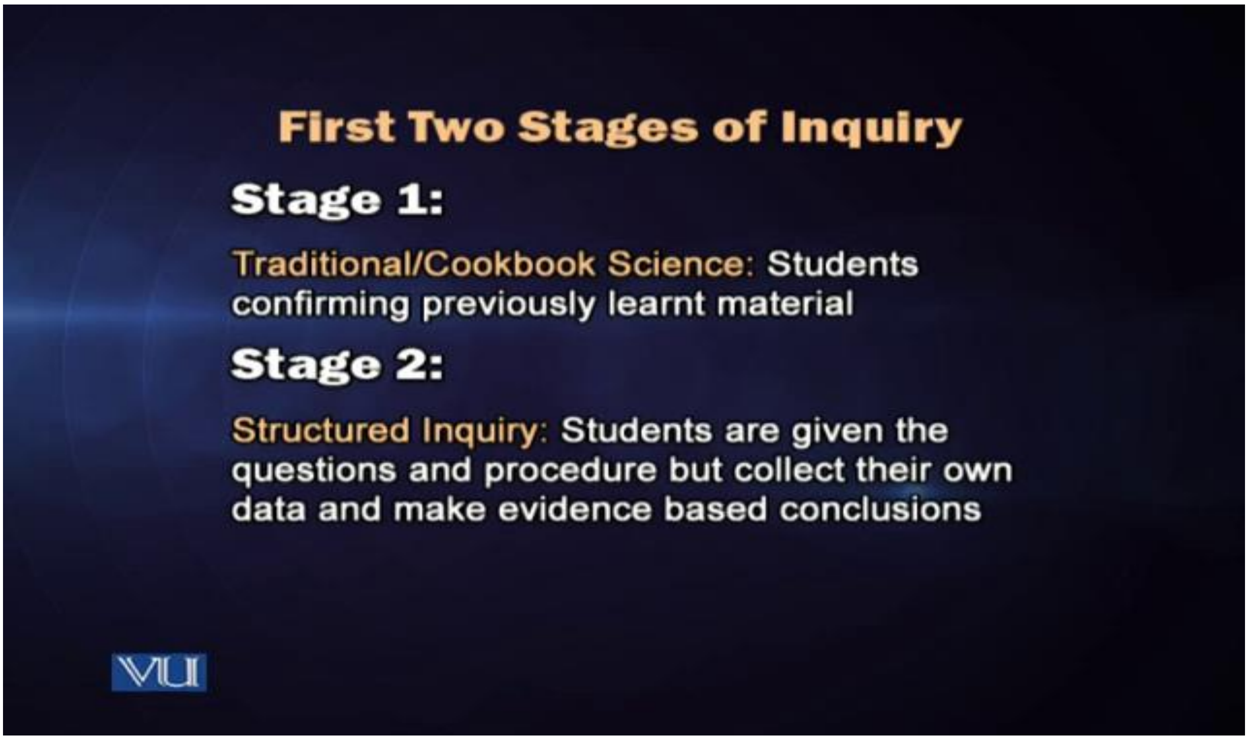
In demonstration method teacher is actually conducting the experiments but we must have the pupil involvement also.

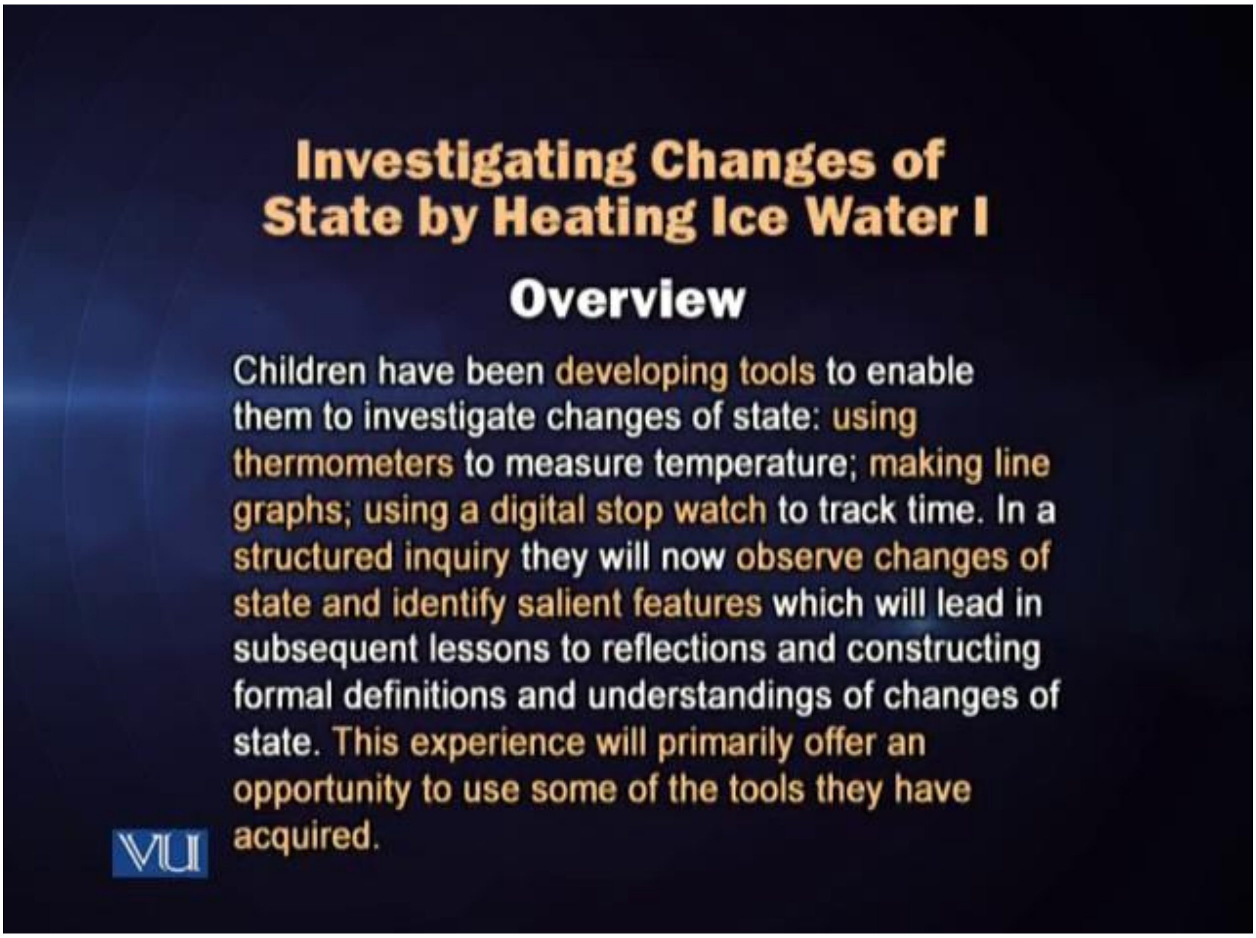
Inquiry

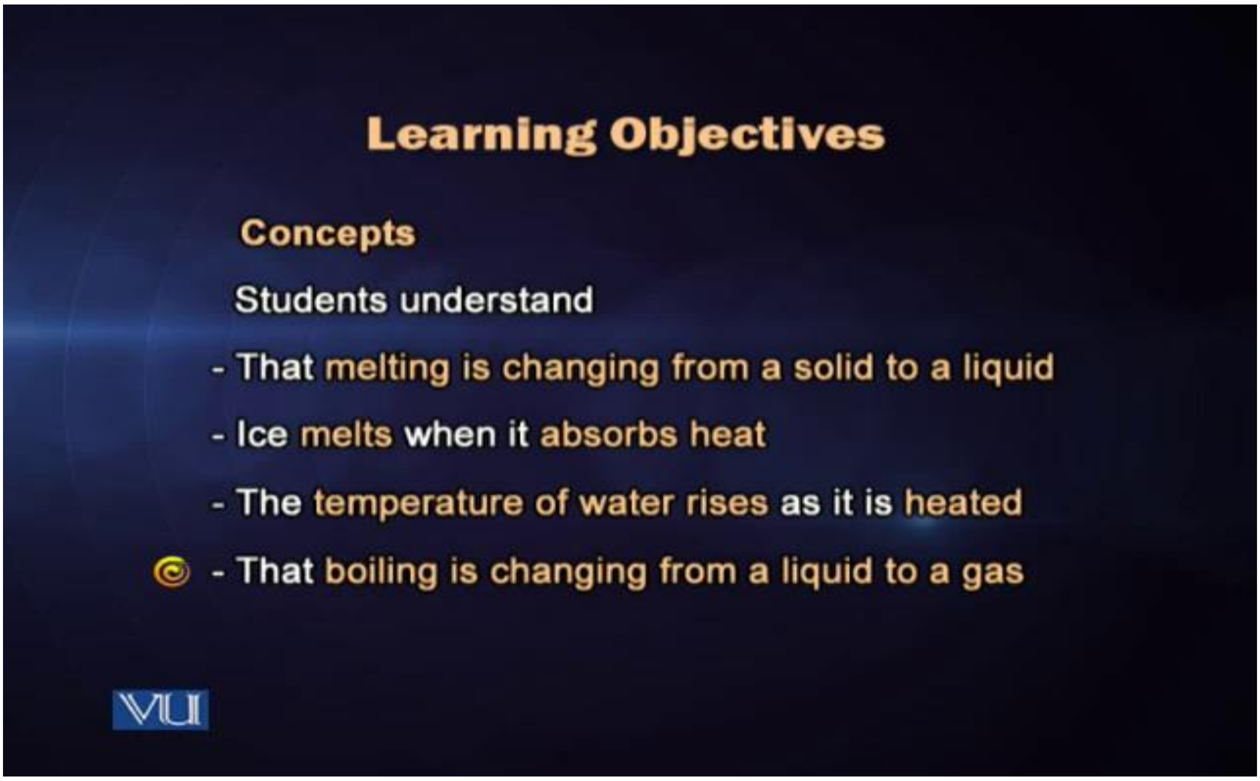
Inquiry is done through experiments. Inquiry is not simply hands-on learning. In inquiry method we collect our data and analyze it. We can do the inquiry without experiments too.

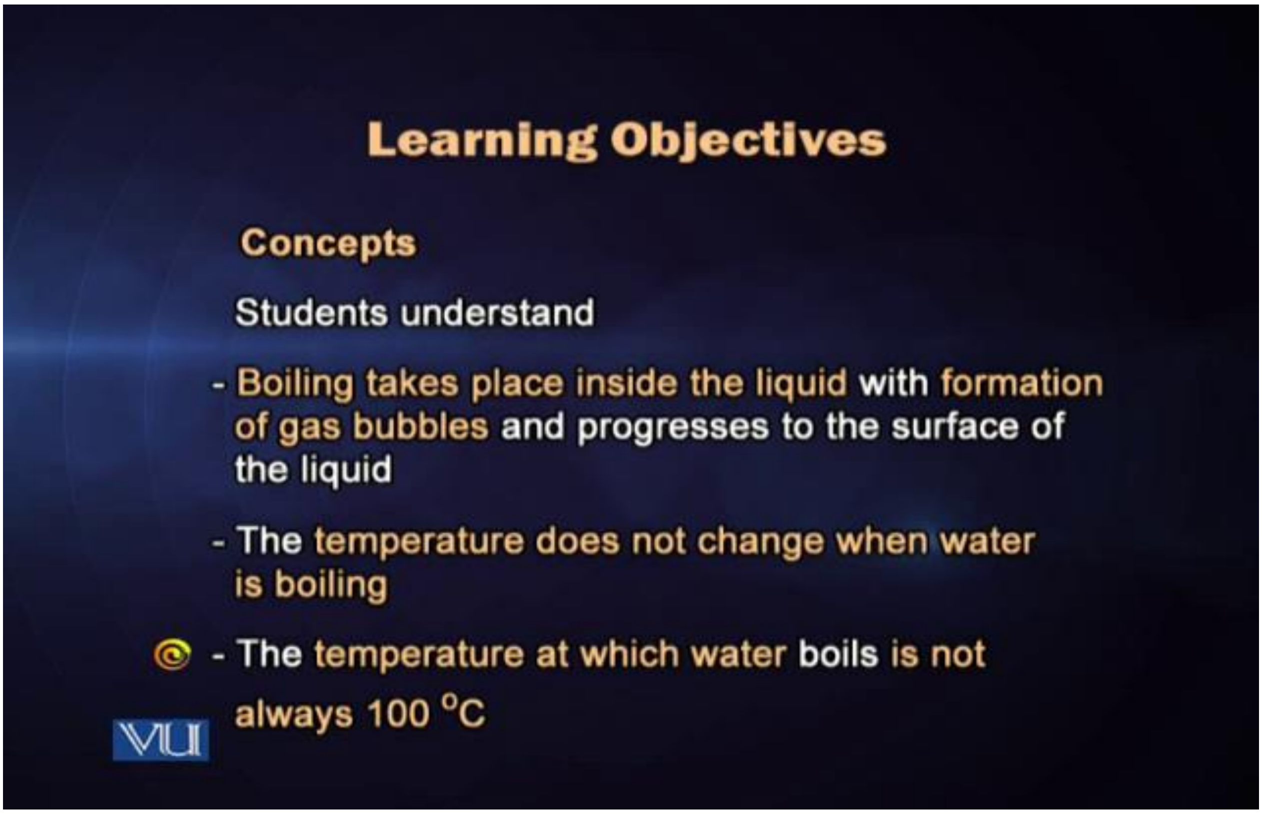


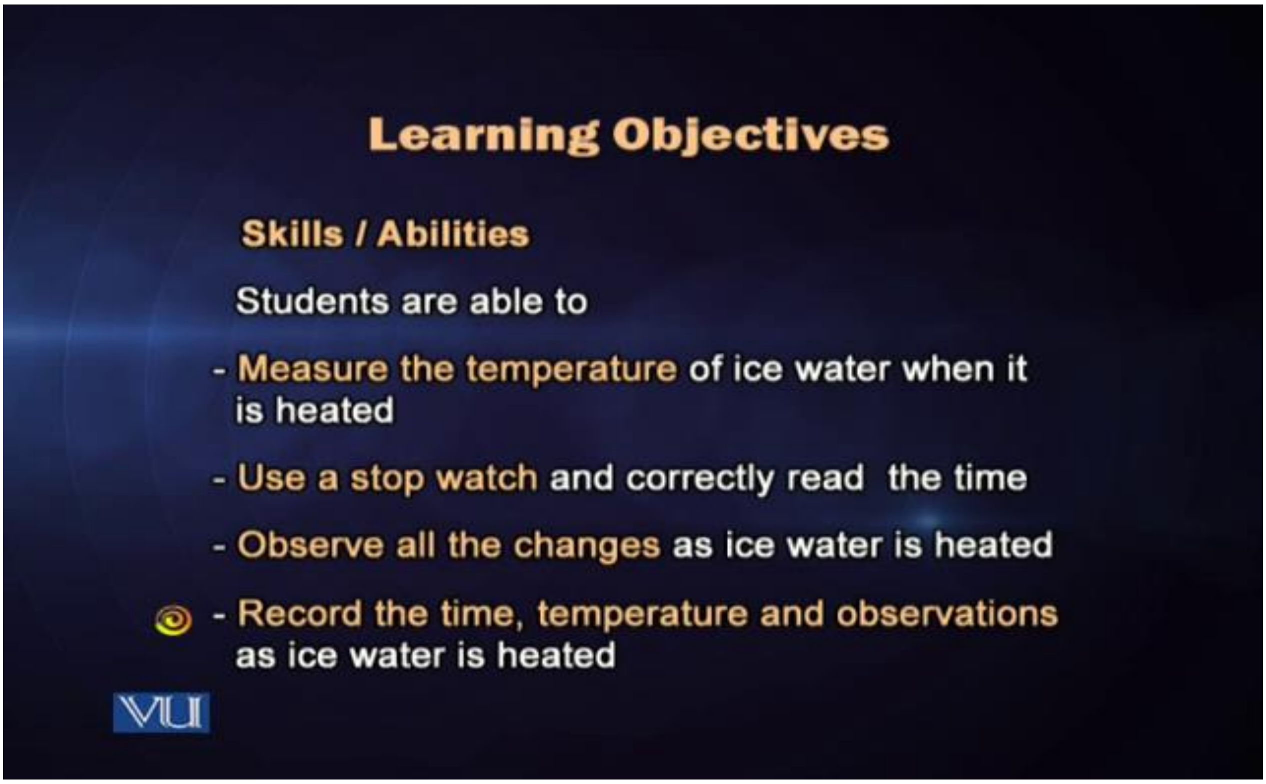
We use all these approaches to empower children to develop the ability to think themselves.

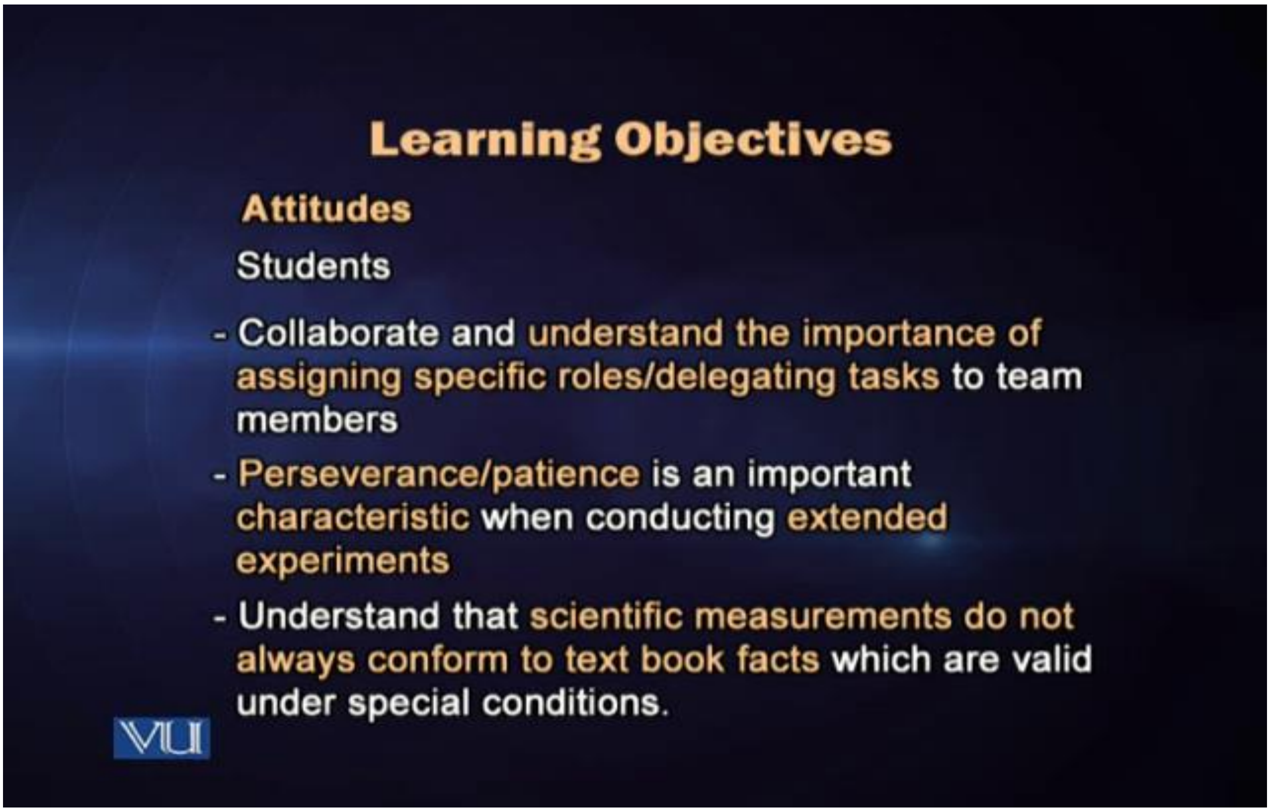

First Two Stages of Inquiry
Stage 1:
Traditional/Cookbook Science: Students confirming previously learnt material
Stage 2:
Structured Inquiry: Students are given the questions and procedure but collect their own data and make evidence based conclusions
VU

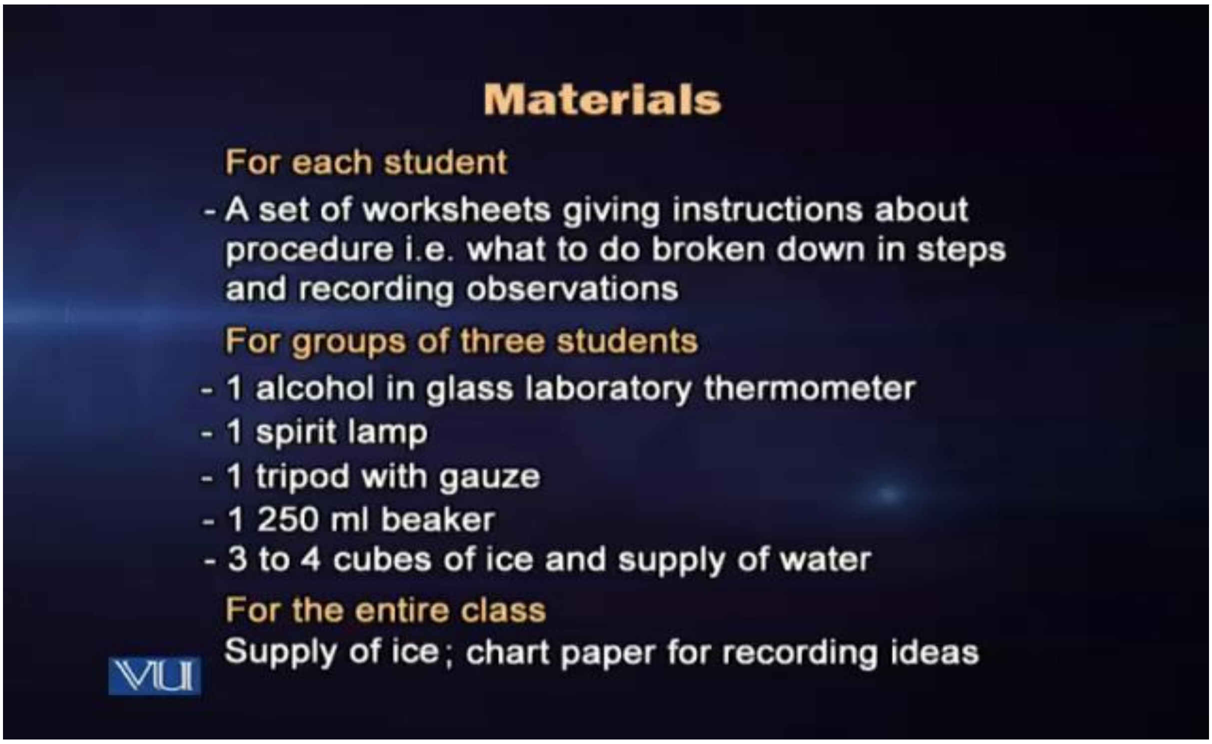

Investigating Changes of State by Heating Ice Water I
Overview
Children have been developing tools to enable them to investigate changes of state: using thermometers to measure temperature; making line graphs; using a digital stop watch to track time. In a structured inquiry they will now observe changes of state and identify salient features which will lead in subsequent lessons to reflections and constructing formal definitions and understandings of changes of state. This experience will primarily offer an opportunity to use some of the tools they have acquired.
VU


Learning Objectives
Concepts
Students understand
- That melting is changing from a solid to a liquid
- Ice melts when it absorbs heat
- The temperature of water rises as it is heated
- That boiling is changing from a liquid to a gas
VU


Learning Objectives
Concepts
Students understand
- Boiling takes place inside the liquid with formation of gas bubbles and progresses to the surface of the liquid
- The temperature does not change when water is boiling
- The temperature at which water boils is not always 100 °C
VU

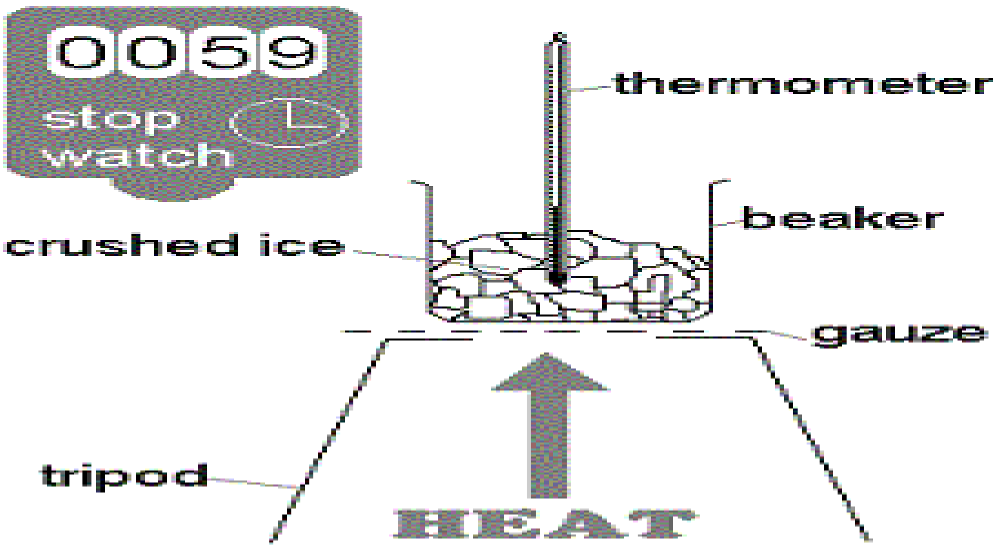

Learning Objectives
Skills / Abilities
Students are able to
- Measure the temperature of ice water when it is heated
- Use a stop watch and correctly read the time
- Observe all the changes as ice water is heated
- Record the time, temperature and observations as ice water is heated
VU


Learning Objectives
Attitudes
Students
- Collaborate and understand the importance of assigning specific roles/delegating tasks to team members
- Perseverance/patience is an important characteristic when conducting extended experiments
- Understand that scientific measurements do not always conform to text book facts which are valid under special conditions.
VU



Demonstration

The apparatus was set up as shown in the diagram.
The initial temperature of the ice was taken and recorded in a table (at time zero). The teacher made sure that the thermometer was in place (in the center of the ice mass) for long enough to allow the thread of the thermometer to fully contract before noting the reading.
The stop watch was started and the ice was heated steadily (the bunsen flame was not adjusted once set in place so that heat energy was given to the ice/water at a steady rate) and gently (half-closed-hole bunsen flame), until the water had been boiling for three minutes During this time the temperature of the ice/water was taken every minute and recorded in the table.



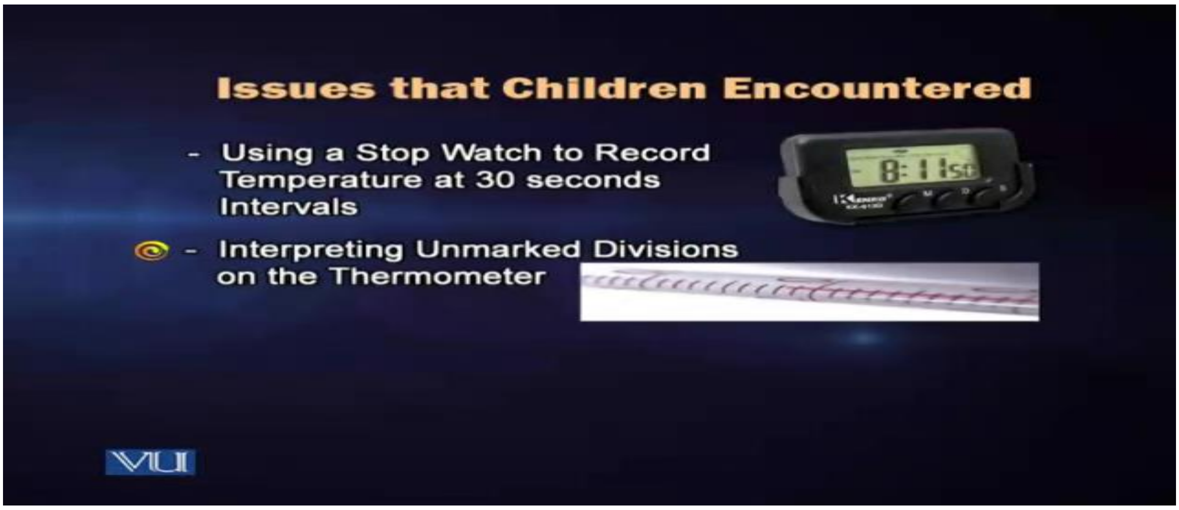
To Minimize Errors
Before each reading was taken the ice/water was stirred and care was taken to read the instrument at eye-level and to keep the bulb of the thermometer fully immersed - and not resting on the bottom of the beaker.

Lecture No 26

Investigating the changes of State

(Class activity)

Teacher set the apparatus in the classroom. Firstly the students noted the room temperature. Teacher set the thermometer in a stand and its upper part was in the beaker. Because children did not have any experience to handle the scientific equipment earlier. The teacher had set up the equipment for all the children. Students had their stop watches. They were going to note the temperature in centigrade. It is important to ensure that whether the students understand to measuring scales. Now the teacher assigned the specific roles to the children. There were three students in the group and three roles were assigned that were time keeper, temperature reader and recorder. This was also a novel thing for the students. Teacher explained the worksheets to the students. There were the columns of time, temperature and observations. The focus of the children was to observe the changes of the stages.Teacher asked the students if they had any questions before starting the experiment. Teacher lighted the spirit lamp for the students. The flame was low because the students had this first experiment. And they could not be able to handle this. Students started writing their readings. Teacher encountered issues with two groups.



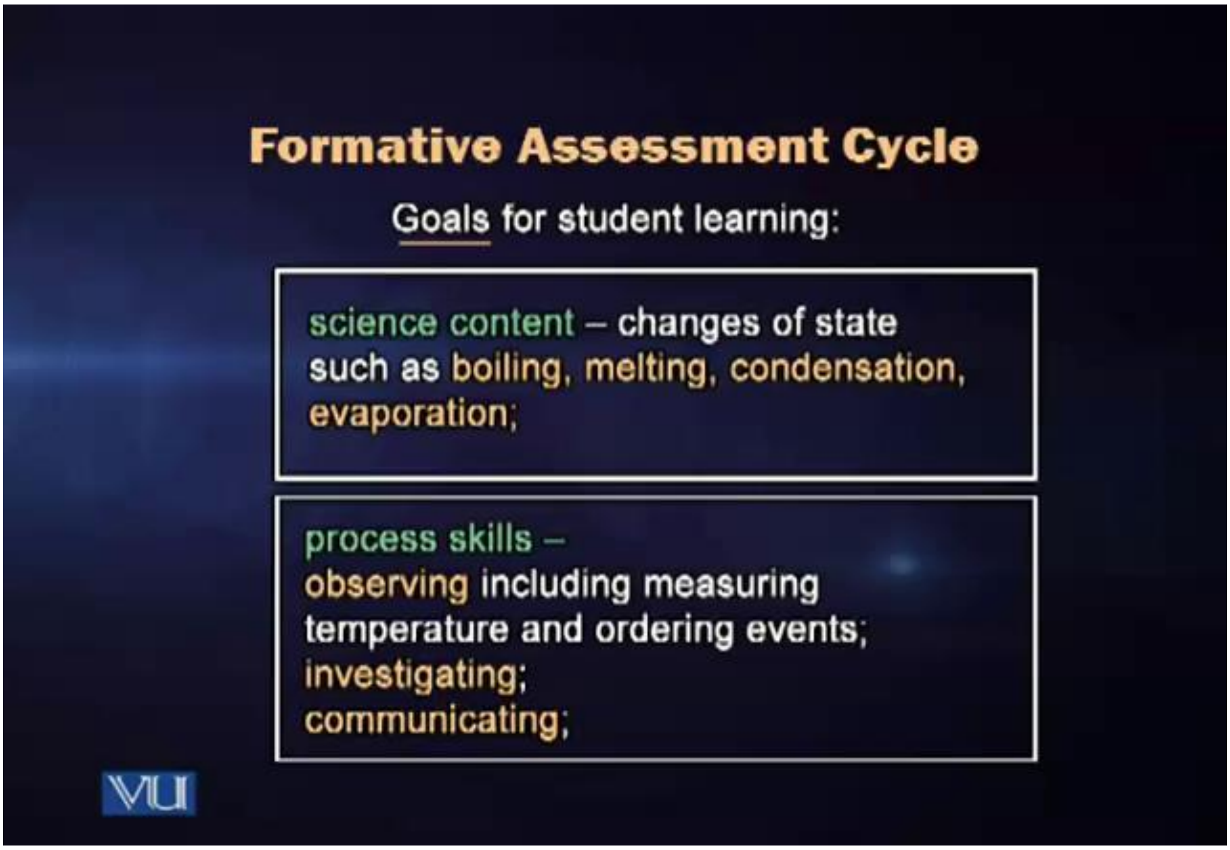
Lecture No 27

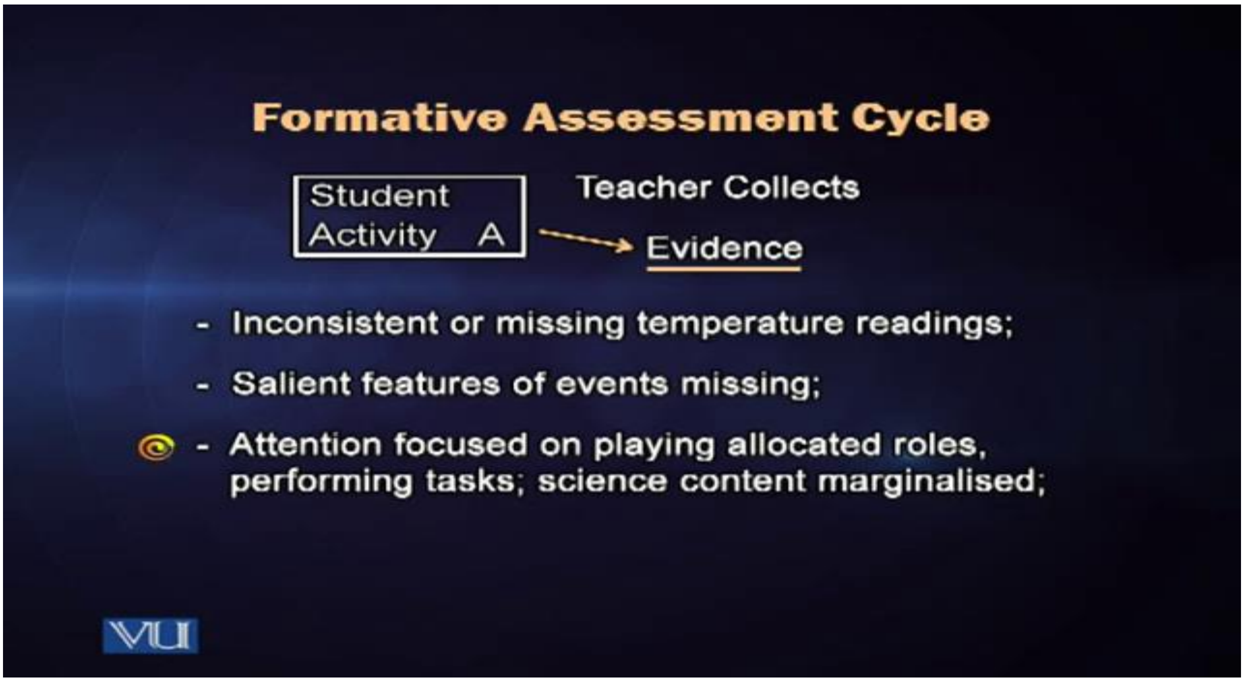
Formative Assessment and investigating changes of state by Heating Ice 2

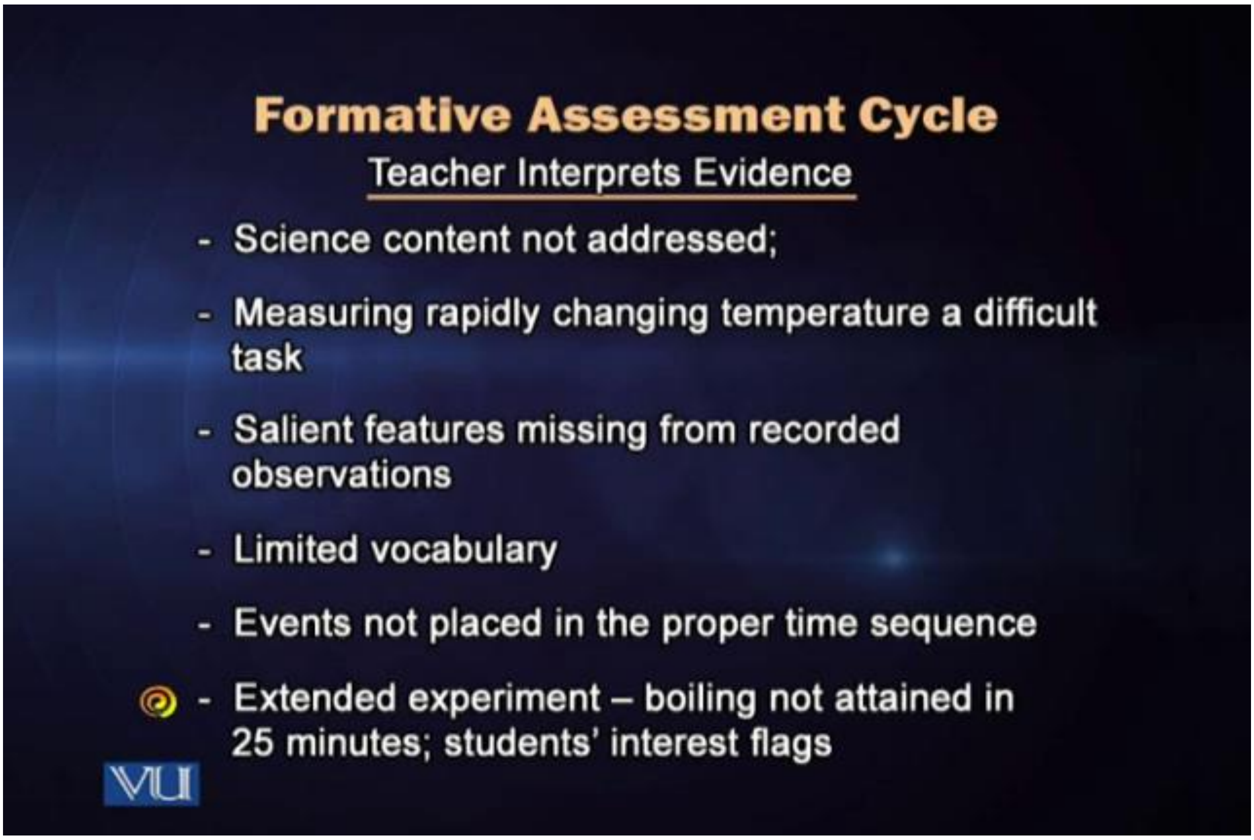
Formative assessment is assessment for learning. Its purpose is to see whether our learning objectives are fulfilled or not. And we immediately address the problems. This is a very critical form of assessment.

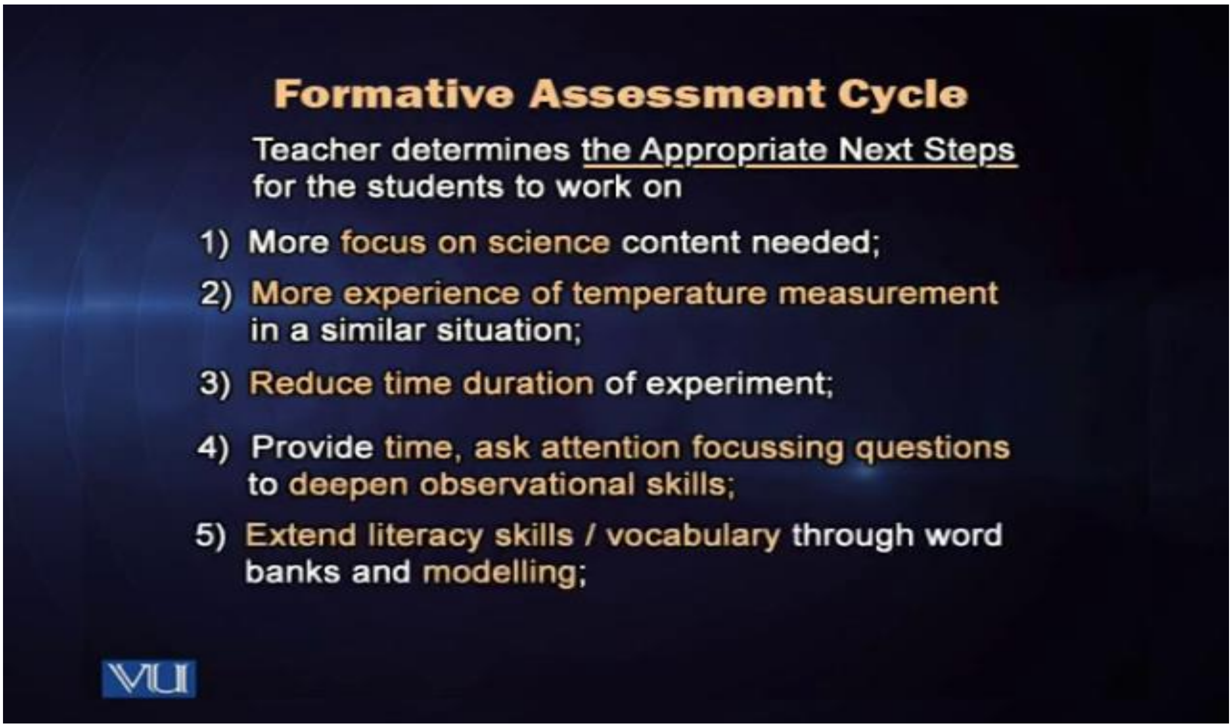
Formative Assessment Cycle

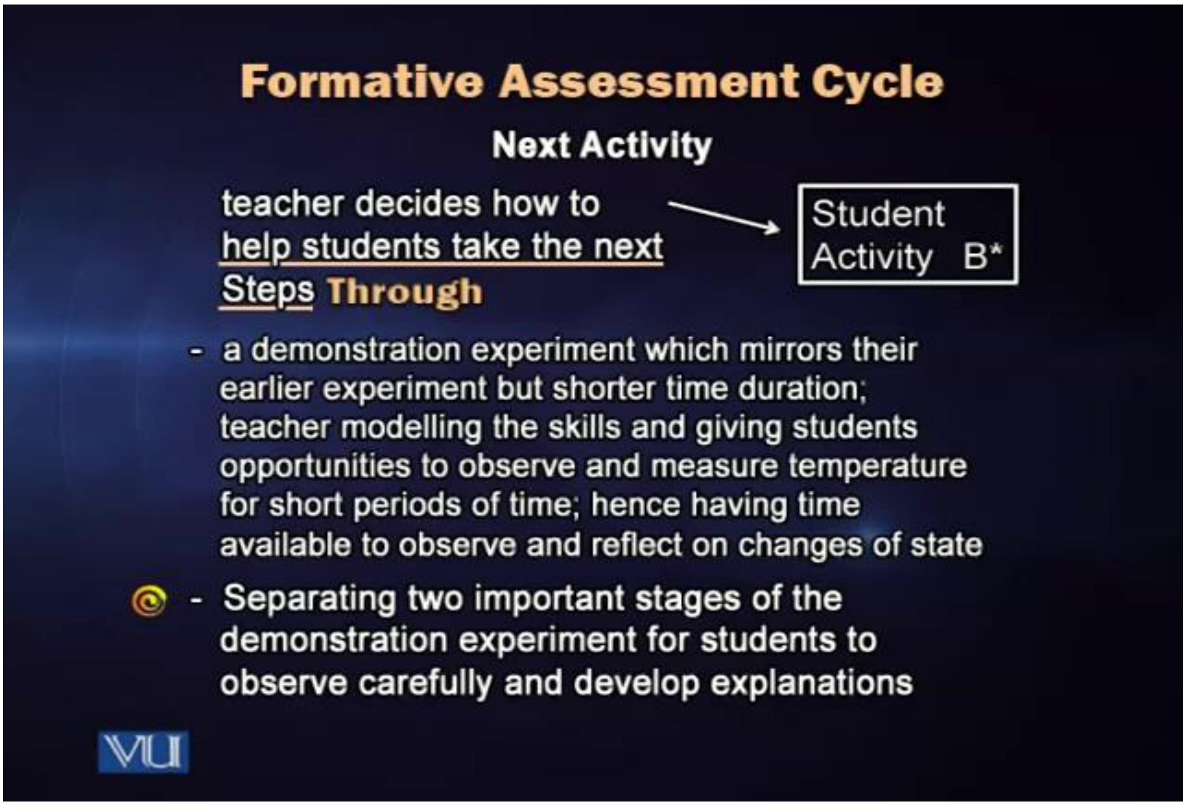
1. Goals for students learning (such as science content, process skills or attitudes).
2. Teacher collects evidence of student thinking related to goals.
3. Teacher interprets evidence of student thinking resulting in a judgment of achievement related to goals.
4. Teacher determines the appropriate next step for the students to work on.
5. Teacher decides how to help students to take the next steps.



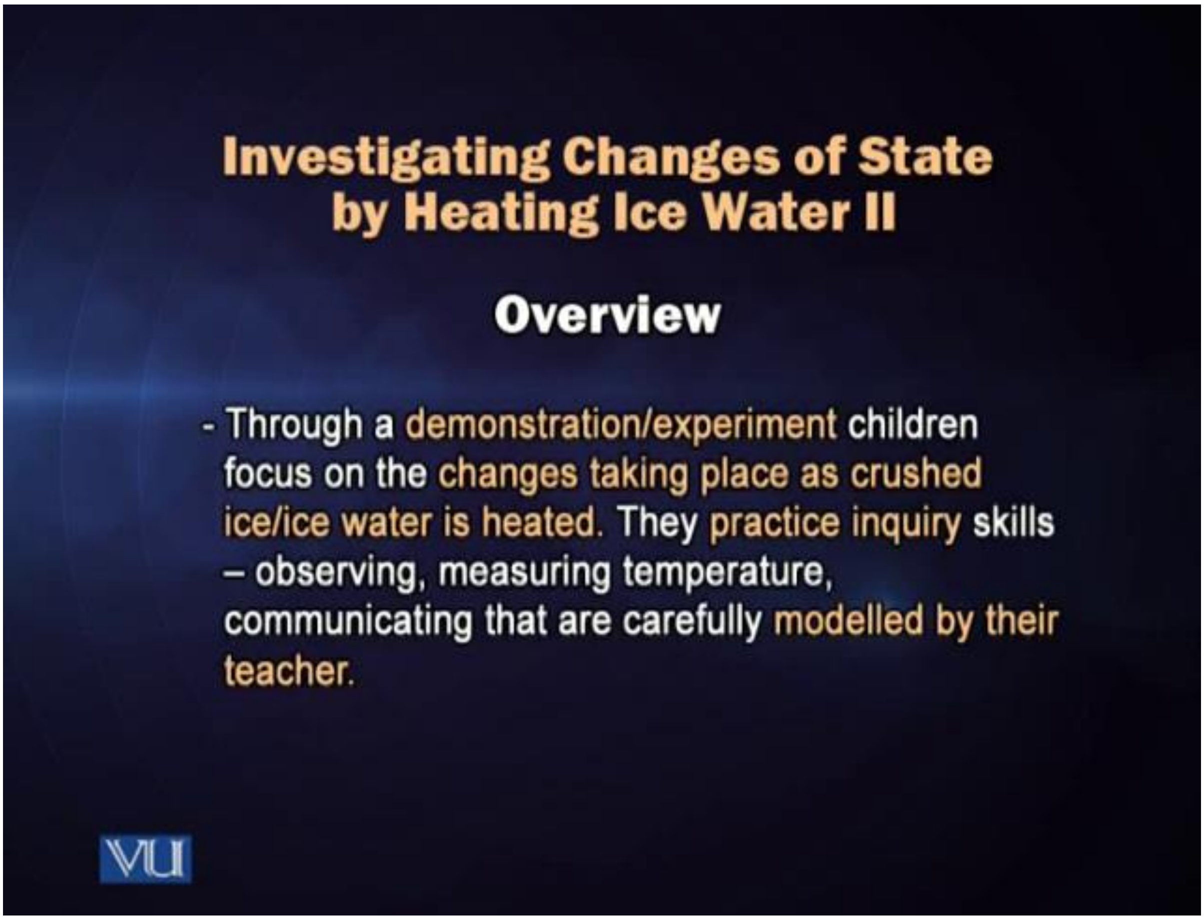

Formative Assessment Cycle
Student Activity A
Teacher Collects Evidence
- Inconsistent or missing temperature readings;
- Salient features of events missing;
- Attention focused on playing allocated roles, performing tasks; science content marginalised;

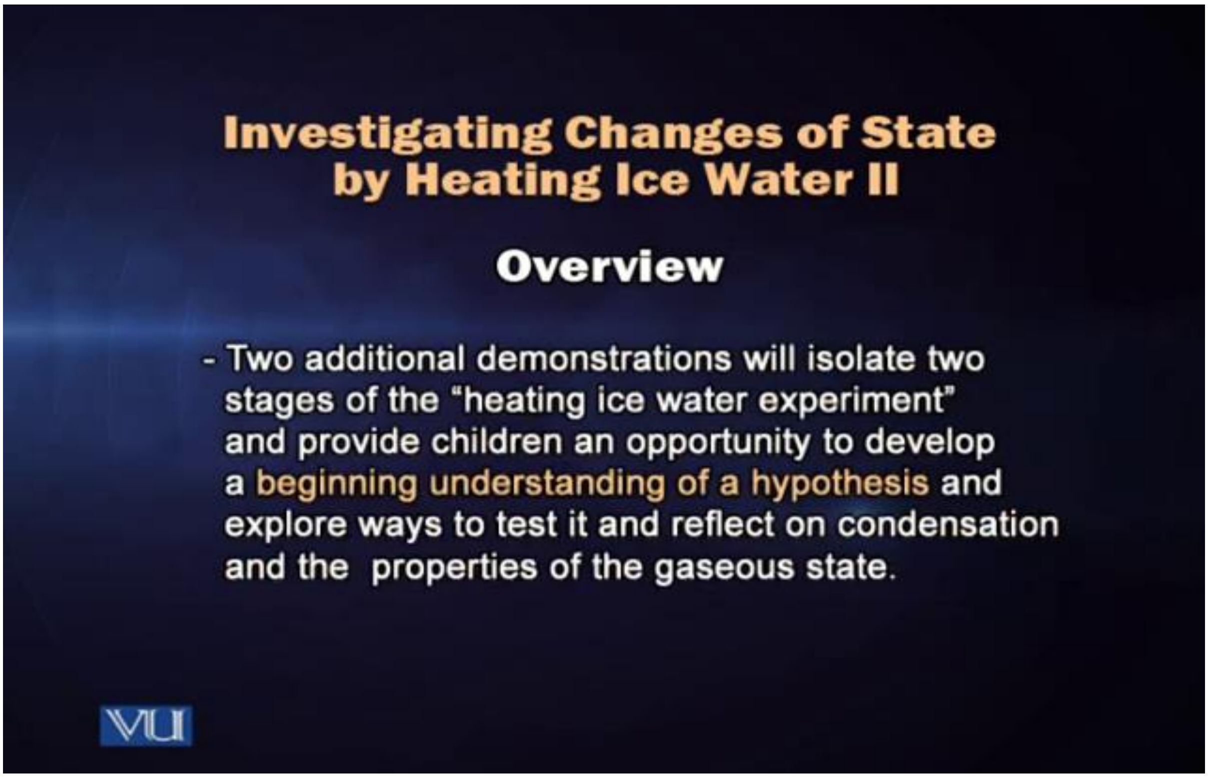

Formative Assessment Cycle
Teacher Interprets Evidence
- Science content not addressed;
- Measuring rapidly changing temperature a difficult task
- Salient features missing from recorded observations
- Limited vocabulary
- Events not placed in the proper time sequence
- Extended experiment – boiling not attained in 25 minutes; students' interest flags

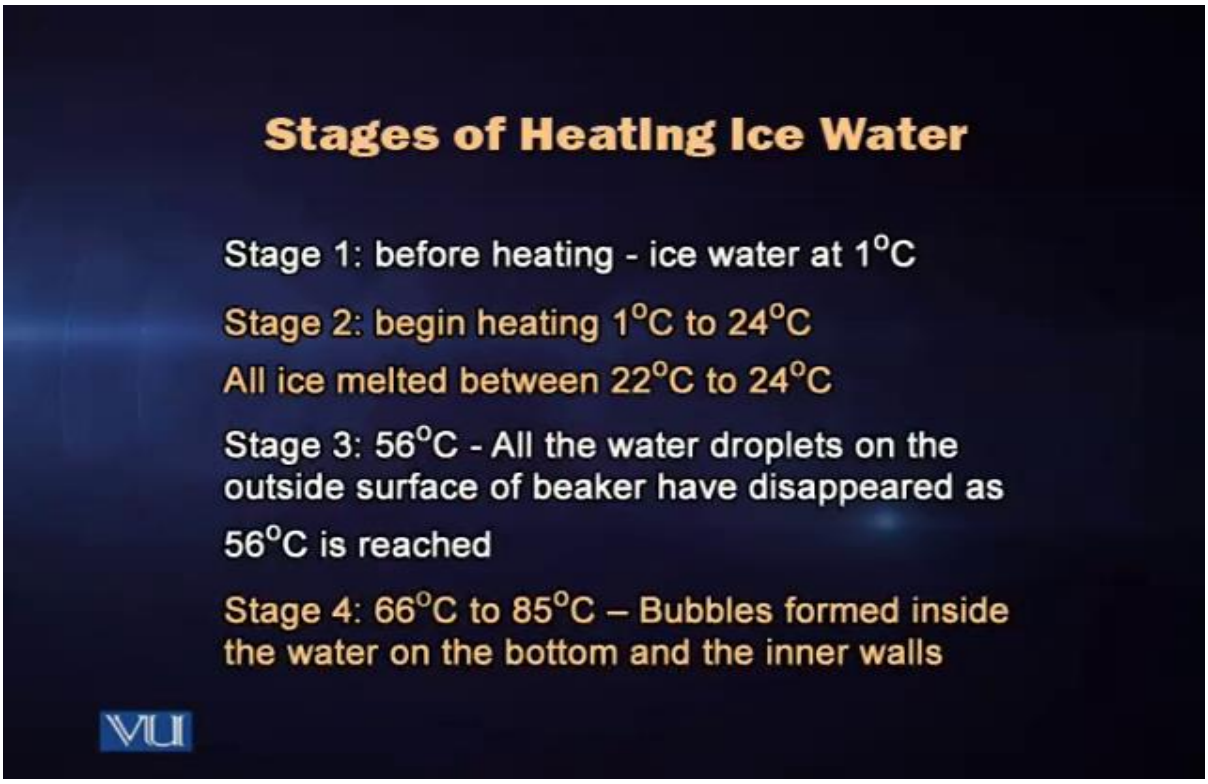

Formative Assessment Cycle
Teacher determines the Appropriate Next Steps for the students to work on
1) More focus on science content needed;
2) More experience of temperature measurement in a similar situation;
3) Reduce time duration of experiment;
4) Provide time, ask attention focussing questions to deepen observational skills;
5) Extend literacy skills / vocabulary through word banks and modelling;

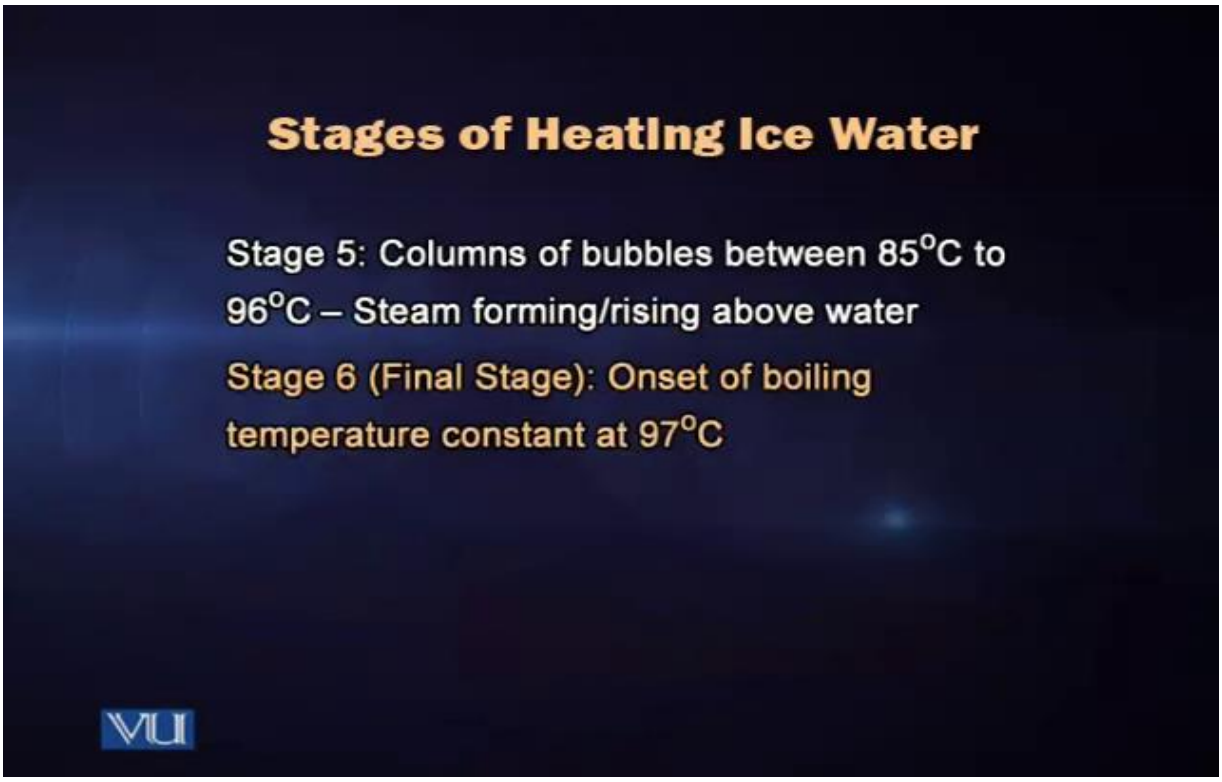

Formative Assessment Cycle
Next Activity
teacher decides how to help students take the next Steps Through
Student Activity B*
- a demonstration experiment which mirrors their earlier experiment but shorter time duration; teacher modelling the skills and giving students opportunities to observe and measure temperature for short periods of time; hence having time available to observe and reflect on changes of state
- Separating two important stages of the demonstration experiment for students to observe carefully and develop explanations

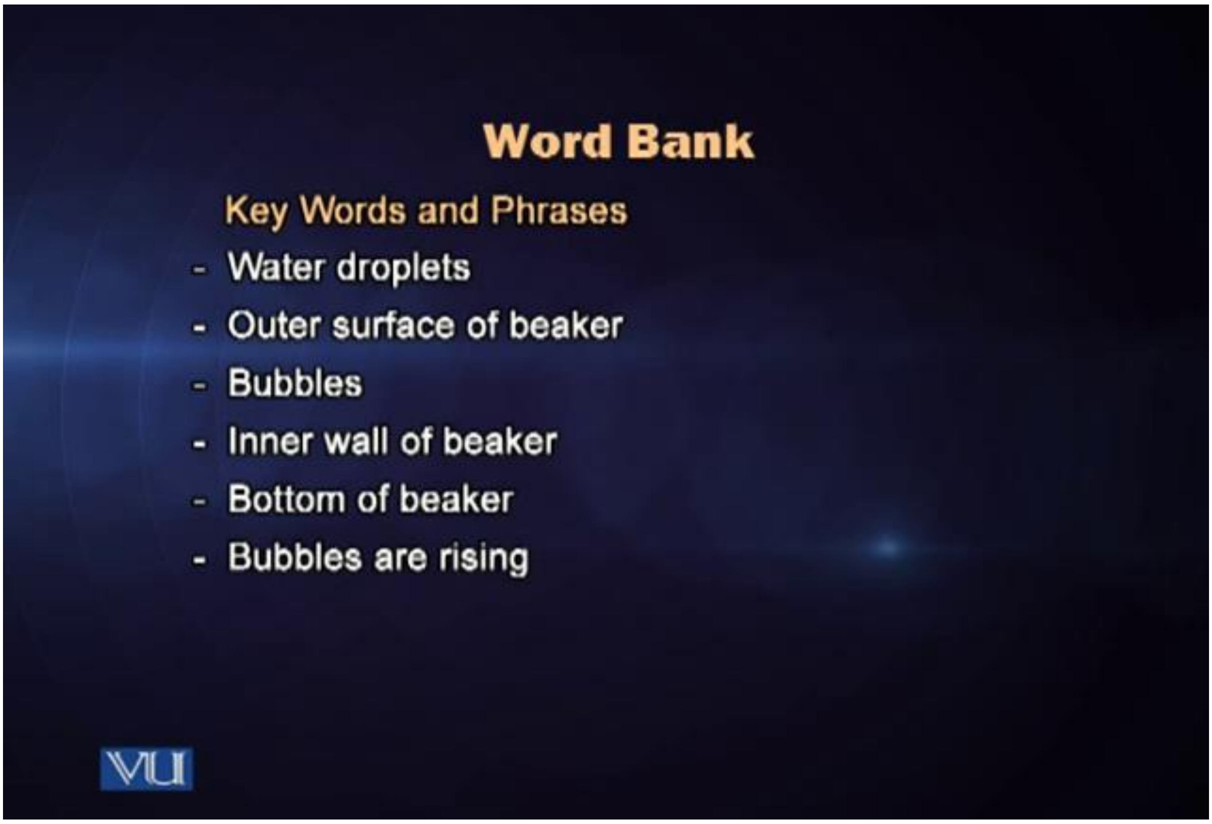

Demonstration Experiment
- Build on prior experiences to have expectations
- Use that to explore discrepant/unfamiliar events
- Opportunities for developing inquiry skills
VU


Investigating Changes of State by Heating Ice Water II
Overview
- Through a demonstration/experiment children focus on the changes taking place as crushed ice/ice water is heated. They practice inquiry skills – observing, measuring temperature, communicating that are carefully modelled by their teacher.
VU

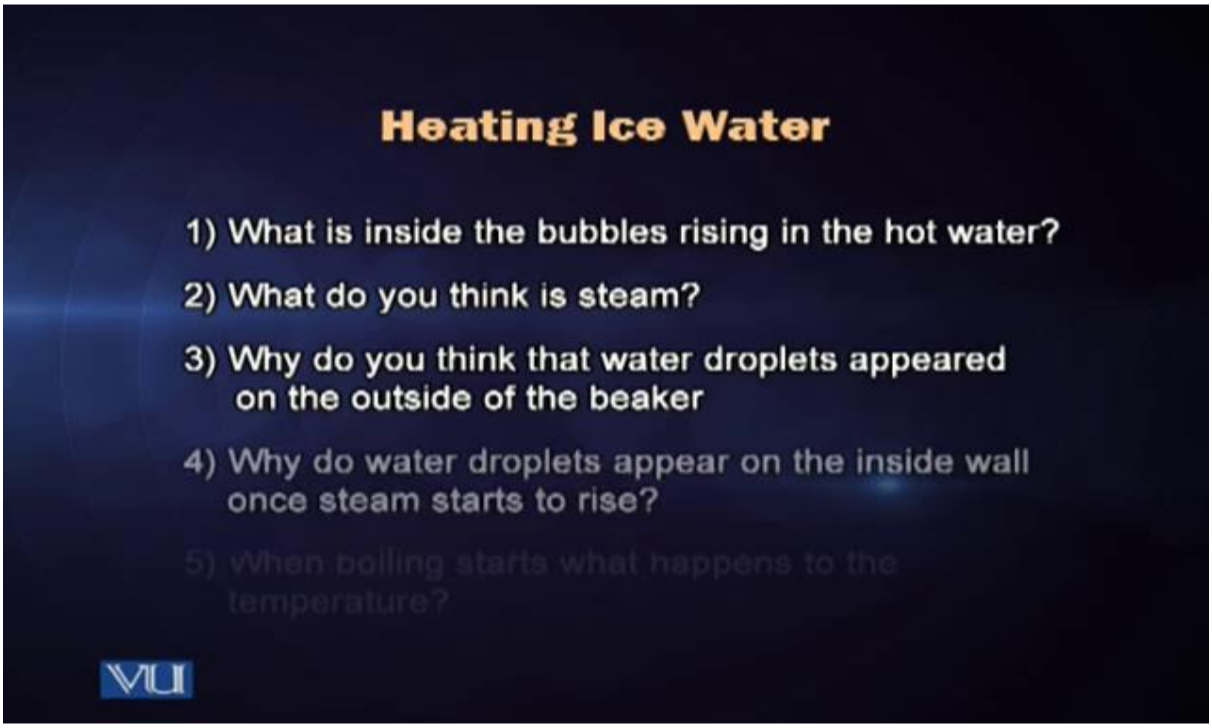

Investigating Changes of State
by Heating Ice Water II
Overview
- Two additional demonstrations will isolate two stages of the "heating ice water experiment" and provide children an opportunity to develop a beginning understanding of a hypothesis and explore ways to test it and reflect on condensation and the properties of the gaseous state.


Stages of HeatIng Ice Water
Stage 1: before heating - ice water at 1°C
Stage 2: begin heating 1°C to 24°C
All ice melted between 22°C to 24°C
Stage 3: 56°C - All the water droplets on the outside surface of beaker have disappeared as 56°C is reached
Stage 4: 66°C to 85°C – Bubbles formed inside the water on the bottom and the inner walls


Stages of Heating Ice Water
Stage 5: Columns of bubbles between 85°C to 96°C – Steam forming/rising above water
Stage 6 (Final Stage): Onset of boiling temperature constant at 97°C
VU

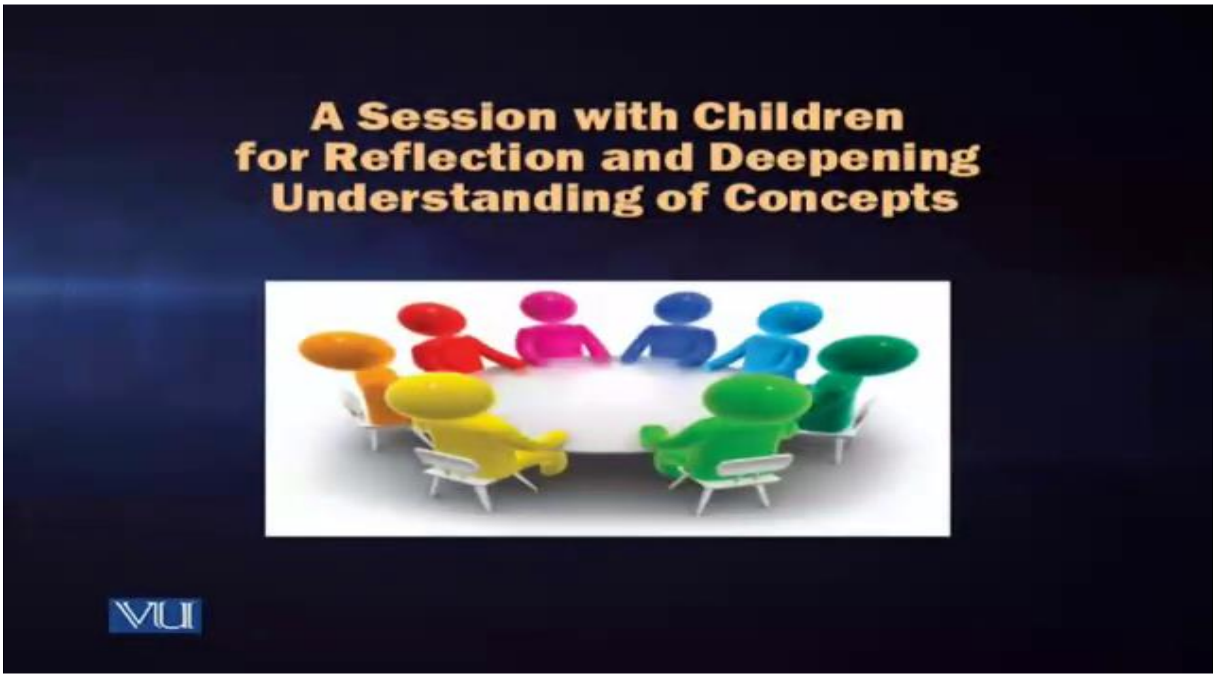

Word Bank
Key Words and Phrases
- Water droplets
- Outer surface of beaker
- Bubbles
- Inner wall of beaker
- Bottom of beaker
- Bubbles are rising
VU

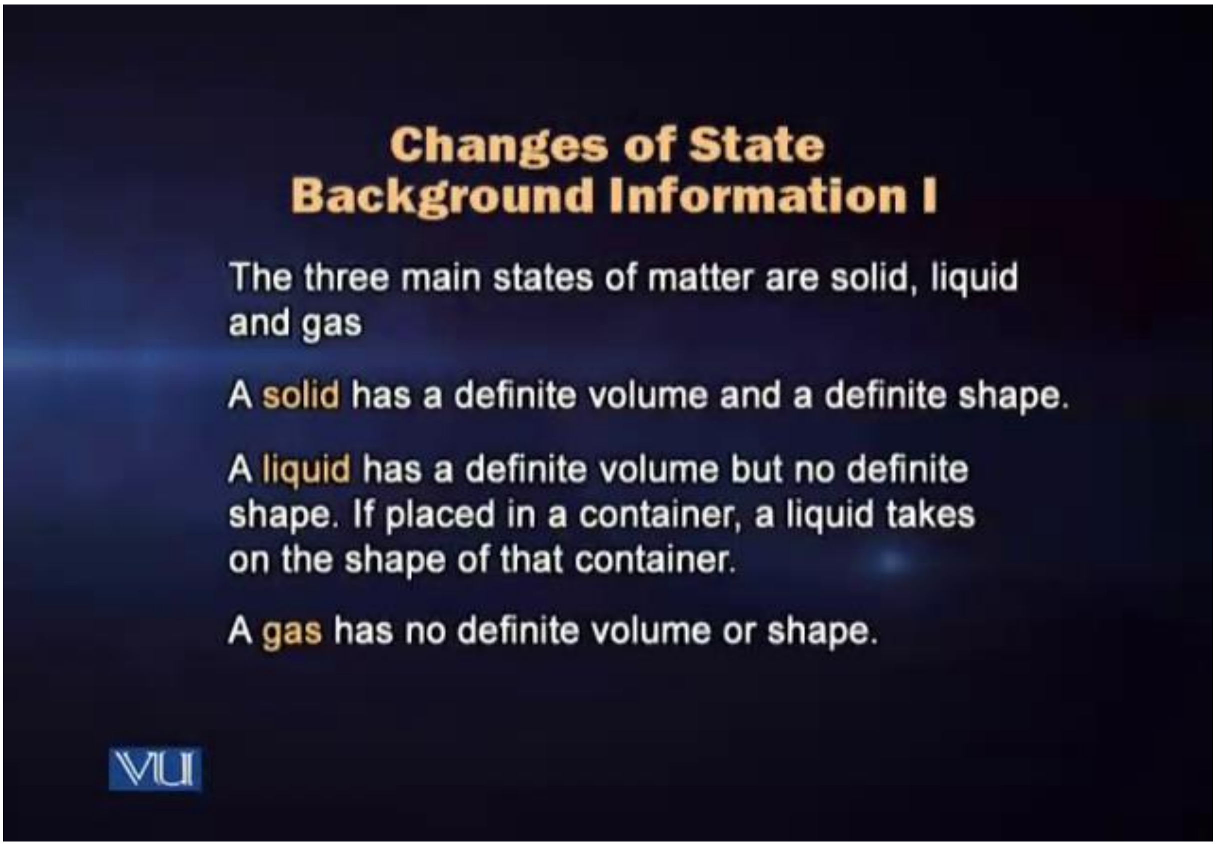
Condensation means when a gas changes into liquids.Teacher gave two beakers, two paper lids and a magnifying glass to each group. In one beaker teacher put some ice and closed the lid. In the second baker teacher poured some steamy hot water and put the lid on it. Magnifying glass on the ice baker had nothing on it while the magnifying glass of hot water had little drops of water. And the lid was also slightly wet from one side. Teacher asked the students to make some hypothesis for the situation.



Lecture No 28

<u>Changes of State “Background Information”</u>



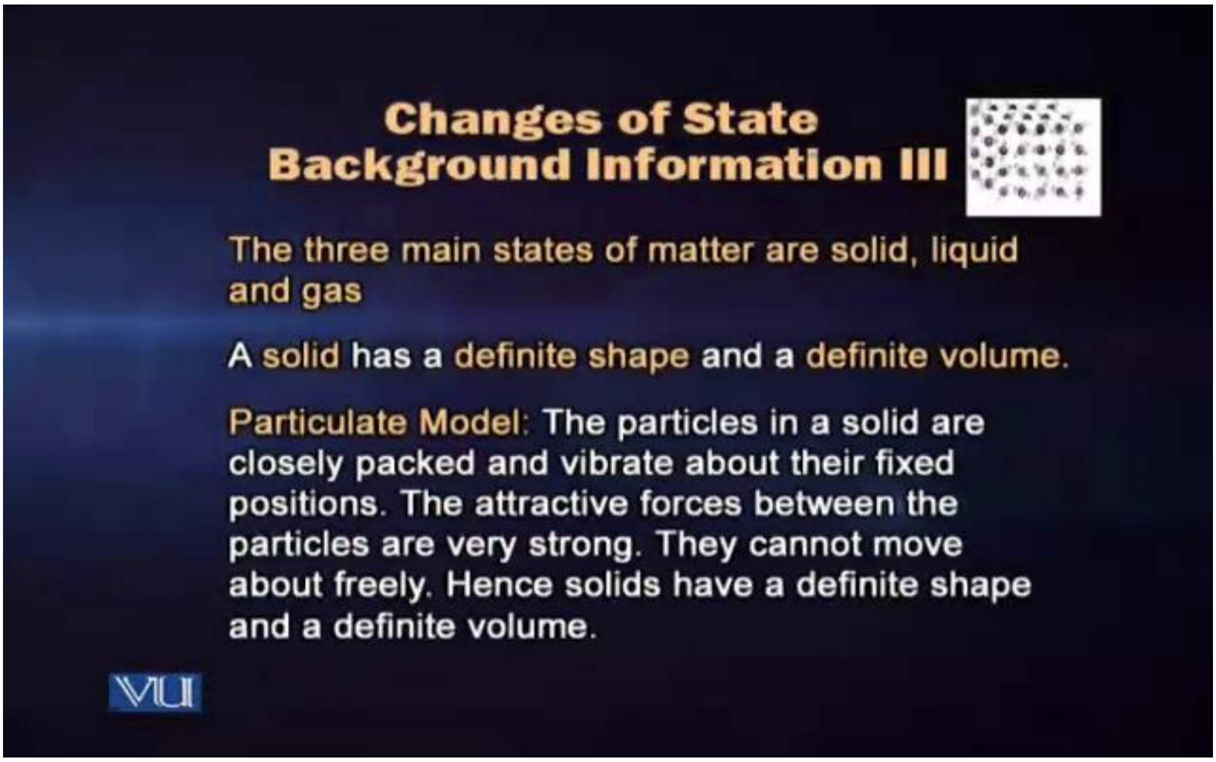


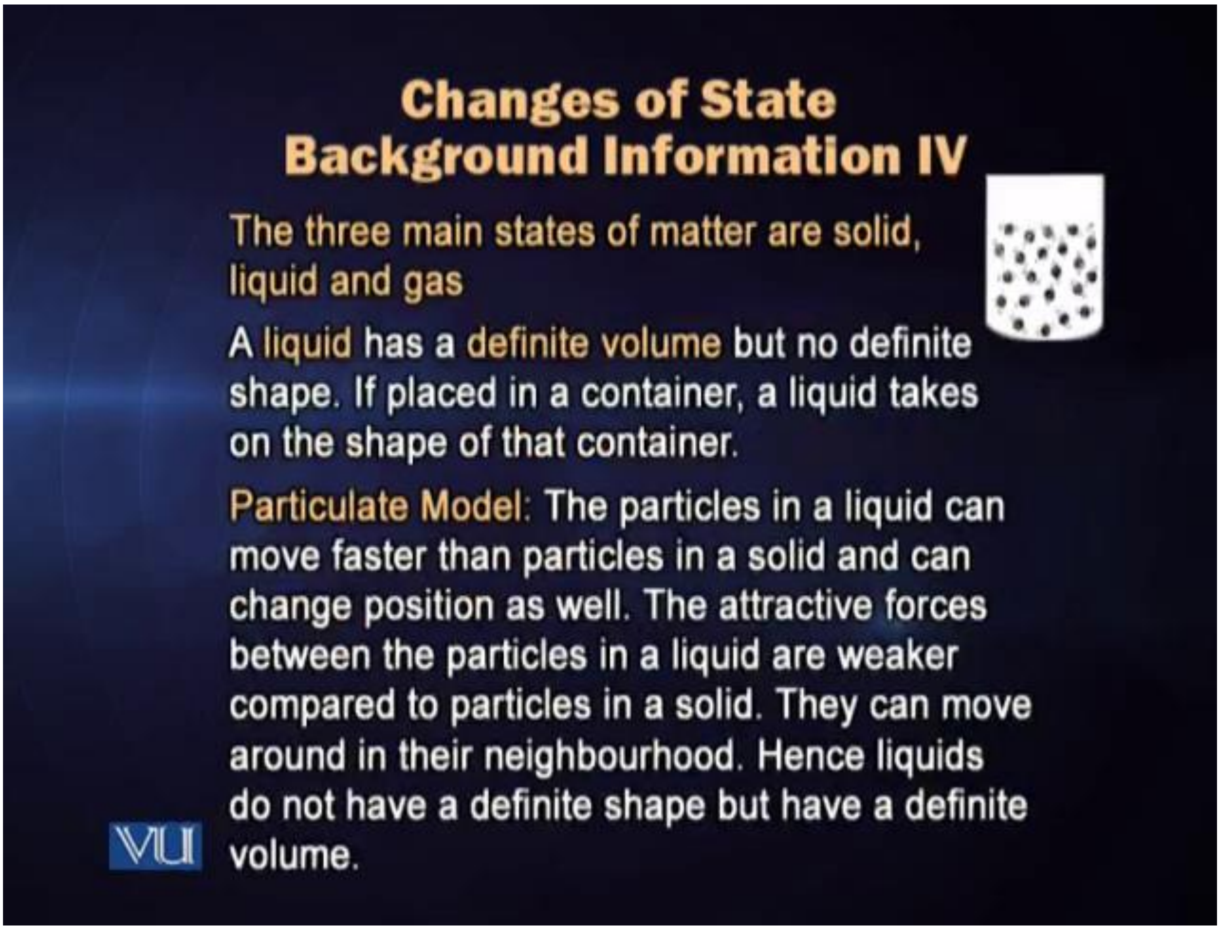
Changes of State
Background Information II

The three main states of matter are solid, liquid and gas

Particulate Model: All types of matter is made up of tiny particles which are too small to be seen but the properties of each state can be explained by the behaviour of these invisible particles.

Changes of State
Background Information II


Changes of State
Background Information III
The three main states of matter are solid, liquid and gas
A solid has a definite shape and a definite volume.
Particulate Model: The particles in a solid are closely packed and vibrate about their fixed positions. The attractive forces between the particles are very strong. They cannot move about freely. Hence solids have a definite shape and a definite volume.
VU


Changes of State
Background Information IV
The three main states of matter are solid, liquid and gas
A liquid has a definite volume but no definite shape. If placed in a container, a liquid takes on the shape of that container.
Particulate Model: The particles in a liquid can move faster than particles in a solid and can change position as well. The attractive forces between the particles in a liquid are weaker compared to particles in a solid. They can move around in their neighbourhood. Hence liquids do not have a definite shape but have a definite volume.
VU

Changes of State
Background Information V

The three main states of matter are solid, liquid and gas

A gas has no definite volume or shape.

Particulate Model: The attractive forces between its particles are very weak. Its particles can move to all parts of a container. Hence a gas fills its container completely.

VU

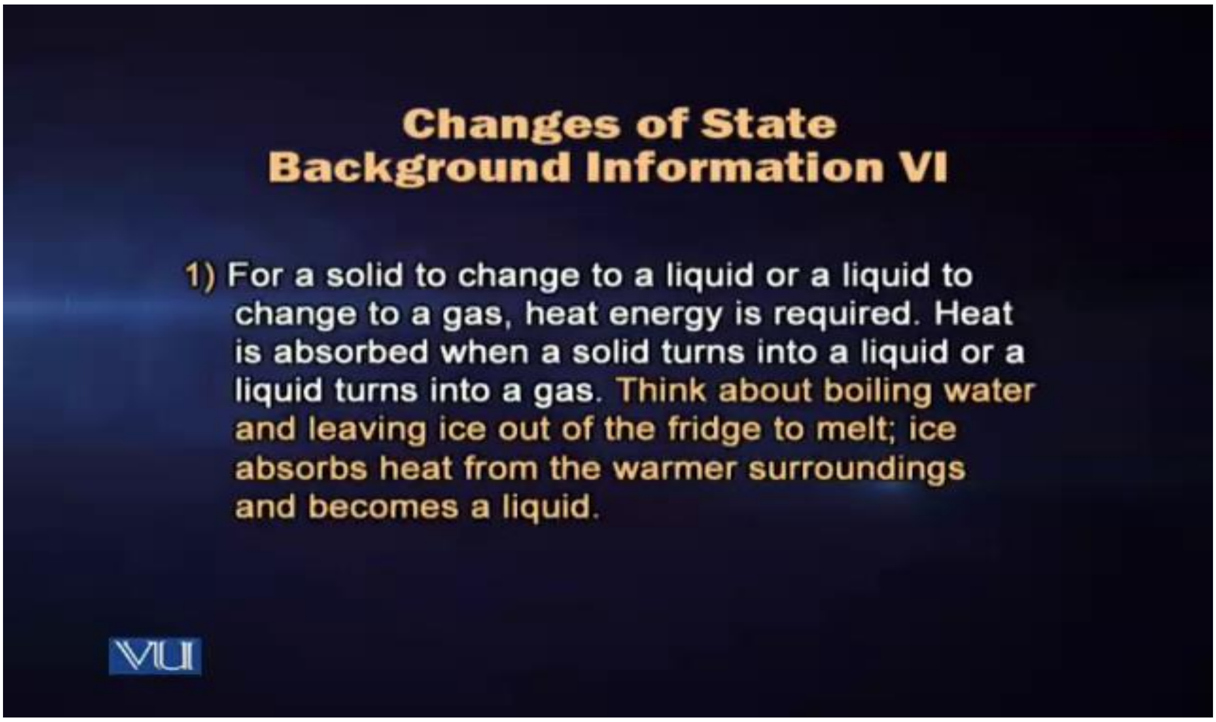
Children modelling different states

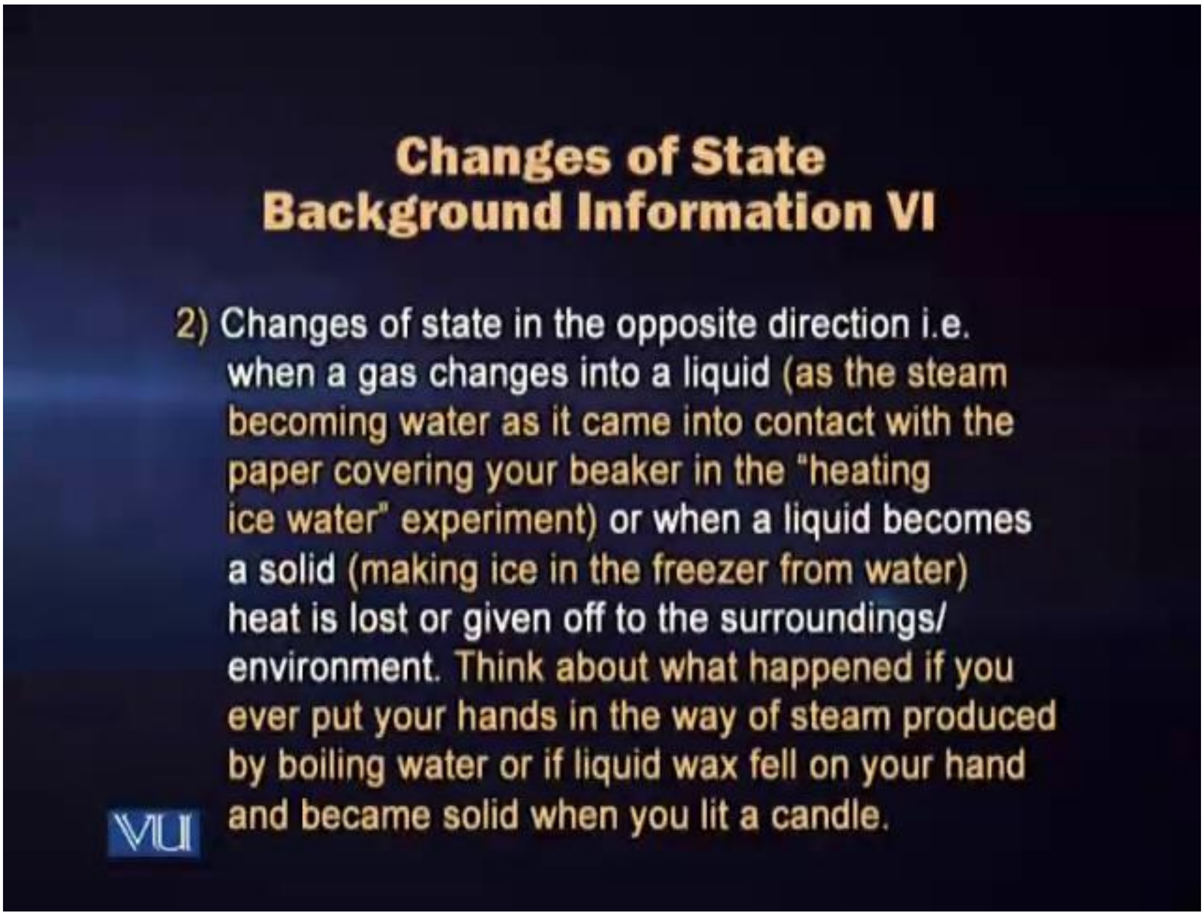
- Solid : 12 to 20 children forming an array and moving slightly back and forth about the location where they are standing. It is evident that a solid has a well defined shape

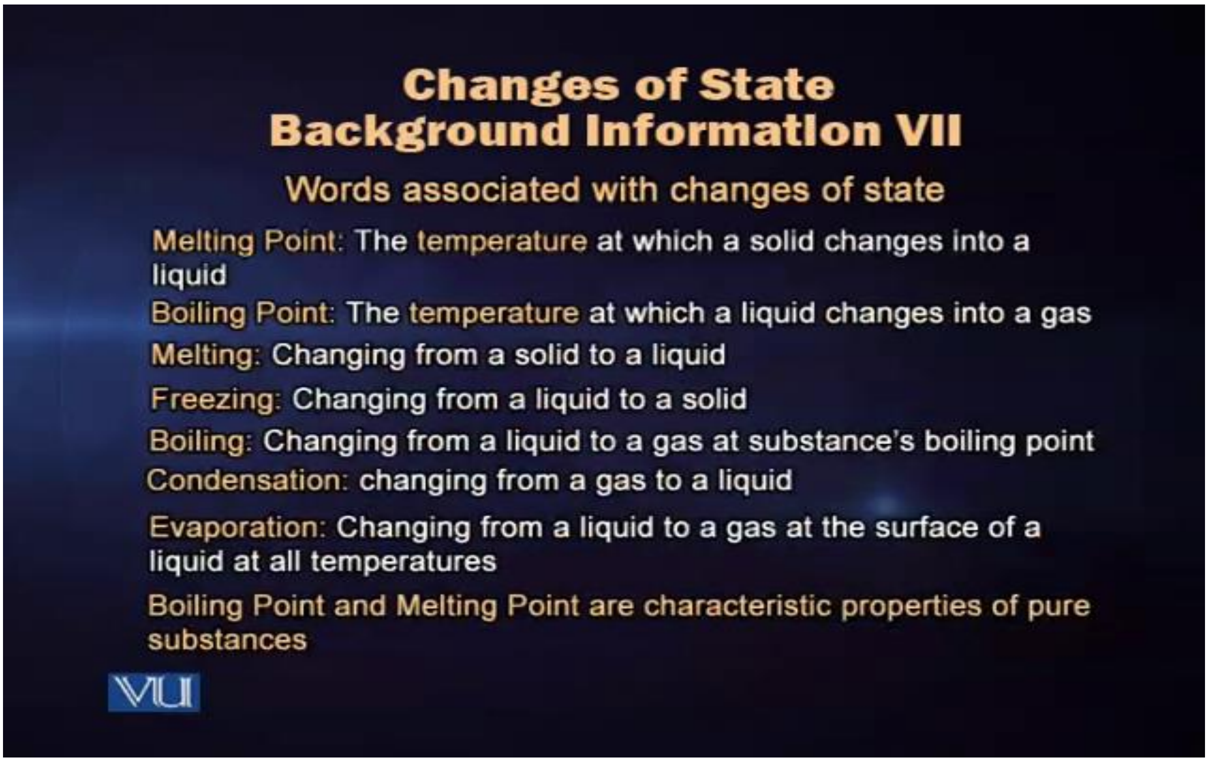
Liquid : 12 to 20 children initially forming an array but every child moving around its nearest neighbours. It is evident a liquid does not have a well defined shape.

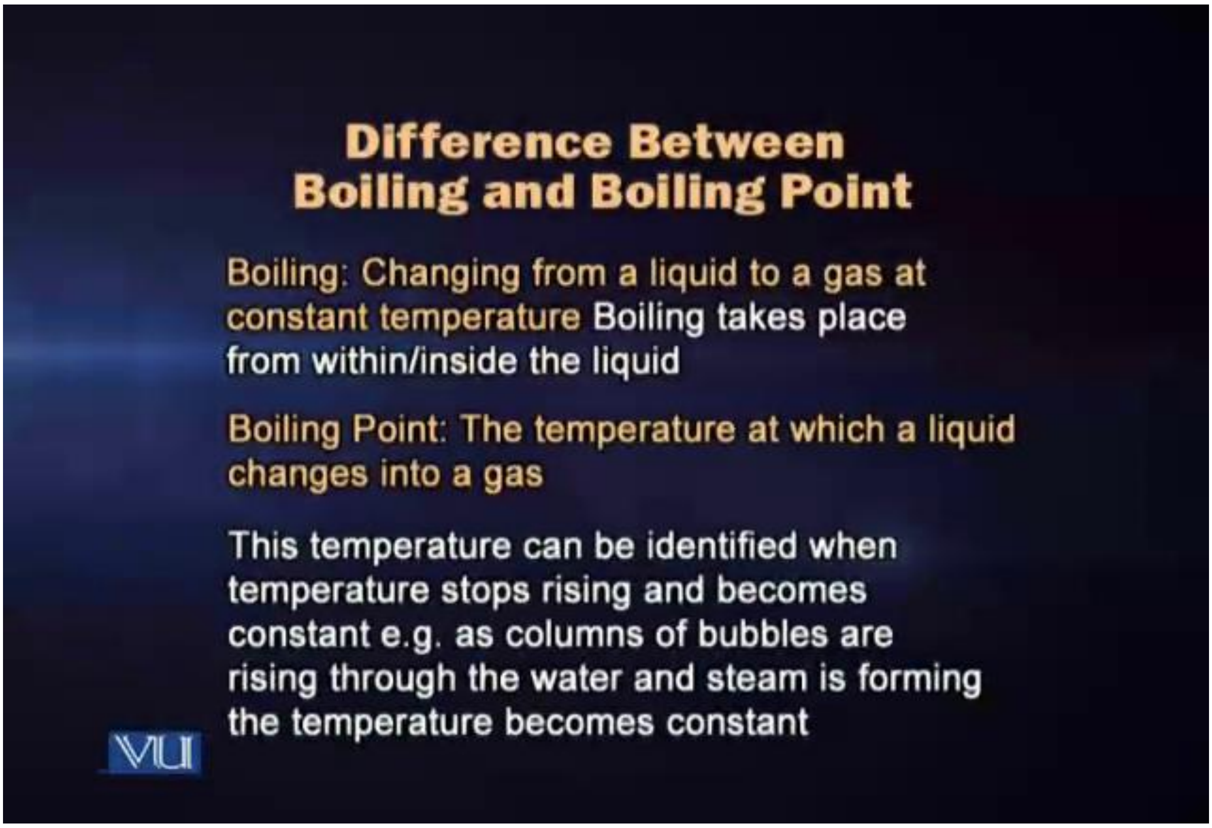
Gas : 12 to 20 children running around randomly in the whole classroom; It is evident that a gas fills the room completely.

VU

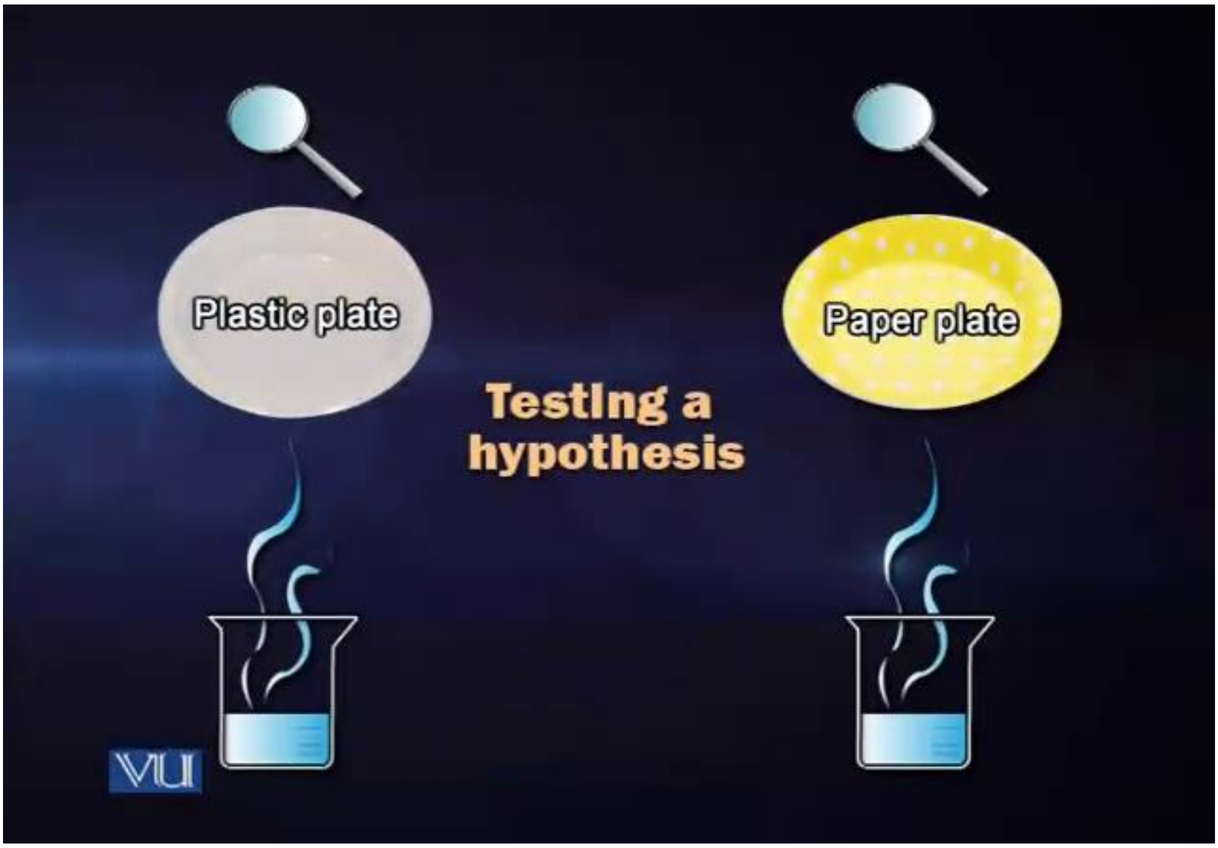

Changes of State
Background Information VI
1) For a solid to change to a liquid or a liquid to change to a gas, heat energy is required. Heat is absorbed when a solid turns into a liquid or a liquid turns into a gas. Think about boiling water and leaving ice out of the fridge to melt; ice absorbs heat from the warmer surroundings and becomes a liquid.


Changes of State
Background Information VI
2) Changes of state in the opposite direction i.e. when a gas changes into a liquid (as the steam becoming water as it came into contact with the paper covering your beaker in the "heating ice water" experiment) or when a liquid becomes a solid (making ice in the freezer from water) heat is lost or given off to the surroundings/ environment. Think about what happened if you ever put your hands in the way of steam produced by boiling water or if liquid wax fell on your hand and became solid when you lit a candle.


Changes of State
Background Information VII
Words associated with changes of state
Melting Point: The temperature at which a solid changes into a liquid
Boiling Point: The temperature at which a liquid changes into a gas
Melting: Changing from a solid to a liquid
Freezing: Changing from a liquid to a solid
Boiling: Changing from a liquid to a gas at substance's boiling point
Condensation: changing from a gas to a liquid
Evaporation: Changing from a liquid to a gas at the surface of a liquid at all temperatures
Boiling Point and Melting Point are characteristic properties of pure substances
VU


Difference Between
Boiling and Boiling Point
Boiling: Changing from a liquid to a gas at constant temperature Boiling takes place from within/inside the liquid
Boiling Point: The temperature at which a liquid changes into a gas
This temperature can be identified when temperature stops rising and becomes constant e.g. as columns of bubbles are rising through the water and steam is forming the temperature becomes constant
VU


"Dramatic" Experiments
Making Rainfall
VU

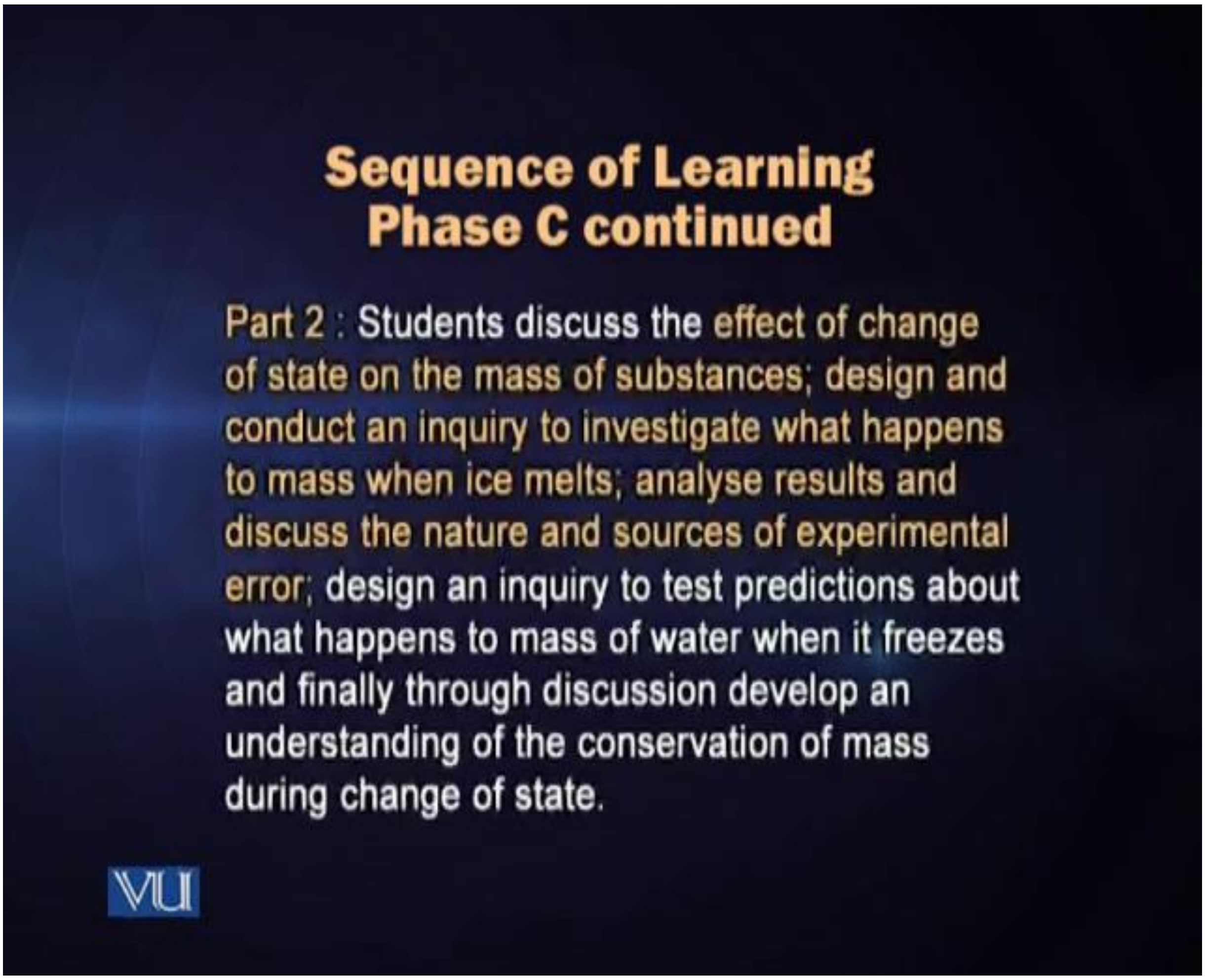

Plastic plate
Paper plate
Testing a hypothesis
VU

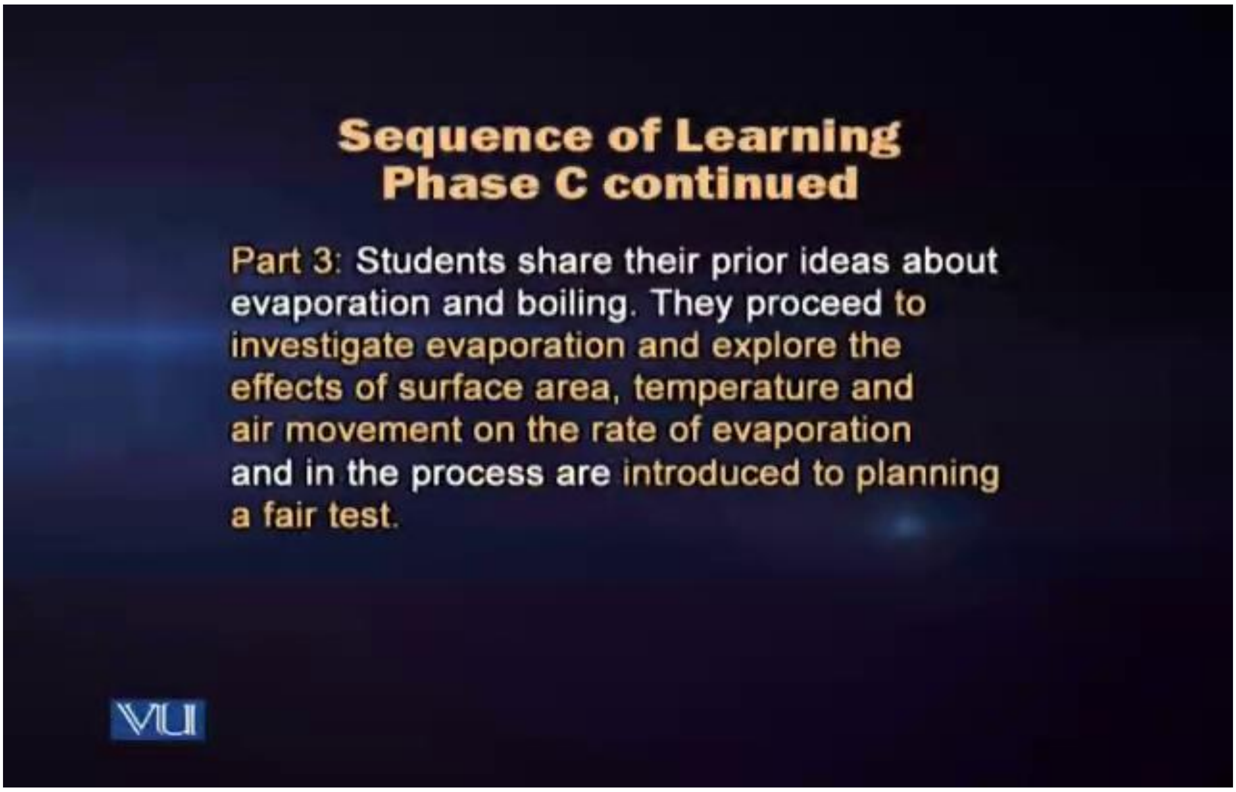
Testing of Hypothesis 1

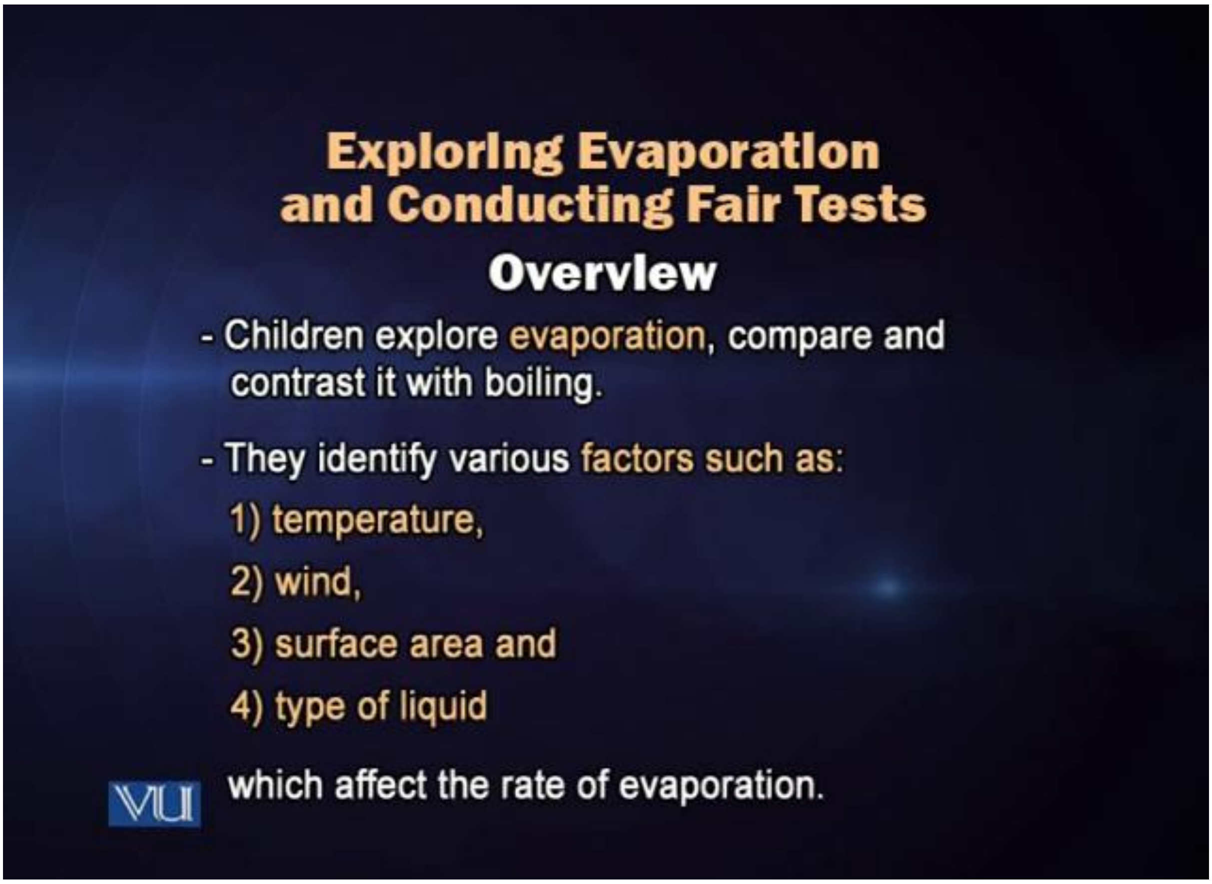
Students made the hypothesis that there will be no mist on the plastic lid even if we put the steamy hot water in the beaker. Teacher took two beakers, poured some hot water in them. She put cardboard lid on one beaker and plastic lid on the other. Put two magnifying glasses on both lids. Then she examined that there was clear mist on the magnifying glass with cardboard lid. The magnifying glass with plastic lid had nothing on it. Teacher told the students that hypothesis can be rejected. It cannot be proved. Our results can only strengthen our hypothesis.

Testing the hypothesis 2

Teacher put a pan with water on the stove. When the heat started coming from the pan. She poured some ice in another pan that was dry. She put the pan on the steam when the steam touched the dry surface of the pan the water drops started coming from the surface of the pan.



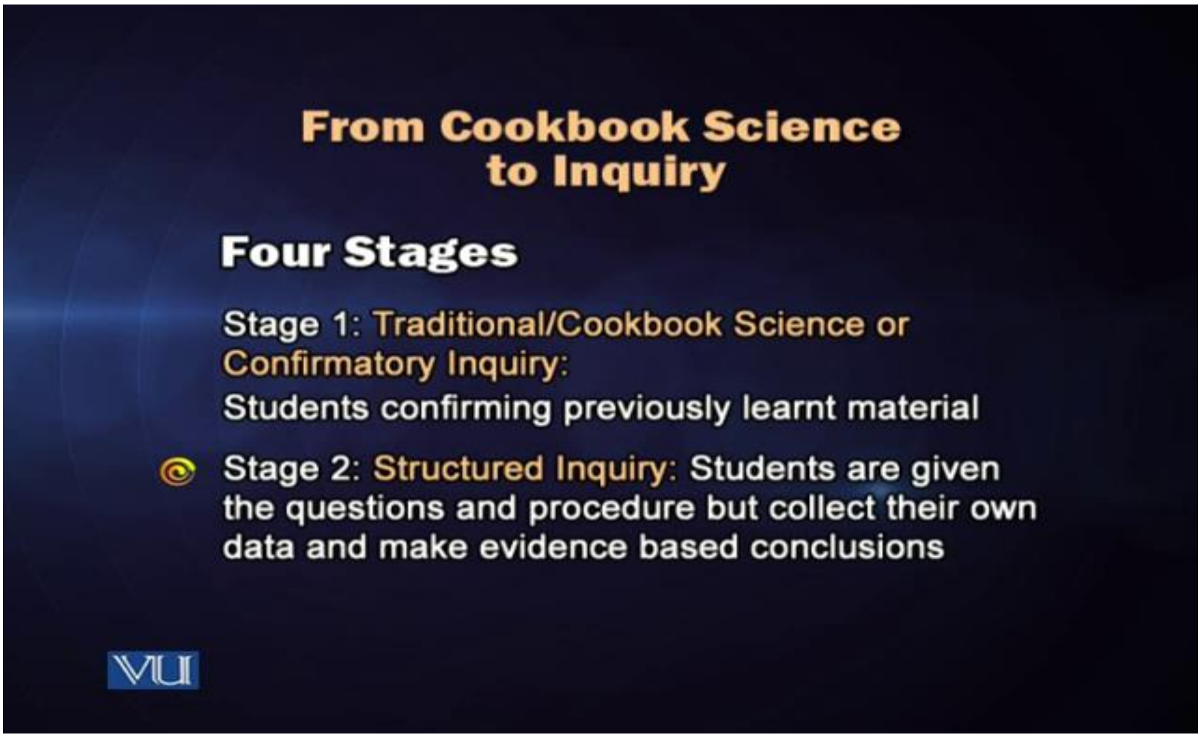

Sequence of Learning
Phase C continued
Part 3: Students share their prior ideas about evaporation and boiling. They proceed to investigate evaporation and explore the effects of surface area, temperature and air movement on the rate of evaporation and in the process are introduced to planning a fair test.

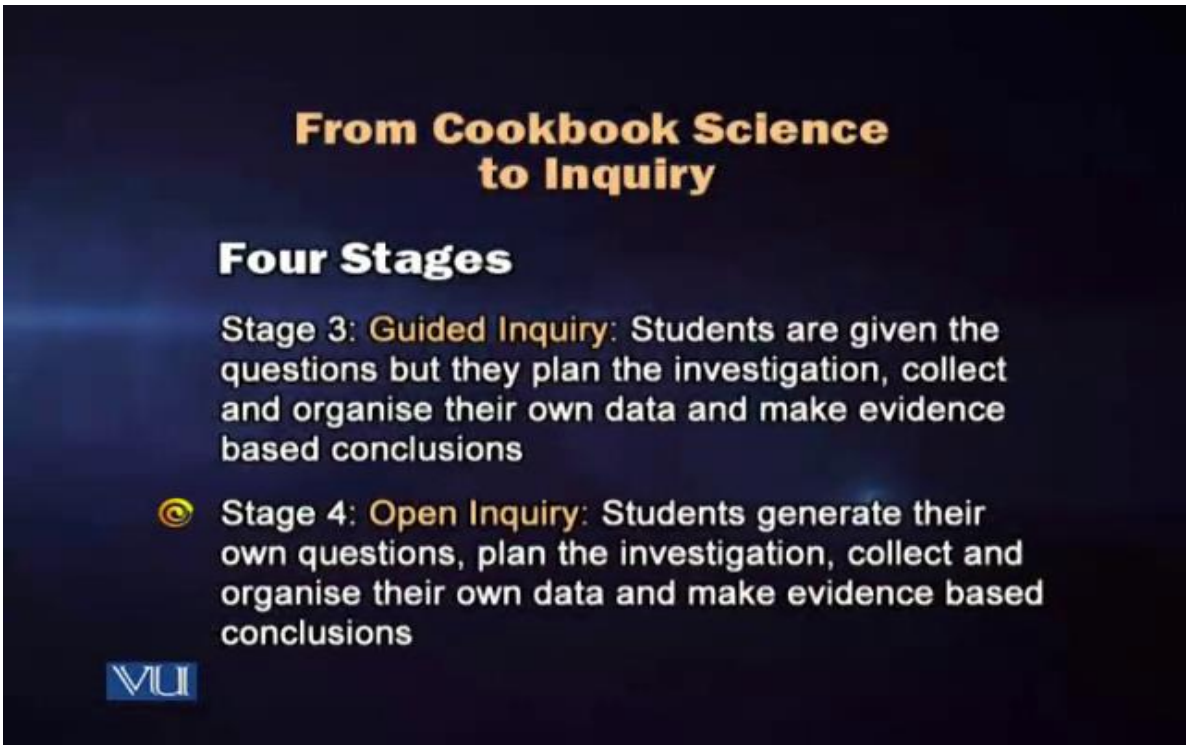

Exploring Evaporation and Conducting Fair Tests
Overview
- Children explore evaporation, compare and contrast it with boiling.
- They identify various factors such as:
1) temperature,
2) wind,
3) surface area and
4) type of liquid
which affect the rate of evaporation.

Teacher told the students that boiling and boiling point are both different. Boiling is a process through which the water changes its state. And temperature at which boiling takes place is called boiling point.

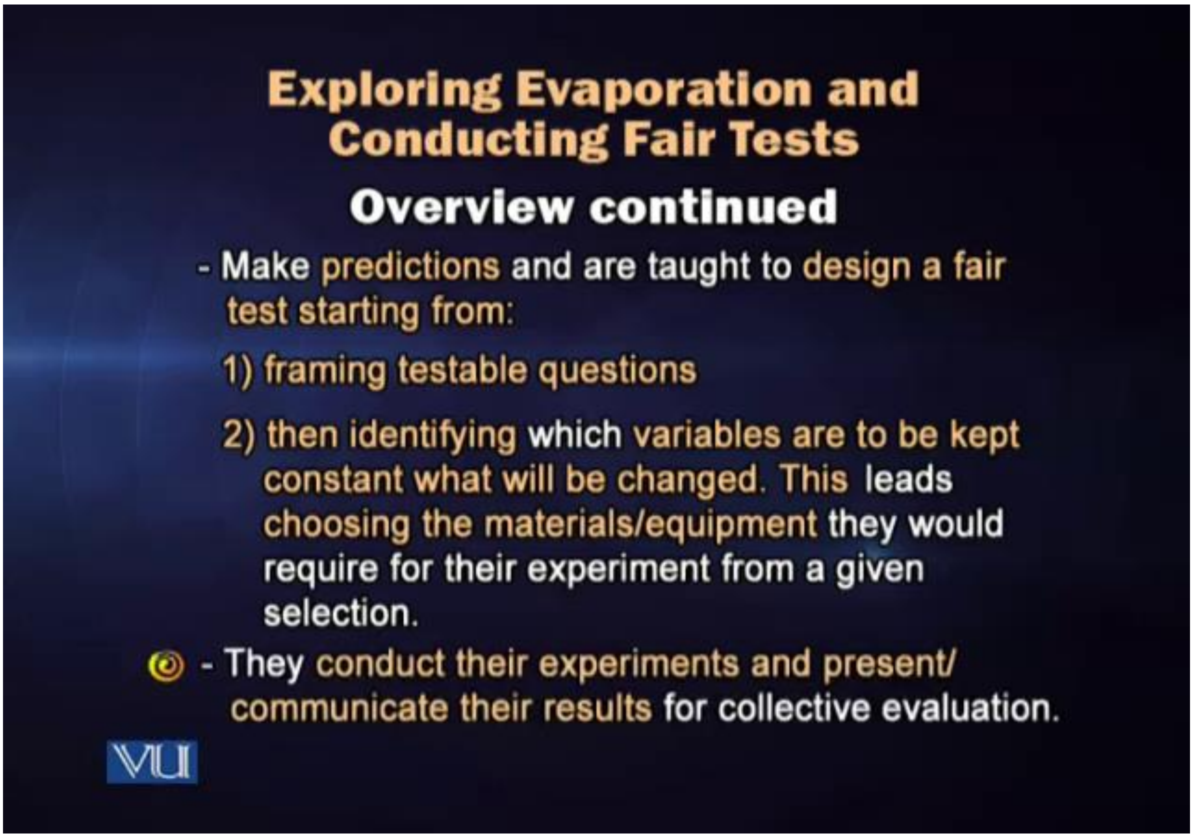
Lecture No 29

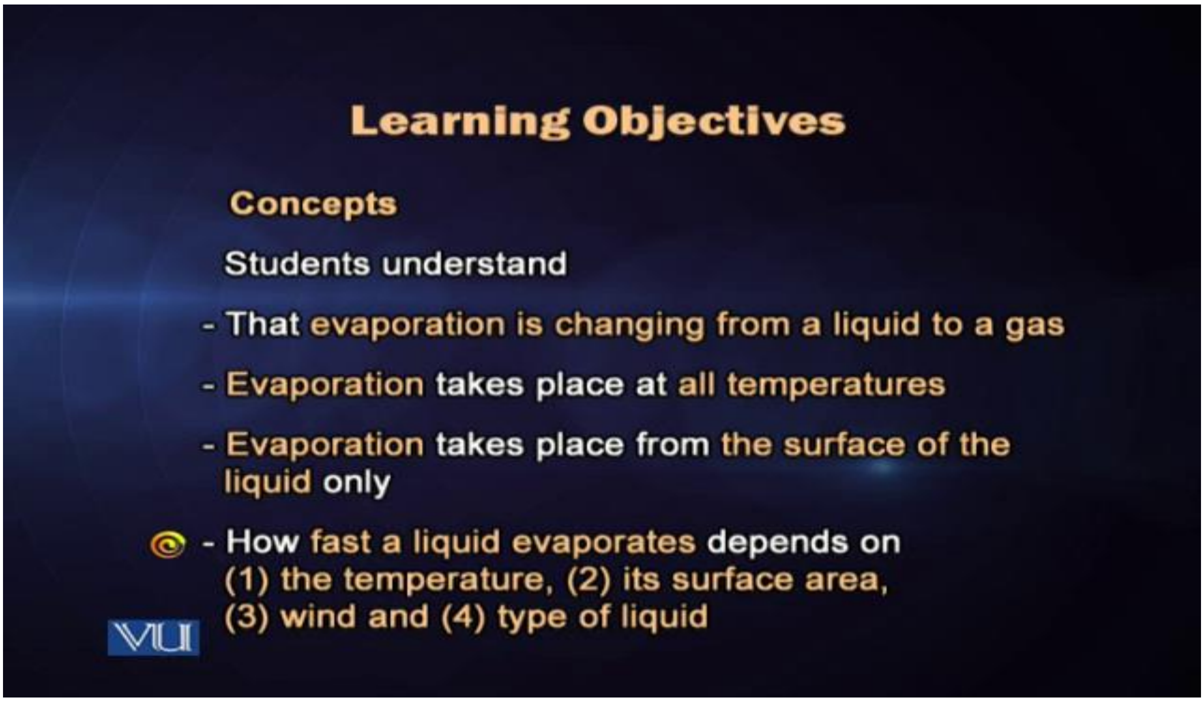
Exploring Evaporation and Conducting Fair Test

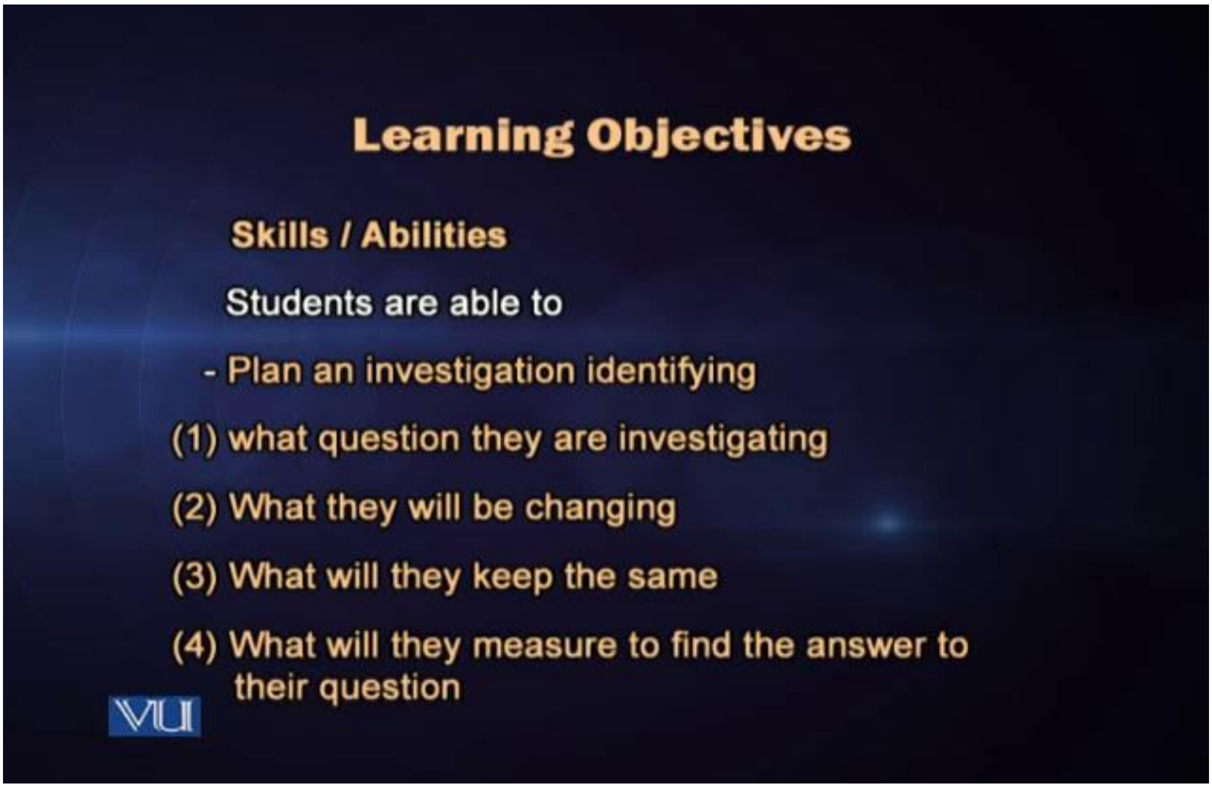


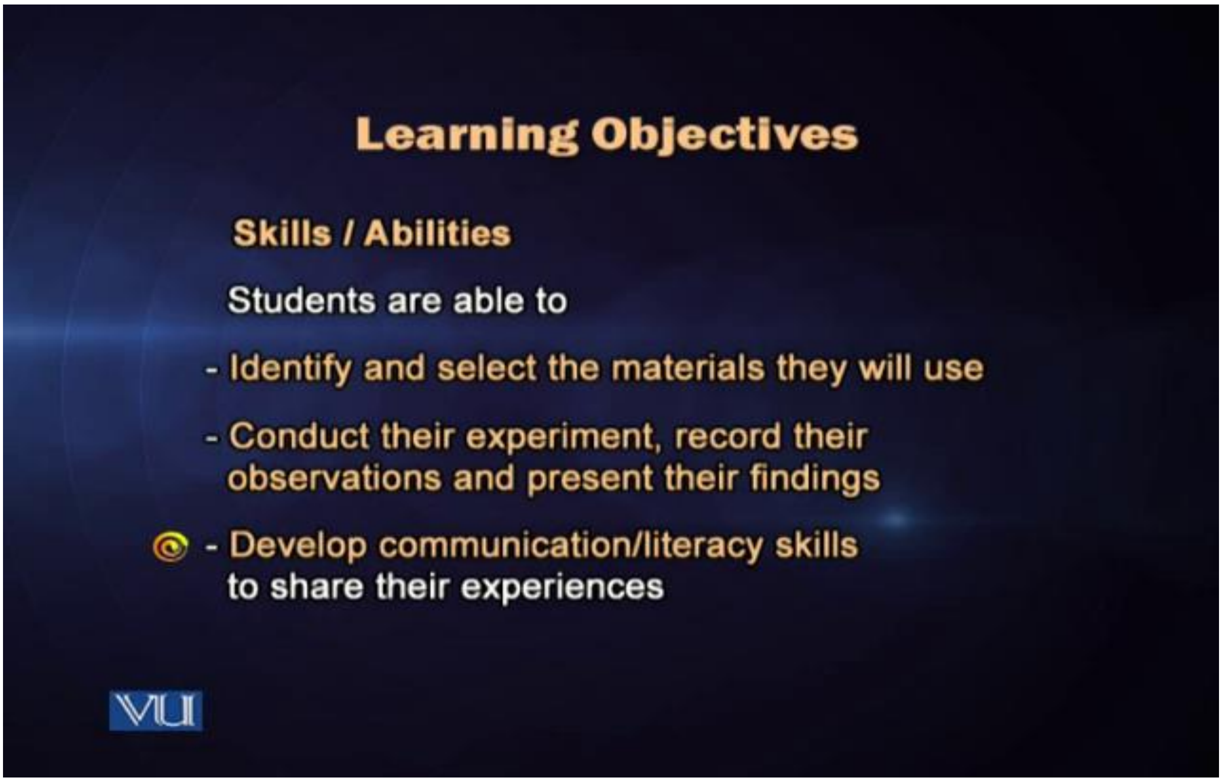


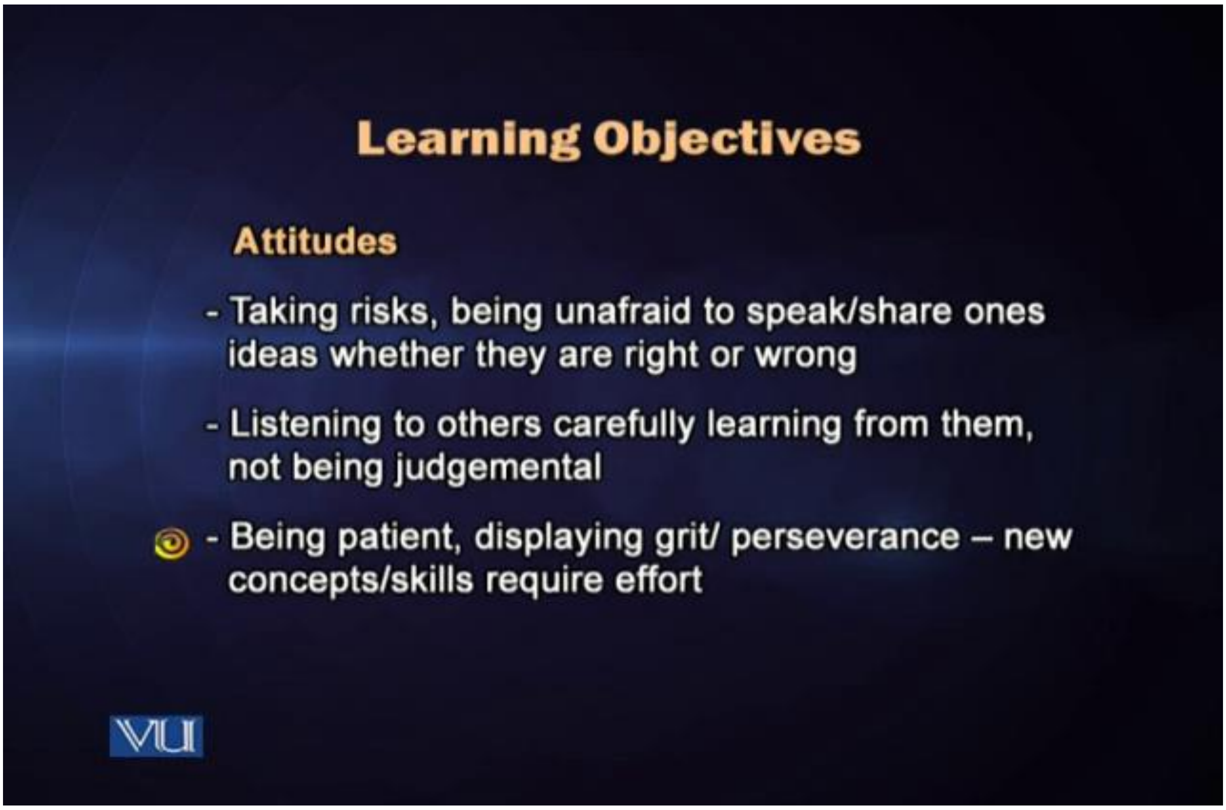

Scaffolding
Scaffolding: a structure made of wooden planks or metal rods to support a building while it is being constructed; it is removed once the building is constructed
VU

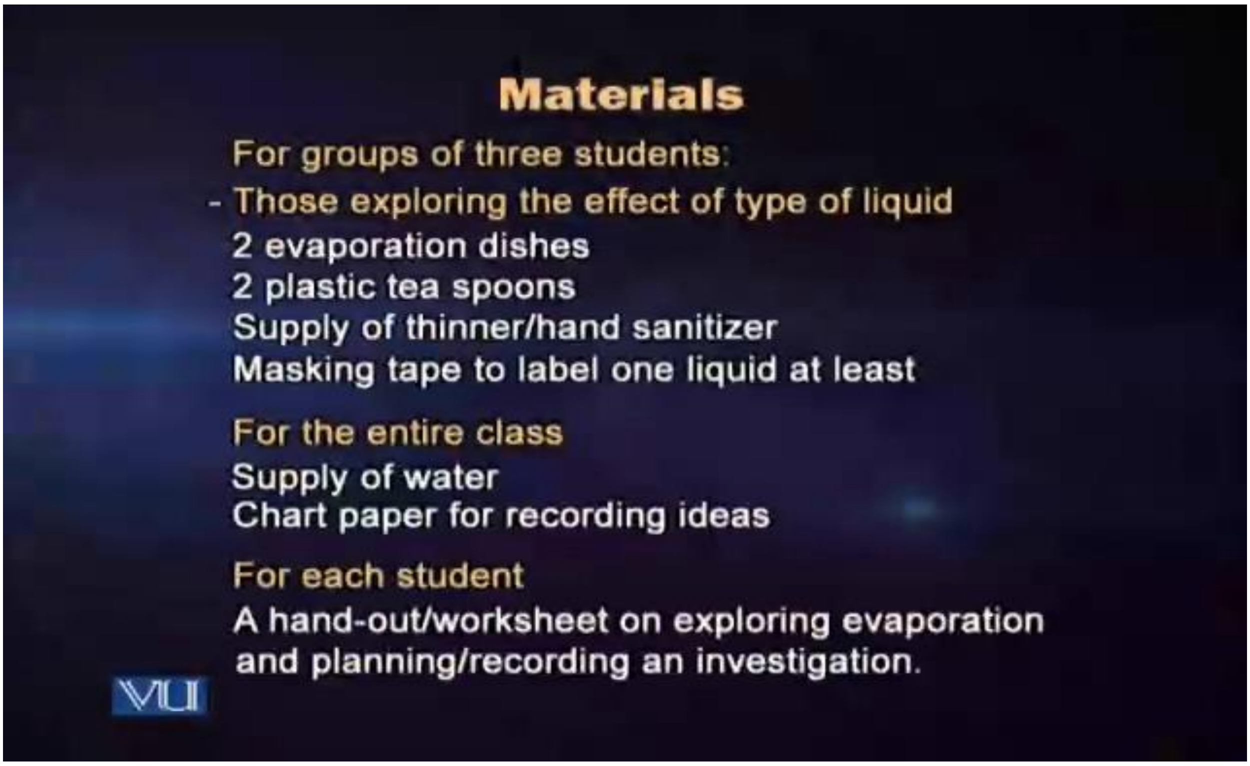

Exploring Evaporation and Conducting Fair Tests
Overview continued
- Make predictions and are taught to design a fair test starting from:
1) framing testable questions
2) then identifying which variables are to be kept constant what will be changed. This leads choosing the materials/equipment they would require for their experiment from a given selection.
- They conduct their experiments and present/ communicate their results for collective evaluation.
VU

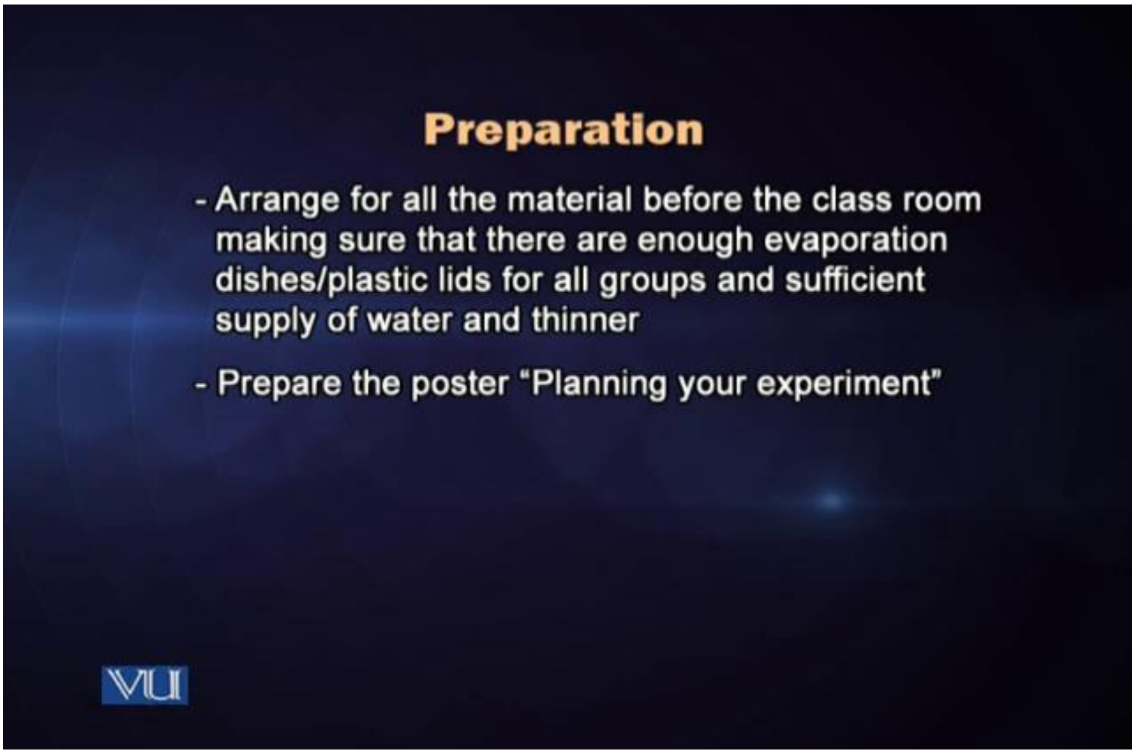

Learning Objectives
Concepts
Students understand
- That evaporation is changing from a liquid to a gas
- Evaporation takes place at all temperatures
- Evaporation takes place from the surface of the liquid only
- How fast a liquid evaporates depends on (1) the temperature, (2) its surface area, (3) wind and (4) type of liquid
VU

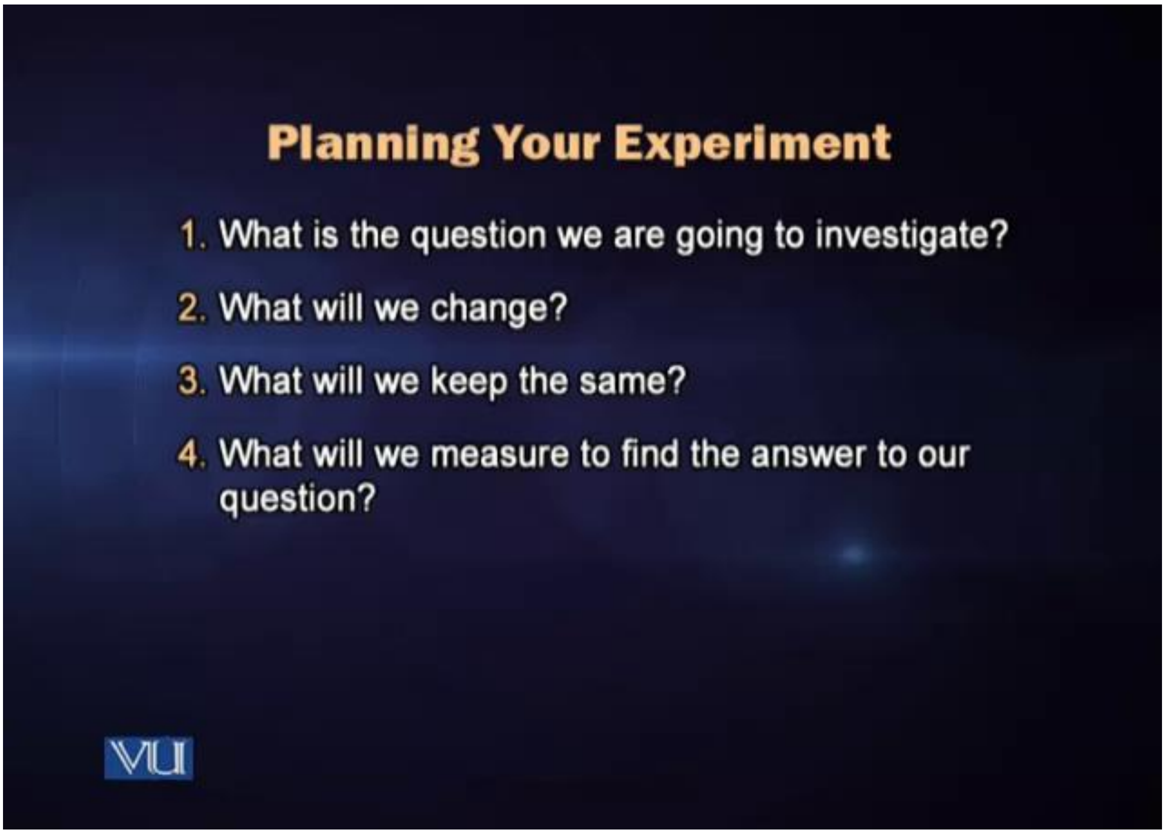

Learning Objectives
Skills / Abilities
Students are able to
- Plan an investigation identifying
(1) what question they are investigating
(2) What they will be changing
(3) What will they keep the same
(4) What will they measure to find the answer to their question
VU

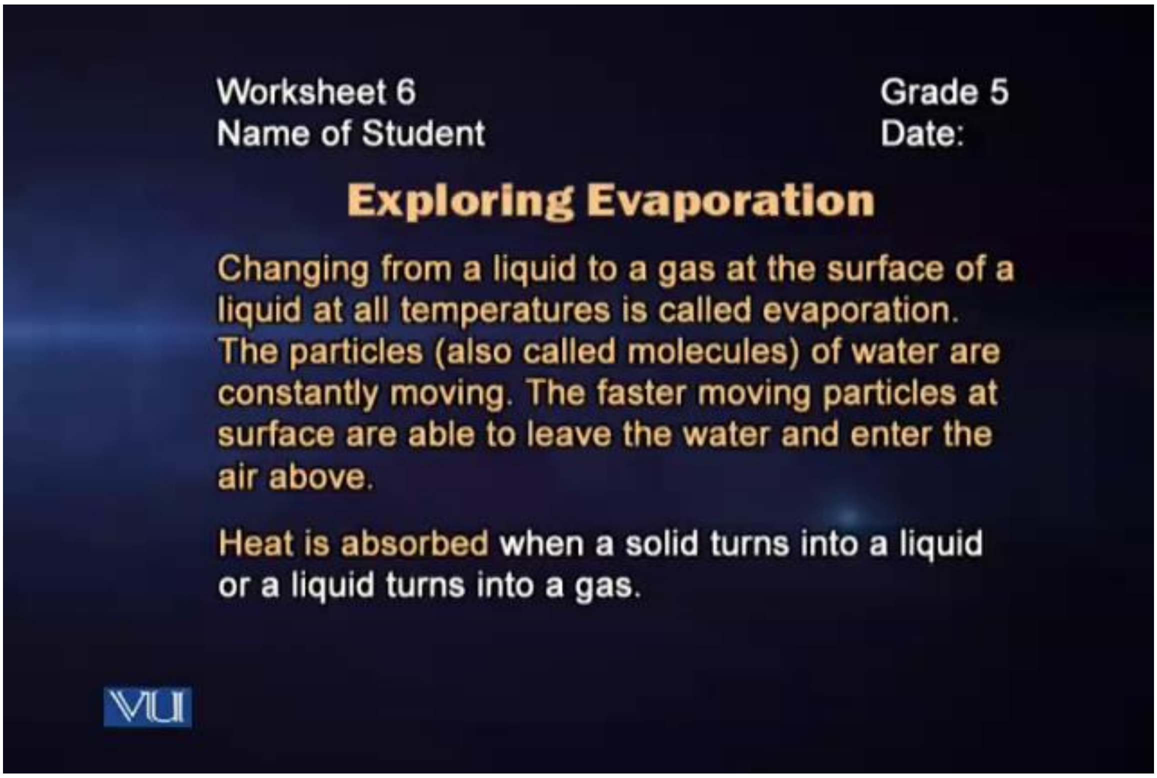

Learning Objectives
Skills / Abilities
Students are able to
- Identify and select the materials they will use
- Conduct their experiment, record their observations and present their findings
- Develop communication/literacy skills to share their experiences
VU

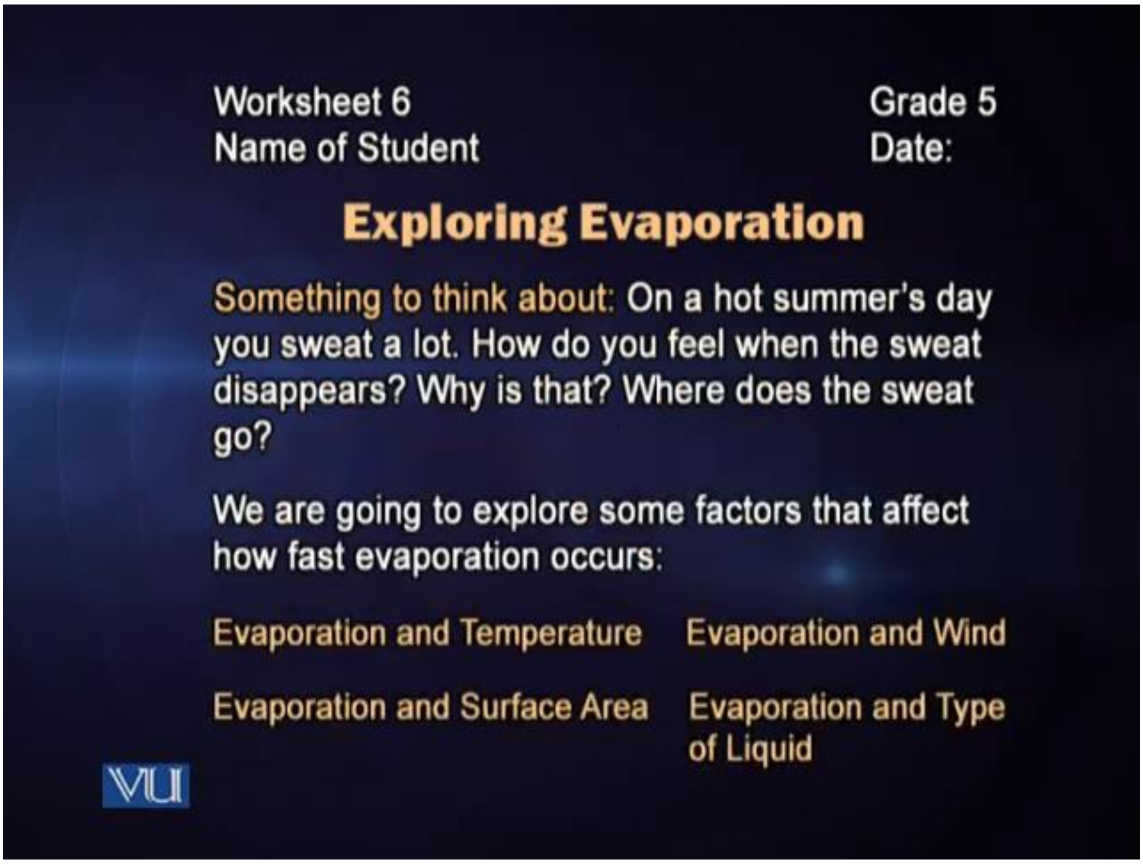

Learning Objectives
Attitudes
- Taking risks, being unafraid to speak/share ones ideas whether they are right or wrong
- Listening to others carefully learning from them, not being judgemental
- Being patient, displaying grit/ perseverance – new concepts/skills require effort
VU

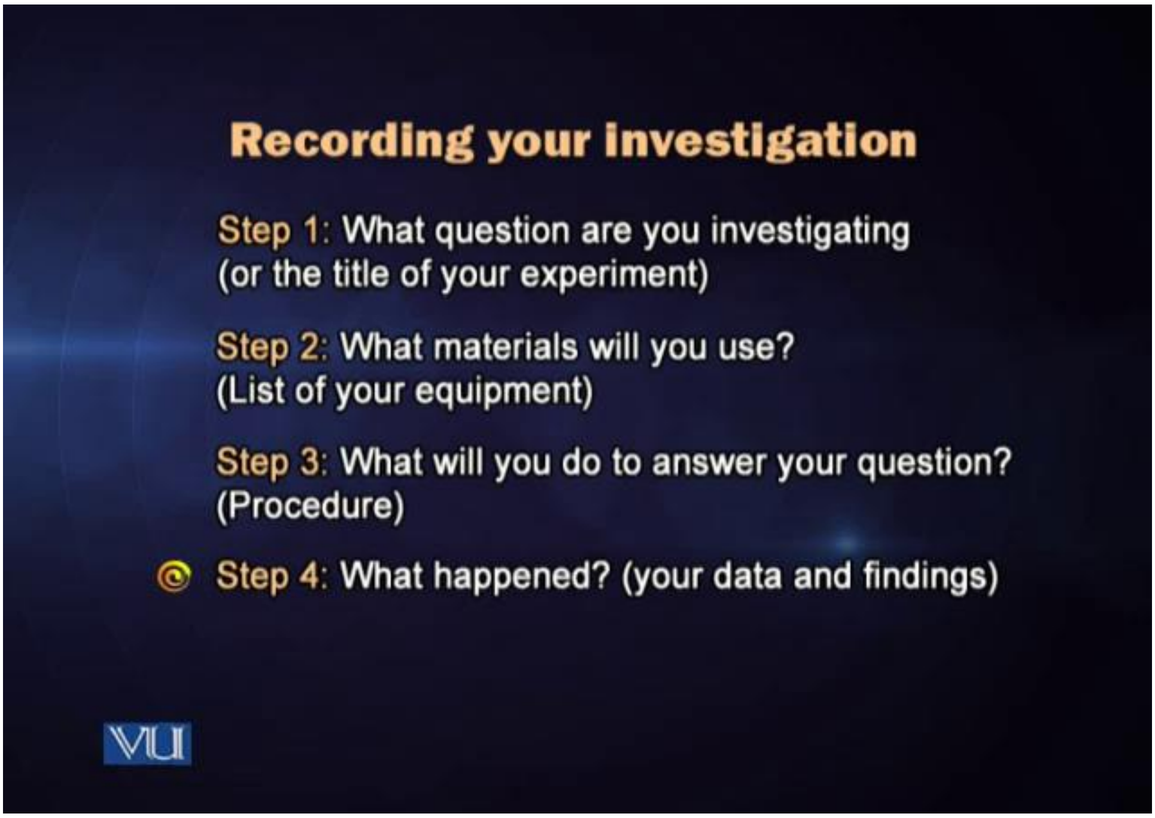

Materials
For groups of three students:
- Those exploring the effect of type of liquid
2 evaporation dishes
2 plastic tea spoons
Supply of thinner/hand sanitizer
Masking tape to label one liquid at least
For the entire class
Supply of water
Chart paper for recording ideas
For each student
A hand-out/worksheet on exploring evaporation and planning/recording an investigation.
VU


Preparation
- Arrange for all the material before the class room making sure that there are enough evaporation dishes/plastic lids for all groups and sufficient supply of water and thinner
- Prepare the poster "Planning your experiment"
VU


Planning Your Experiment
1. What is the question we are going to investigate?
2. What will we change?
3. What will we keep the same?
4. What will we measure to find the answer to our question?
VU


Worksheet 6
Grade 5
Name of Student
Date:
Exploring Evaporation
Changing from a liquid to a gas at the surface of a liquid at all temperatures is called evaporation. The particles (also called molecules) of water are constantly moving. The faster moving particles at surface are able to leave the water and enter the air above.
Heat is absorbed when a solid turns into a liquid or a liquid turns into a gas.
VU

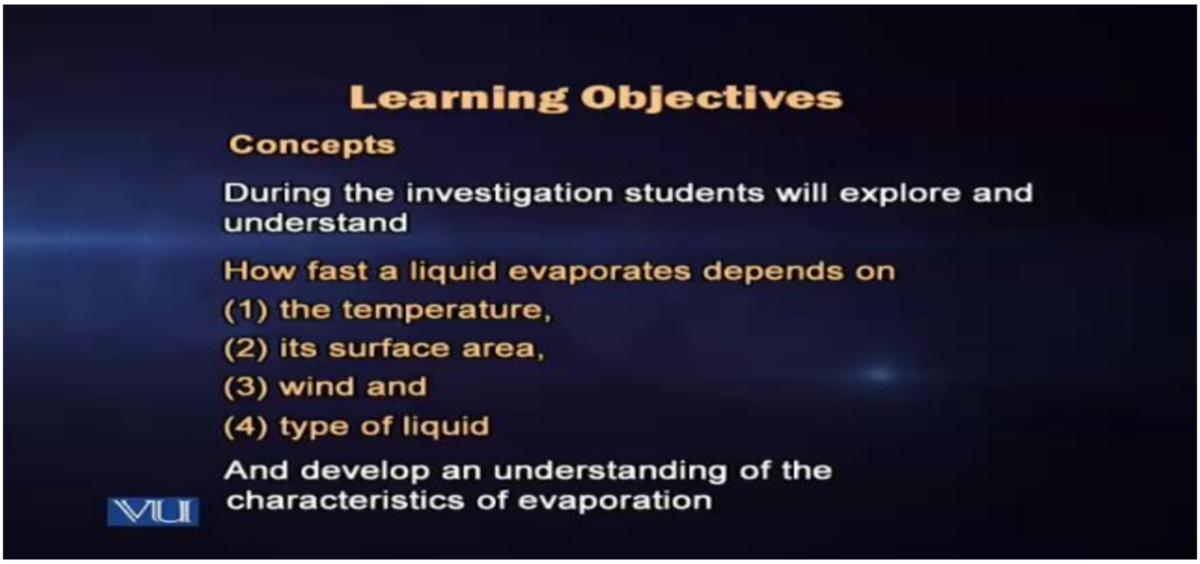

Worksheet 6
Grade 5
Name of Student
Date:
Exploring Evaporation
Something to think about: On a hot summer's day you sweat a lot. How do you feel when the sweat disappears? Why is that? Where does the sweat go?
We are going to explore some factors that affect how fast evaporation occurs:
Evaporation and Temperature
Evaporation and Wind
Evaporation and Surface Area
Evaporation and Type of Liquid
VU

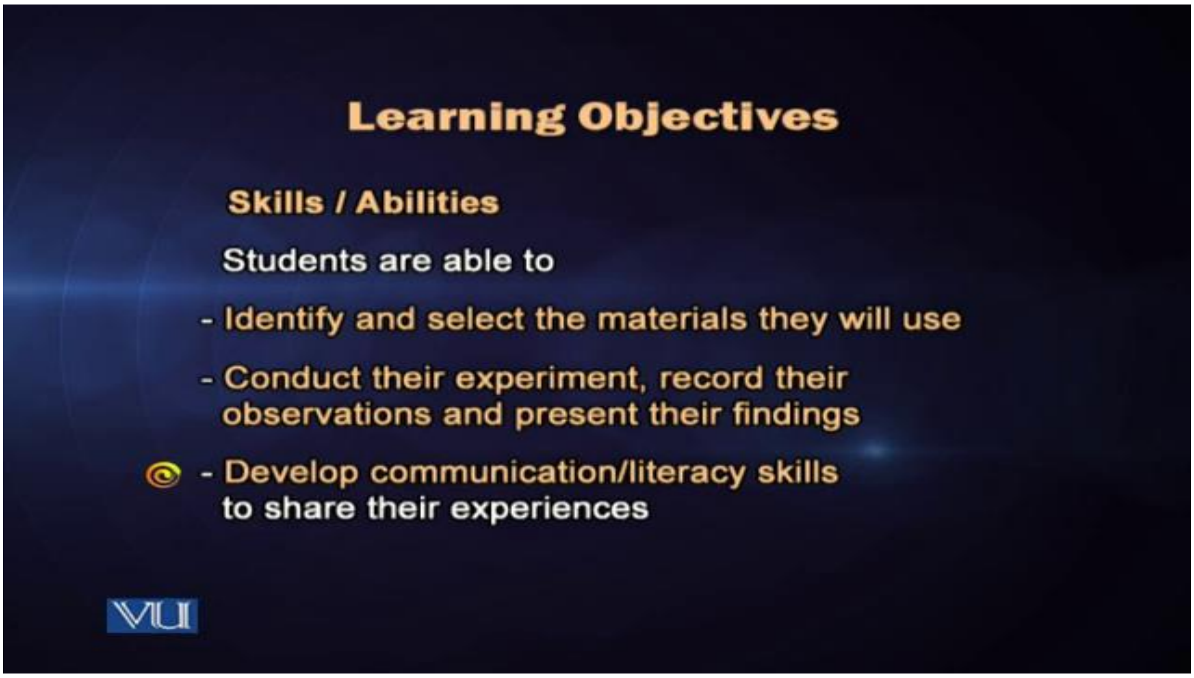

Recording your investigation
Step 1: What question are you investigating (or the title of your experiment)
Step 2: What materials will you use? (List of your equipment)
Step 3: What will you do to answer your question? (Procedure)
Step 4: What happened? (your data and findings)
VU

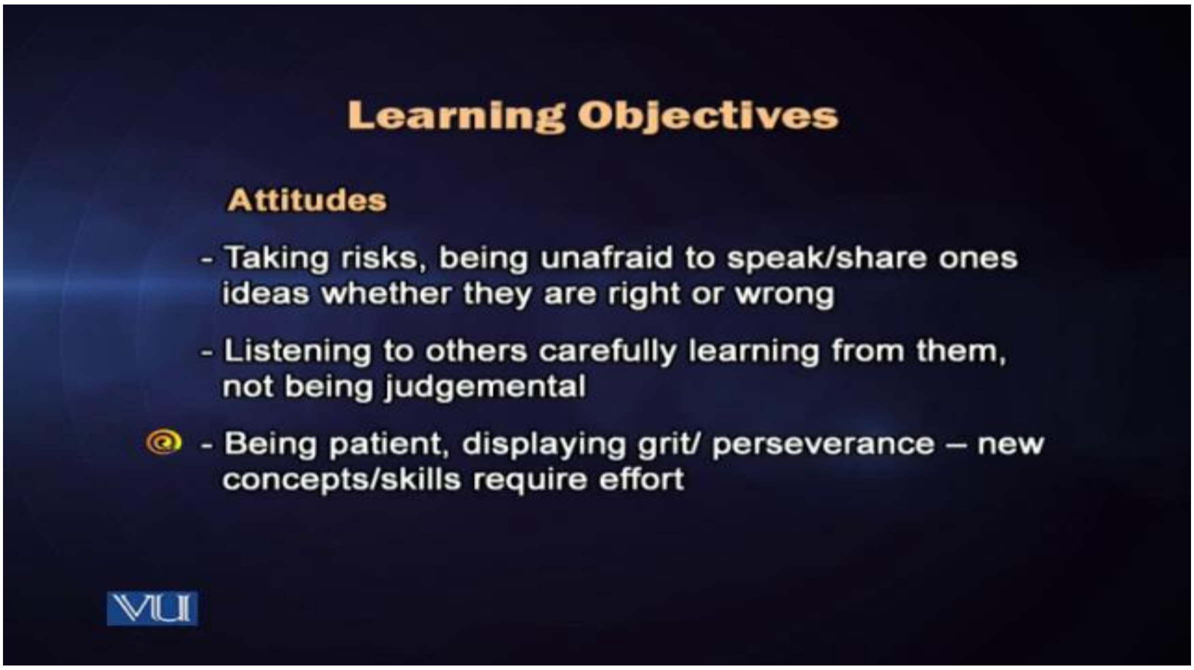
In the class teacher discussed the plan of structure with the students. And discuss the questions of investigation with the students.

Lecture No 30

Concept of Evaporation







Children formulated the questions and shared them with the teacher. The questions of investigation made by children were:

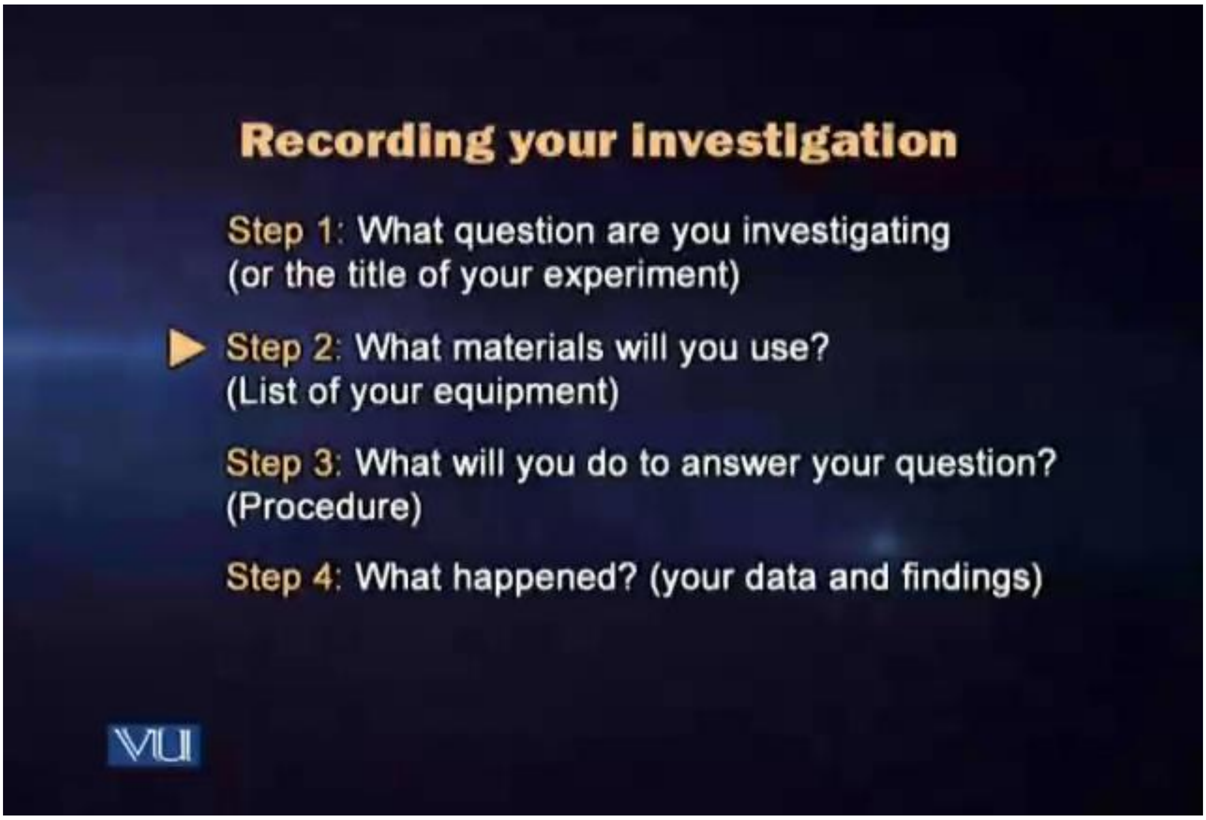
“Does handcenetizer evaporate faster or a thinner?

Will water evaporate faster from a large or a small surface?

Does water evaporate faster in wind or without wind?

What is the difference in evaporation of water in the room or outside the room?”

The next step is what we are changing and what will remain the same. For example in the first question children will change the type of liquids. And everything else remains the same. The size of dishes and the quantity of liquids will be the same.

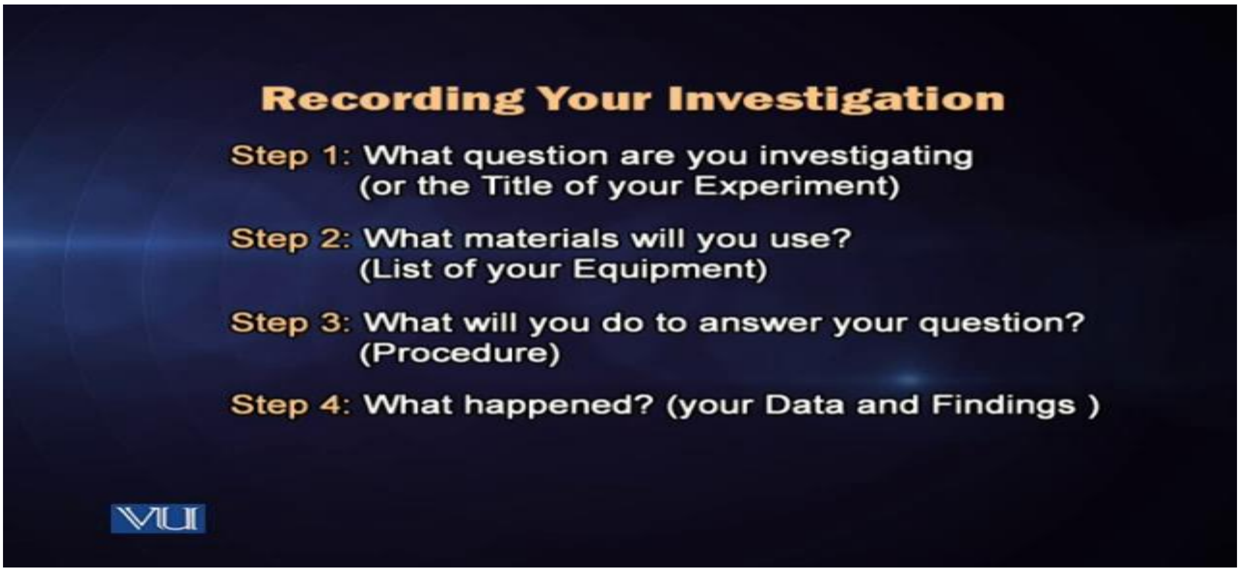


Teacher gave the equipment to the students related to their experiment. Students presented their experiments to the teacher in the classroom. Teacher taught then that science is about developing the skills. Children developed their communication skills through presentation. Teacher gave six minutes to each group for presentation and three minutes for question answer session. A culture of hearing is also important in a presentation. Teacher discussed all four presentations in the classroom.

Lecture No 31

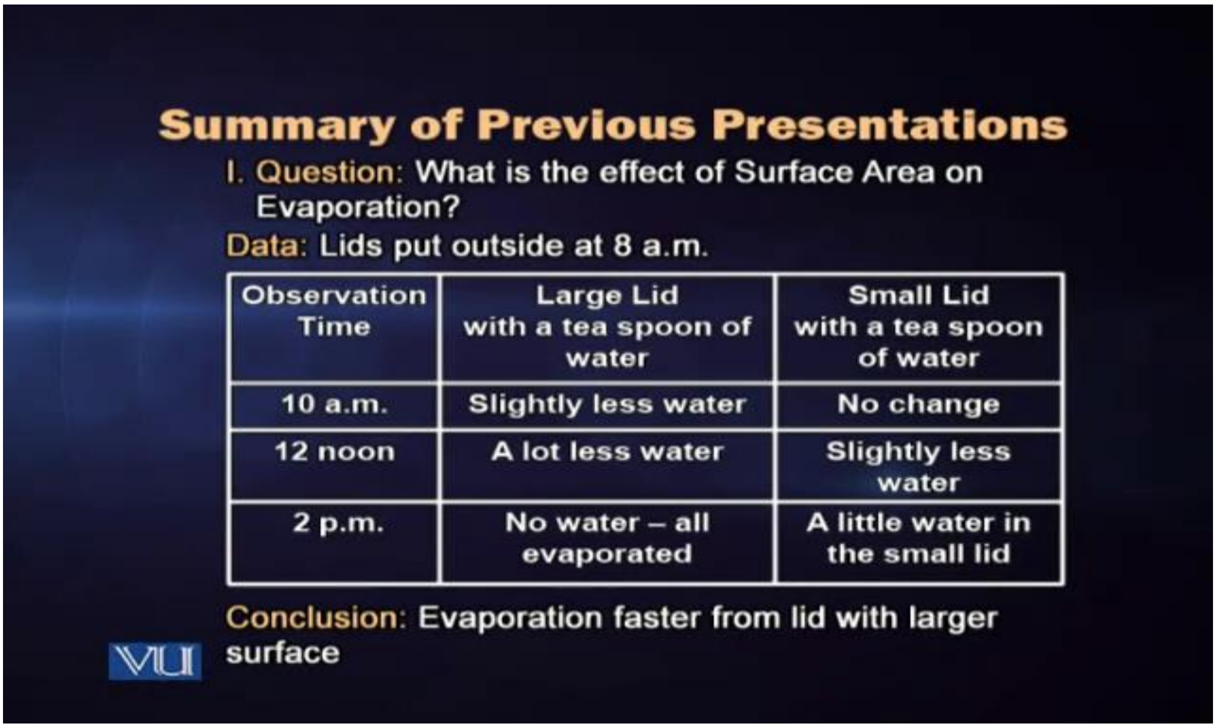
Presentations of children on Evaporation

Review of the template that children have used for the investigation

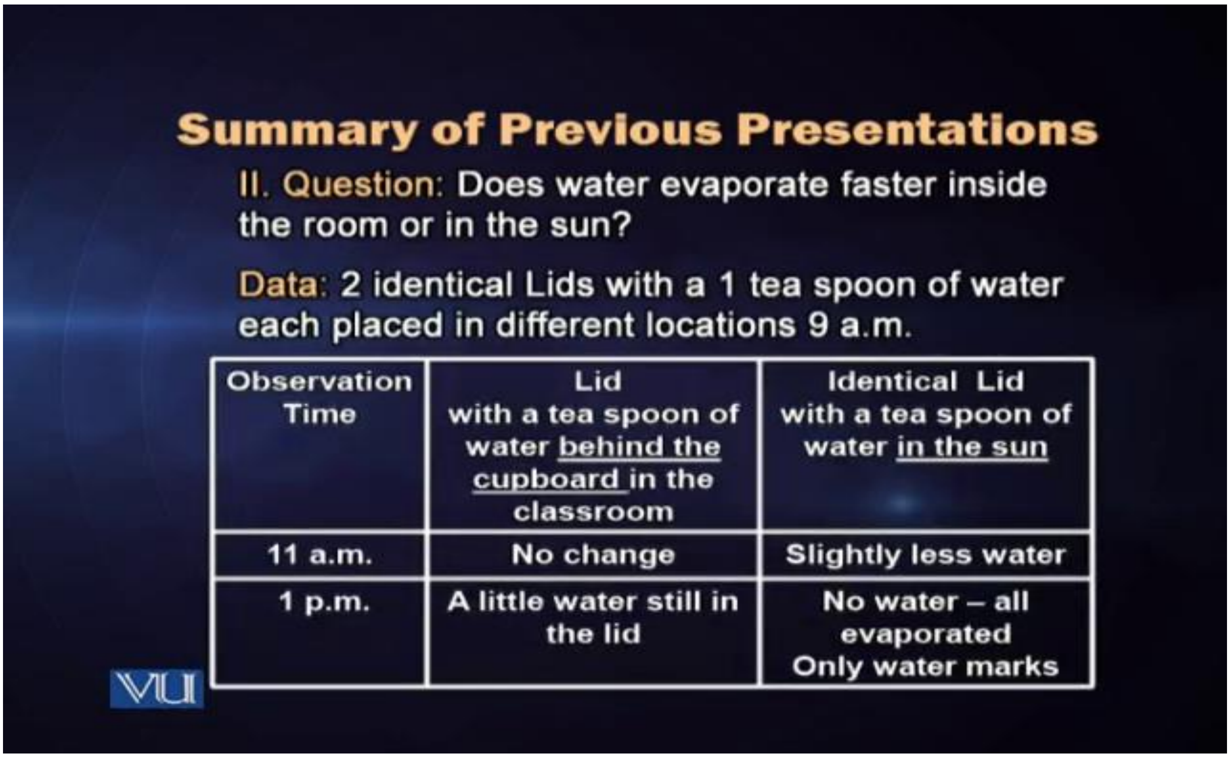


Summary of the presentations

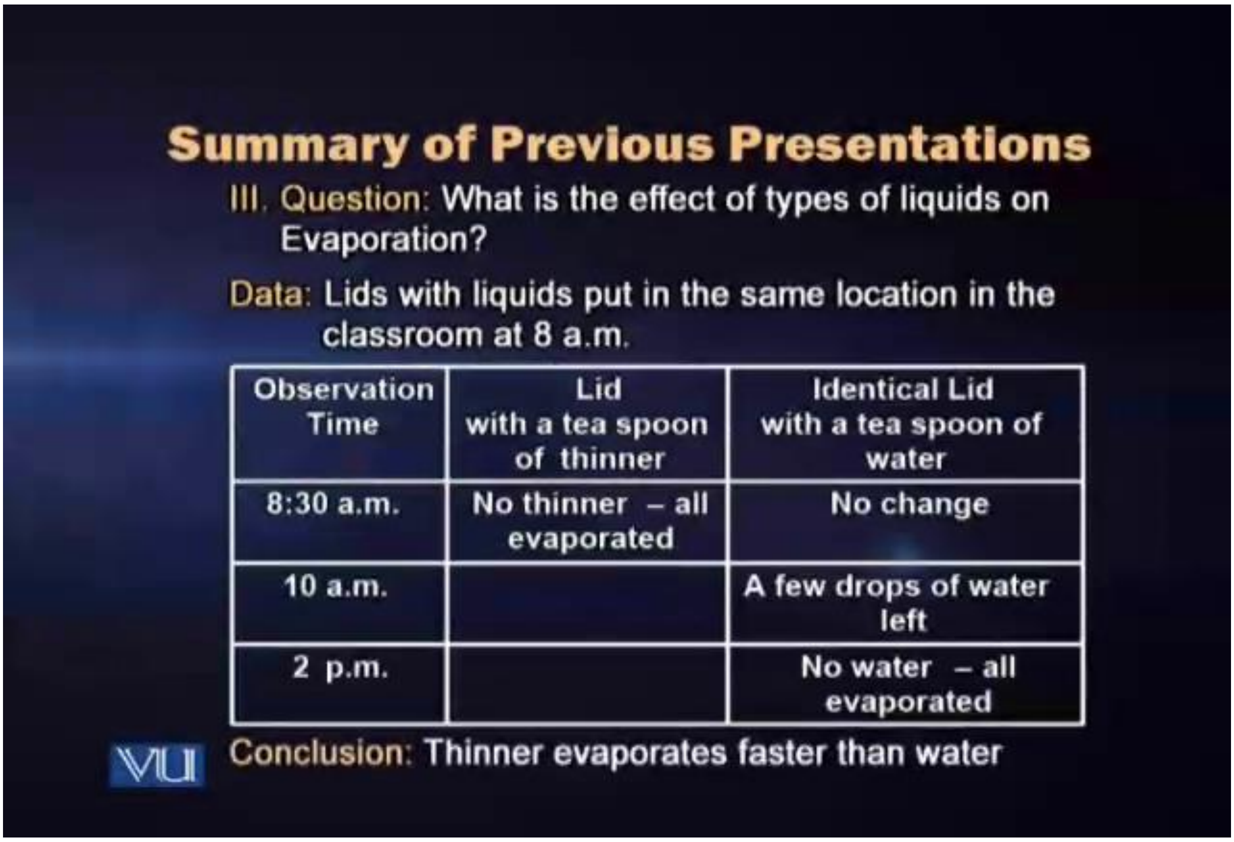
Presentation 1:



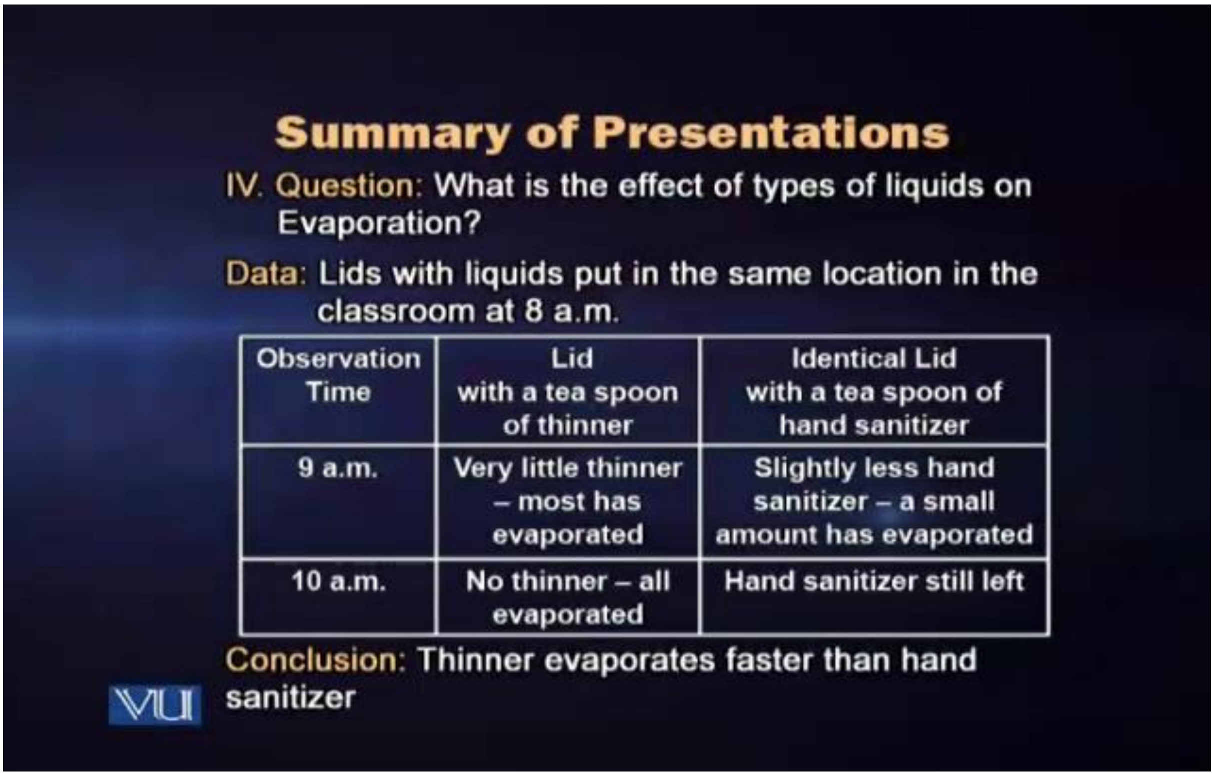
Presentation 2:



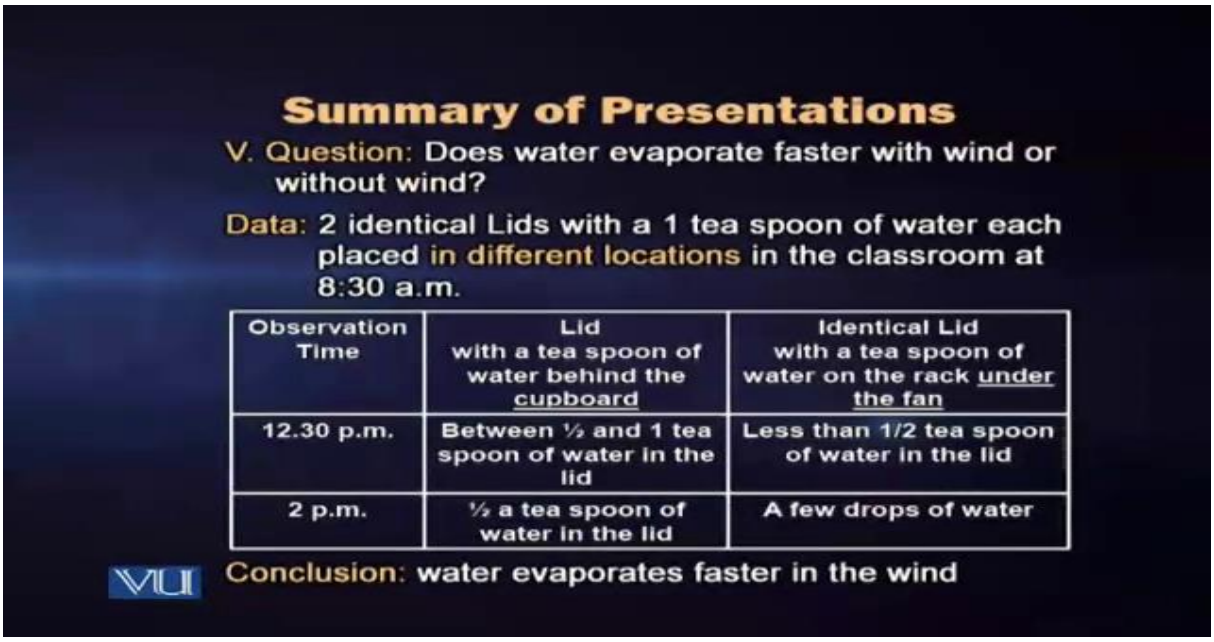
Presentation 3:



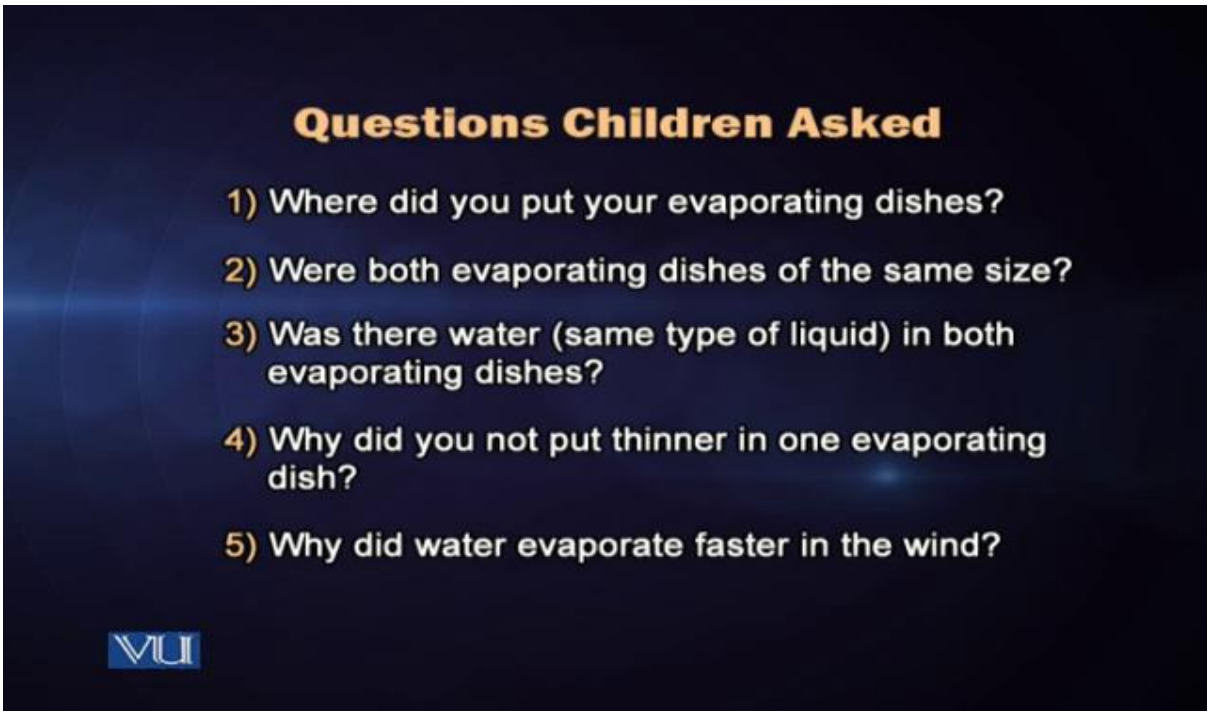
Presentation 4:



Presentation 5:



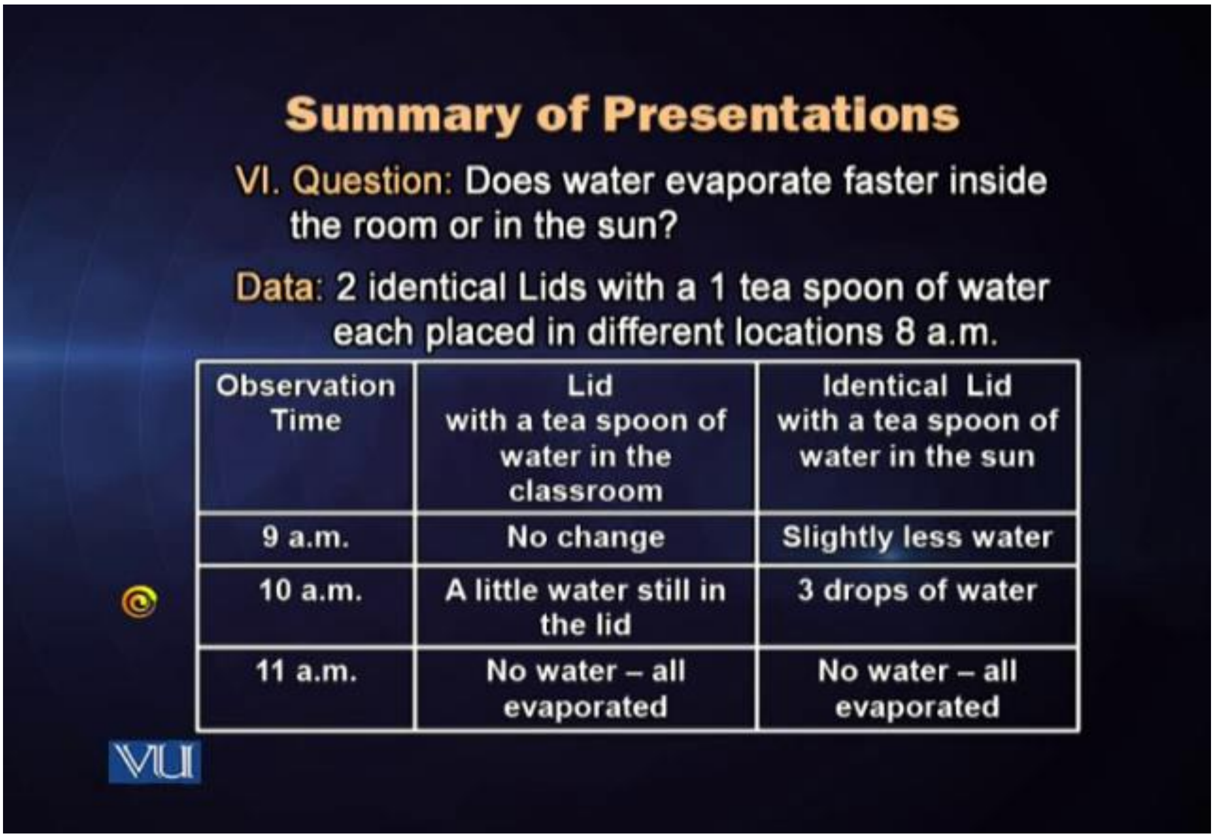
At the end there was question answer session. Questions that were asked by the students:



Questions Children Asked

1) Where did you put your evaporating dishes?
2) Were both evaporating dishes of the same size?
3) Was there water (same type of liquid) in both evaporating dishes?
4) Why did you not put thinner in one evaporating dish?
5) Why did water evaporate faster in the wind?

Presentation 6:

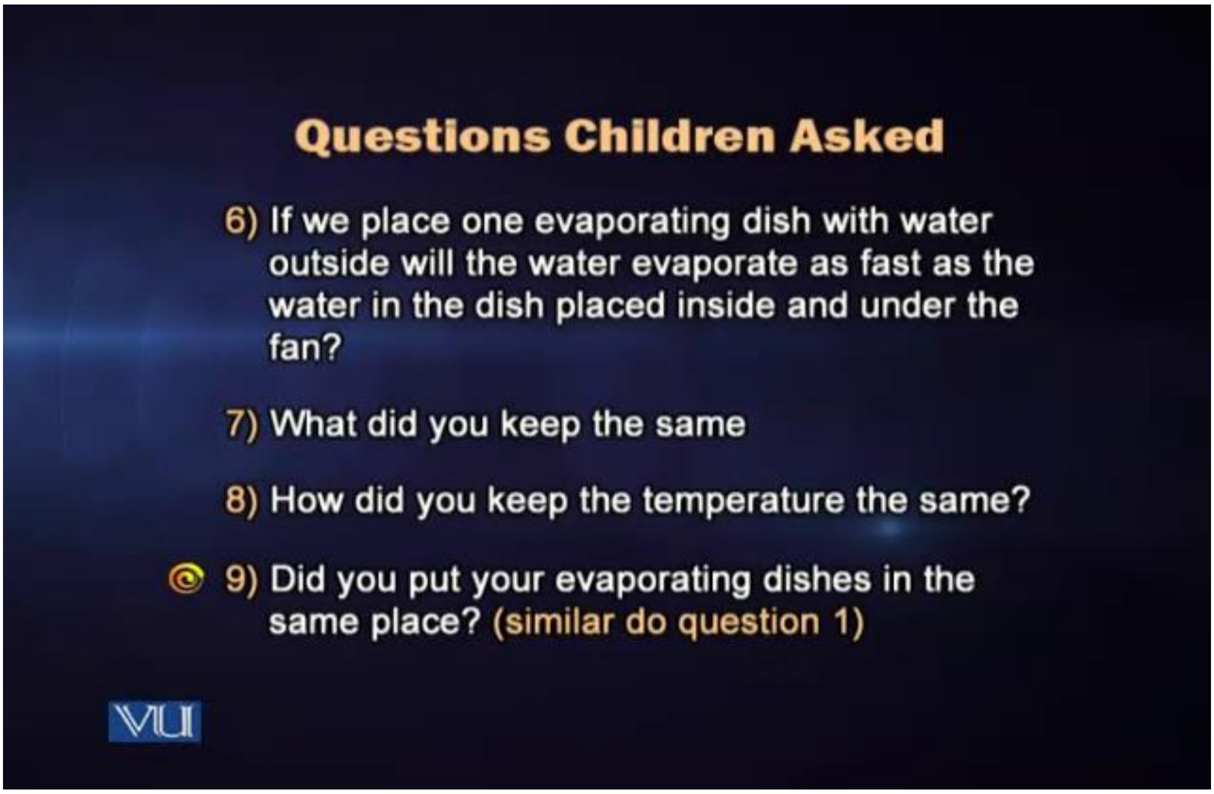


Summary of Presentations

VI. Question: Does water evaporate faster inside the room or in the sun?

Data: 2 identical Lids with a 1 tea spoon of water each placed in different locations 8 a.m.

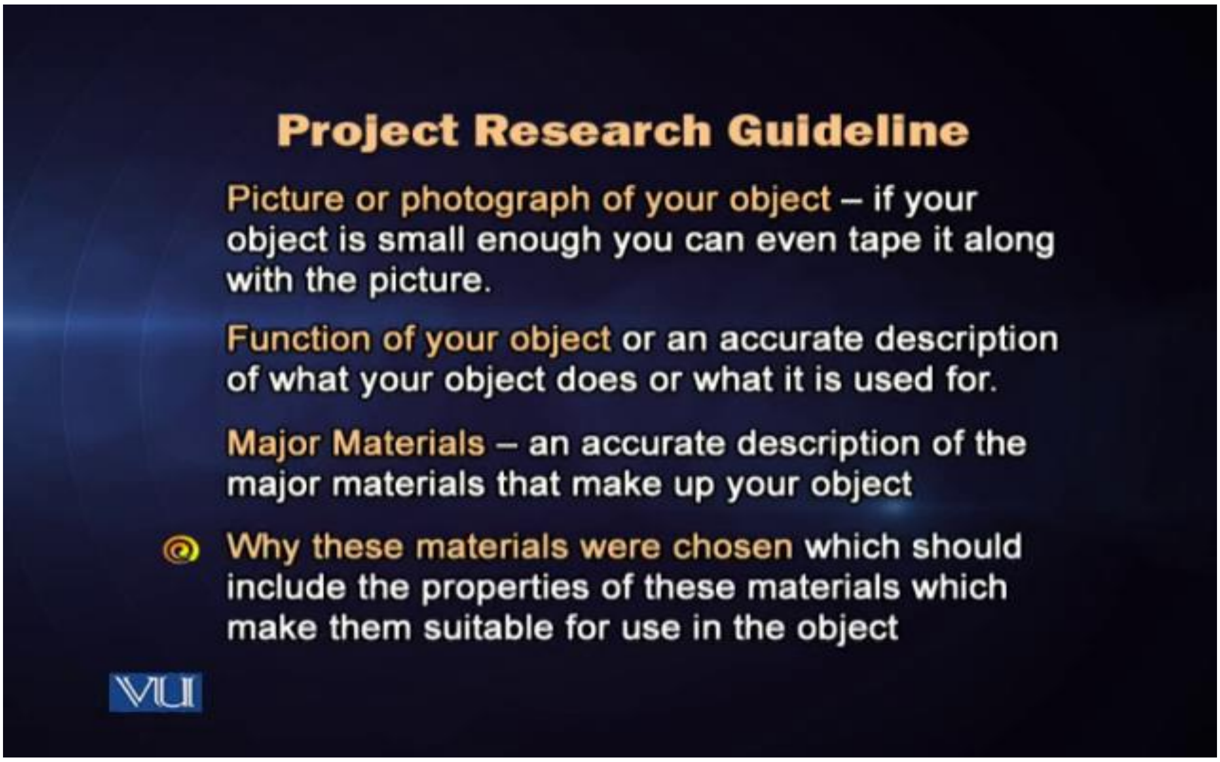
Observation Time	Lid with a tea spoon of water in the classroom	Identical Lid with a tea spoon of water in the sun
9 a.m.	No change	Slightly less water
10 a.m.	A little water still in the lid	3 drops of water
11 a.m.	No water – all evaporated	No water – all evaporated

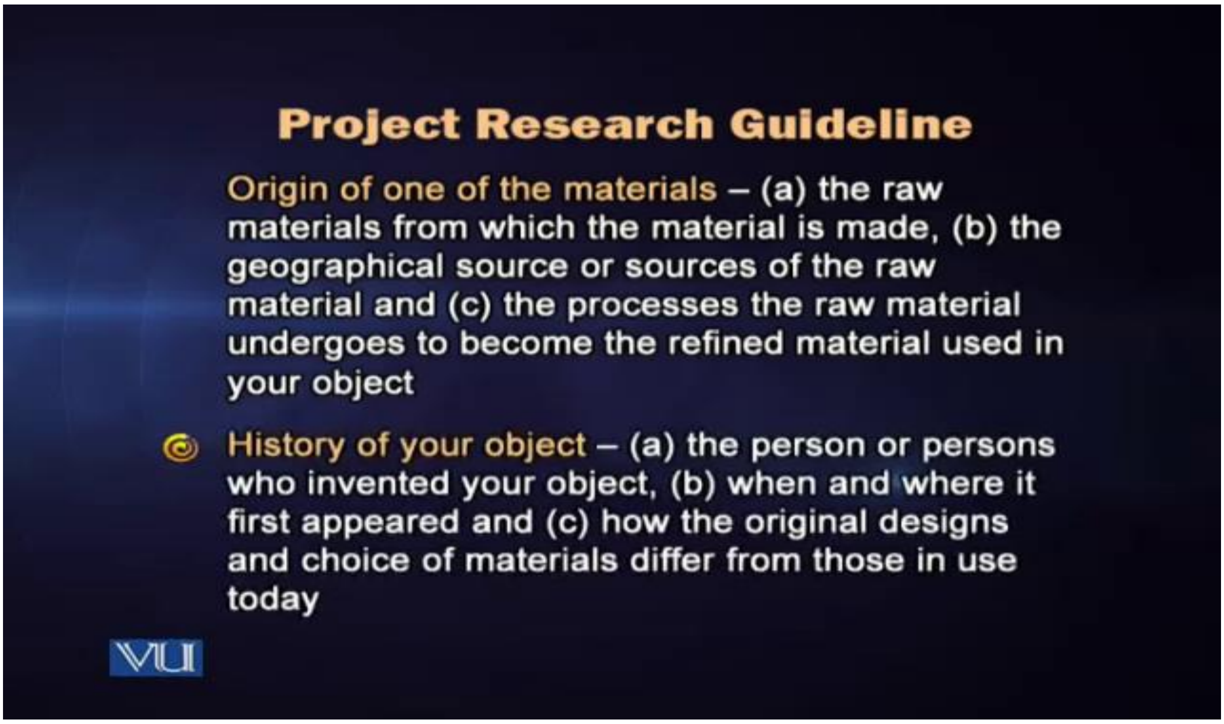


These presentations enhanced the communication and literacy skills of the students. Students started sharing their ideas. They built up their creative thinking by asking the questions.

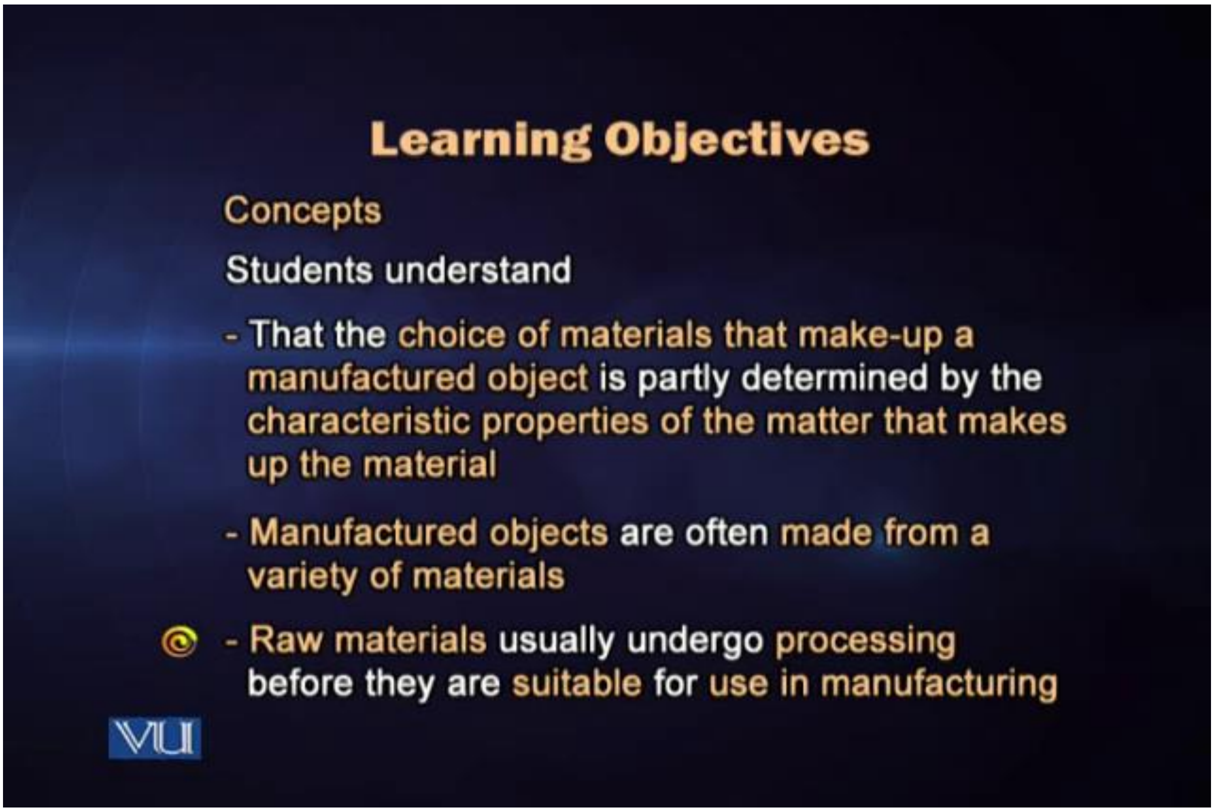
Lecture No 32

Research Project Guideline






Presenting the research project on properties of materials by focussing on a common "manufactured" object
A Review
- Students were introduced to their research project at the start of the unit.
- Students formed pairs and were asked to take a week to select a simple object and give reasons for their choice.
- They were given a project schedule and a research guideline. They were given four weeks to complete and present their project.
VU

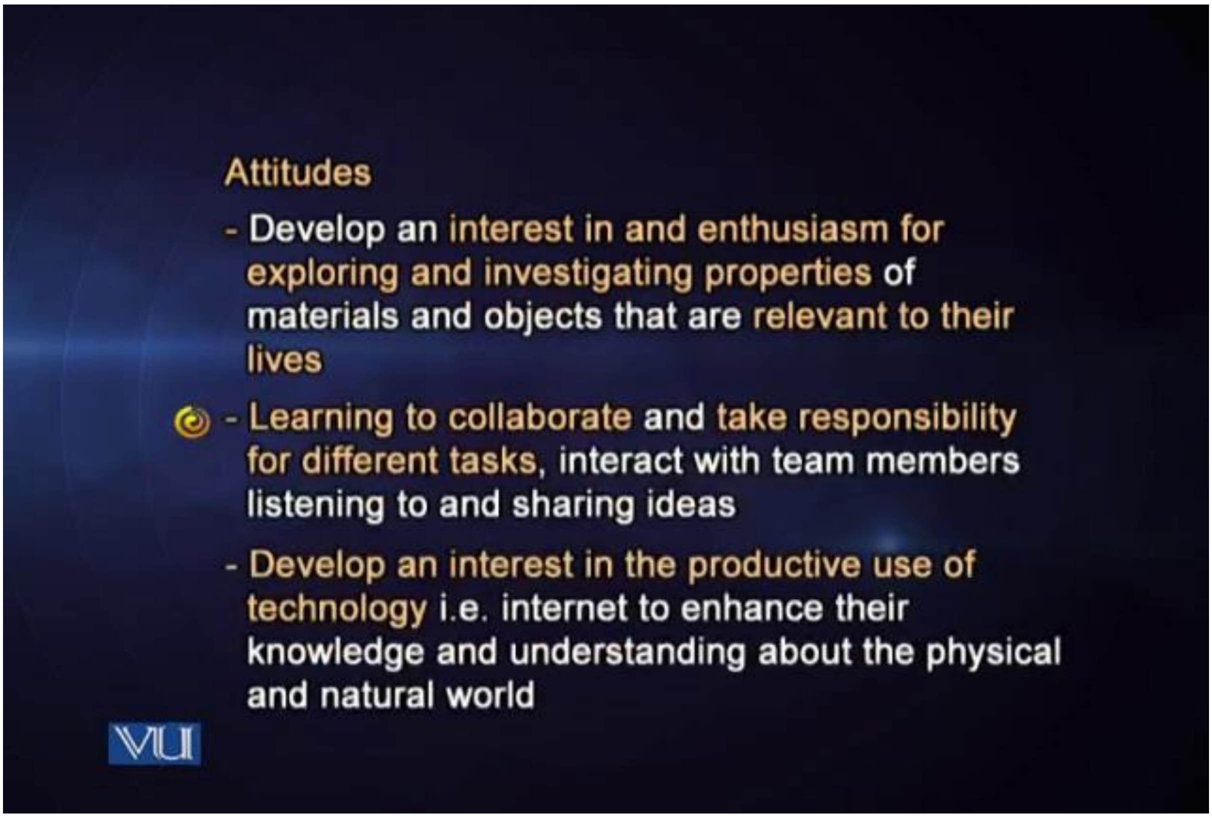

Learning Objectives
Concepts
Students understand
- That the choice of materials that make-up a manufactured object is partly determined by the characteristic properties of the matter that makes up the material
- Manufactured objects are often made from a variety of materials
- Raw materials usually undergo processing before they are suitable for use in manufacturing
VU

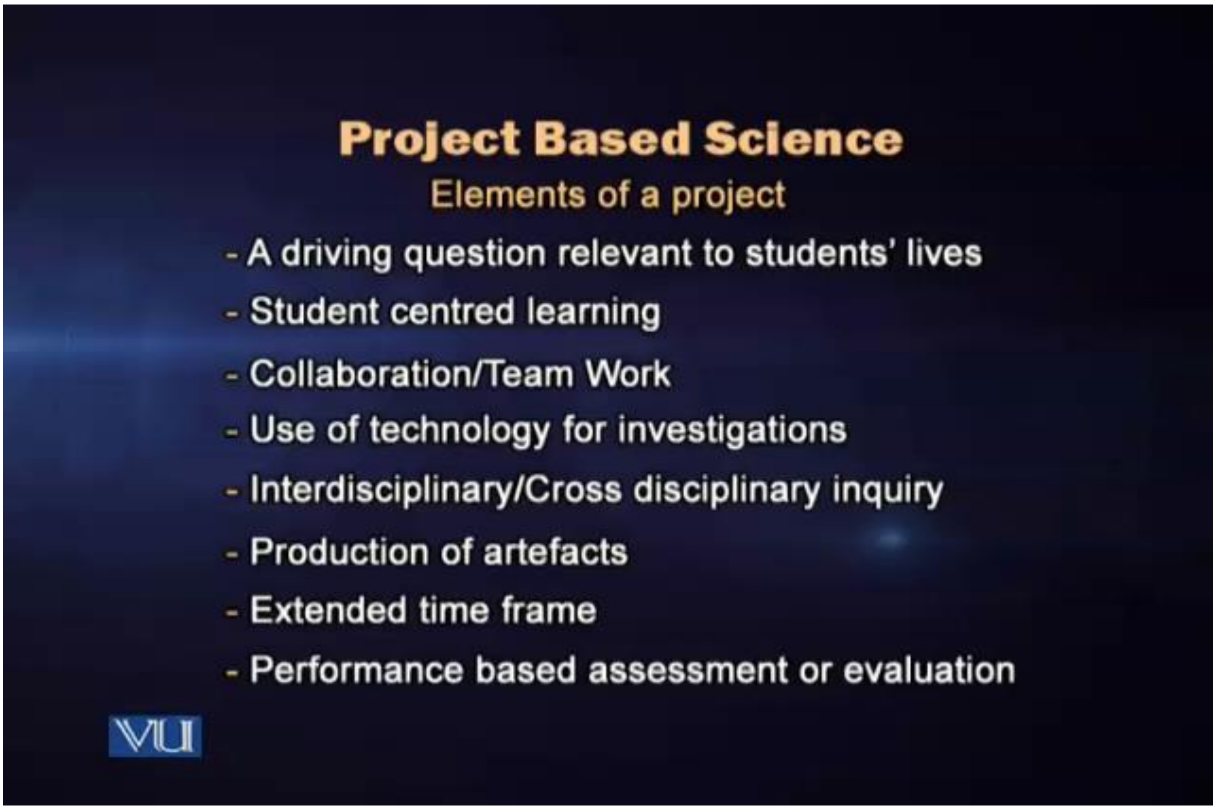
Skills / Abilities

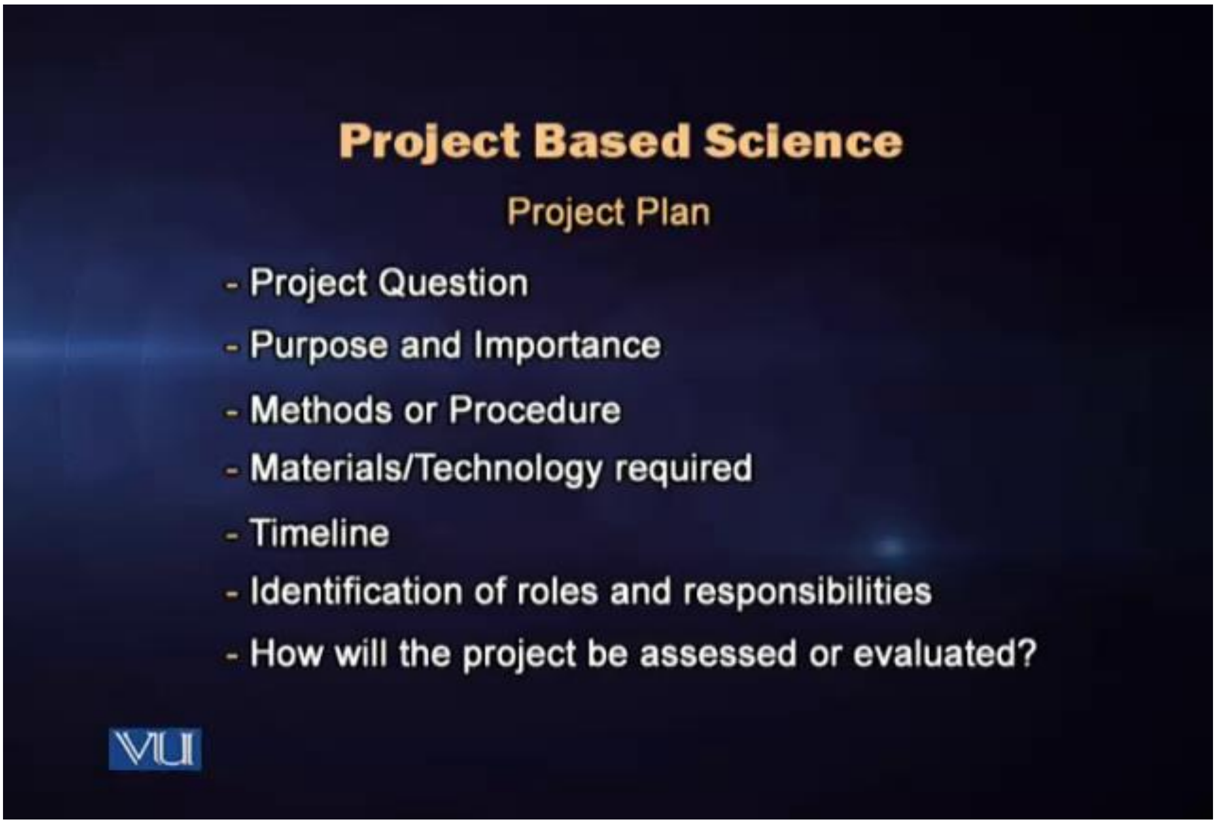
Students are able to

- Select a simple manufactured object and
  - (i) Explain the function of the object
  - (ii) Identify the major materials that make-up the object
  - (iii) Identify the properties of the materials that make them suitable for use in the object
  - (iv) Identify the raw materials that make-up one of the materials and the refining process that makes them usable in the object

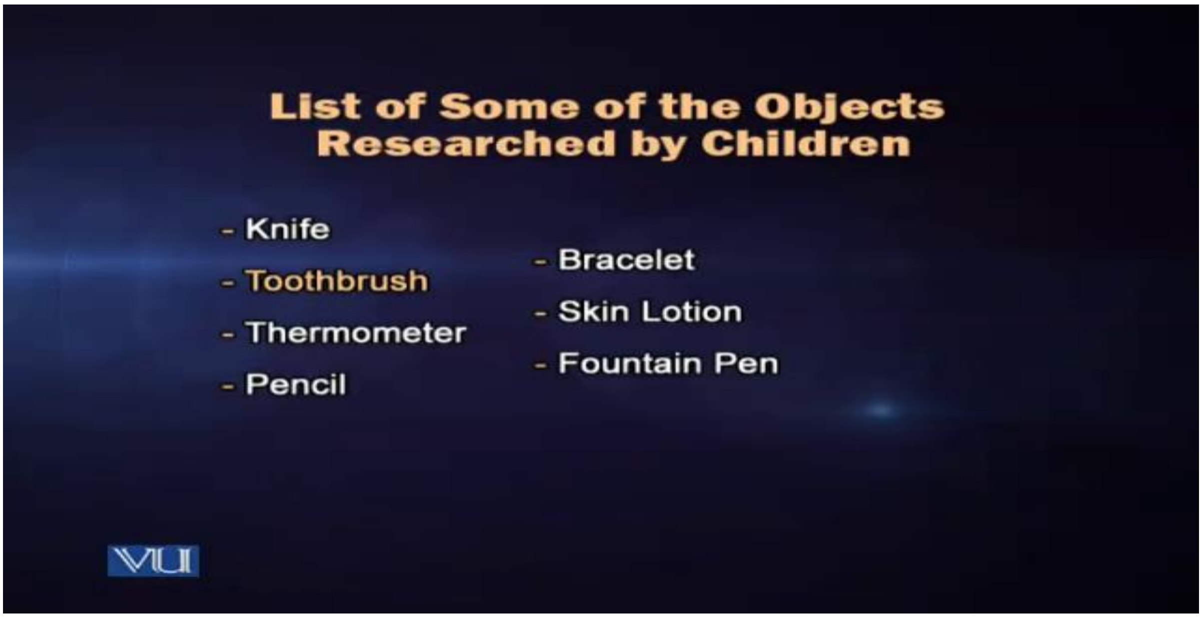
- Conduct research using the internet
- Communicate by creating an exhibit and giving an oral presentation
- Defend their findings and critique others using logical reasoning and evidence

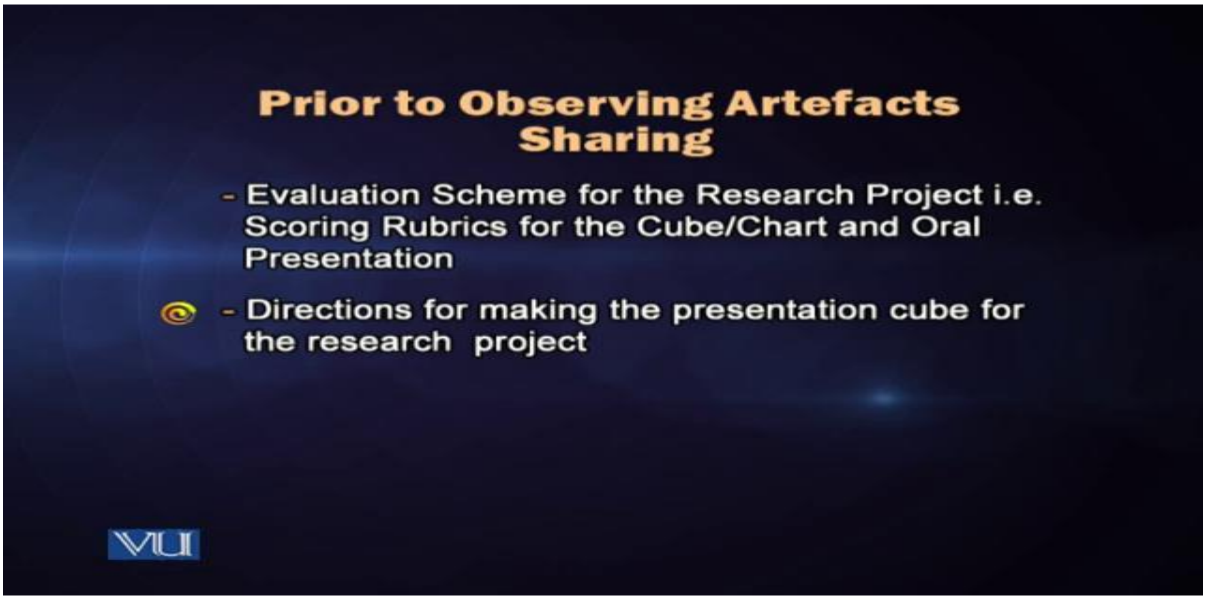

Attitudes
- Develop an interest in and enthusiasm for exploring and investigating properties of materials and objects that are relevant to their lives
- Learning to collaborate and take responsibility for different tasks, interact with team members listening to and sharing ideas
- Develop an interest in the productive use of technology i.e. internet to enhance their knowledge and understanding about the physical and natural world
VU

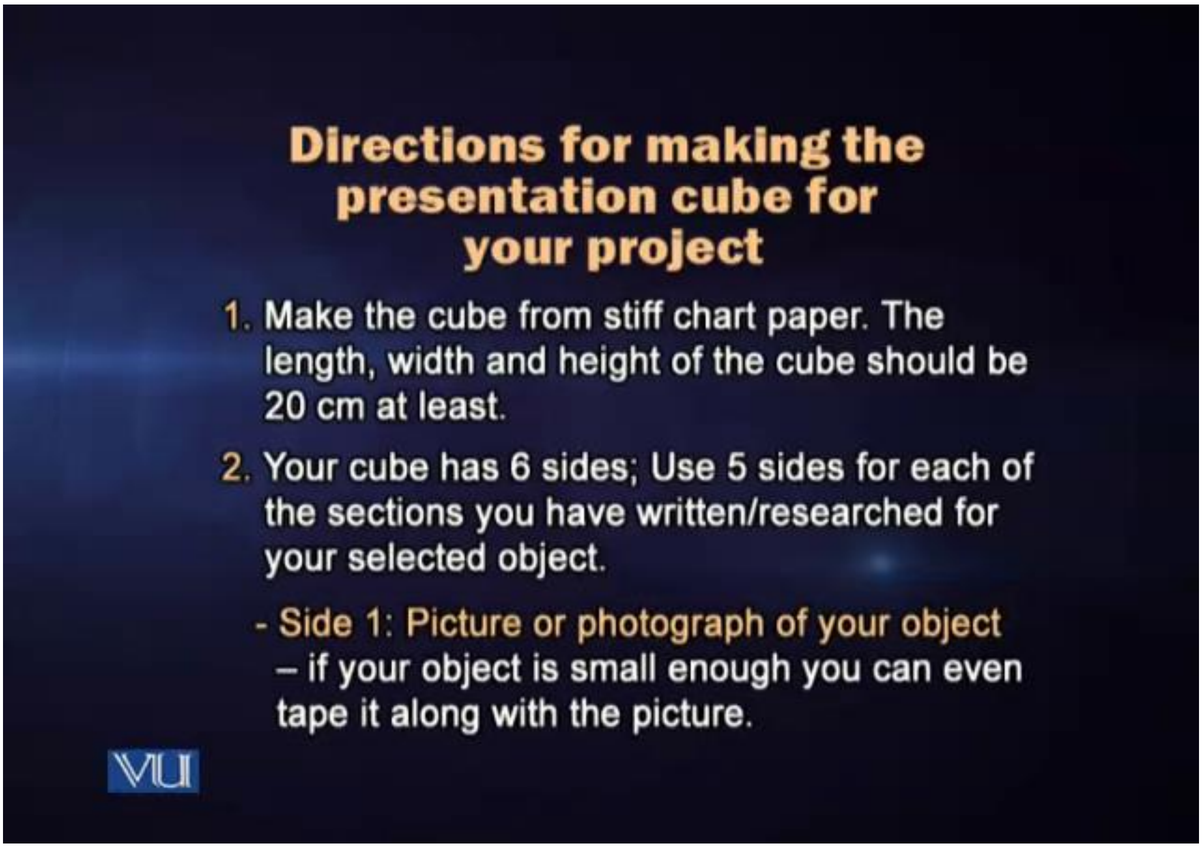

Project Based Science
Elements of a project
- A driving question relevant to students' lives
- Student centred learning
- Collaboration/Team Work
- Use of technology for investigations
- Interdisciplinary/Cross disciplinary inquiry
- Production of artefacts
- Extended time frame
- Performance based assessment or evaluation
VU

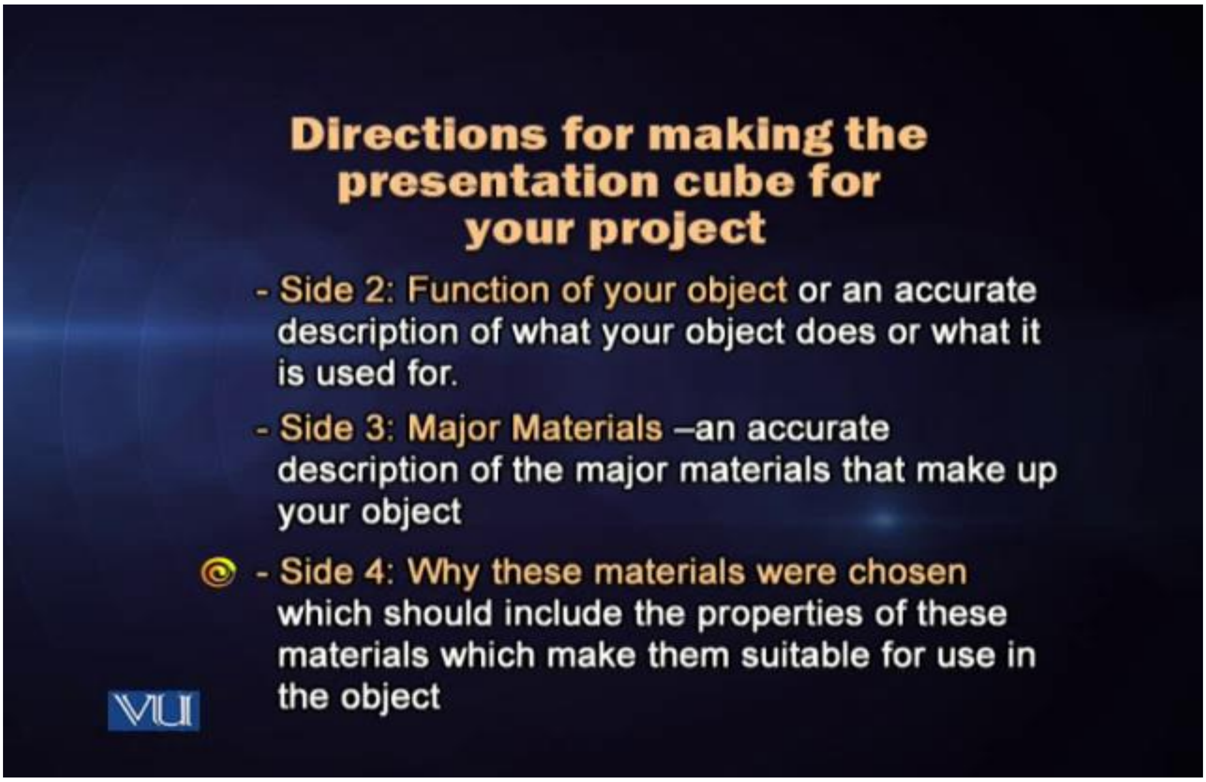

Project Based Science
Project Plan
- Project Question
- Purpose and Importance
- Methods or Procedure
- Materials/Technology required
- Timeline
- Identification of roles and responsibilities
- How will the project be assessed or evaluated?
VU

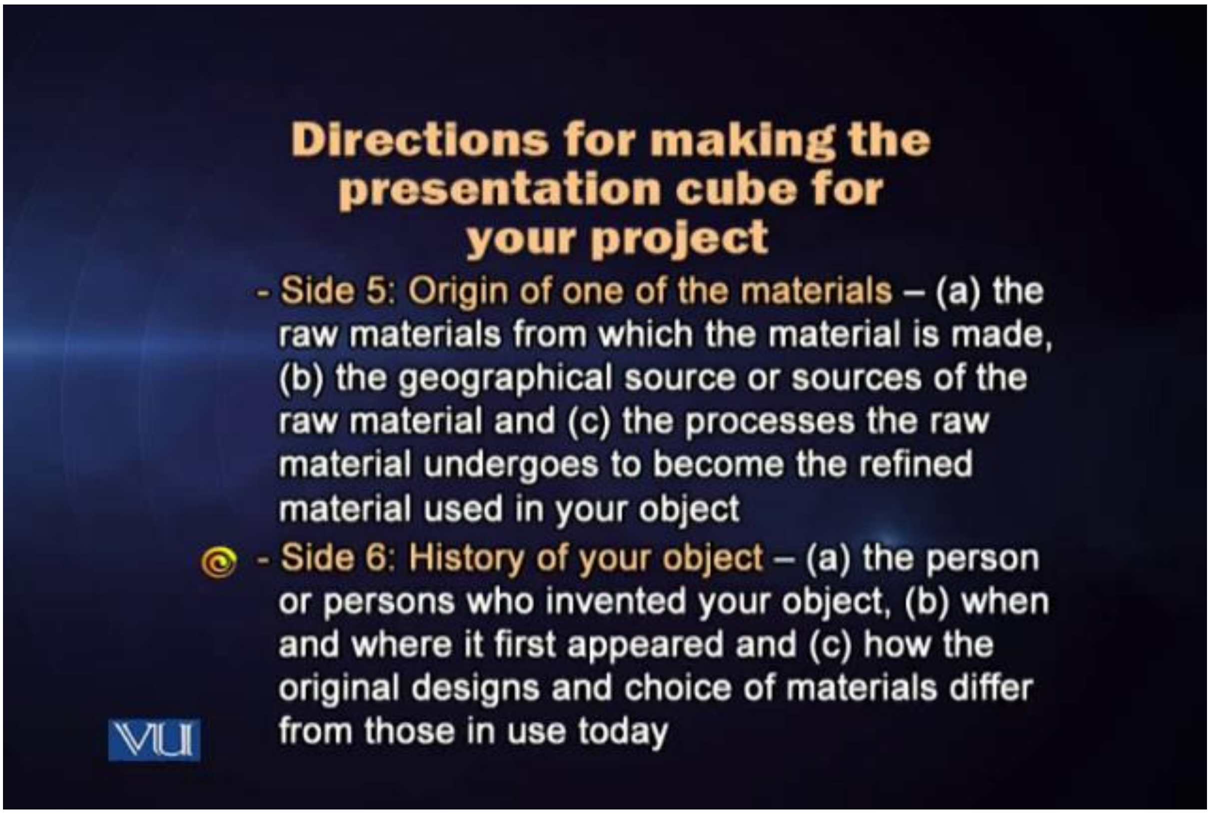

Project Schedule
Activities
- Short Paragraph naming your object and reason for choosing it. Deadline: 1 week later
- An outline of the information you will research and the sources – books and internet sites – you will use. Deadline: 2 weeks later
- Complete project – information displayed on the sides of a large cube that you will be given instructions to construct
Deadline: 4 weeks later
- Presentation
Deadline: 5 weeks later
VU


List of Some of the Objects Researched by Children
- Knife
- Toothbrush
- Thermometer
- Pencil
- Bracelet
- Skin Lotion
- Fountain Pen
VU

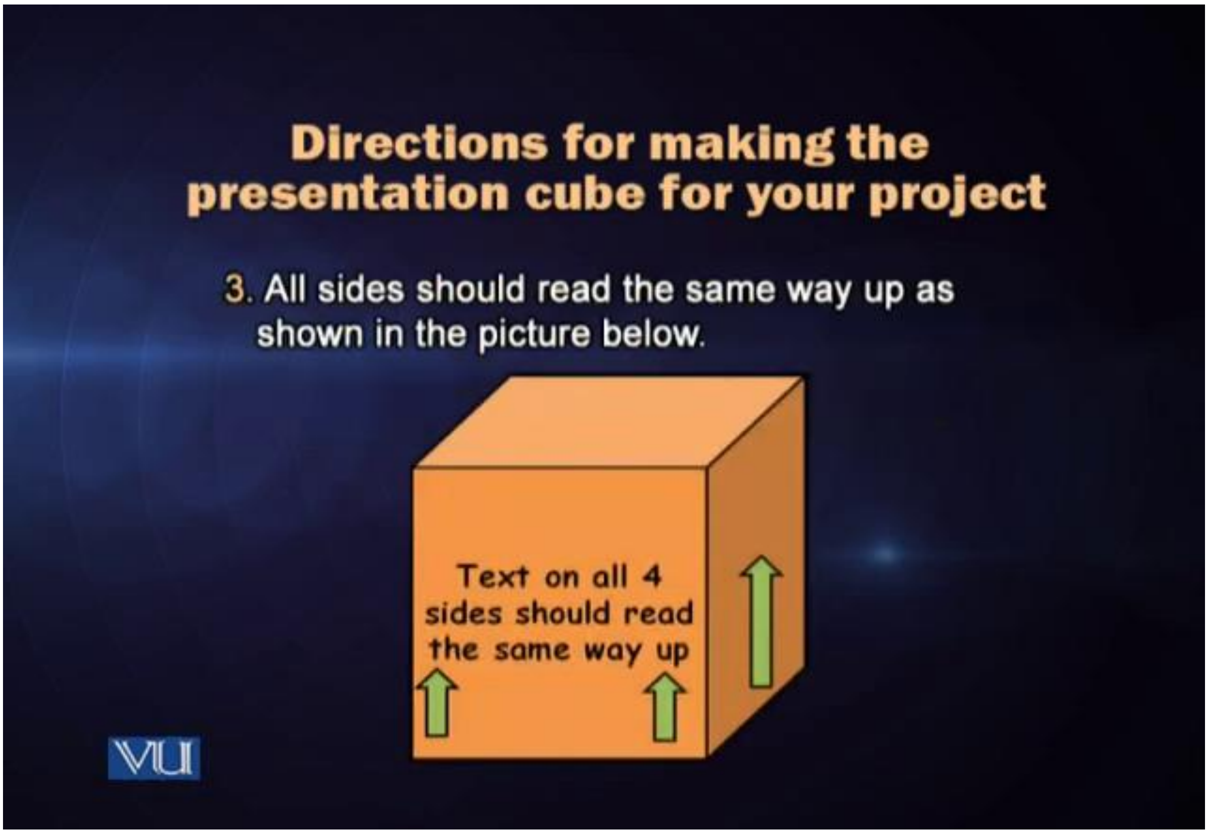

Prior to Observing Artefacts Sharing
- Evaluation Scheme for the Research Project i.e. Scoring Rubrics for the Cube/Chart and Oral Presentation
- Directions for making the presentation cube for the research project
VU


Directions for making the presentation cube for your project
1. Make the cube from stiff chart paper. The length, width and height of the cube should be 20 cm at least.
2. Your cube has 6 sides; Use 5 sides for each of the sections you have written/researched for your selected object.
- Side 1: Picture or photograph of your object – if your object is small enough you can even tape it along with the picture.
VU


Directions for making the presentation cube for your project
- Side 2: Function of your object or an accurate description of what your object does or what it is used for.
- Side 3: Major Materials –an accurate description of the major materials that make up your object
- Side 4: Why these materials were chosen which should include the properties of these materials which make them suitable for use in the object
VU


Directions for making the presentation cube for your project
- Side 5: Origin of one of the materials – (a) the raw materials from which the material is made, (b) the geographical source or sources of the raw material and (c) the processes the raw material undergoes to become the refined material used in your object
- Side 6: History of your object – (a) the person or persons who invented your object, (b) when and where it first appeared and (c) how the original designs and choice of materials differ from those in use today


Resource
Properties of Matter
Science and Technology Concepts for Middle Schools
Smithsonian/The National Academies
National Science and Resources Center



Scoring Rubric for Cubic Chart

Section	What Should be Included	Total Points
Function	An accurate description of what your object does or what it is used for.	5
Major Materials	An accurate description of the major materials that make up your object	5
Why these materials were chosen	Clear and sound reasons -this should include the properties of these materials which make them suitable for use in the object	10

Origin of one of the materials	Brief descriptions of the following: (a) One of the materials that makes up the object (b) the raw materials from which the material is made, (c) the geographical source or sources of the raw material and (d) the processes the raw material undergoes to become the refined material used in your object	10
History of your object	(a) the person or persons who invented your object, (b) when and where it first appeared and (c) how the original designs and choice of materials differ from those in use today	5
Presentation of the cube	(a) Correct spelling (b) Clear pictures/diagrams (c) Imaginative design and decoration	15

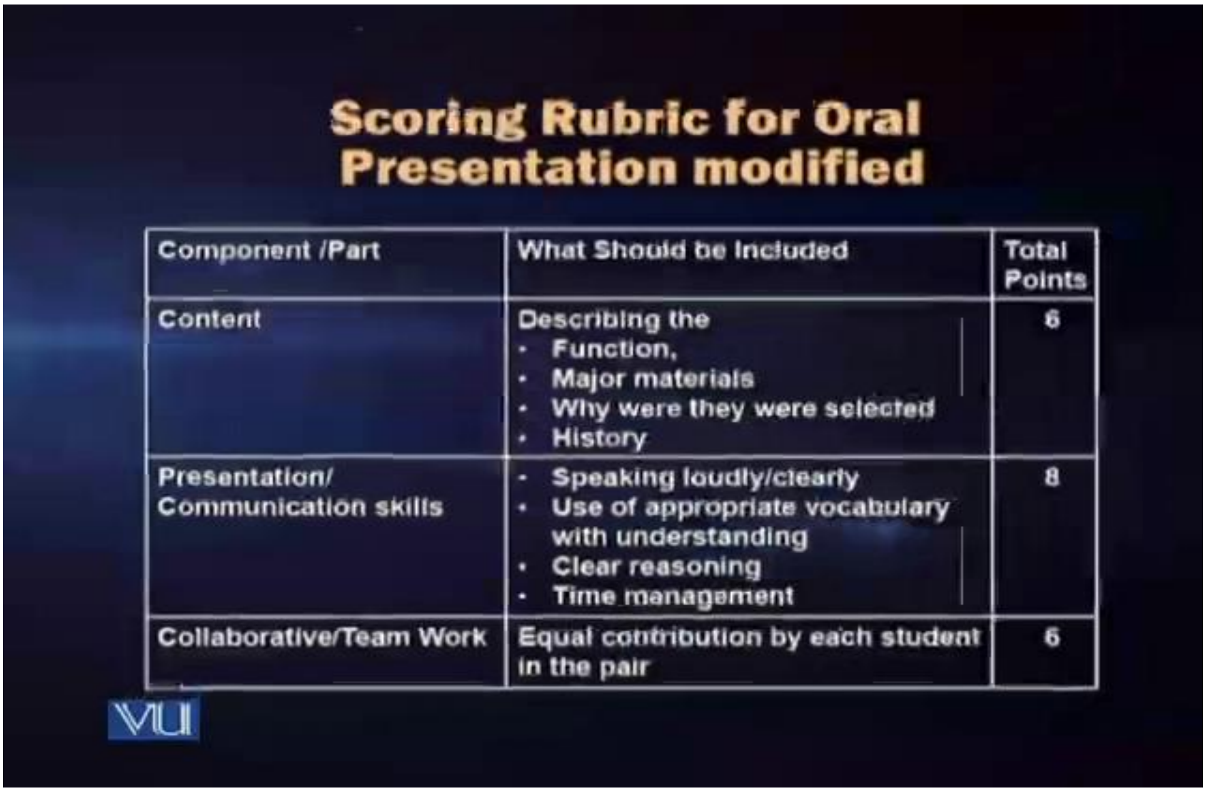
Scoring Rubric for the Cube/Chart Modified

Section	What should be included	Total Points
Function	An accurate description of what your object does or what it is used for.	4
Major Materials	An accurate description of the major materials that make up your object	6
Why these materials were chosen	Clear and sound reasons -this should include the properties of these materials which make them suitable for use in the object	10
History of your object	(a) the person or persons who invented your object, (b) when and where it first appeared and (c) how the original designs and choice of materials differ from those in use today	6
Presentation of the cube	(a) Clear pictures/diagrams (b) Imaginative design and decoration	4

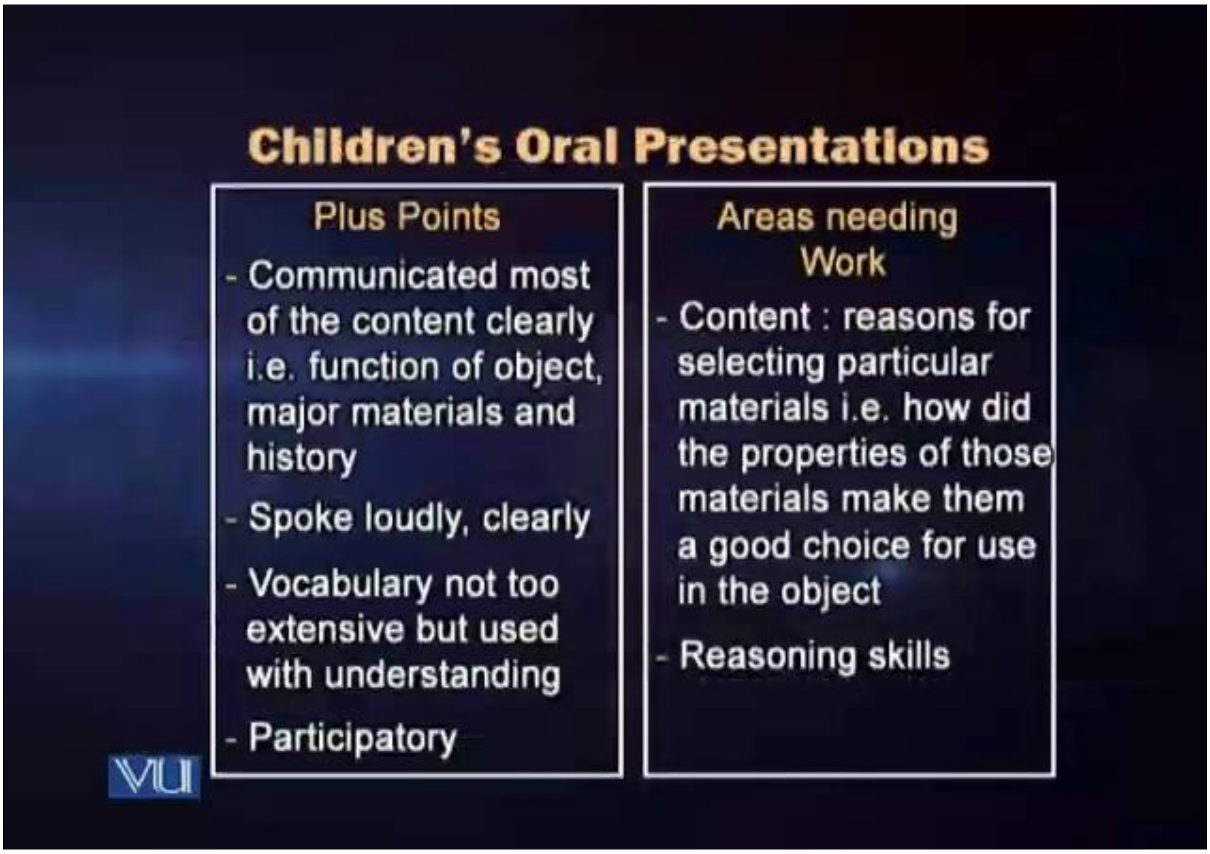
Scoring Rubric for Oral Presentation

Component /Part	What Should be Included	Total Points
Content	Detailed descriptions of the following: (a) One of the materials that makes up the object (b) The properties of that material (c) The properties of that material that make it a good choice for use in the object (d) the raw materials from which the material is made,	6

	(e) the geographical source or sources of the raw material and (f) the processes the raw material undergoes to become the refined material used in your object	
Presentation/ Communication skills	- Speaking loudly/clearly - Use of appropriate vocabulary with understanding - Clear reasoning - Time management	8
Collaborative/ Team W[illegible]	Equal contribution by each student in the pair	6



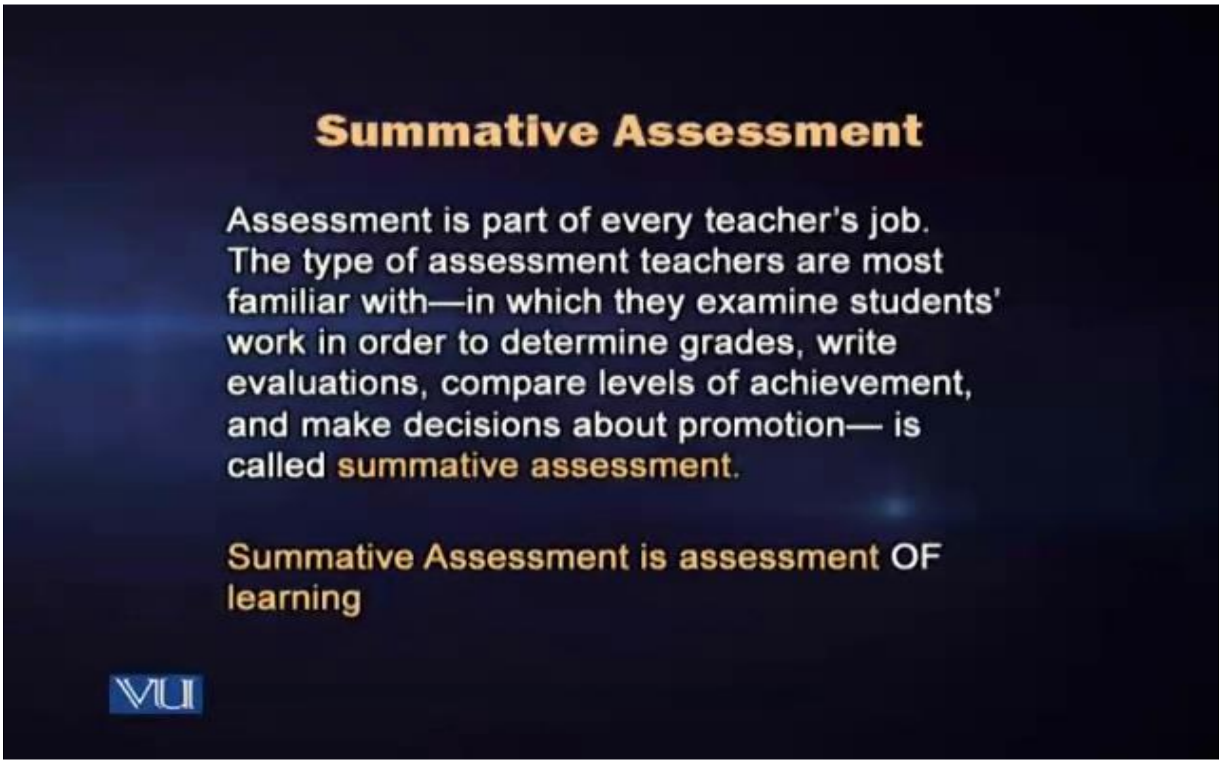
Component /Part	What Should be Included	Total Points
Content	Describing the • Function, • Major materials • Why were they were selected • History	6
Presentation/ Communication skills	• Speaking loudly/clearly • Use of appropriate vocabulary with understanding • Clear reasoning • Time management	8
Collaborative/Team Work	Equal contribution by each student in the pair	6

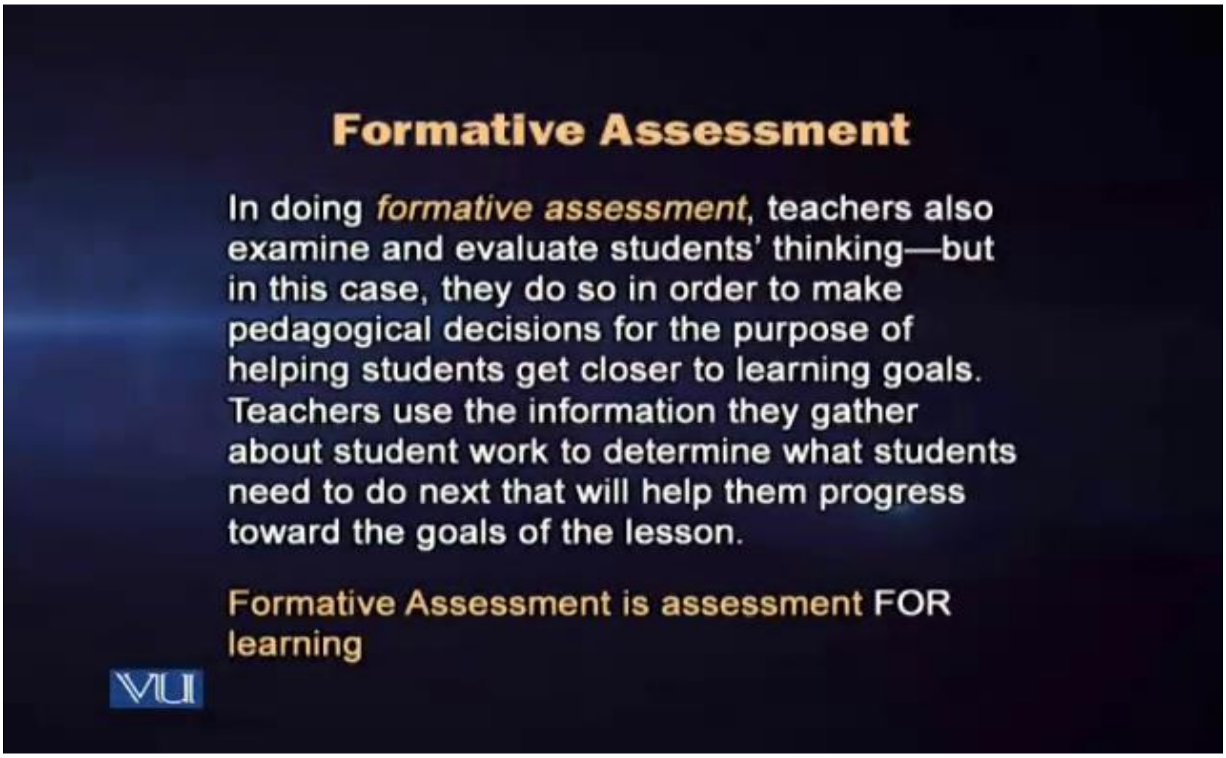



Fountain Pen – A History in Pictures
Quill pen
and inkpot
One of the first
fountain pens
with ink reservoir
inside the pen
Present day
fountain pen
VU

Lecture No 33

Concept and Skills to be Assessed





Concepts and Skills to be Assessed

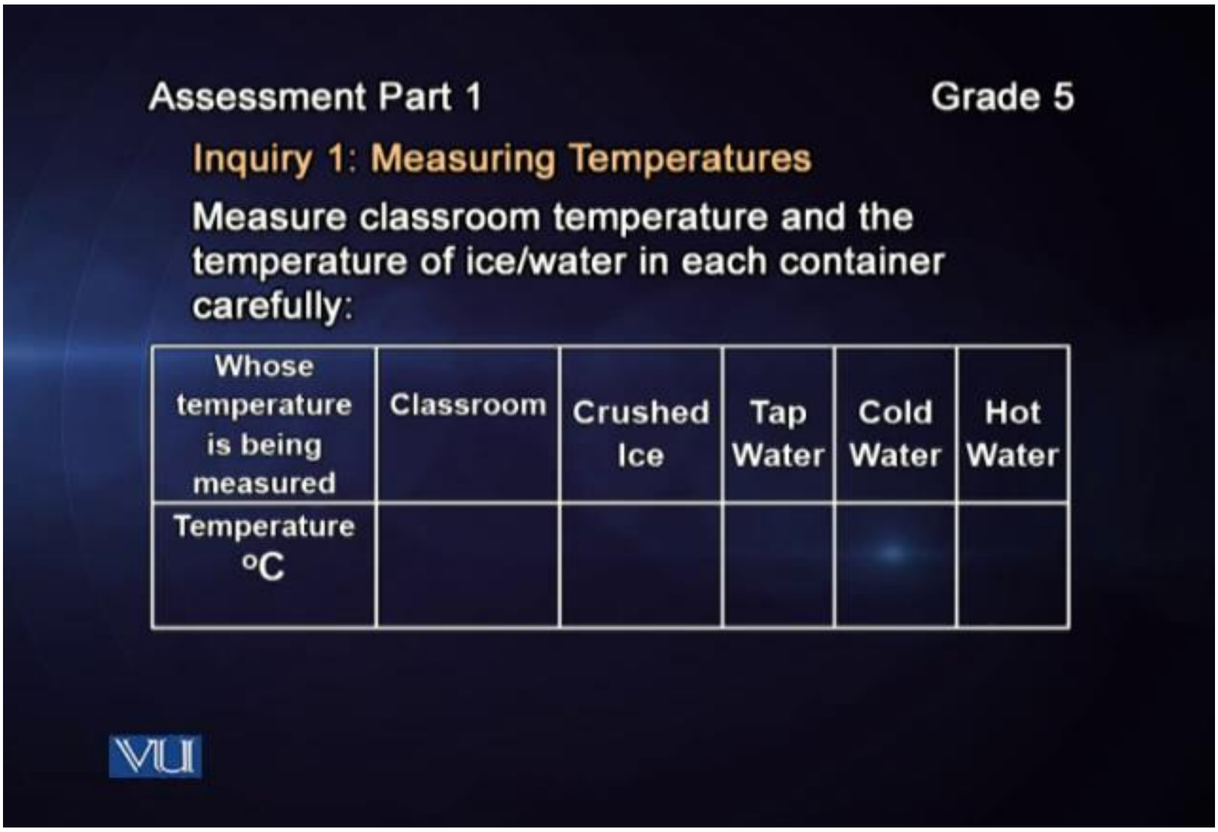
Concepts Associated with Changes of State

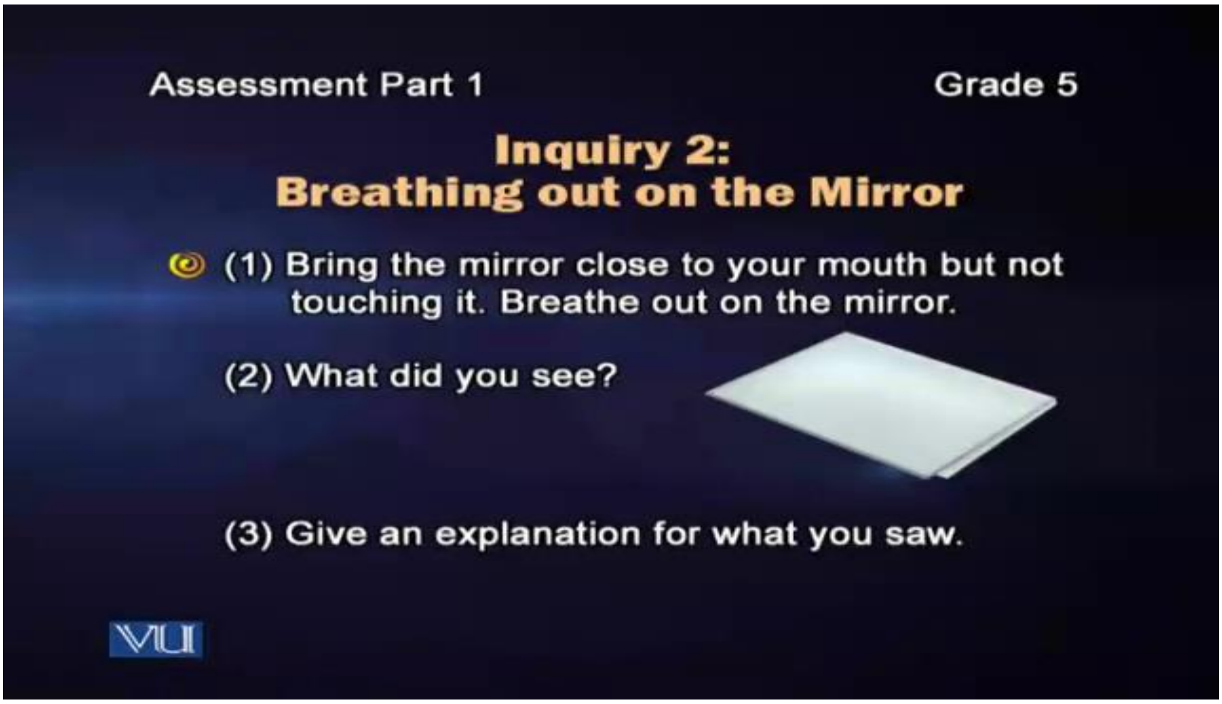
characteristics of solids, liquids, melting, freezing, boiling, evaporation and condensation
– recognising different changes of state and *properties of materials*;

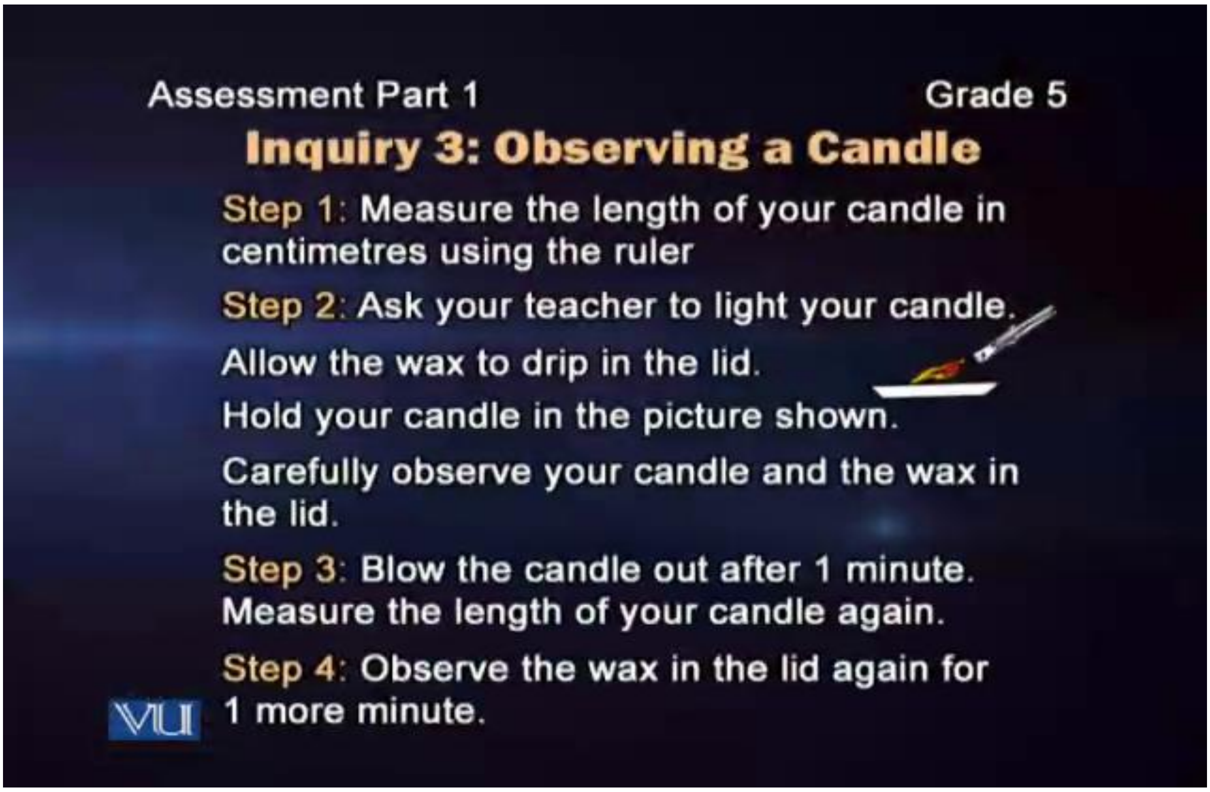
Concepts and Skills to be Assessed

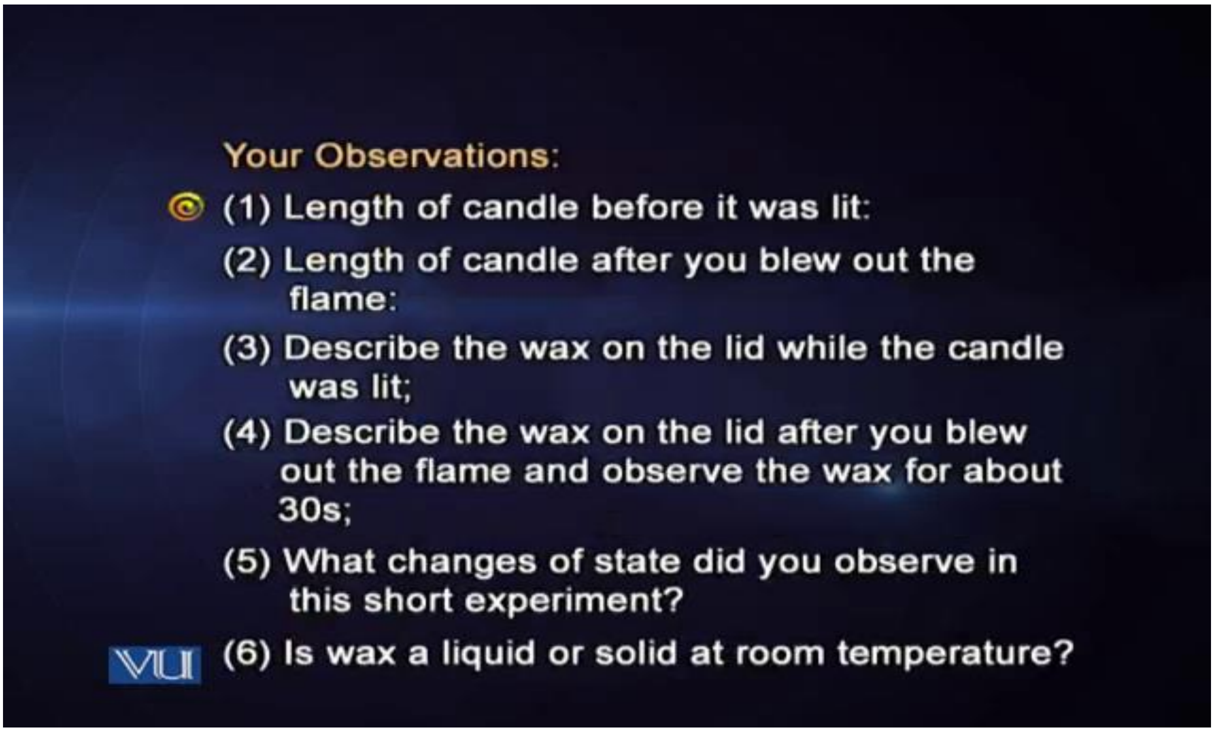
Skills

1) Temperature measurements
2) Graphing – Identifying coordinates of points and plotting points
3) Communicating especially appropriate use of scientific vocabulary i.e. science literacy
4) Observing
5) Interpreting and Analysing
6) *Hypothesising i.e. coming up with explanations of observed phenomena
*(hypothesis مفروضہ)


Assessment Part 1
Grade 5
Inquiry 1: Measuring Temperatures
Measure classroom temperature and the temperature of ice/water in each container carefully:
Whose temperature is being measured
Classroom
Crushed Ice
Tap Water
Cold Water
Hot Water
Temperature °C
VU


Assessment Part 1
Grade 5
Inquiry 2:
Breathing out on the Mirror
(1) Bring the mirror close to your mouth but not touching it. Breathe out on the mirror.
(2) What did you see?
(3) Give an explanation for what you saw.
VU


Assessment Part 1
Grade 5
Inquiry 3: Observing a Candle
Step 1: Measure the length of your candle in centimetres using the ruler
Step 2: Ask your teacher to light your candle.
Allow the wax to drip in the lid.
Hold your candle in the picture shown.
Carefully observe your candle and the wax in the lid.
Step 3: Blow the candle out after 1 minute.
Measure the length of your candle again.
Step 4: Observe the wax in the lid again for 1 more minute.


Your Observations:
(1) Length of candle before it was lit:
(2) Length of candle after you blew out the flame:
(3) Describe the wax on the lid while the candle was lit;
(4) Describe the wax on the lid after you blew out the flame and observe the wax for about 30s;
(5) What changes of state did you observe in this short experiment?
(6) Is wax a liquid or solid at room temperature?

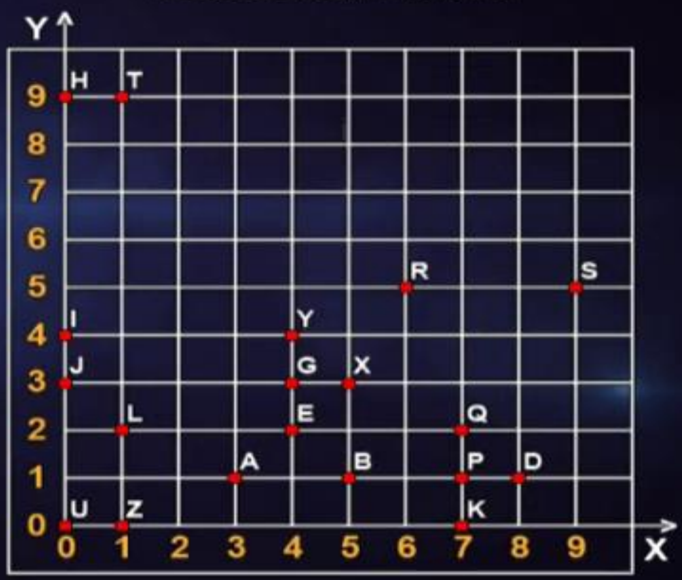
Part 2 of Assessment

comprises of
TW0 WORKSHEETS

on 1) Plotting and Identifying Coordinates Points on a Grid

2) Reading Temperature from Pictures of Thermometers

Assessment Part 2a



I. Tell what point is located at each ordered pair.

1) (0,9) ______ 6) (8,1) ______

2) (0,3) ______ 7) (4,2) ______

3) (3,1) ______ 8) (6,5) ______

4) (1,2) ______ 9) (5,1) ______

5) (4,4) ______ 10) (0,0) ______

VU

II. Write the ordered pair for each given point.

11) Q ______ 14) T ______ 17) Z ______

12) P ______ 15) K ______ 18) G ______

13) S ______ 16) I ______ 19) X ______

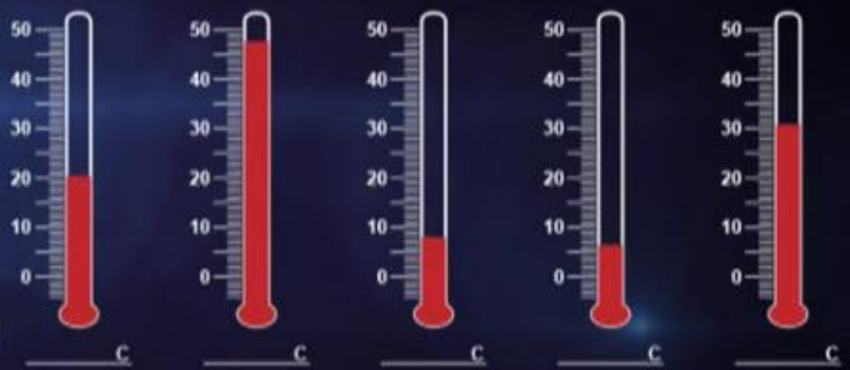
VU

III. Plot the following points on the coorinate grid.

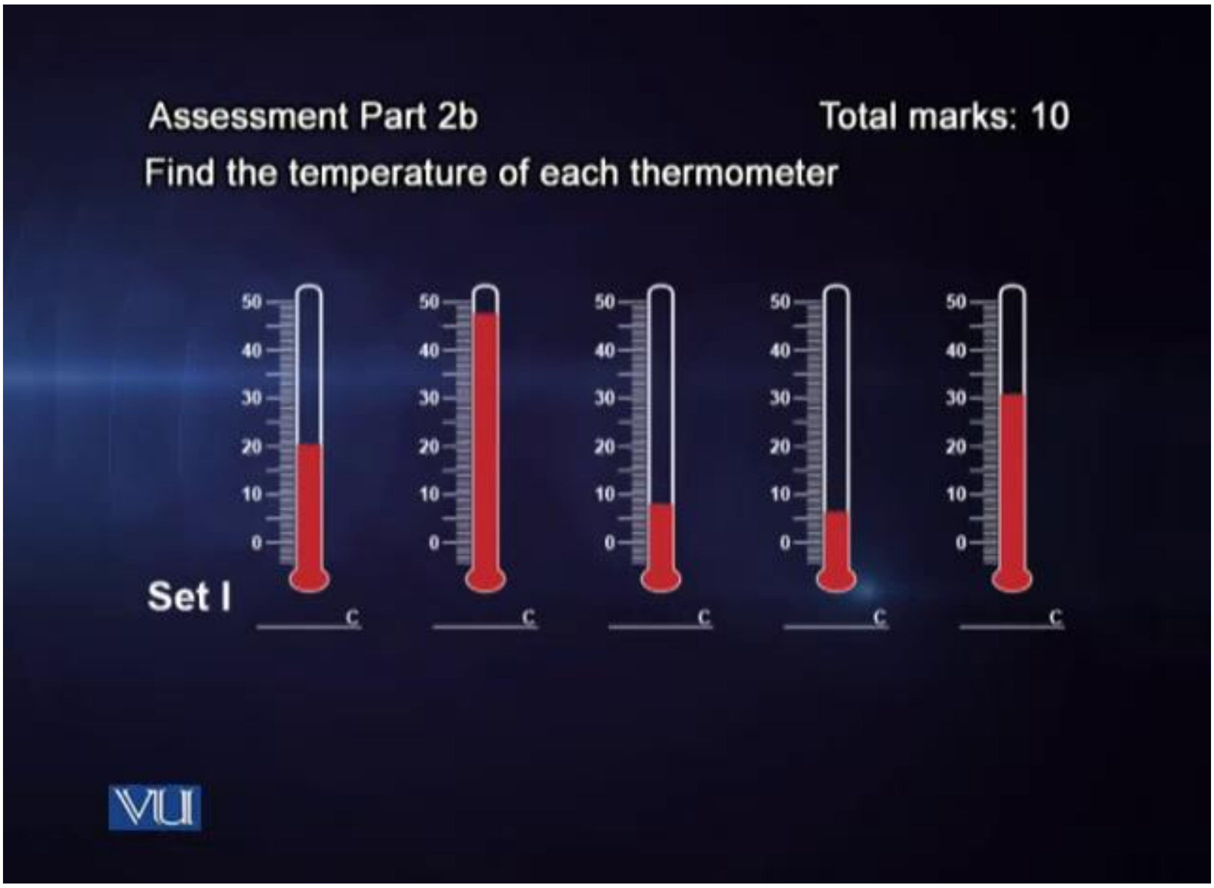
20)	C (8,2)	22)	F (0,7)	24)	V (0,8)
21)	M (7,5)	23)	O (0,2)	25)	N (5,8)

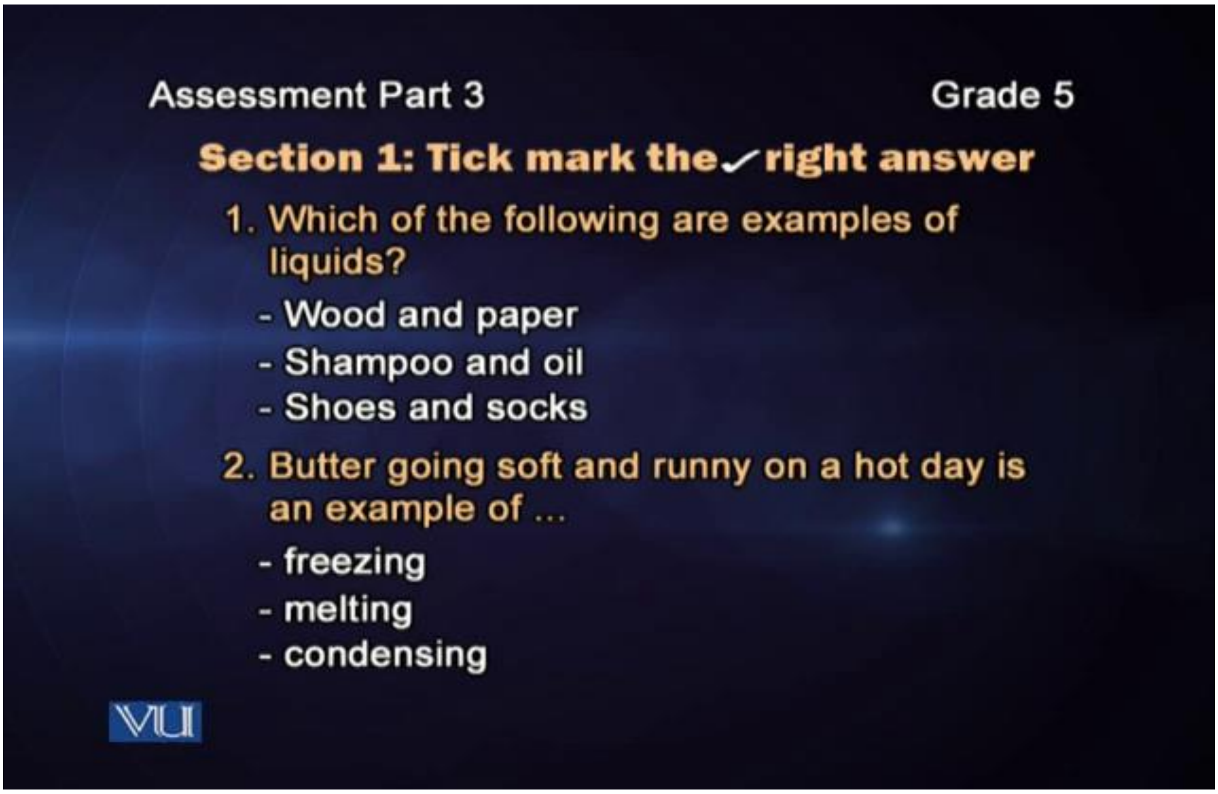
Assessment Part 2b — Total marks: 10

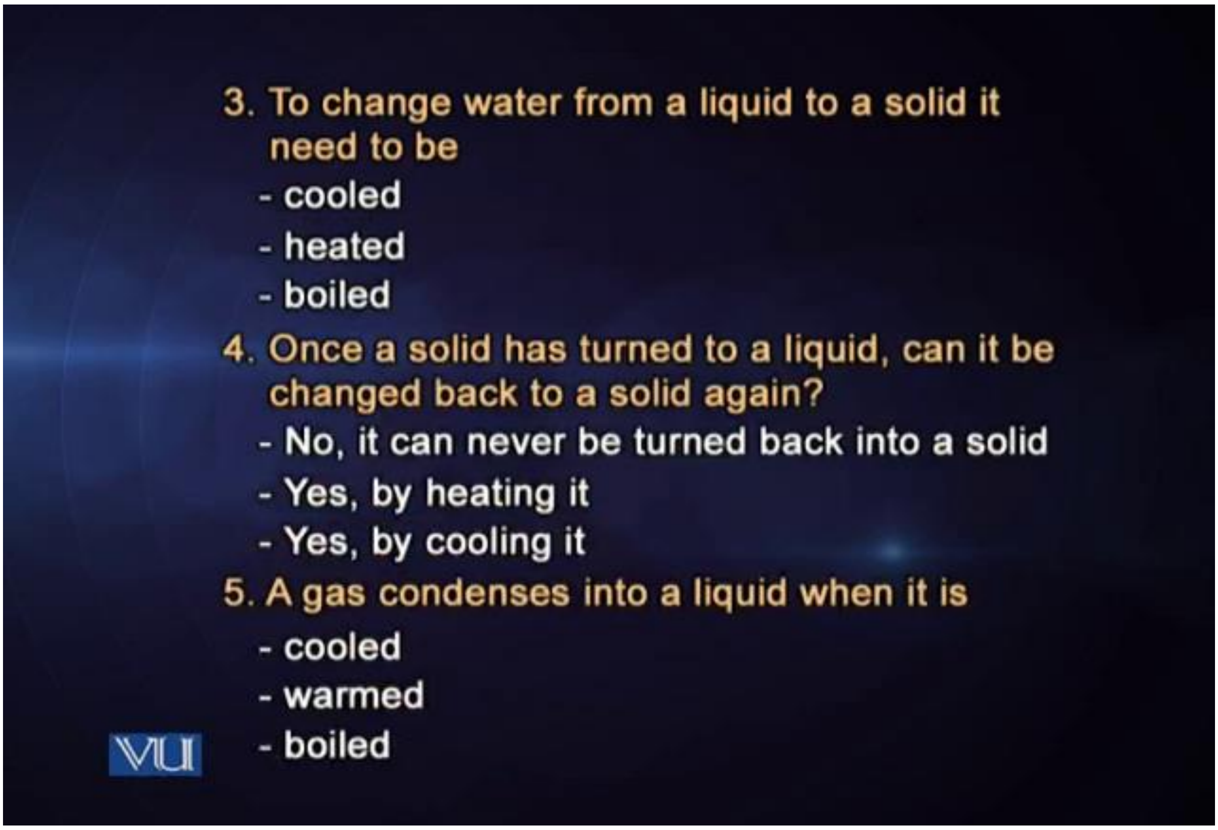
Find the temperature of each thermometer

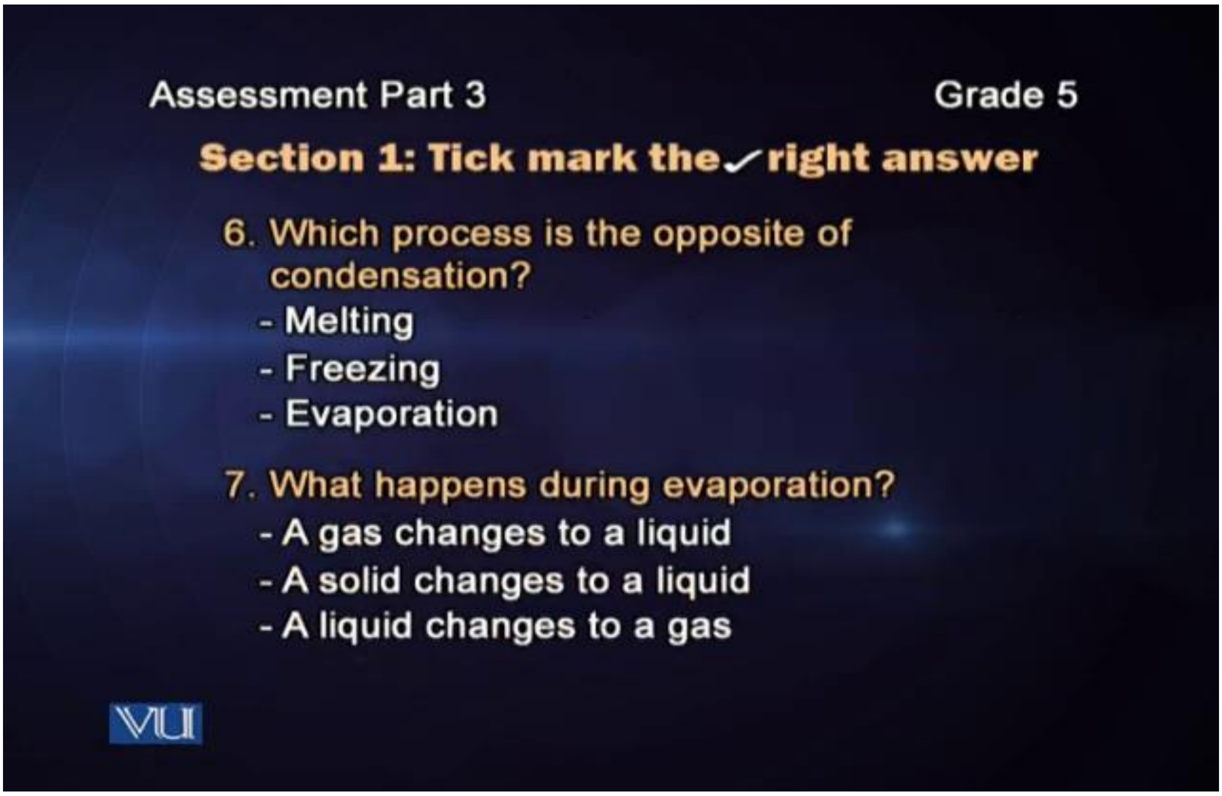


Set I


Assessment Part 2b
Total marks: 10
Find the temperature of each thermometer
Set I
C
C
C
C
C


Assessment Part 3
Grade 5
Section 1: Tick mark the ✓ right answer
1. Which of the following are examples of liquids?
- Wood and paper
- Shampoo and oil
- Shoes and socks
2. Butter going soft and runny on a hot day is an example of ...
- freezing
- melting
- condensing


3. To change water from a liquid to a solid it need to be
- cooled
- heated
- boiled
4. Once a solid has turned to a liquid, can it be changed back to a solid again?
- No, it can never be turned back into a solid
- Yes, by heating it
- Yes, by cooling it
5. A gas condenses into a liquid when it is
- cooled
- warmed
- boiled
VU


Assessment Part 3
Grade 5
Section 1: Tick mark the ✓ right answer
6. Which process is the opposite of condensation?
- Melting
- Freezing
- Evaporation
7. What happens during evaporation?
- A gas changes to a liquid
- A solid changes to a liquid
- A liquid changes to a gas
VU

8. Melting point is
- The temperature at which a solid changes into a liquid
- When a solid changes into a liquid
- The temperature at which a liquid changes into a gas

9. Evaporation can take place
- At the boiling point of a liquid
- At all temperatures and from the surface of the liquid only
- At all temperatures and bubbles rise up through the liquid

10. A solid has
- A definite volume
- A definite volume and shape
- No definite shape or volume

Section 2: WHICH MATERIAL?

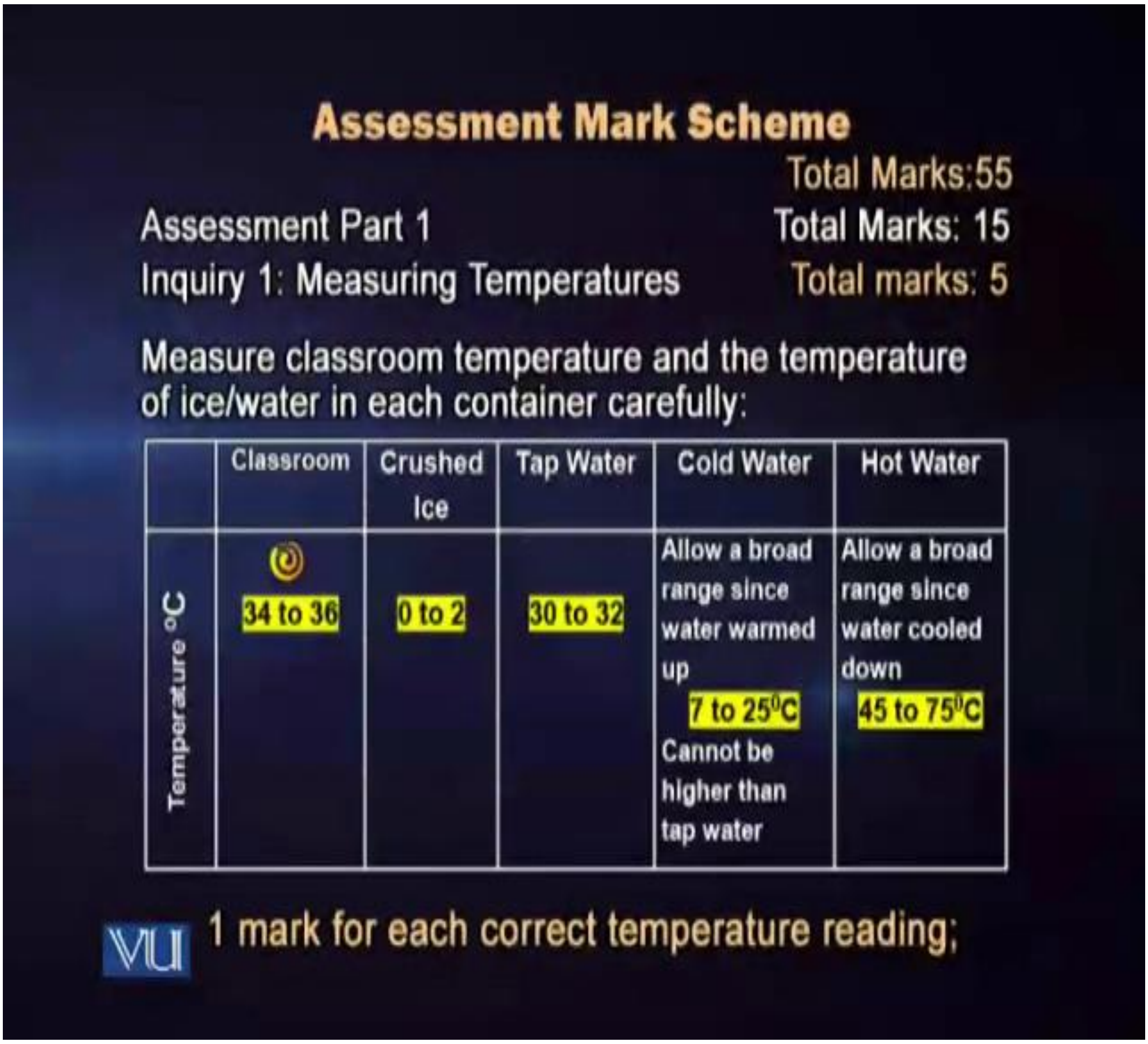
All these items are made from materials

Write down next to each item which materials you think are used to make it and what is it about it that makes it suitable to be used for that item

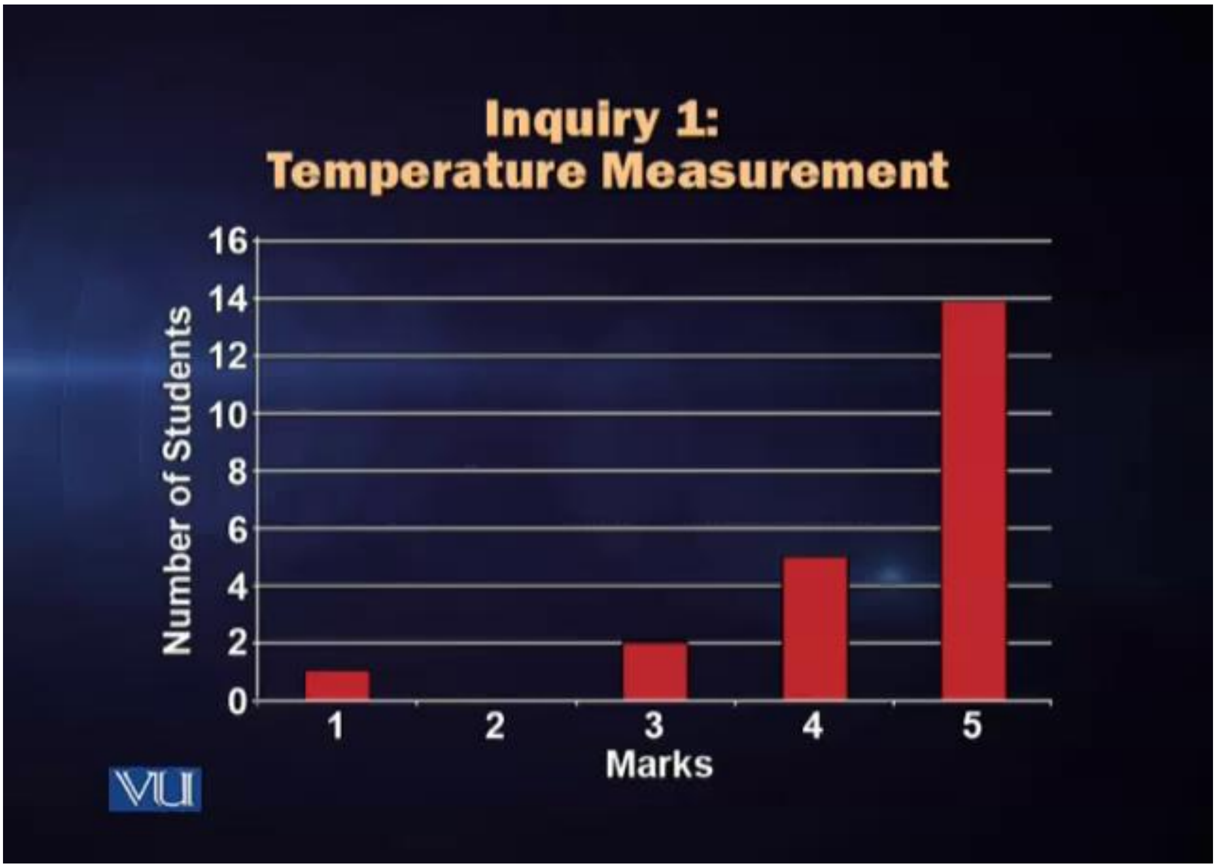
Material:
Why is it chosen?

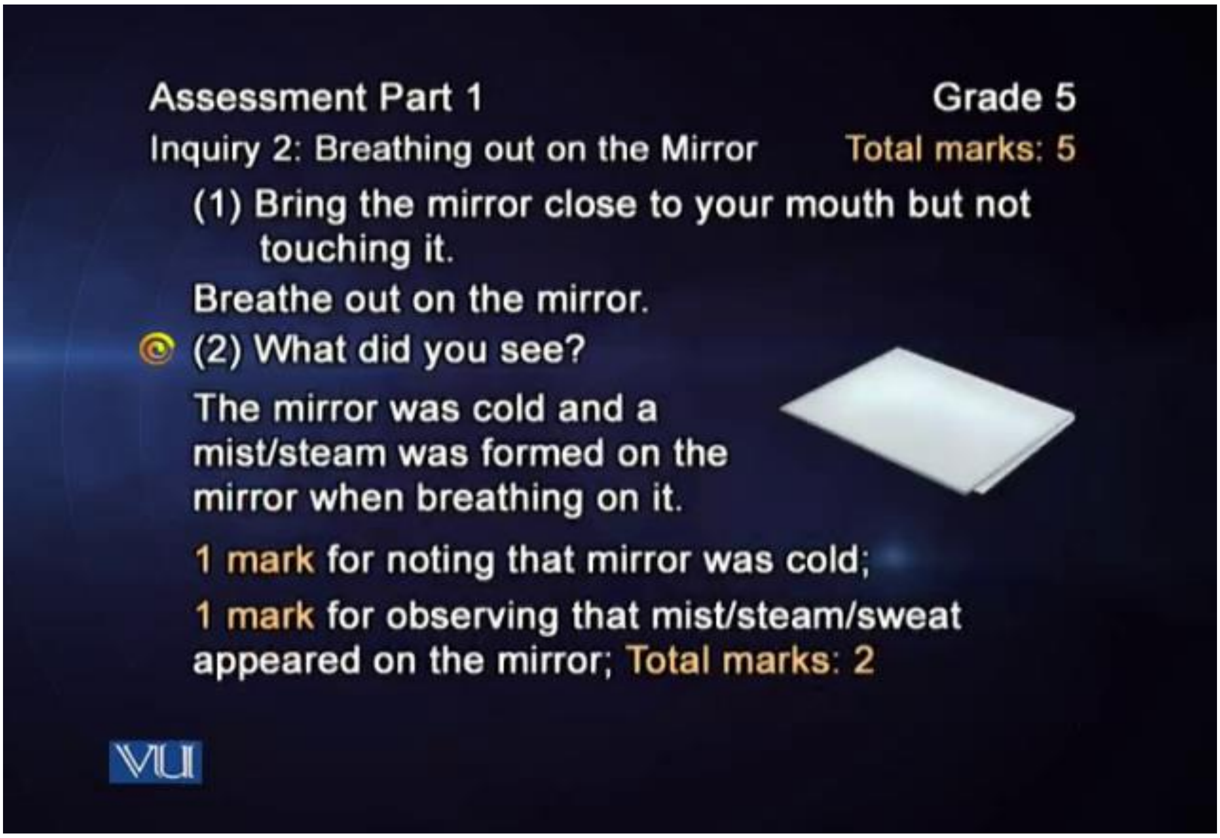
Material:
Why is it chosen?

Material:
Why is it chosen?



	Classroom	Crushed Ice	Tap Water	Cold Water	Hot Water
Temperature °C	34 to 36	0 to 2	30 to 32	Allow a broad range since water warmed up 7 to 25^{0}C Cannot be higher than tap water	Allow a broad range since water cooled down 45 to 75^{0}C


Inquiry 1:
Temperature Measurement
Number of Students
16
14
12
10
8
6
4
2
0
1
2
3
4
5
Marks
VU


Assessment Part 1
Grade 5
Inquiry 2: Breathing out on the Mirror
Total marks: 5
(1) Bring the mirror close to your mouth but not touching it.
Breathe out on the mirror.
(2) What did you see?
The mirror was cold and a mist/steam was formed on the mirror when breathing on it.
1 mark for noting that mirror was cold;
1 mark for observing that mist/steam/sweat appeared on the mirror; Total marks: 2
VU

Assessment Part 1 Grade 5

- (3) Give an explanation for what you saw.

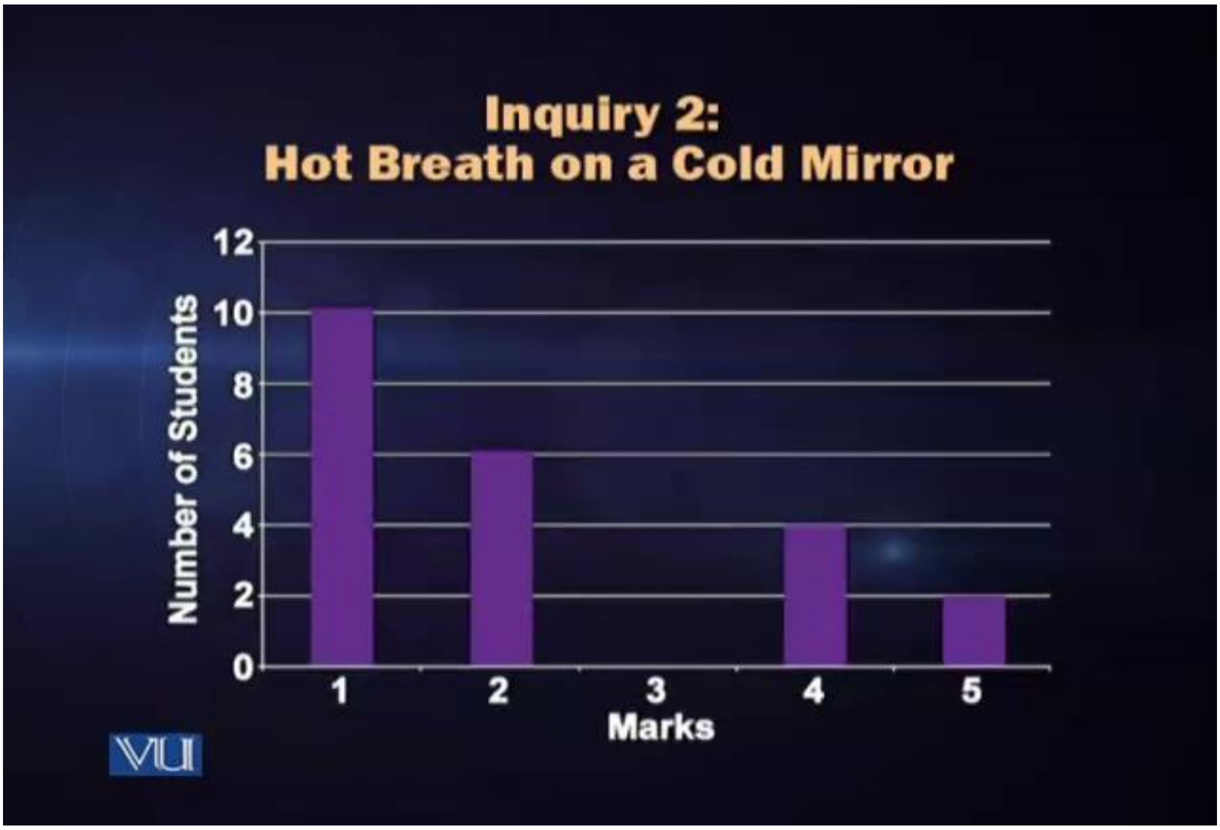
  Breathe is warm (warm air) and contains water vapours; when the warm breath/warm water vapours come in contact with the cold mirror surface they lose heat and turn from gas to liquid i.e. condense. The mist/steam on the mirror surface is liquid water.

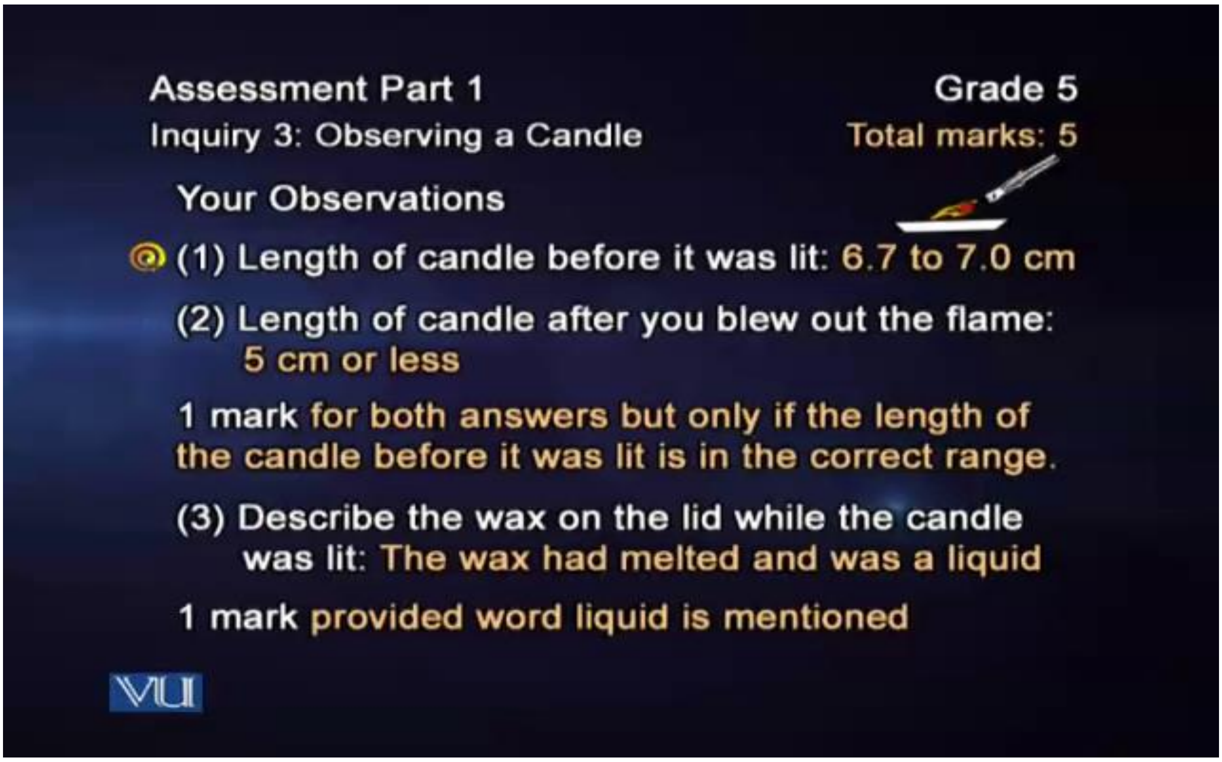
  1 mark for mentioning warm breath;

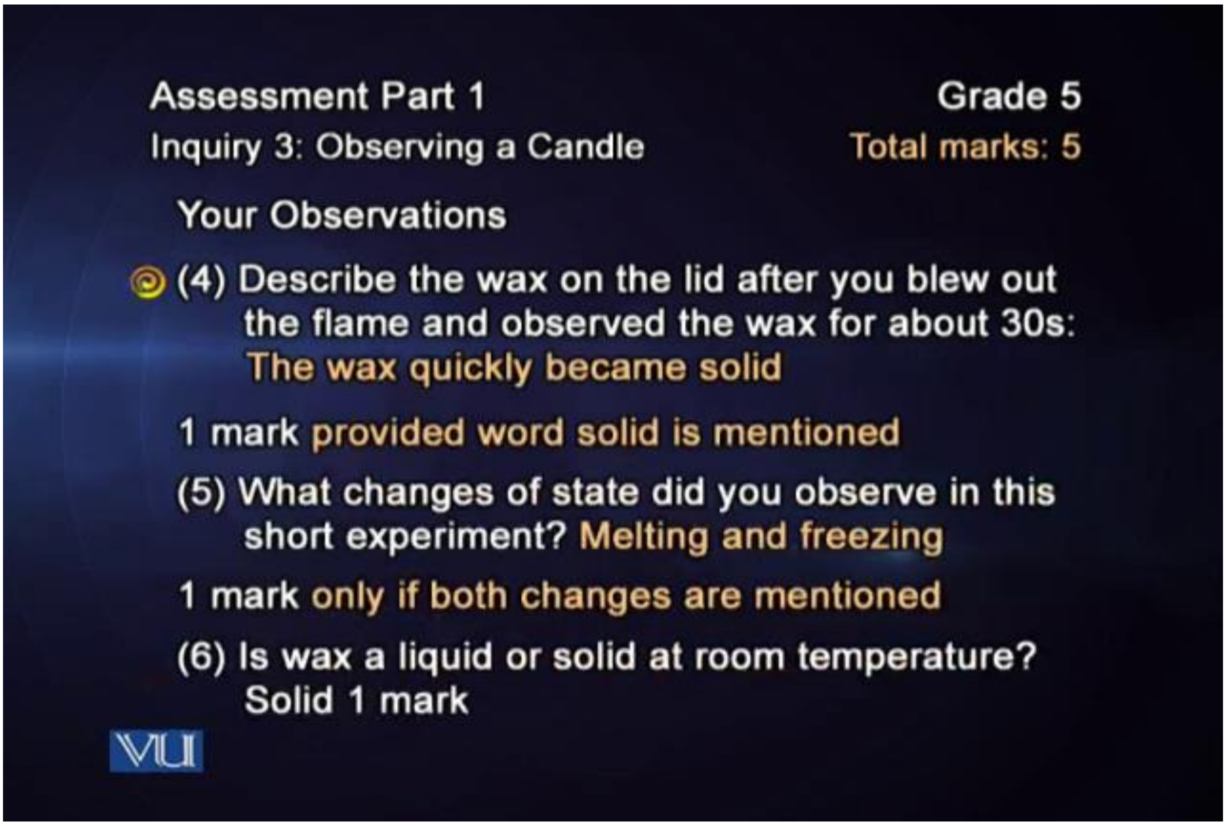
  1 mark for warm breath or warm water vapour coming into contact or hitting the cold surface of the mirror;

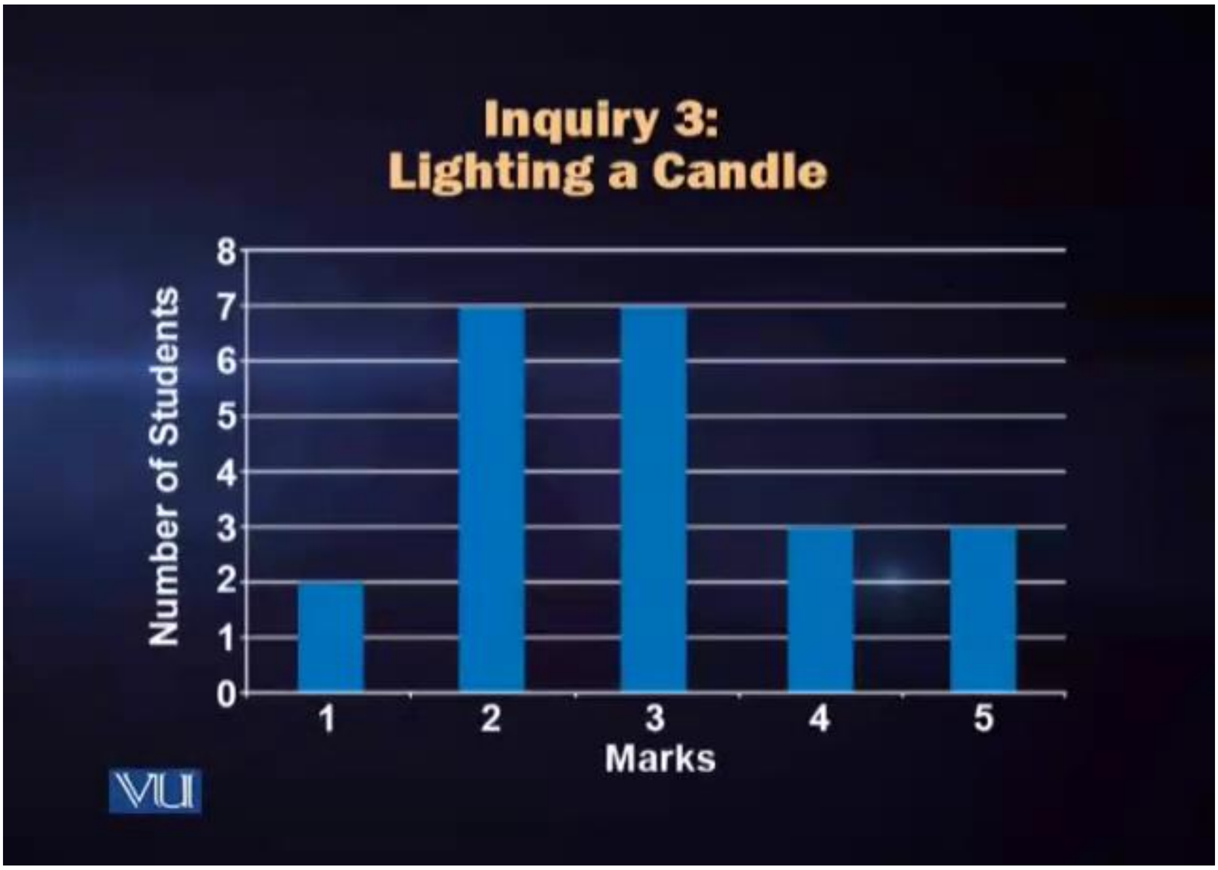
  1 mark for gas turning into liquid or condensation;

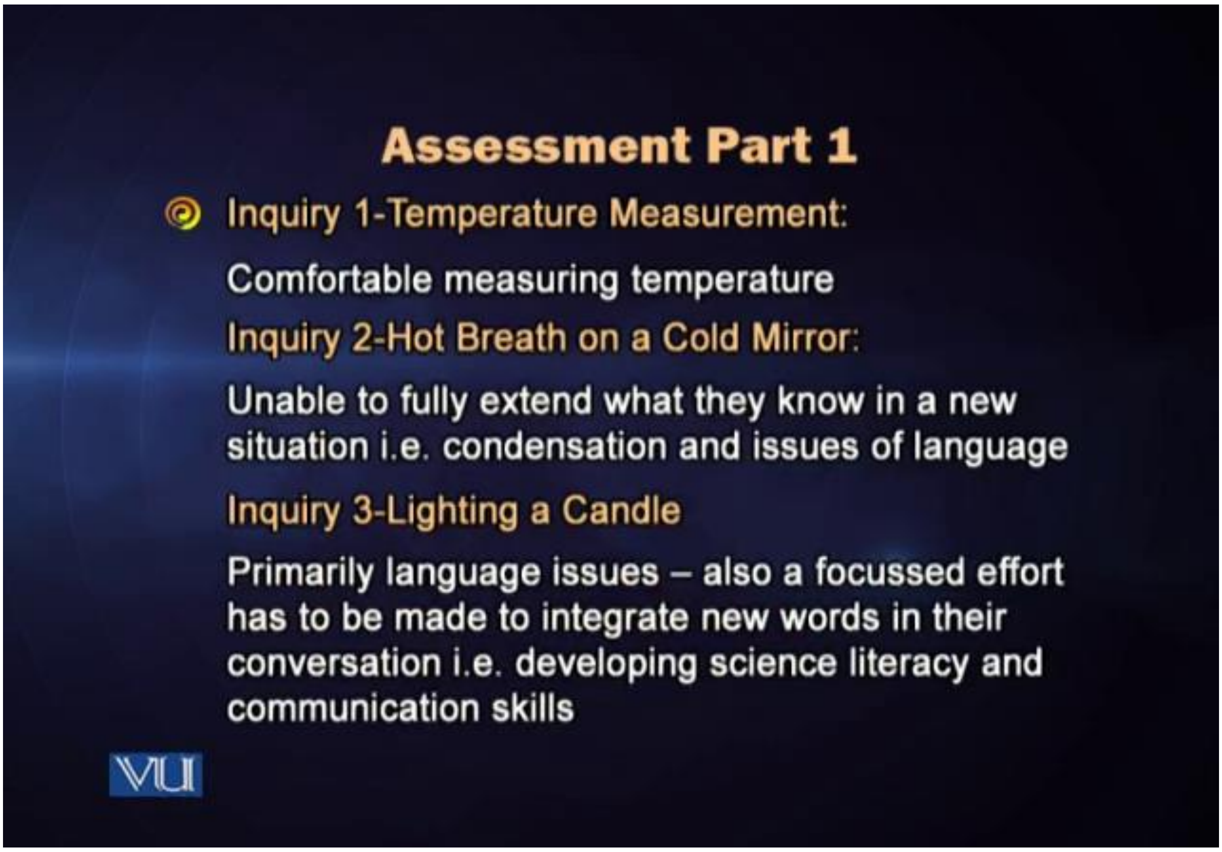
  Total marks:3

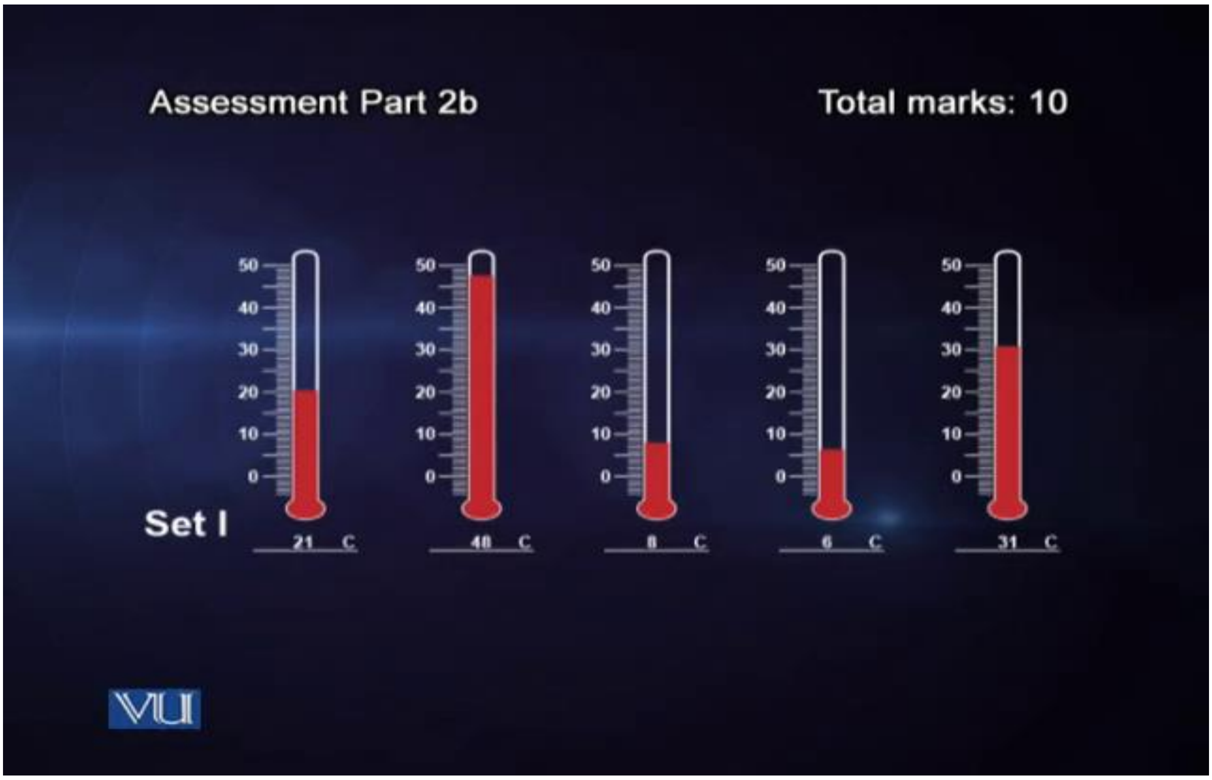


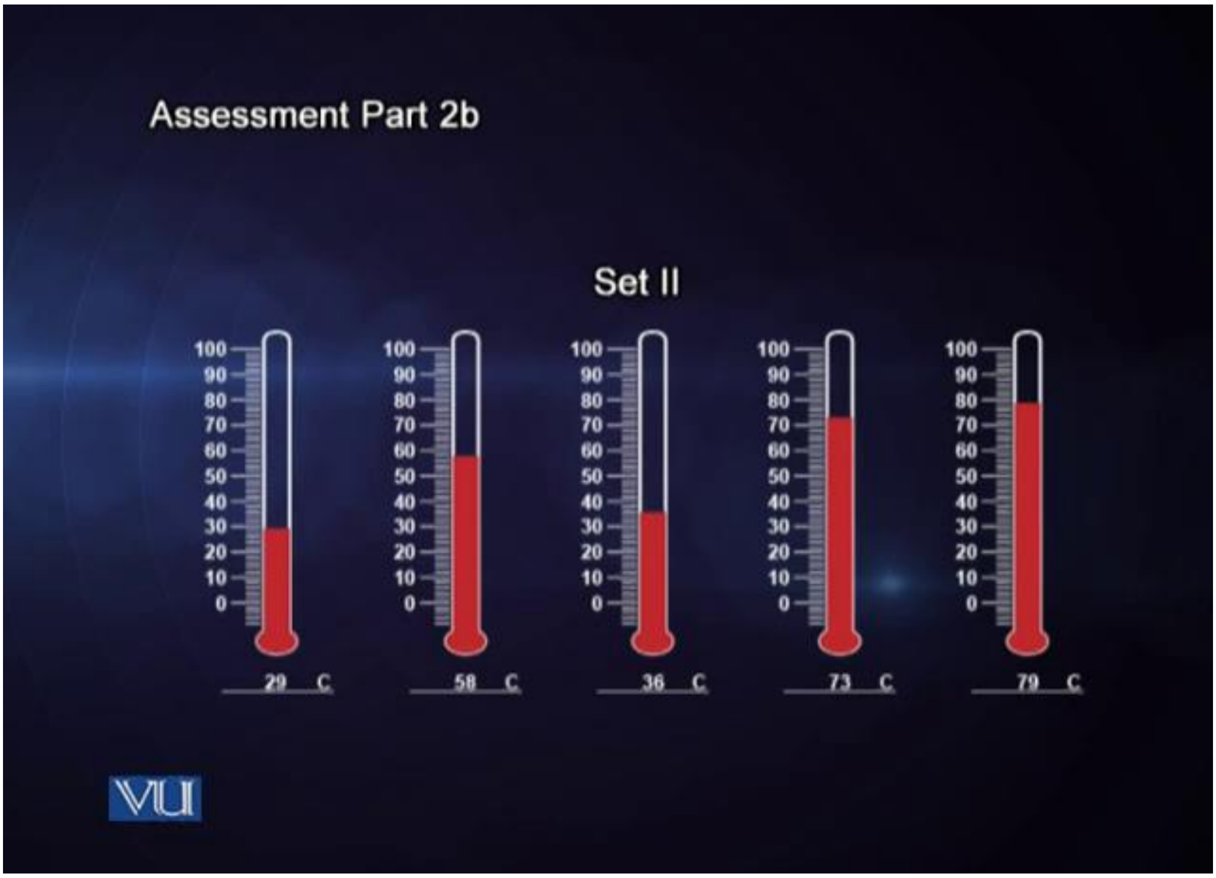

Assessment Part 1
Grade 5
Inquiry 3: Observing a Candle
Total marks: 5
Your Observations
(1) Length of candle before it was lit: 6.7 to 7.0 cm
(2) Length of candle after you blew out the flame: 5 cm or less
1 mark for both answers but only if the length of the candle before it was lit is in the correct range.
(3) Describe the wax on the lid while the candle was lit: The wax had melted and was a liquid
1 mark provided word liquid is mentioned
VU

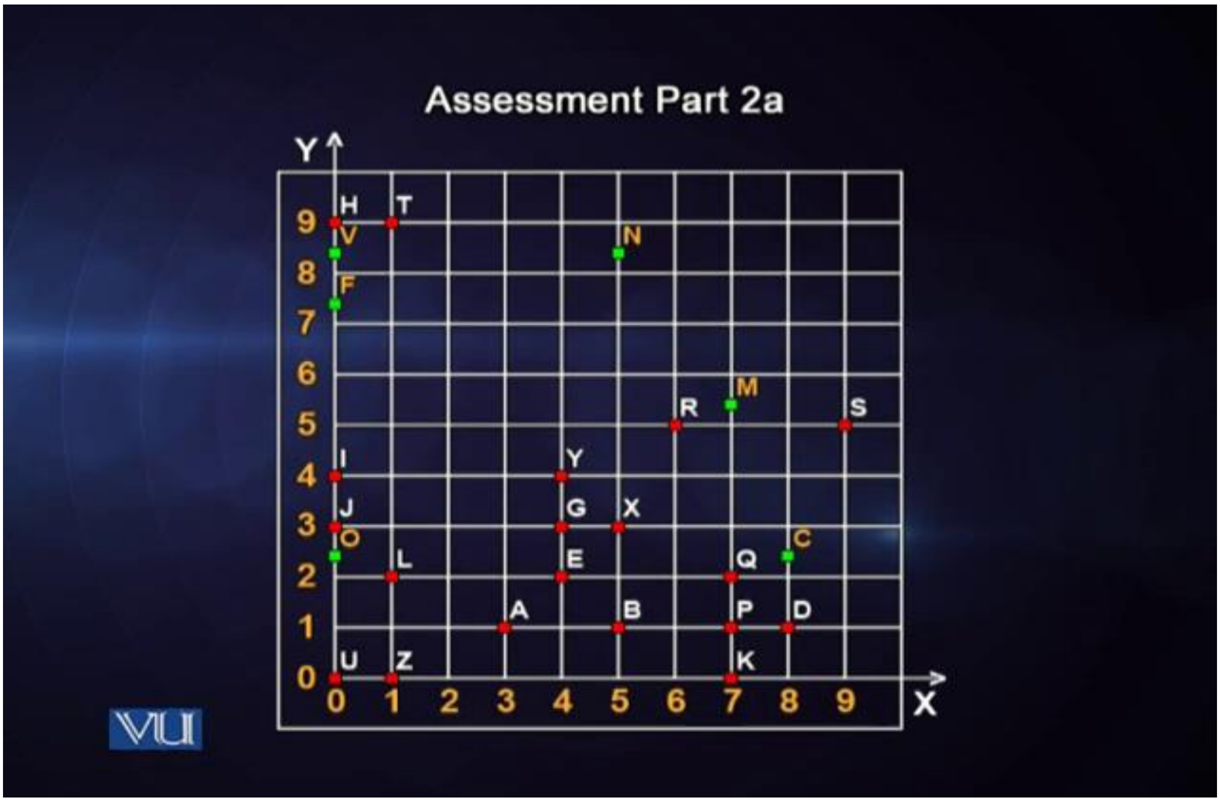

Assessment Part 1
Grade 5
Inquiry 3: Observing a Candle
Total marks: 5
Your Observations
(4) Describe the wax on the lid after you blew out the flame and observed the wax for about 30s: The wax quickly became solid
1 mark provided word solid is mentioned
(5) What changes of state did you observe in this short experiment? Melting and freezing
1 mark only if both changes are mentioned
(6) Is wax a liquid or solid at room temperature? Solid 1 mark
VU

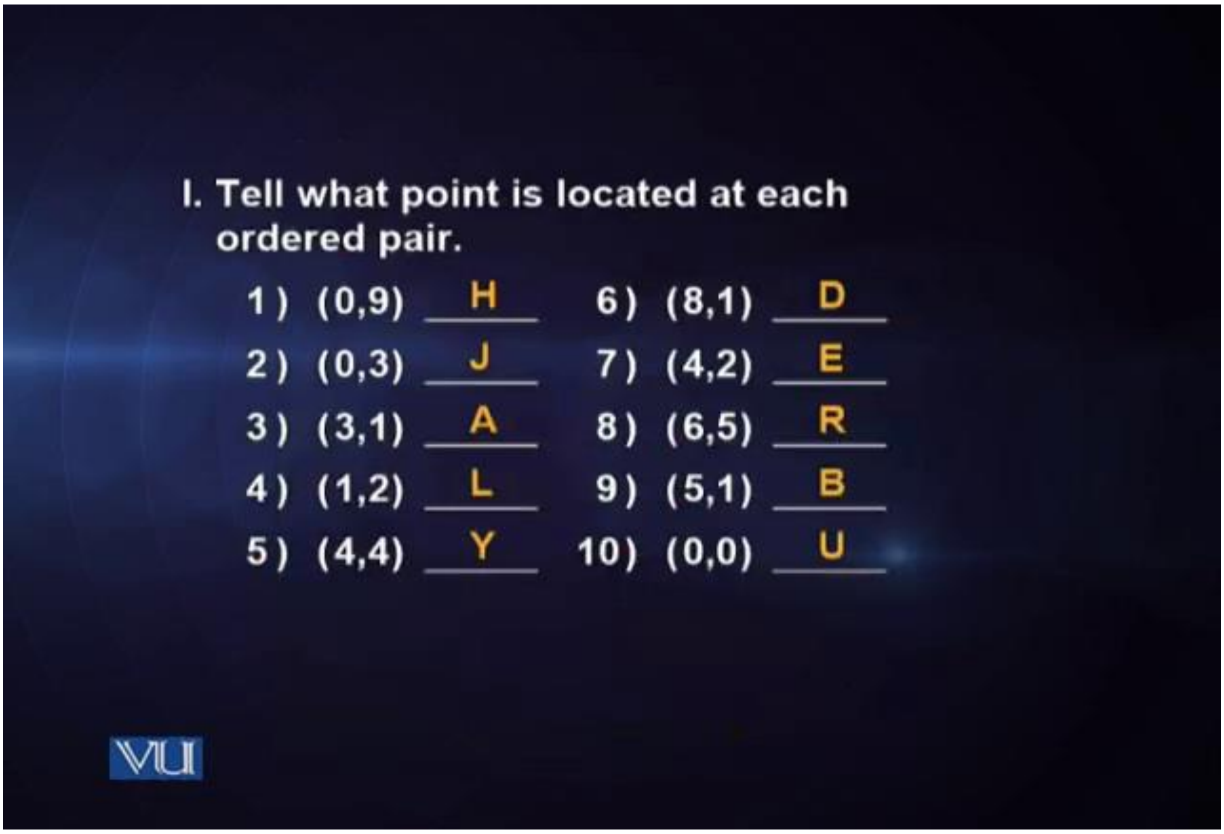

Inquiry 3:
Lighting a Candle
Number of Students
8
7
6
5
4
3
2
1
0
1
2
3
4
5
Marks
VU


Assessment Part 1
Inquiry 1-Temperature Measurement:
Comfortable measuring temperature
Inquiry 2-Hot Breath on a Cold Mirror:
Unable to fully extend what they know in a new situation i.e. condensation and issues of language
Inquiry 3-Lighting a Candle
Primarily language issues – also a focussed effort has to be made to integrate new words in their conversation i.e. developing science literacy and communication skills
VU


Assessment Part 2b
Total marks: 10
Set I
21 C
48 C
8 C
6 C
31 C

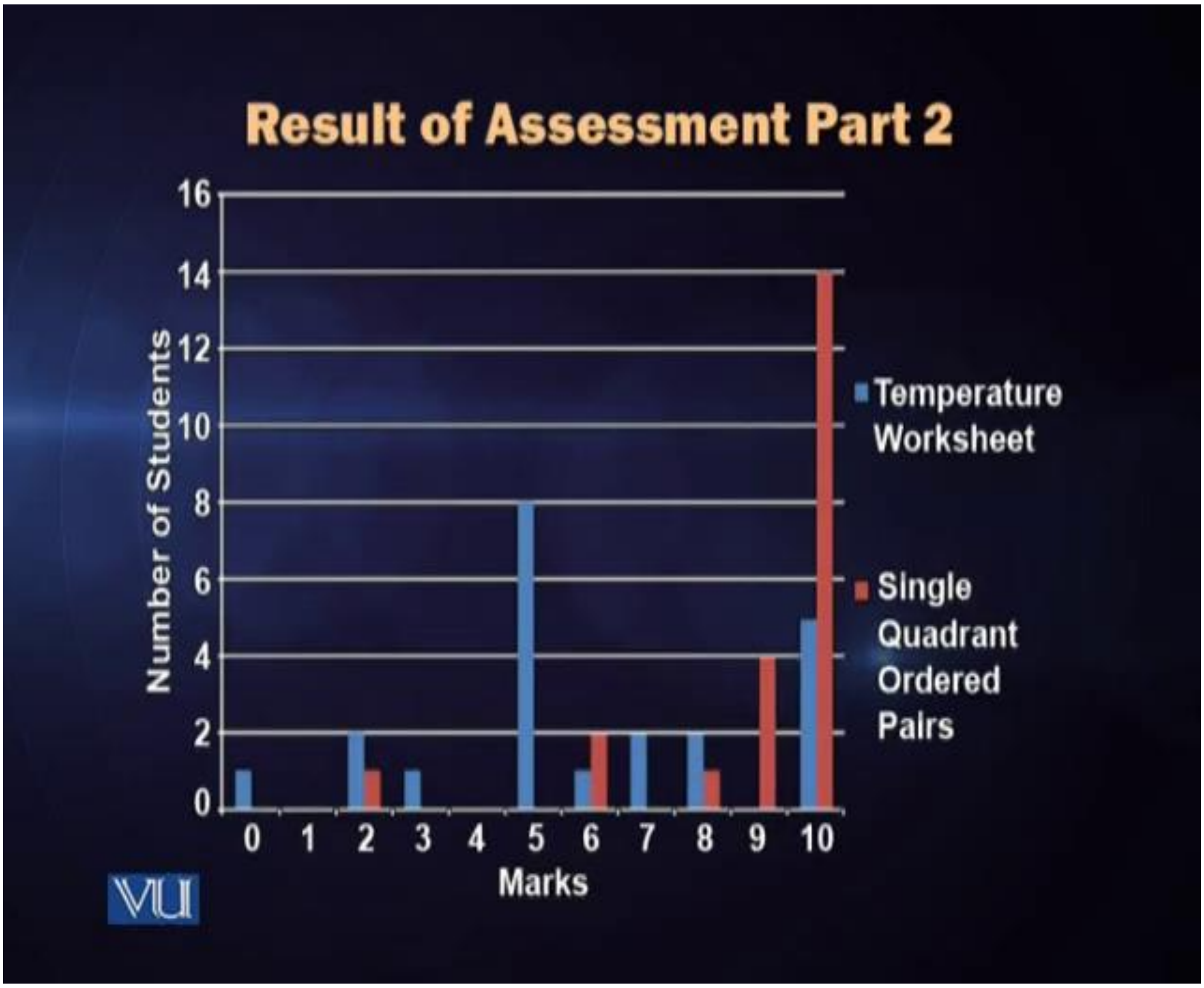

Assessment Part 2b
Set II
29 C
58 C
36 C
73 C
79 C


Assessment Part 2a
Y
X
H
T
V
N
F
M
R
S
I
Y
J
G
X
O
C
L
E
Q
A
B
P
D
U
Z
K
0 1 2 3 4 5 6 7 8 9
0 1 2 3 4 5 6 7 8 9
VU


I. Tell what point is located at each ordered pair.
1) (0,9) H
2) (0,3) J
3) (3,1) A
4) (1,2) L
5) (4,4) Y
6) (8,1) D
7) (4,2) E
8) (6,5) R
9) (5,1) B
10) (0,0) U
VU

II. Write the ordered pair for each given point.

11)	Q	(7,2)	14)	T	(1,9)	17)	Z	(1,0)
12)	P	(7,1)	15)	K	(7,0)	18)	G	(4,3)
13)	S	(9,5)	16)	I	(0,4)	19)	X	(5,3)



Assessment Part 2

Interpreting Temperature Scales where each division is equal to 2 degrees centigrade is problematic – integration of measurement skills in mathematics and science is imperative

More experience with graphing required especially making line graphs and understanding how graphs model the physical and real world

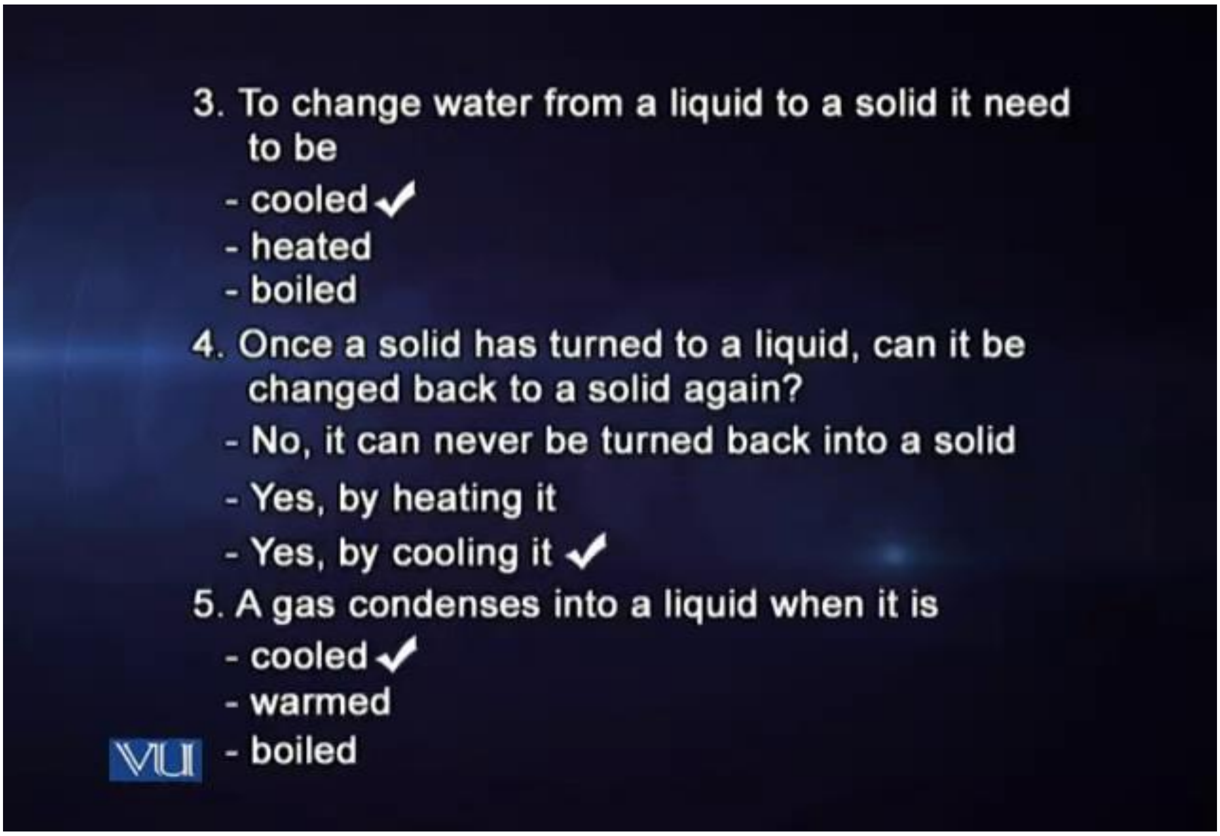
VU

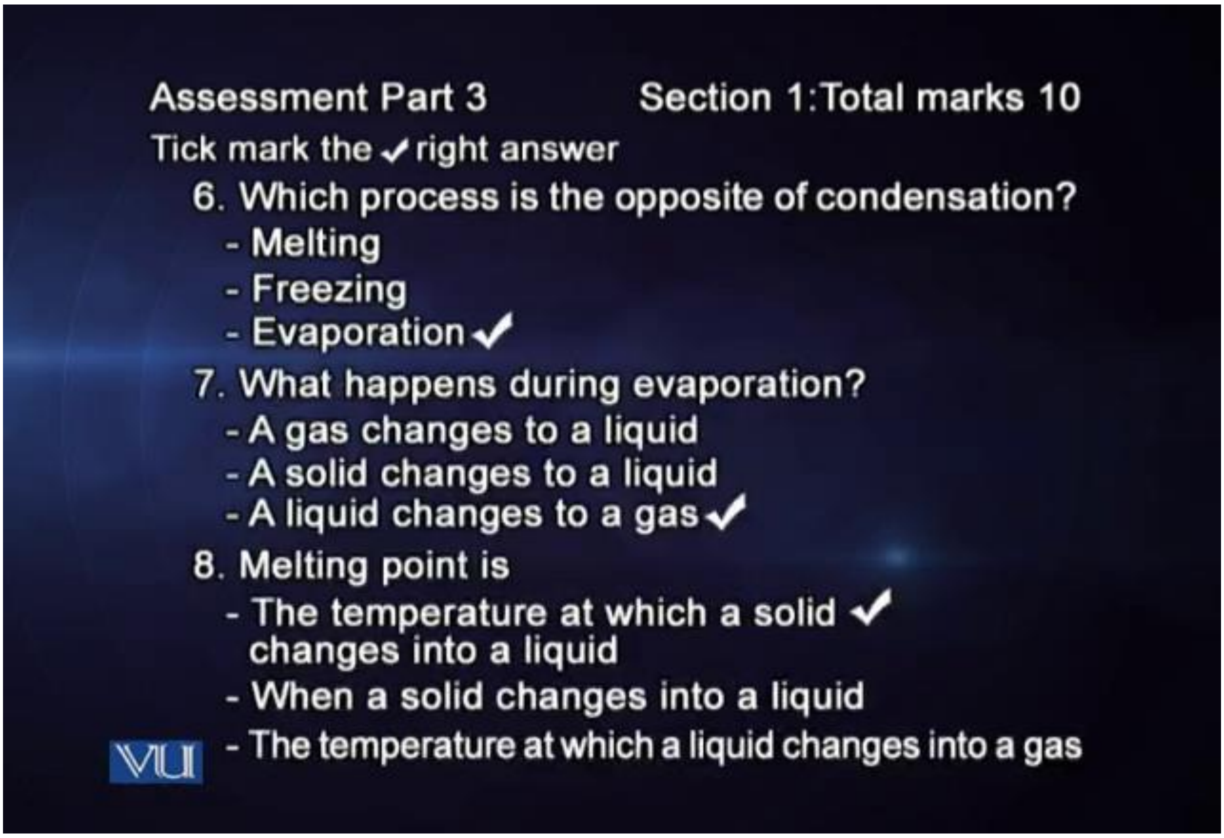
Assessment Part 3 Section 1:Total marks 10

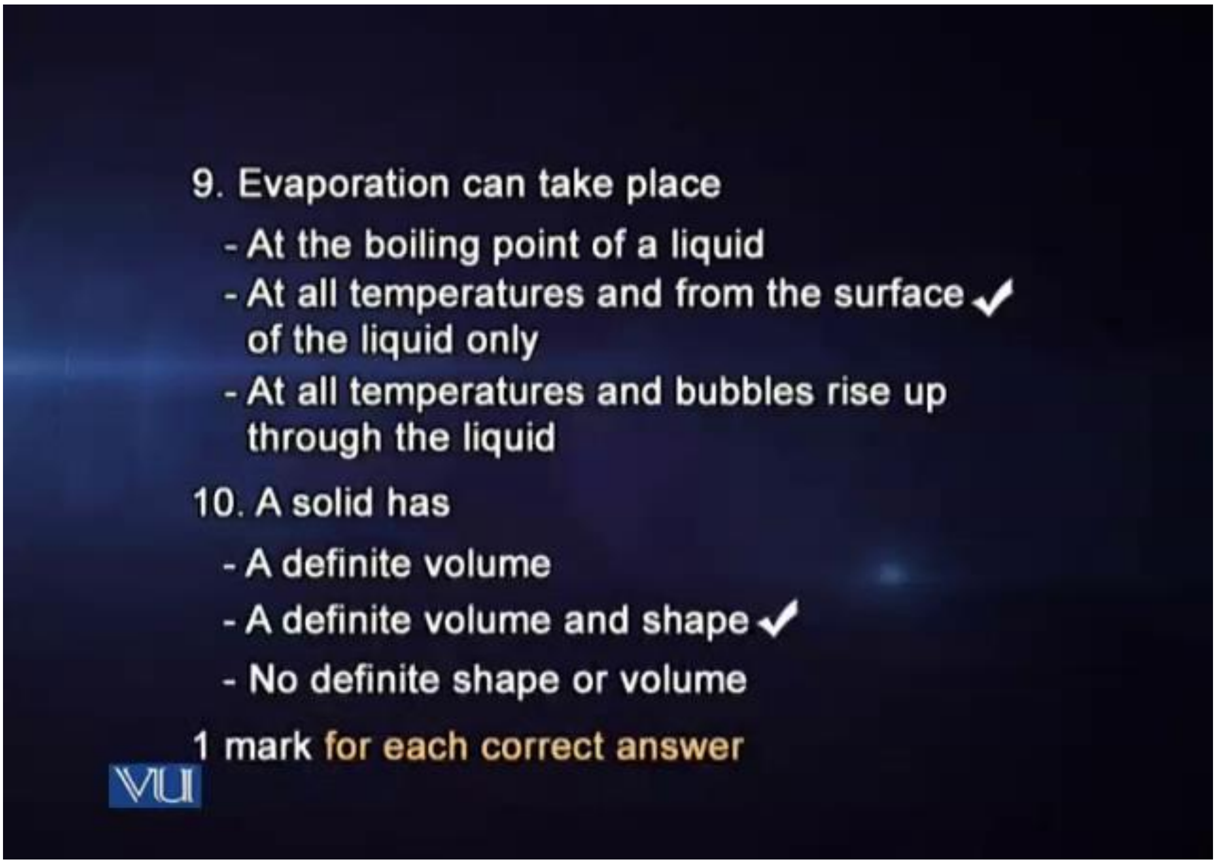
Tick mark the ✓ right answer

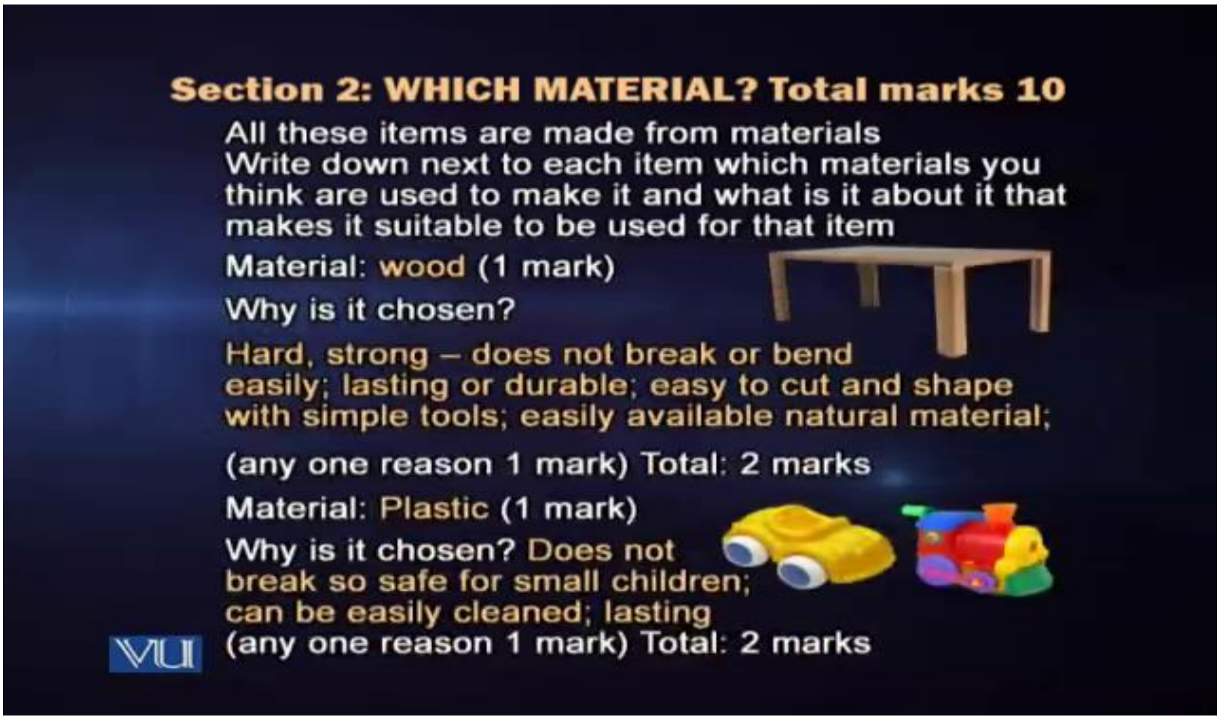
1. To change water from a liquid to a solid it need to be
   - cooled ✓
   - heated
   - boiled
2. Butter going soft and runny on a hot day is an example of ...
   - freezing
   - melting ✓
   - condensing

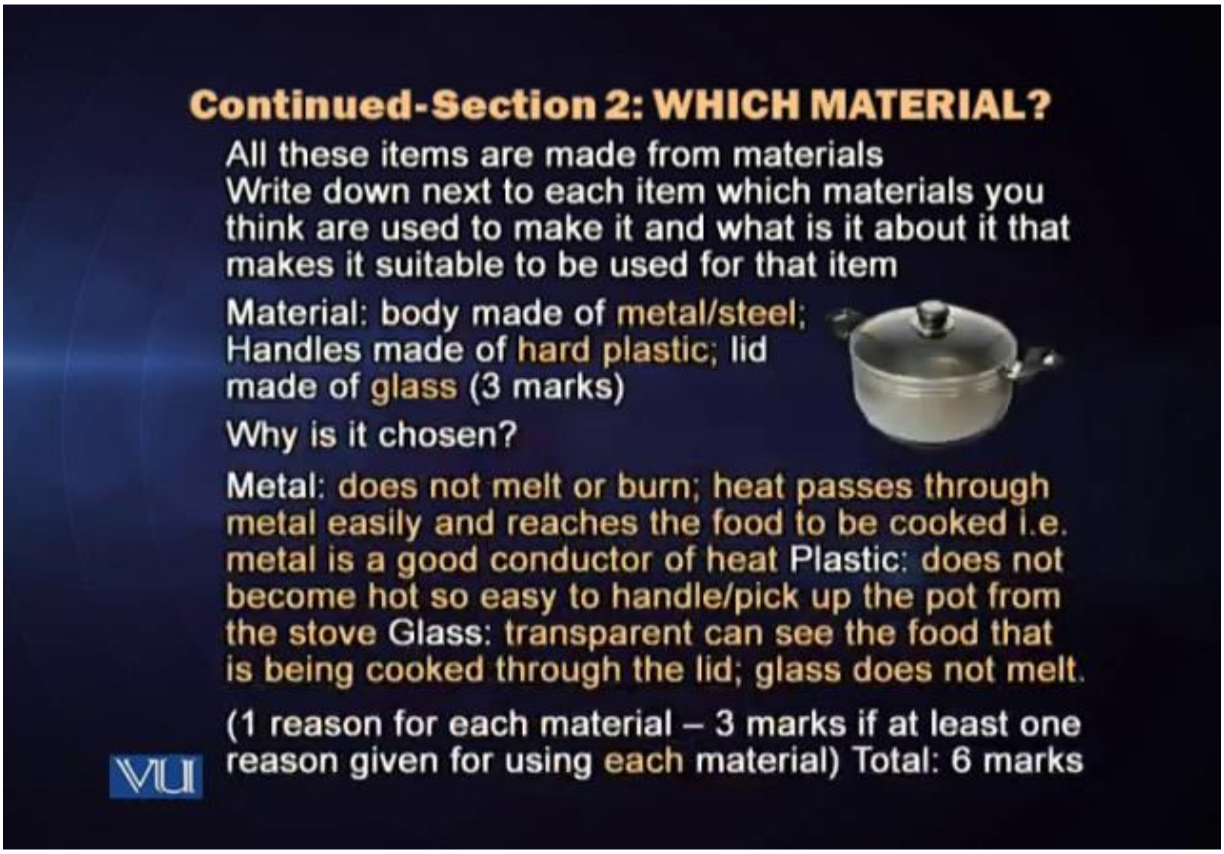
VU

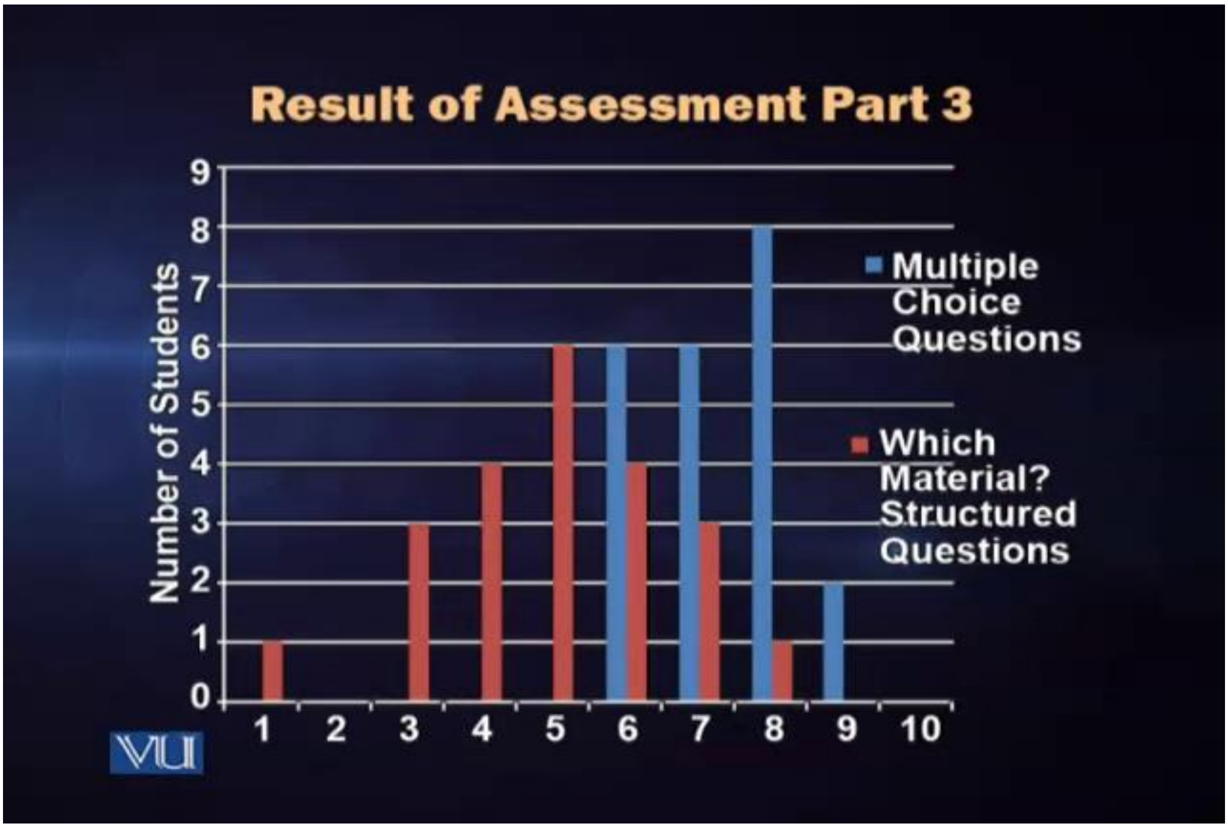

3. To change water from a liquid to a solid it need to be
- cooled ✓
- heated
- boiled
4. Once a solid has turned to a liquid, can it be changed back to a solid again?
- No, it can never be turned back into a solid
- Yes, by heating it
- Yes, by cooling it ✓
5. A gas condenses into a liquid when it is
- cooled ✓
- warmed
- boiled
VU

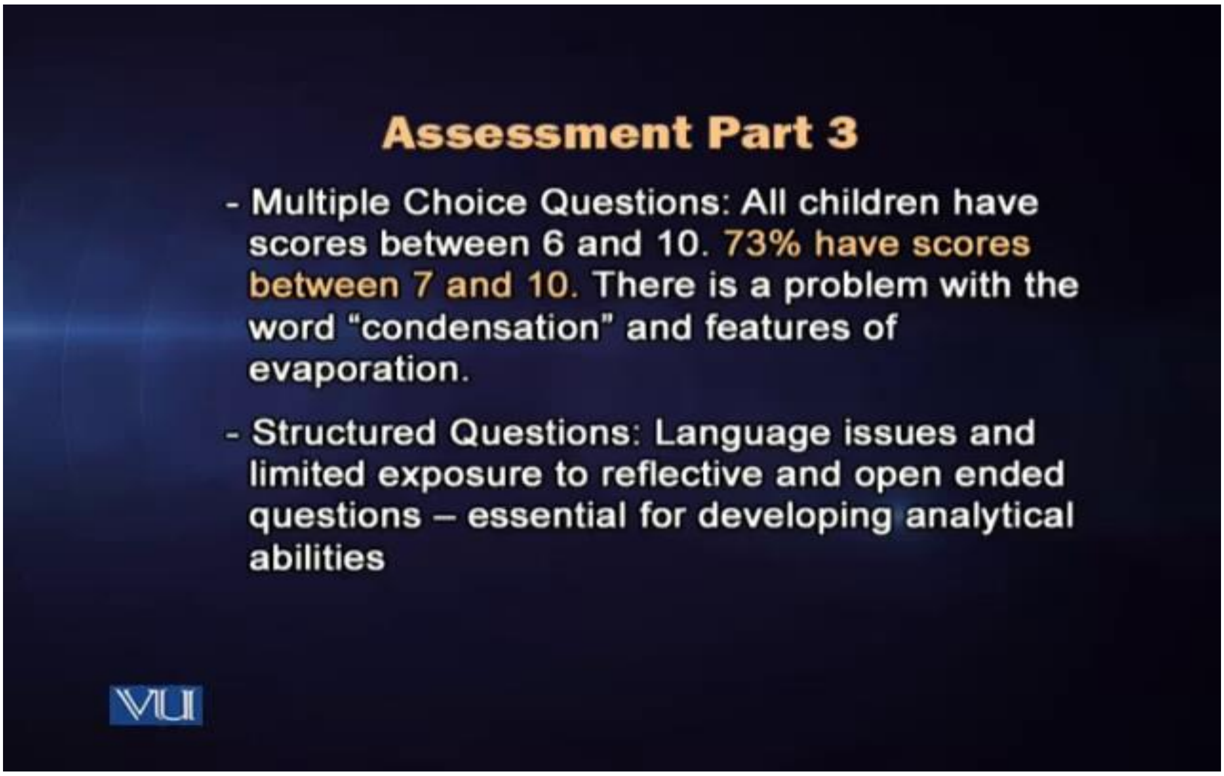

Assessment Part 3
Section 1:Total marks 10
Tick mark the ✓ right answer
6. Which process is the opposite of condensation?
- Melting
- Freezing
- Evaporation ✓
7. What happens during evaporation?
- A gas changes to a liquid
- A solid changes to a liquid
- A liquid changes to a gas ✓
8. Melting point is
- The temperature at which a solid ✓ changes into a liquid
- When a solid changes into a liquid
- The temperature at which a liquid changes into a gas
VU


9. Evaporation can take place
- At the boiling point of a liquid
- At all temperatures and from the surface of the liquid only ✓
- At all temperatures and bubbles rise up through the liquid
10. A solid has
- A definite volume
- A definite volume and shape ✓
- No definite shape or volume
1 mark for each correct answer
VU


Section 2: WHICH MATERIAL? Total marks 10
All these items are made from materials
Write down next to each item which materials you think are used to make it and what is it about it that makes it suitable to be used for that item
Material: wood (1 mark)
Why is it chosen?
Hard, strong – does not break or bend easily; lasting or durable; easy to cut and shape with simple tools; easily available natural material;
(any one reason 1 mark) Total: 2 marks
Material: Plastic (1 mark)
Why is it chosen? Does not break so safe for small children; can be easily cleaned; lasting
(any one reason 1 mark) Total: 2 marks
VU

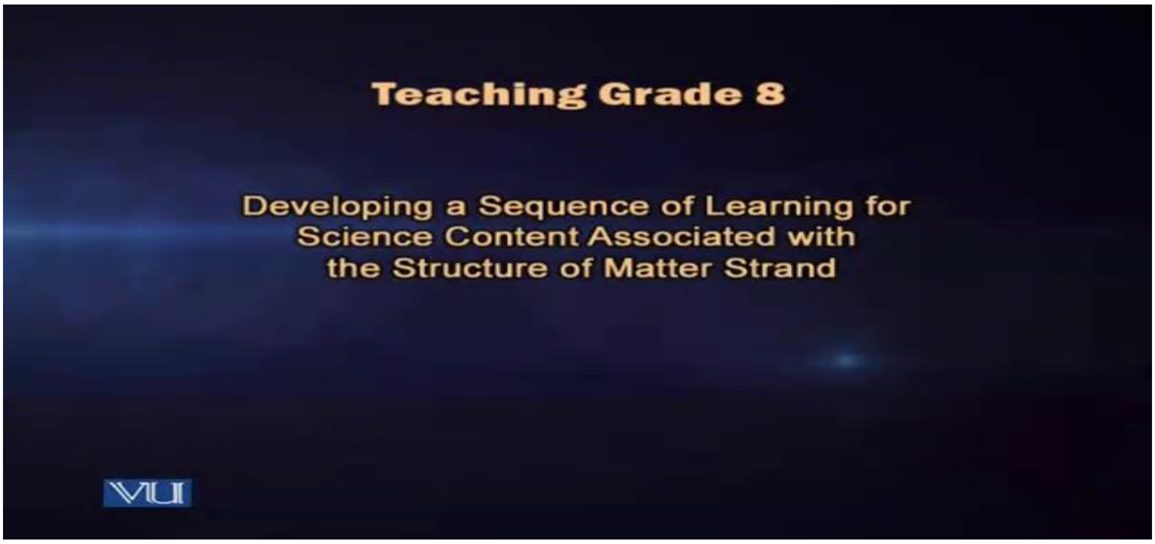

Continued-Section 2: WHICH MATERIAL?
All these items are made from materials
Write down next to each item which materials you think are used to make it and what is it about it that makes it suitable to be used for that item
Material: body made of metal/steel; Handles made of hard plastic; lid made of glass (3 marks)
Why is it chosen?
Metal: does not melt or burn; heat passes through metal easily and reaches the food to be cooked i.e. metal is a good conductor of heat Plastic: does not become hot so easy to handle/pick up the pot from the stove Glass: transparent can see the food that is being cooked through the lid; glass does not melt.
(1 reason for each material – 3 marks if at least one reason given for using each material) Total: 6 marks
VU


Result of Assessment Part 3
Number of Students
0
1
2
3
4
5
6
7
8
9
1
2
3
4
5
6
7
8
9
10
Multiple Choice Questions
Which Material? Structured Questions
VU

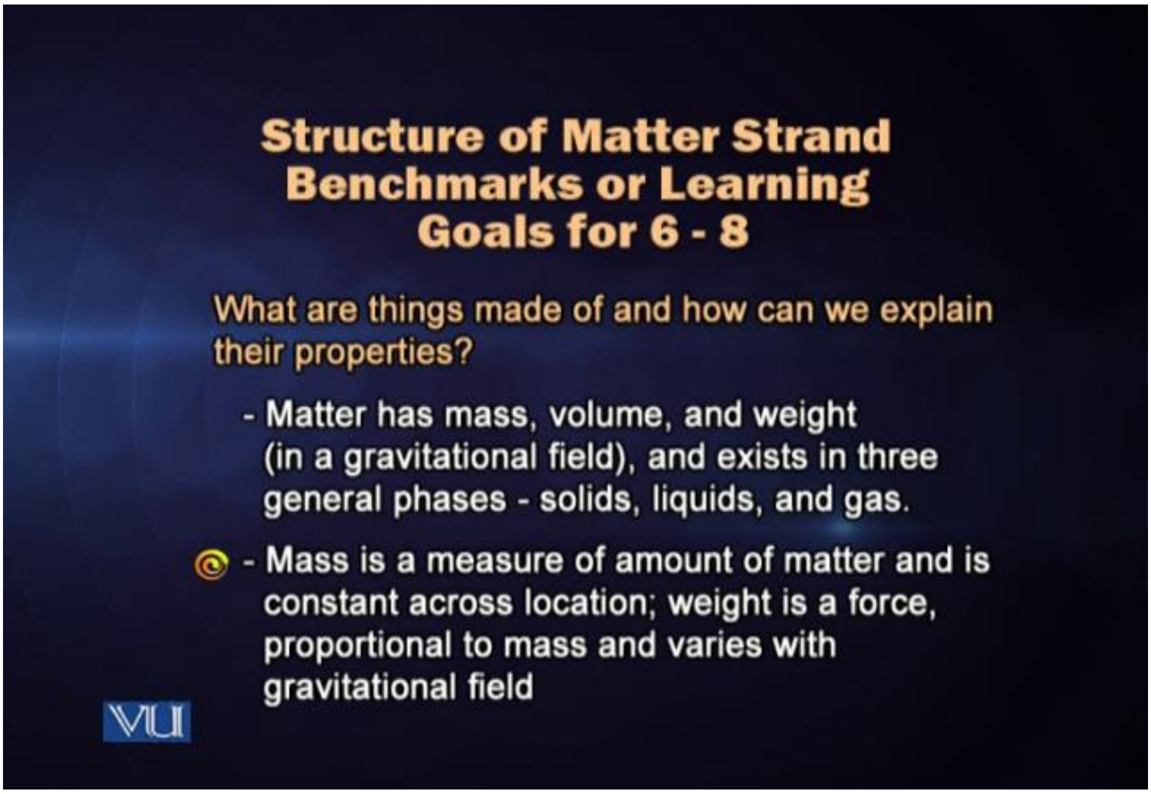

Assessment Part 3
- Multiple Choice Questions: All children have scores between 6 and 10. 73% have scores between 7 and 10. There is a problem with the word "condensation" and features of evaporation.
- Structured Questions: Language issues and limited exposure to reflective and open ended questions – essential for developing analytical abilities
VU

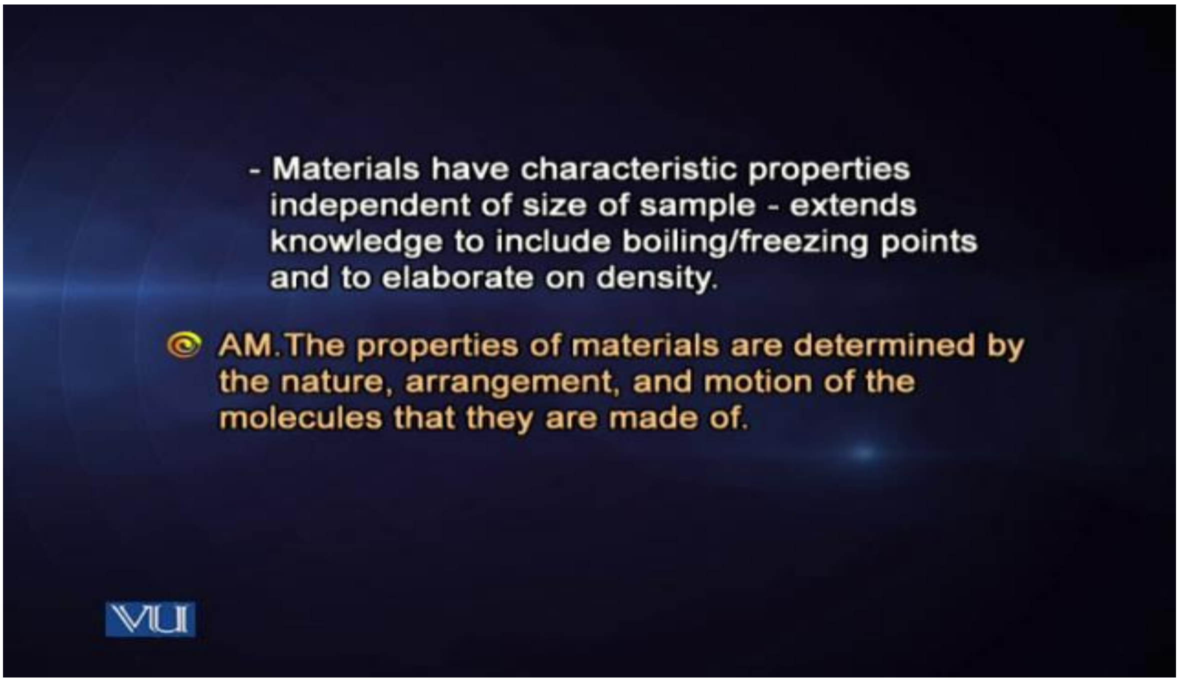
Lecture No 34

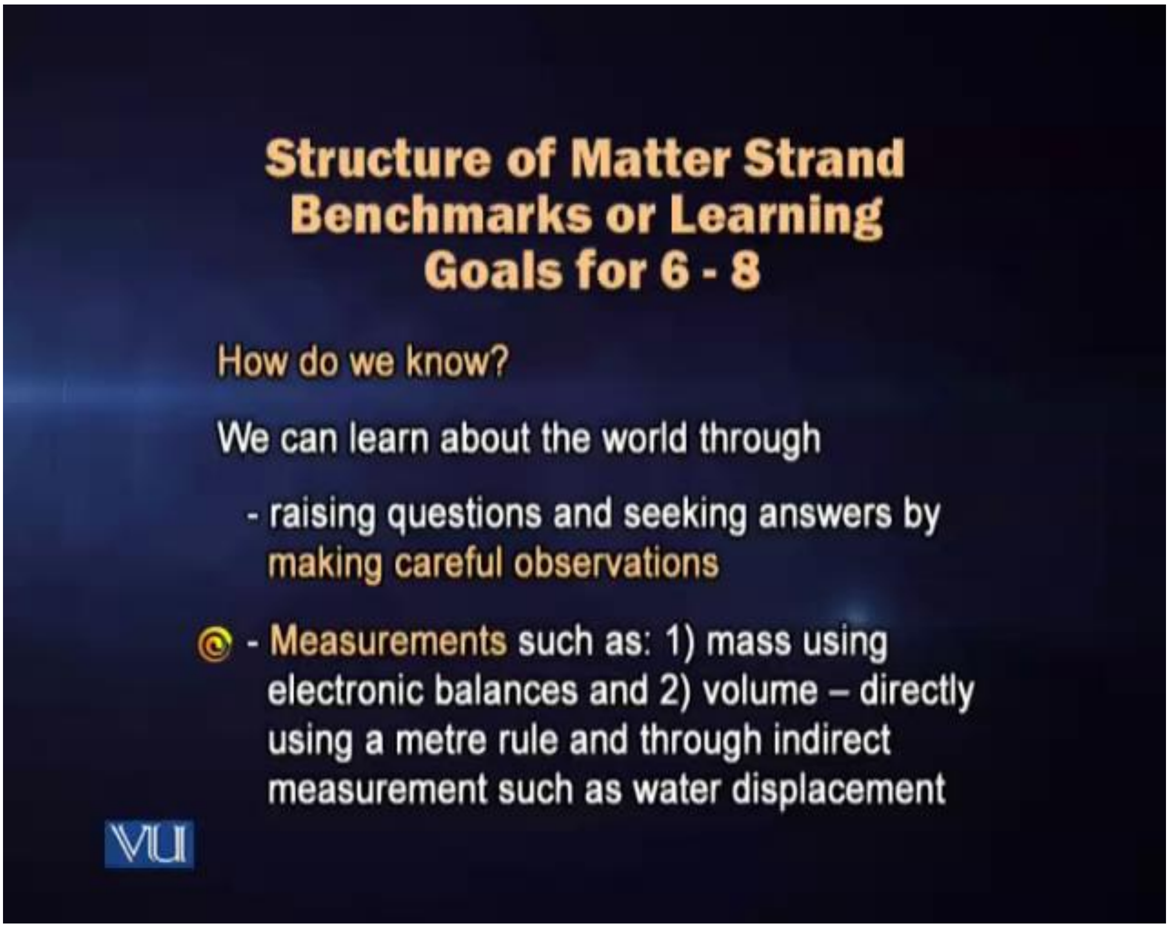
Structure of Matter Strand for Grade 6-8

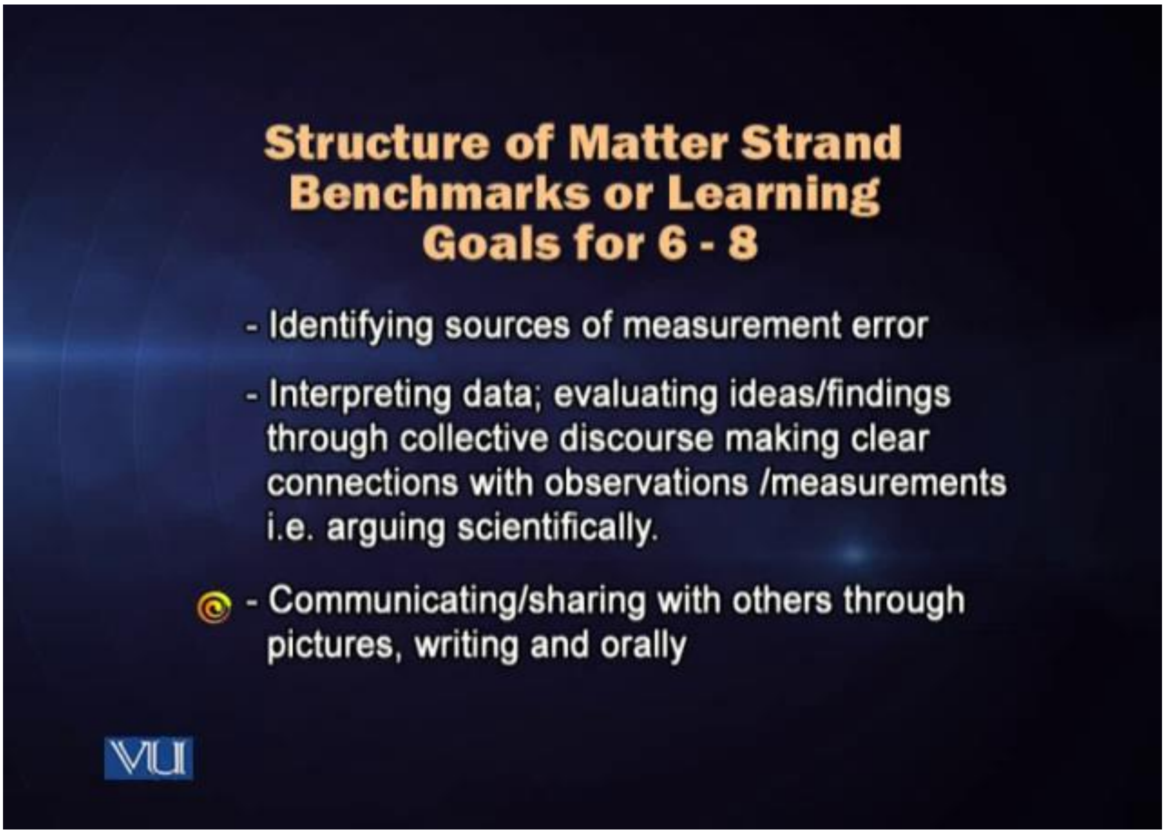


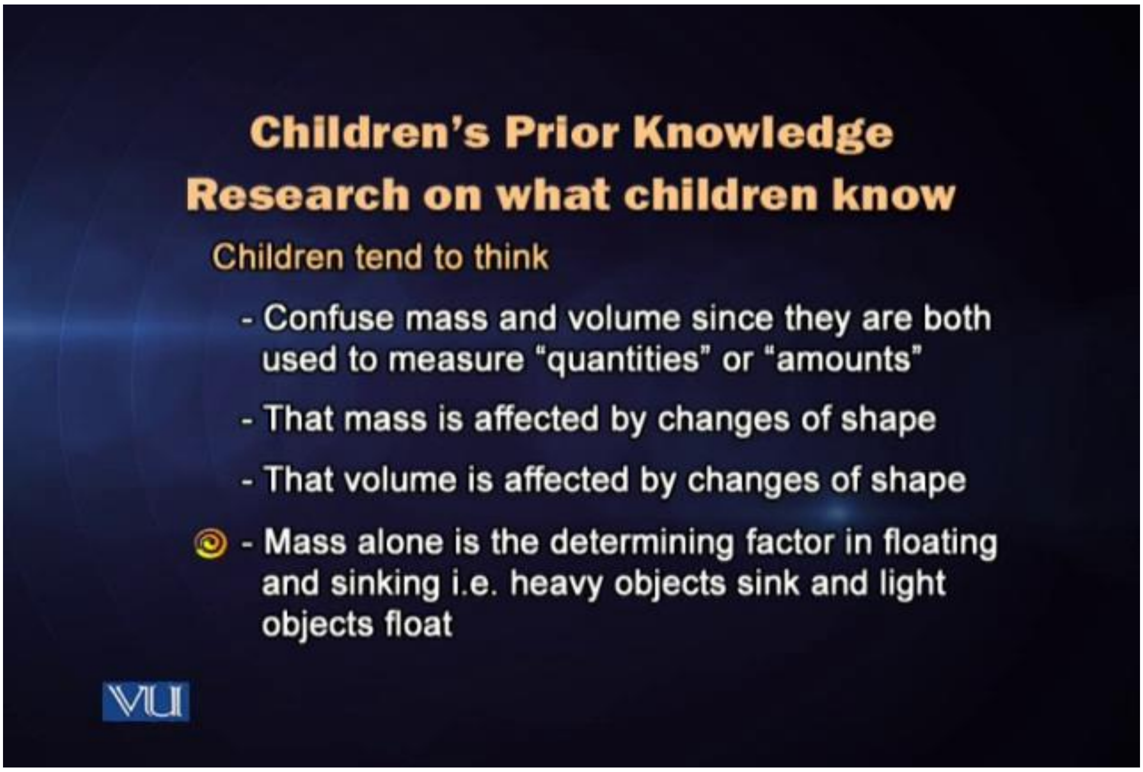
In grade 8 we are focusing the properties of materials. We want the children to understand the mass and volume and are able to differentiate between them. We want them to know the density of materials.

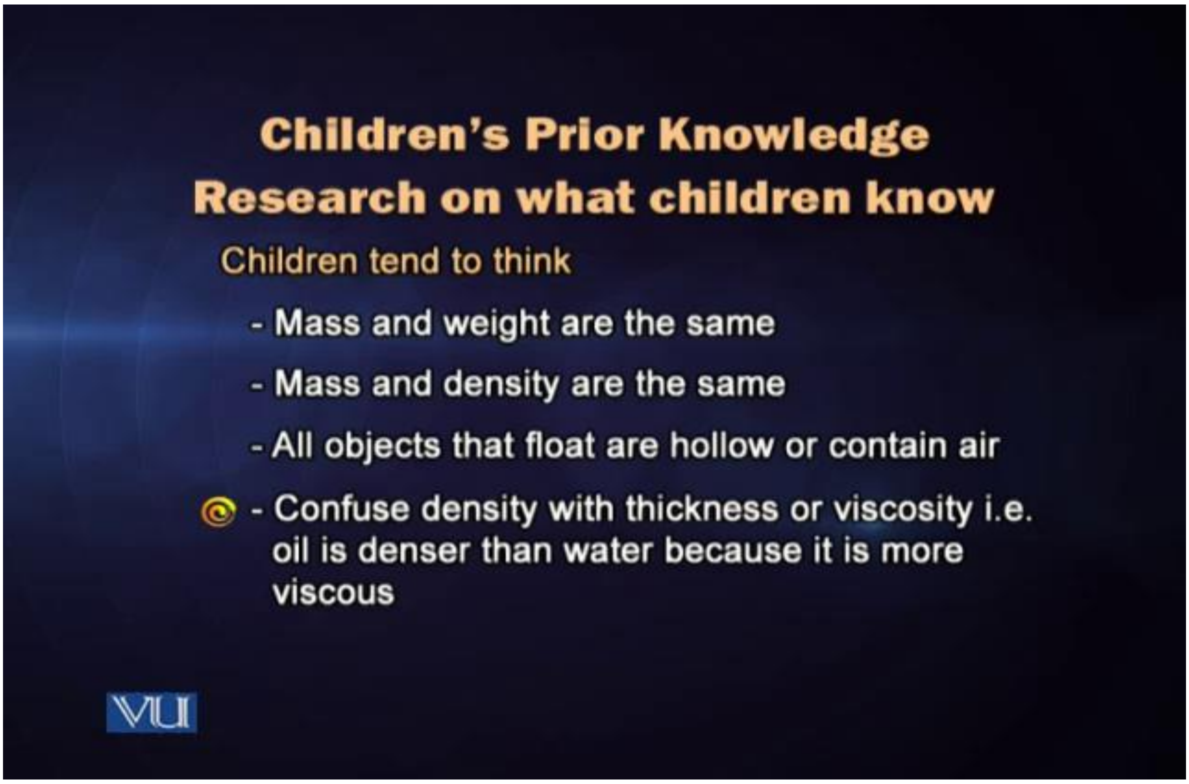



- Materials have characteristic properties independent of size of sample - extends knowledge to include boiling/freezing points and to elaborate on density.
AM. The properties of materials are determined by the nature, arrangement, and motion of the molecules that they are made of.
VU


Structure of Matter Strand Benchmarks or Learning Goals for 6 - 8
How do we know?
We can learn about the world through
- raising questions and seeking answers by making careful observations
- Measurements such as: 1) mass using electronic balances and 2) volume – directly using a metre rule and through indirect measurement such as water displacement
VU


Structure of Matter Strand Benchmarks or Learning Goals for 6 - 8
- Identifying sources of measurement error
- Interpreting data; evaluating ideas/findings through collective discourse making clear connections with observations /measurements i.e. arguing scientifically.
- Communicating/sharing with others through pictures, writing and orally
VU


Children's Prior Knowledge
Research on what children know
Children tend to think
- Confuse mass and volume since they are both used to measure "quantities" or "amounts"
- That mass is affected by changes of shape
- That volume is affected by changes of shape
- Mass alone is the determining factor in floating and sinking i.e. heavy objects sink and light objects float
VU


Children's Prior Knowledge
Research on what children know
Children tend to think
- Mass and weight are the same
- Mass and density are the same
- All objects that float are hollow or contain air
- Confuse density with thickness or viscosity i.e. oil is denser than water because it is more viscous
VU


Sequence of Learning Template
Phase A: Assessing Prior Knowledge
Phase B: Developing a Background
Phase C: Main Content of the
D,E etc. : Unit/Topic
Final Phase: Applying their Skills and Knowledge
VU

Sequence of Learning for the Unit: Discovering Density

Phase A

Staging Activity: Eliciting prior knowledge about matter

Students engage in six inquiries specially designed to assess their prior understanding and skills associated with

- Different states of matter,
- Measuring mass and volume and
- Floating and sinking and hence density

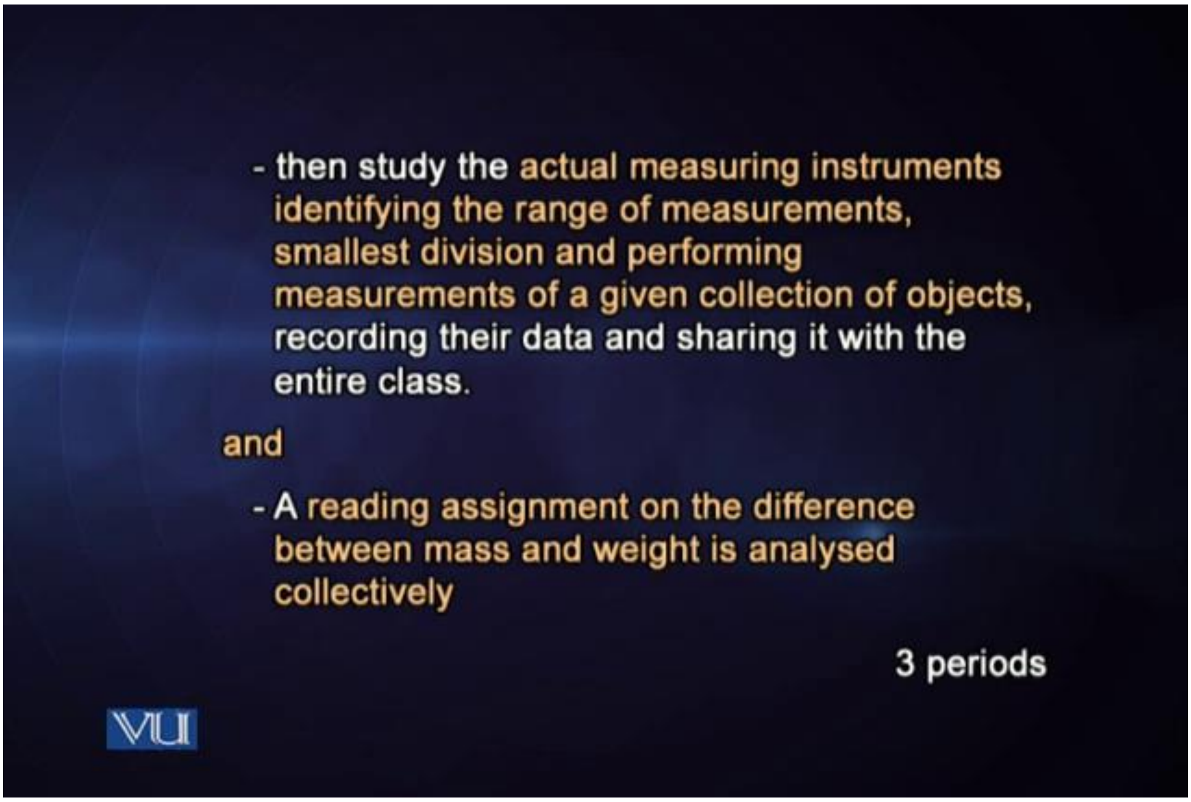
2 periods

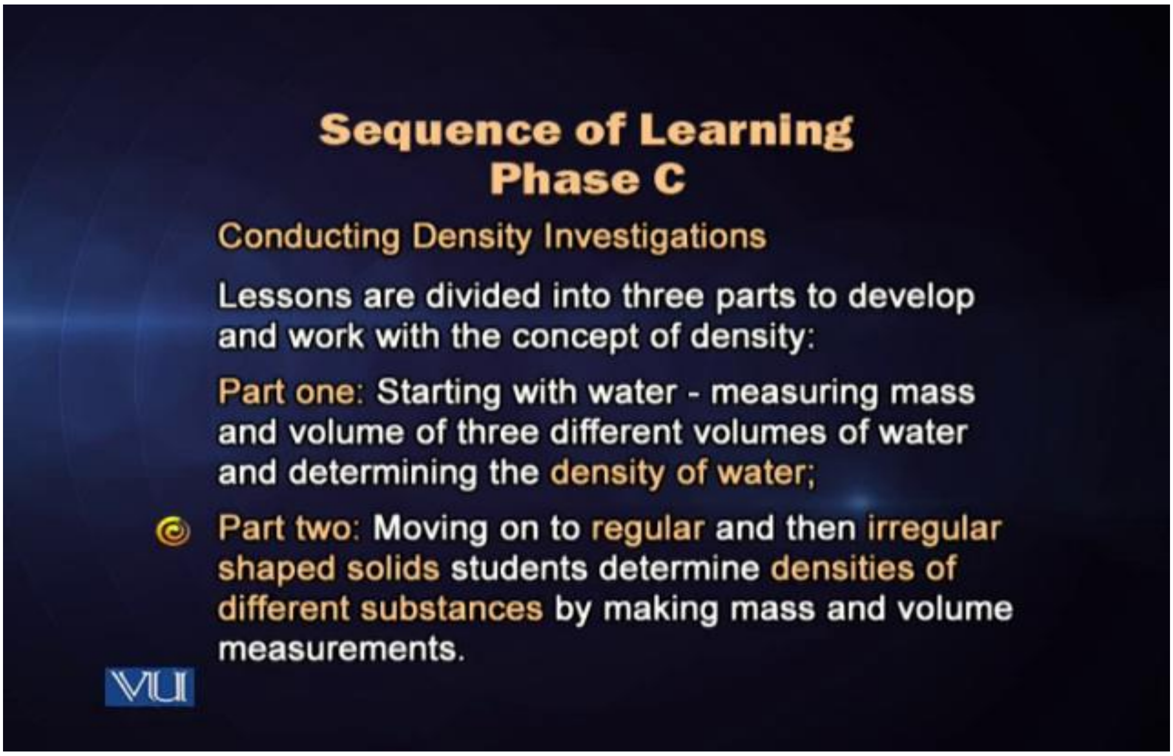
Sequence of Learning

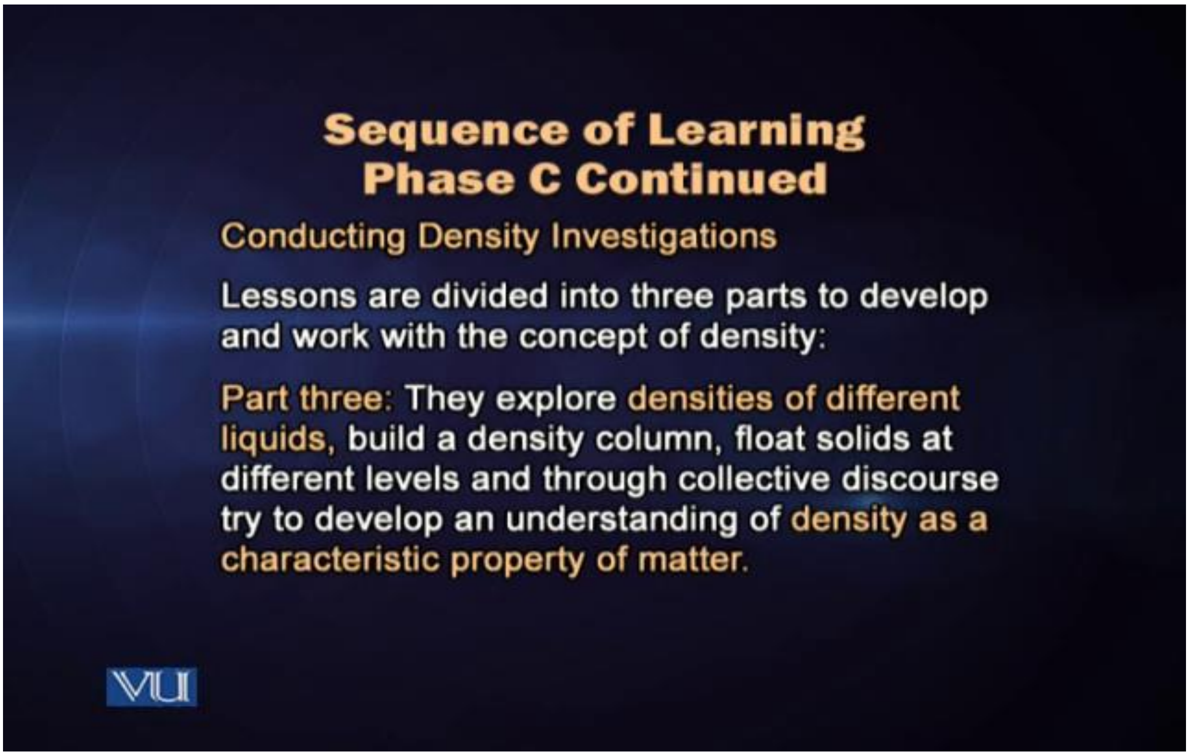
Phase B

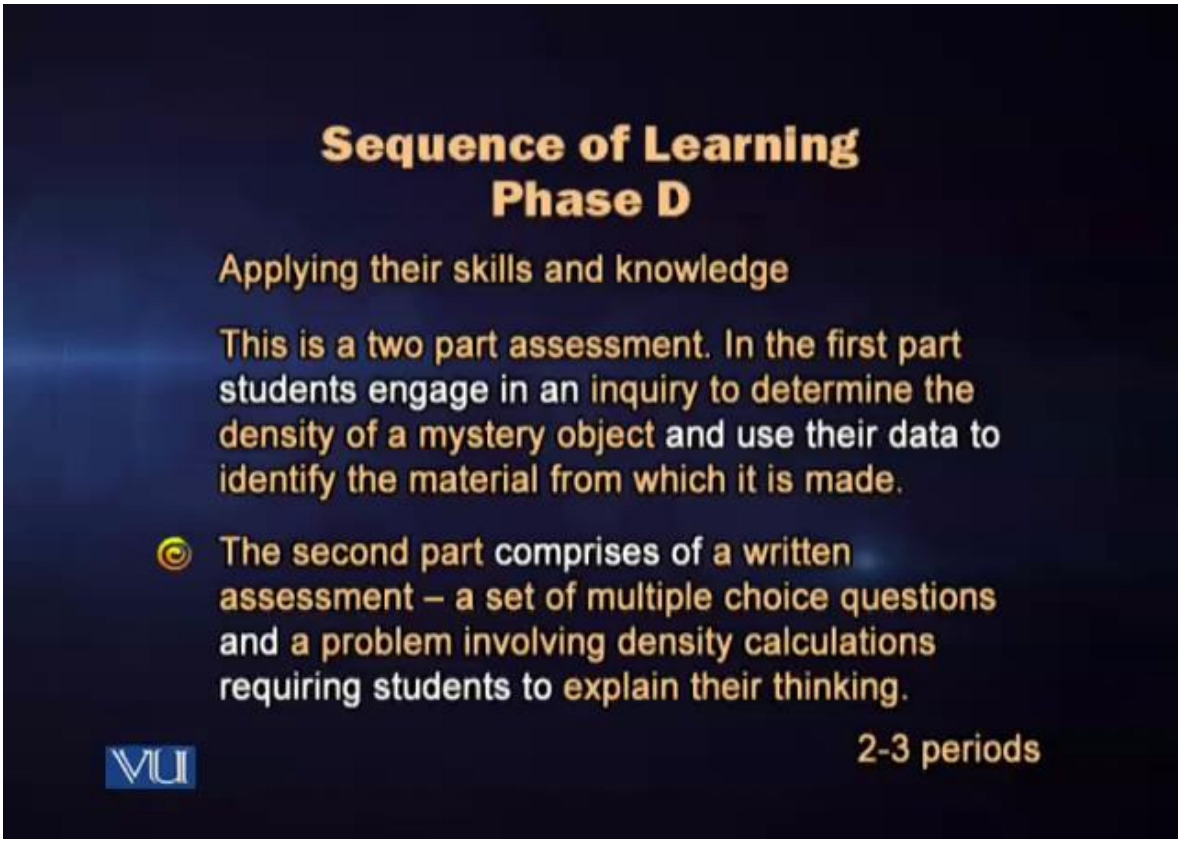
Developing Background for Density Investigations: learning to Measure Length, Volume and Mass

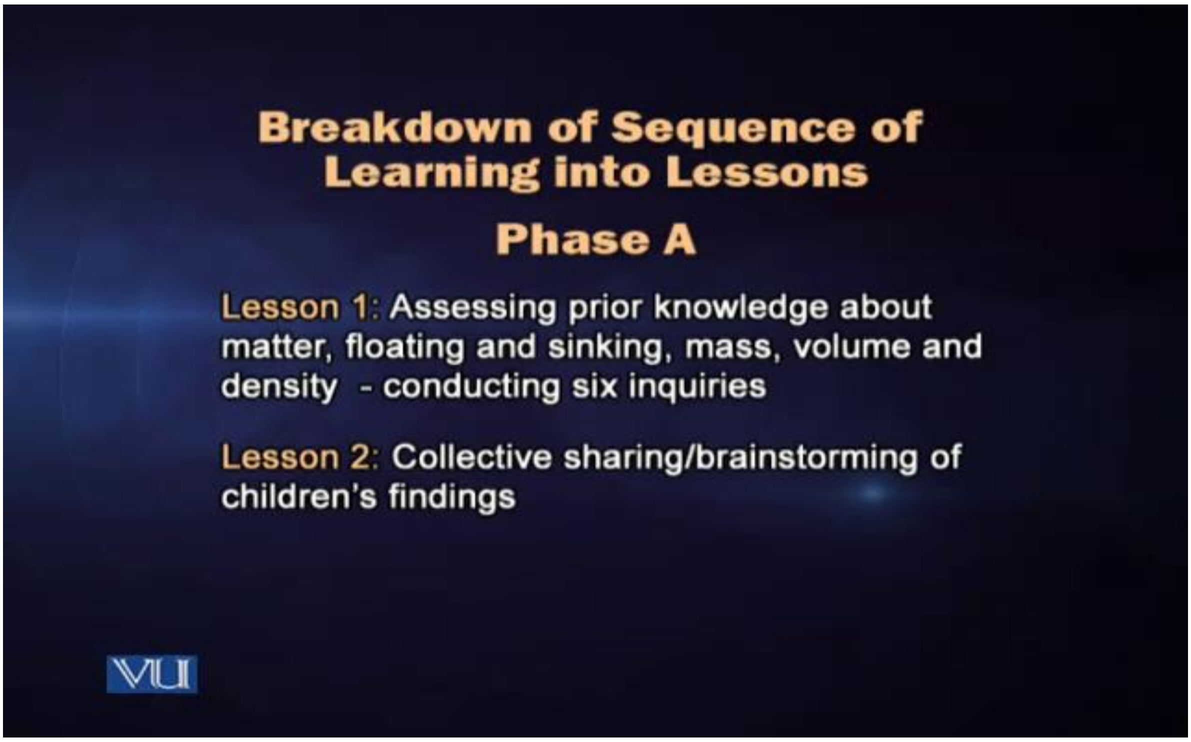
Focusing first on length, then volume and finally mass students

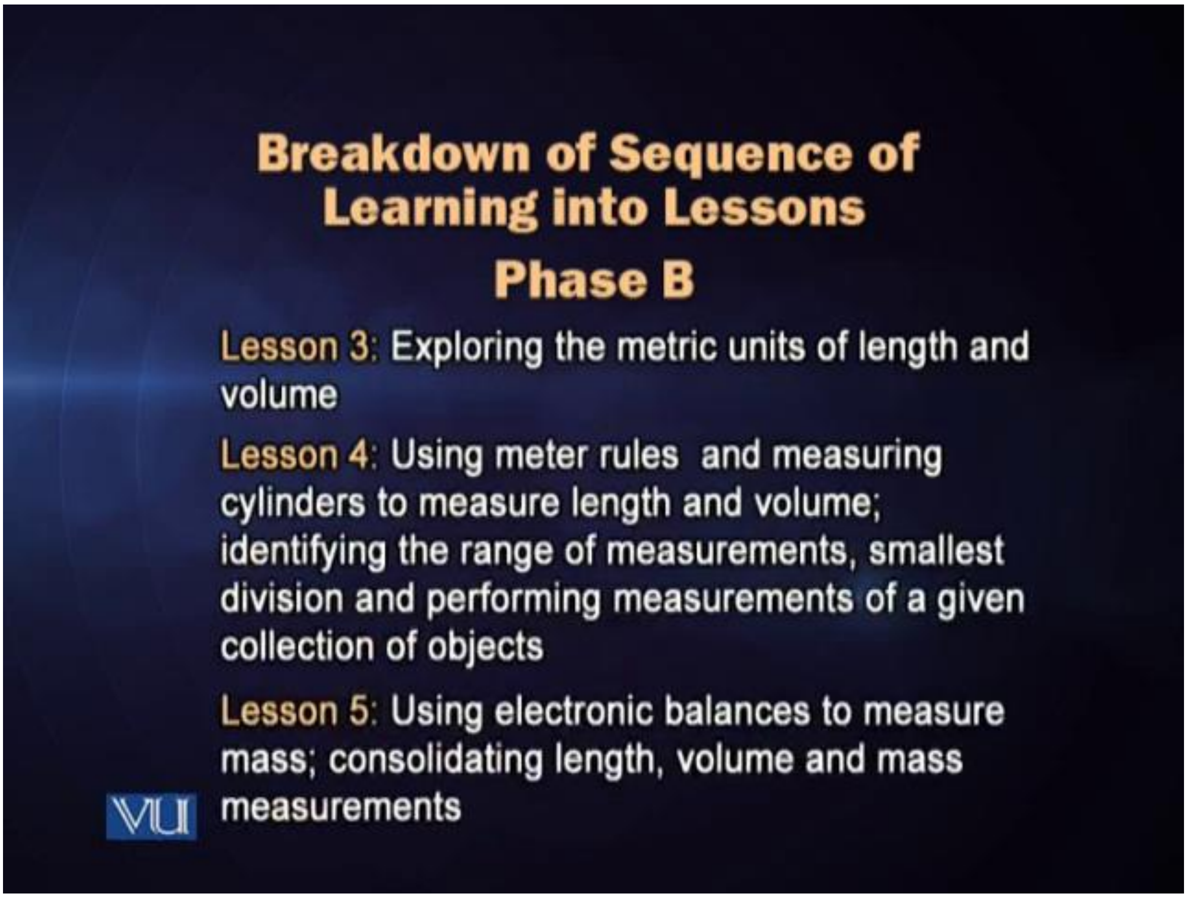

- then study the actual measuring instruments identifying the range of measurements, smallest division and performing measurements of a given collection of objects, recording their data and sharing it with the entire class.
and
- A reading assignment on the difference between mass and weight is analysed collectively
3 periods

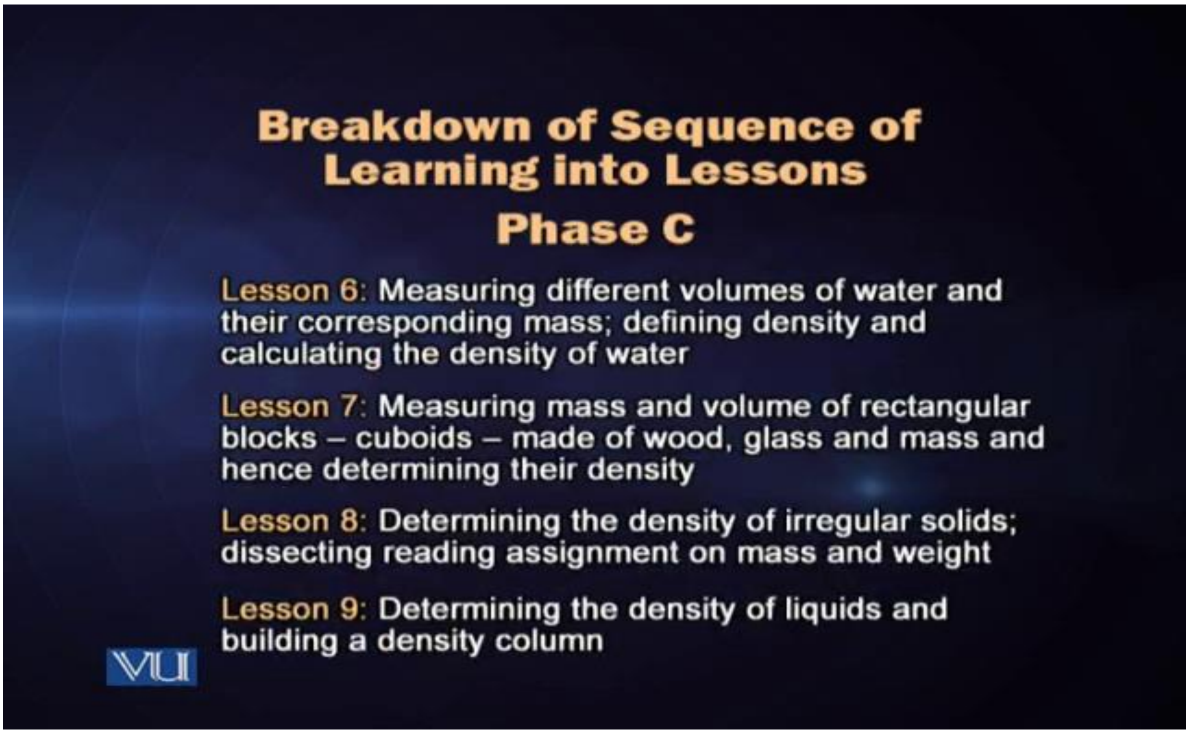

Sequence of Learning
Phase C
Conducting Density Investigations
Lessons are divided into three parts to develop and work with the concept of density:
Part one: Starting with water - measuring mass and volume of three different volumes of water and determining the density of water;
Part two: Moving on to regular and then irregular shaped solids students determine densities of different substances by making mass and volume measurements.

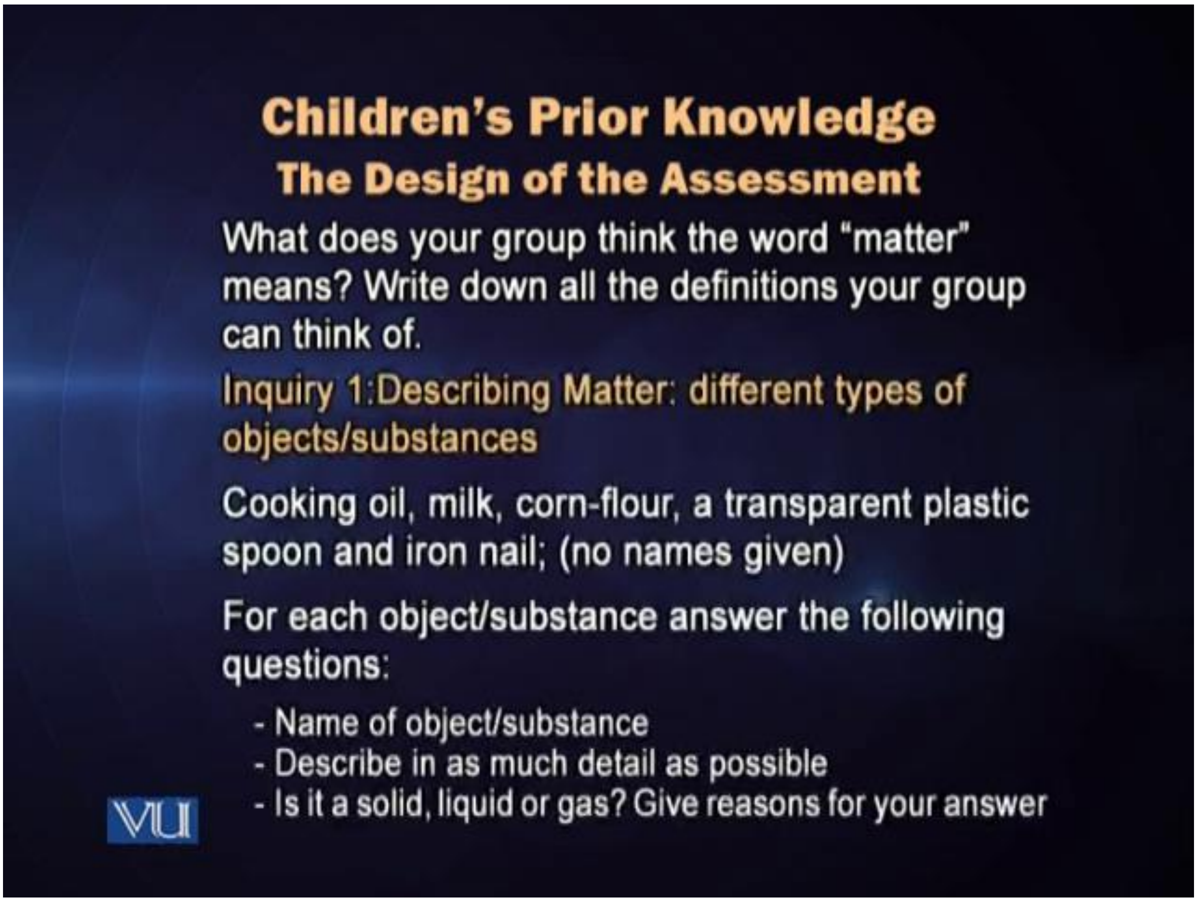

Sequence of Learning
Phase C Continued
Conducting Density Investigations
Lessons are divided into three parts to develop and work with the concept of density:
Part three: They explore densities of different liquids, build a density column, float solids at different levels and through collective discourse try to develop an understanding of density as a characteristic property of matter.
VU


Sequence of Learning
Phase D
Applying their skills and knowledge
This is a two part assessment. In the first part students engage in an inquiry to determine the density of a mystery object and use their data to identify the material from which it is made.
The second part comprises of a written assessment – a set of multiple choice questions and a problem involving density calculations requiring students to explain their thinking.
2-3 periods
VU


Breakdown of Sequence of Learning into Lessons
Phase A
Lesson 1: Assessing prior knowledge about matter, floating and sinking, mass, volume and density - conducting six inquiries
Lesson 2: Collective sharing/brainstorming of children's findings
VU


Breakdown of Sequence of Learning into Lessons
Phase B
Lesson 3: Exploring the metric units of length and volume
Lesson 4: Using meter rules and measuring cylinders to measure length and volume; identifying the range of measurements, smallest division and performing measurements of a given collection of objects
Lesson 5: Using electronic balances to measure mass; consolidating length, volume and mass measurements
VU


Breakdown of Sequence of Learning into Lessons
Phase C
Lesson 6: Measuring different volumes of water and their corresponding mass; defining density and calculating the density of water
Lesson 7: Measuring mass and volume of rectangular blocks – cuboids – made of wood, glass and mass and hence determining their density
Lesson 8: Determining the density of irregular solids; dissecting reading assignment on mass and weight
Lesson 9: Determining the density of liquids and building a density column
VU


Children's Prior Knowledge
The Design of the Assessment
What does your group think the word "matter" means? Write down all the definitions your group can think of.
Inquiry 1:Describing Matter: different types of objects/substances
Cooking oil, milk, corn-flour, a transparent plastic spoon and iron nail; (no names given)
For each object/substance answer the following questions:
- Name of object/substance
- Describe in as much detail as possible
- Is it a solid, liquid or gas? Give reasons for your answer
VU

Children's Prior Knowledge
The Design of the Assessment

Inquiry 2: Two syringes connected by a tube

- Push one syringe in. What do you observe?
- Draw what happens when the syringe is pushed in.
- Can you explain what you observed after one syringe was pushed in.

Inquiry 3: Floating and Sinking

- Place the piece of clay in water. What happened?
- Now roll the piece into a ball (you can use the hammer if you like) and place it in the water again. What happened?
- Why do you think rolling the clay into ball makes it behave differently in water?

VU

Children's Prior Knowledge
The Design of the Assessment

Inquiry 4: Exploring water

You have coloured water in the beaker. Use the measuring cylinder to pour 50 ml of coloured water in the conical flask, 50 ml in the empty beaker and then fill the measuring cylinder again up to the 50 ml mark. Place the conical flask, beaker and cylinder containing 50 ml water each side by side and draw a picture of all three.

What can you say about the behaviour of water?

VU

Children's Prior Knowledge
The Design of the Assessment

Inquiry 5: Mixing Liquids

1. Look at the bottle carefully. Then shake the bottle two times. Allow it to stand for 2 minutes. What do you observe?
2. What do you know about the two liquids in the bottle?

VU

Inquiry 6: Comparing masses

Use the electronic balance to measure mass.

Mass of Empty Cup =……….g;

Mass of Sand and Cup = ……….g

Mass of Sand = ……….g

Mass of Tea leaves and Cup = ……….g

Mass of Tea leaves = ……….g

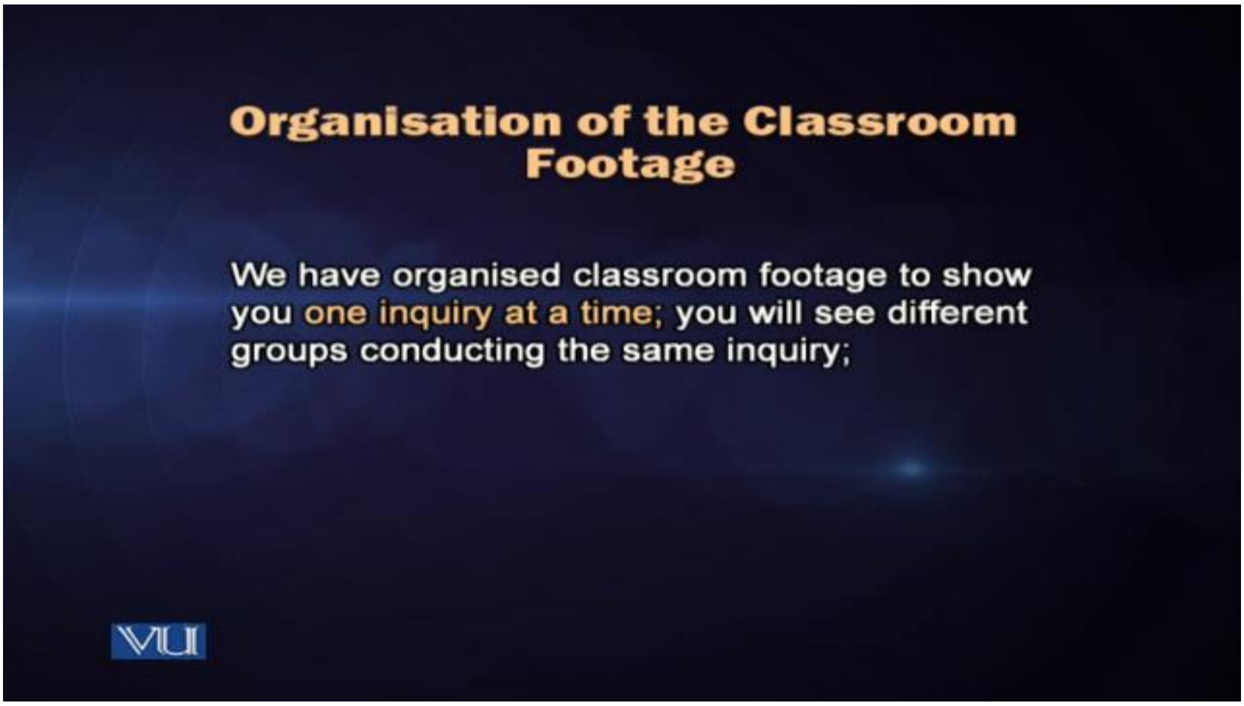
What can you say about the volumes of tea and sand? Are they the same or different? Give reasons for your answer.

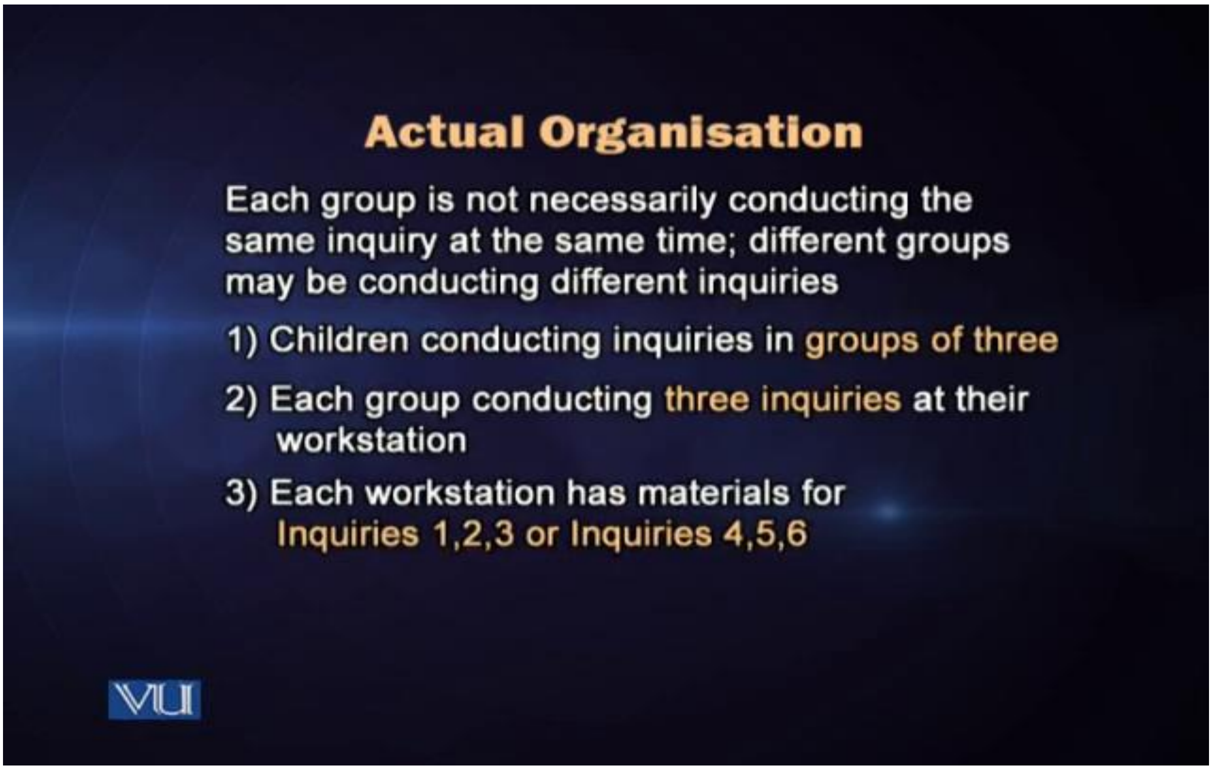
VU

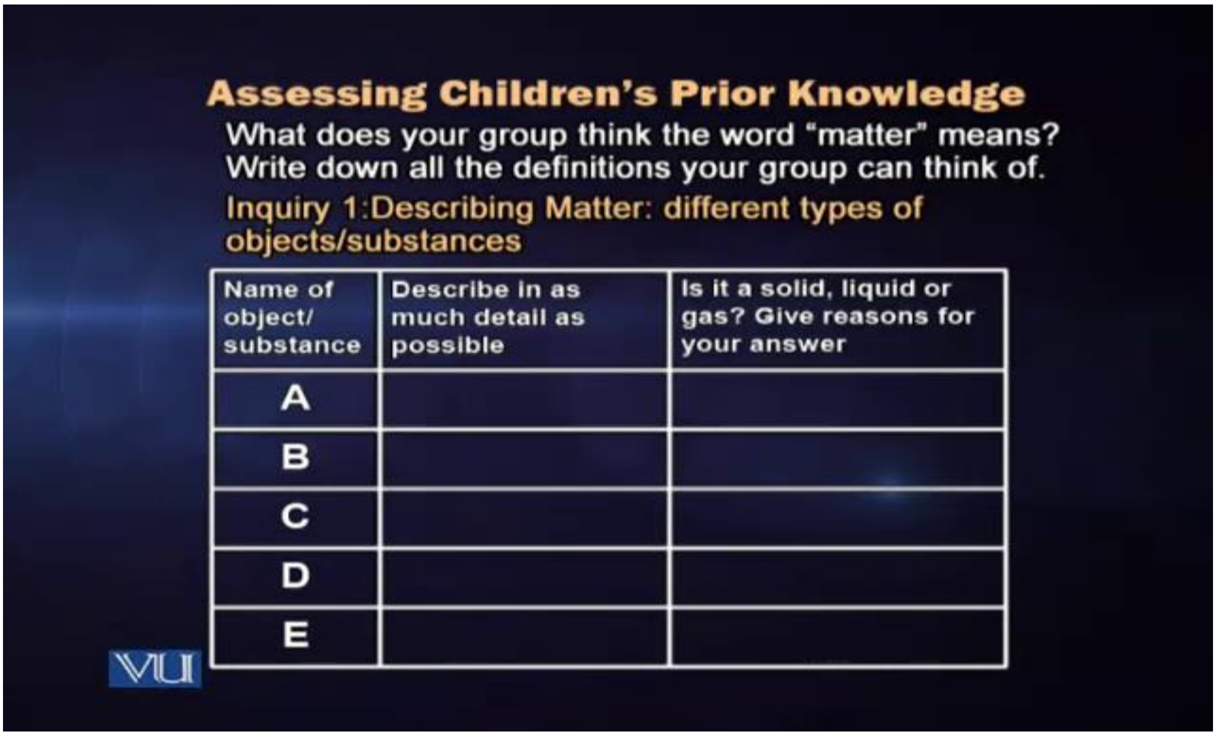
Lecture No 35

Assessing Children Prior Knowledge

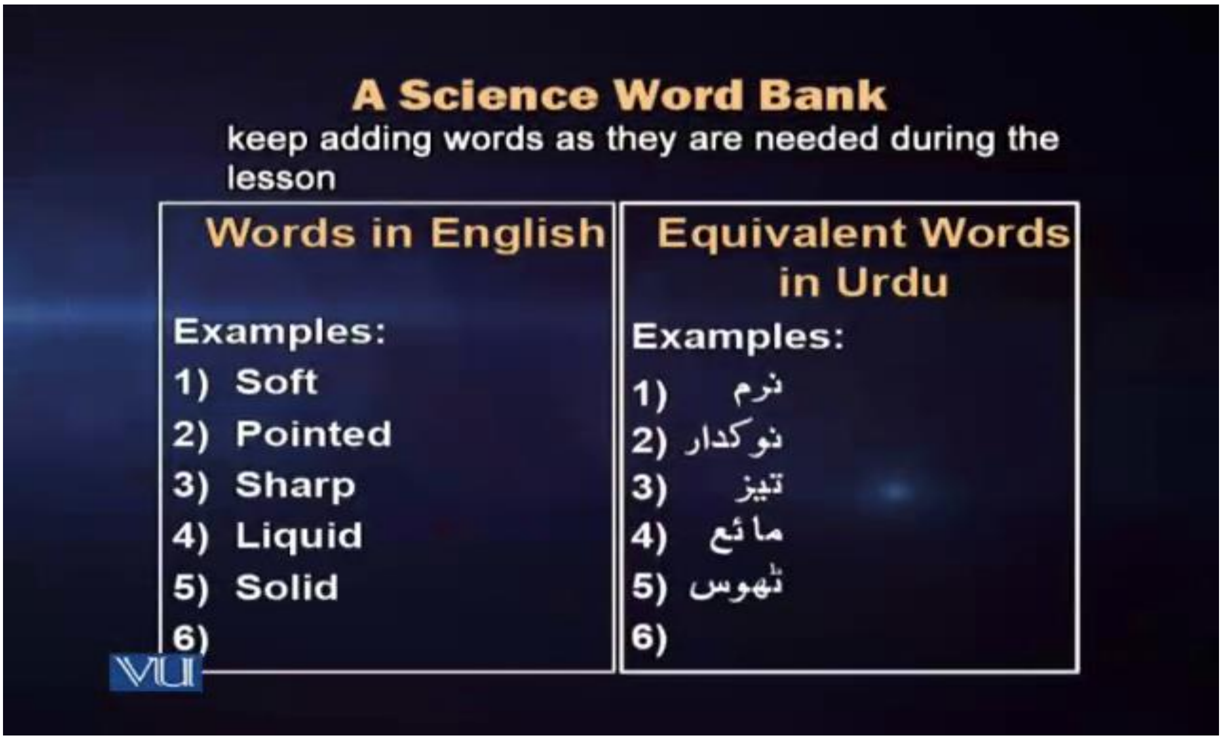
This lecture is about assessing children prior knowledge. In the class teacher told the students that she wanted to examine the concepts of children about the state of matter, its volume, mass, weight and density. Teacher told the students that it was not a test but it was only for the teacher to know the baseline of the students. Teacher had arranged the six short experiments for the students. Students had to work in the group of three. Teacher had labelled the tables with experiment 1,2 and 3. So that it would be easier for the students to record their findings in the worksheets accordingly. Teacher told the students that she had given all the clear instructions in the worksheets but if they had any questions that might ask. Teacher told the students that they could give 5 to 7 minutes to one experiment. Because these were the short inquiries so there was no need to spend more time on experiments. At the end teacher told them that she would switch over the groups.

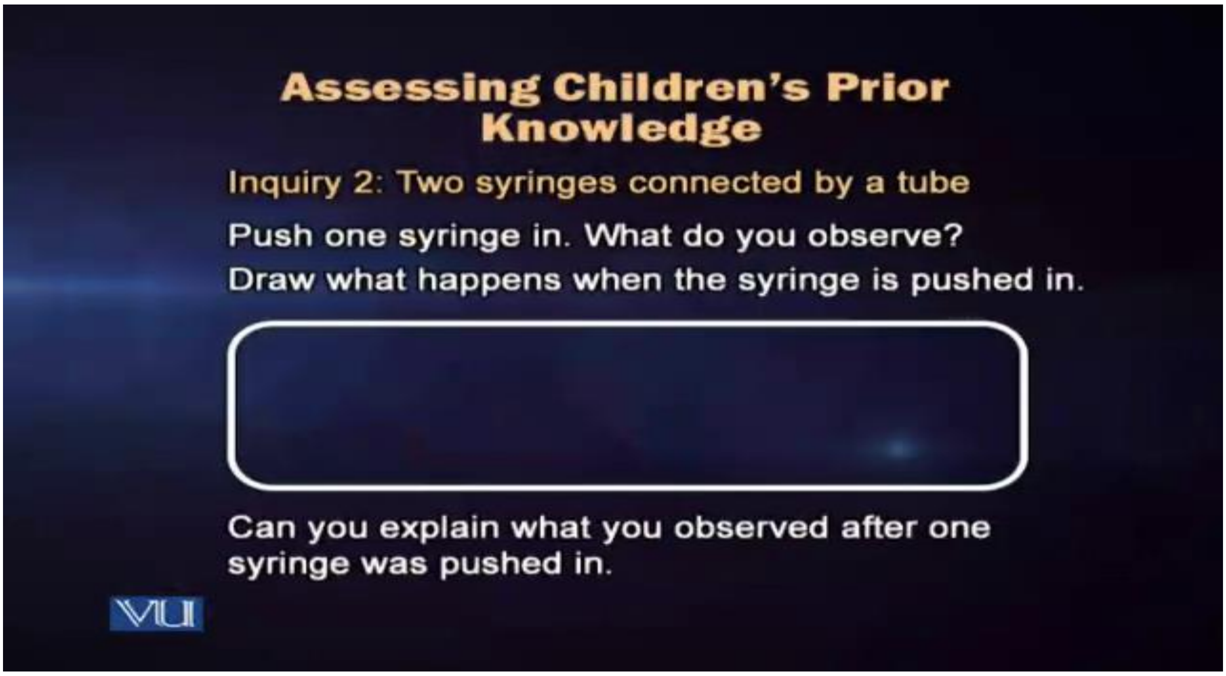




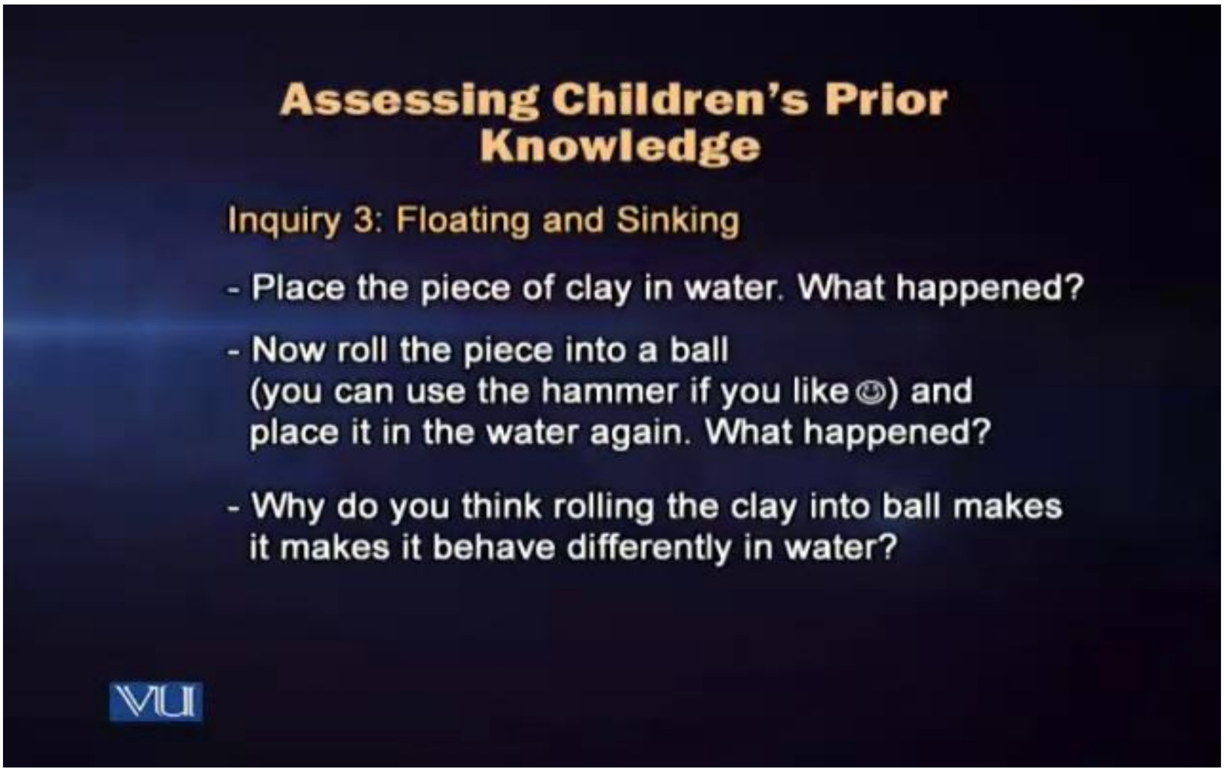


During the above first inquiry teacher wrote the word bank on the white board related to the properties of matter so that if the children had any difficulty they could understand it easily. In the first inquiry children were observing, discussing and recording.

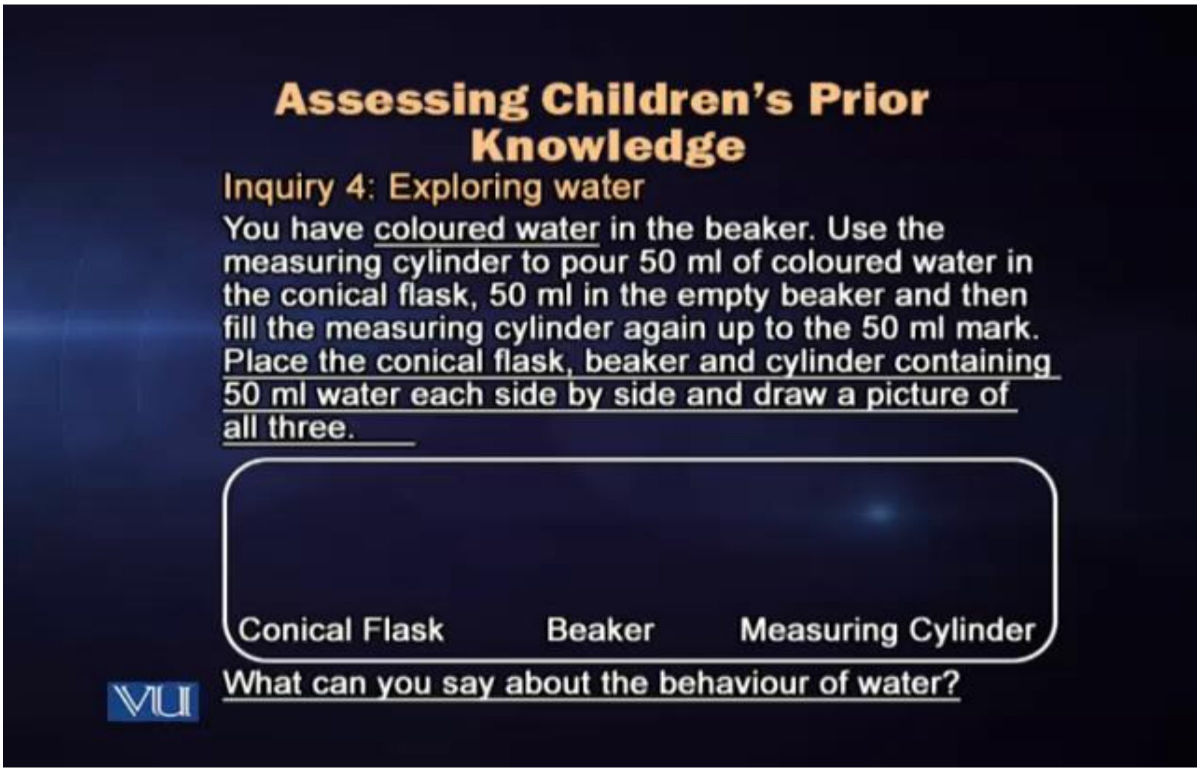




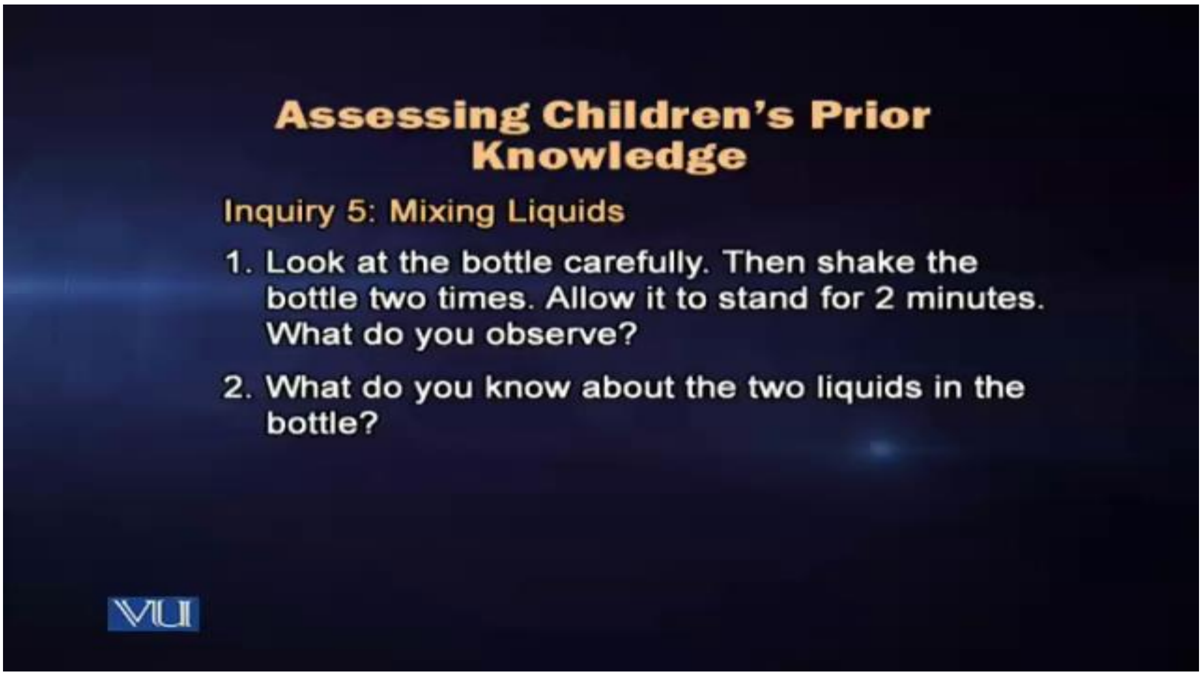
This was a short inquiry and children did not have any difficulty during this inquiry.

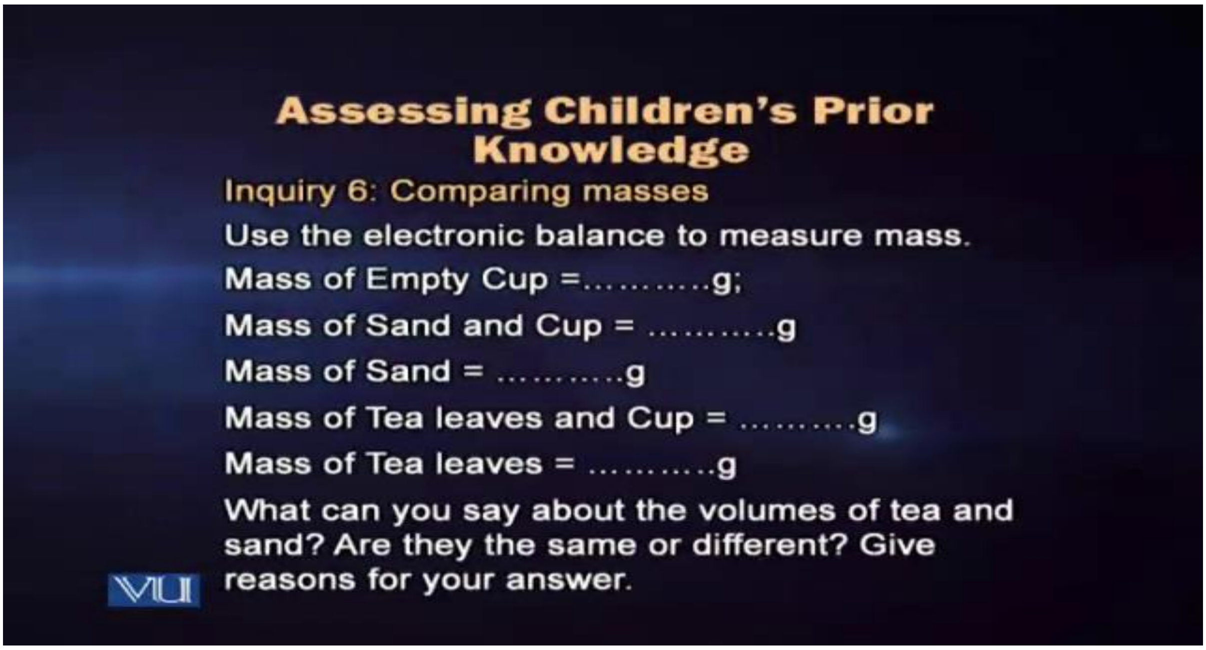


Students had some problem while putting the clay into the water. They were not putting the clay gently into the water and it was sinking. Teacher had a discussion with the children on that and they understood that they had to put the clay boat as well as the clay ball gently into the water and saw the results of floating and sinking.



In this inquiry teacher understood that the notion of the children of volume in milliliter was not clear.





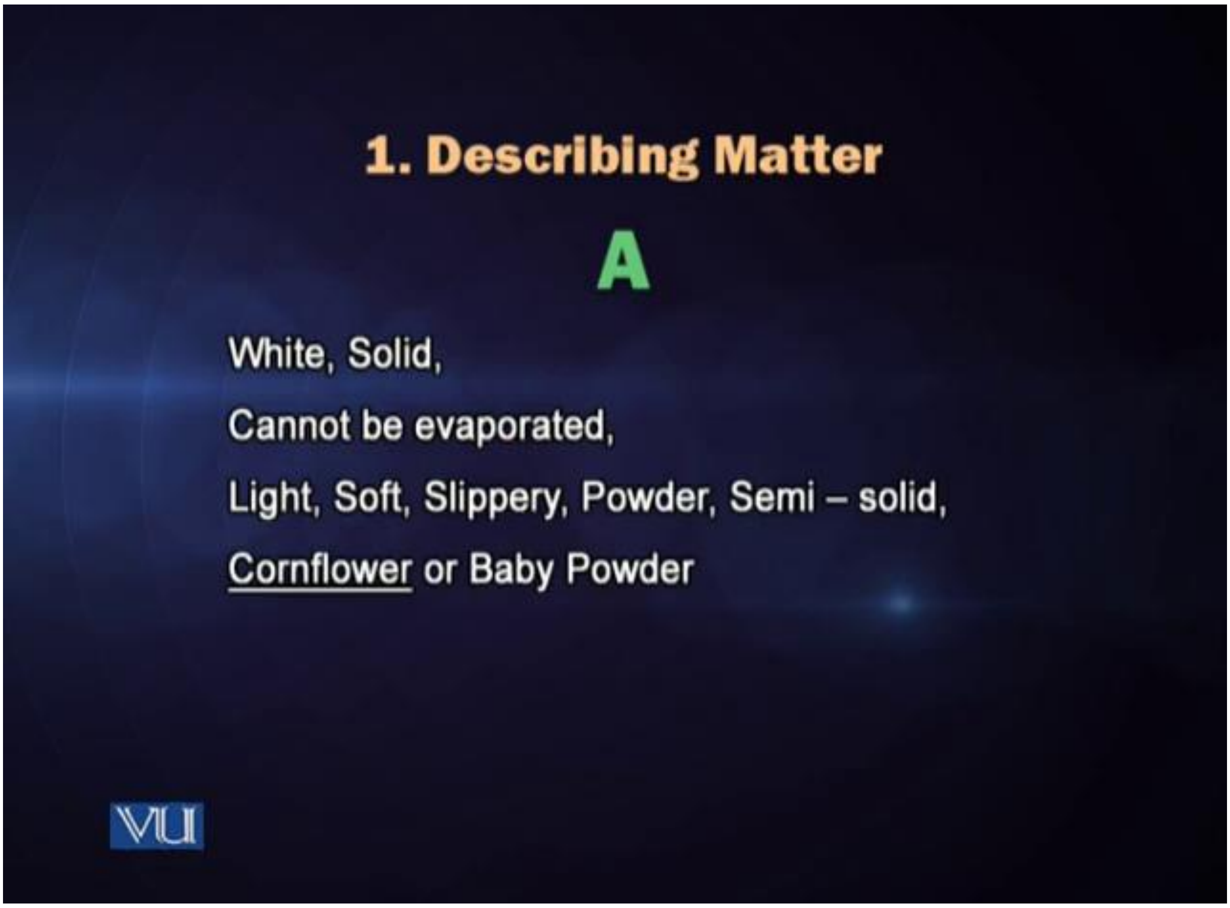
The end segment was about the students sharing all their findings about the six inquiries. Teacher must give the students courage to speak. He or she must make them realized that what they are saying is valuable. And moreover they can learn from each other through sharing.

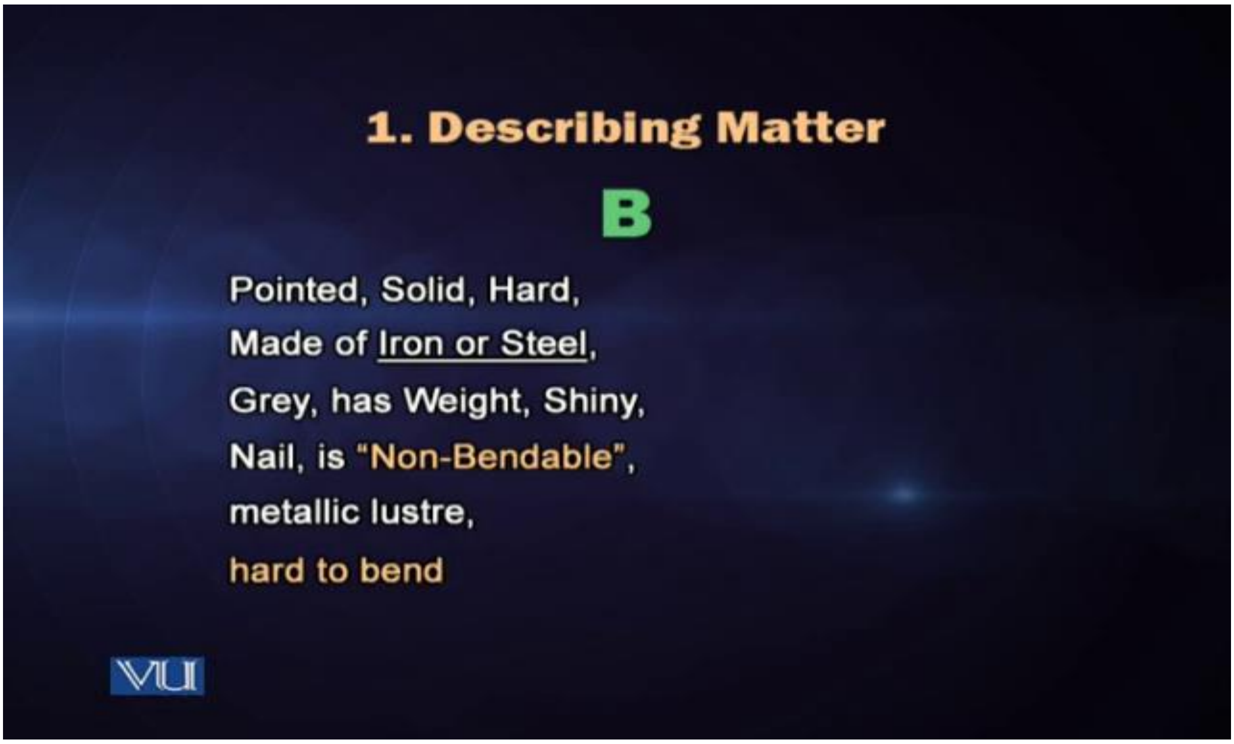
Lecture No 36

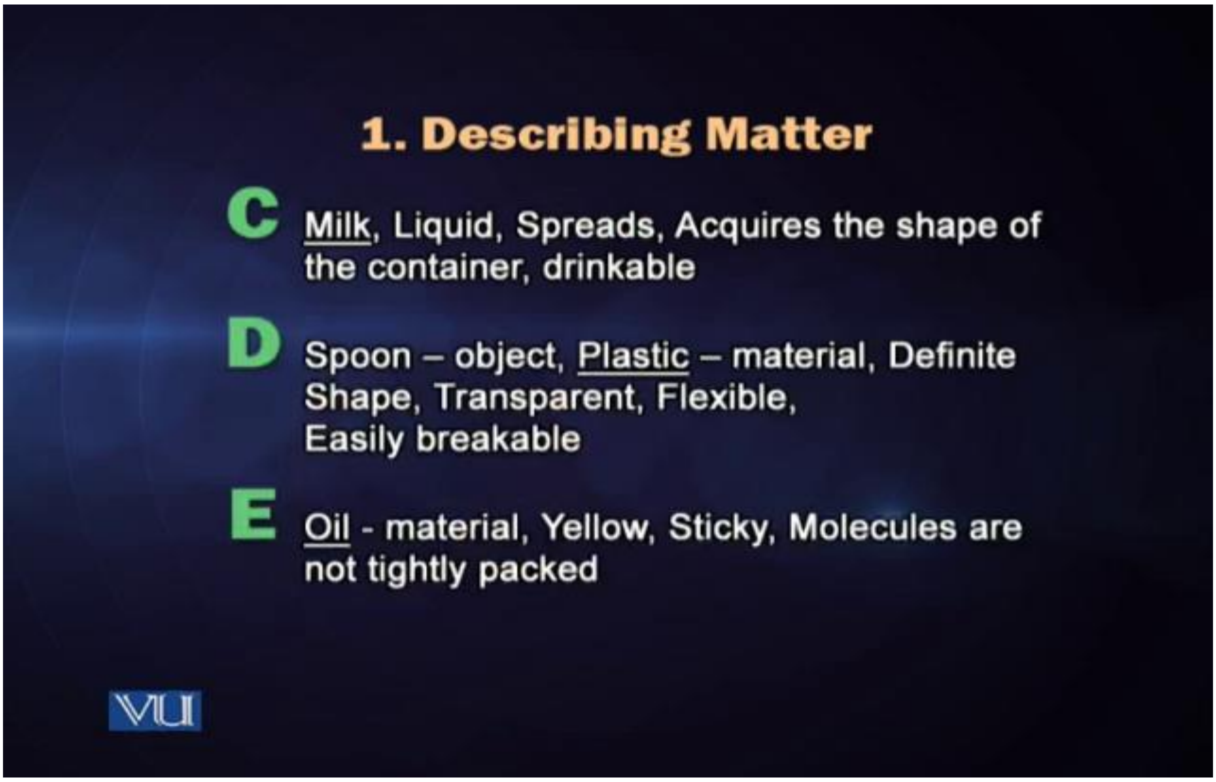
Developing Communication and Literacy Skills of the Students

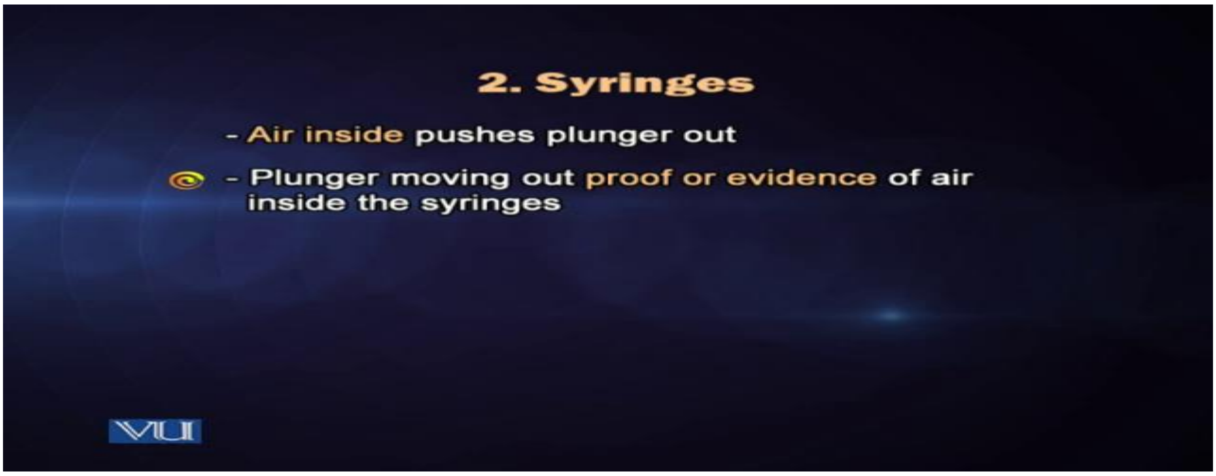
This lecture focus on the communication and literacy skills of the students.

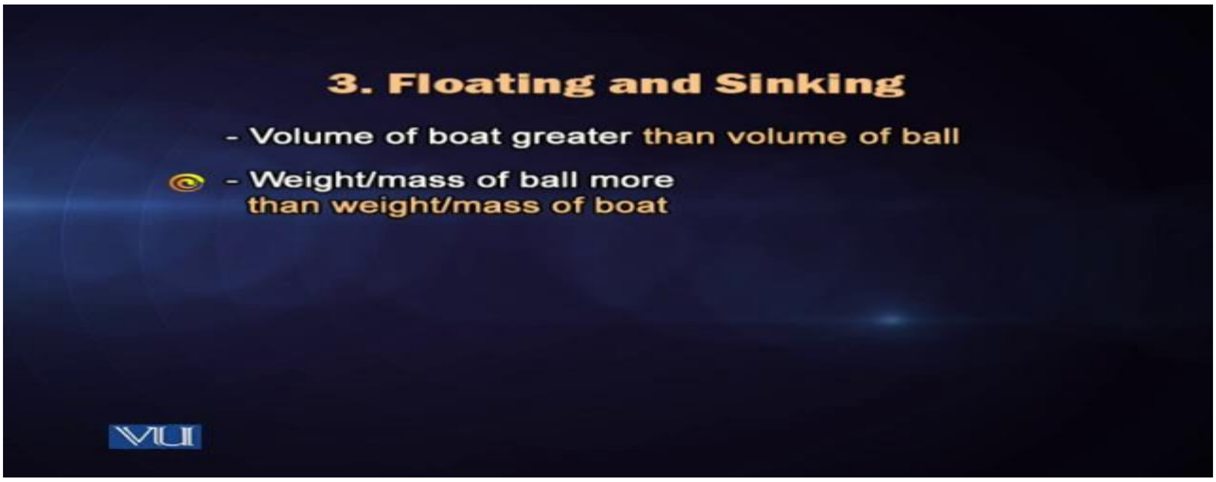
Children Ideas

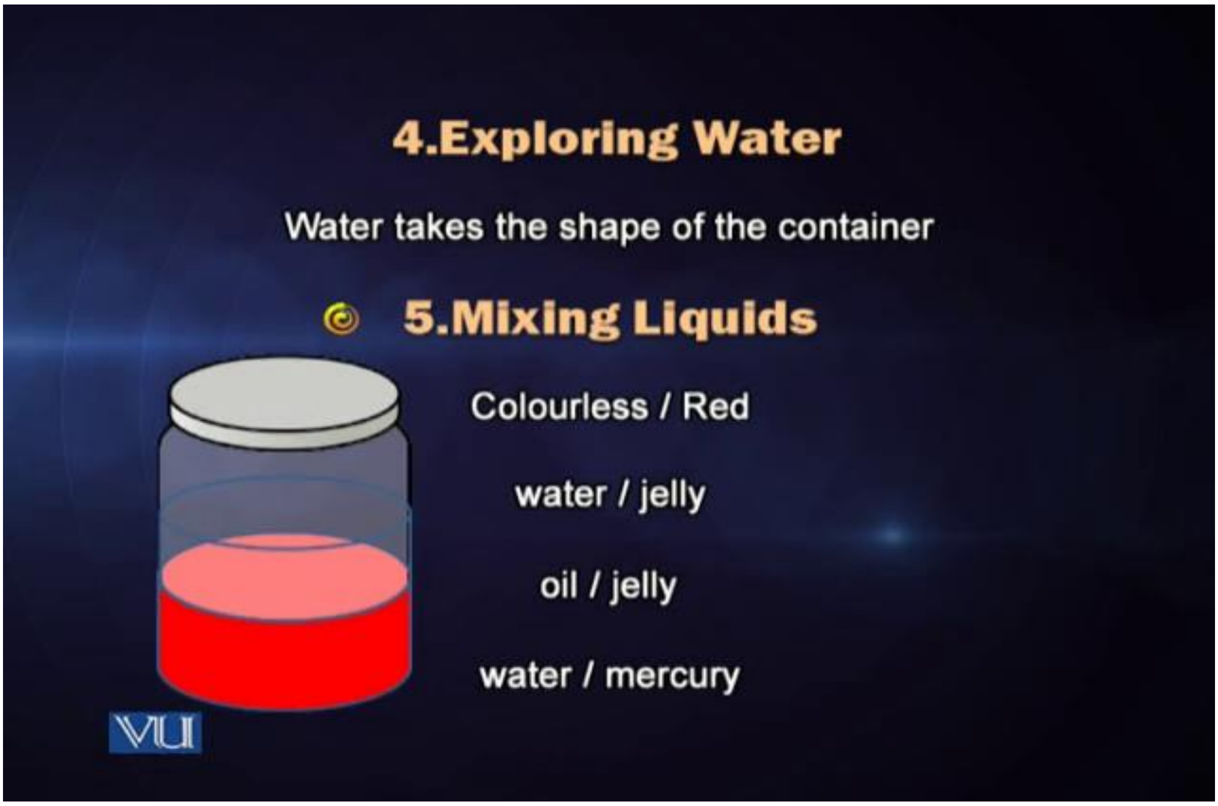


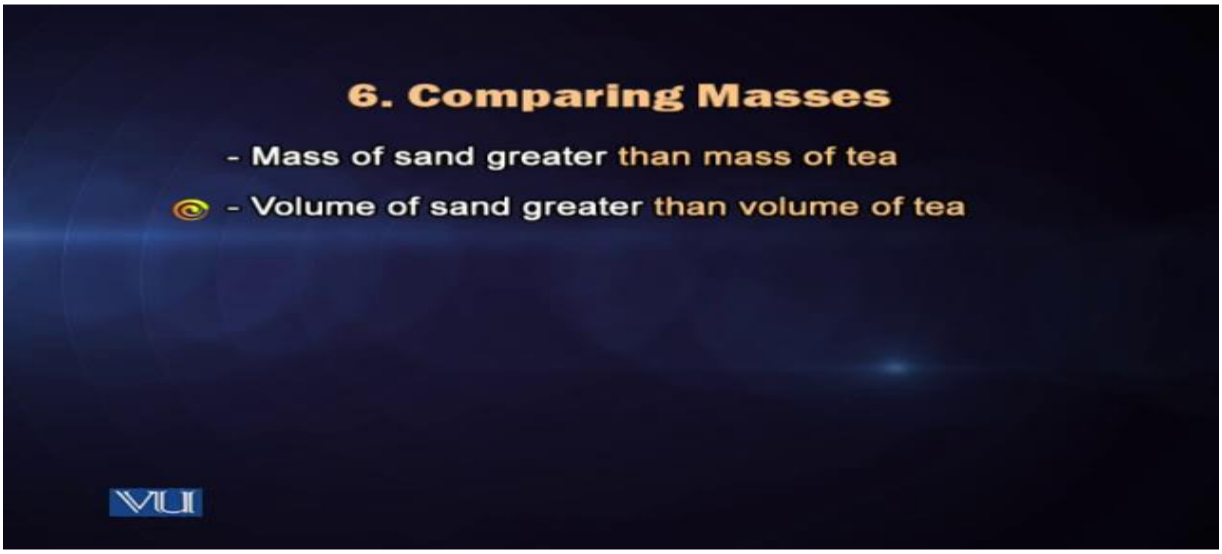

1. Describing Matter
B
Pointed, Solid, Hard,
Made of Iron or Steel,
Grey, has Weight, Shiny,
Nail, is "Non-Bendable",
metallic lustre,
hard to bend
VU


1. Describing Matter
C
Milk, Liquid, Spreads, Acquires the shape of the container, drinkable
D
Spoon – object, Plastic – material, Definite Shape, Transparent, Flexible, Easily breakable
E
Oil - material, Yellow, Sticky, Molecules are not tightly packed
VU


2. Syringes
- Air inside pushes plunger out
- Plunger moving out proof or evidence of air inside the syringes


3. Floating and Sinking
- Volume of boat greater than volume of ball
- Weight/mass of ball more than weight/mass of boat

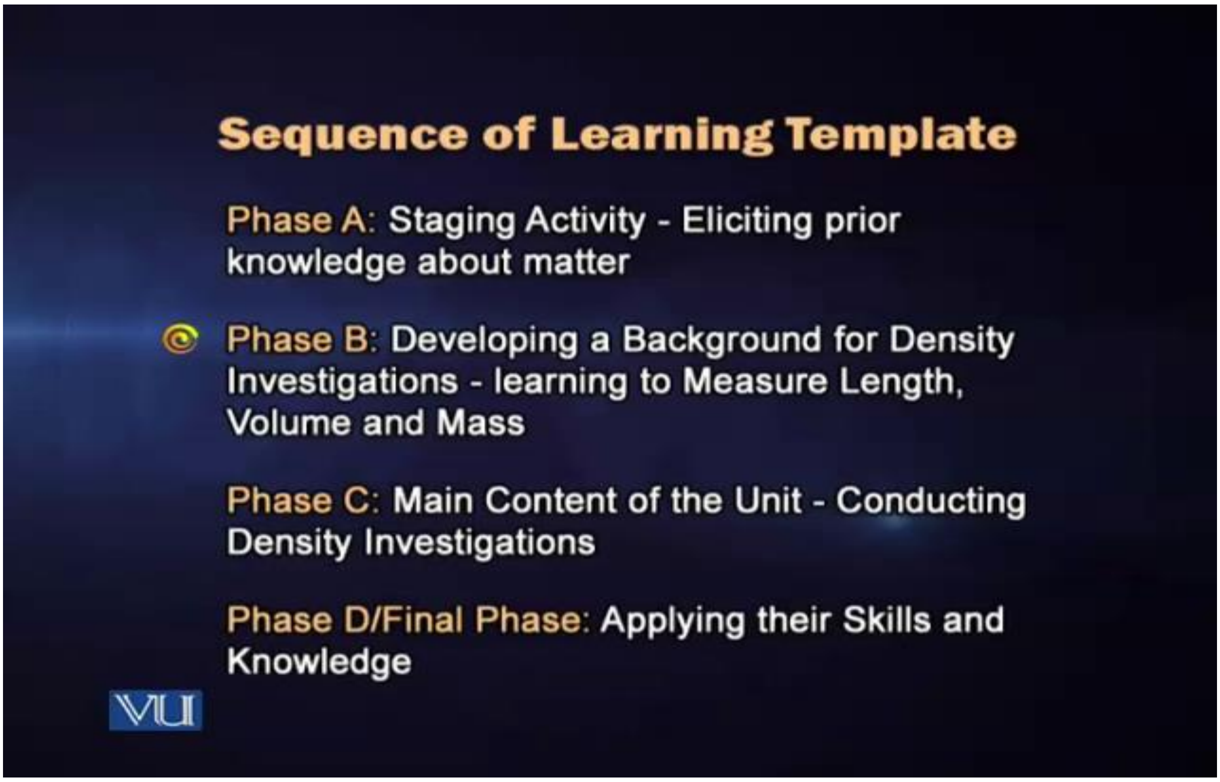

4.Exploring Water
Water takes the shape of the container
5.Mixing Liquids
Colourless / Red
water / jelly
oil / jelly
water / mercury



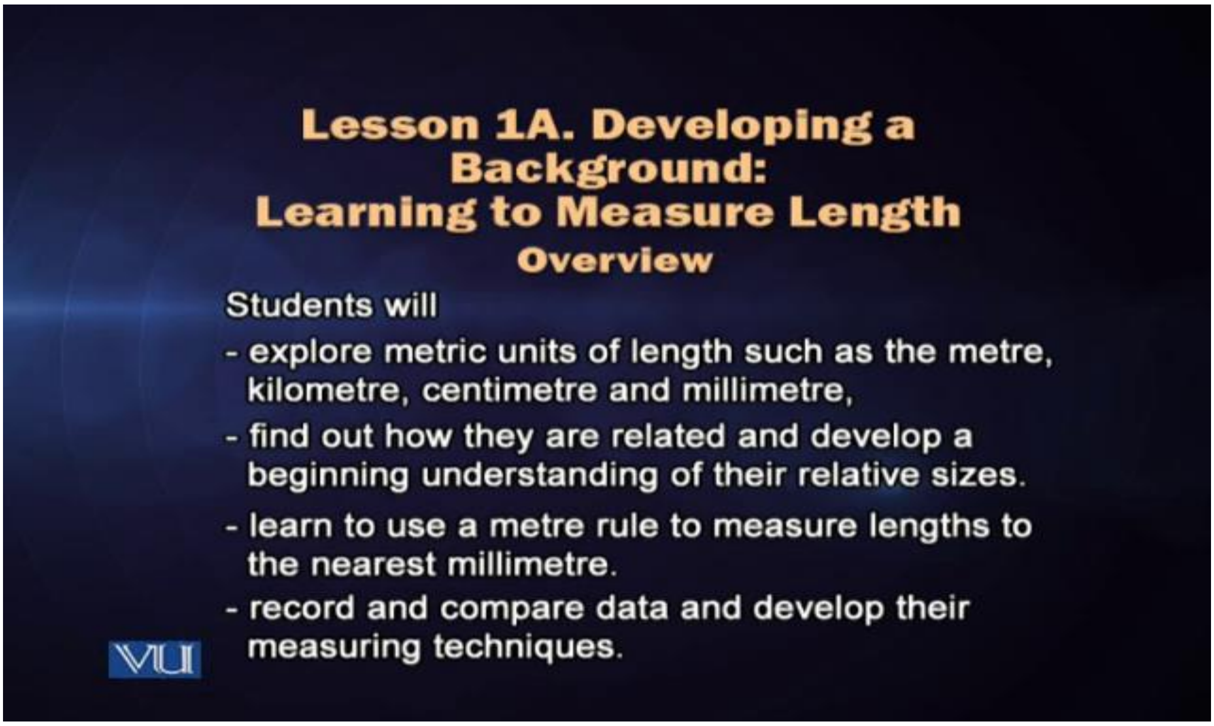
The first student teacher discussion was focusing the communication skillsthrough drawings. This was the new idea for the children therefore teacher modeled how drawings convey the messages. In the inquiry of floating and sinking teacher examined that the ideas of students about mass volume and weight were confusing. All the class had the assumption that because the weight of clay ball was more than the clay boat so it sank. But teacher challenged their assumption. She put an aluminum foil into the water and it sank although it was also light weighted.Constructive criticism is the integral part of the science experiments and teacher must encourage them. Teacher also told the students that the most important thing in the class discussion is that students must not interrupt each other during the discussions. Everyone will have his or her own time to talk. It is important to disagree but let the person talk and give the reason for his or her perspective. Students thought that mass and volume were the same things. Teacher challenged their assumption she dis the experiment in front of the students that although sand mass was more than the tea leaves yet the volume of the tea leaves was more than the sand.

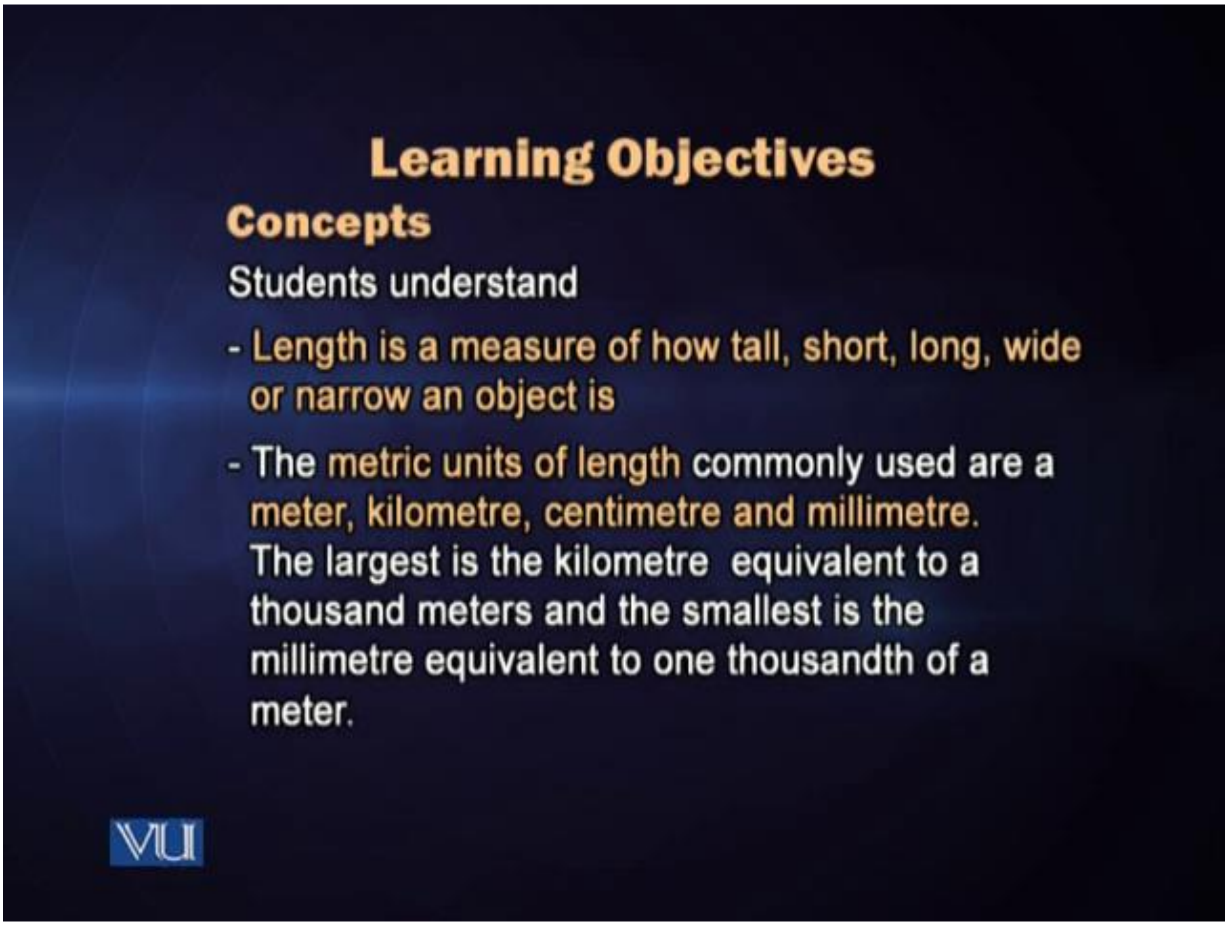
Lecture No 37

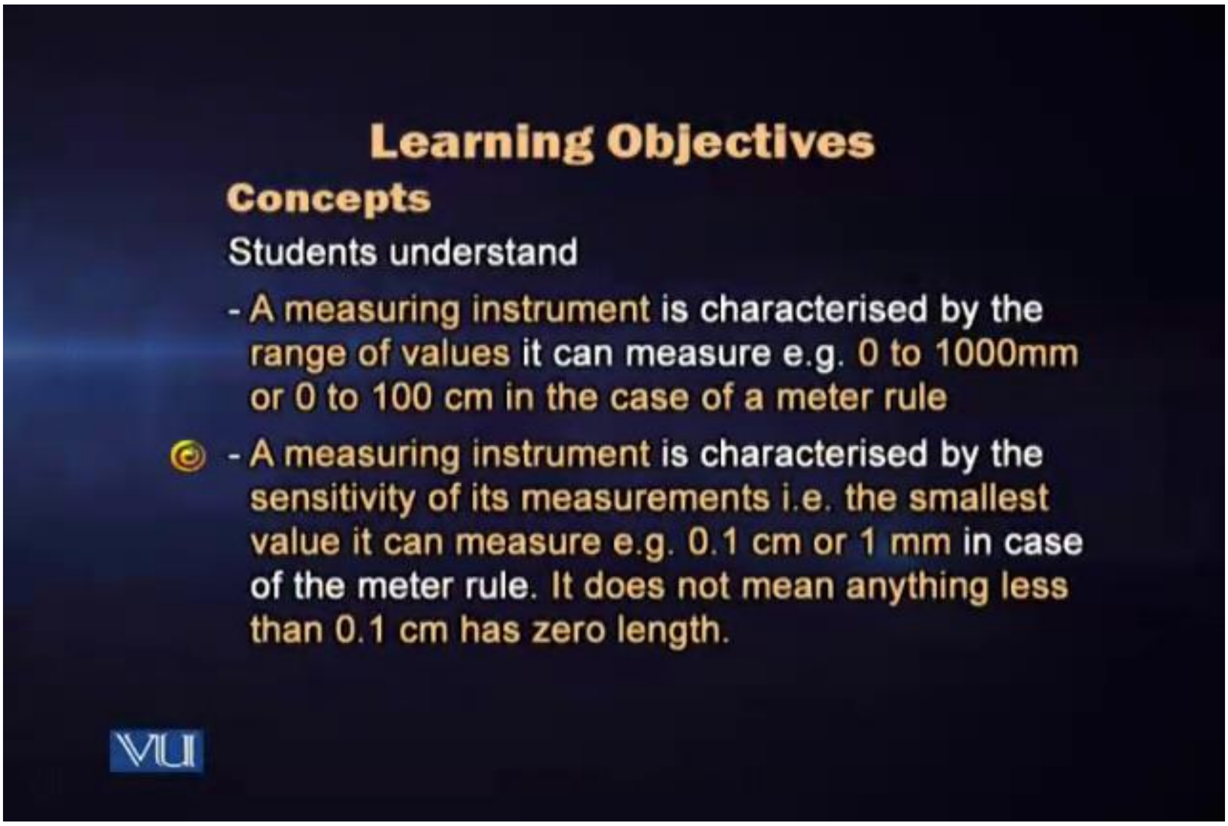
Developing a backgroung learning of "Measuring the Length"

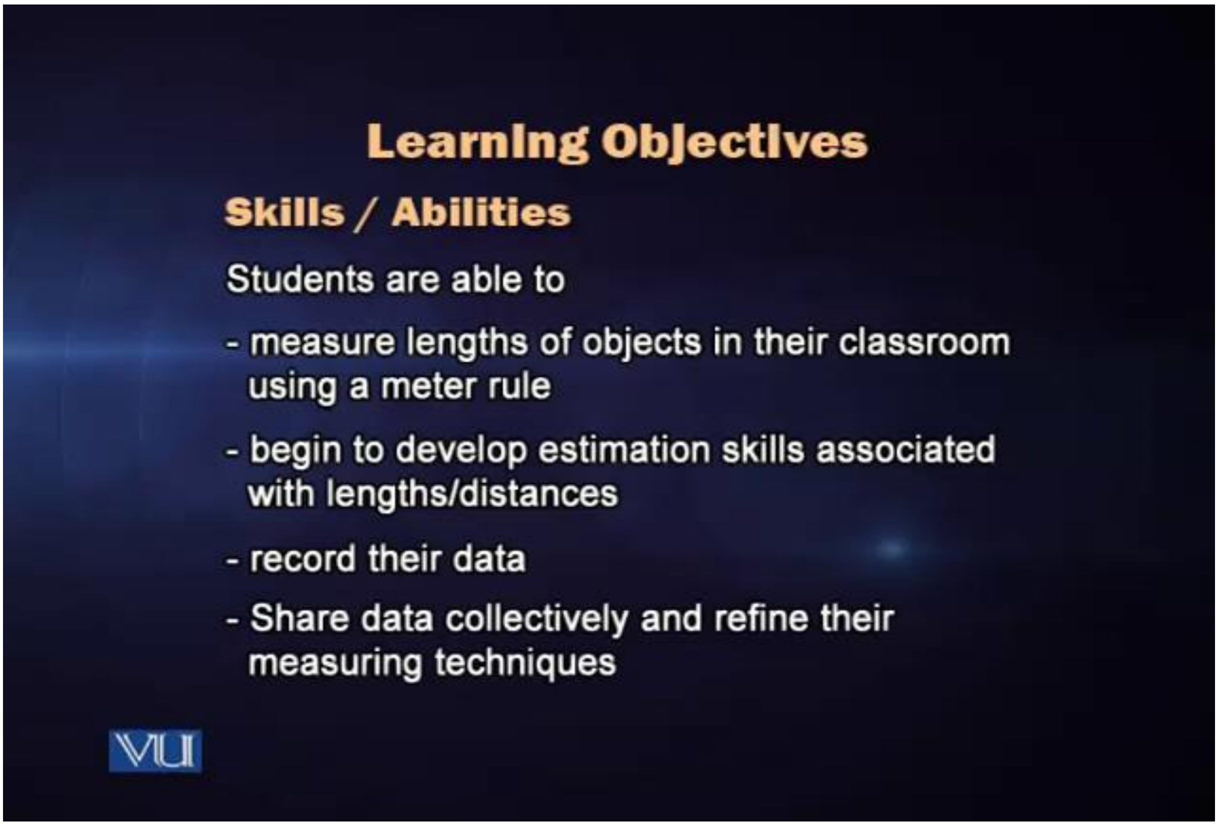


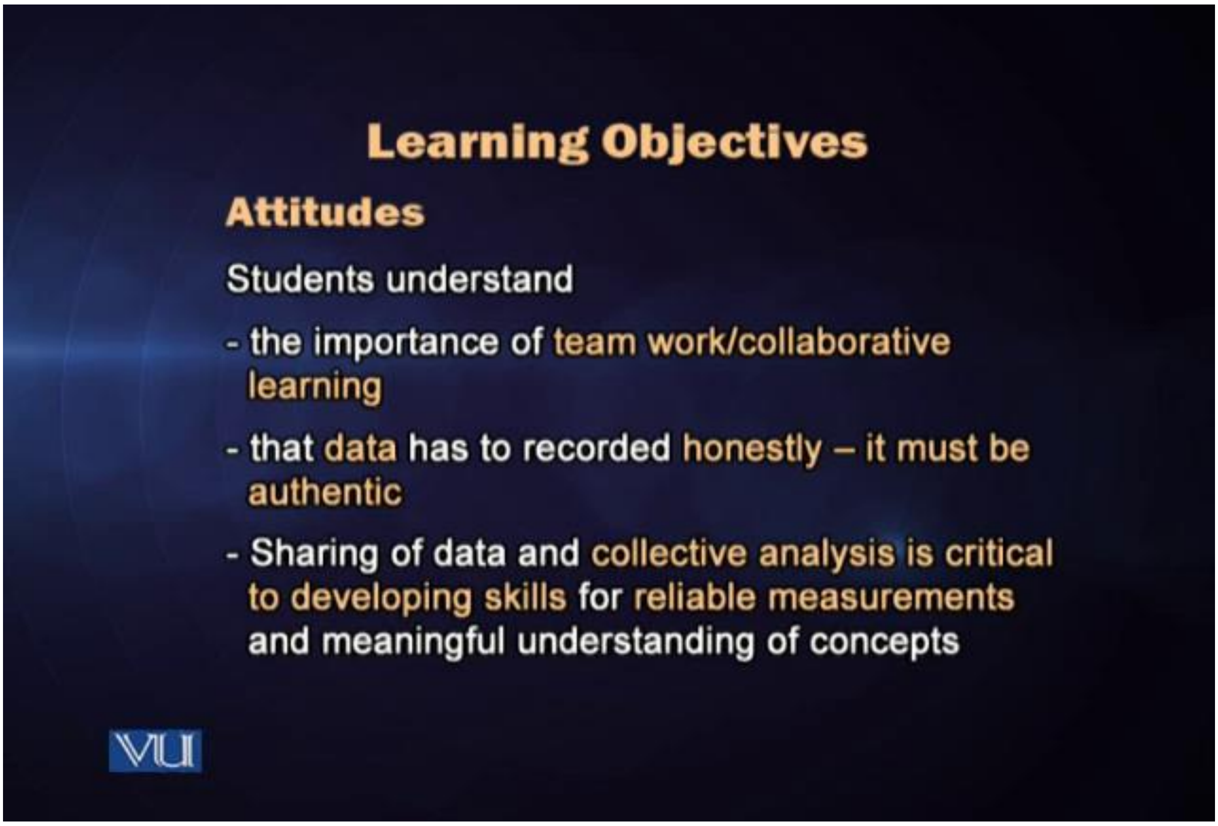
This lecture will focus on the Phase "B" of the learning sequence template.

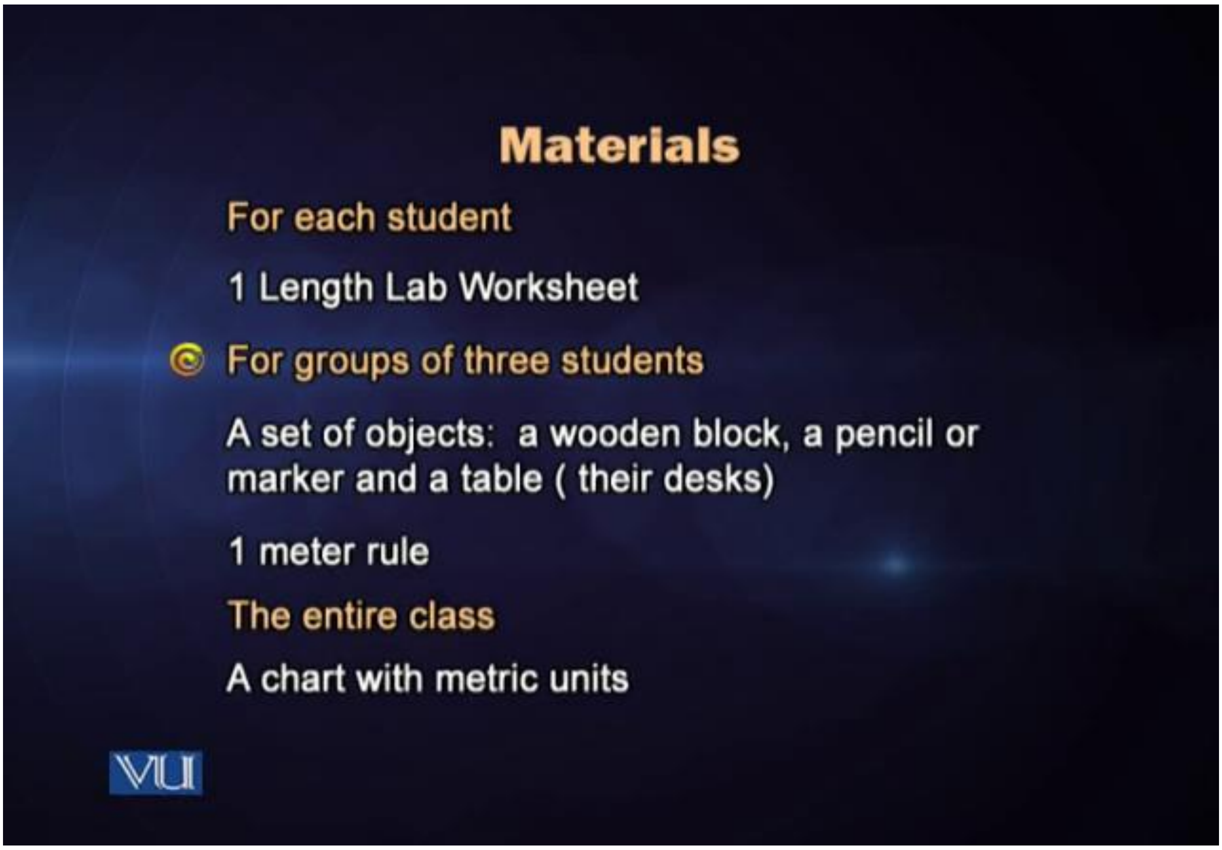


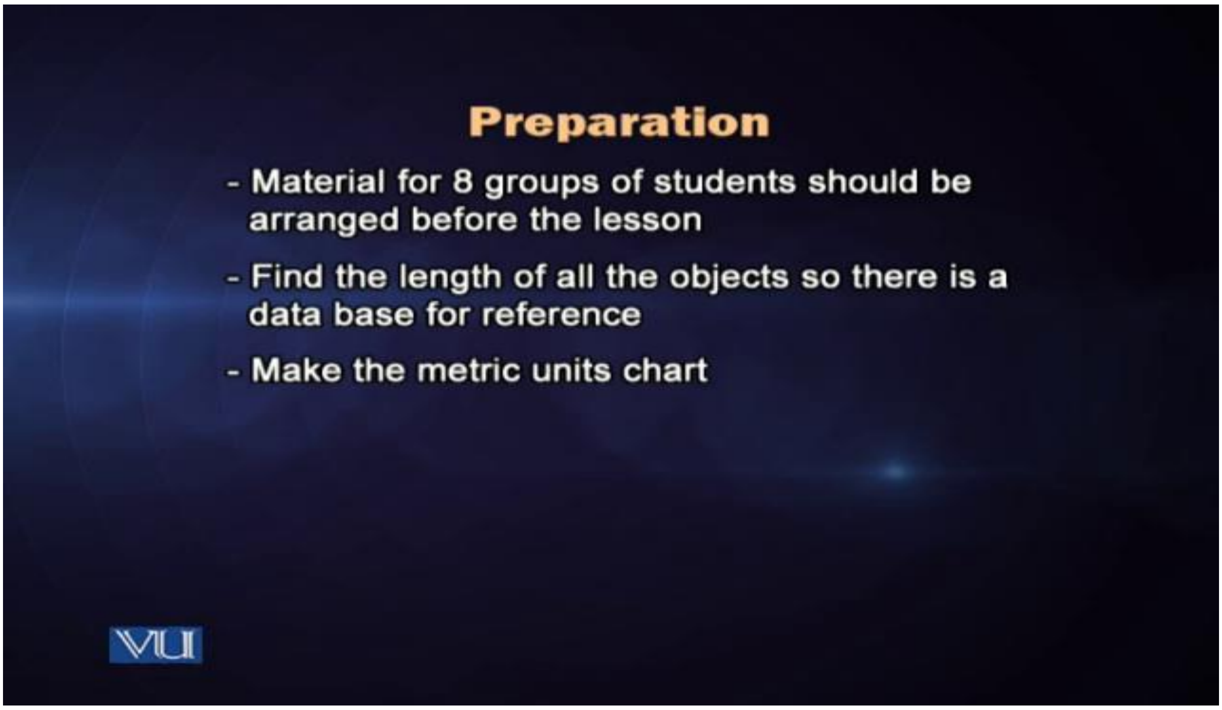

Learning Objectives
Concepts
Students understand
- Length is a measure of how tall, short, long, wide or narrow an object is
- The metric units of length commonly used are a meter, kilometre, centimetre and millimetre. The largest is the kilometre equivalent to a thousand meters and the smallest is the millimetre equivalent to one thousandth of a meter.
VU


Learning Objectives
Concepts
Students understand
- A measuring instrument is characterised by the range of values it can measure e.g. 0 to 1000mm or 0 to 100 cm in the case of a meter rule
- A measuring instrument is characterised by the sensitivity of its measurements i.e. the smallest value it can measure e.g. 0.1 cm or 1 mm in case of the meter rule. It does not mean anything less than 0.1 cm has zero length.
VU

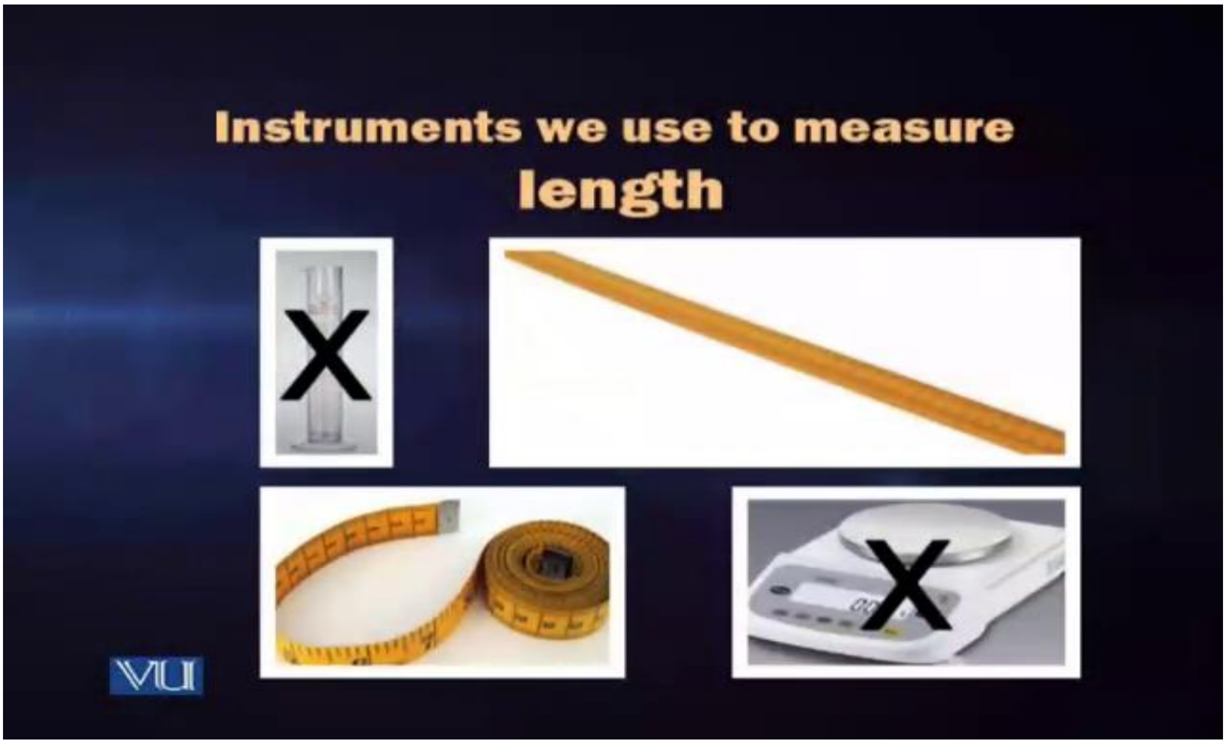

Learning Objectives
Skills / Abilities
Students are able to
- measure lengths of objects in their classroom using a meter rule
- begin to develop estimation skills associated with lengths/distances
- record their data
- Share data collectively and refine their measuring techniques
VU

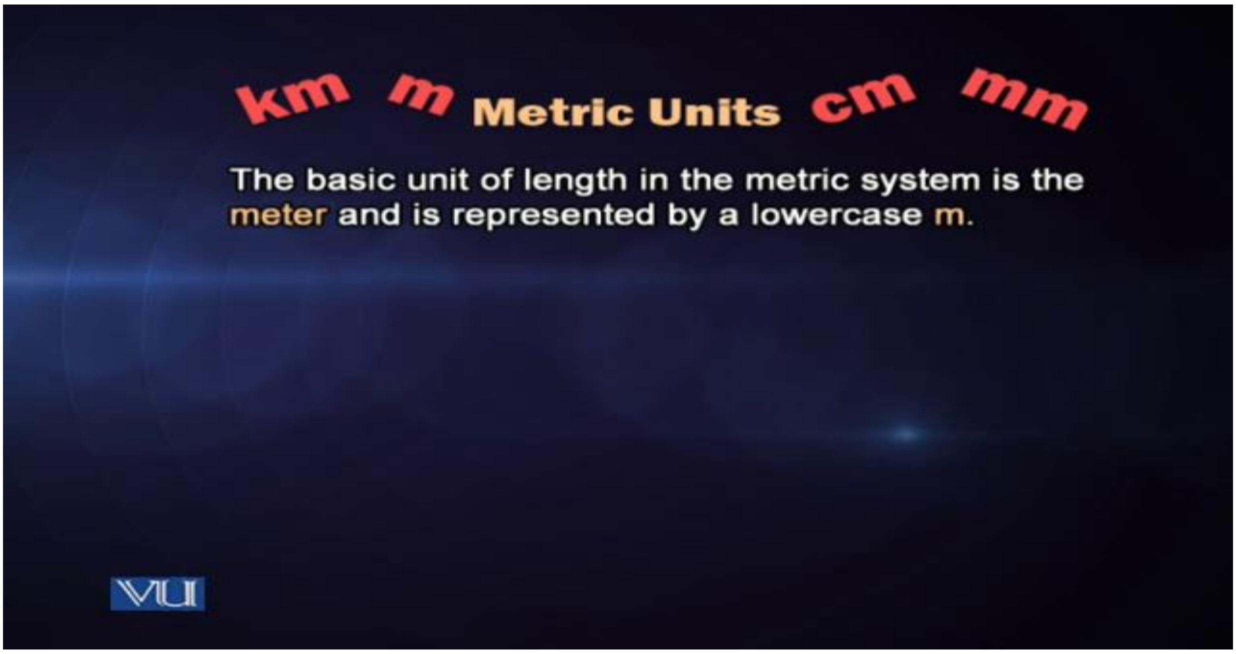

Learning Objectives
Attitudes
Students understand
- the importance of team work/collaborative learning
- that data has to recorded honestly – it must be authentic
- Sharing of data and collective analysis is critical to developing skills for reliable measurements and meaningful understanding of concepts
VU

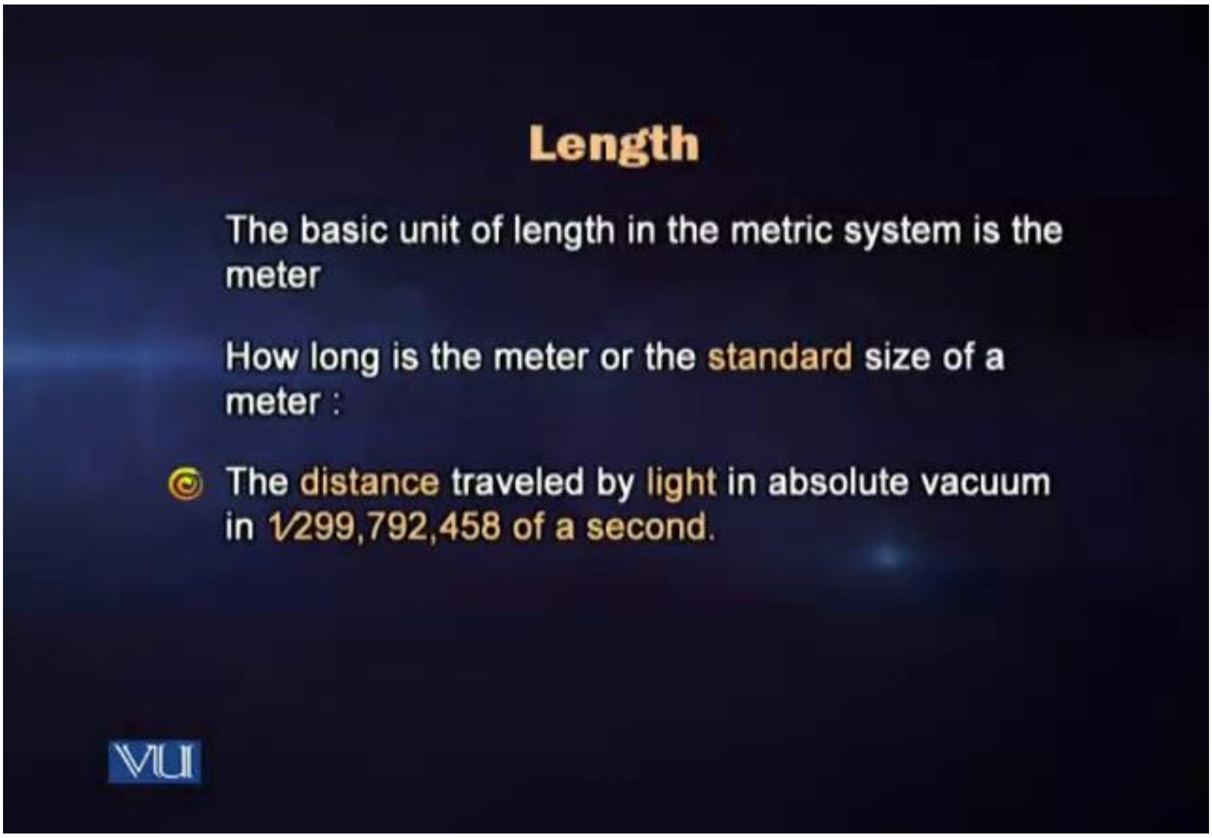


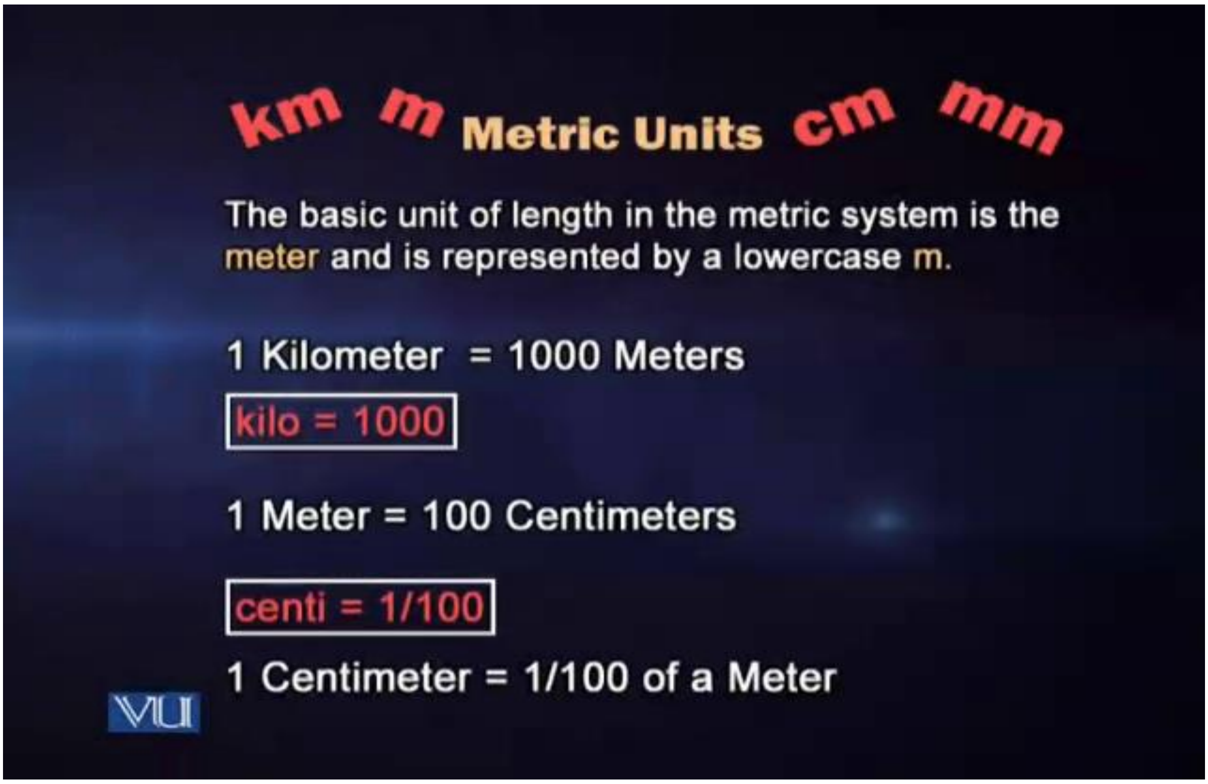


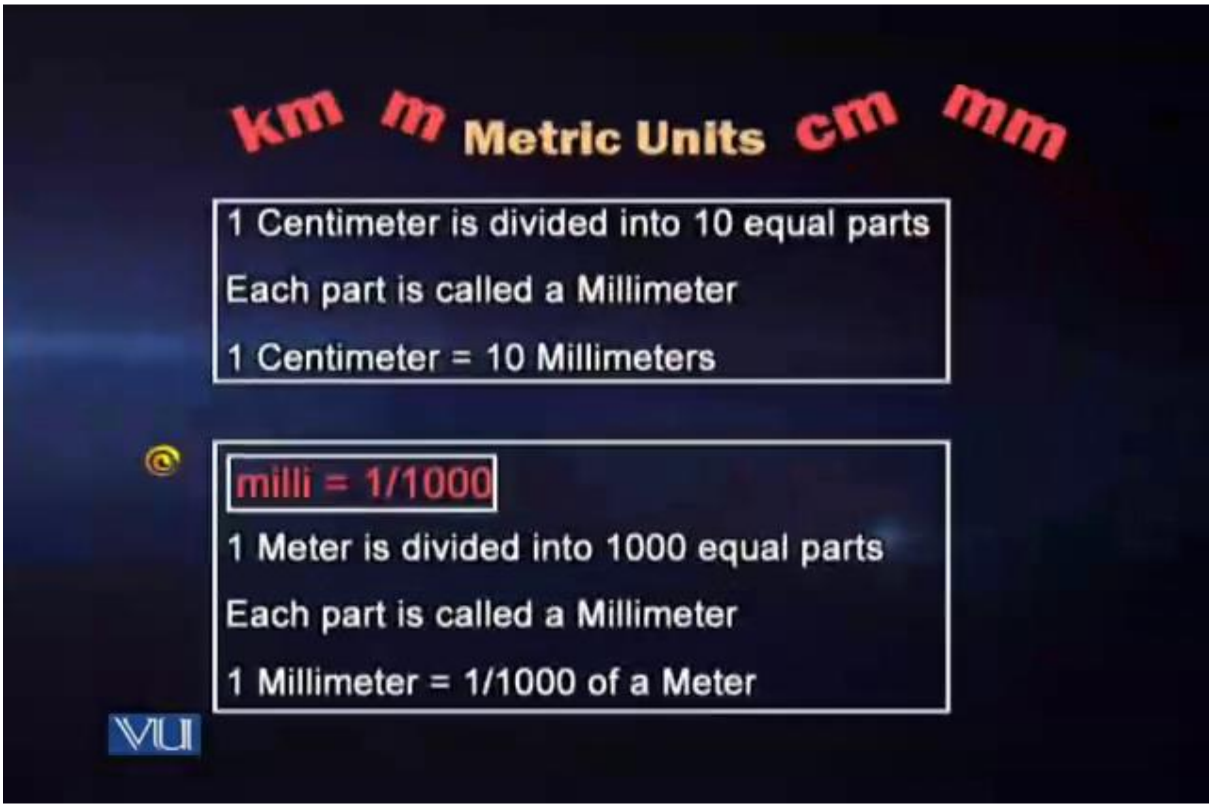
In the class activity teacher introduced the length notion. For the measurement of length we use the metric rule.

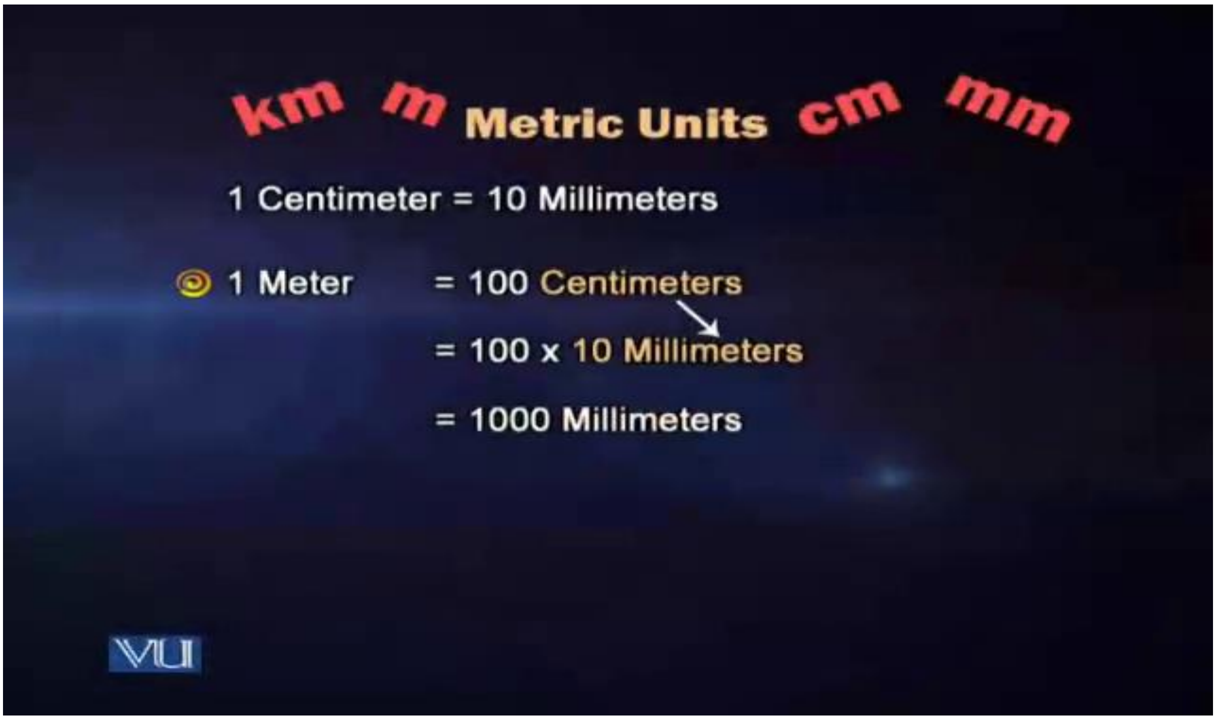

Instruments we use to measure
length
X
X

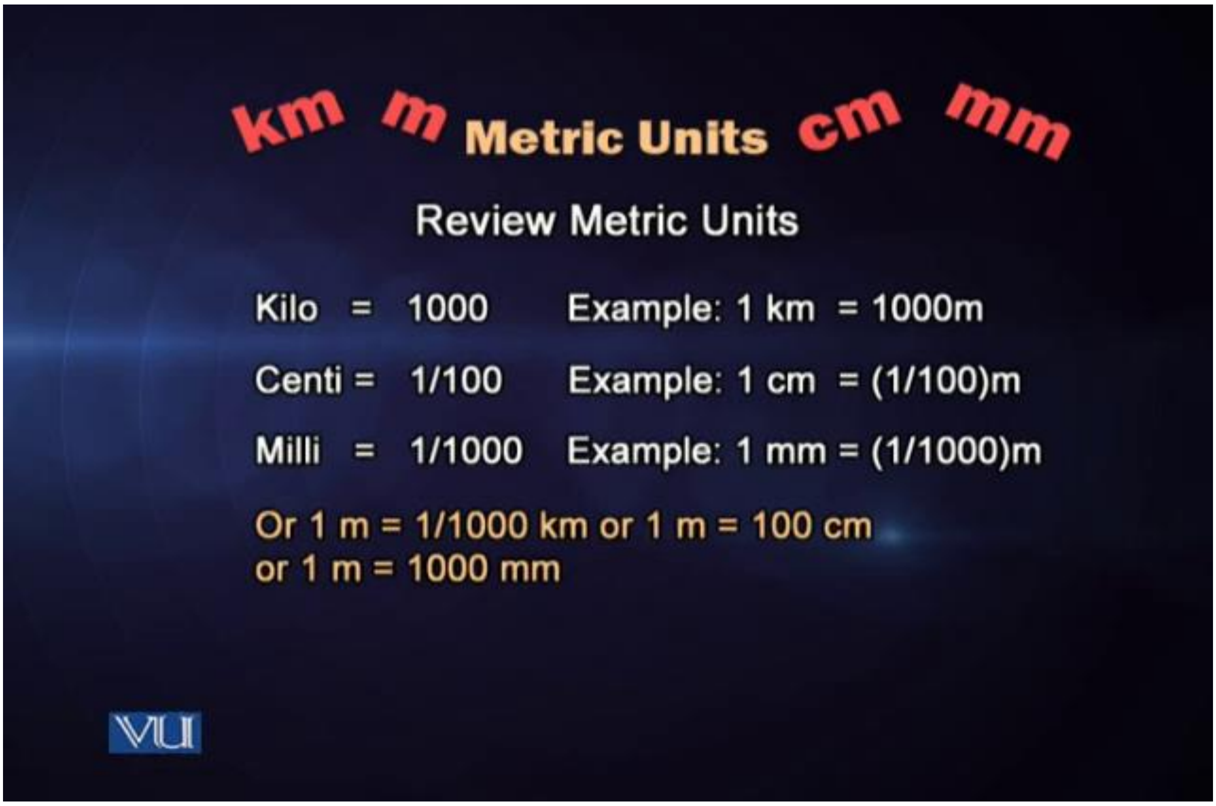

km m Metric Units cm mm
The basic unit of length in the metric system is the meter and is represented by a lowercase m.

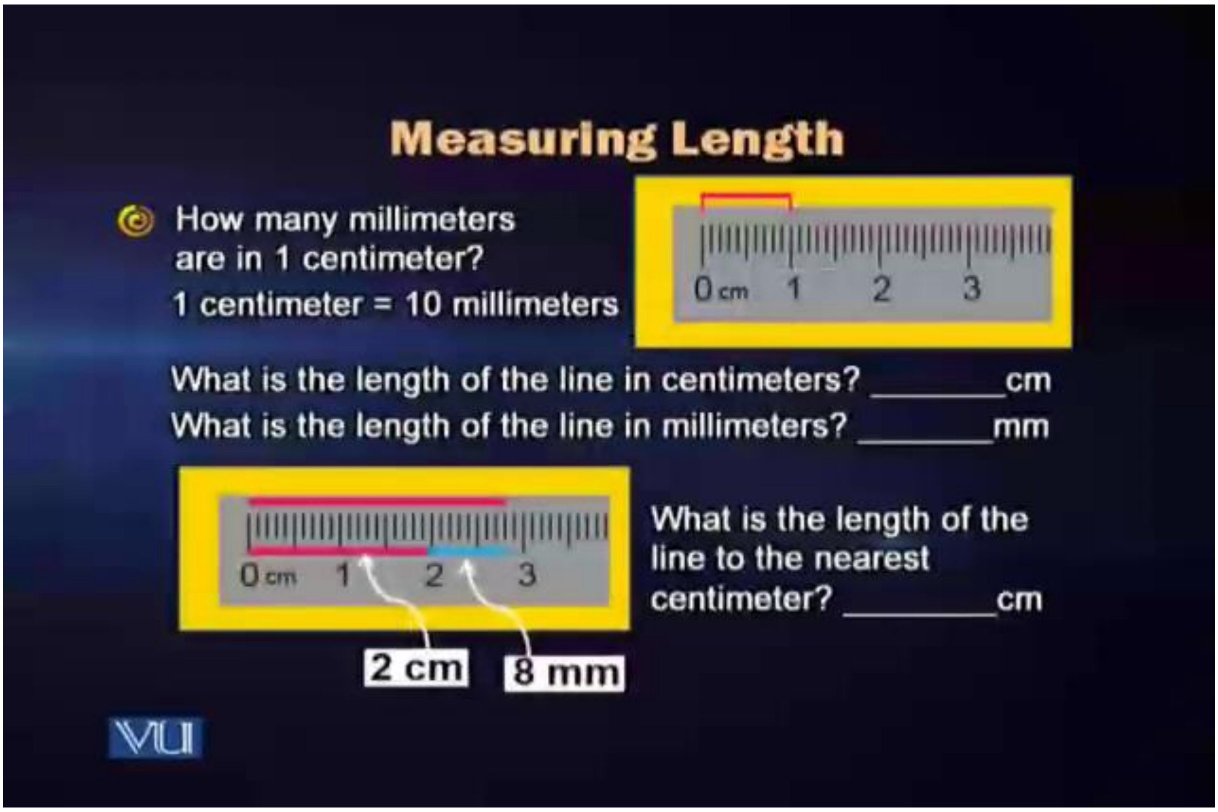

Length
The basic unit of length in the metric system is the meter
How long is the meter or the standard size of a meter :
The distance traveled by light in absolute vacuum in 1⁄299,792,458 of a second.
VU

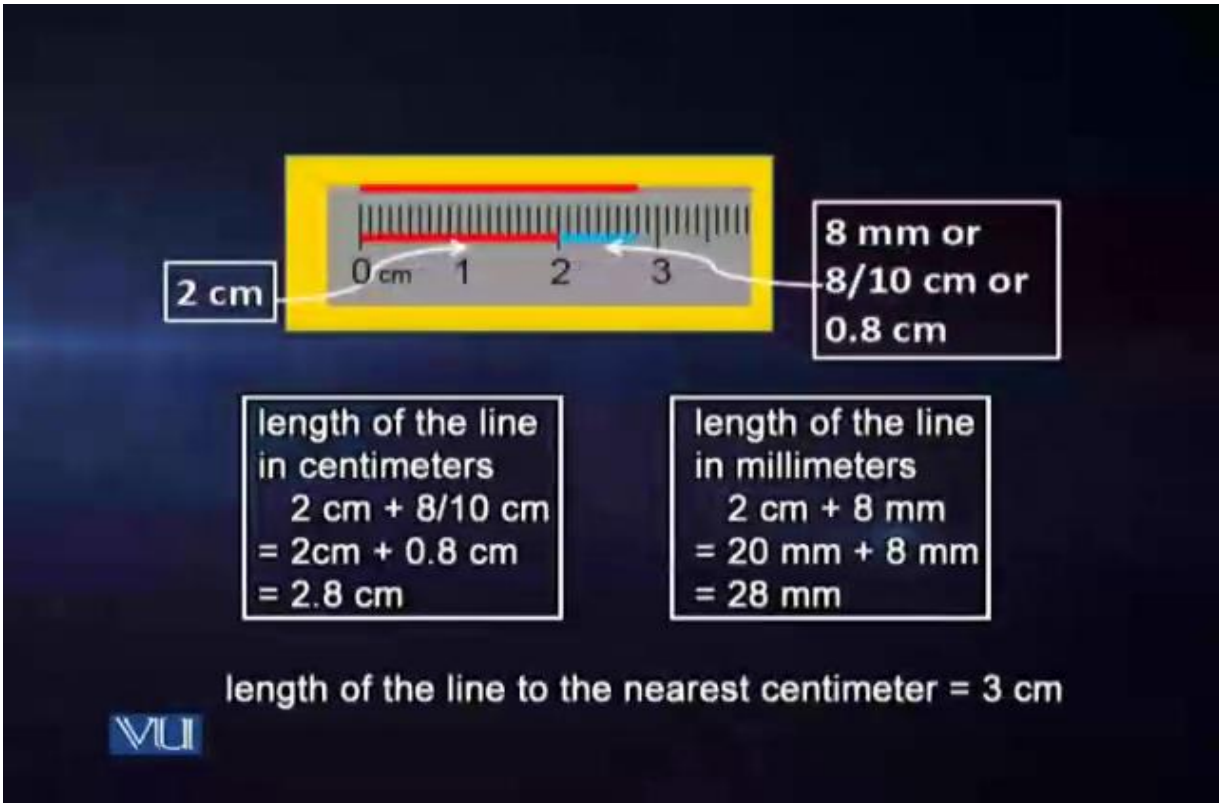

km m Metric Units cm mm
The basic unit of length in the metric system is the meter and is represented by a lowercase m.
1 Kilometer = 1000 Meters
kilo = 1000
1 Meter = 100 Centimeters
centi = 1/100
1 Centimeter = 1/100 of a Meter
VU

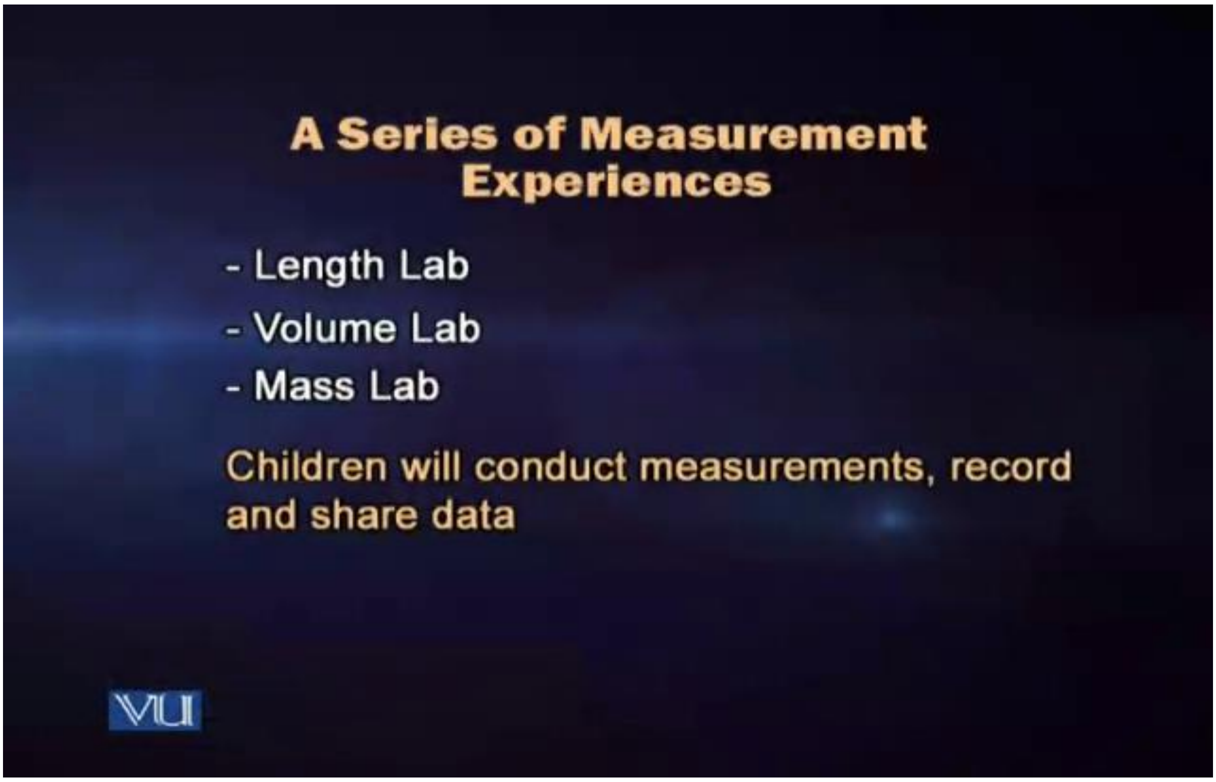

km m Metric Units cm mm
1 Centimeter is divided into 10 equal parts
Each part is called a Millimeter
1 Centimeter = 10 Millimeters
milli = 1/1000
1 Meter is divided into 1000 equal parts
Each part is called a Millimeter
1 Millimeter = 1/1000 of a Meter

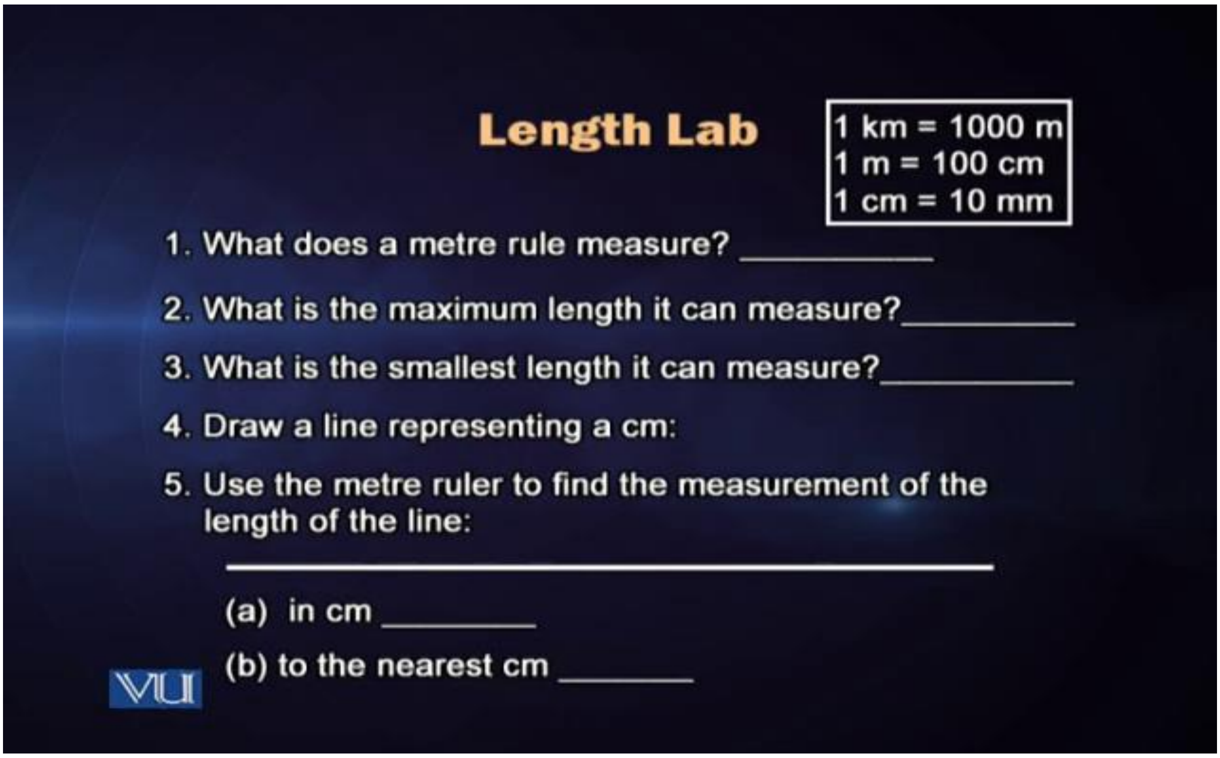

km m Metric Units cm mm
1 Centimeter = 10 Millimeters
1 Meter = 100 Centimeters
= 100 x 10 Millimeters
= 1000 Millimeters


km m Metric Units cm mm
Review Metric Units
Kilo = 1000 Example: 1 km = 1000m
Centi = 1/100 Example: 1 cm = (1/100)m
Milli = 1/1000 Example: 1 mm = (1/1000)m
Or 1 m = 1/1000 km or 1 m = 100 cm
or 1 m = 1000 mm
VU

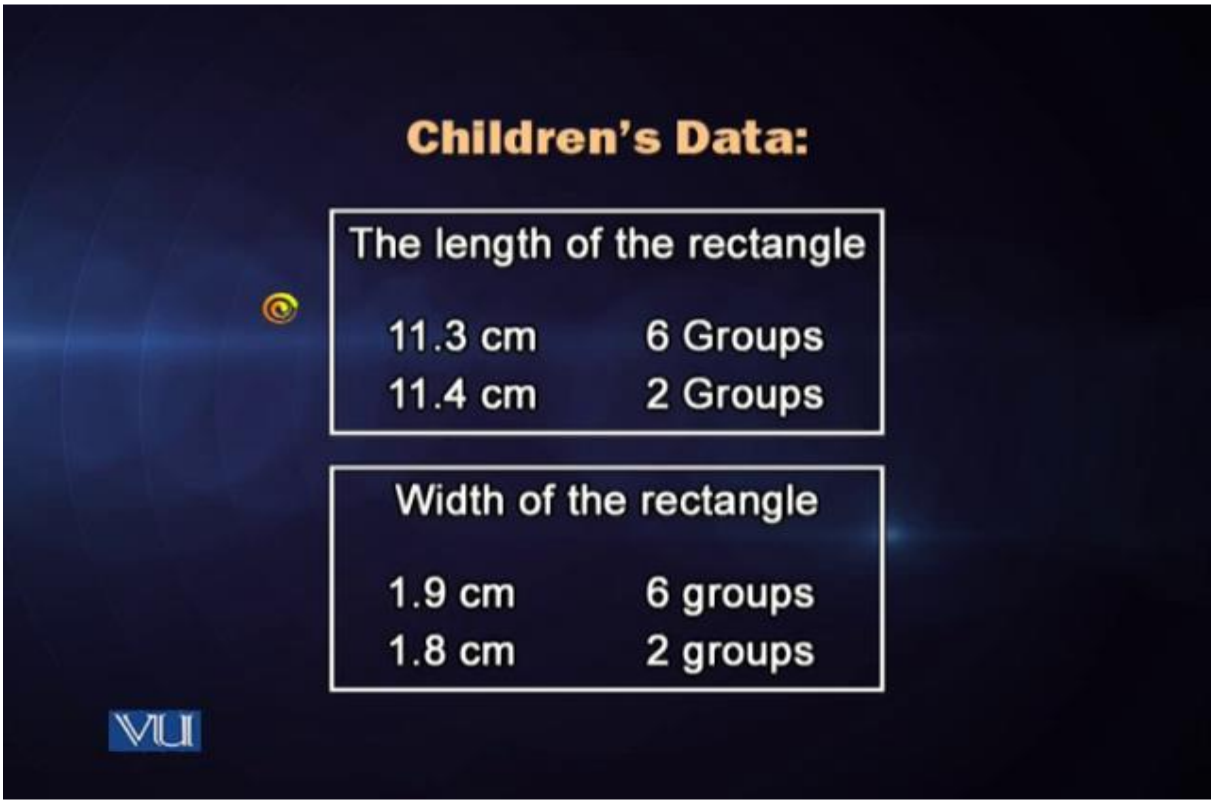

Measuring Length
How many millimeters are in 1 centimeter?
1 centimeter = 10 millimeters
0 cm 1 2 3
What is the length of the line in centimeters? ________cm
What is the length of the line in millimeters? ________mm
0 cm 1 2 3
2 cm
8 mm
What is the length of the line to the nearest centimeter? _________cm
VU


2 cm
0 cm 1 2 3
8 mm or
8/10 cm or
0.8 cm
length of the line
in centimeters
2 cm + 8/10 cm
= 2cm + 0.8 cm
= 2.8 cm
length of the line
in millimeters
2 cm + 8 mm
= 20 mm + 8 mm
= 28 mm
length of the line to the nearest centimeter = 3 cm

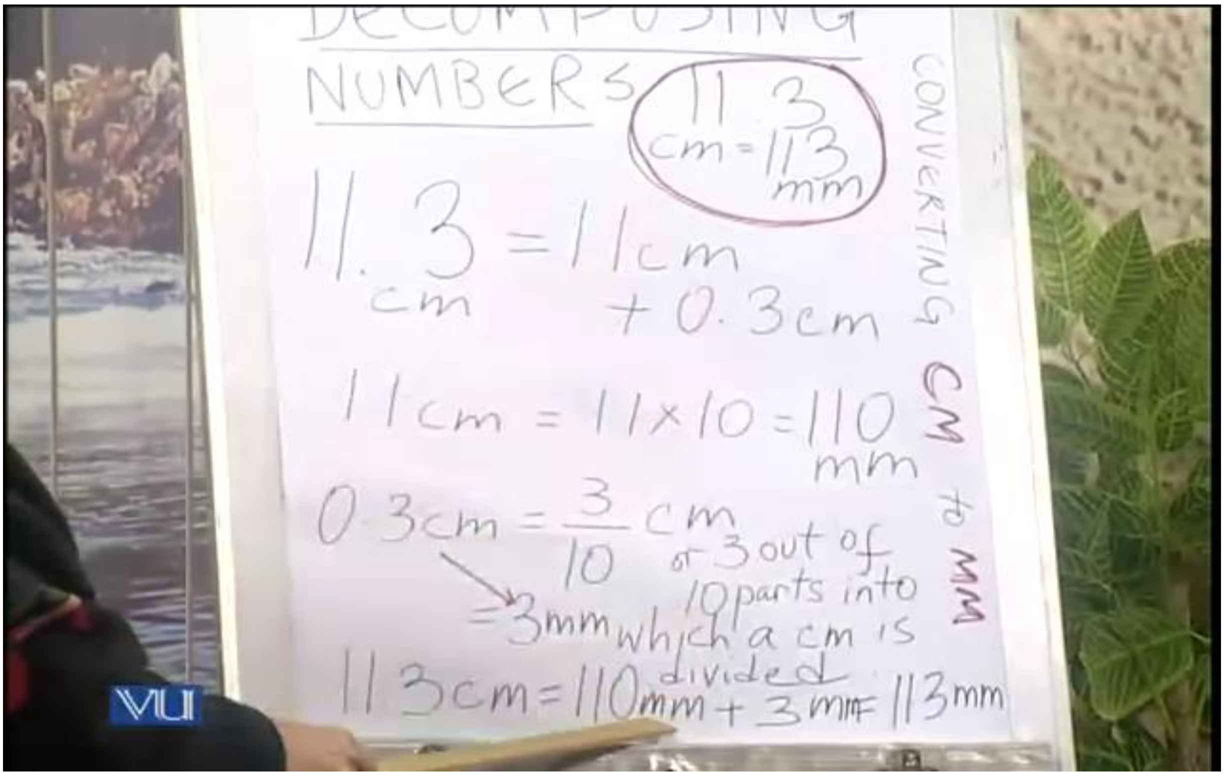

A Series of Measurement
Experiences
- Length Lab
- Volume Lab
- Mass Lab
Children will conduct measurements, record and share data

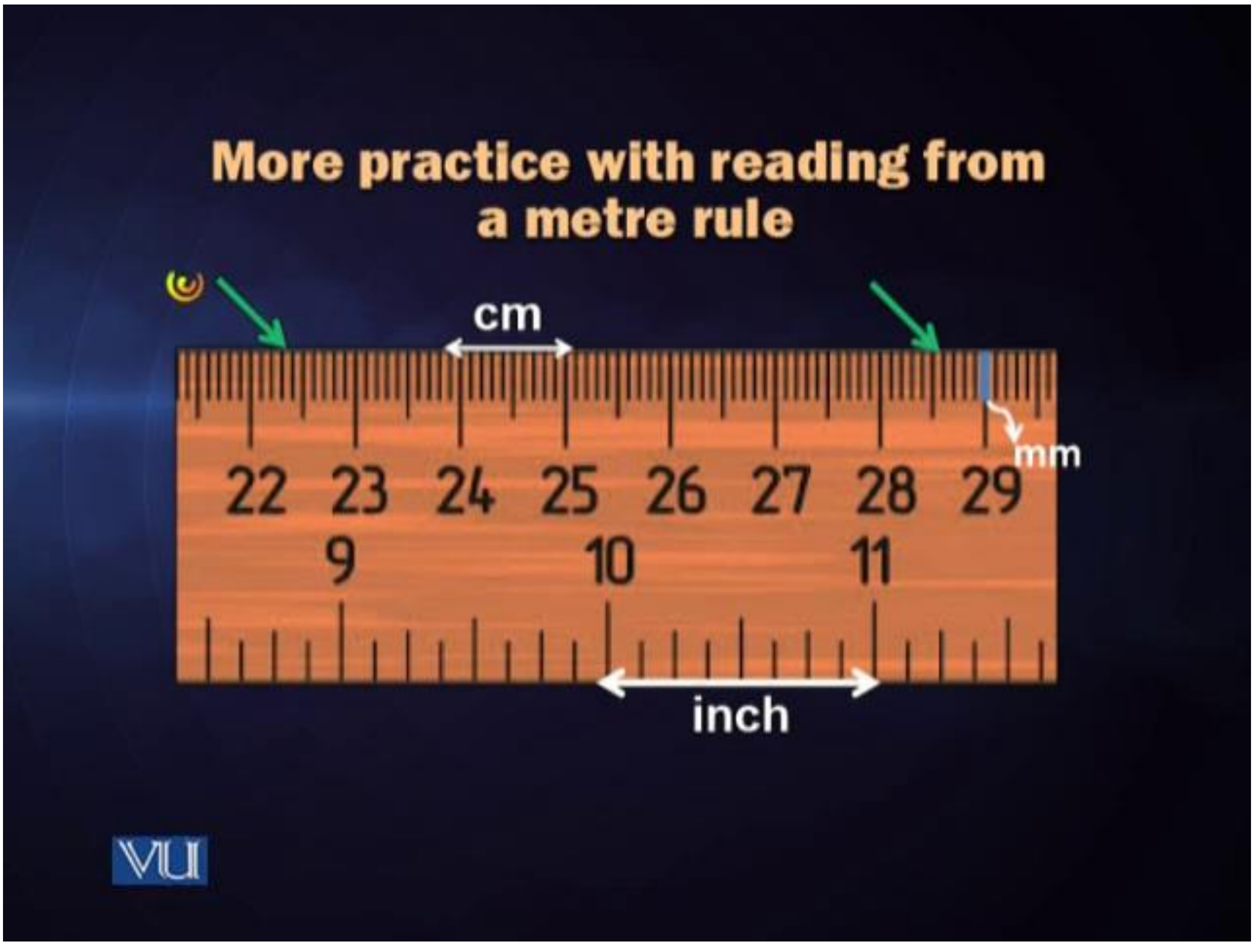


Teacher asked the above questions to the students that a meter rule can measure the length. The maximum length it can measure is 1 meter and the minimum length it can measure is 1 millimeter. Then the teacher told the students to draw a line of 1 centimeter. For the fifth question children data was as follow:



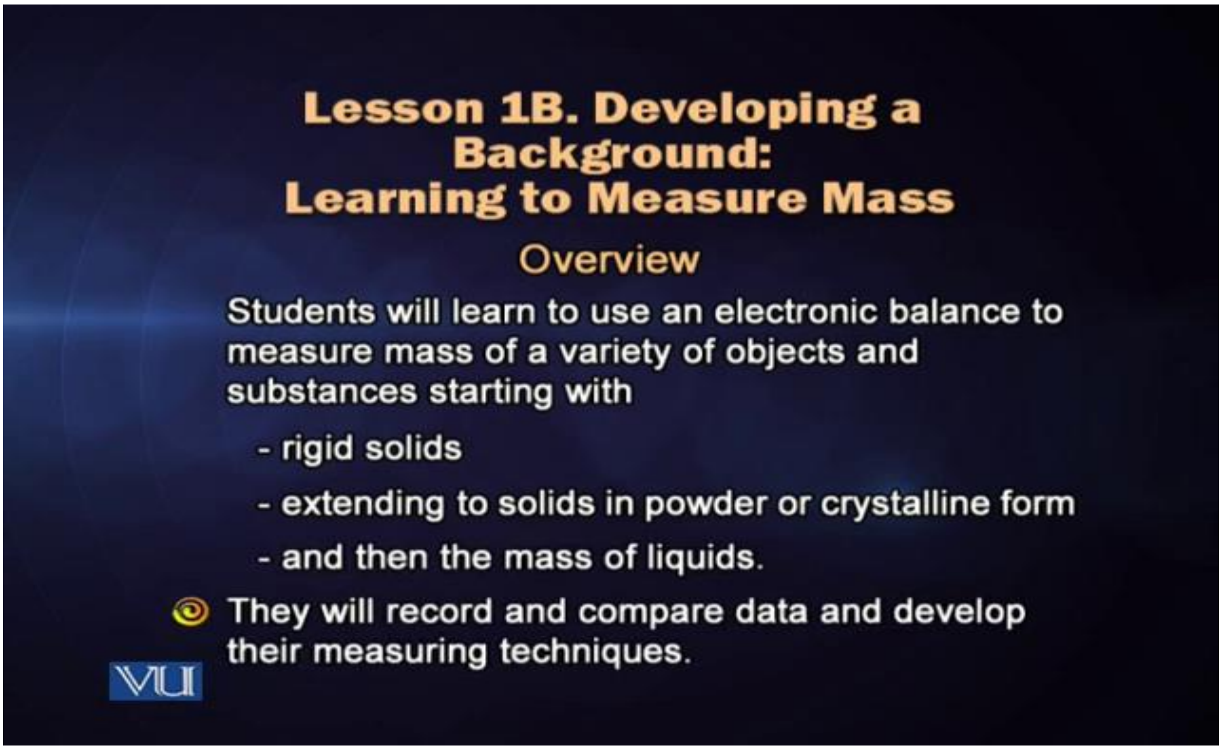
Teacher also elaborated how to decompose the numbers at the end.

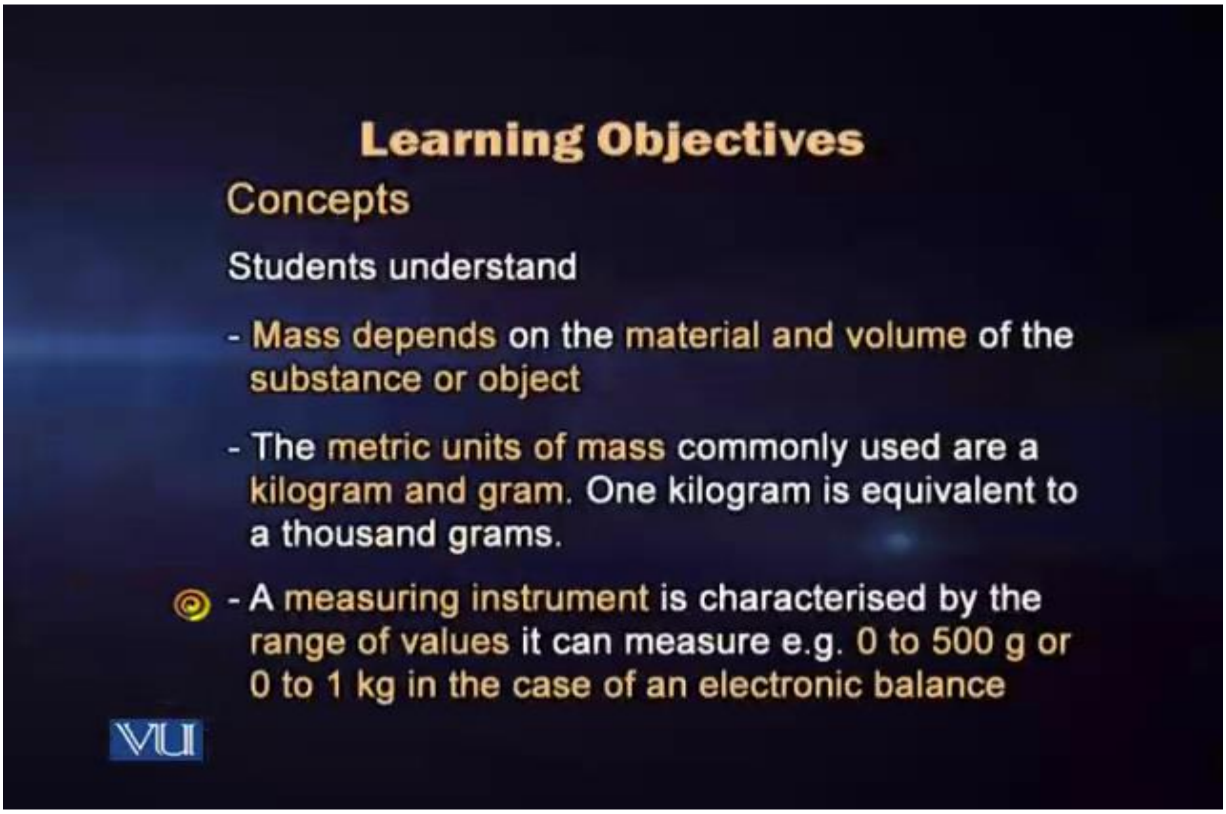


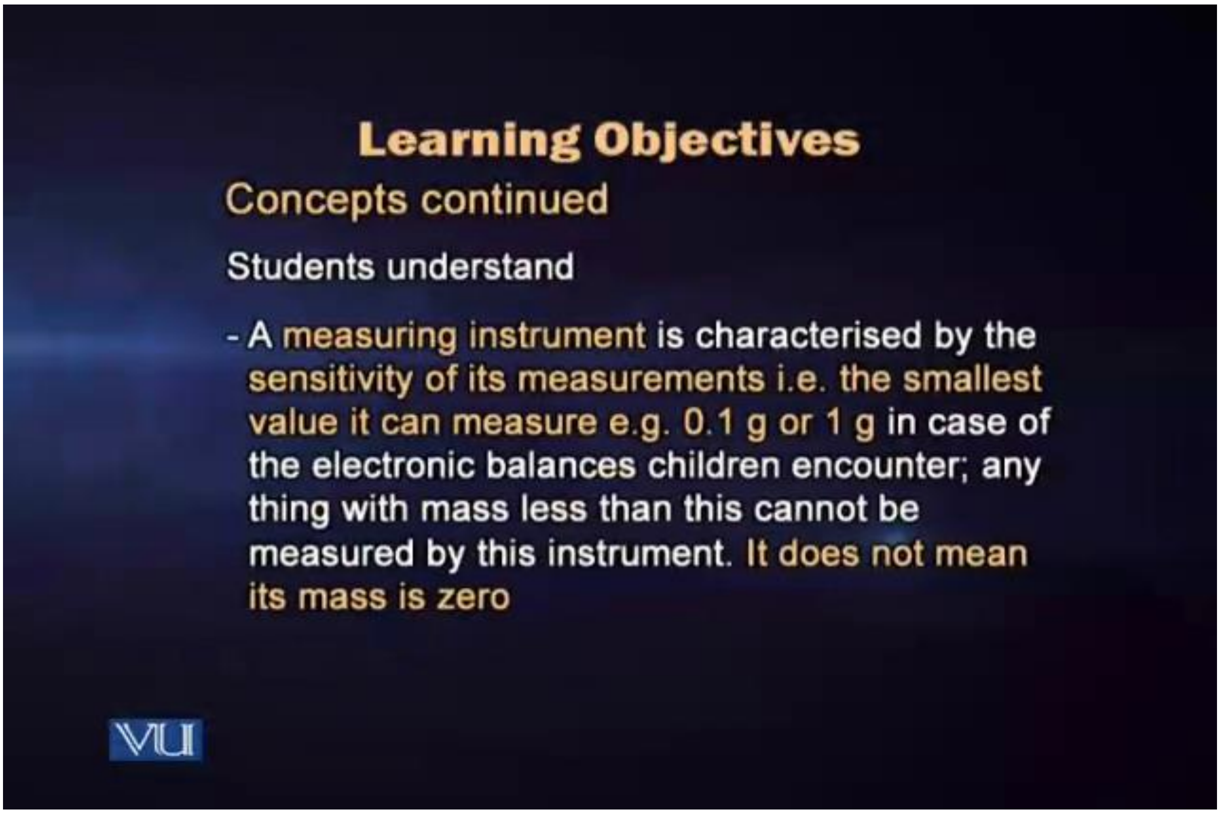

More practice with reading from a metre rule
cm
mm
22 23 24 25 26 27 28 29
9
10
11
inch
VU

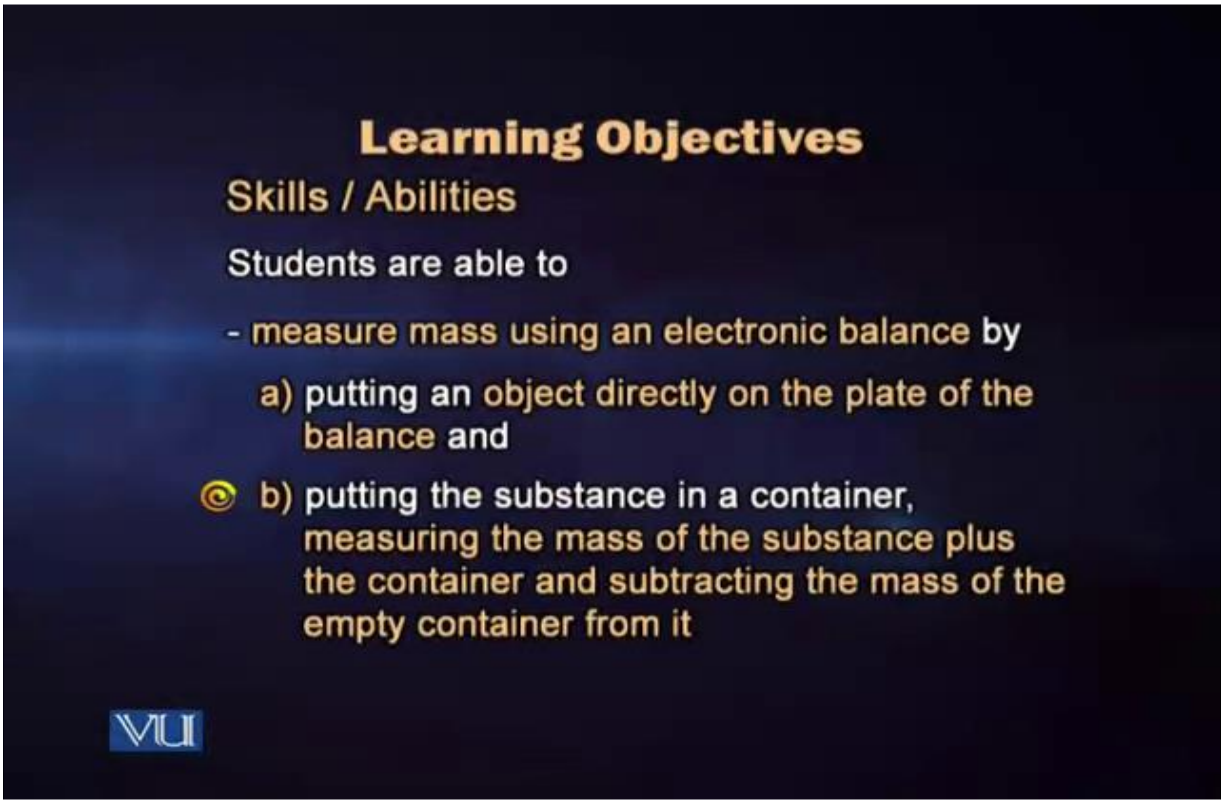
Lecture No 38

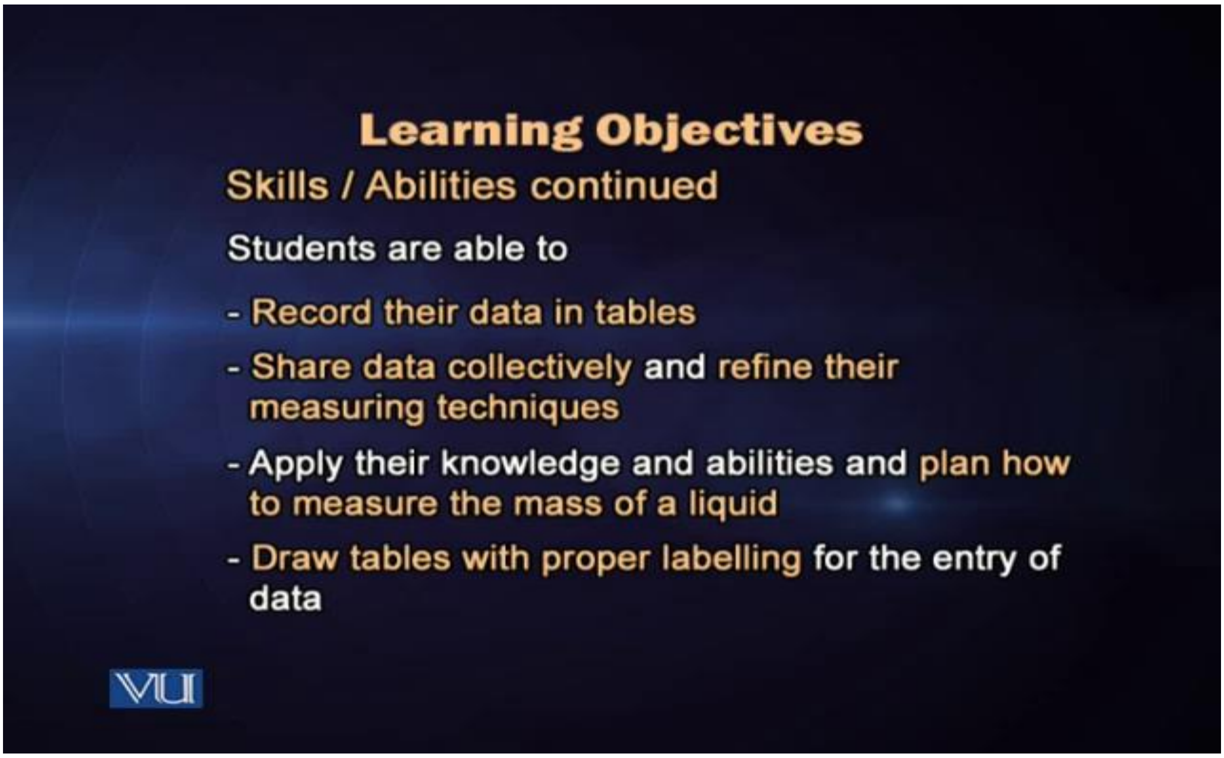
Developing a background learning to measure the “Mass”

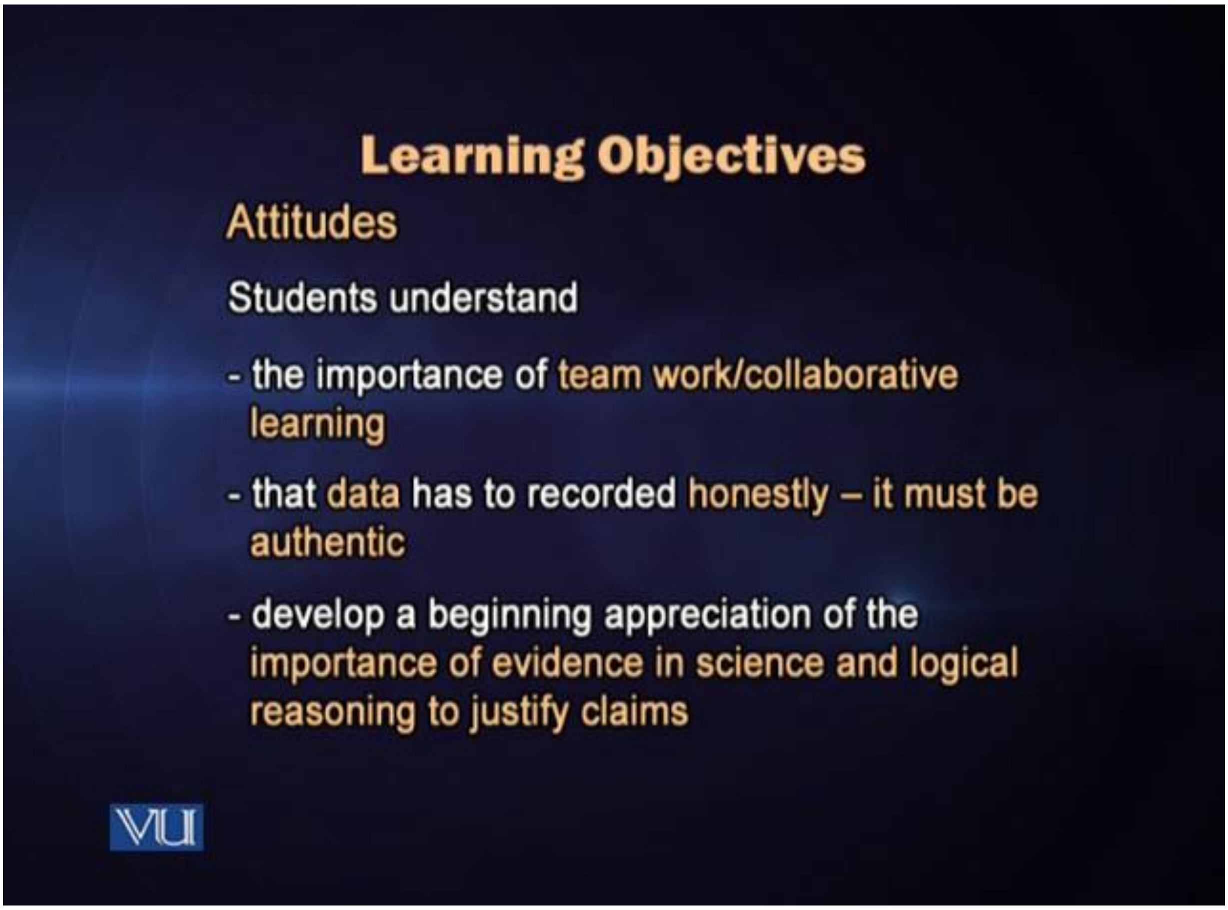


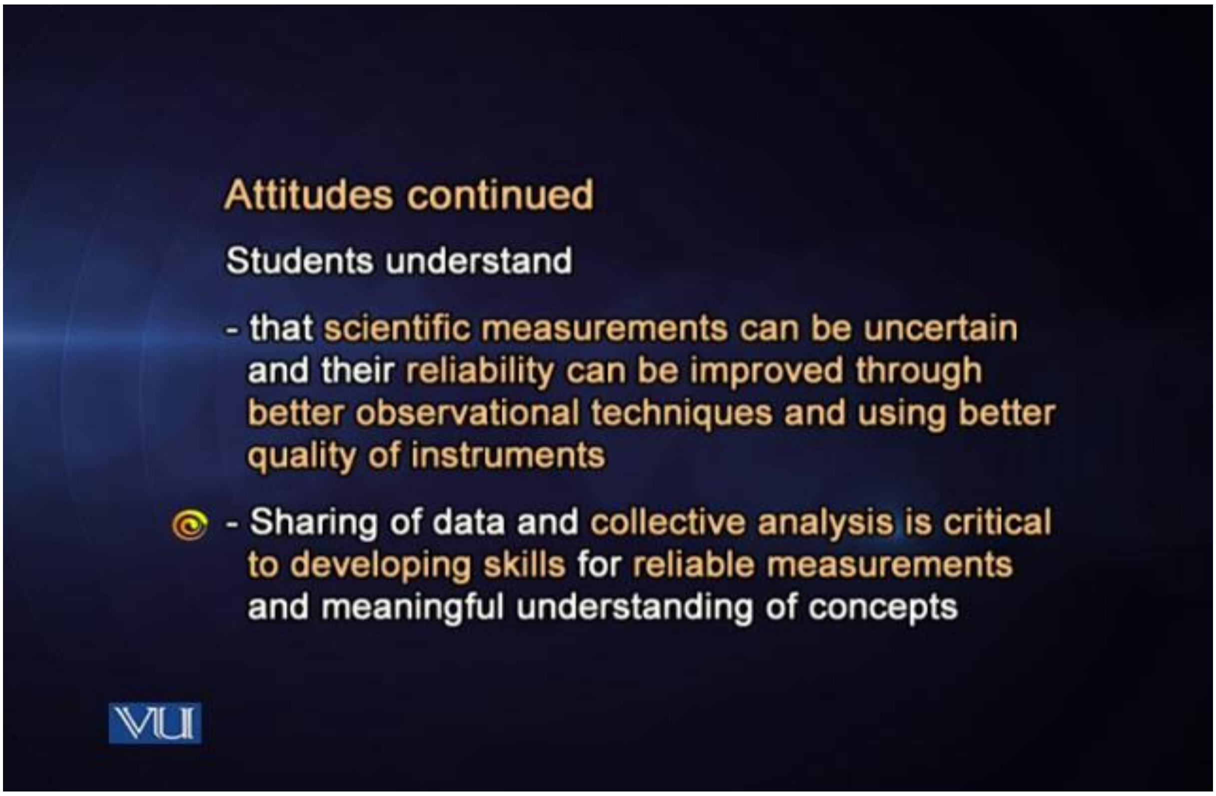


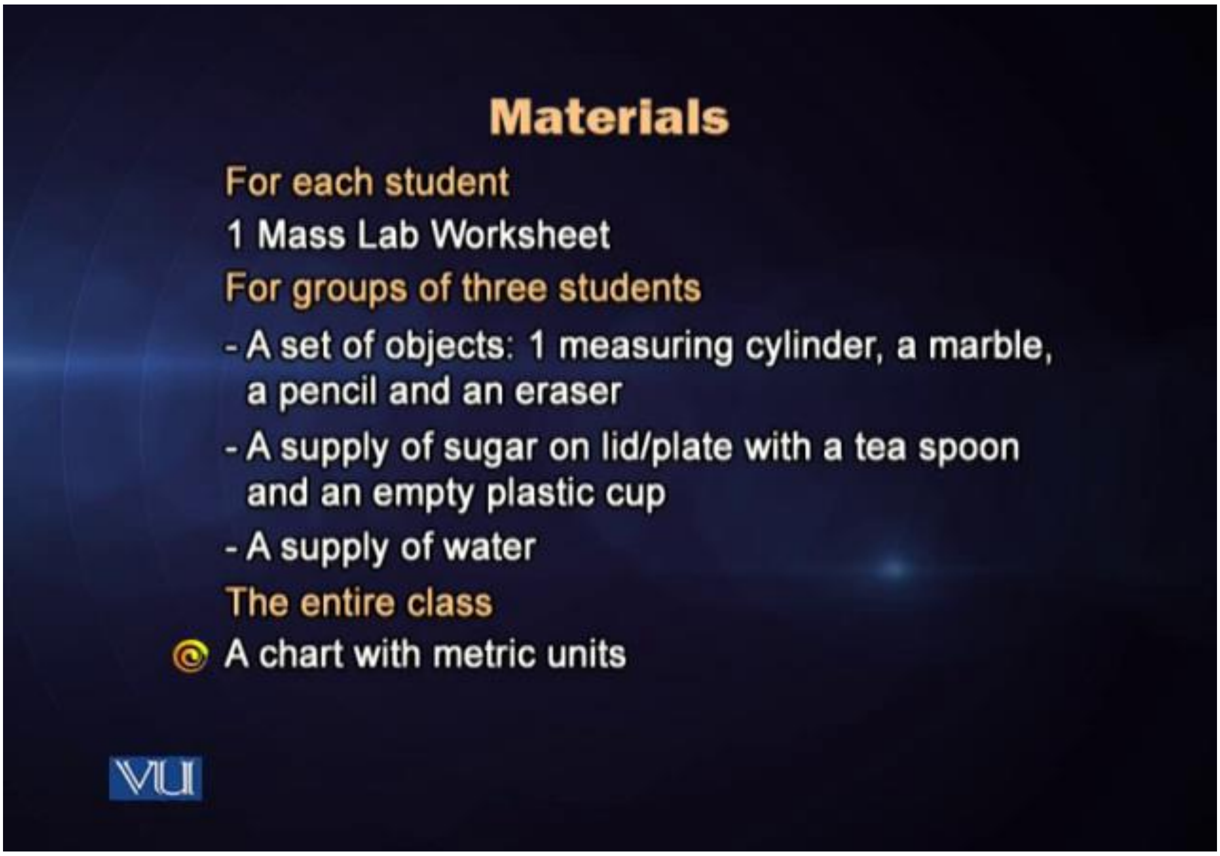

Learning Objectives
Concepts continued
Students understand
- A measuring instrument is characterised by the sensitivity of its measurements i.e. the smallest value it can measure e.g. 0.1 g or 1 g in case of the electronic balances children encounter; any thing with mass less than this cannot be measured by this instrument. It does not mean its mass is zero
VU

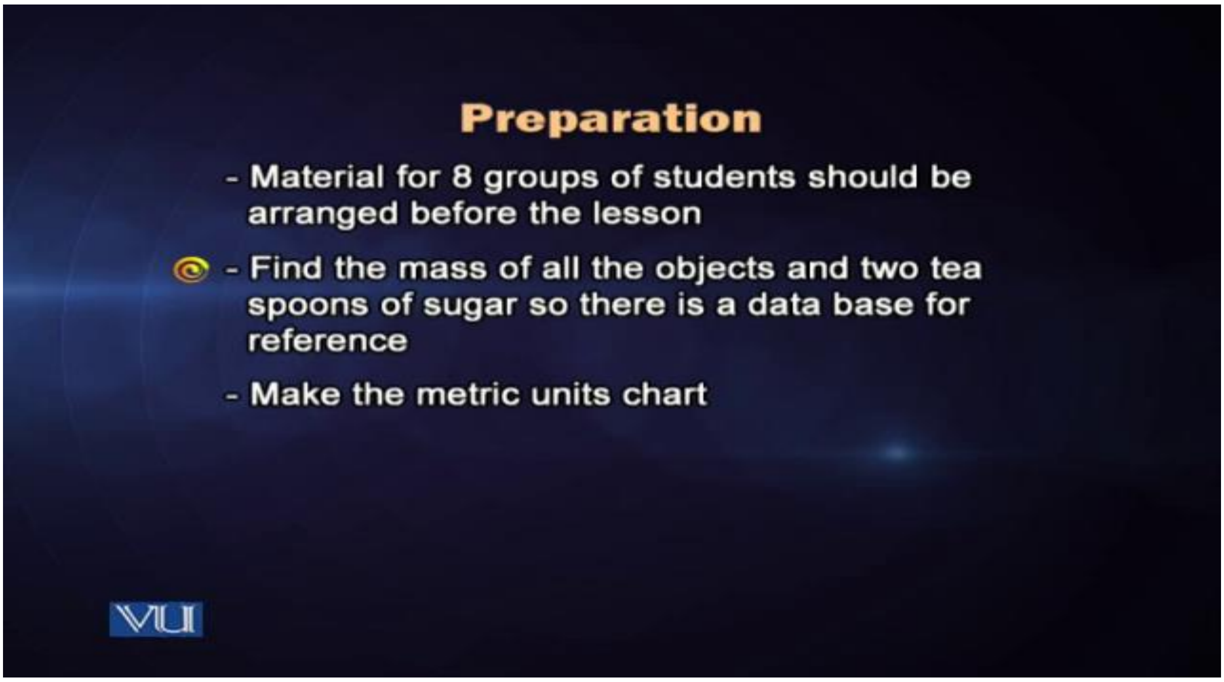

Learning Objectives
Skills / Abilities
Students are able to
- measure mass using an electronic balance by
a) putting an object directly on the plate of the balance and
b) putting the substance in a container, measuring the mass of the substance plus the container and subtracting the mass of the empty container from it
VU


Learning Objectives
Skills / Abilities continued
Students are able to
- Record their data in tables
- Share data collectively and refine their measuring techniques
- Apply their knowledge and abilities and plan how to measure the mass of a liquid
- Draw tables with proper labelling for the entry of data
VU


Learning Objectives
Attitudes
Students understand
- the importance of team work/collaborative learning
- that data has to recorded honestly – it must be authentic
- develop a beginning appreciation of the importance of evidence in science and logical reasoning to justify claims
VU


Attitudes continued
Students understand
- that scientific measurements can be uncertain and their reliability can be improved through better observational techniques and using better quality of instruments
- Sharing of data and collective analysis is critical to developing skills for reliable measurements and meaningful understanding of concepts
VU

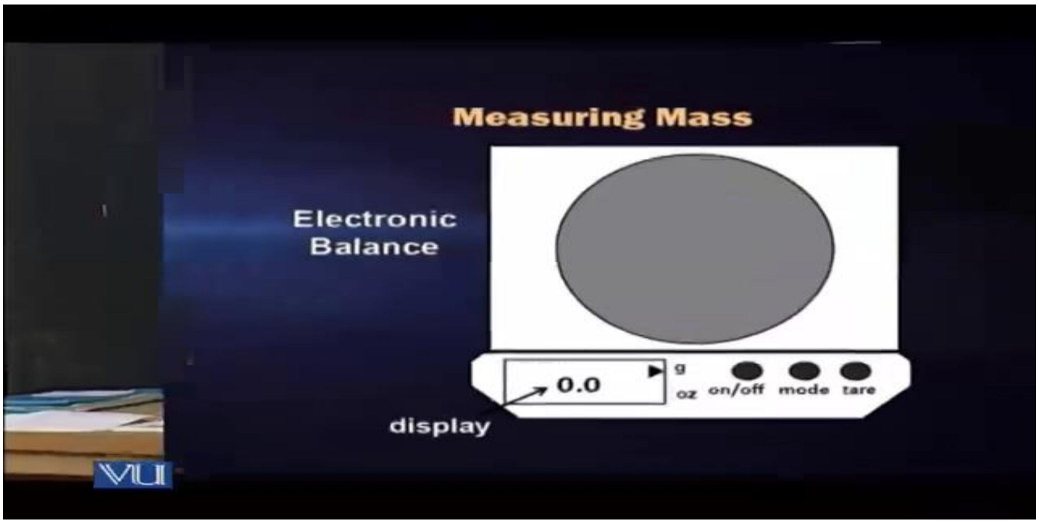

Materials
For each student
1 Mass Lab Worksheet
For groups of three students
- A set of objects: 1 measuring cylinder, a marble, a pencil and an eraser
- A supply of sugar on lid/plate with a tea spoon and an empty plastic cup
- A supply of water
The entire class
A chart with metric units
VU



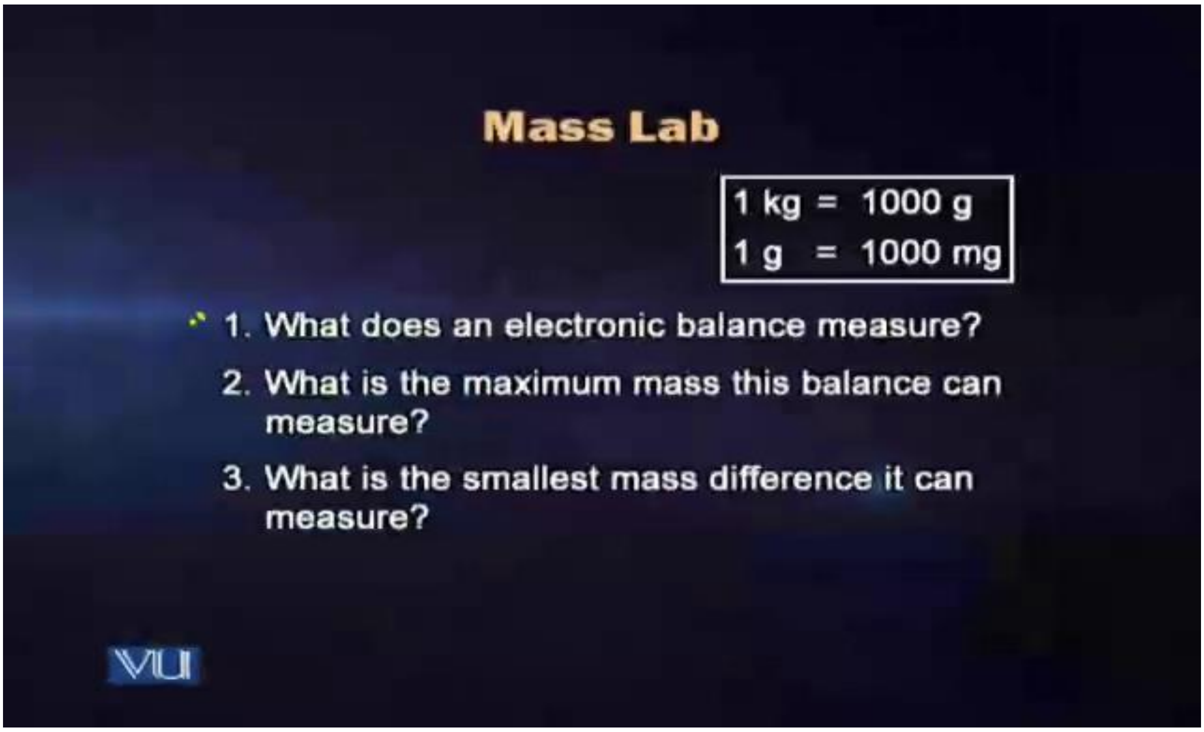
Classroom Activity

The teacher introduced the electronic balance in the class. She told the students that this was used for measuring the mass of objects. She displayed the parts of electronic balance on the computer slides.

- Electronic balance can measure in the grams and owns units.
- We can maximum measures 500 grams on electronic balance.
- And smallest measurement will be .1 grams.

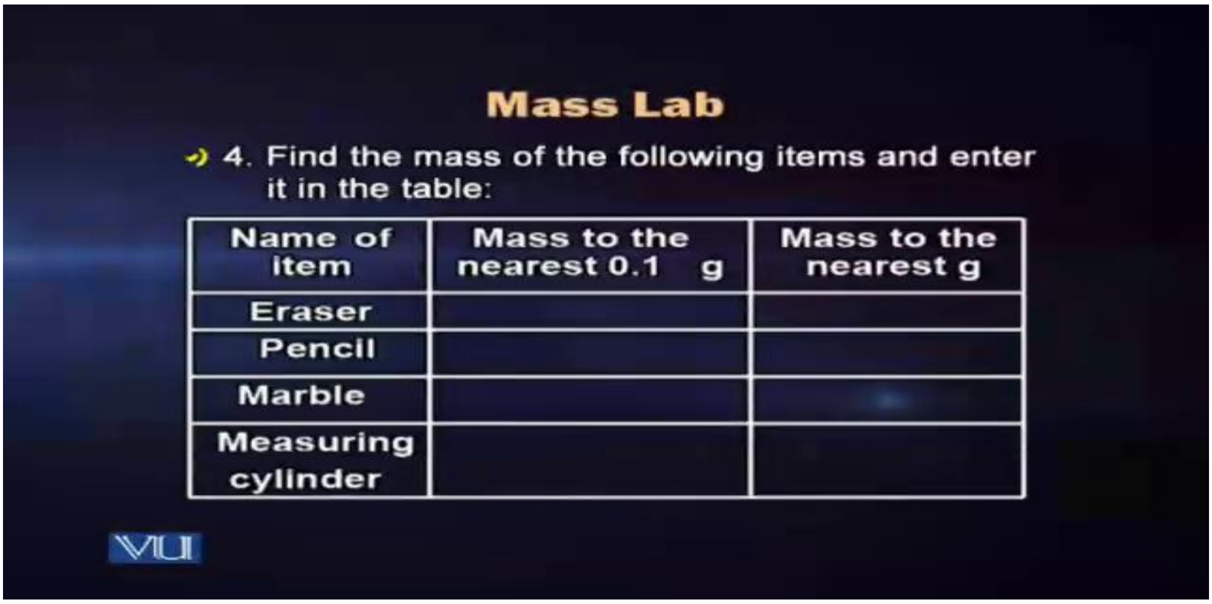


Than the teacher reviewed all her discussion by asking some questions to the students.

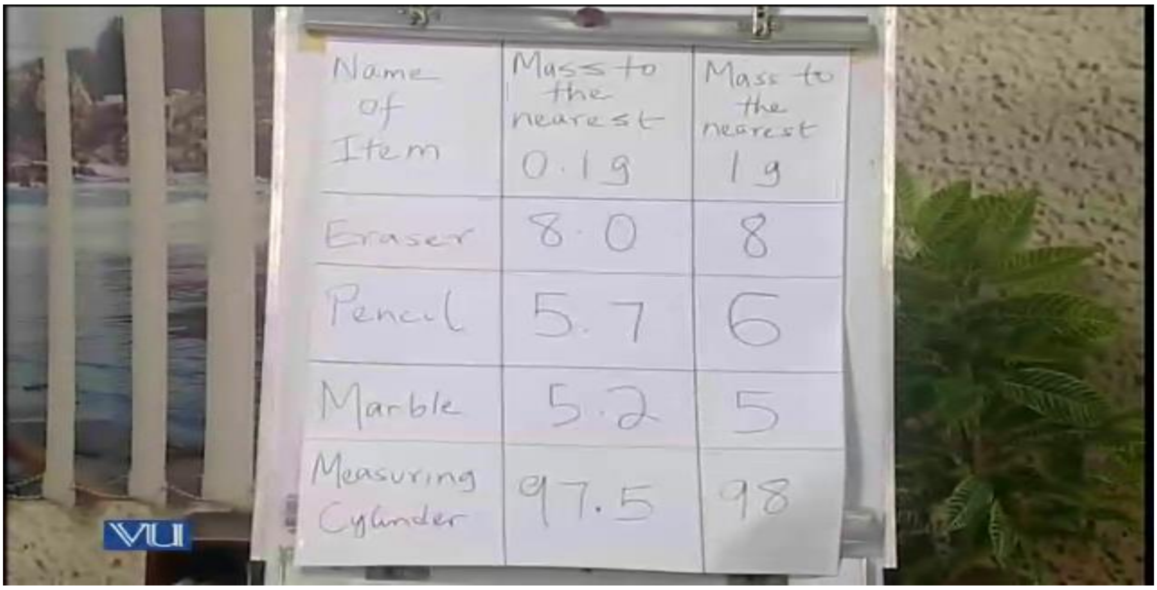


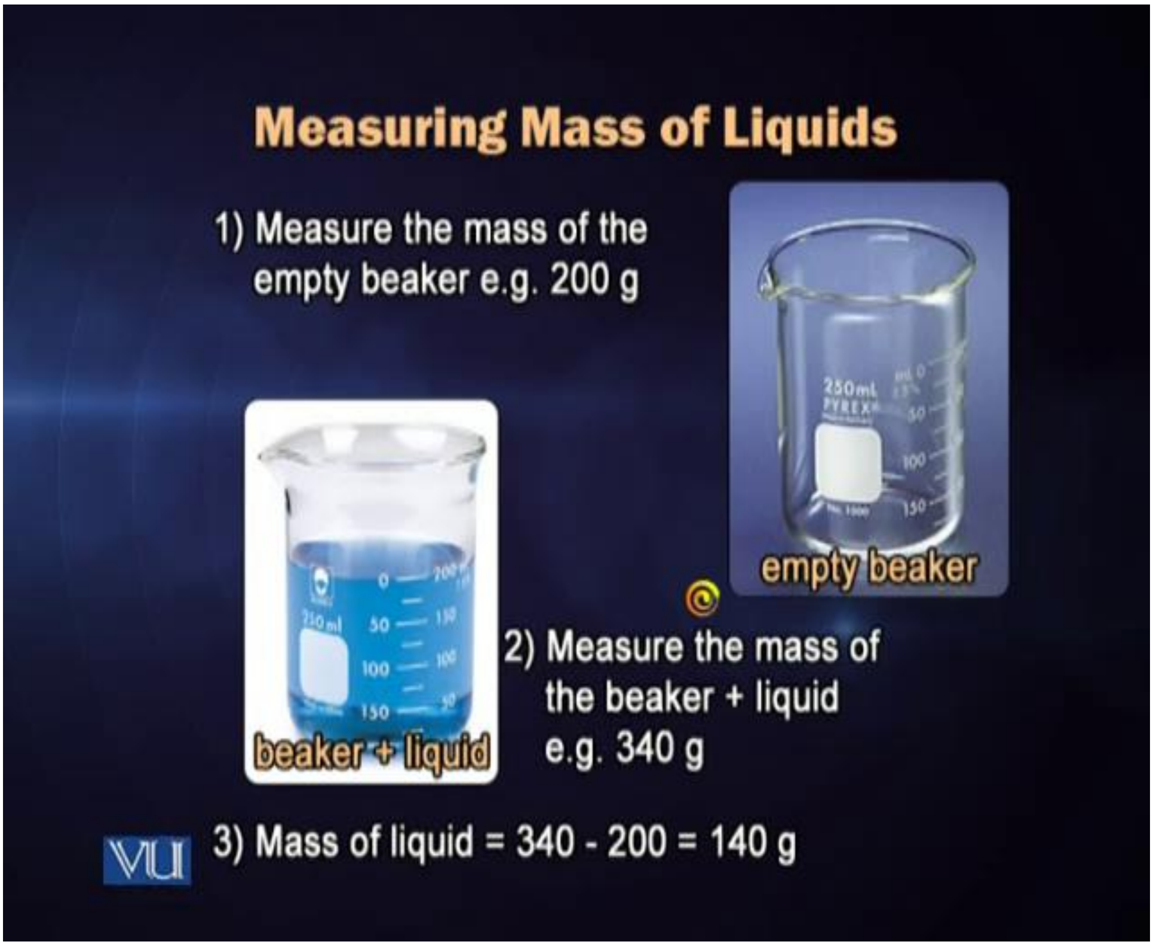
The teacher also told the students that they must put the objects within the range of .1 to 500 grams and not more or less than that.

Teacher gave the mass lab table to the students and students started measuring the mass of the objects according to the table. The table which students had to fill was as follow:

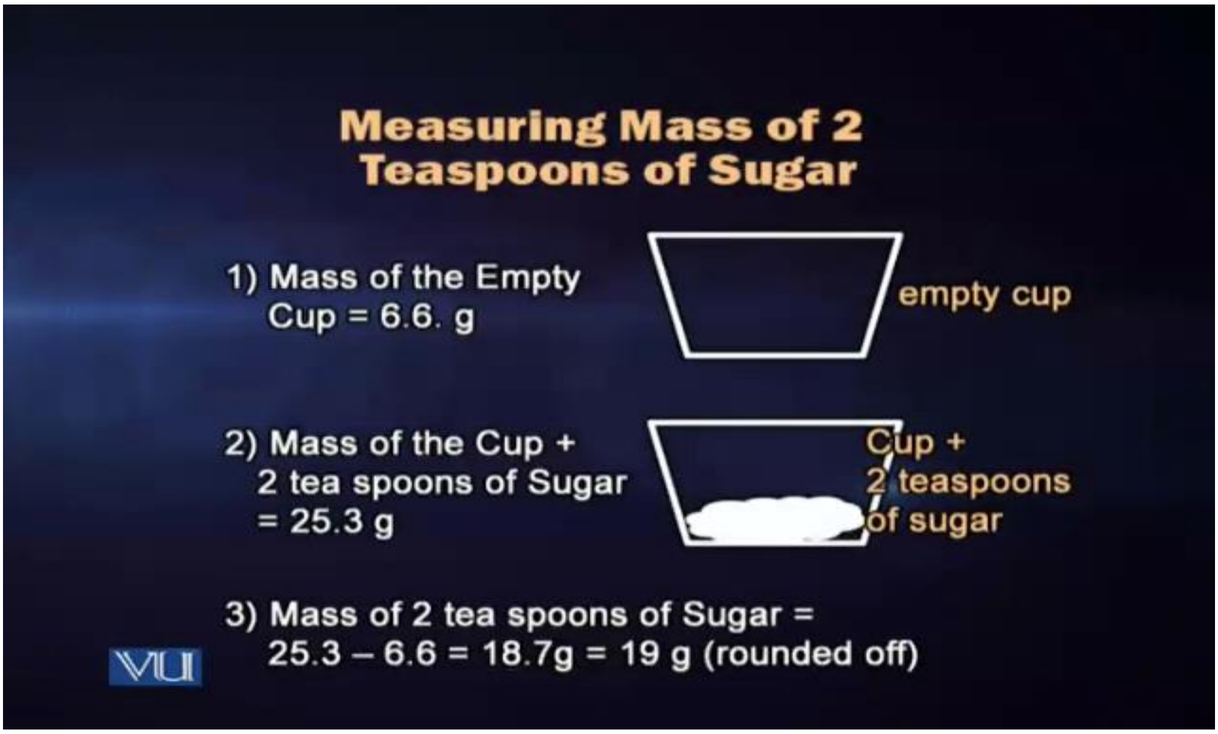


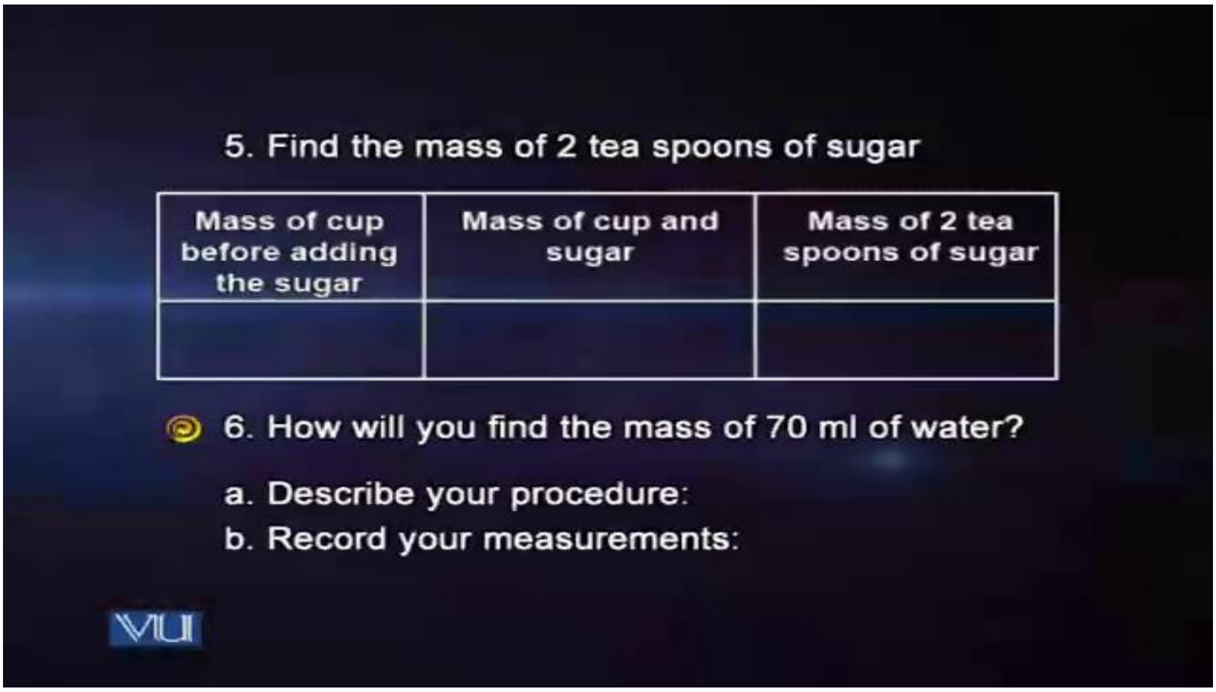
Teacher also had her readings on the chart paper.



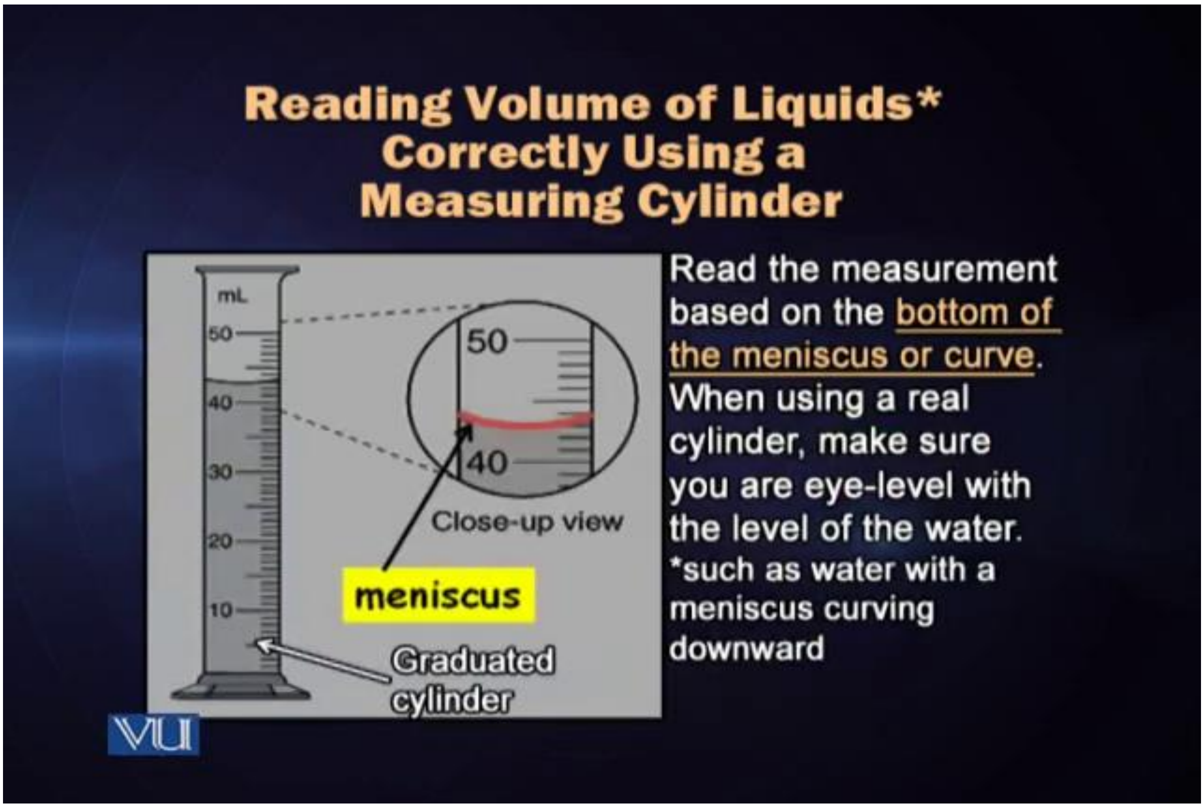


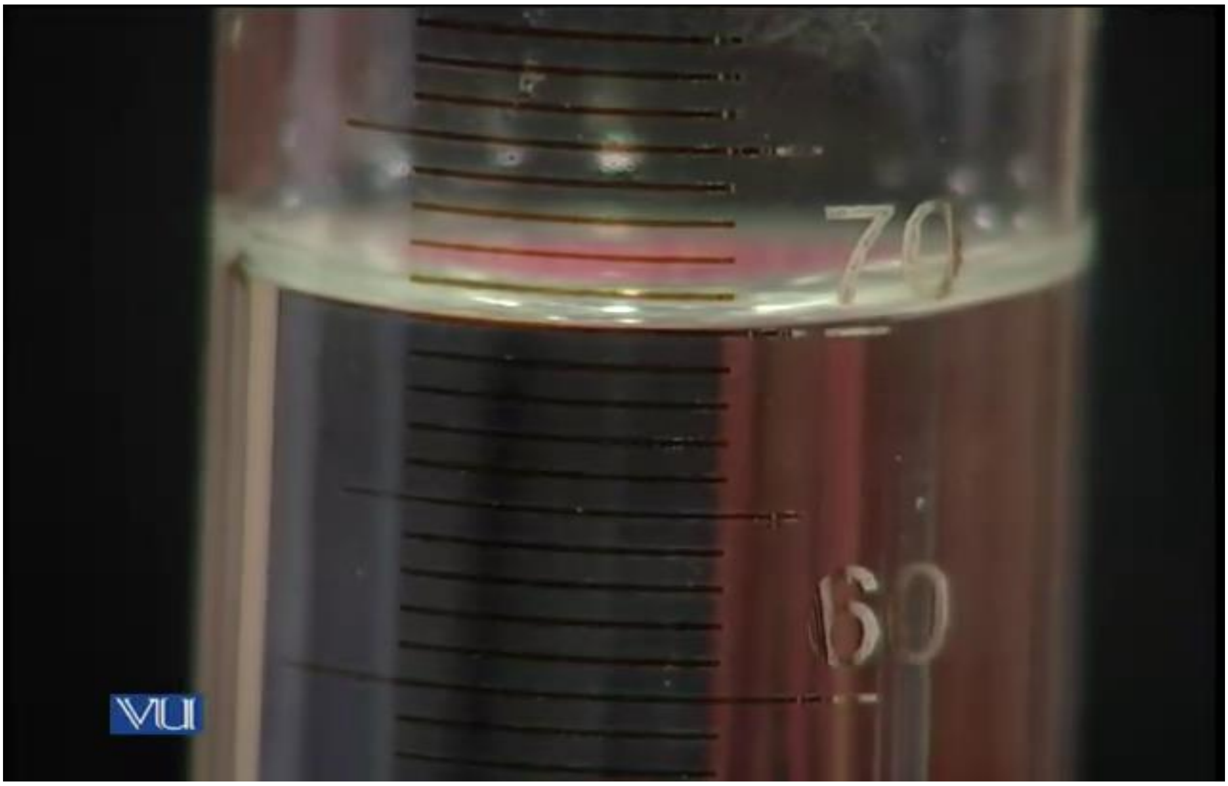
Then the teacher gave them 2 teaspoons of sugar to measure. Students started the activity. They firstly measured the empty cup mass. Then they put the sugar into the cup and measure the mass of sugar with the cup. They subtract the mass of the cup from the total mass (mass of sugar with the cup). And this was the final result.

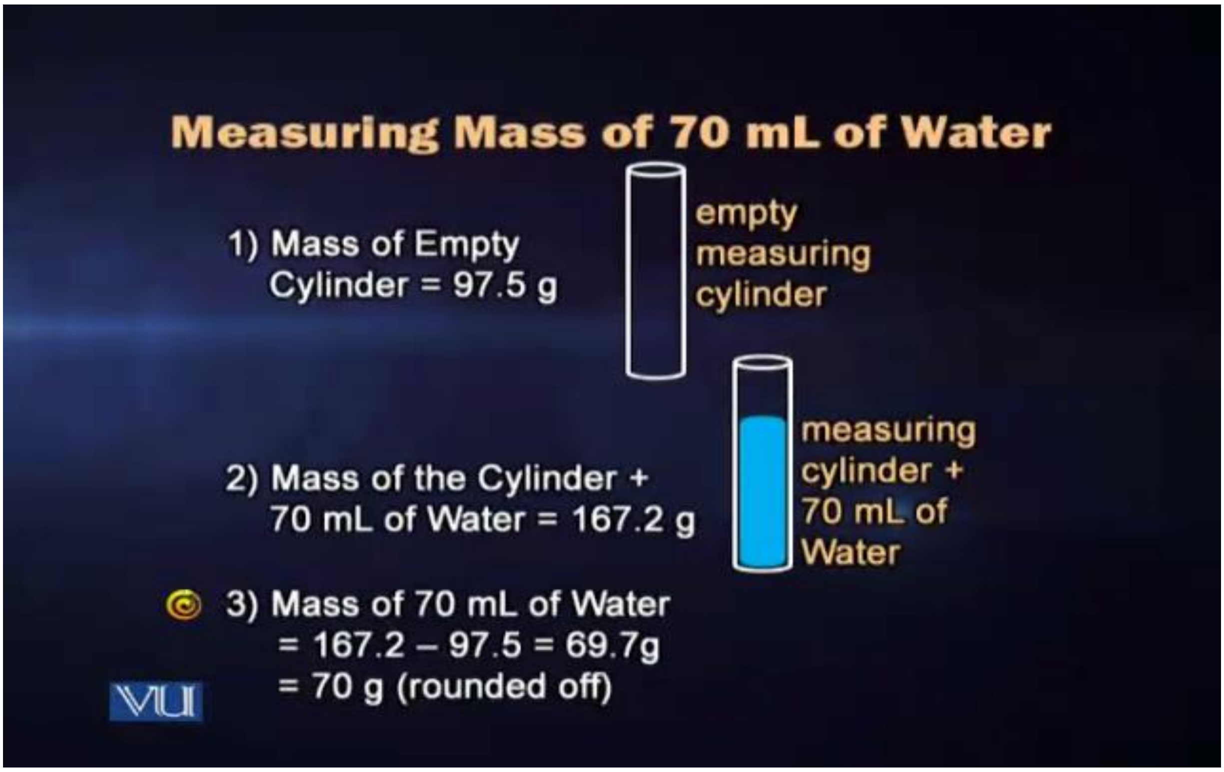




The next activity was measuring the mass of 70 ml of water. Firstly teacher described how can the students fill the cylinder with the appropriate quantity.


Reading Volume of Liquids*
Correctly Using a
Measuring Cylinder
mL
50
40
30
20
10
50
40
Close-up view
meniscus
Graduated cylinder
Read the measurement based on the bottom of the meniscus or curve.
When using a real cylinder, make sure you are eye-level with the level of the water.
*such as water with a meniscus curving downward
VU

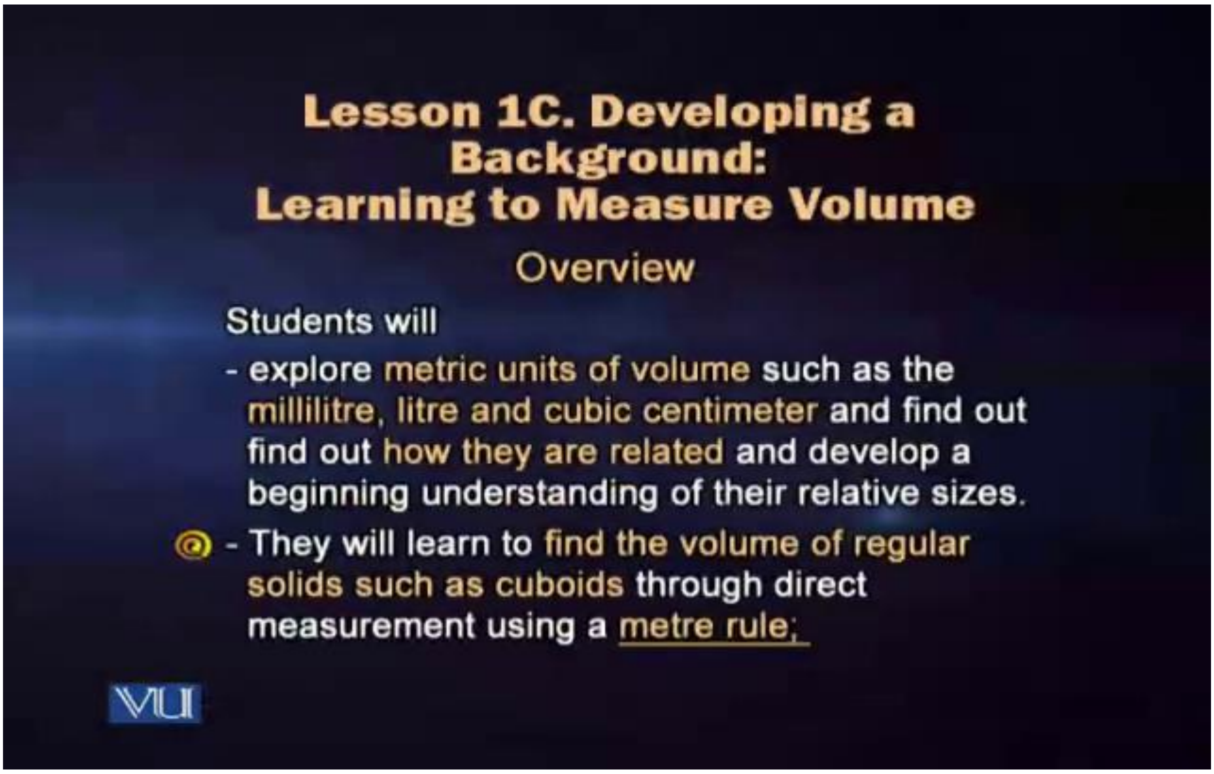

70
60
VU

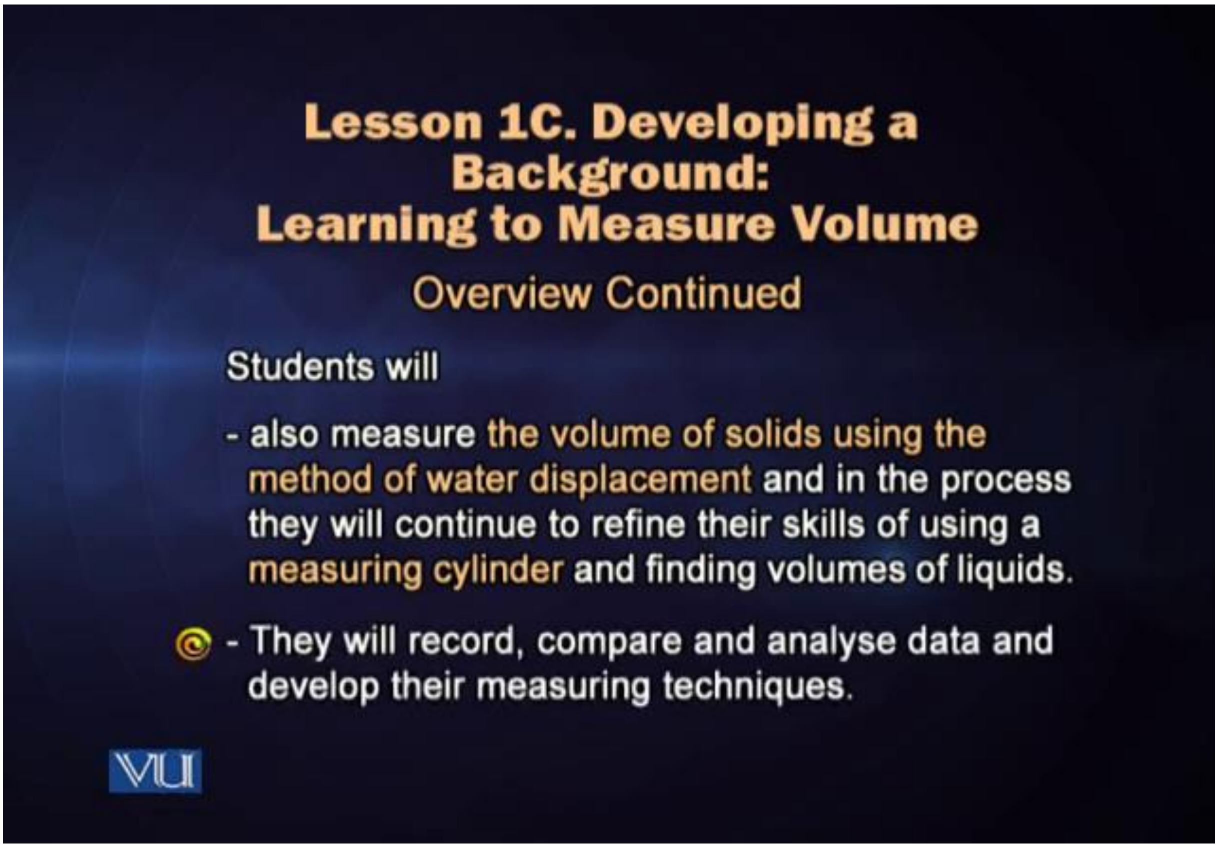


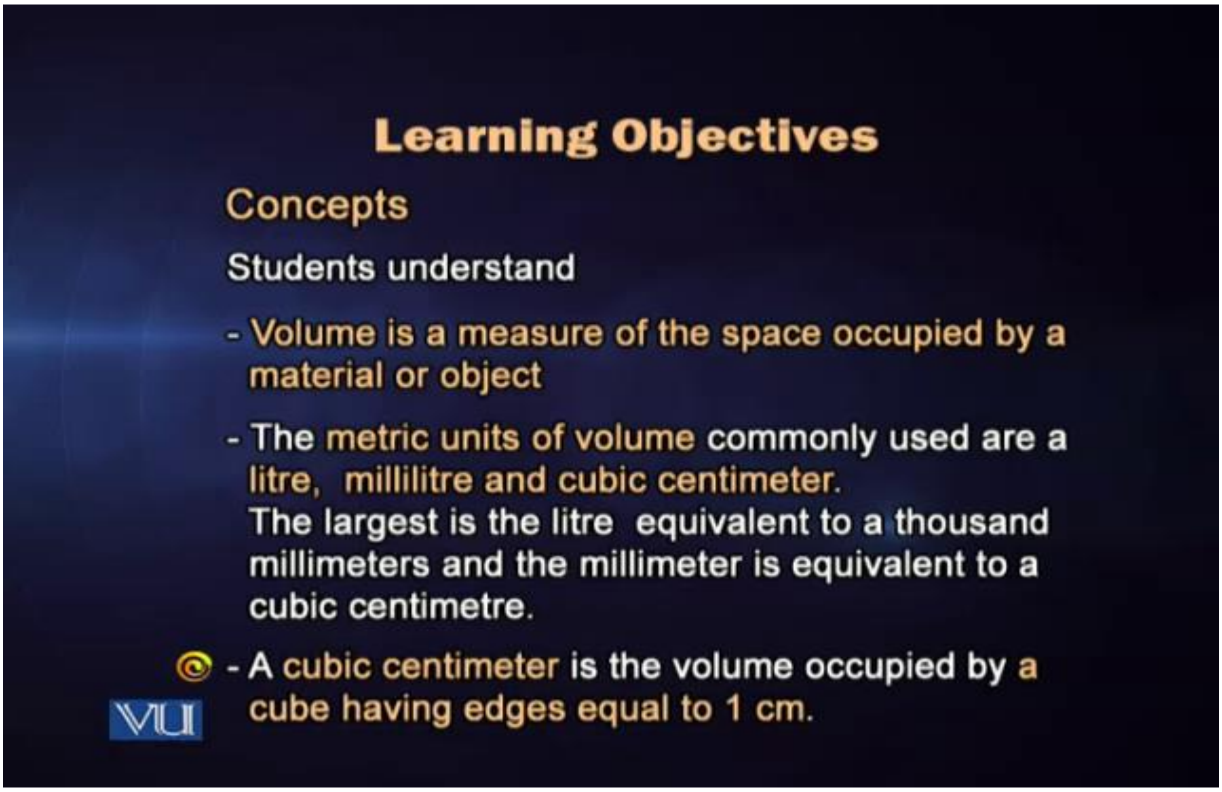
Students started measuring the empty cylinder first. Then the students measured the cylinder with the water. And subtract the cylinder mass from the total mass. At the end students shared their findings with the teacher.

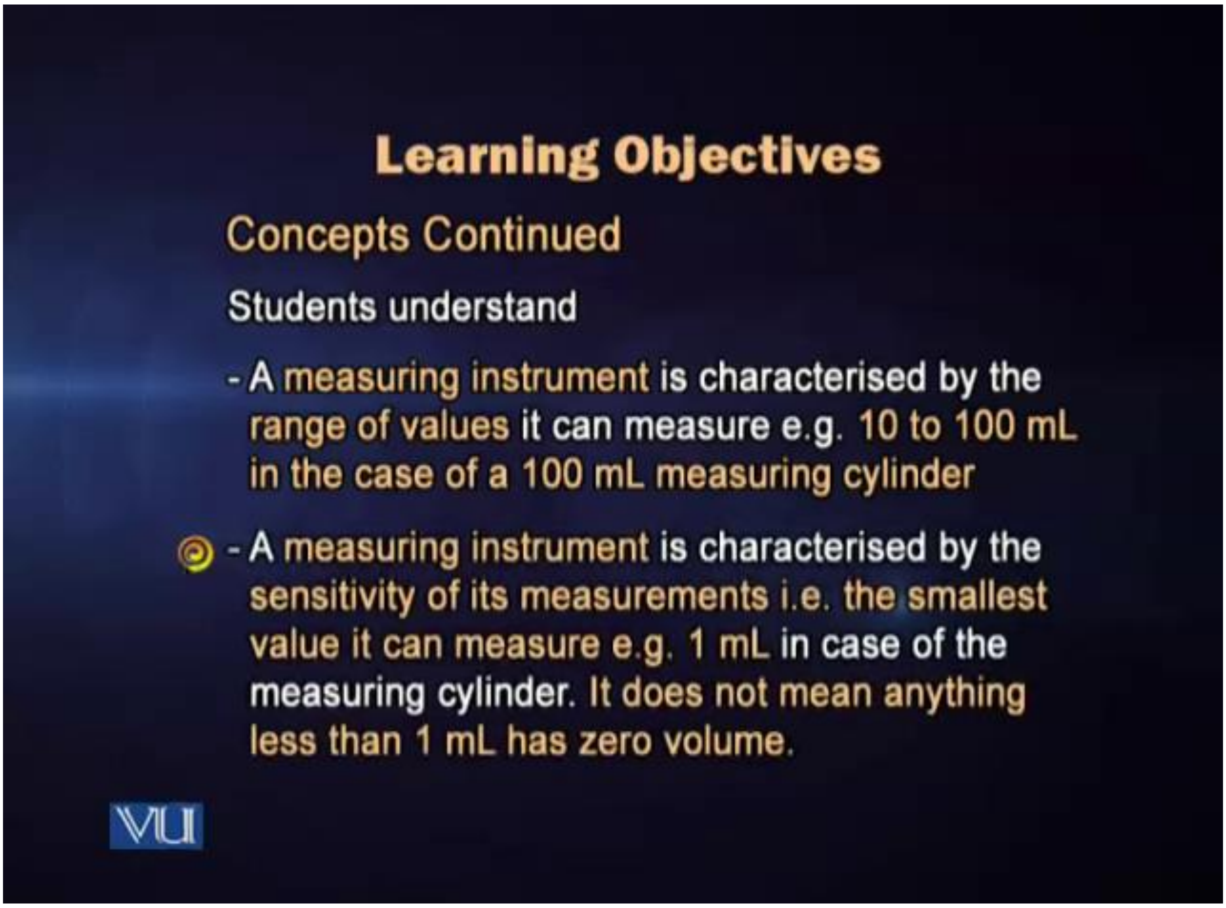
Lecture No 39

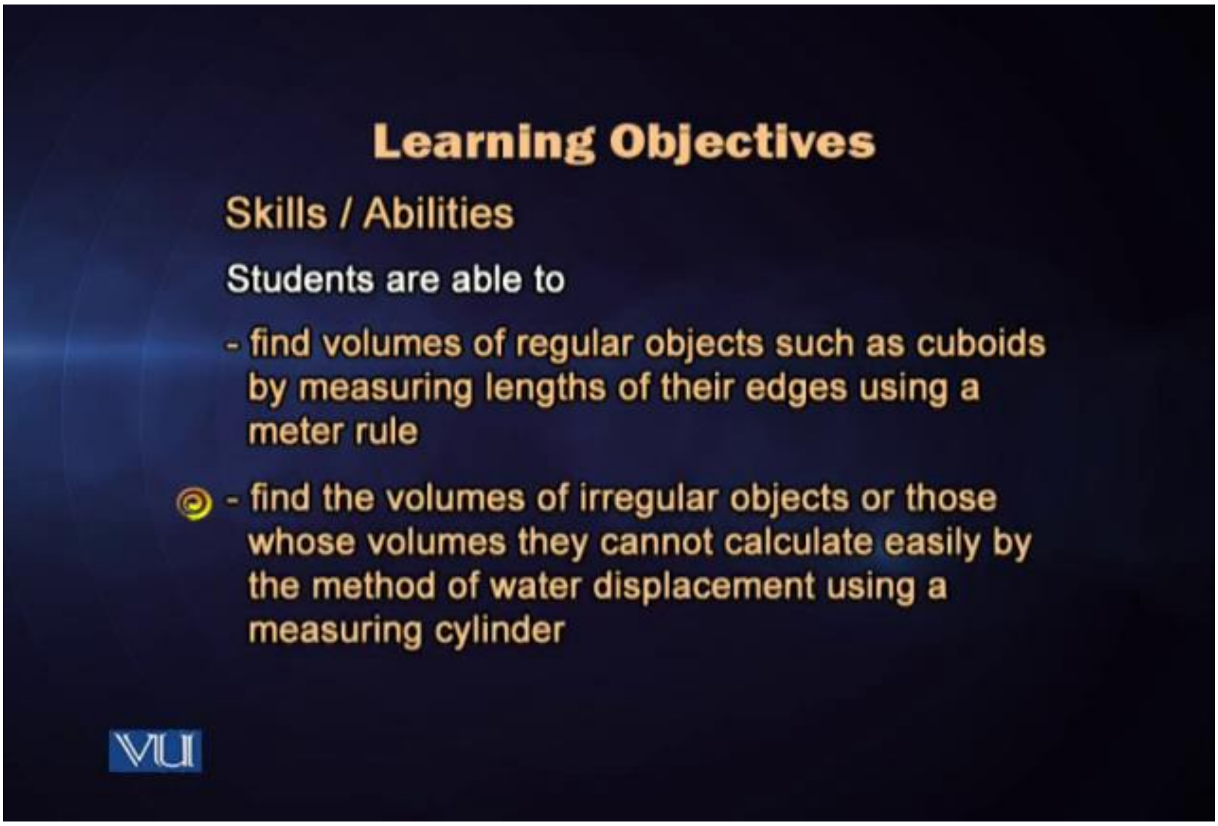
Developing a background learning to measure "Density"

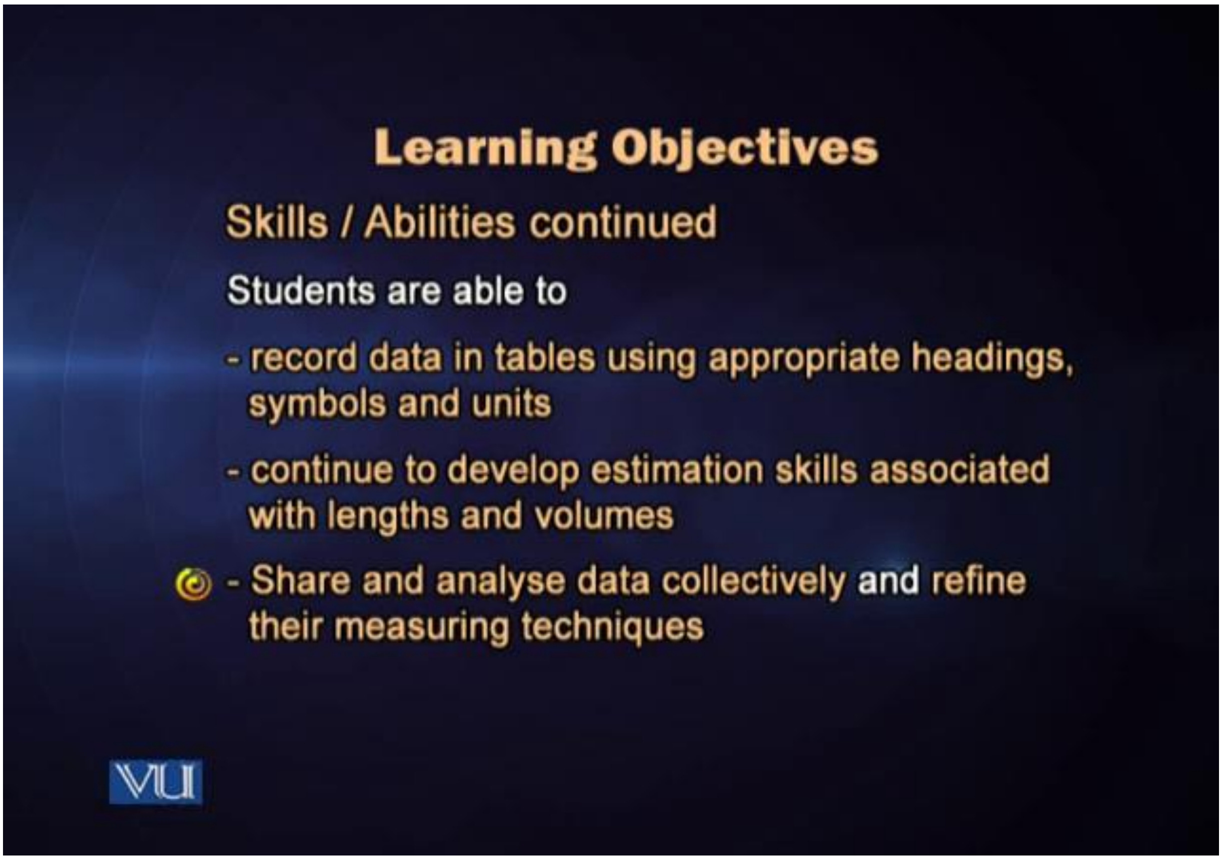


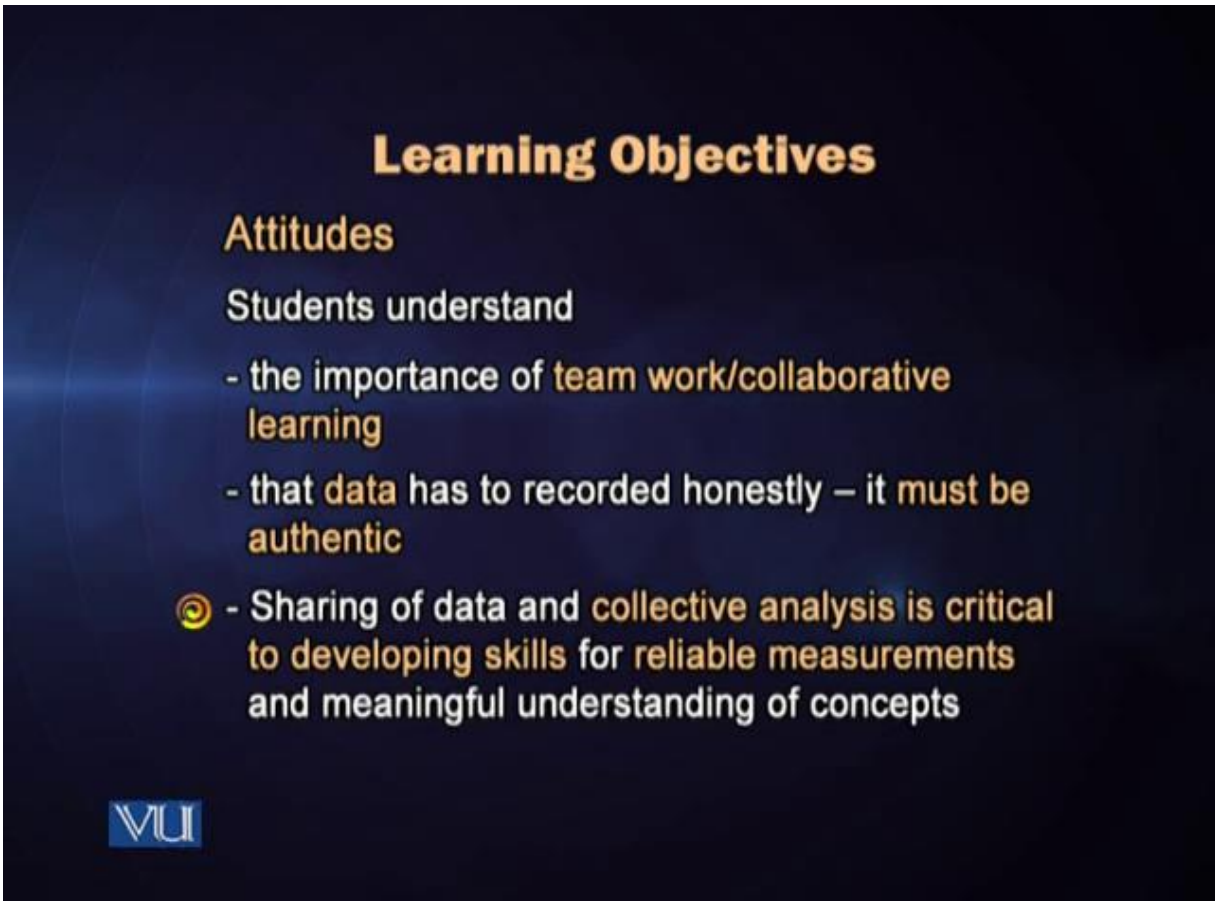


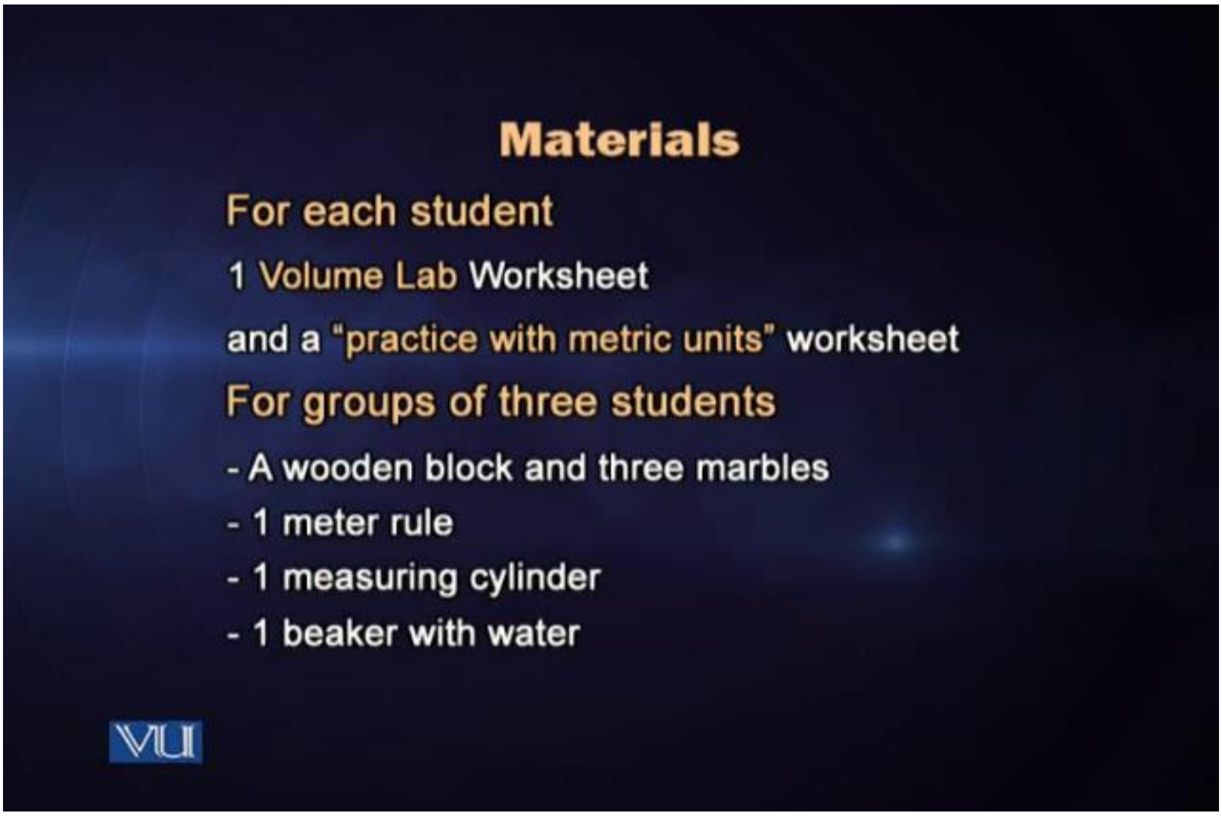

Learning Objectives
Concepts
Students understand
- Volume is a measure of the space occupied by a material or object
- The metric units of volume commonly used are a litre, millilitre and cubic centimeter.
The largest is the litre equivalent to a thousand millimeters and the millimeter is equivalent to a cubic centimetre.
- A cubic centimeter is the volume occupied by a cube having edges equal to 1 cm.
VU

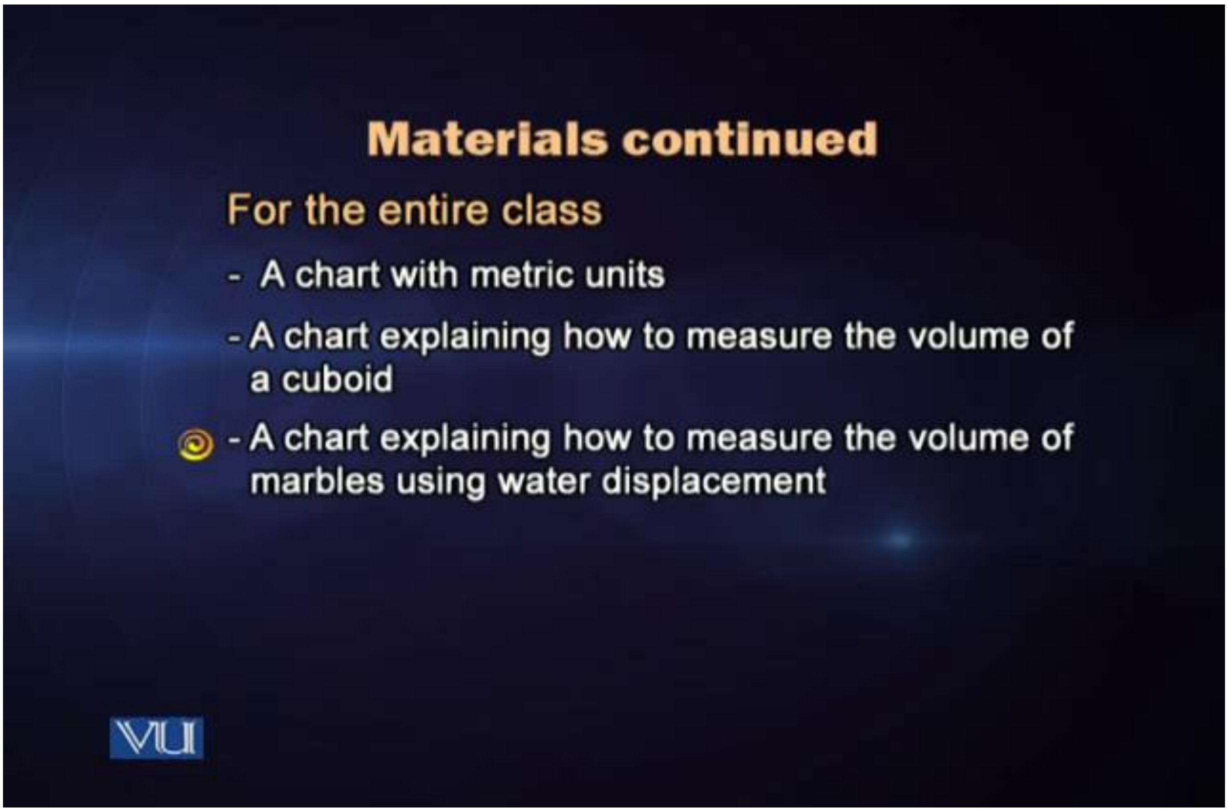

Learning Objectives
Concepts Continued
Students understand
- A measuring instrument is characterised by the range of values it can measure e.g. 10 to 100 mL in the case of a 100 mL measuring cylinder
- A measuring instrument is characterised by the sensitivity of its measurements i.e. the smallest value it can measure e.g. 1 mL in case of the measuring cylinder. It does not mean anything less than 1 mL has zero volume.
VU

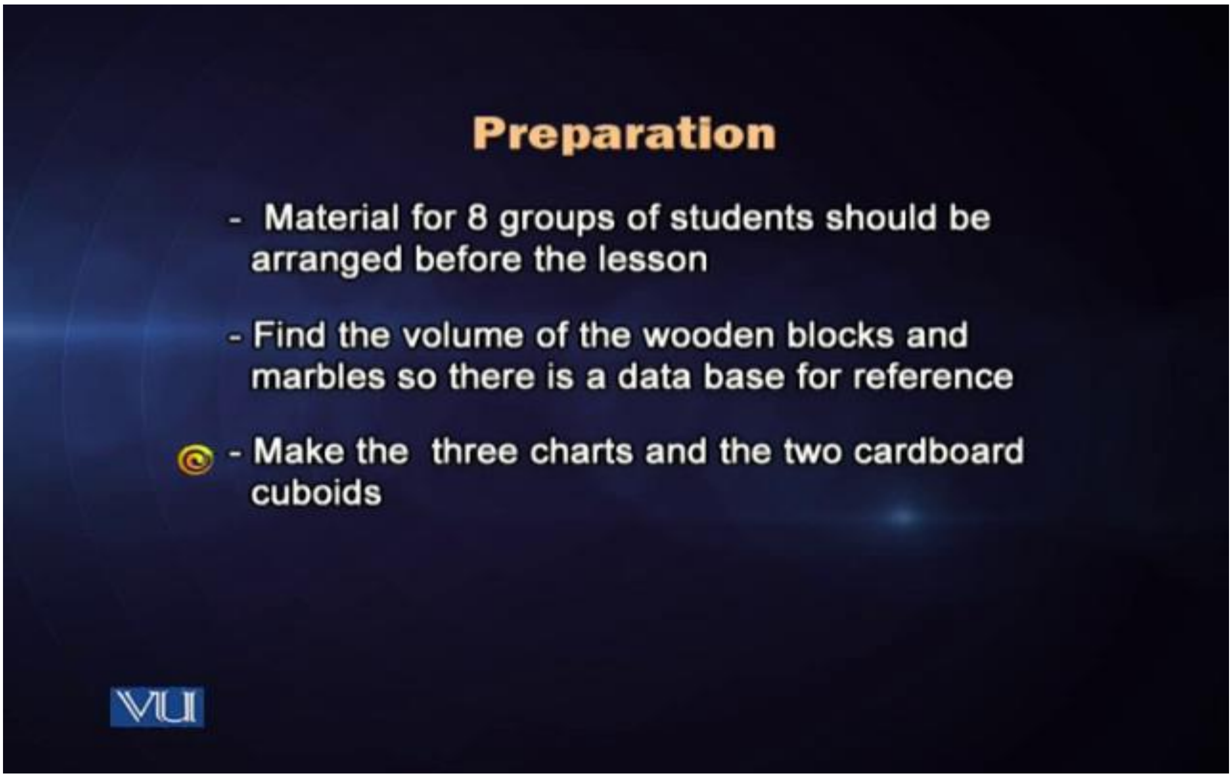

Learning Objectives
Skills / Abilities
Students are able to
- find volumes of regular objects such as cuboids by measuring lengths of their edges using a meter rule
- find the volumes of irregular objects or those whose volumes they cannot calculate easily by the method of water displacement using a measuring cylinder
VU

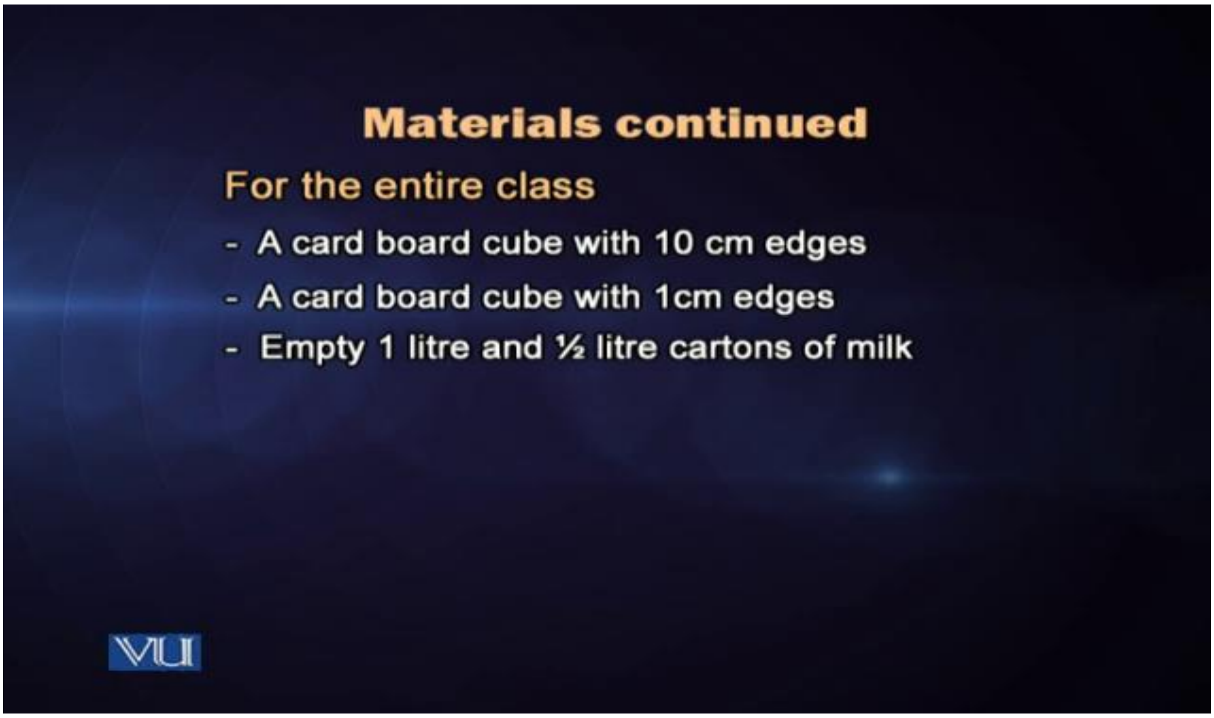

Learning Objectives
Skills / Abilities continued
Students are able to
- record data in tables using appropriate headings, symbols and units
- continue to develop estimation skills associated with lengths and volumes
- Share and analyse data collectively and refine their measuring techniques
VU

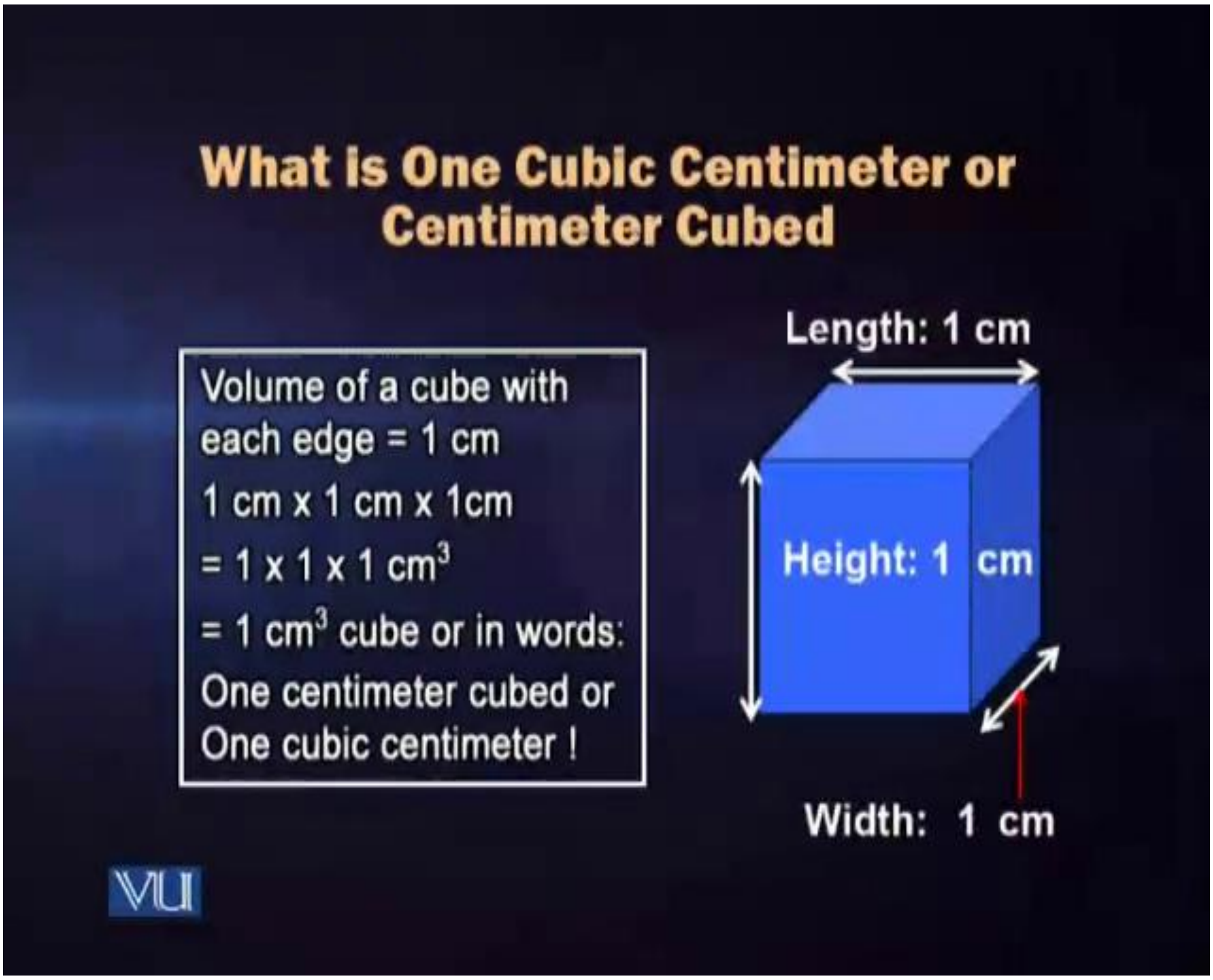

Learning Objectives
Attitudes
Students understand
- the importance of team work/collaborative learning
- that data has to recorded honestly – it must be authentic
- Sharing of data and collective analysis is critical to developing skills for reliable measurements and meaningful understanding of concepts
VU

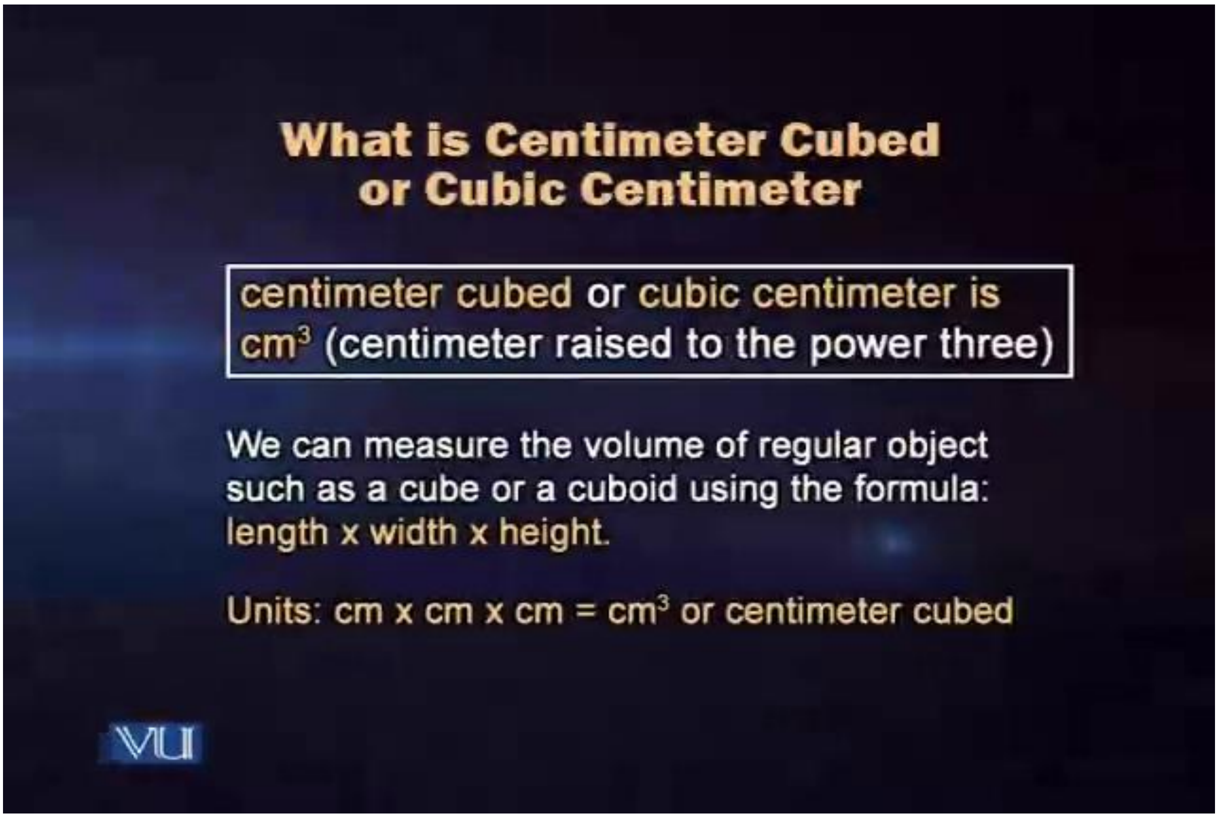

Materials
For each student
1 Volume Lab Worksheet
and a "practice with metric units" worksheet
For groups of three students
- A wooden block and three marbles
- 1 meter rule
- 1 measuring cylinder
- 1 beaker with water
VU

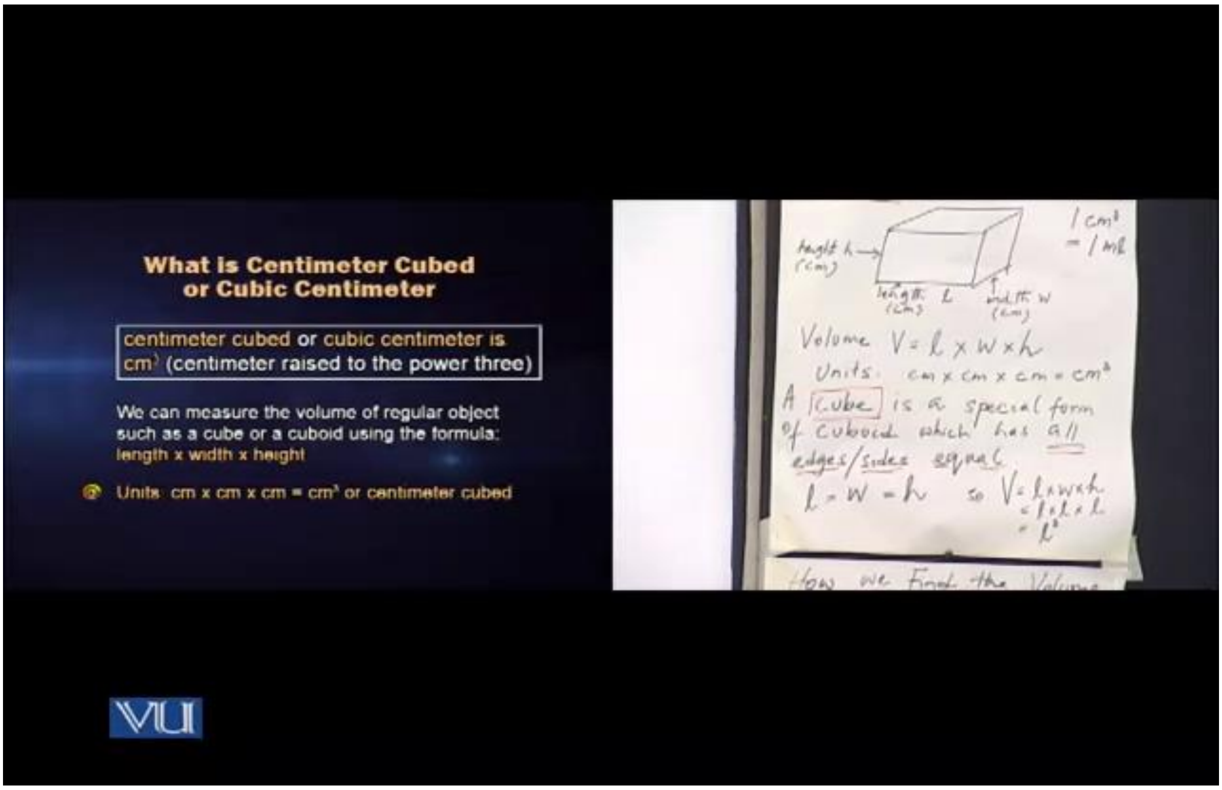

Materials continued
For the entire class
- A chart with metric units
- A chart explaining how to measure the volume of a cuboid
- A chart explaining how to measure the volume of marbles using water displacement
VU

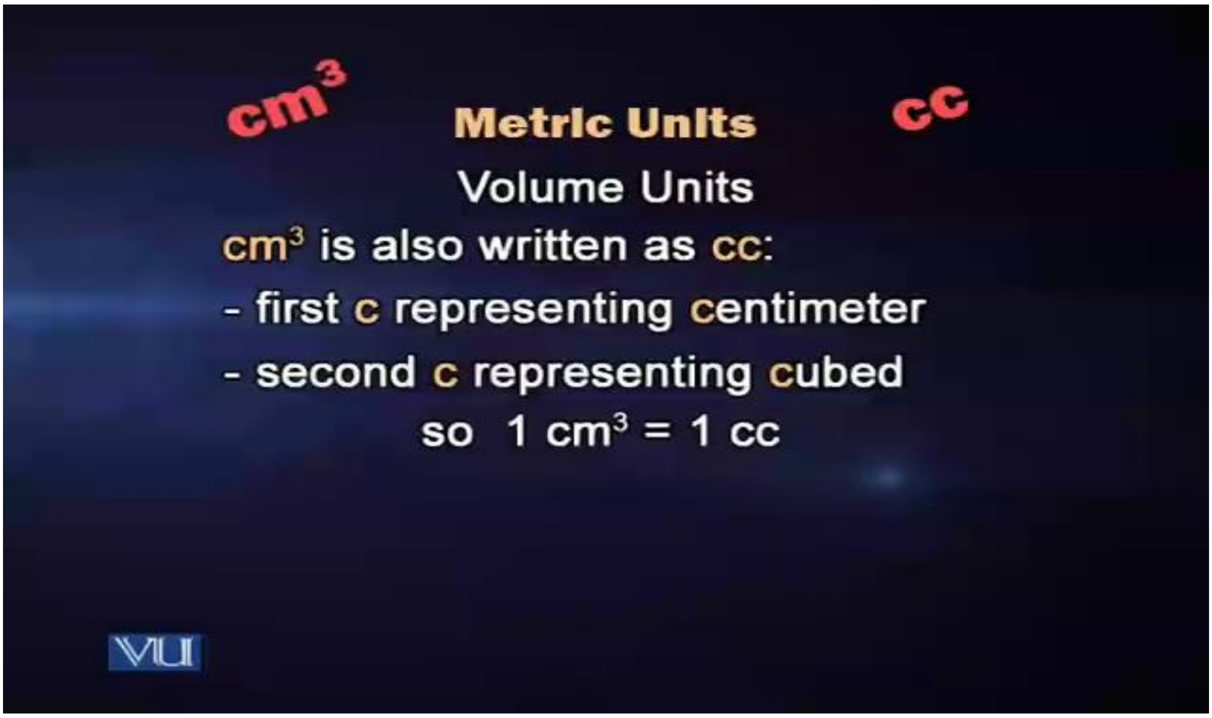

Preparation
- Material for 8 groups of students should be arranged before the lesson
- Find the volume of the wooden blocks and marbles so there is a data base for reference
- Make the three charts and the two cardboard cuboids
VU

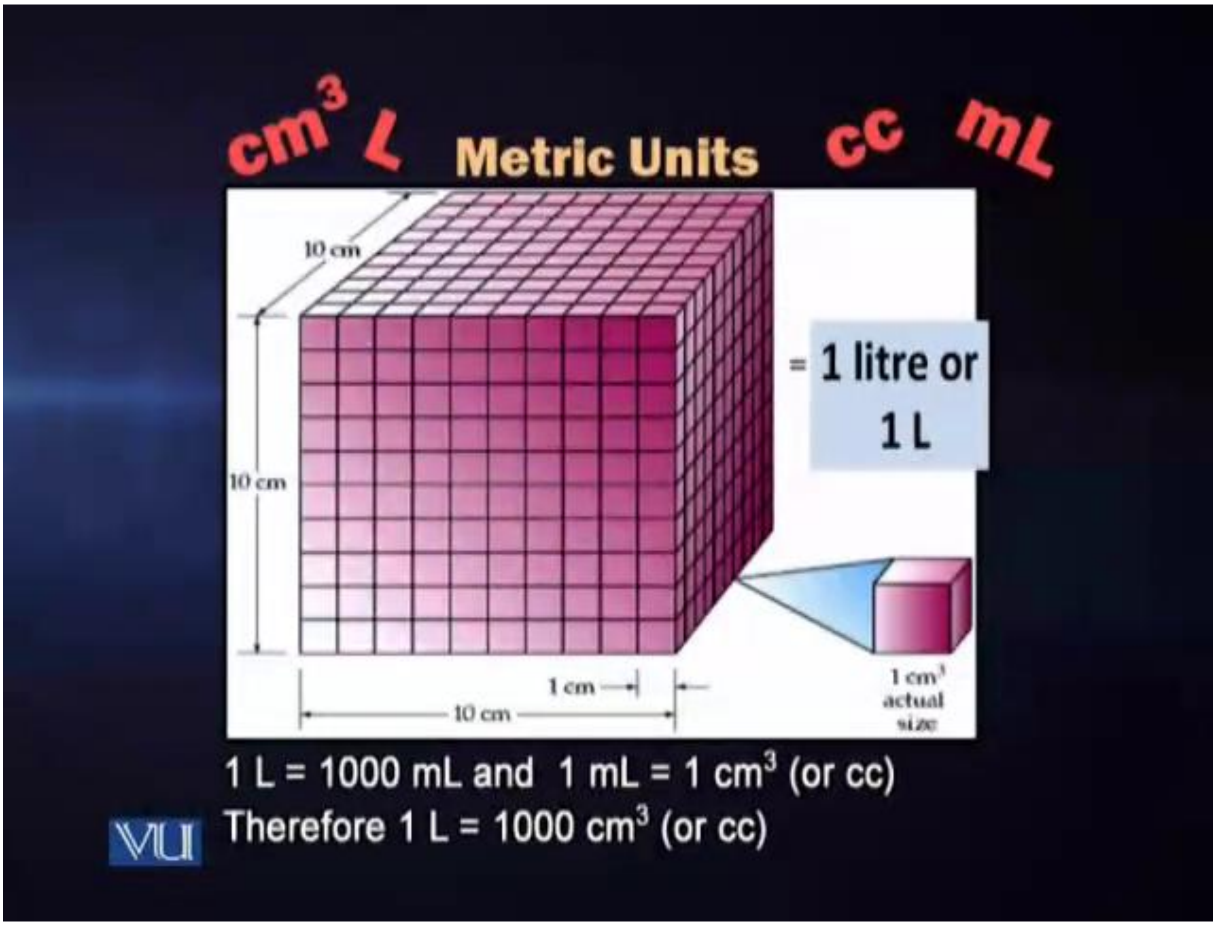

Materials continued
For the entire class
- A card board cube with 10 cm edges
- A card board cube with 1cm edges
- Empty 1 litre and ½ litre cartons of milk
VU

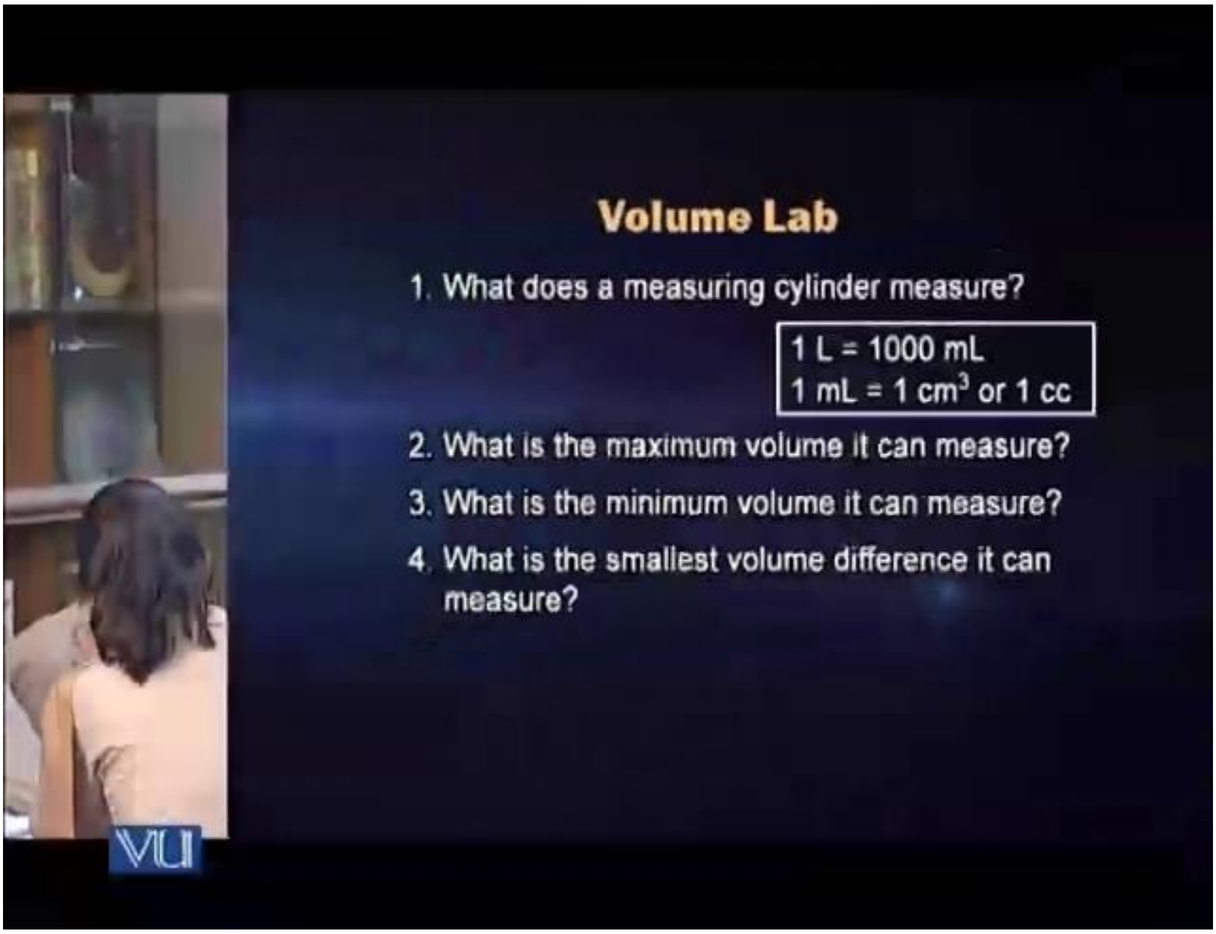

What is One Cubic Centimeter or Centimeter Cubed
Volume of a cube with each edge = 1 cm
1 cm x 1 cm x 1cm
= 1 x 1 x 1 cm³
= 1 cm³ cube or in words:
One centimeter cubed or One cubic centimeter !
Length: 1 cm
Height: 1 cm
Width: 1 cm
VU

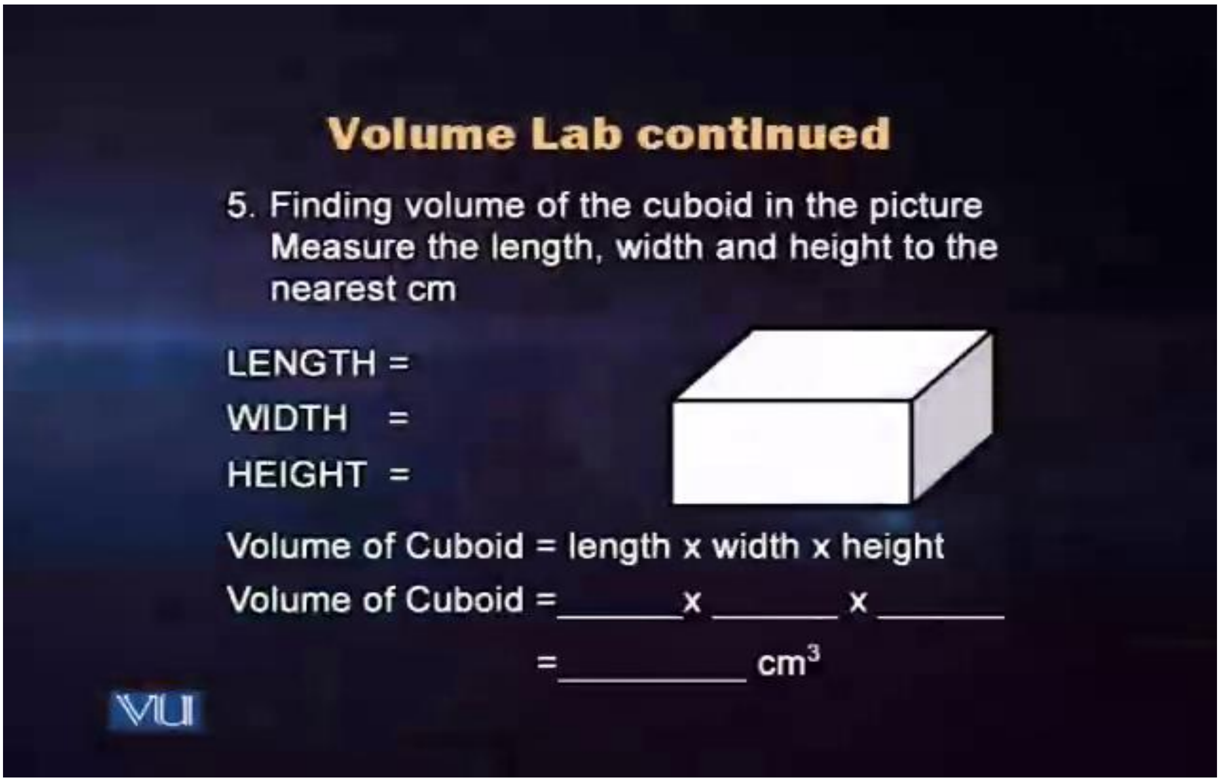

What is Centimeter Cubed or Cubic Centimeter
centimeter cubed or cubic centimeter is cm³ (centimeter raised to the power three)
We can measure the volume of regular object such as a cube or a cuboid using the formula: length x width x height.
Units: cm x cm x cm = cm³ or centimeter cubed
VU

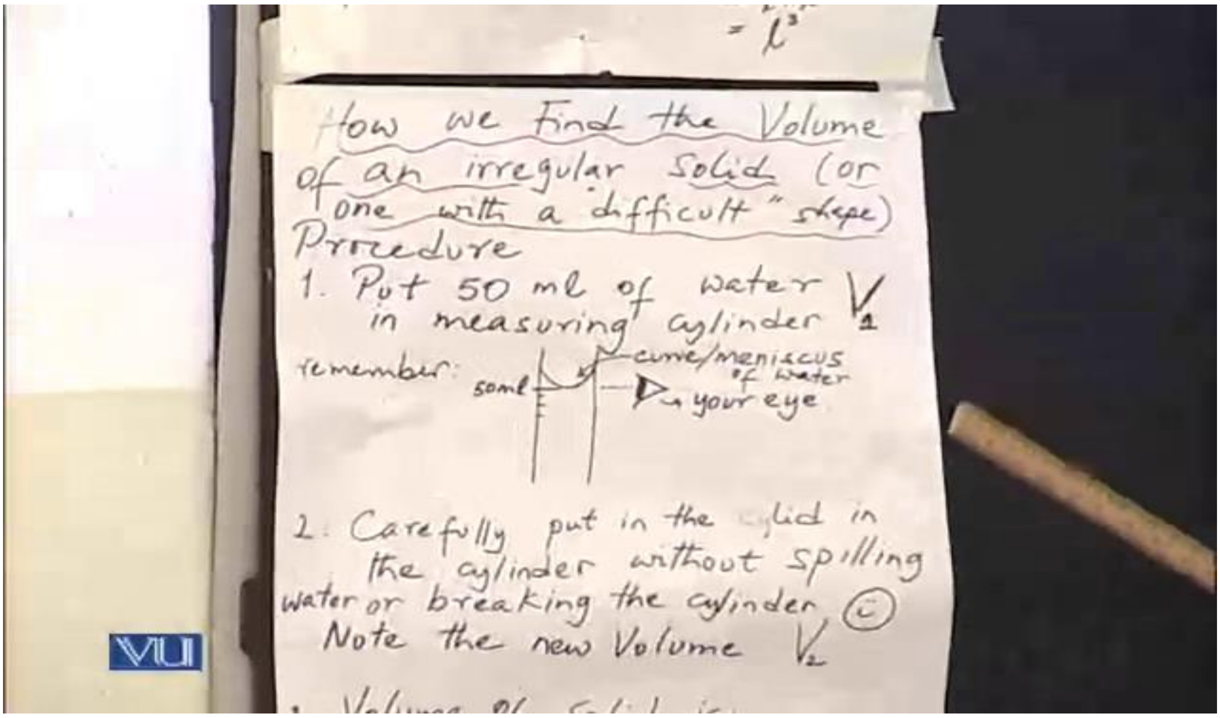

What is Centimeter Cubed or Cubic Centimeter
centimeter cubed or cubic centimeter is cm³ (centimeter raised to the power three)
We can measure the volume of regular object such as a cube or a cuboid using the formula: length x width x height
Units: cm x cm x cm = cm³ or centimeter cubed
1 cm³ = 1 mL
Volume V = l x w x h
Units: cm x cm x cm = cm³
A cube is a special form of cuboid which has all edges/sides equal
l = w = h so V = l x w x h = l x l x l = l³
VU

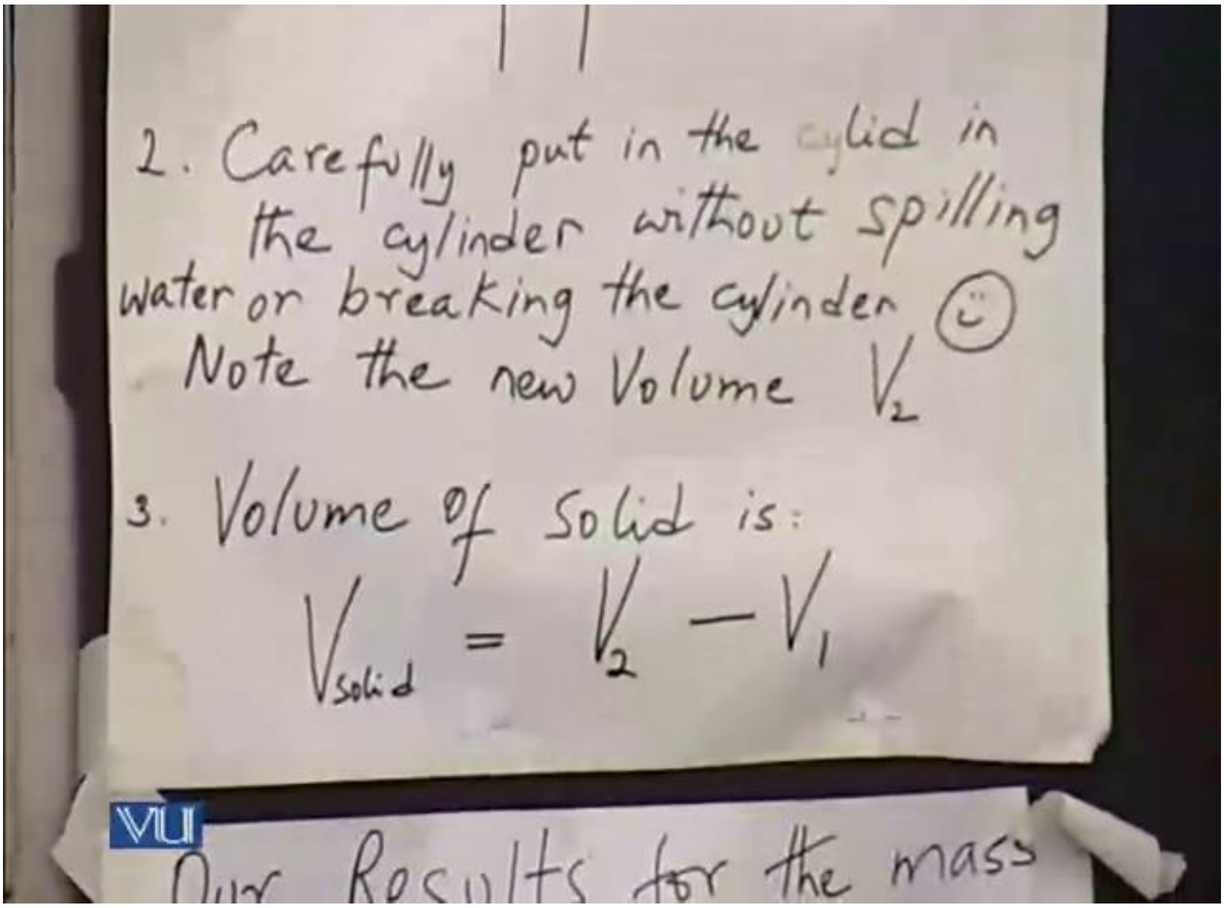

cm3
Metric Units
cc
Volume Units
cm3 is also written as cc:
- first c representing centimeter
- second c representing cubed
so 1 cm3 = 1 cc
VU

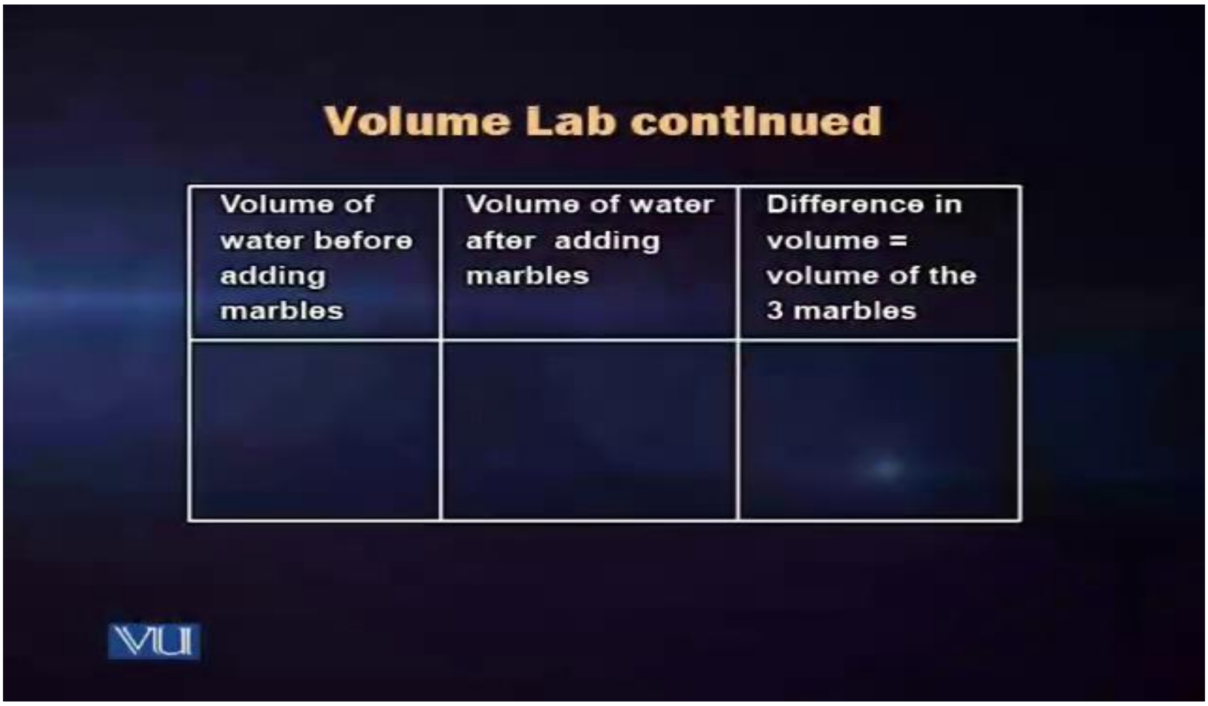

cm3
L
Metric Units
cc
mL
10 cm
10 cm
= 1 litre or 1 L
1 cm
10 cm
1 cm3 actual size
1 L = 1000 mL and 1 mL = 1 cm3 (or cc)
Therefore 1 L = 1000 cm3 (or cc)
VU

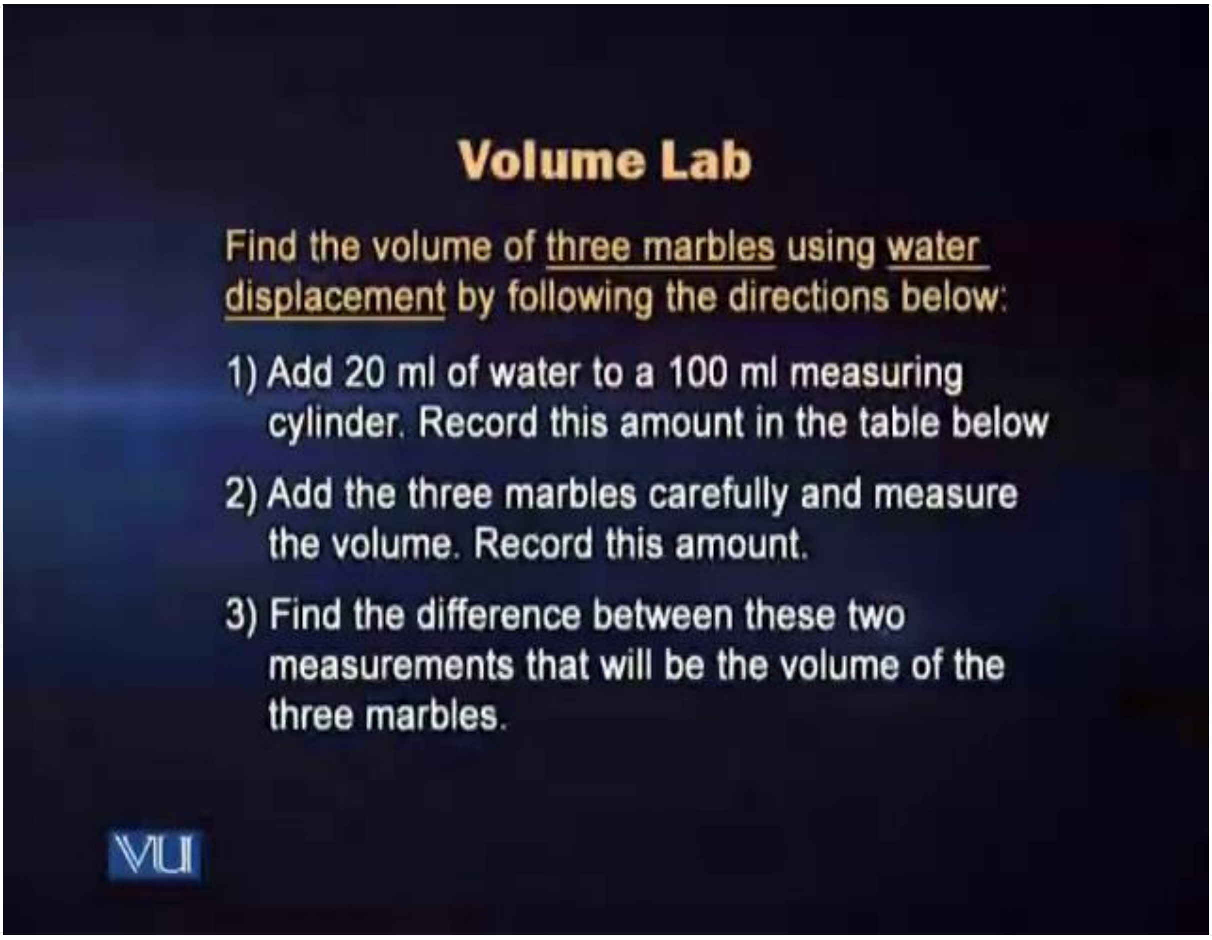

Volume Lab
1. What does a measuring cylinder measure?
1 L = 1000 mL
1 mL = 1 cm³ or 1 cc
2. What is the maximum volume it can measure?
3. What is the minimum volume it can measure?
4. What is the smallest volume difference it can measure?
VU


Volume Lab continued
5. Finding volume of the cuboid in the picture
Measure the length, width and height to the nearest cm
LENGTH =
WIDTH =
HEIGHT =
Volume of Cuboid = length x width x height
Volume of Cuboid =______x ______ x ______
=_________ cm³
VU


How we Find the Volume of an irregular Solid (or one with a "difficult" shape)
Procedure
1. Put 50 ml of water in measuring cylinder V_1
remember:
some
curve/meniscus of water
your eye
2. Carefully put in the solid in the cylinder without spilling water or breaking the cylinder
Note the new Volume V_2


2. Carefully put in the solid in the cylinder without spilling water or breaking the cylinder
Note the new Volume V_2
3. Volume of Solid is:
$V_{solid} = V_2 - V_1$
Our Results for the mass


Volume Lab continued
Volume of water before adding marbles
Volume of water after adding marbles
Difference in volume = volume of the 3 marbles
VU

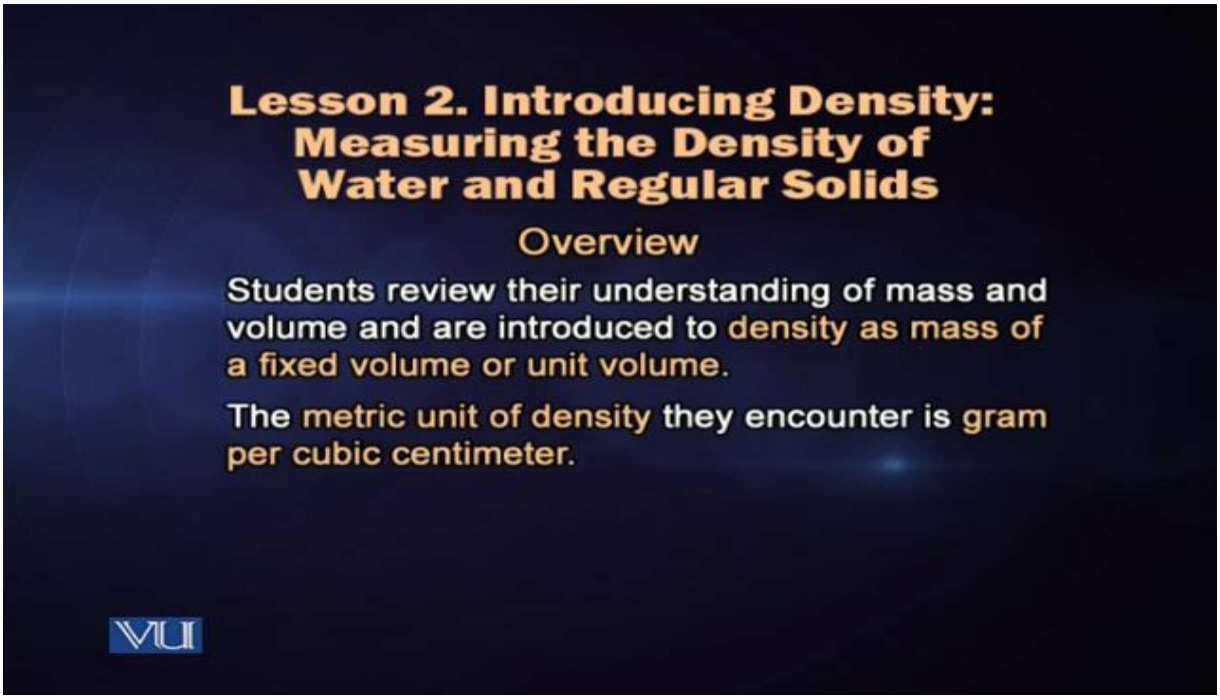

Volume Lab
Find the volume of three marbles using water displacement by following the directions below:
1) Add 20 ml of water to a 100 ml measuring cylinder. Record this amount in the table below
2) Add the three marbles carefully and measure the volume. Record this amount.
3) Find the difference between these two measurements that will be the volume of the three marbles.
VU

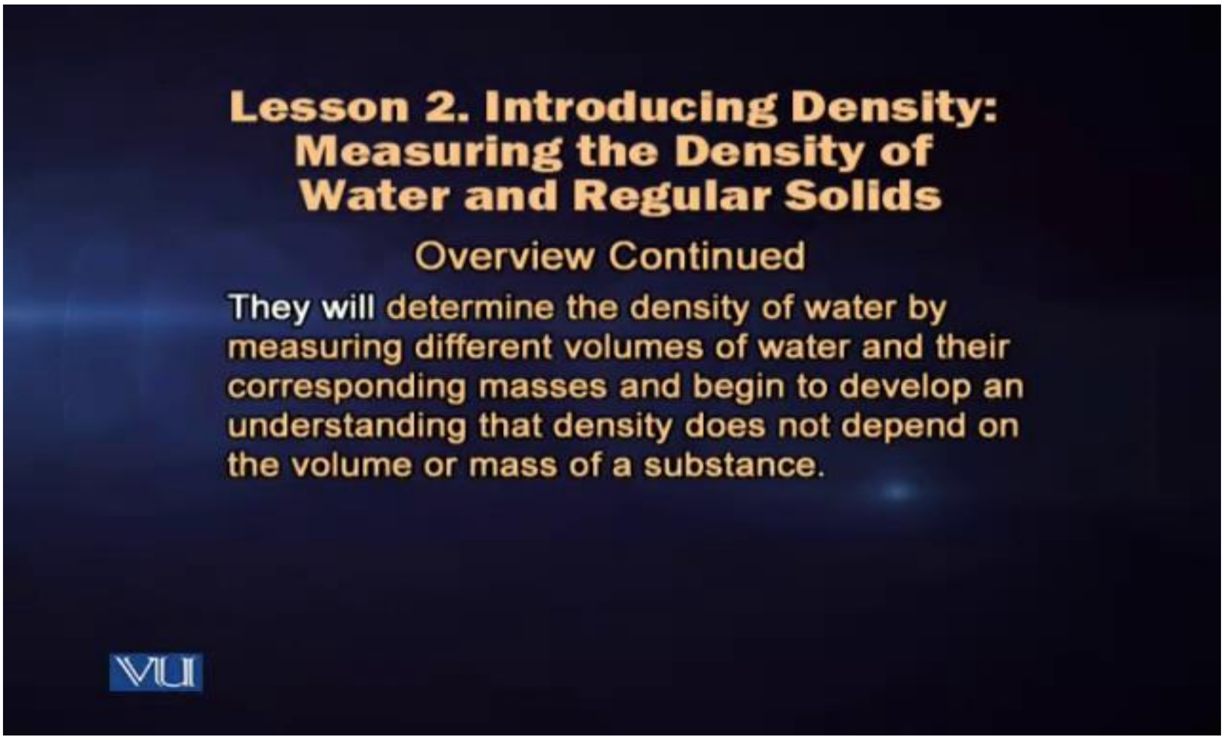
Volume of three marbles

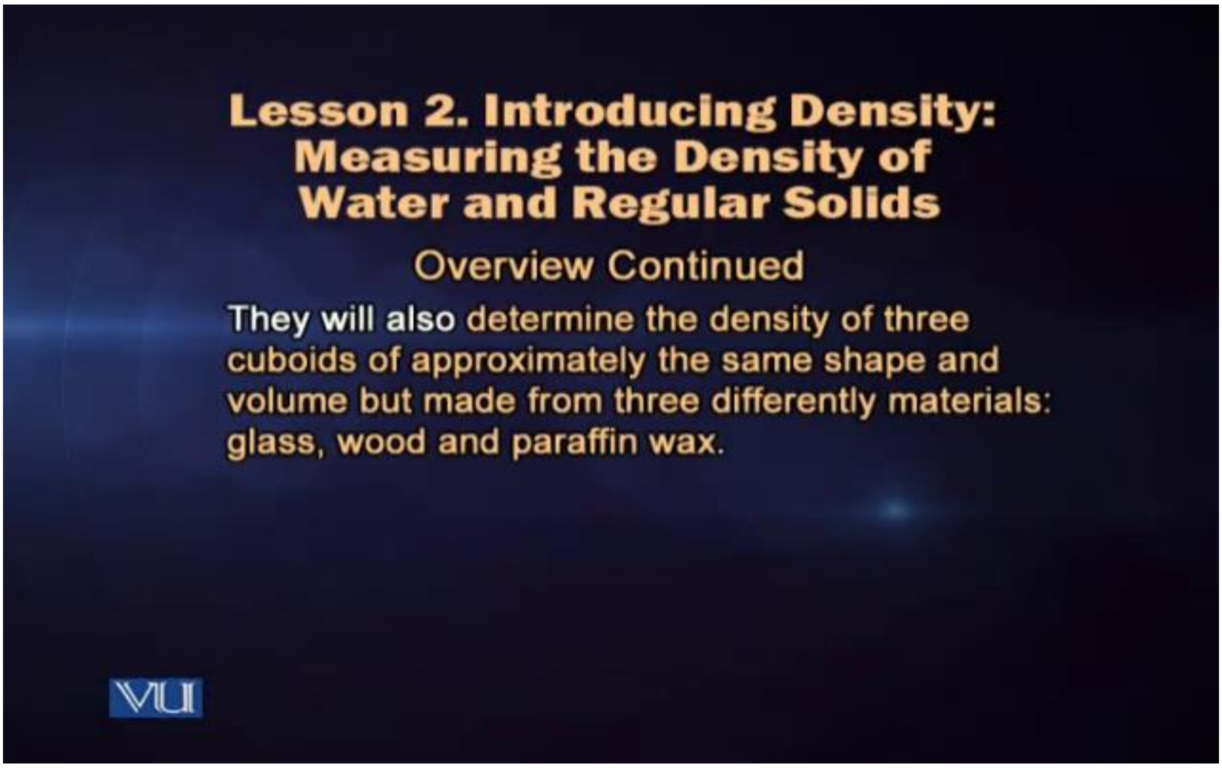
Volume of water (mL)	Volume of water plus 3 marbles (mL)	Volume of 3 marbles (mL)
Data of 5 groups out of 8 is the same :		
50	56	6
Data of Remaining 3 groups :		
20	26	6
20	28	8
20	27	7

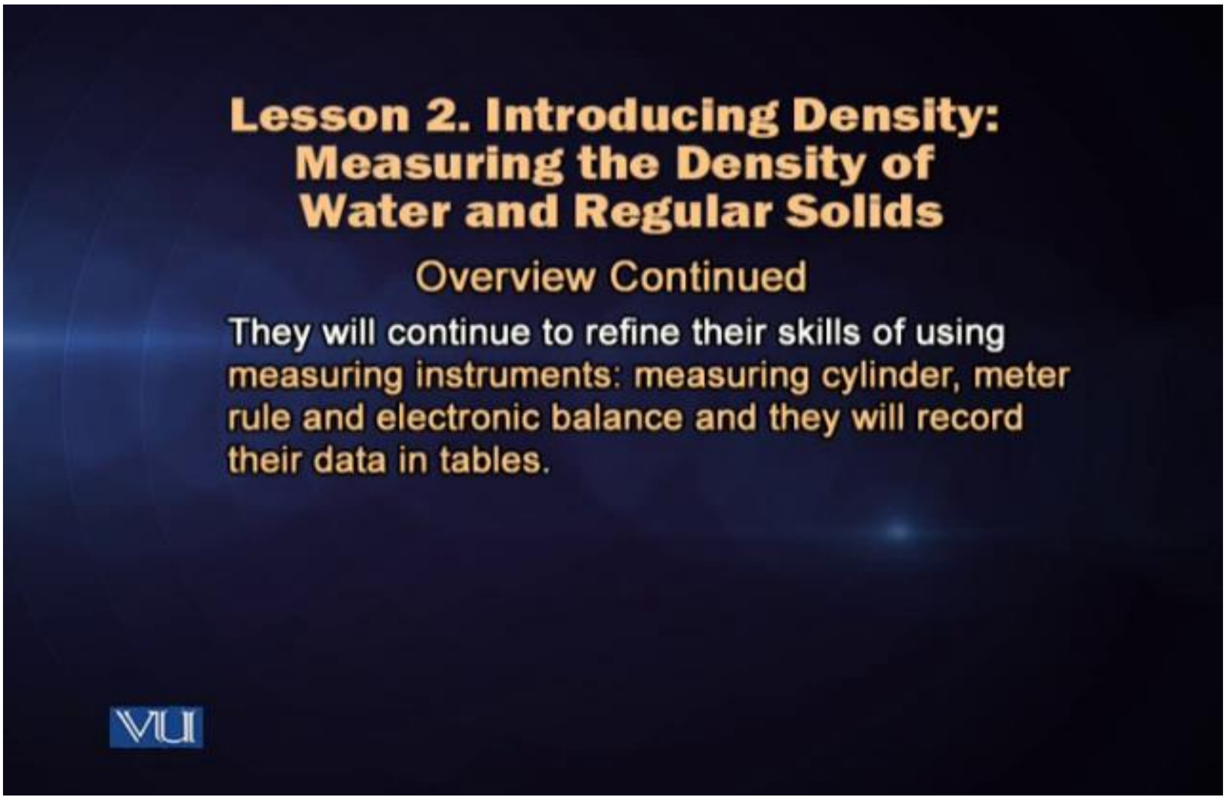
Lecture No 40

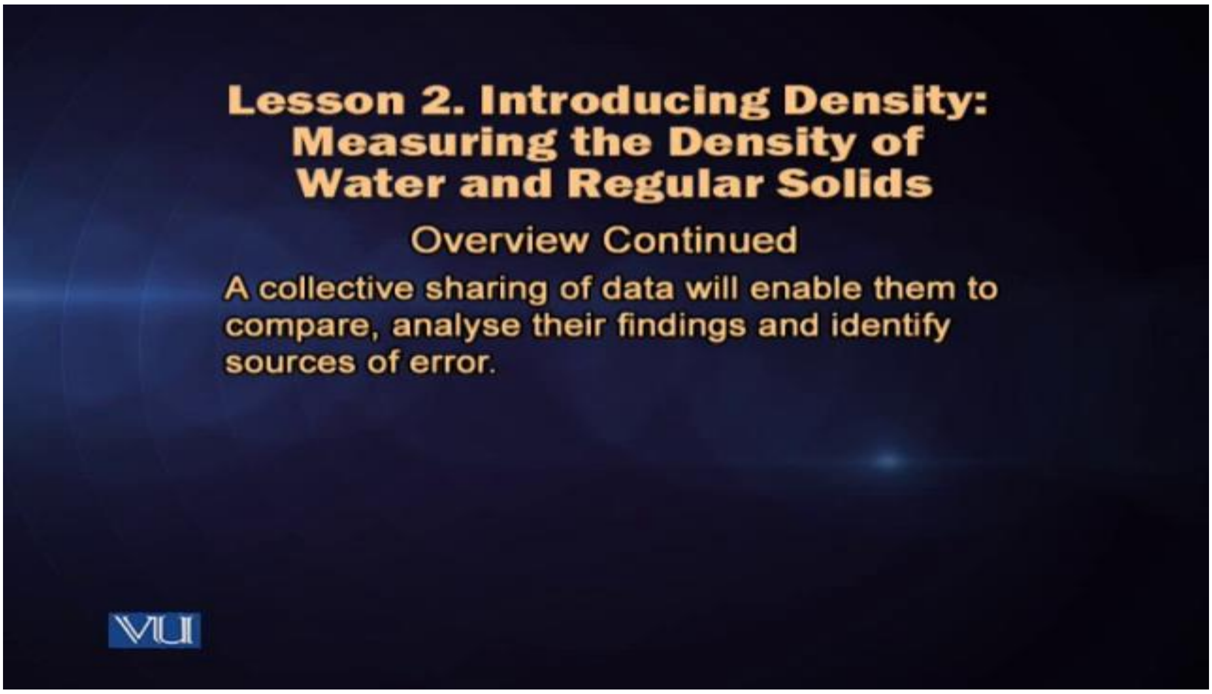
Density measurement activities

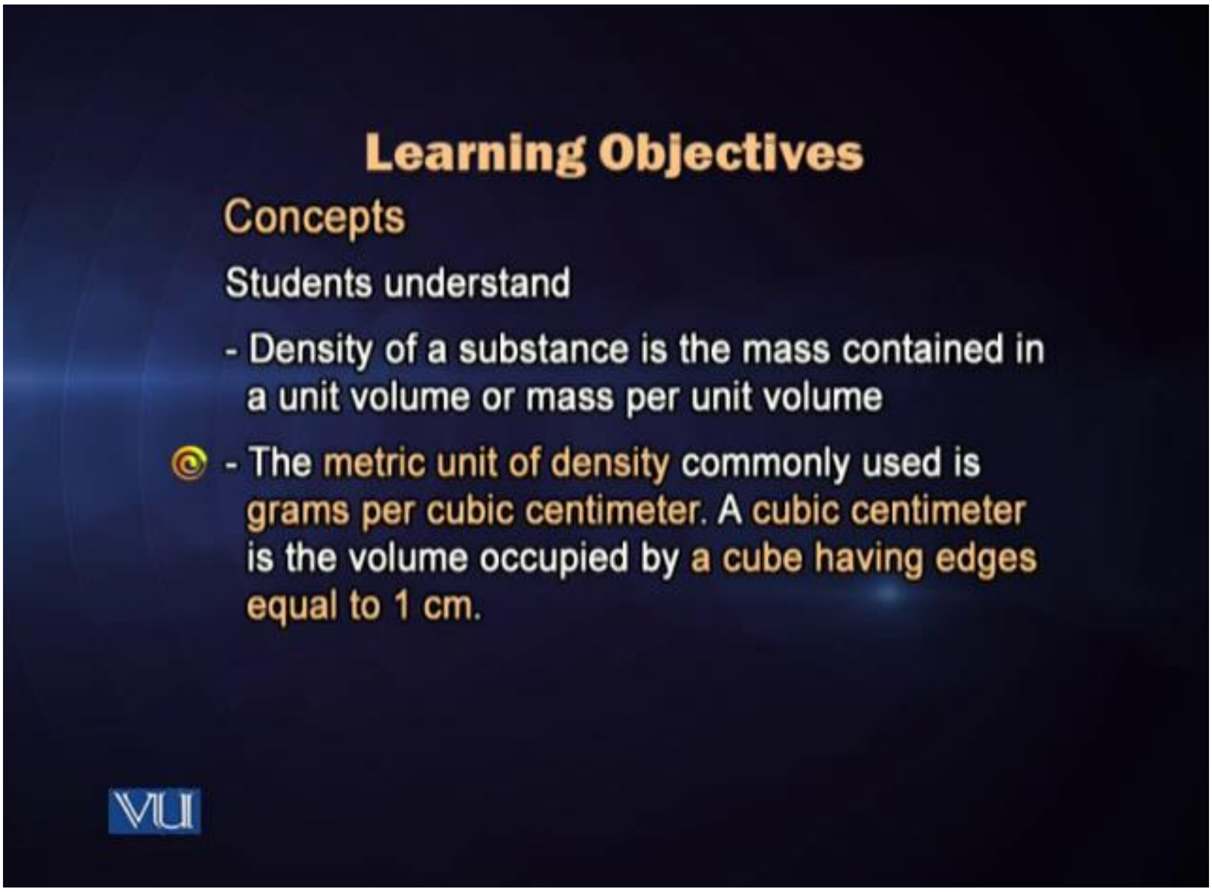


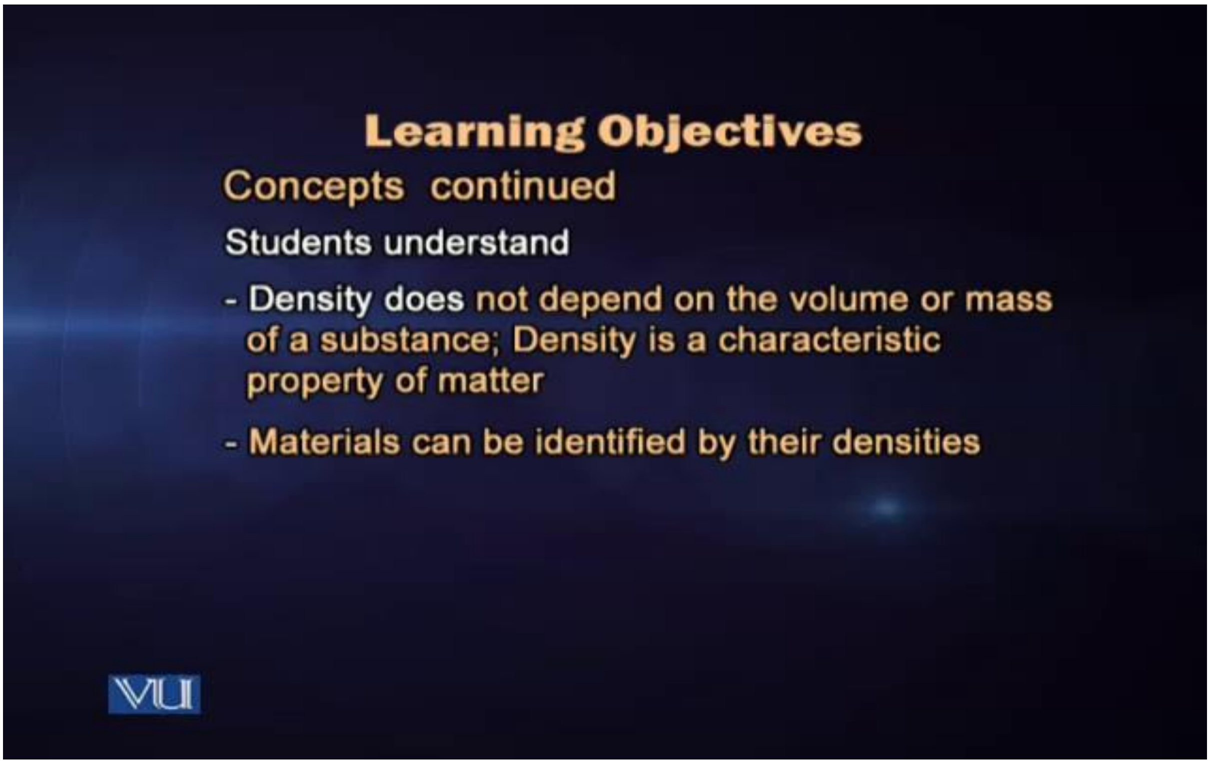


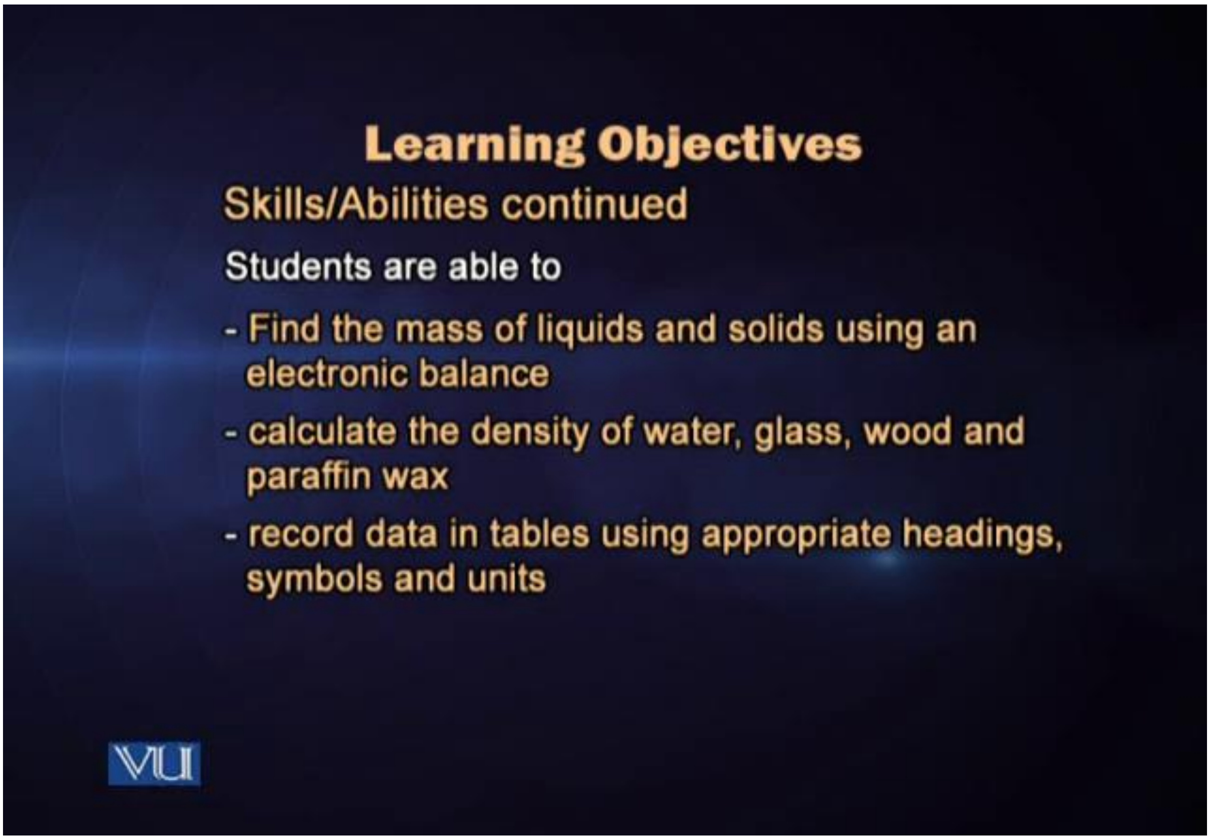

Lesson 2. Introducing Density: Measuring the Density of Water and Regular Solids
Overview Continued
They will also determine the density of three cuboids of approximately the same shape and volume but made from three differently materials: glass, wood and paraffin wax.
VU

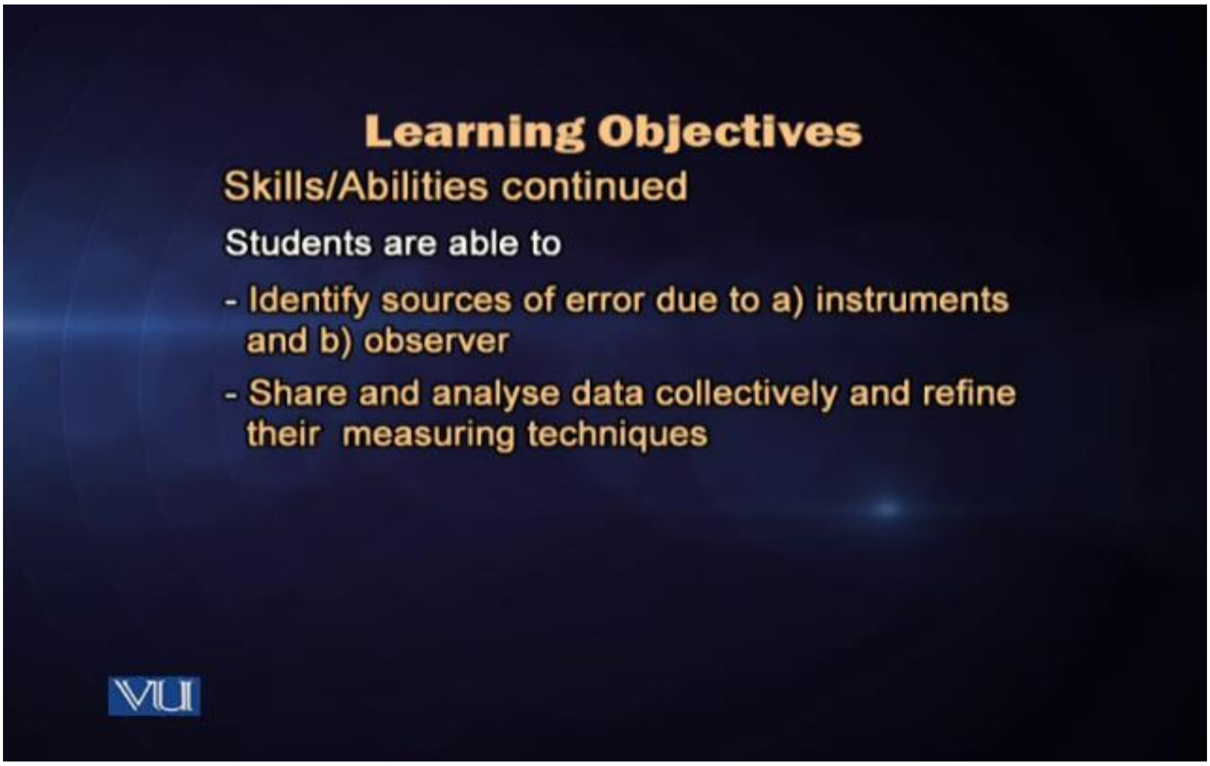

Lesson 2. Introducing Density: Measuring the Density of Water and Regular Solids
Overview Continued
They will continue to refine their skills of using measuring instruments: measuring cylinder, meter rule and electronic balance and they will record their data in tables.
VU

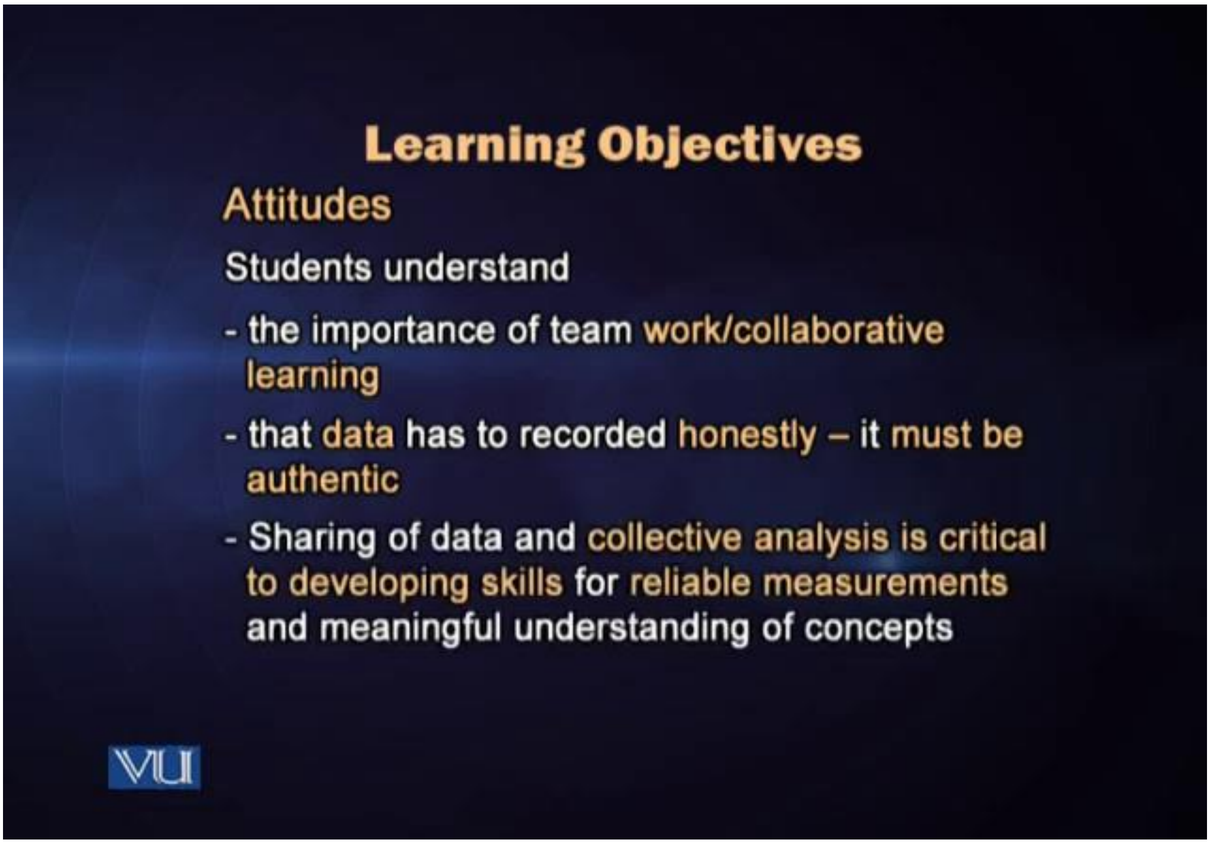

Lesson 2. Introducing Density: Measuring the Density of Water and Regular Solids
Overview Continued
A collective sharing of data will enable them to compare, analyse their findings and identify sources of error.
VU

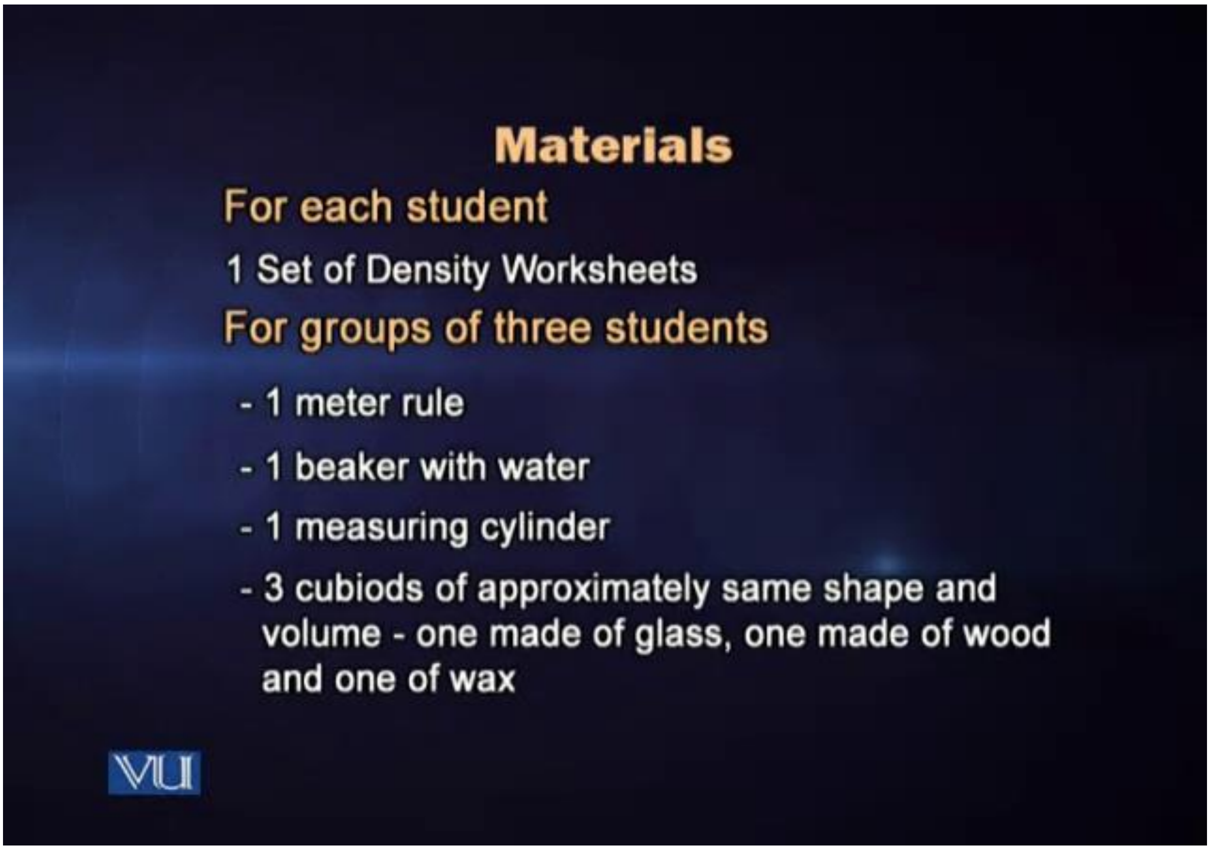

Learning Objectives
Concepts
Students understand
- Density of a substance is the mass contained in a unit volume or mass per unit volume
- The metric unit of density commonly used is grams per cubic centimeter. A cubic centimeter is the volume occupied by a cube having edges equal to 1 cm.
VU

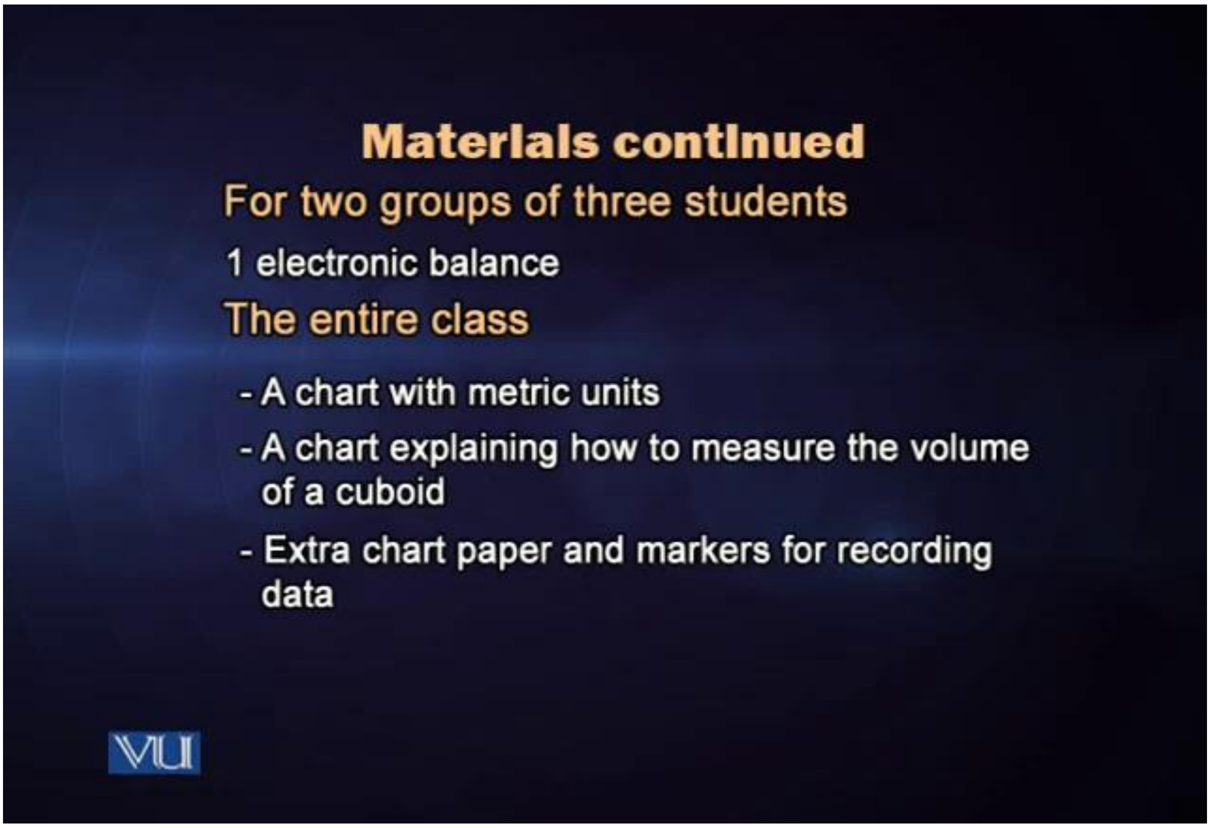

Learning Objectives
Concepts continued
Students understand
- Density does not depend on the volume or mass of a substance; Density is a characteristic property of matter
- Materials can be identified by their densities
VU

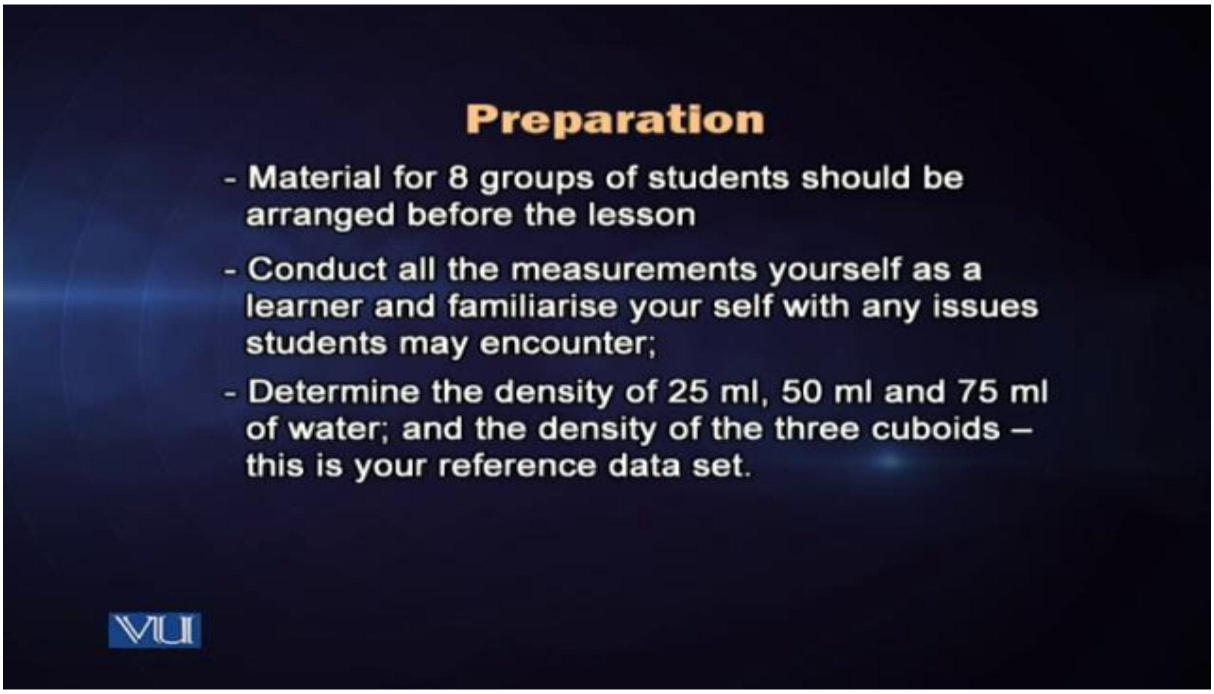

Learning Objectives
Skills/Abilities continued
Students are able to
- Find the mass of liquids and solids using an electronic balance
- calculate the density of water, glass, wood and paraffin wax
- record data in tables using appropriate headings, symbols and units
VU

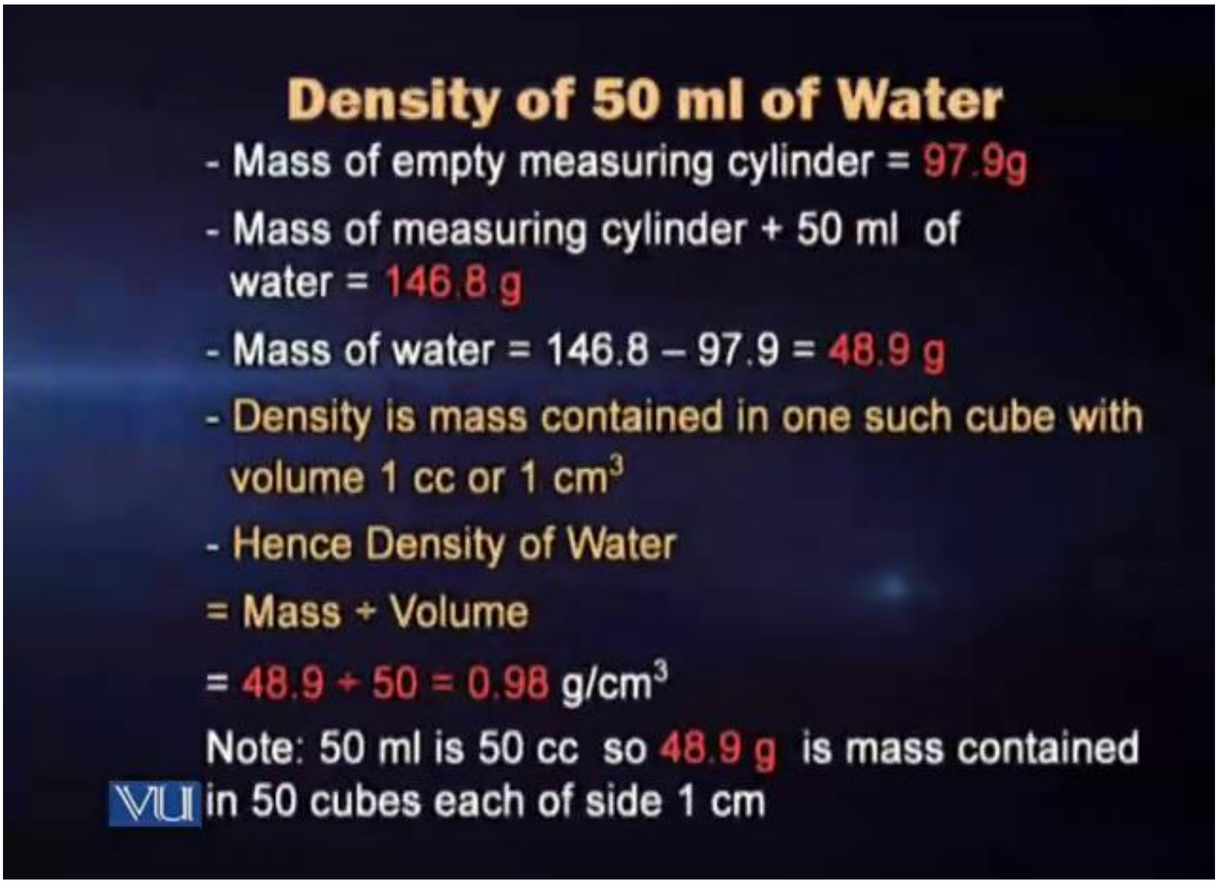

Learning Objectives
Skills/Abilities continued
Students are able to
- Identify sources of error due to a) instruments and b) observer
- Share and analyse data collectively and refine their measuring techniques
VU


Learning Objectives
Attitudes
Students understand
- the importance of team work/collaborative learning
- that data has to recorded honestly – it must be authentic
- Sharing of data and collective analysis is critical to developing skills for reliable measurements and meaningful understanding of concepts
VU


Materials
For each student
1 Set of Density Worksheets
For groups of three students
- 1 meter rule
- 1 beaker with water
- 1 measuring cylinder
- 3 cubiods of approximately same shape and volume - one made of glass, one made of wood and one of wax
VU


Materials continued
For two groups of three students
1 electronic balance
The entire class
- A chart with metric units
- A chart explaining how to measure the volume of a cuboid
- Extra chart paper and markers for recording data
VU


Preparation
- Material for 8 groups of students should be arranged before the lesson
- Conduct all the measurements yourself as a learner and familiarise your self with any issues students may encounter;
- Determine the density of 25 ml, 50 ml and 75 ml of water; and the density of the three cuboids – this is your reference data set.


Density of 50 ml of Water
- Mass of empty measuring cylinder = 97.9g
- Mass of measuring cylinder + 50 ml of water = 146.8 g
- Mass of water = 146.8 – 97.9 = 48.9 g
- Density is mass contained in one such cube with volume 1 cc or 1 cm^3
- Hence Density of Water
= Mass ÷ Volume
= 48.9 ÷ 50 = 0.98 g/cm^3
Note: 50 ml is 50 cc so 48.9 g is mass contained in 50 cubes each of side 1 cm

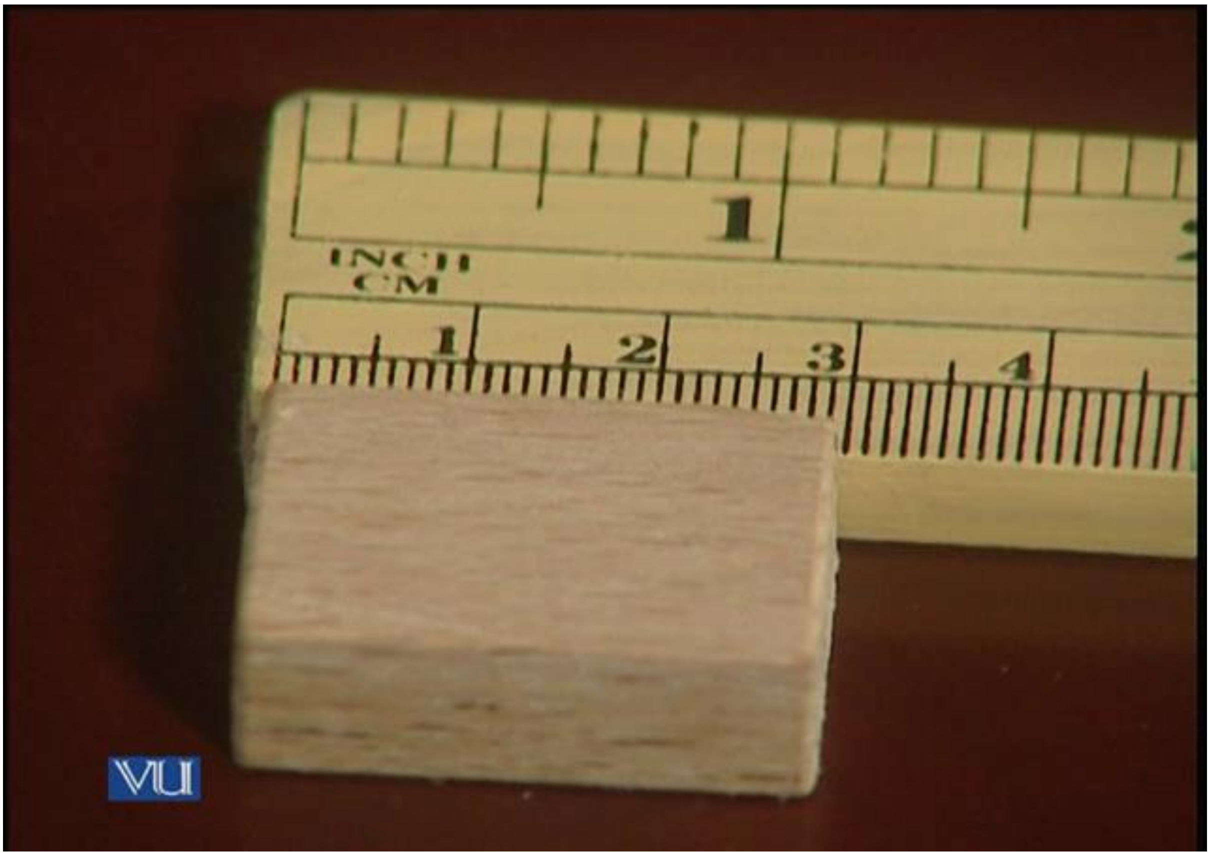
Mass of 25 ml of Water

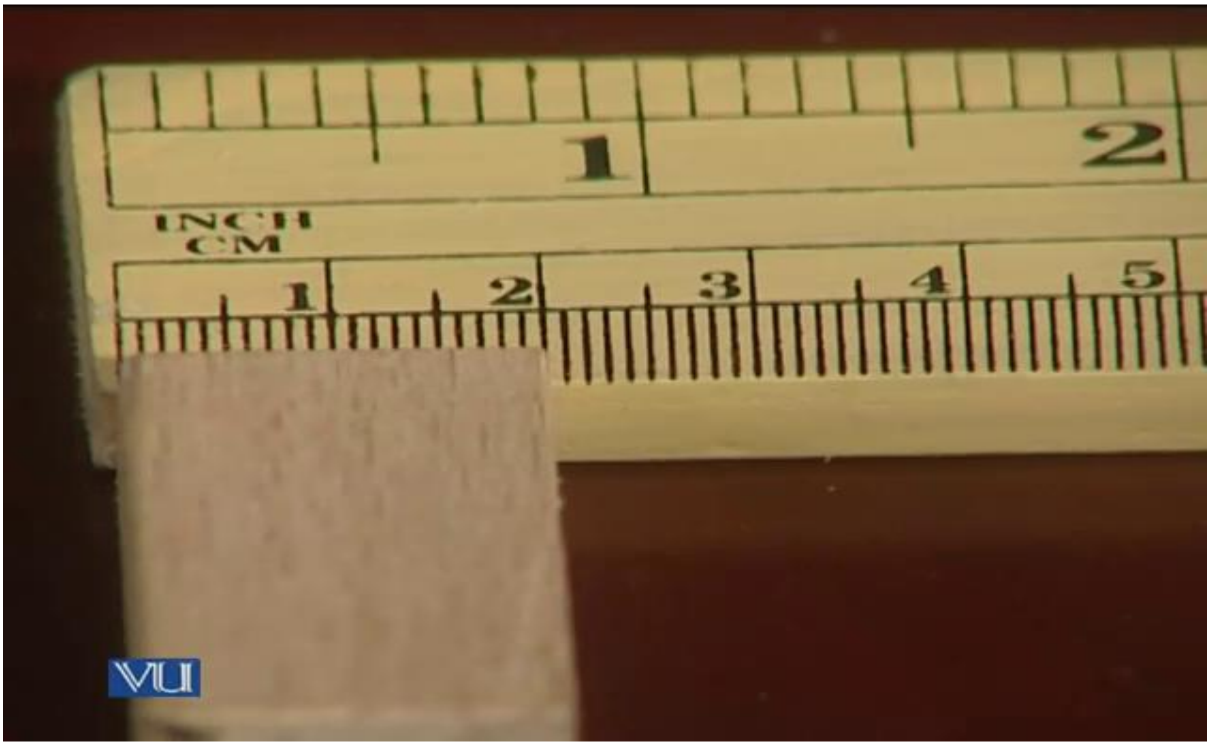
- Mass of empty measuring cylinder = 109.1 g
- Mass of measuring cylinder + 75 ml of water = 132.4 g
- Mass of 25 ml of water = 132.4 – 109.1 = 23.3 g

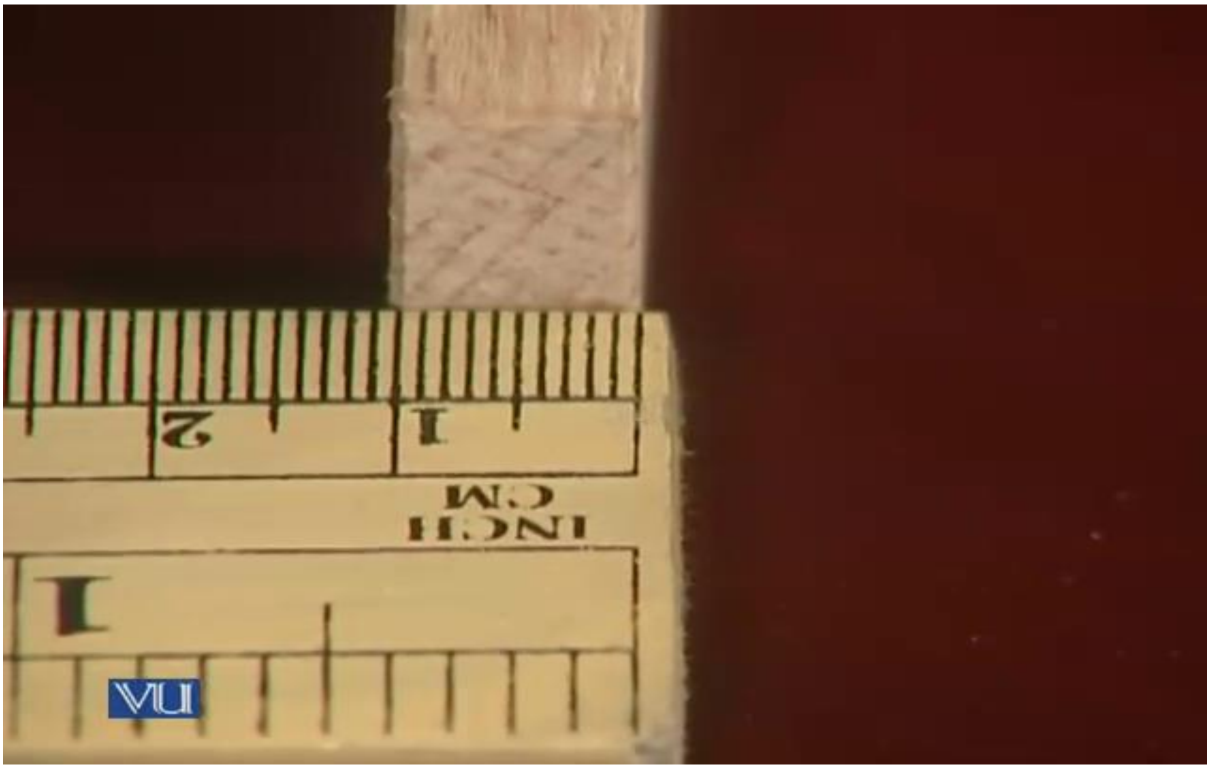
VU

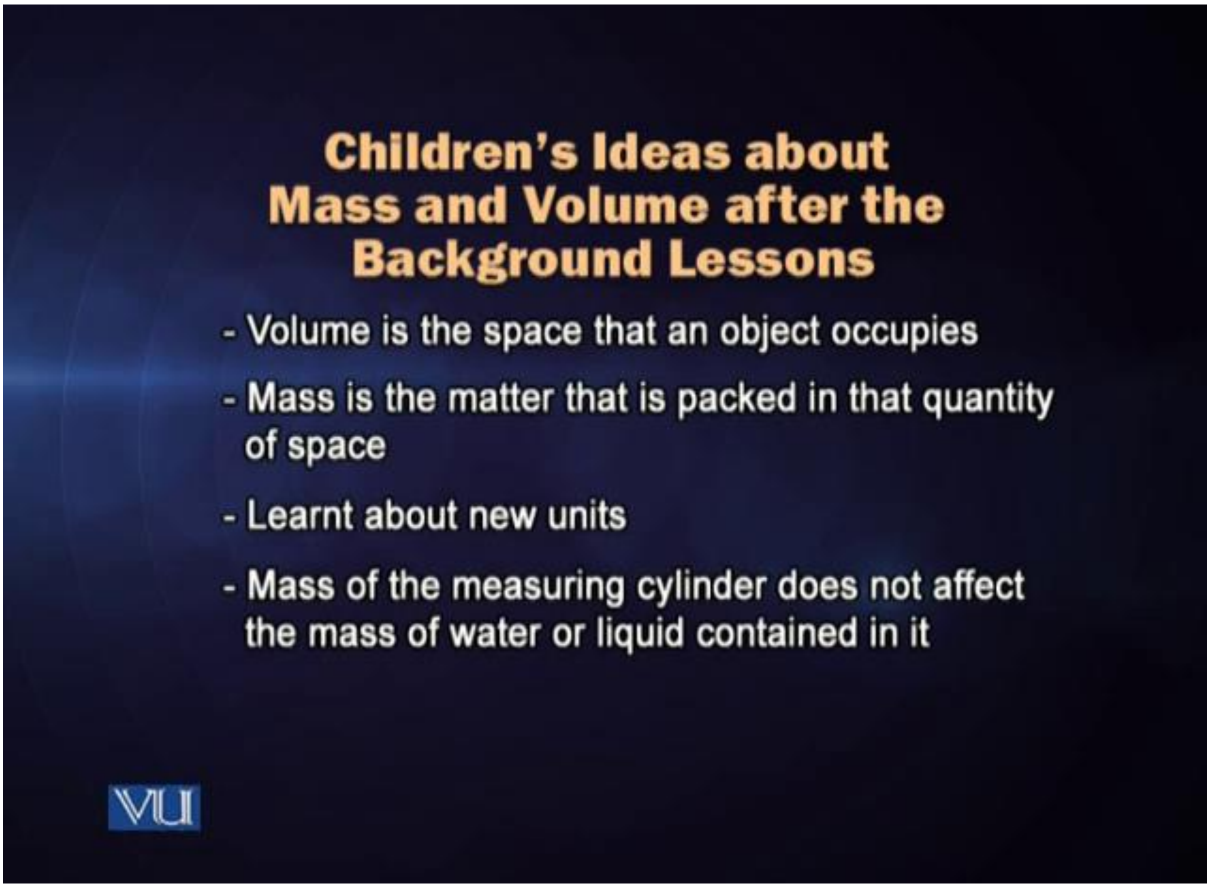
Volume of Water (ml) or (cm^3)	Mass of Water (g)	Density of water is the Mass of 1 cm^3 of water Density = Mass ÷ Volume (g/cm^3)
25	23.3	23.3 ÷ 25 = 0.93
50	48.9	48.9 ÷ 50 = 0.98
75	74.6	74.6 ÷ 75 = 0.99

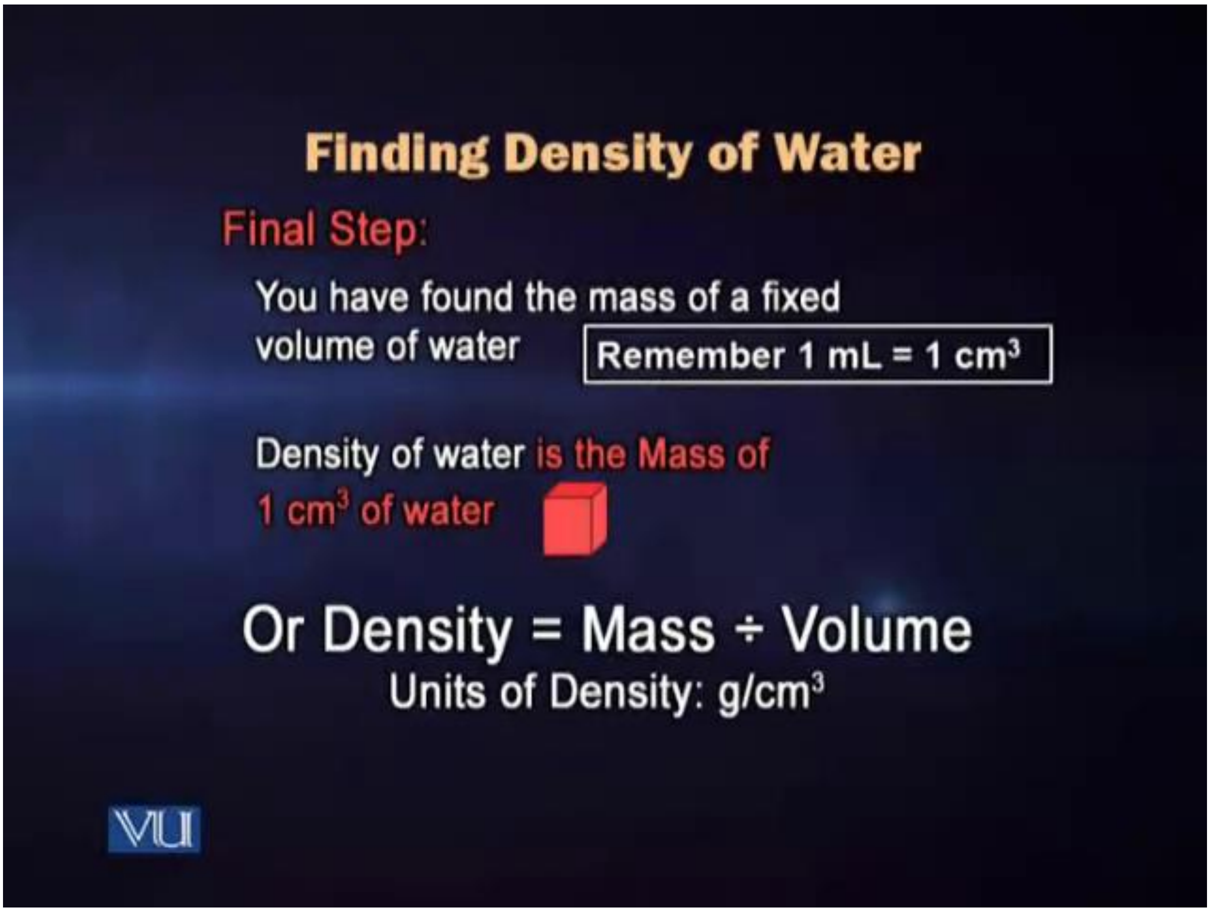
VU

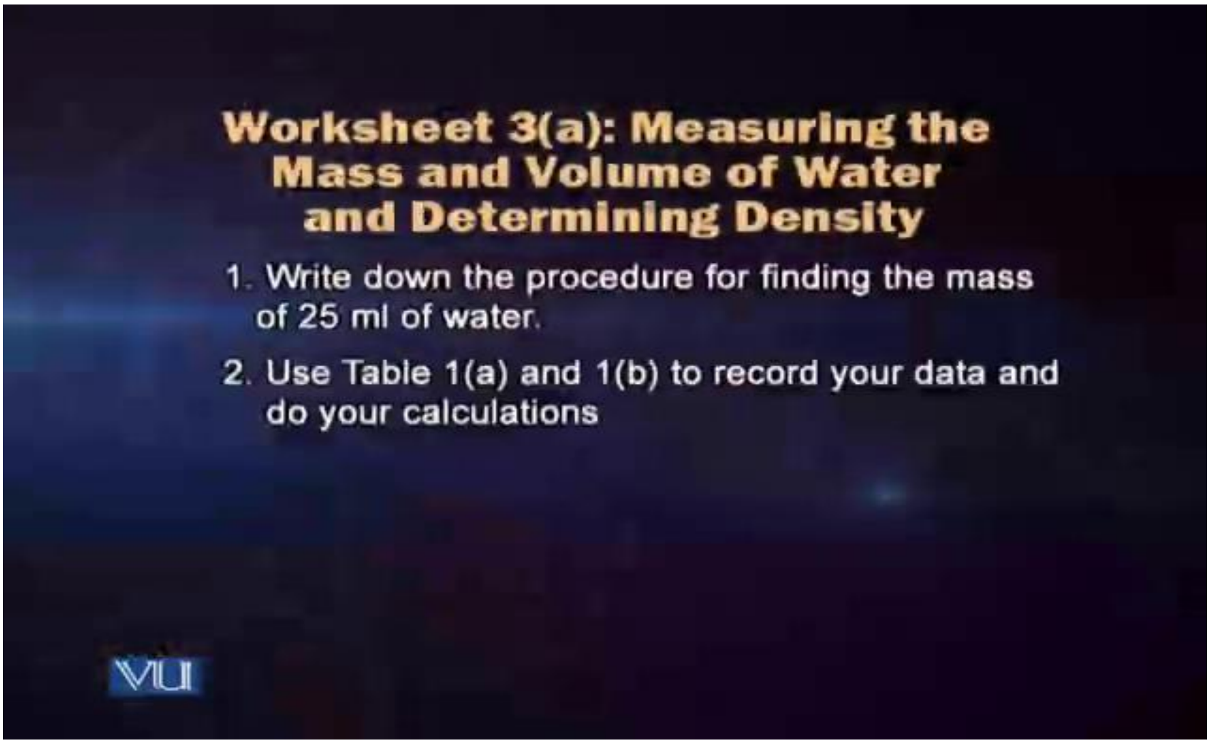

1
INCH
CM
1
2
3
4
VU


1
2
INCH
CM
1
2
3
4
5
VU




Children's Ideas about Mass and Volume after the Background Lessons
- Volume is the space that an object occupies
- Mass is the matter that is packed in that quantity of space
- Learnt about new units
- Mass of the measuring cylinder does not affect the mass of water or liquid contained in it
VU


Finding Density of Water
Final Step:
You have found the mass of a fixed volume of water
Remember 1 mL = 1 cm³
Density of water is the Mass of 1 cm³ of water
Or Density = Mass ÷ Volume
Units of Density: g/cm³
VU


Worksheet 3(a): Measuring the Mass and Volume of Water and Determining Density
1. Write down the procedure for finding the mass of 25 ml of water.
2. Use Table 1(a) and 1(b) to record your data and do your calculations
VU

4 Step Procedure for Finding Mass of Water

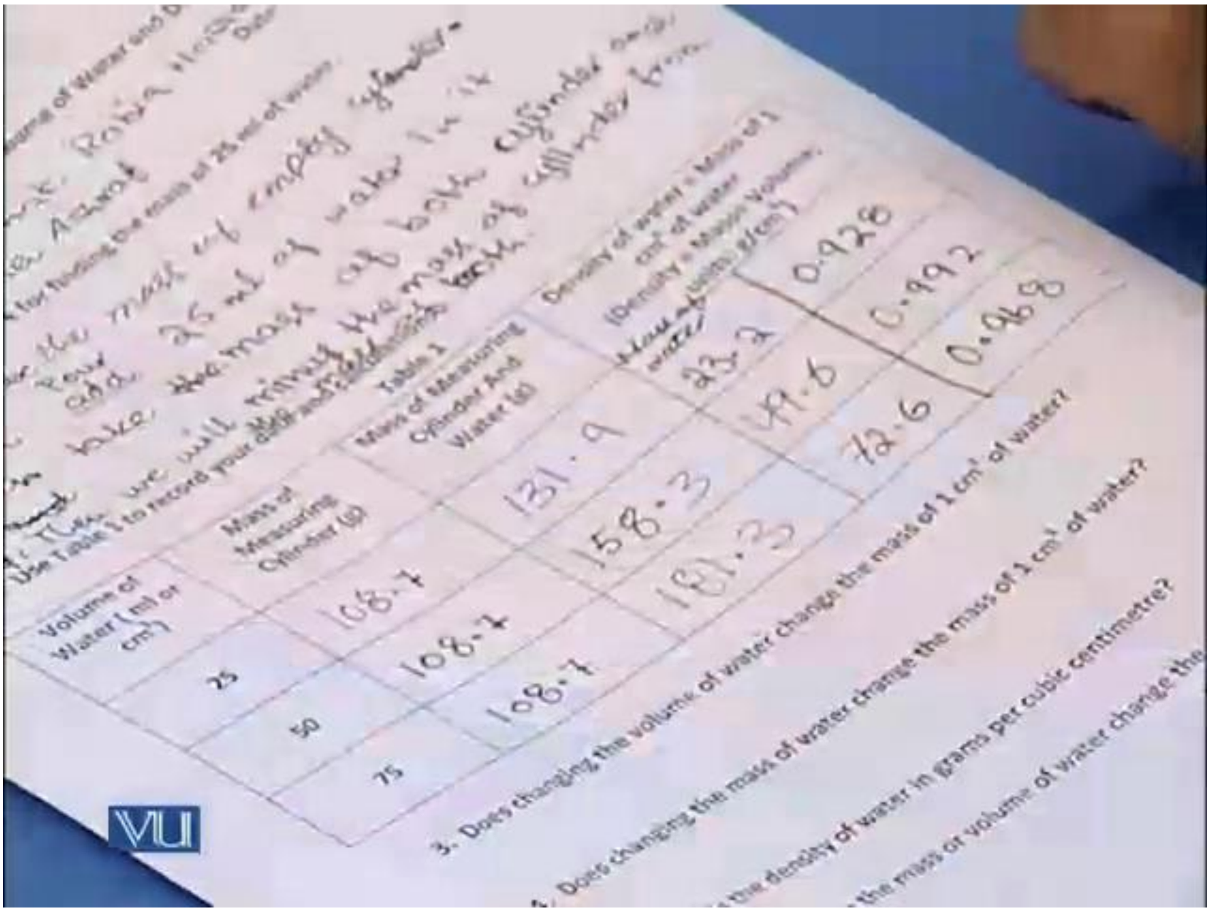
1) Find mass of empty measuring cylinder
2) Pour a fixed volume of water e.g. 25 ml keeping eye directly in line with the bottom of the meniscus
3) Find the mass of measuring cylinder plus water
4) Find mass of water by subtracting mass of empty cylinder from mass of cylinder plus water

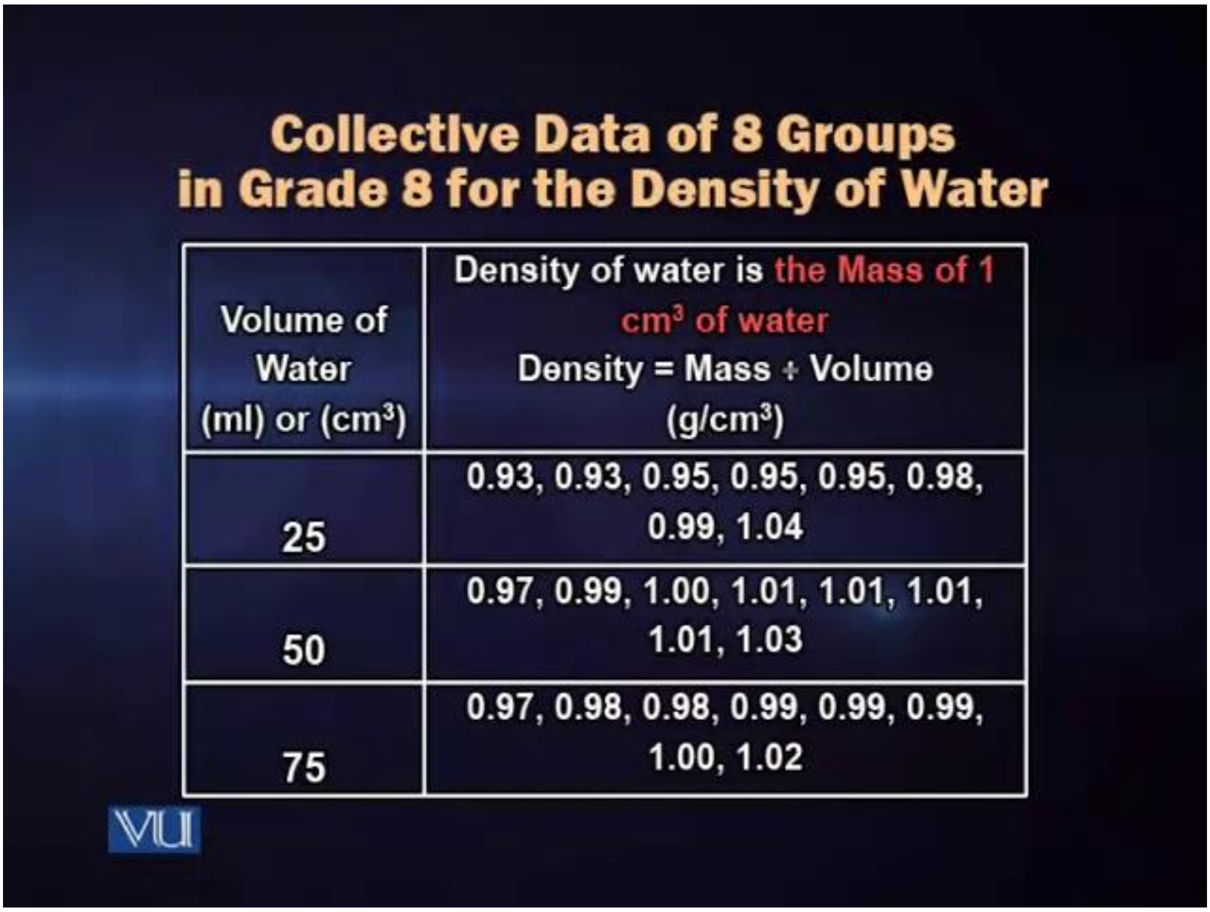
VU

Table 1 (b)

Volume of Water (ml) or (cm^3)	Mass of Water (g)	Density of water is the Mass of 1 cm^3 of water Density = Mass ÷ Volume (g/cm^3)
25		
50		
75		

VU





Collective Data of 8 Groups in Grade 8 for the Density of Water

Volume of Water (ml) or (cm³)	Density of water is the Mass of 1 cm³ of water Density = Mass ÷ Volume (g/cm³)
25	0.93, 0.93, 0.95, 0.95, 0.95, 0.98, 0.99, 1.04
50	0.97, 0.99, 1.00, 1.01, 1.01, 1.01, 1.01, 1.03
75	0.97, 0.98, 0.98, 0.99, 0.99, 0.99, 1.00, 1.02

Worksheet 3(b):Comparing the Densities of Different Substances

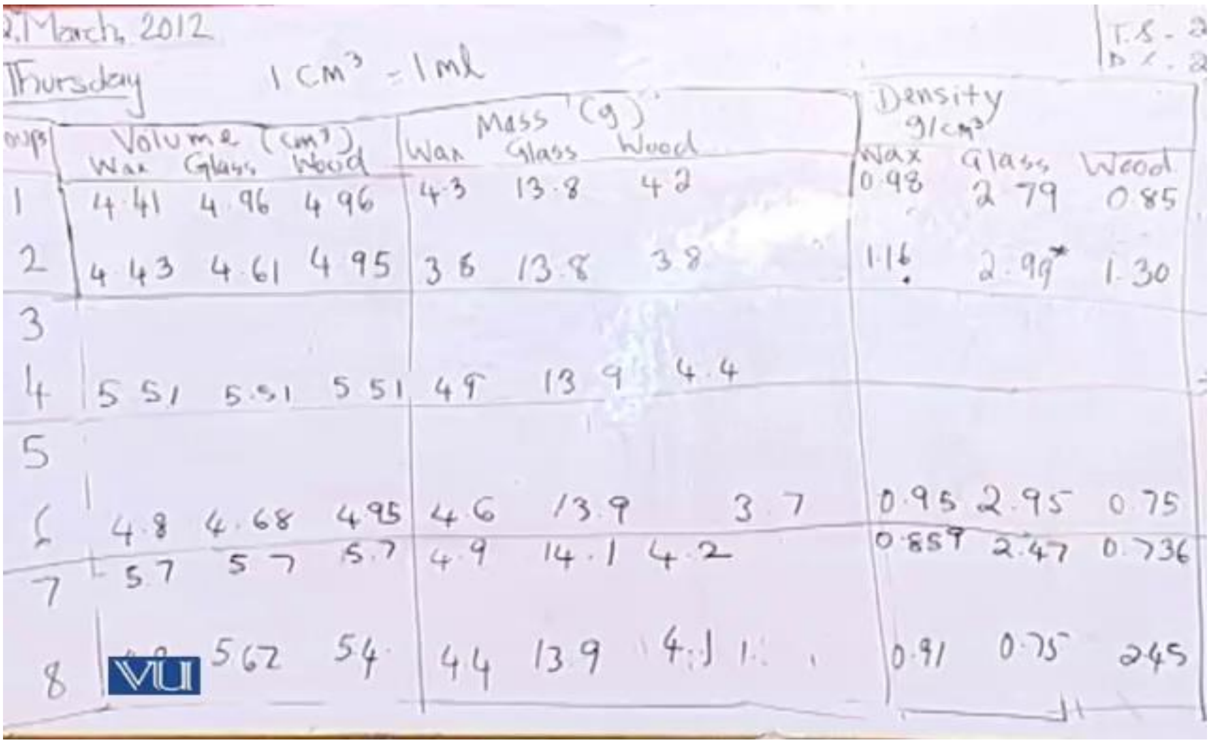
Procedure

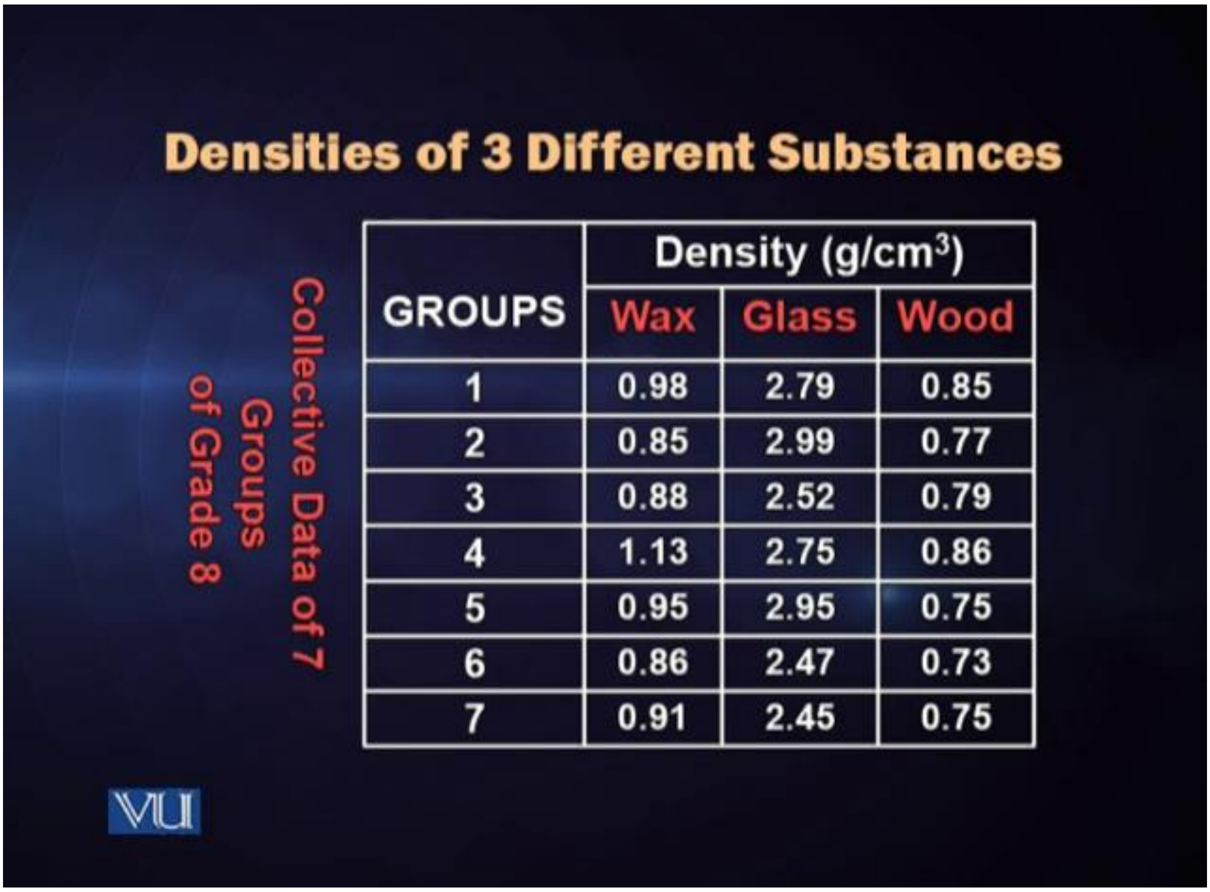
1. Take the blocks of wax, wood and glass out of the tray.
2. Discuss the following questions with other members of your group:
   a) Do you think all the blocks have the same density?
   b) What evidence do you have to support your answer?
   c) What measurements will you need to test your answer?

Worksheet 3(b): Comparing the Densities of Different Substances

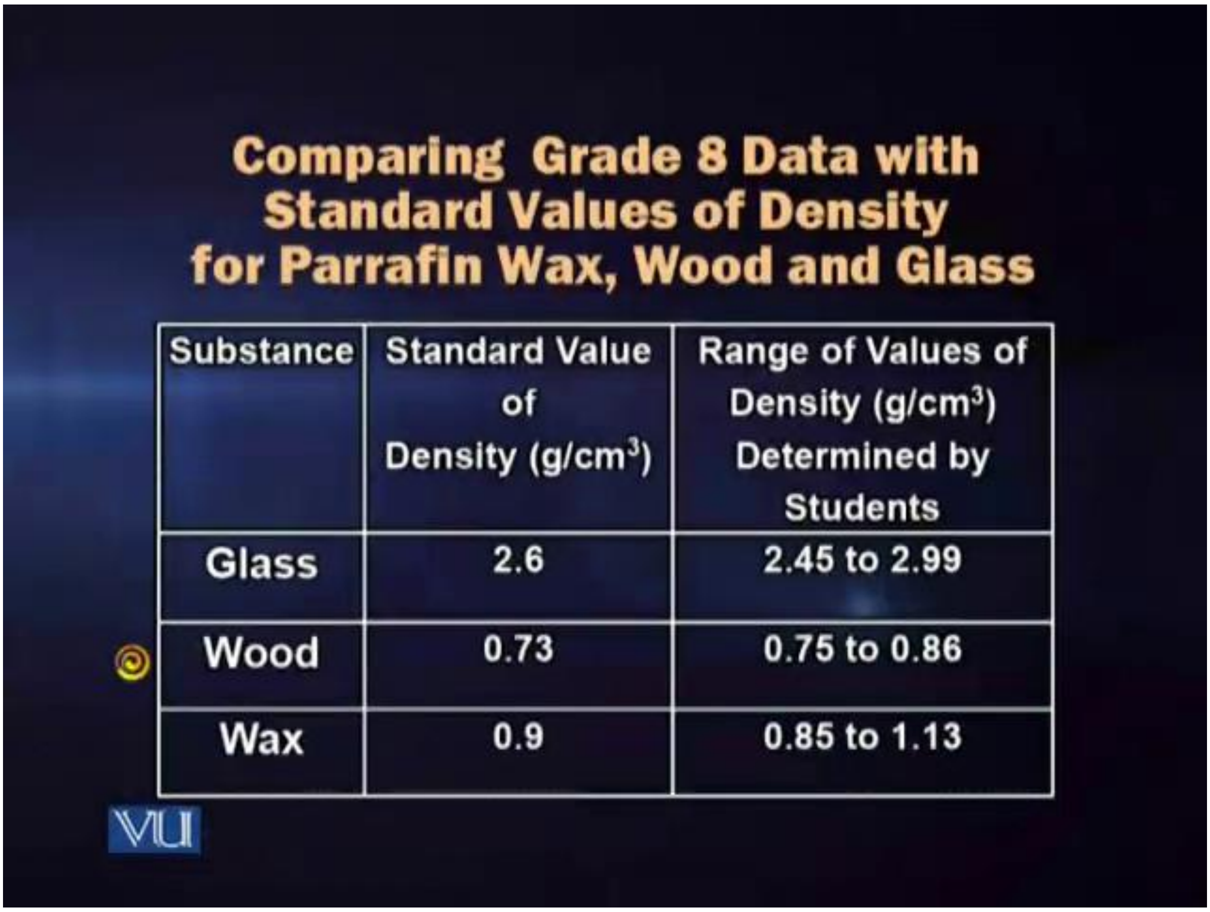
Record your data in Table 2 below:

Substance	Length l (cm)	Width w (cm)	Height h (cm)	Volume V (lxwxh) (cm^3)	Mass m (g)	Density or Mass of 1 cm^3 (m/v) (g/cm^3)
Wax						
Wood						
Glass						





GROUPS	Density (g/cm^3)		
	Wax	Glass	Wood
1	0.98	2.79	0.85
2	0.85	2.99	0.77
3	0.88	2.52	0.79
4	1.13	2.75	0.86
5	0.95	2.95	0.75
6	0.86	2.47	0.73
7	0.91	2.45	0.75

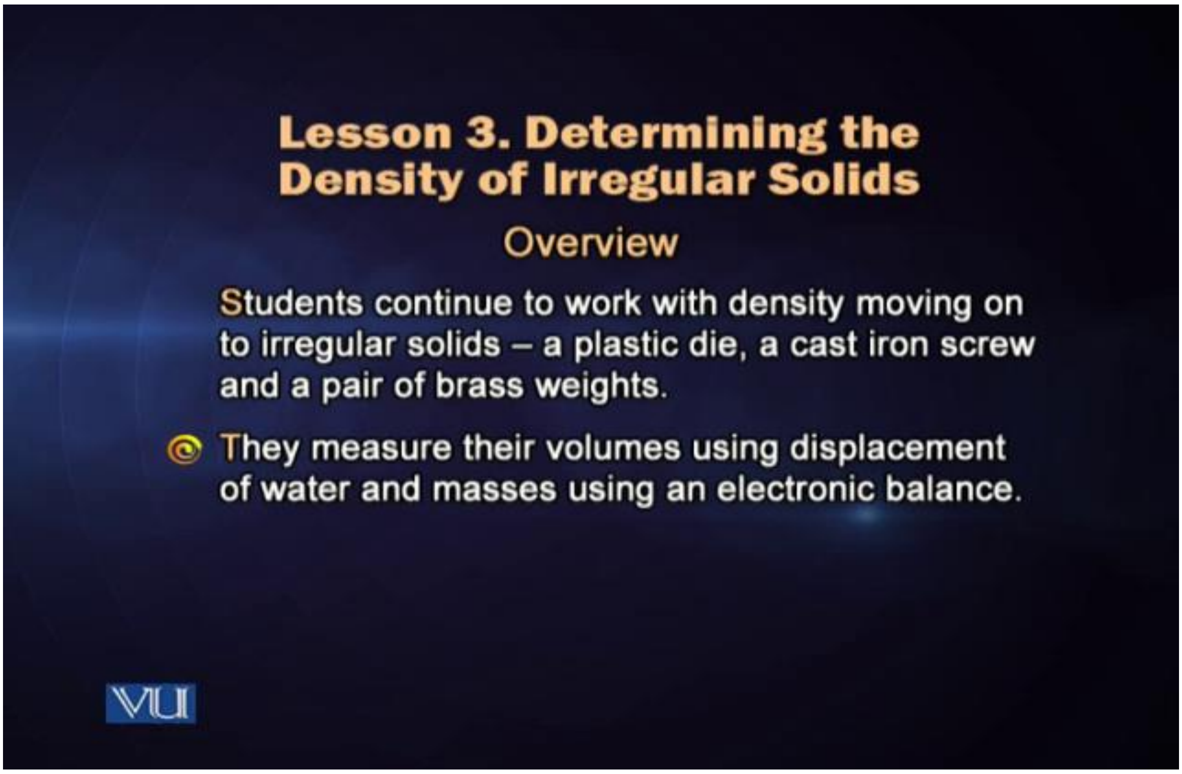


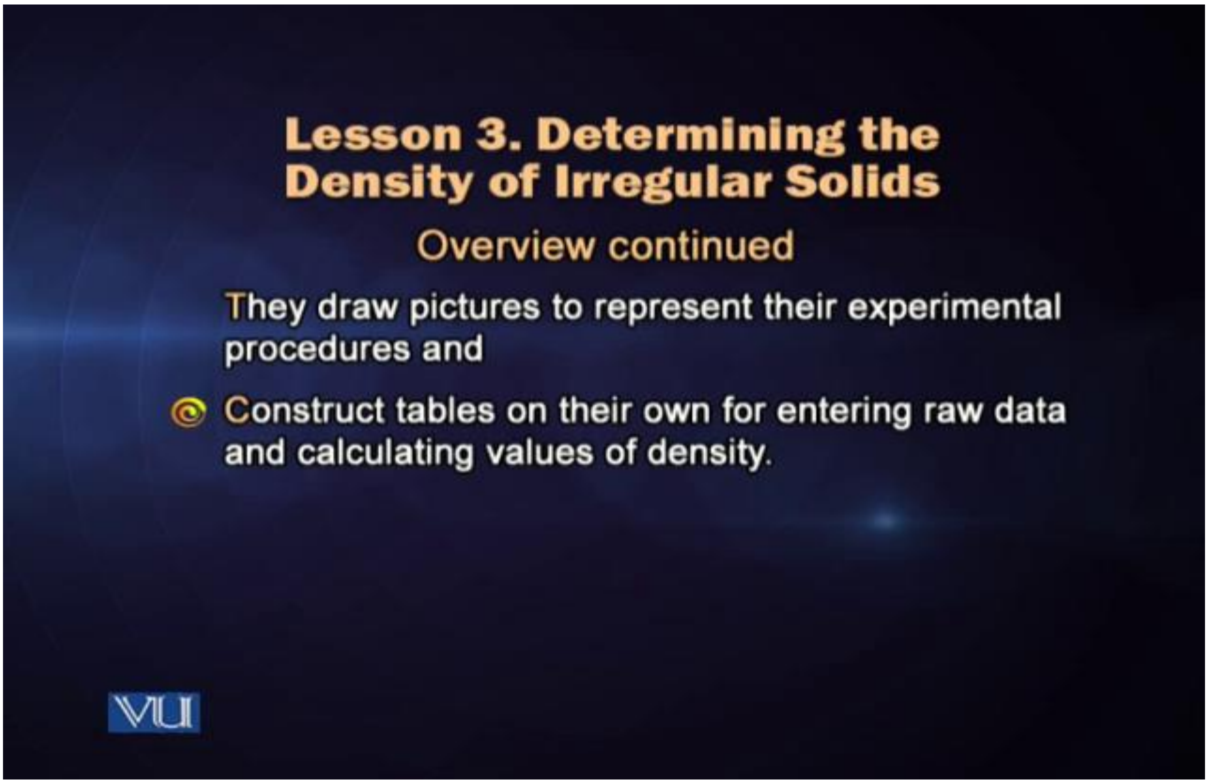
Comparing Grade 8 Data with Standard Values of Density for Parrafin Wax, Wood and Glass

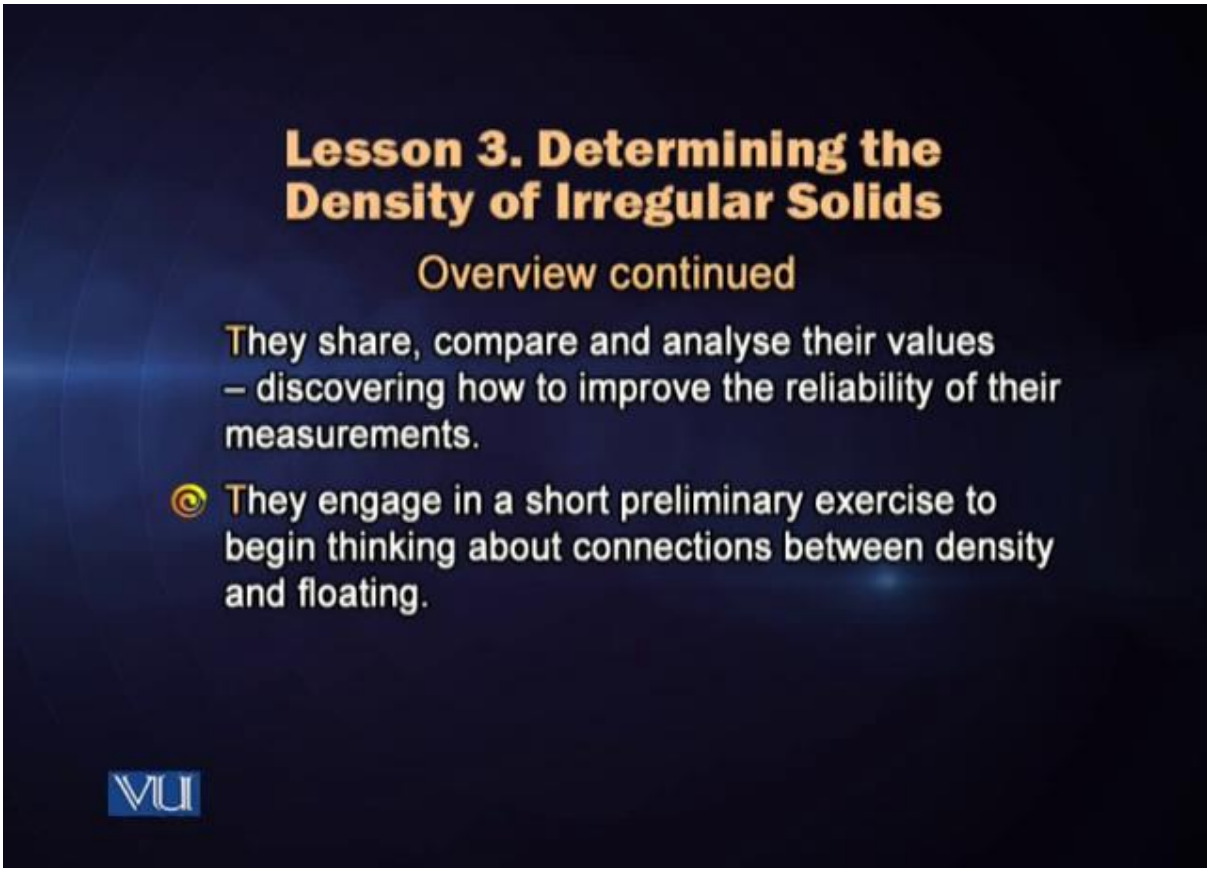
Substance	Standard Value of Density (g/cm^3)	Range of Values of Density (g/cm^3) Determined by Students
Glass	2.6	2.45 to 2.99
Wood	0.73	0.75 to 0.86
Wax	0.9	0.85 to 1.13

Lecture No 41

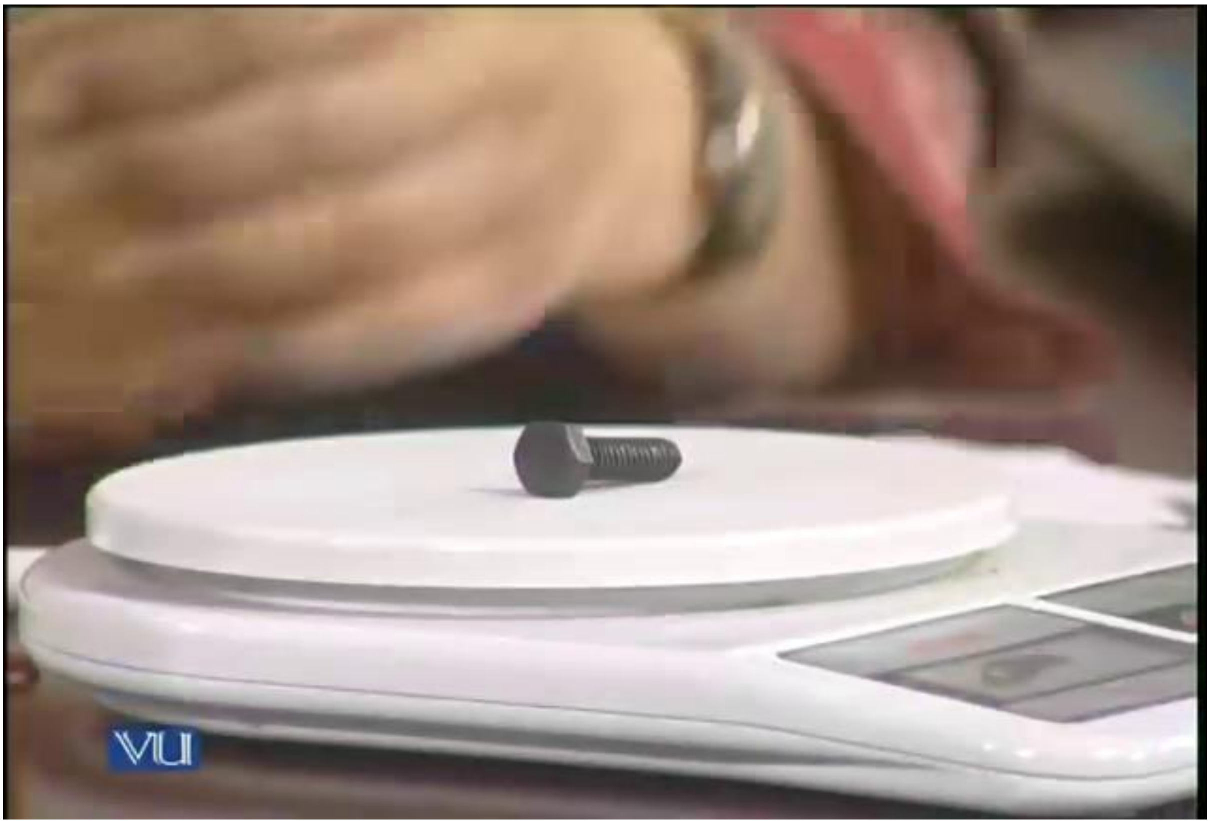
Measurment the Density of Irregular Objects

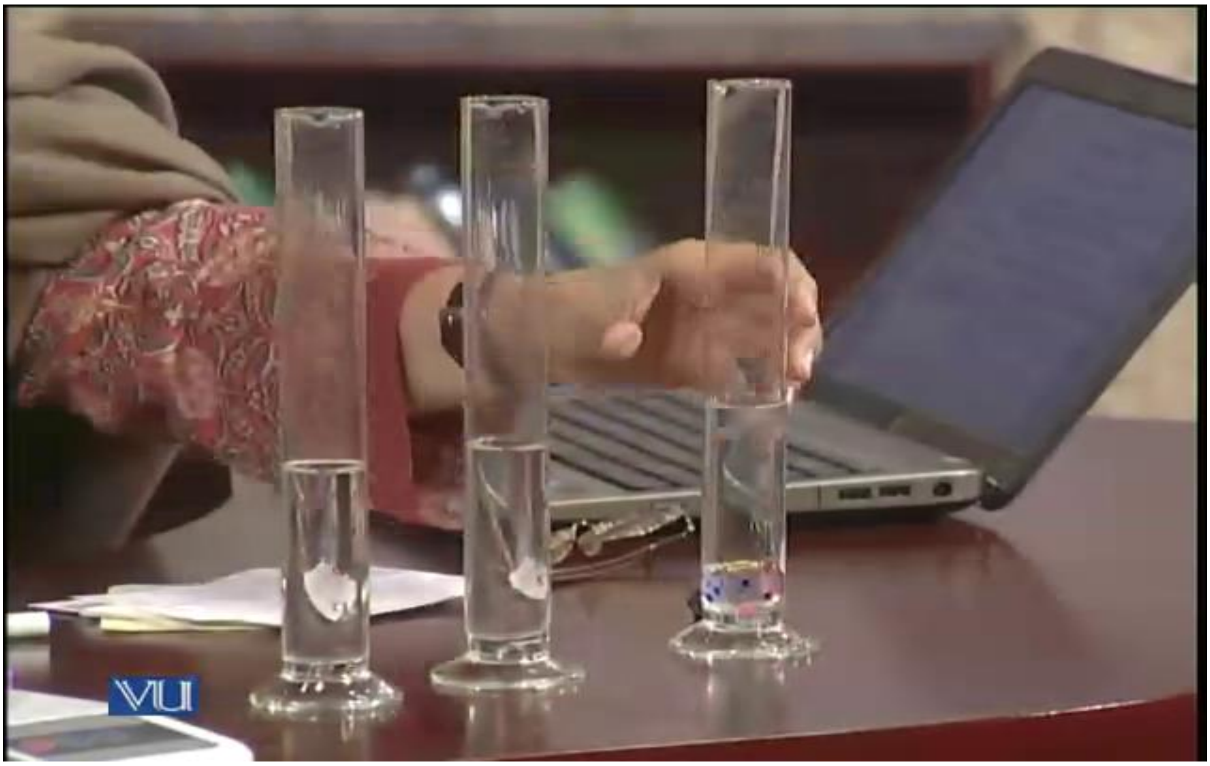





Lesson 3. Determining the Density of Irregular Solids
Overview continued
They share, compare and analyse their values – discovering how to improve the reliability of their measurements.
They engage in a short preliminary exercise to begin thinking about connections between density and floating.
VU


VU





Reference Data

Name of Object	Mass (g)	Volume (mL or cm^3)	Density = Mass /Volume (g/cm^3)
Brass Weights	40	5	8.0
Plastic Die	6.6	6	1.1
Iron Screw	11.9	1 or 2	11.9 or 5.95

VU

Learning Objectives

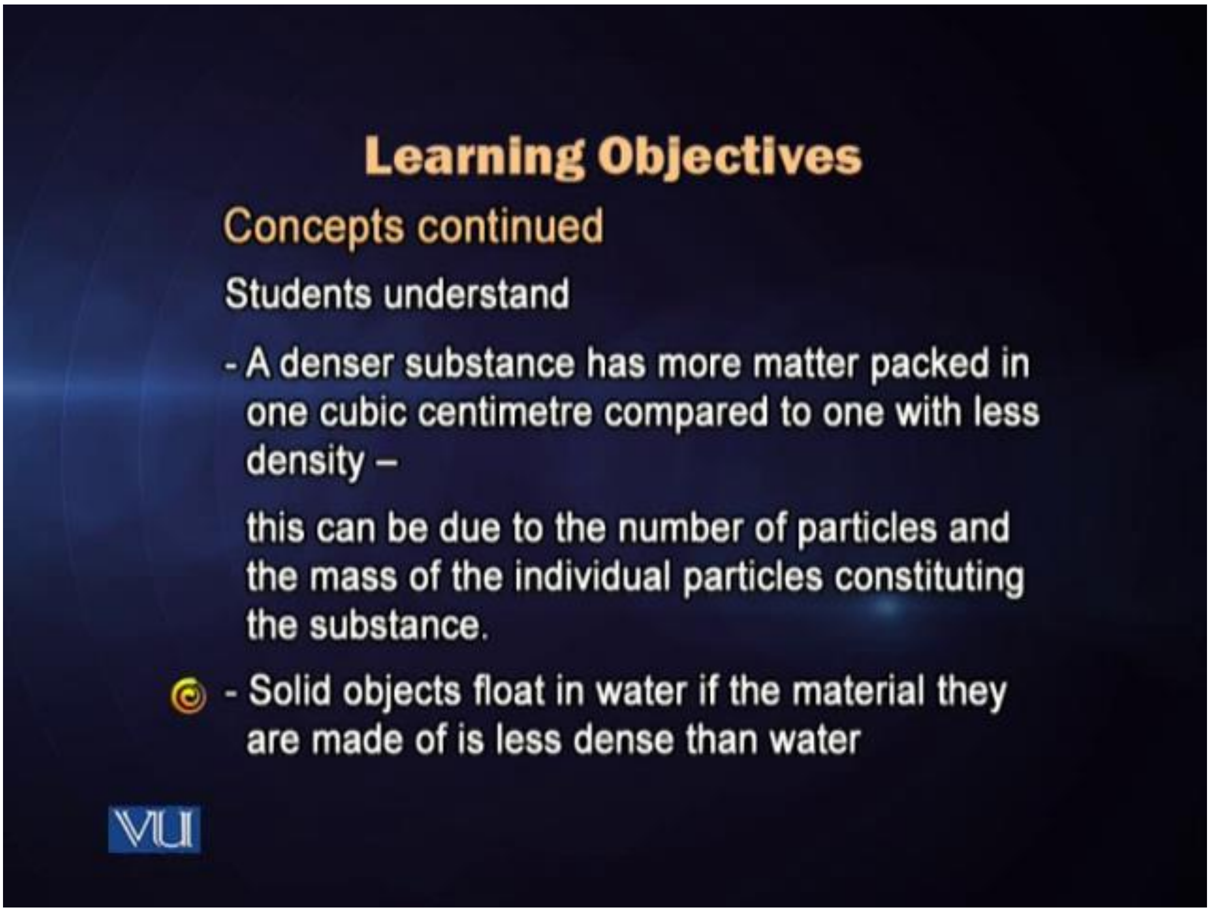
Concepts

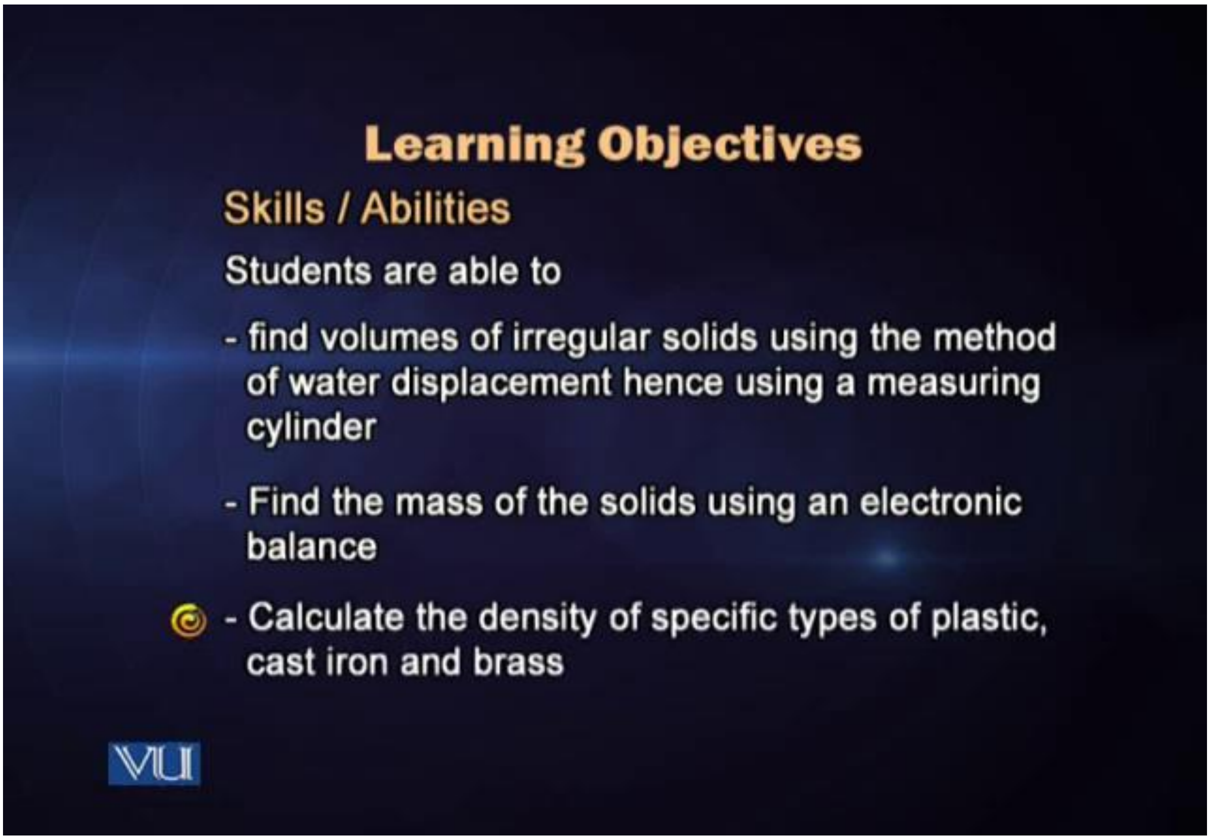
Students understand

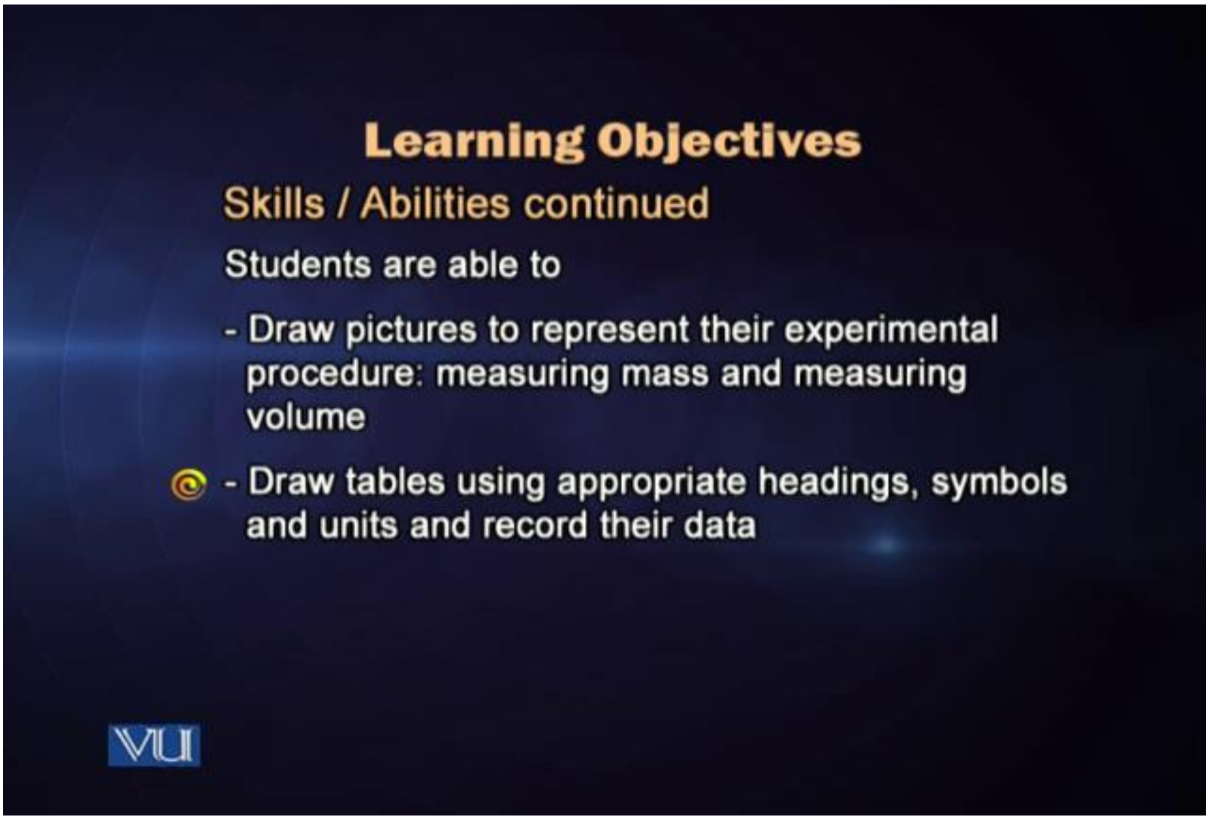
- Density of a substance is the mass contained in a unit volume or mass per unit volume
- The metric unit of density commonly used is grams per cubic centimeter.

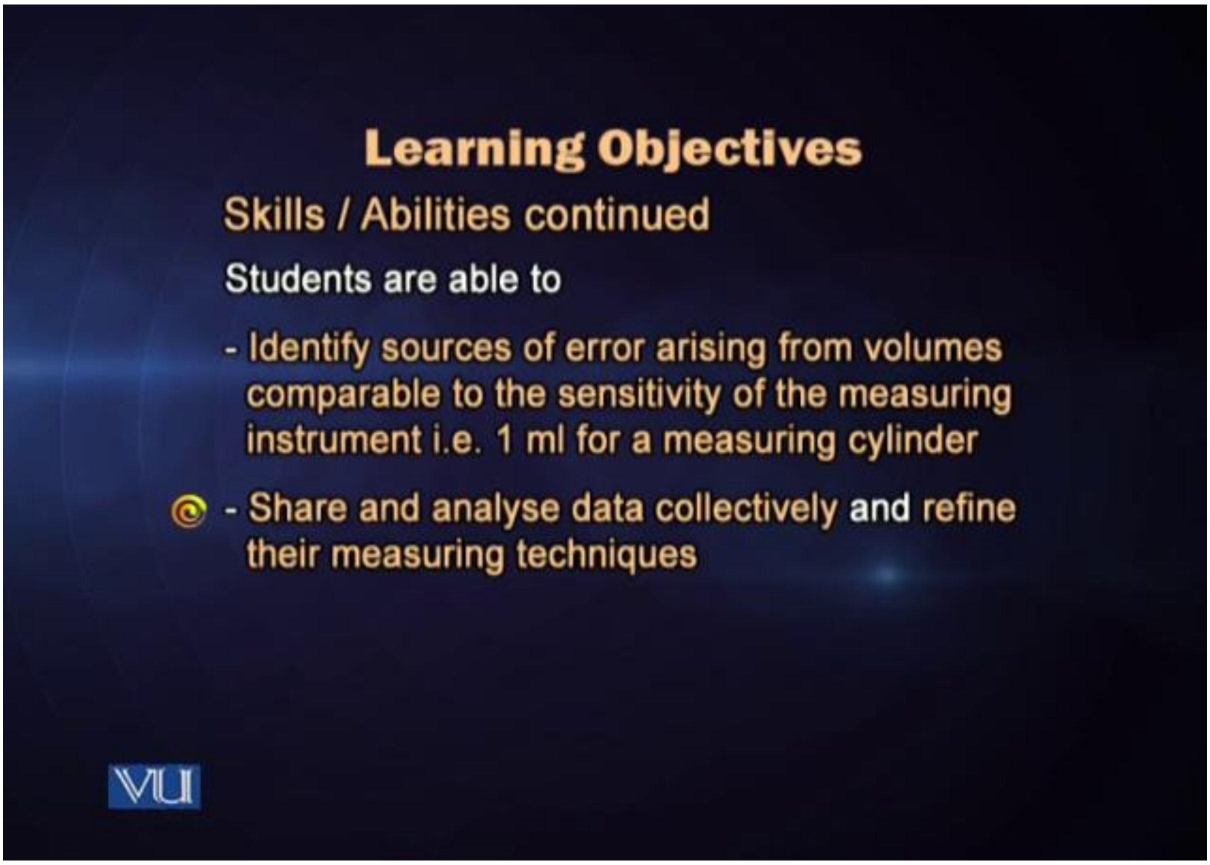
  (A cubic centimeter is the volume occupied by a cube having edges equal to 1 cm.)
- Materials can be identified by their densities

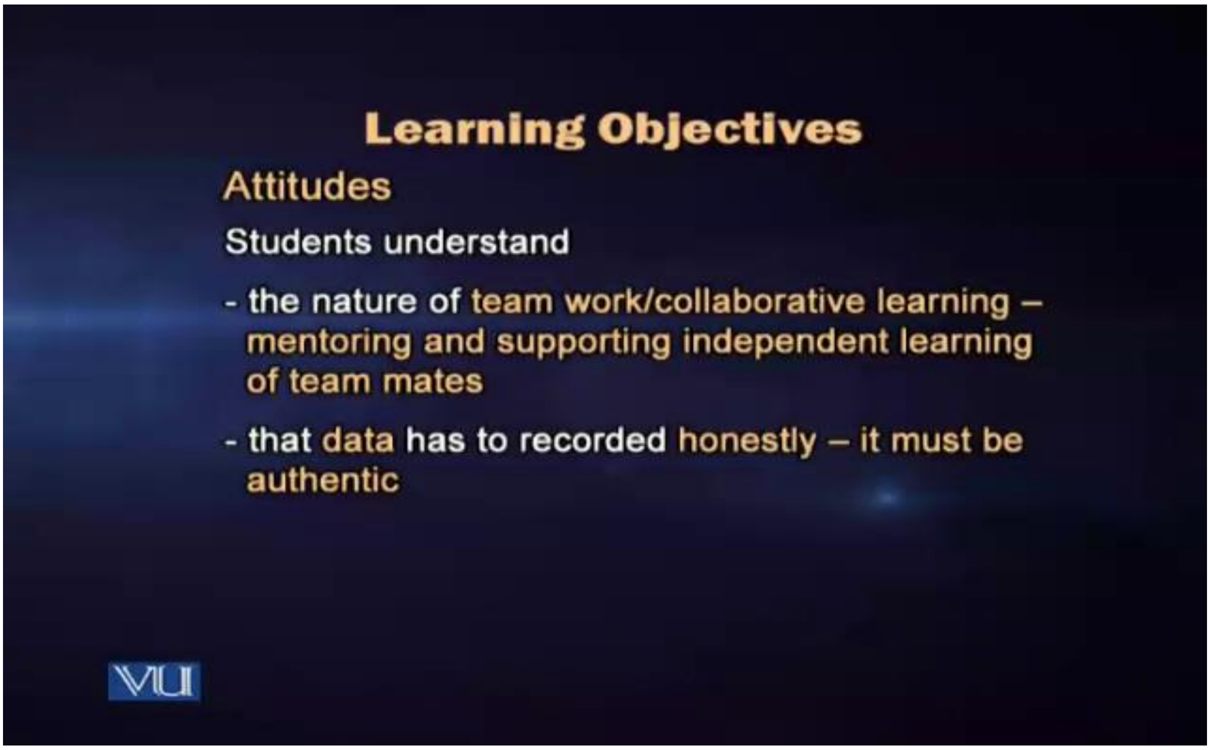
VU


Learning Objectives
Concepts continued
Students understand
- A denser substance has more matter packed in one cubic centimetre compared to one with less density –
this can be due to the number of particles and the mass of the individual particles constituting the substance.
- Solid objects float in water if the material they are made of is less dense than water
VU


Learning Objectives
Skills / Abilities
Students are able to
- find volumes of irregular solids using the method of water displacement hence using a measuring cylinder
- Find the mass of the solids using an electronic balance
- Calculate the density of specific types of plastic, cast iron and brass
VU


Learning Objectives
Skills / Abilities continued
Students are able to
- Draw pictures to represent their experimental procedure: measuring mass and measuring volume
- Draw tables using appropriate headings, symbols and units and record their data
VU


Learning Objectives
Skills / Abilities continued
Students are able to
- Identify sources of error arising from volumes comparable to the sensitivity of the measuring instrument i.e. 1 ml for a measuring cylinder
- Share and analyse data collectively and refine their measuring techniques
VU


Learning Objectives
Attitudes
Students understand
- the nature of team work/collaborative learning – mentoring and supporting independent learning of team mates
- that data has to recorded honestly – it must be authentic
VU

Learning Objectives

Attitudes continued

Students understand

- Sharing of data and collective analysis is critical to developing skills for reliable measurements and meaningful understanding of concepts
- For reliable and valid measurements the size of the object should be significantly greater than the smallest unit of the measuring instrument

Materials

For each student

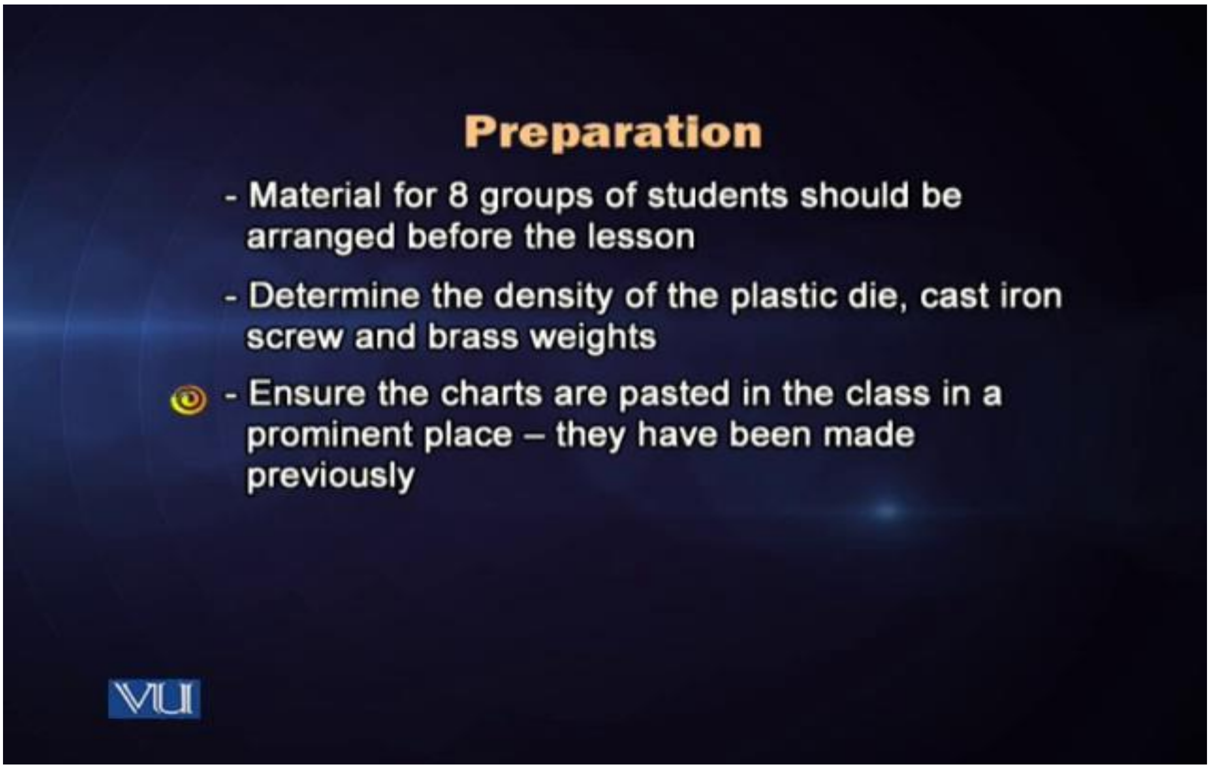
1 Set of Density Worksheets

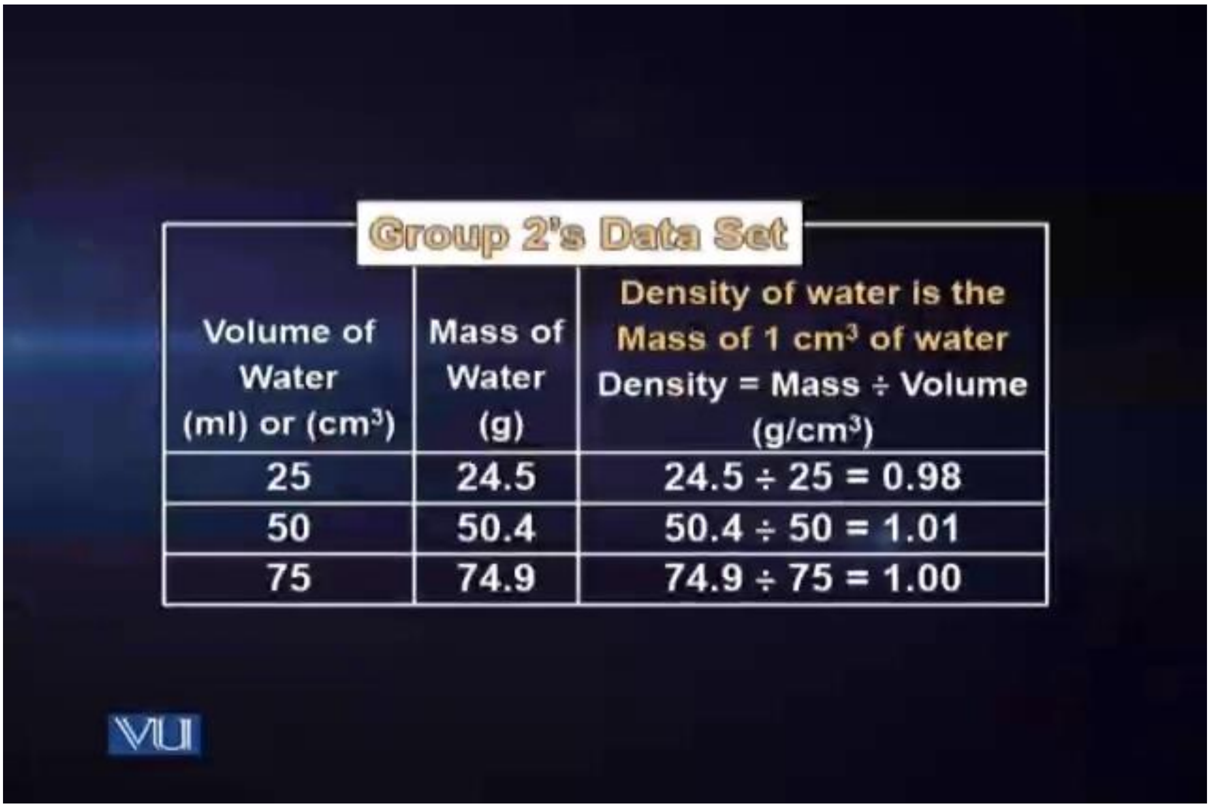
For groups of three students

- 1 plastic die, 1 cast iron screw and a pair of 20 g slotted brass weights
- 1 measuring cylinder
- 1 beaker with water

For two groups of three students

1 electronic balance



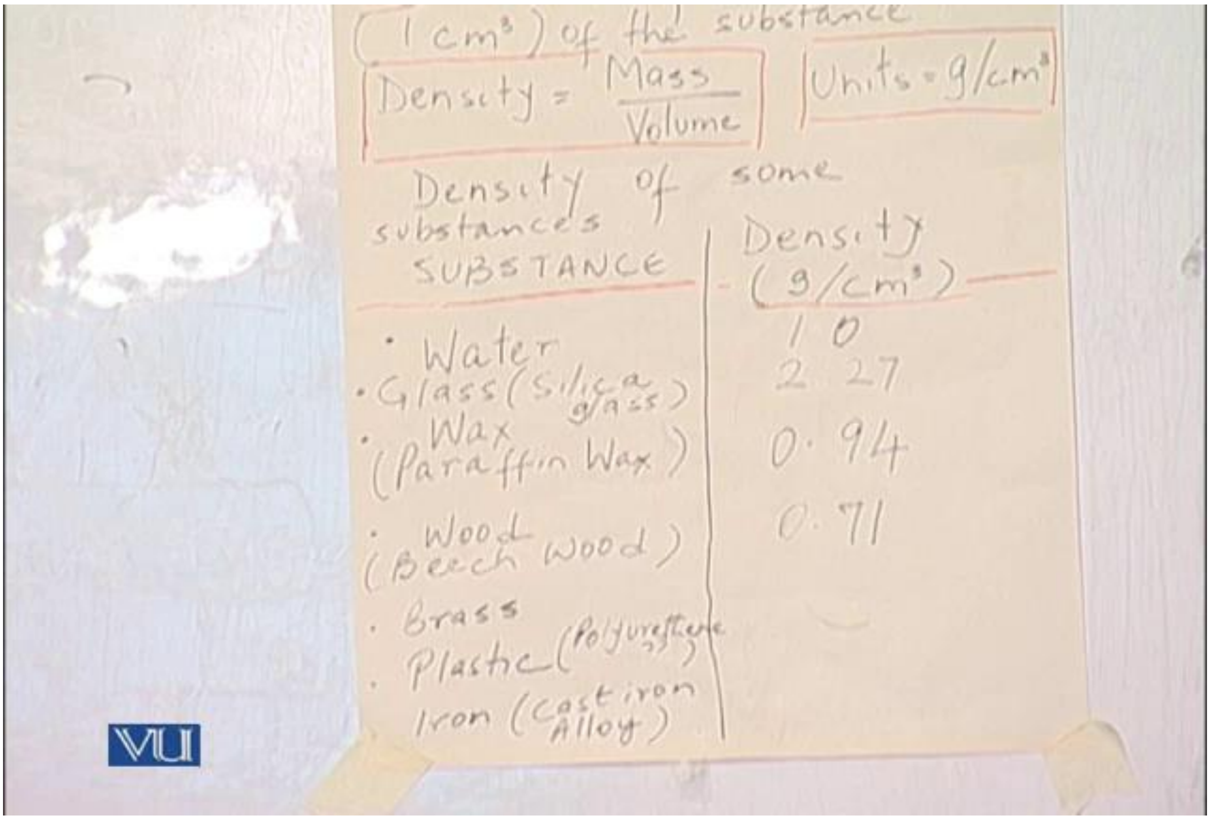

Group 2's Data Set

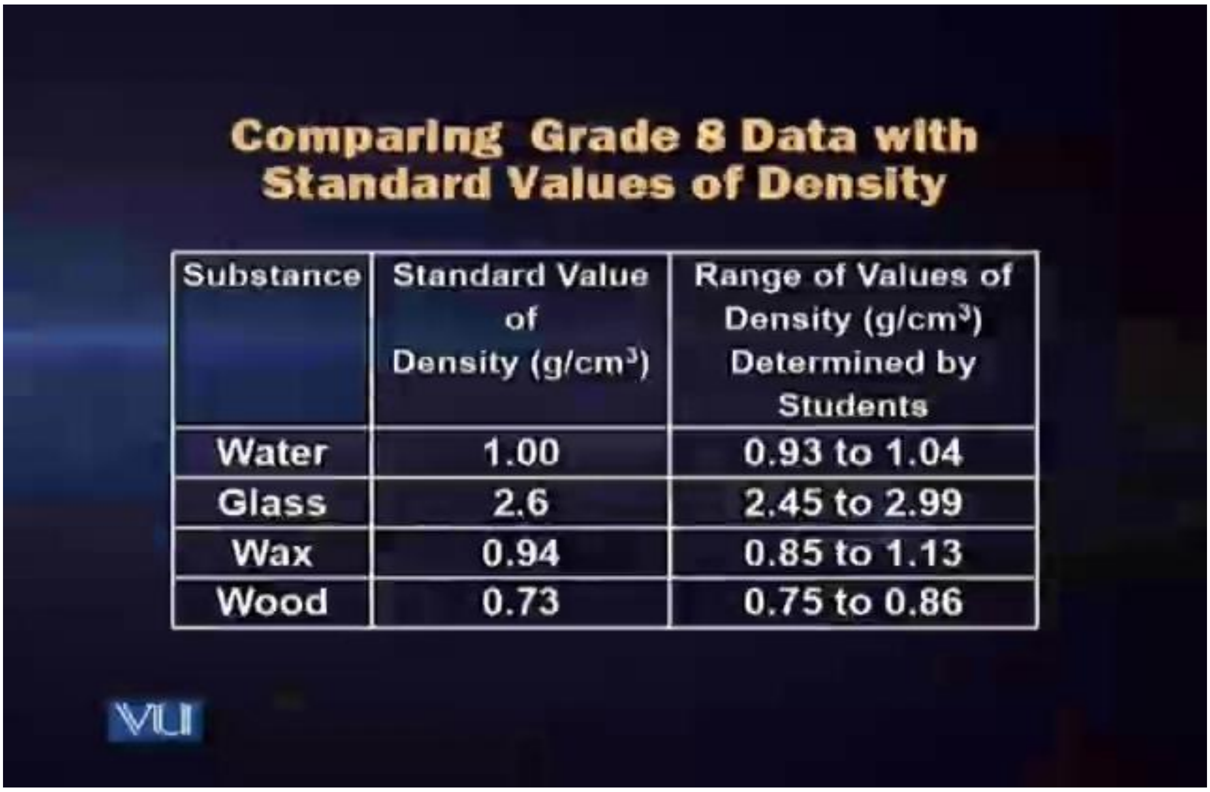
Volume of Water (ml) or (cm^3)	Mass of Water (g)	Density of water is the Mass of 1 cm^3 of water Density = Mass ÷ Volume (g/cm^3)
25	24.5	24.5 ÷ 25 = 0.98
50	50.4	50.4 ÷ 50 = 1.01
75	74.9	74.9 ÷ 75 = 1.00

Group 5's Data Set

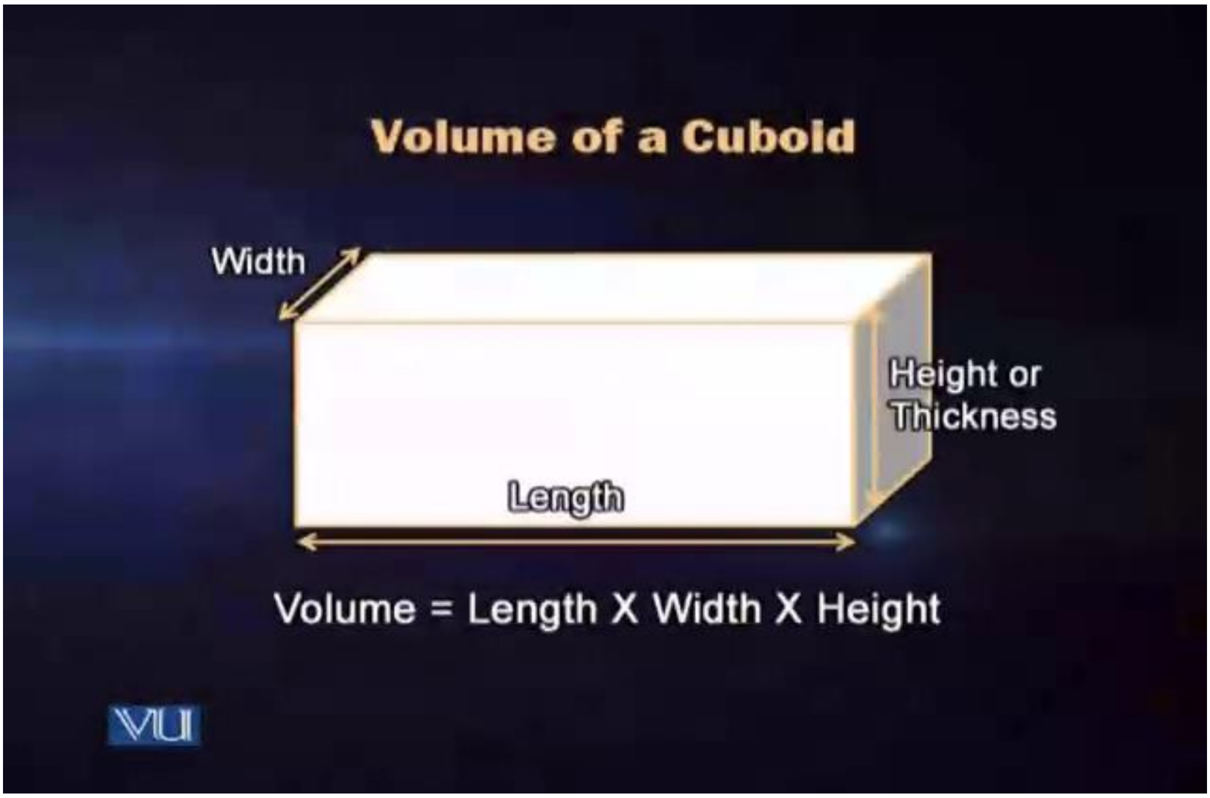
Volume of Water (ml) or (cm^3)	Mass of Water (g)	Density of water is the Mass of 1 cm^3 of water Density = Mass ÷ Volume (g/cm^3)
25	24.8	24.8 ÷ 25 = 0.99
50	50.0	50.0 ÷ 50 = 1.00
75	74.5	74.5 ÷ 75 = 0.99

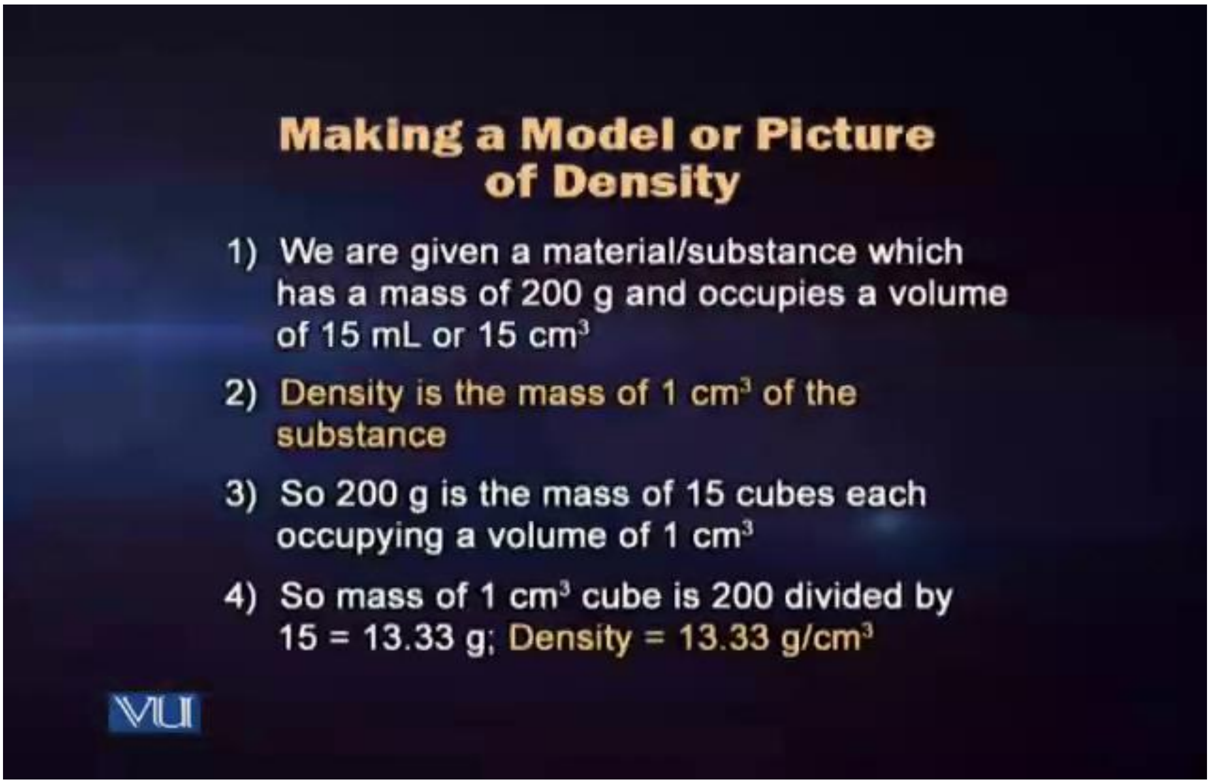
Mass readings indicate actual volume of water less or more than assumed volume	
Assumed Volume of Water (ml) or (cm^3)	**Resulting Mass Readings of Water of different groups; Mass of Water (g)**
25	23.2, 23.8, 26
50	48.3, 50.9, 51.7
75	72.6, 73.5, 76.7

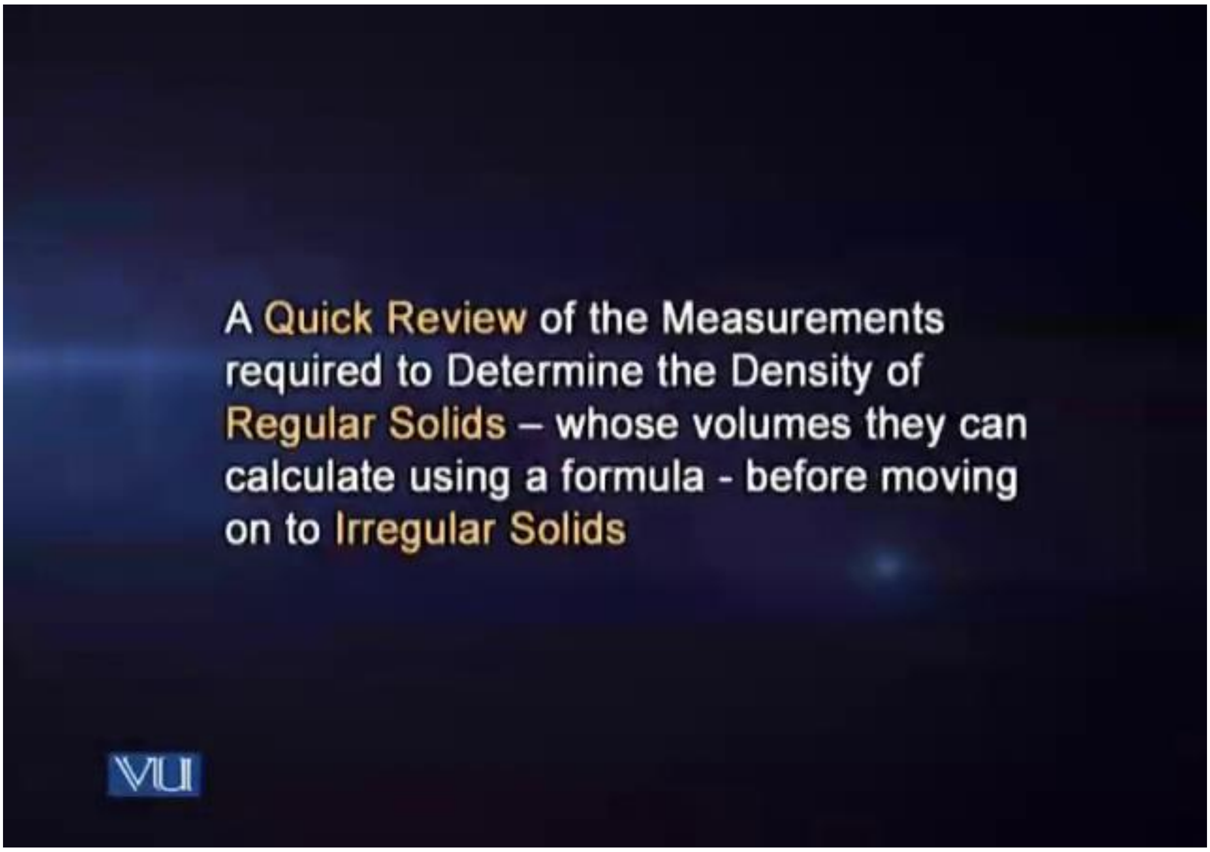


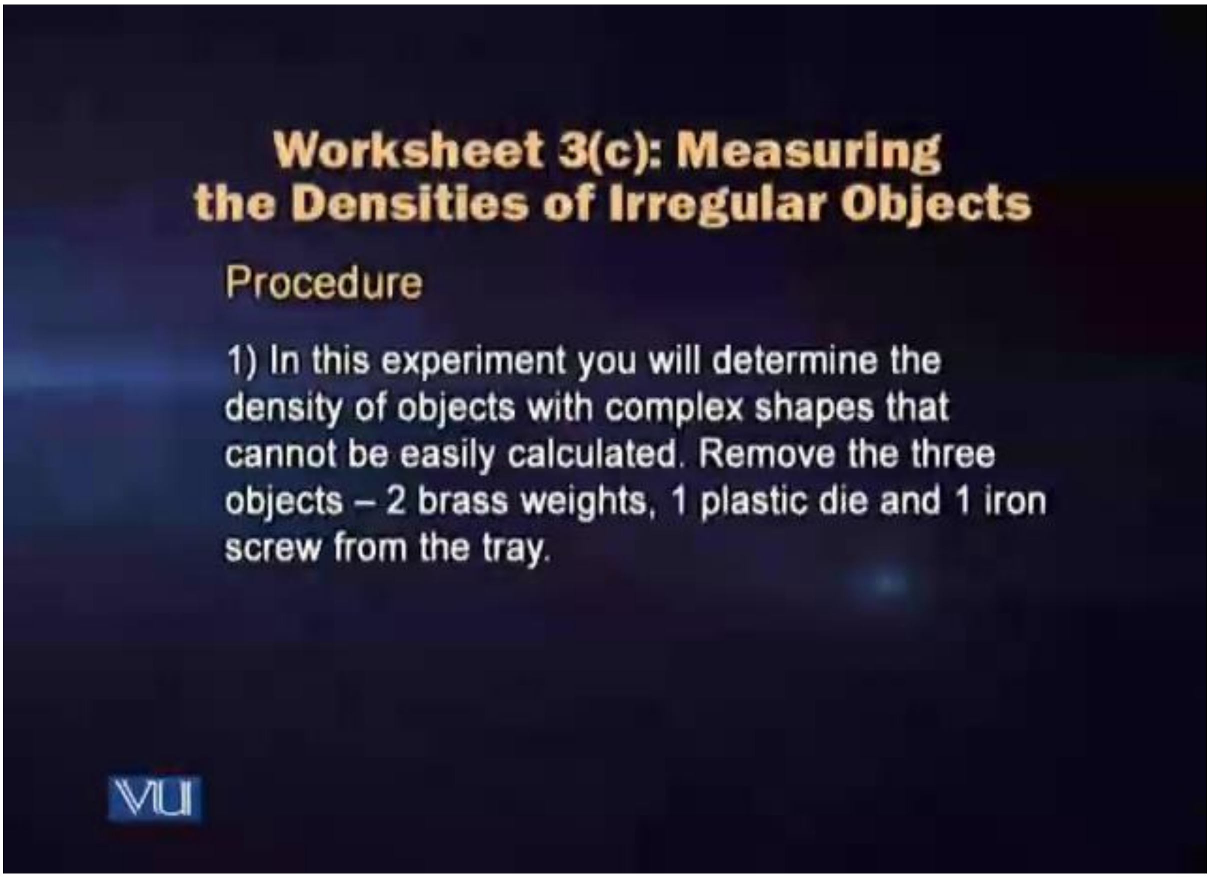


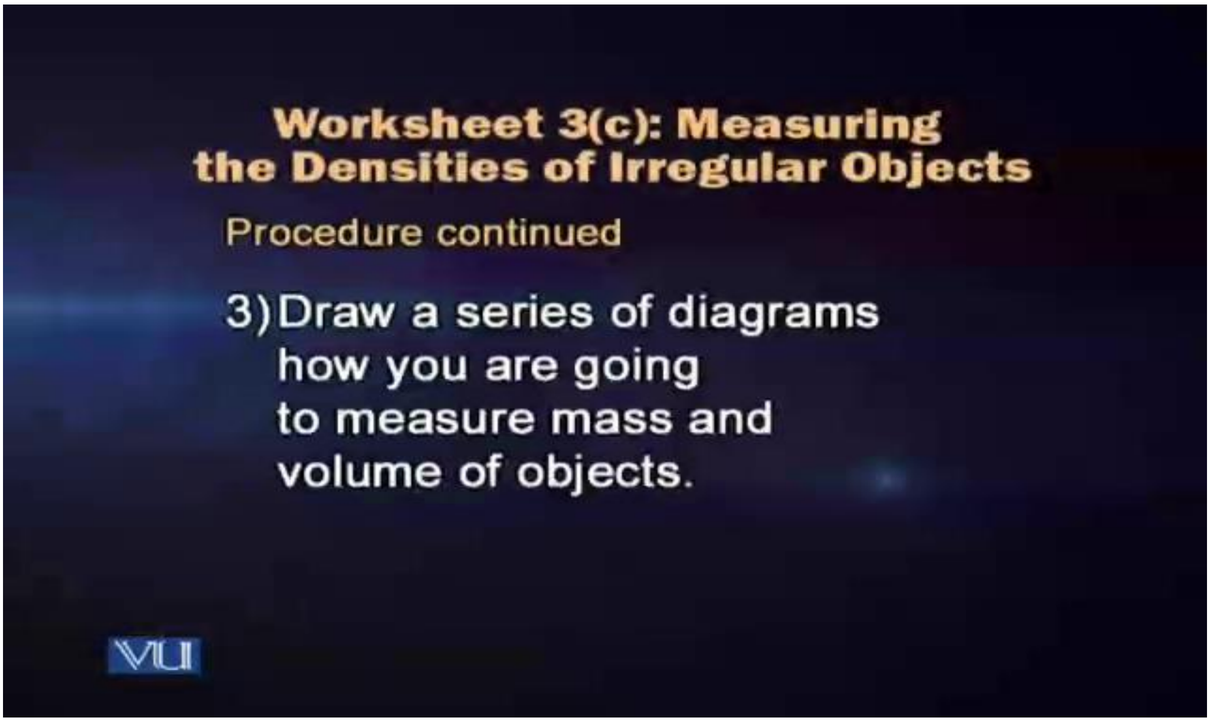
Substance	Standard Value of Density (g/cm^3)	Range of Values of Density (g/cm^3) Determined by Students
Water	1.00	0.93 to 1.04
Glass	2.6	2.45 to 2.99
Wax	0.94	0.85 to 1.13
Wood	0.73	0.75 to 0.86

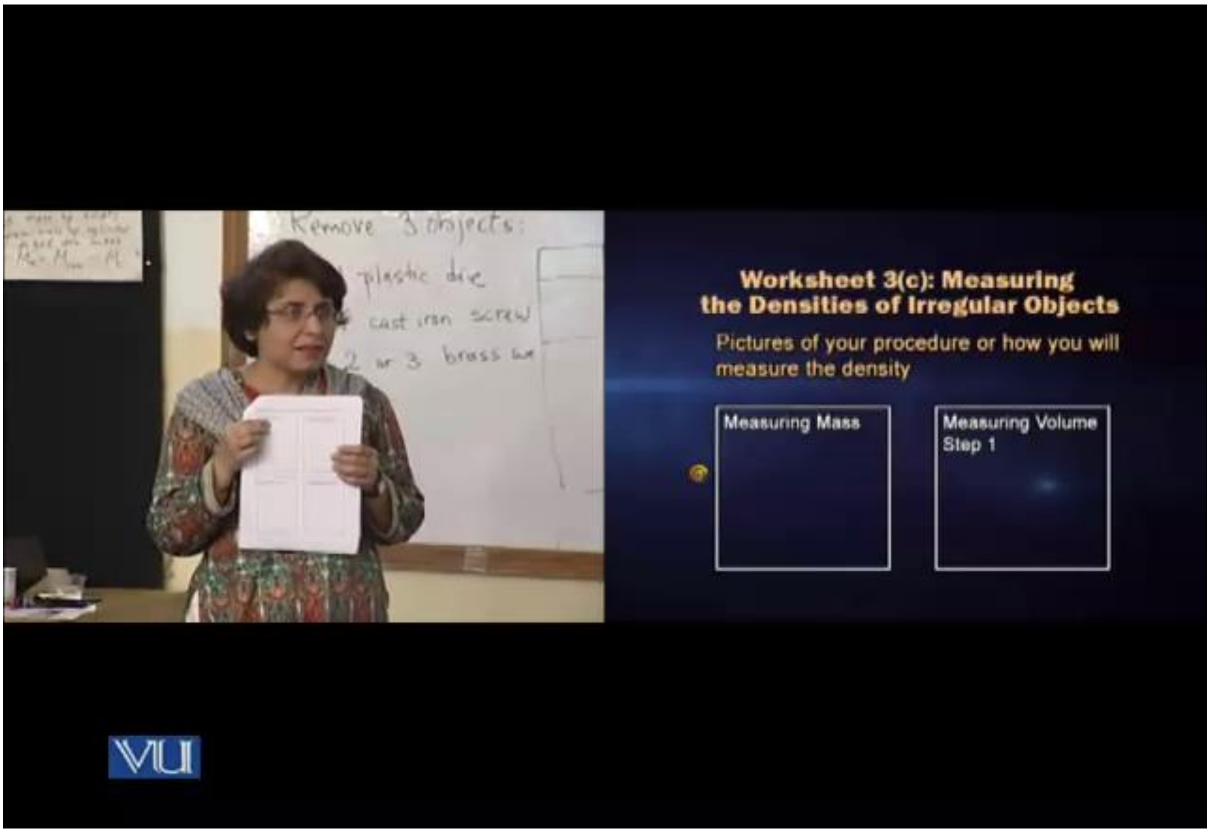

Volume of a Cuboid
Width
Height or Thickness
Length
Volume = Length X Width X Height


Making a Model or Picture of Density
1) We are given a material/substance which has a mass of 200 g and occupies a volume of 15 mL or 15 cm³
2) Density is the mass of 1 cm³ of the substance
3) So 200 g is the mass of 15 cubes each occupying a volume of 1 cm³
4) So mass of 1 cm³ cube is 200 divided by 15 = 13.33 g; Density = 13.33 g/cm³

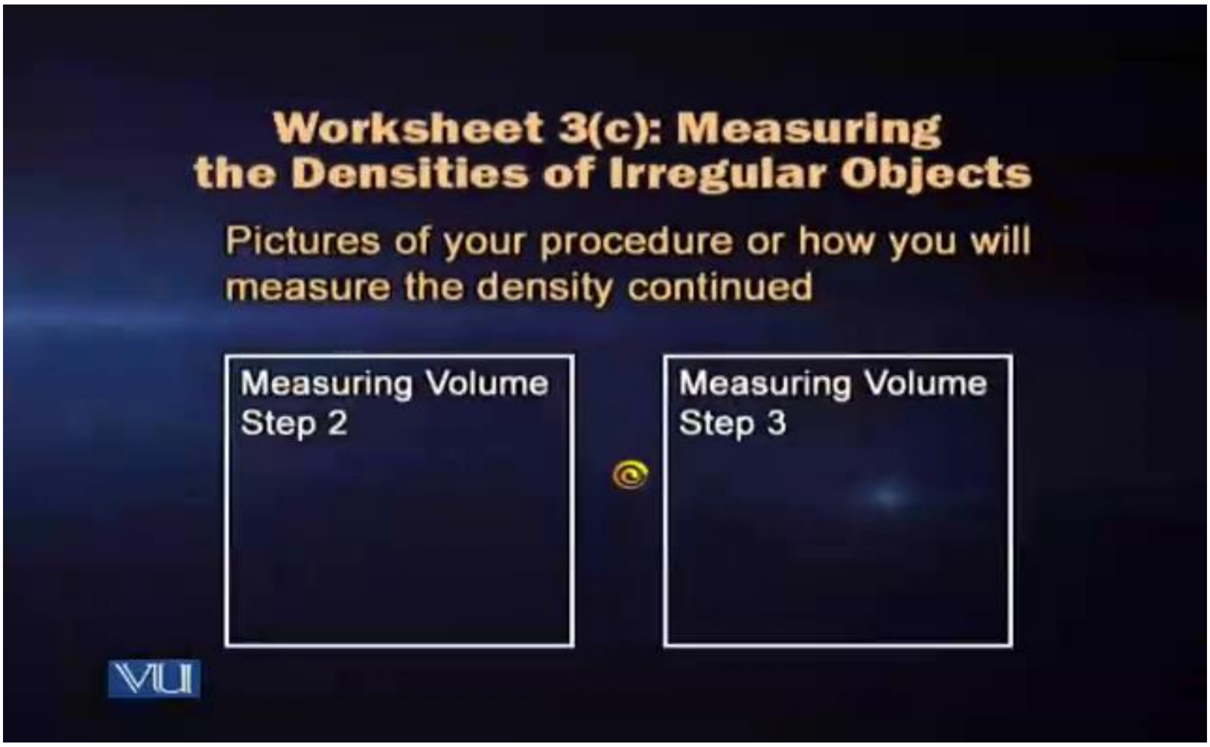

A Quick Review of the Measurements required to Determine the Density of Regular Solids – whose volumes they can calculate using a formula - before moving on to Irregular Solids


Worksheet 3(c): Measuring
the Densities of Irregular Objects
Procedure
1) In this experiment you will determine the density of objects with complex shapes that cannot be easily calculated. Remove the three objects – 2 brass weights, 1 plastic die and 1 iron screw from the tray.
VU

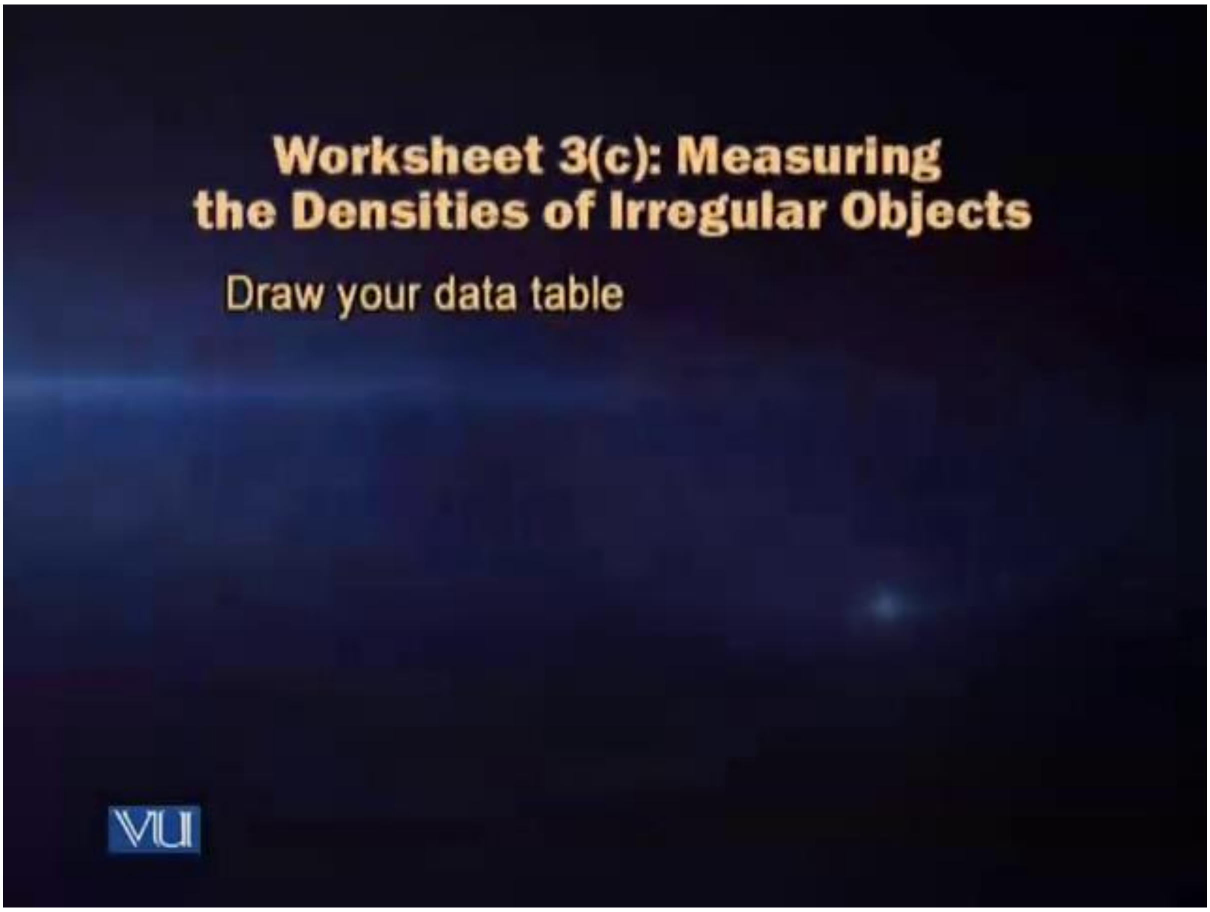

Worksheet 3(c): Measuring
the Densities of Irregular Objects
Procedure continued
3) Draw a series of diagrams how you are going to measure mass and volume of objects.
VU

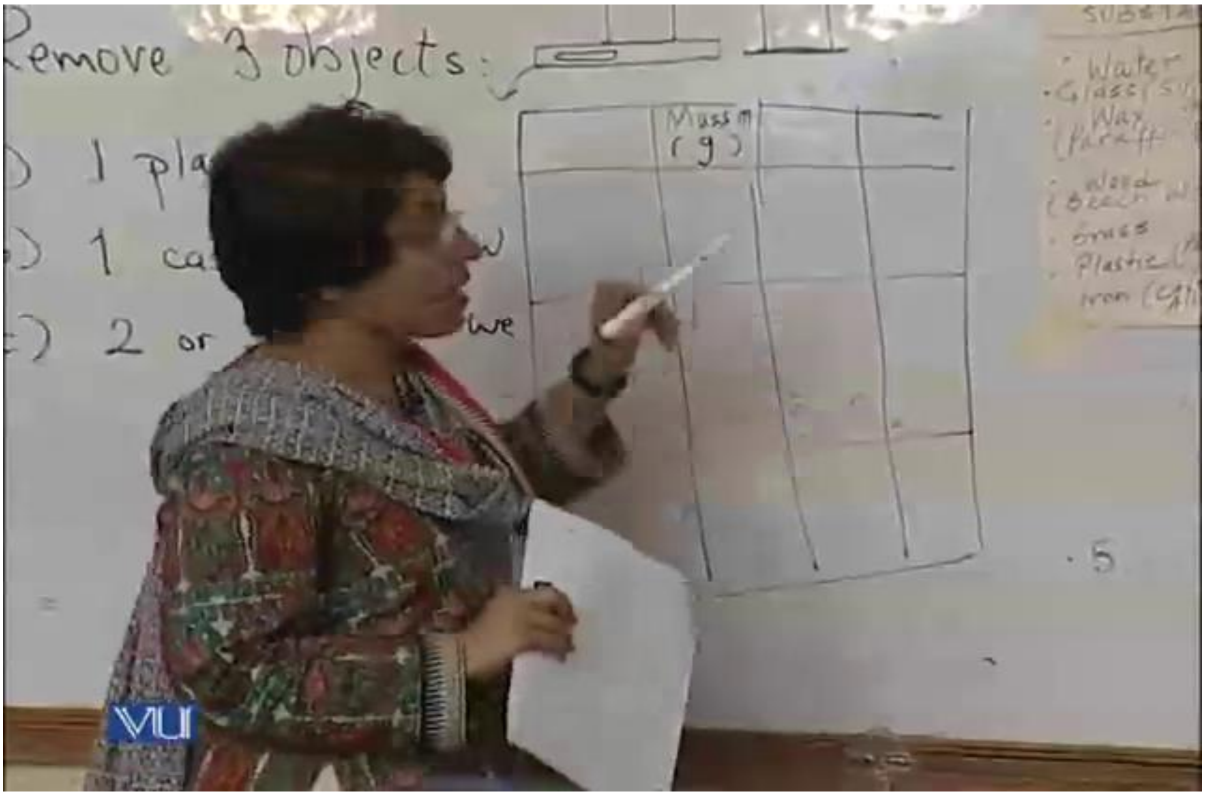


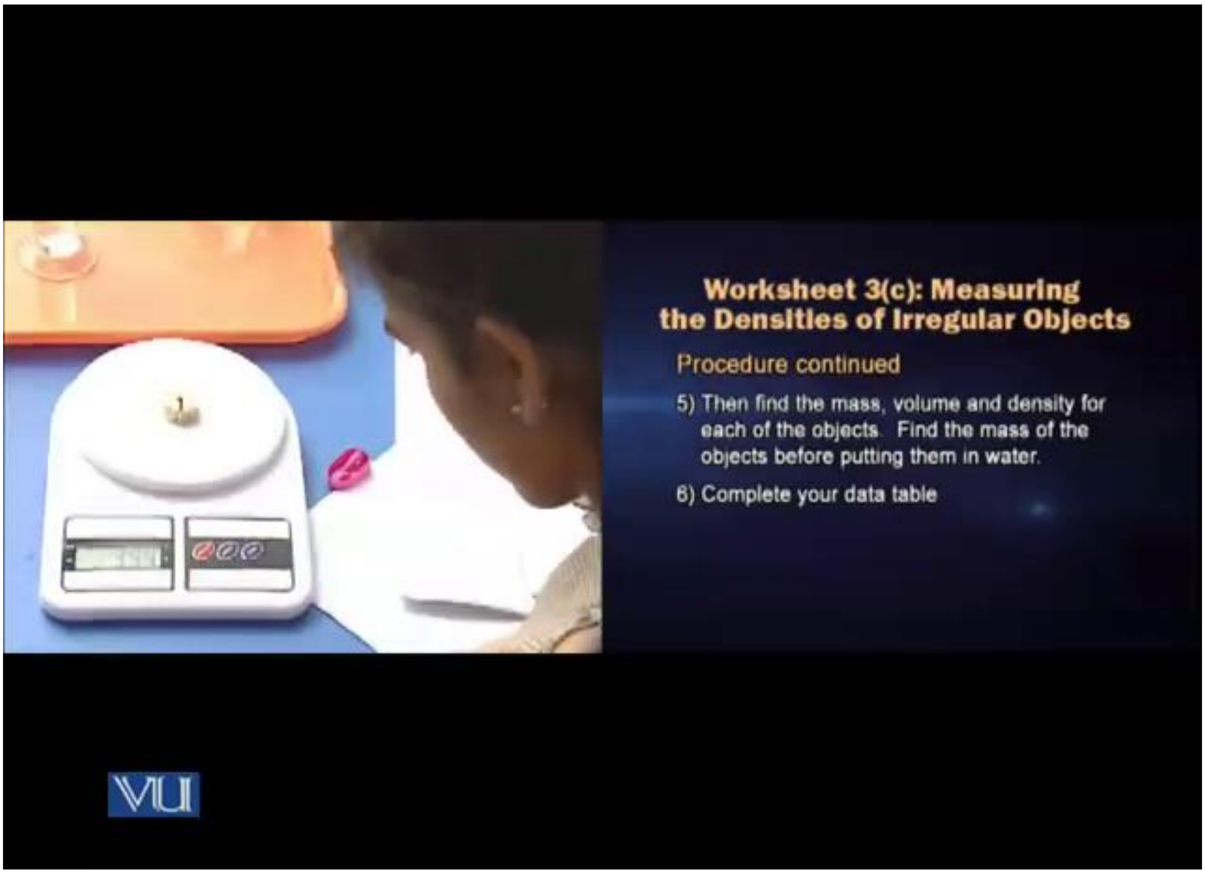
Remove 3 objects:
plastic die
cast iron screw
Worksheet 3(c): Measuring the Densities of Irregular Objects
Pictures of your procedure or how you will measure the density
Measuring Mass
Measuring Volume Step 1

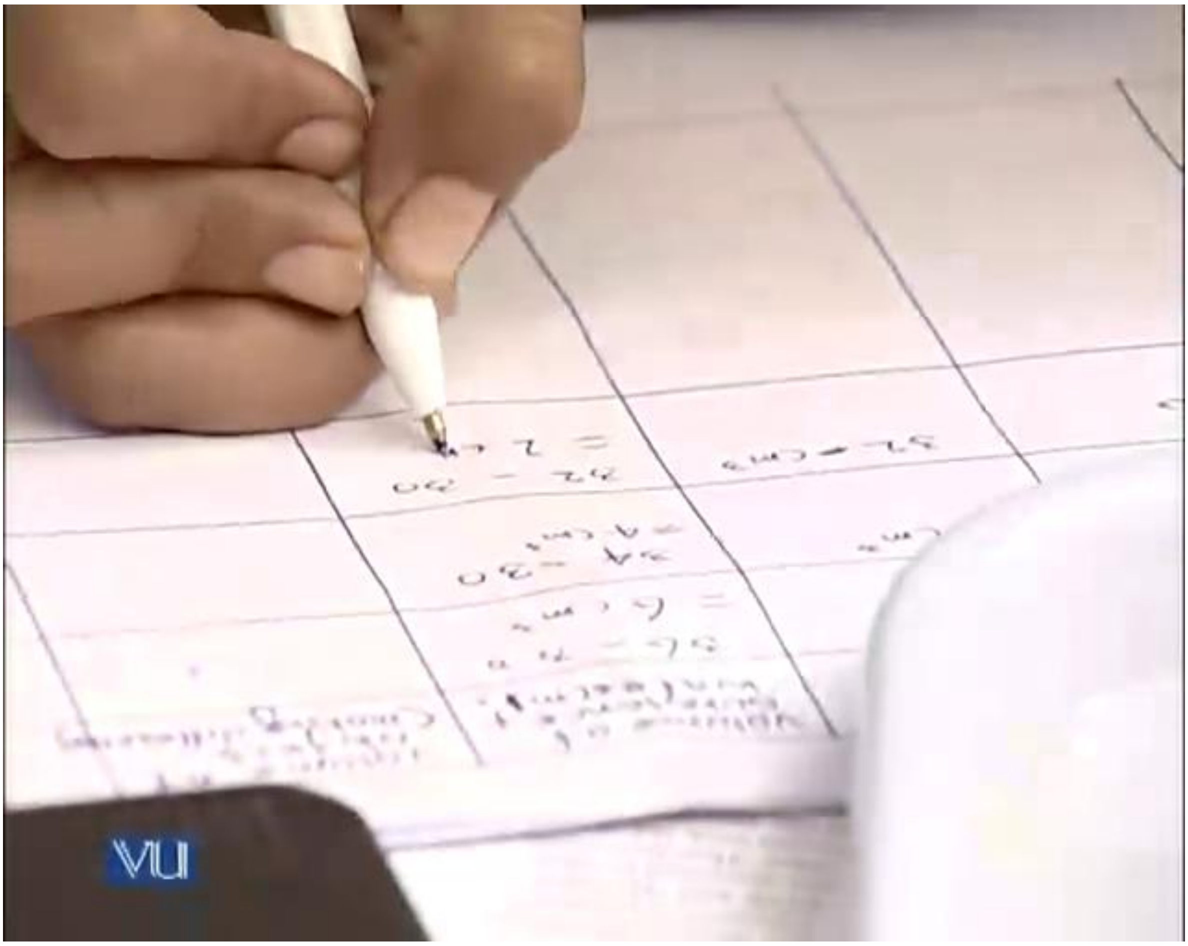


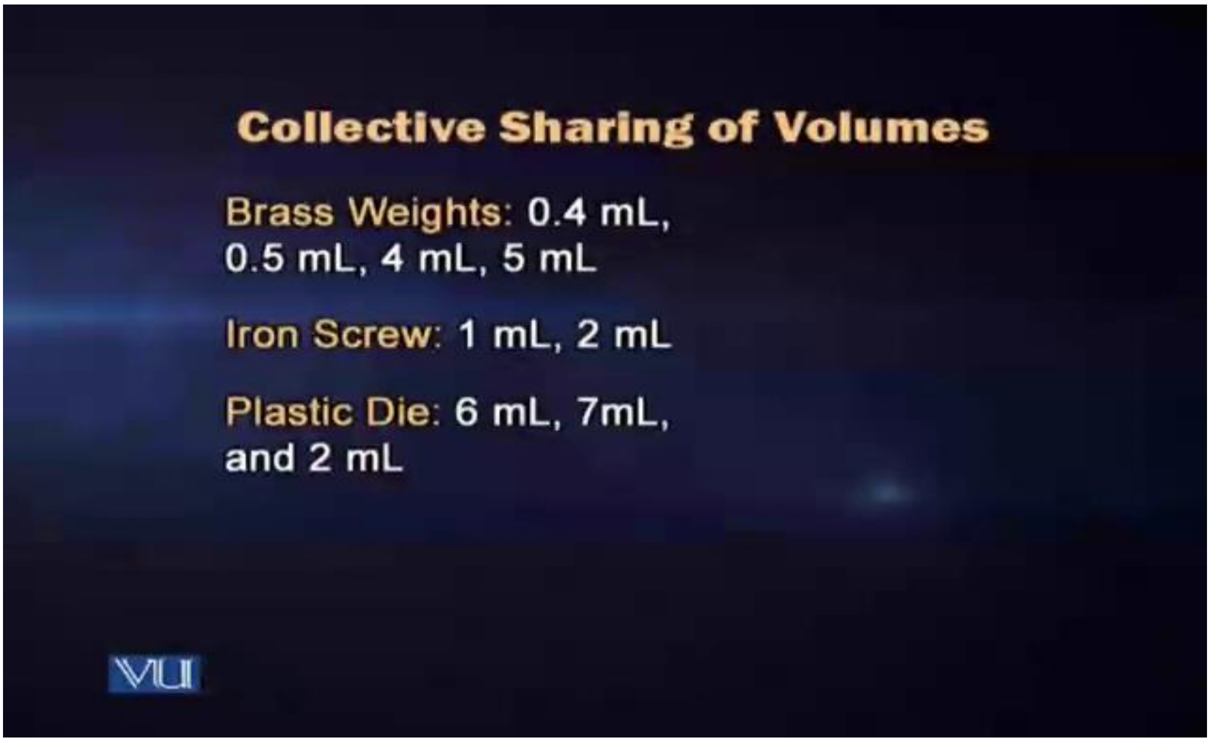
Worksheet 3(c): Measuring the Densities of Irregular Objects
Pictures of your procedure or how you will measure the density continued
Measuring Volume Step 2
Measuring Volume Step 3

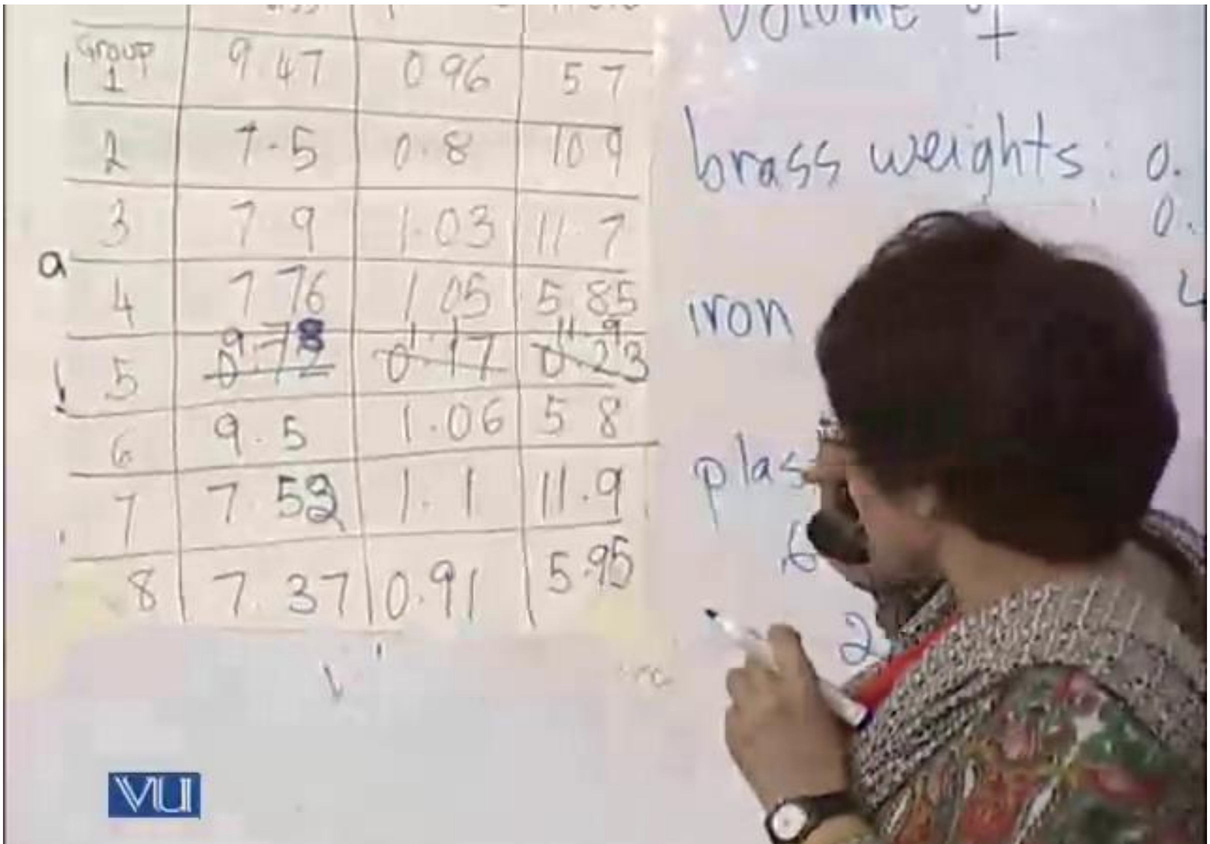

Worksheet 3(c): Measuring the Densities of Irregular Objects
Draw your data table
VU


Remove 3 objects:
Mass m
(g)


Worksheet 3(c): Measuring the Densities of Irregular Objects
Procedure continued
5) Then find the mass, volume and density for each of the objects. Find the mass of the objects before putting them in water.
6) Complete your data table




Collective Sharing of Volumes
Brass Weights: 0.4 mL, 0.5 mL, 4 mL, 5 mL
Iron Screw: 1 mL, 2 mL
Plastic Die: 6 mL, 7mL, and 2 mL
VU


Group 1 9.47 0.96 5.7
2 7.5 0.8 10.9
3 7.9 1.03 11.7
4 7.76 1.05 5.85
6 9.5 1.06 5.8
7 7.53 1.1 11.9
8 7.37 0.91 5.95
brass weights:
iron
VU

Groups	Density (g/cm³)		
	Brass	Plastic	Cast Iron
1	9.47	0.96	5.7
2	7.5	0.8	10.9
3	7.9	1.03	11.7
4	7.76	1.05	5.85
5	~~0.72~~ 9.78	~~0.17~~, 1.1	~~0.23~~, 11.9
6	9.5	1.06	5.8
7	7.52	1.1	11.9
8	7.37	0.91	5.95

VU

Worksheet 3(c): Measuring the Densities of Irregular Objects

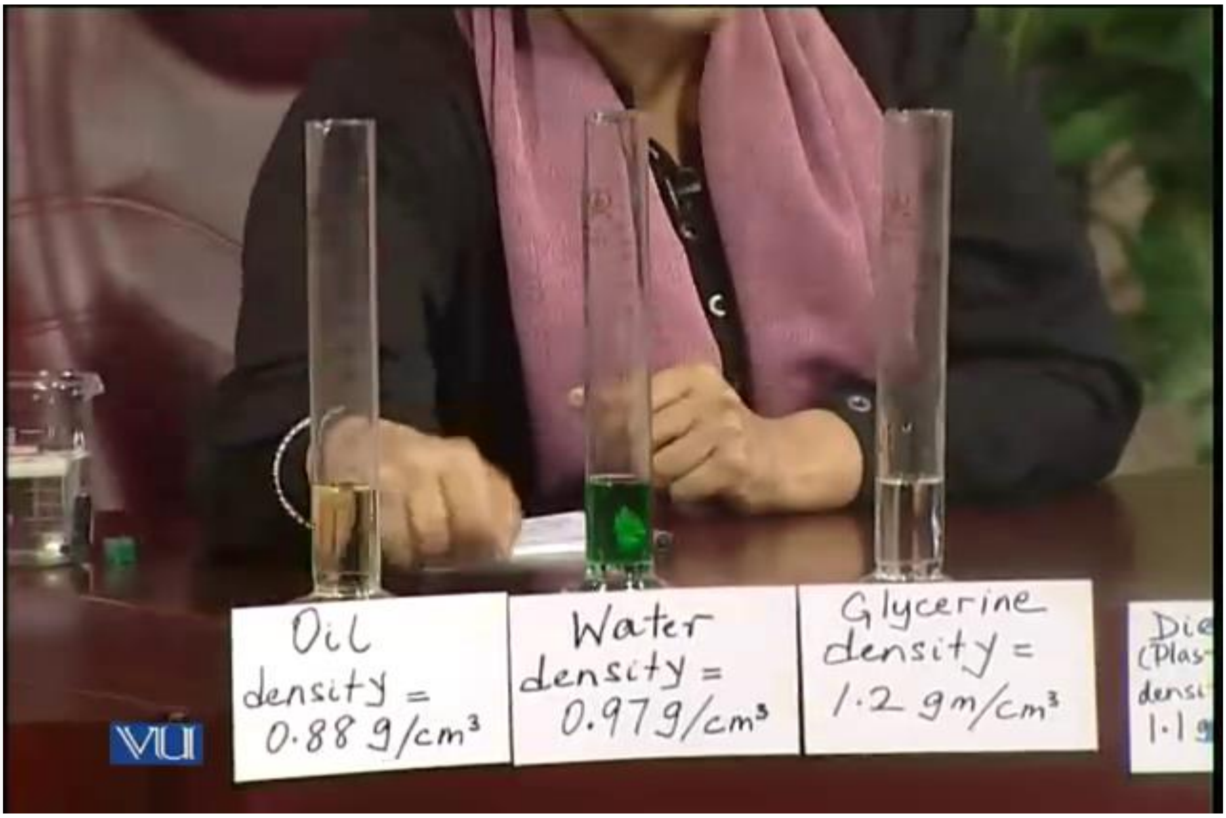
Questions

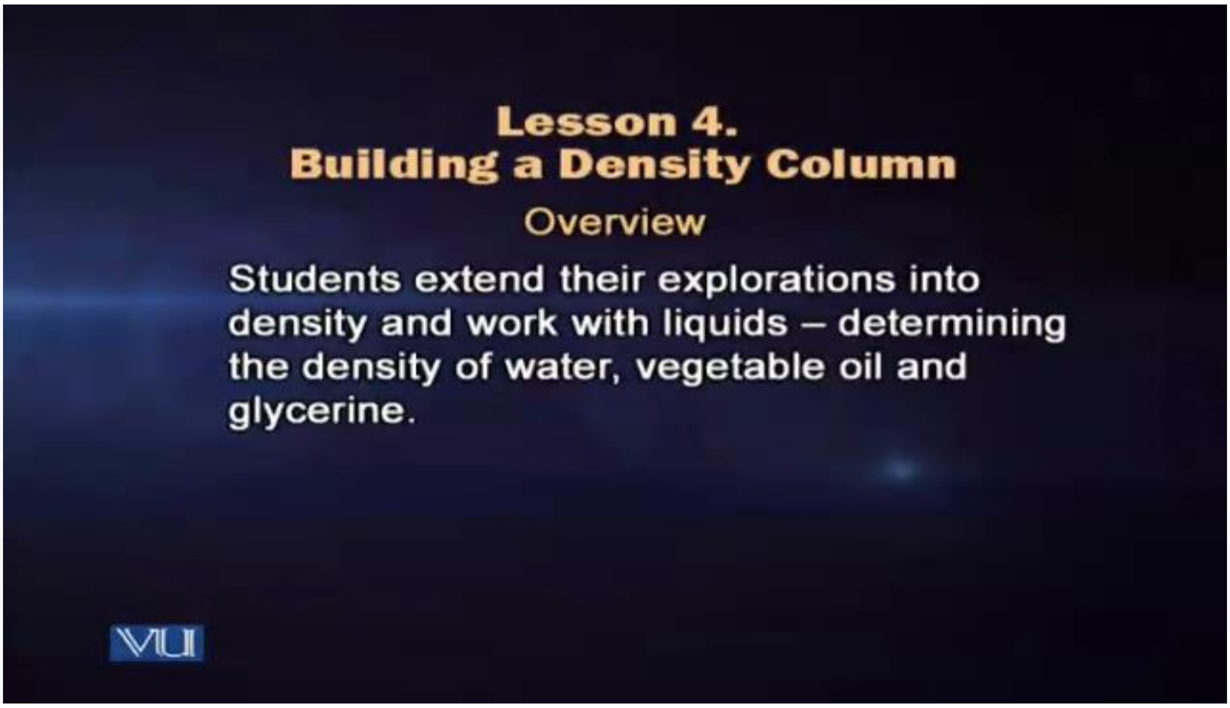
1) Are any of the blocks from the previous experiment and the objects from this experiment made out of the same substance? How did you reach your conclusion?
2) How do the densities compare with the density of water?
3) What is the difference between mass and volume

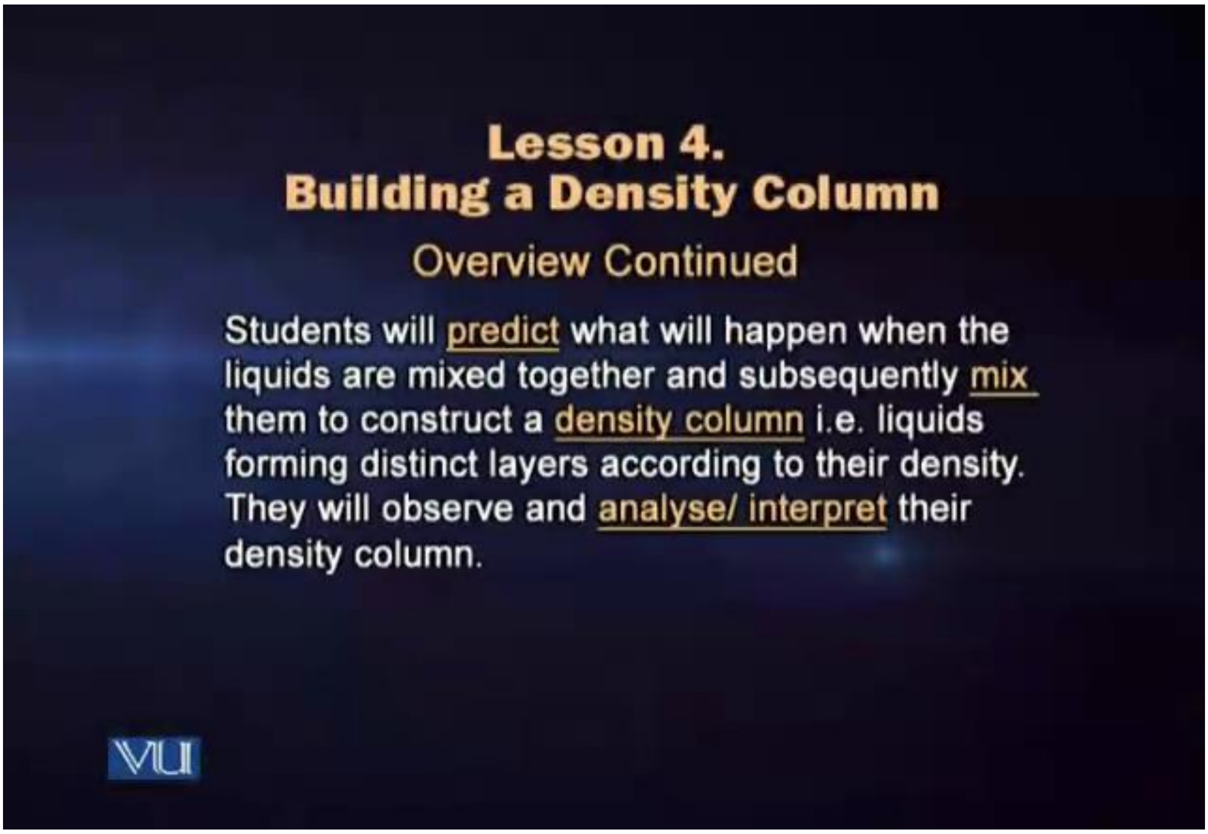
VU

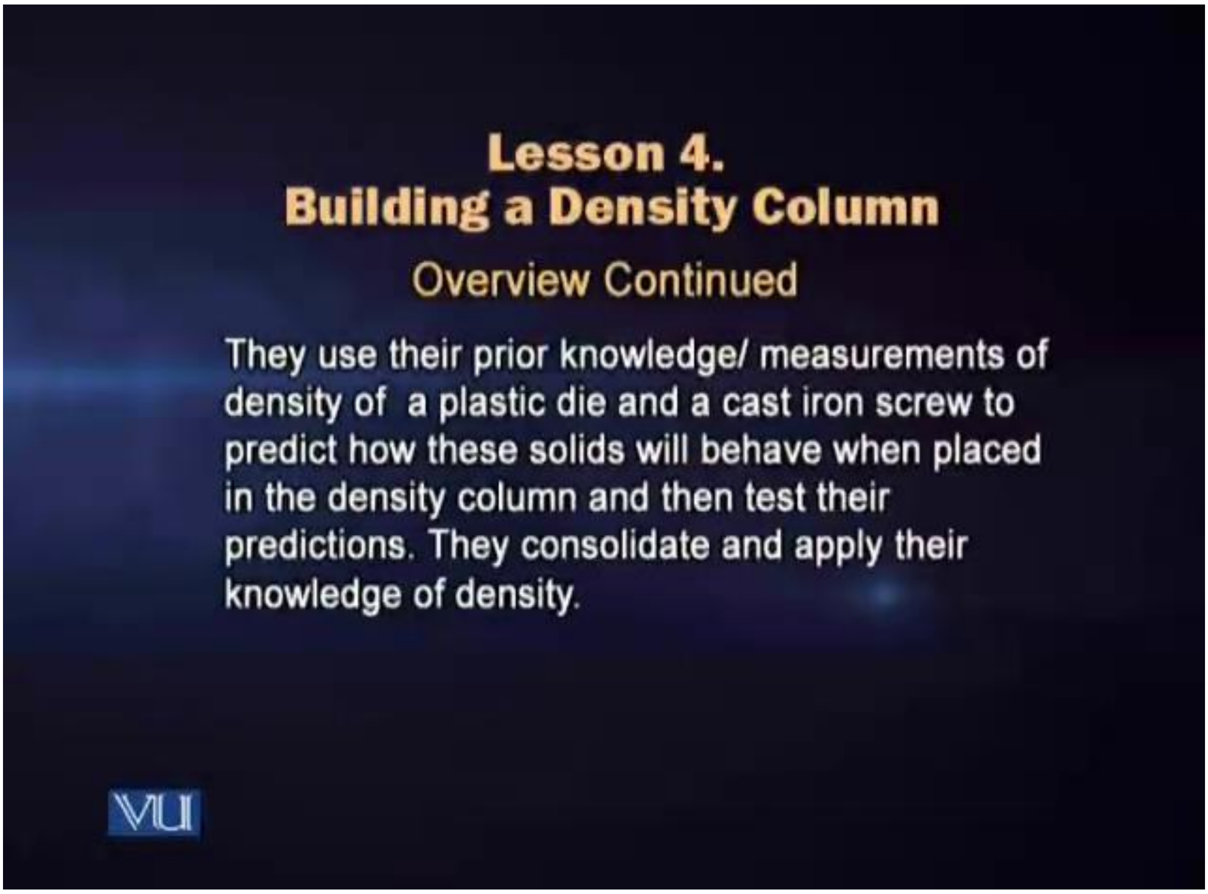
Lecture No 42

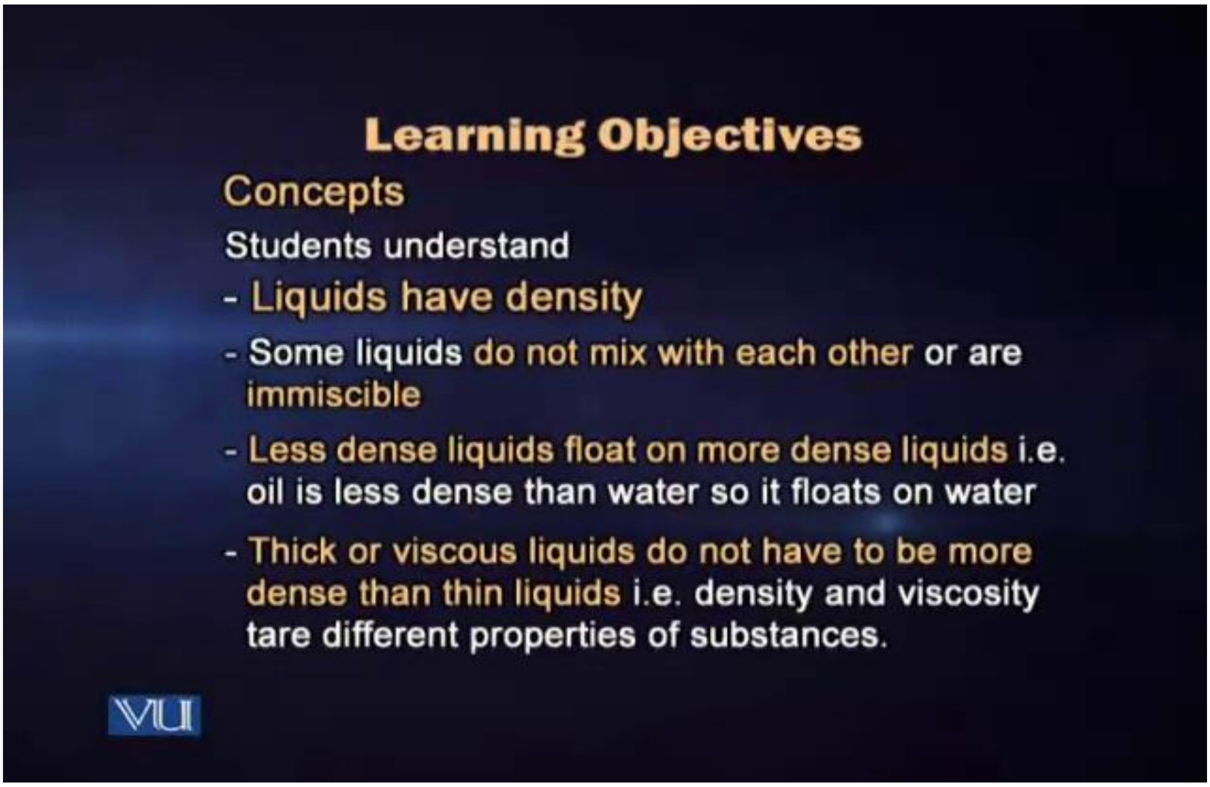
<u>Density of Liquids-A</u>

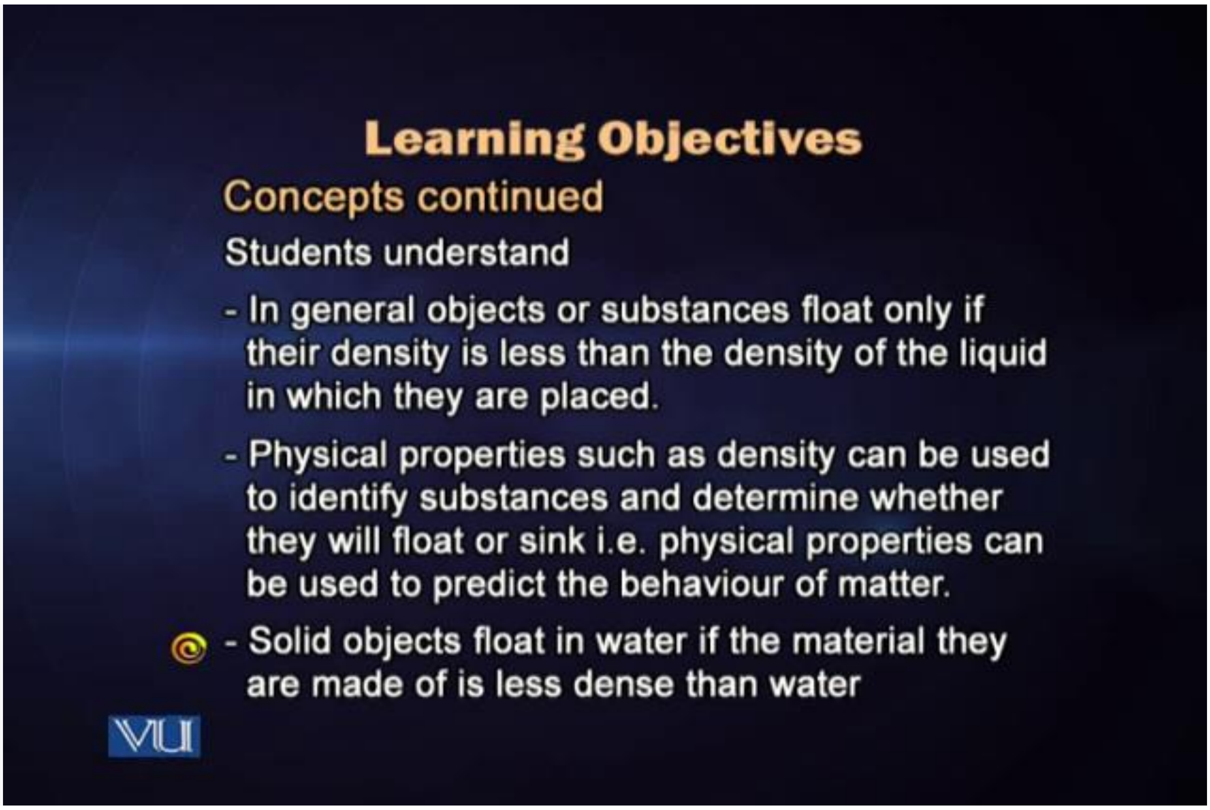


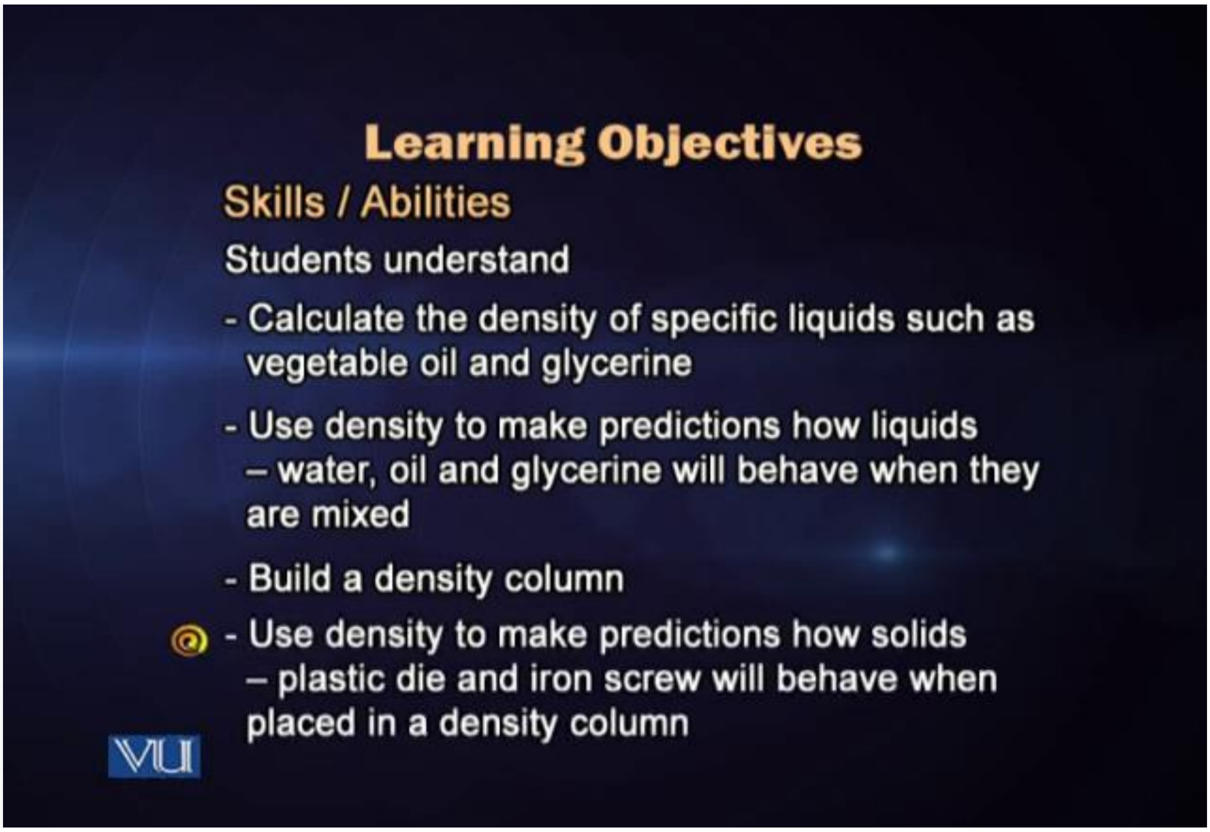


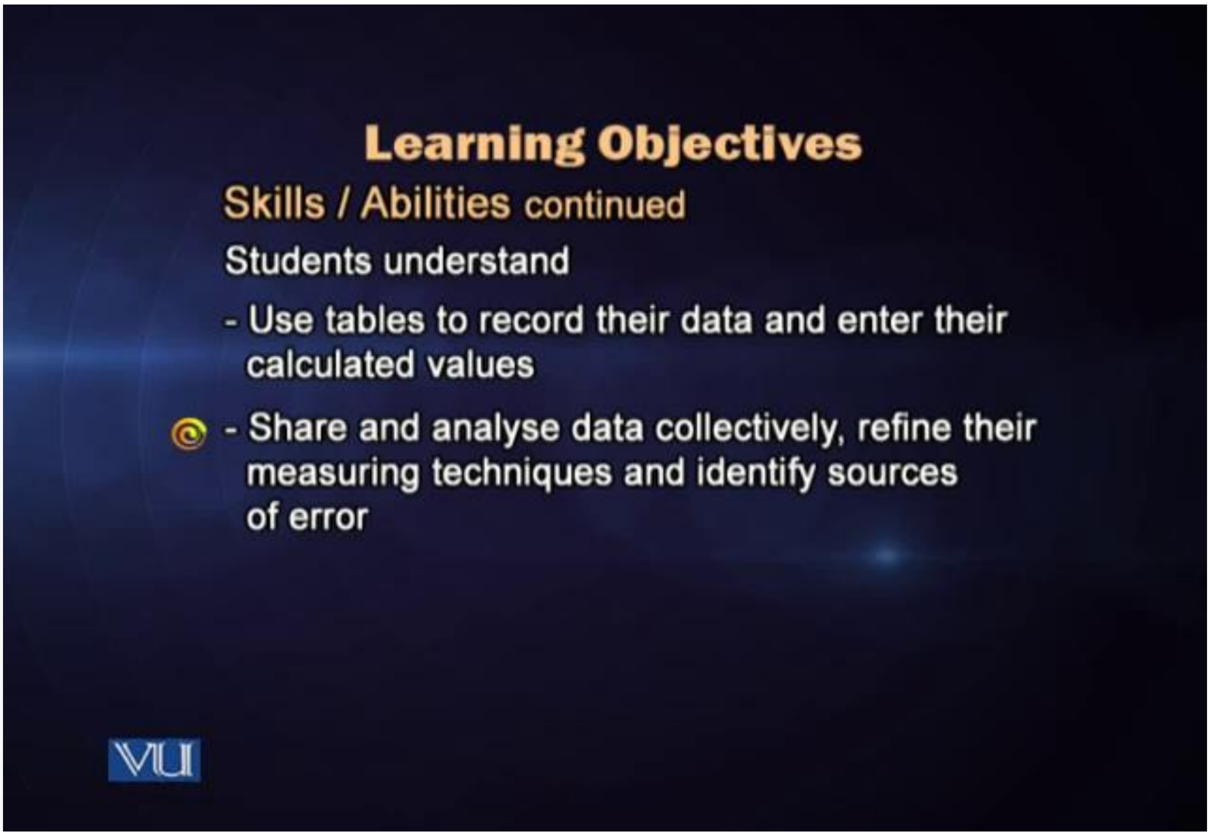

Lesson 4.
Building a Density Column
Overview Continued
Students will predict what will happen when the liquids are mixed together and subsequently mix them to construct a density column i.e. liquids forming distinct layers according to their density. They will observe and analyse/ interpret their density column.
VU

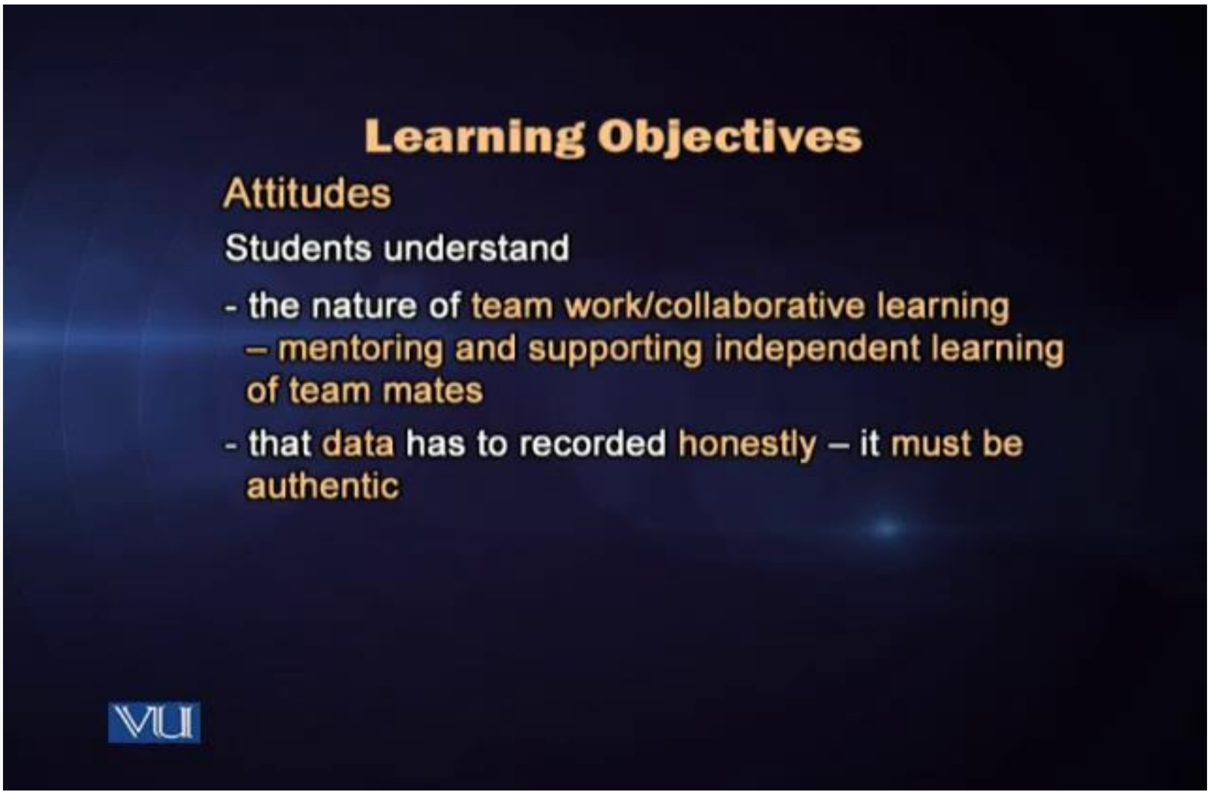

Lesson 4.
Building a Density Column
Overview Continued
They use their prior knowledge/ measurements of density of a plastic die and a cast iron screw to predict how these solids will behave when placed in the density column and then test their predictions. They consolidate and apply their knowledge of density.
VU

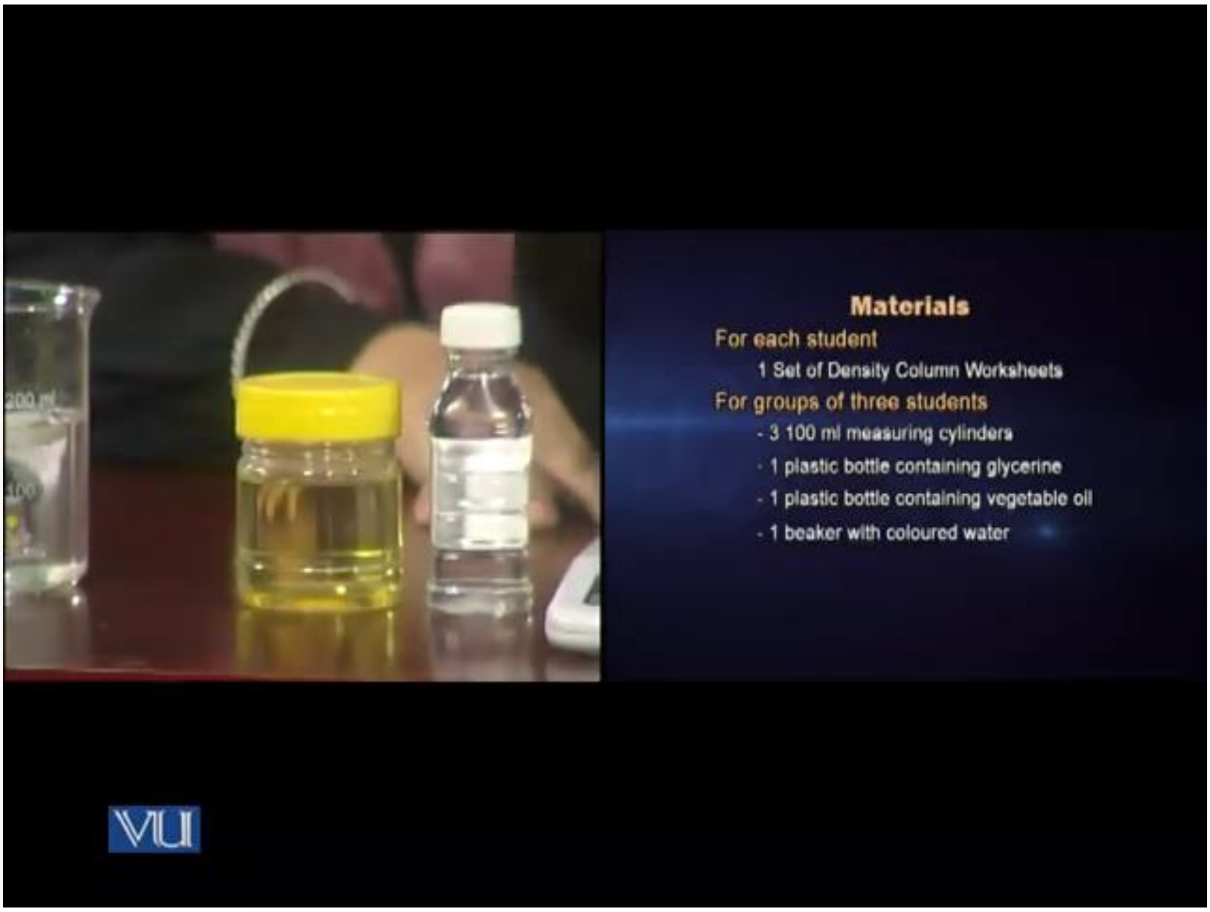

Learning Objectives
Concepts
Students understand
- Liquids have density
- Some liquids do not mix with each other or are immiscible
- Less dense liquids float on more dense liquids i.e. oil is less dense than water so it floats on water
- Thick or viscous liquids do not have to be more dense than thin liquids i.e. density and viscosity tare different properties of substances.
VU


Learning Objectives
Concepts continued
Students understand
- In general objects or substances float only if their density is less than the density of the liquid in which they are placed.
- Physical properties such as density can be used to identify substances and determine whether they will float or sink i.e. physical properties can be used to predict the behaviour of matter.
- Solid objects float in water if the material they are made of is less dense than water
VU

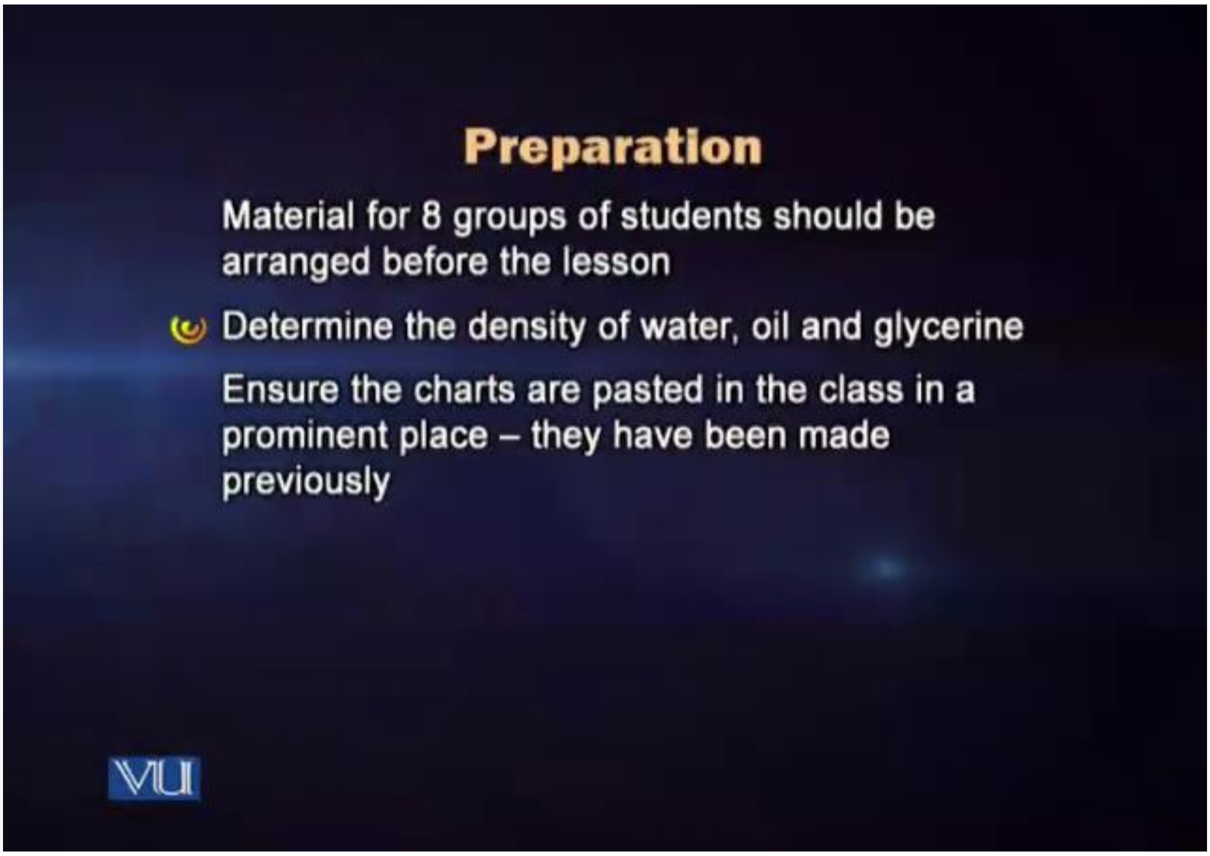

Learning Objectives
Skills / Abilities
Students understand
- Calculate the density of specific liquids such as vegetable oil and glycerine
- Use density to make predictions how liquids – water, oil and glycerine will behave when they are mixed
- Build a density column
- Use density to make predictions how solids – plastic die and iron screw will behave when placed in a density column
VU

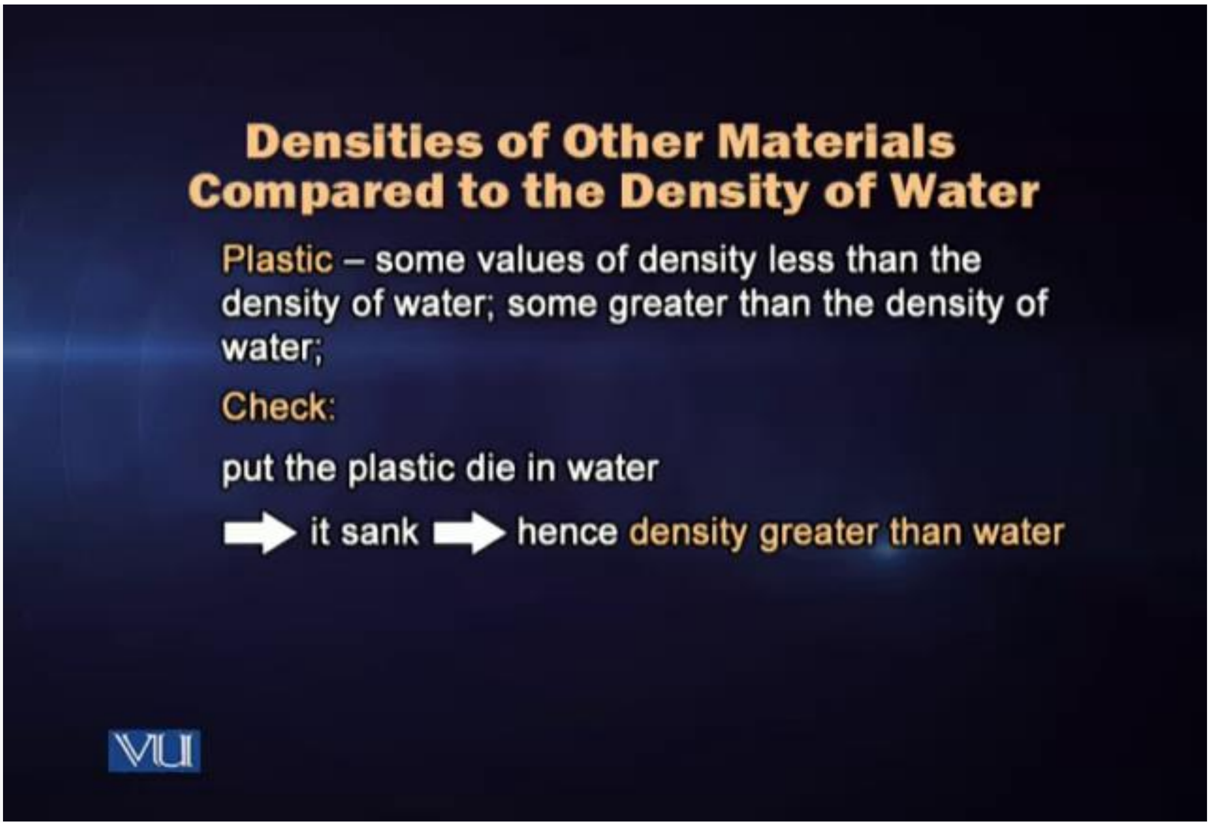

Learning Objectives
Skills / Abilities continued
Students understand
- Use tables to record their data and enter their calculated values
- Share and analyse data collectively, refine their measuring techniques and identify sources of error
VU

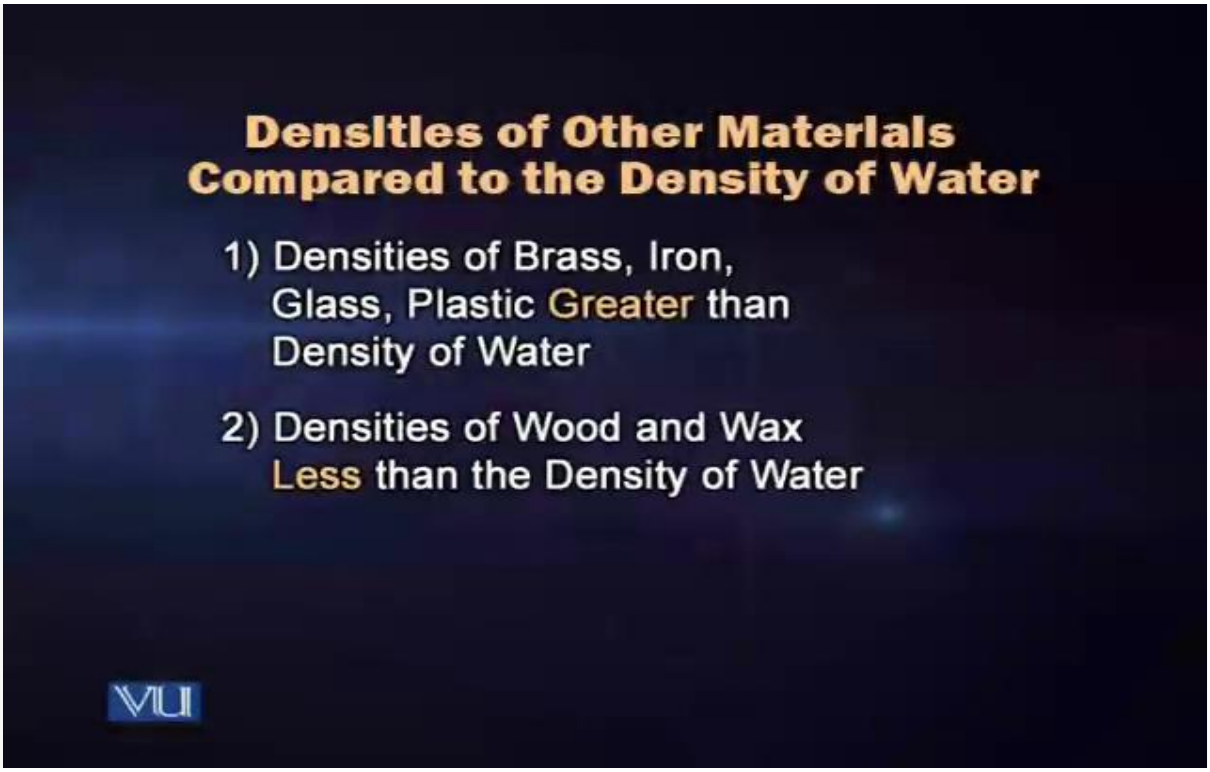

Learning Objectives
Attitudes
Students understand
- the nature of team work/collaborative learning – mentoring and supporting independent learning of team mates
- that data has to recorded honestly – it must be authentic
VU

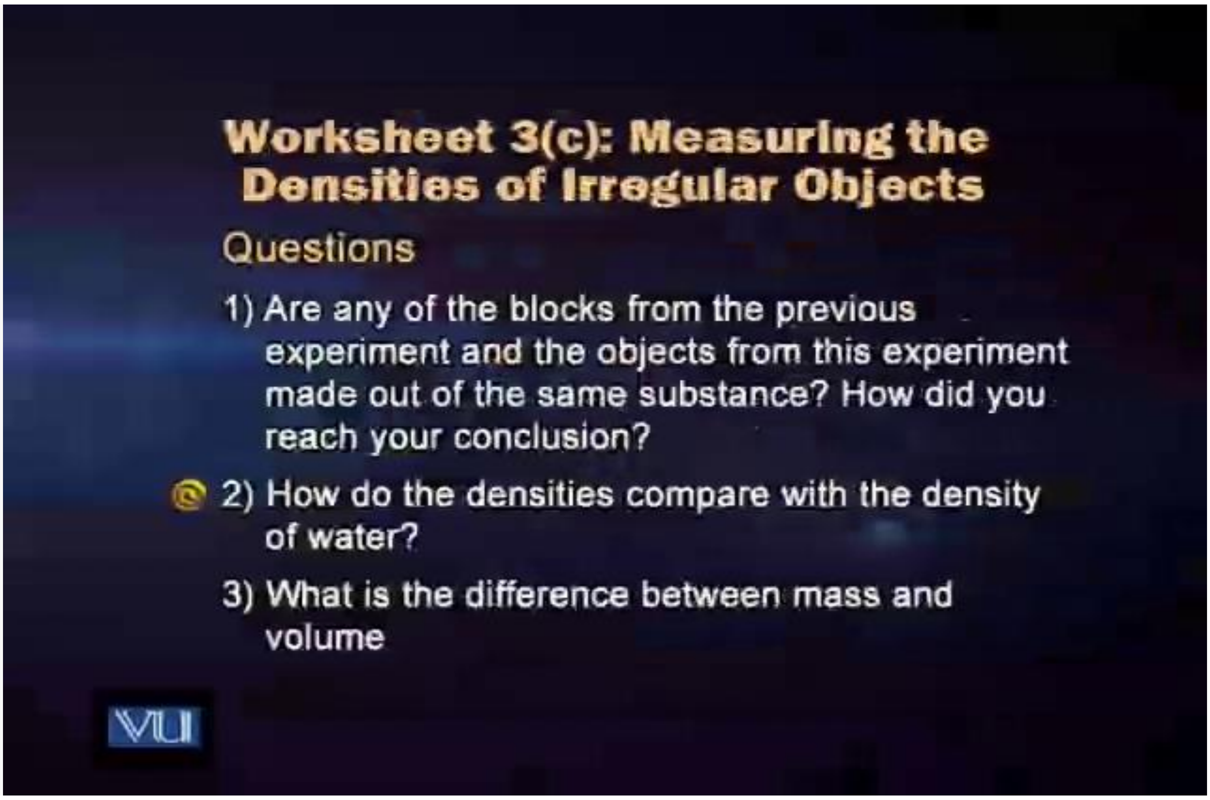

Materials
For each student
1 Set of Density Column Worksheets
For groups of three students
- 3 100 ml measuring cylinders
- 1 plastic bottle containing glycerine
- 1 plastic bottle containing vegetable oil
- 1 beaker with coloured water
VU

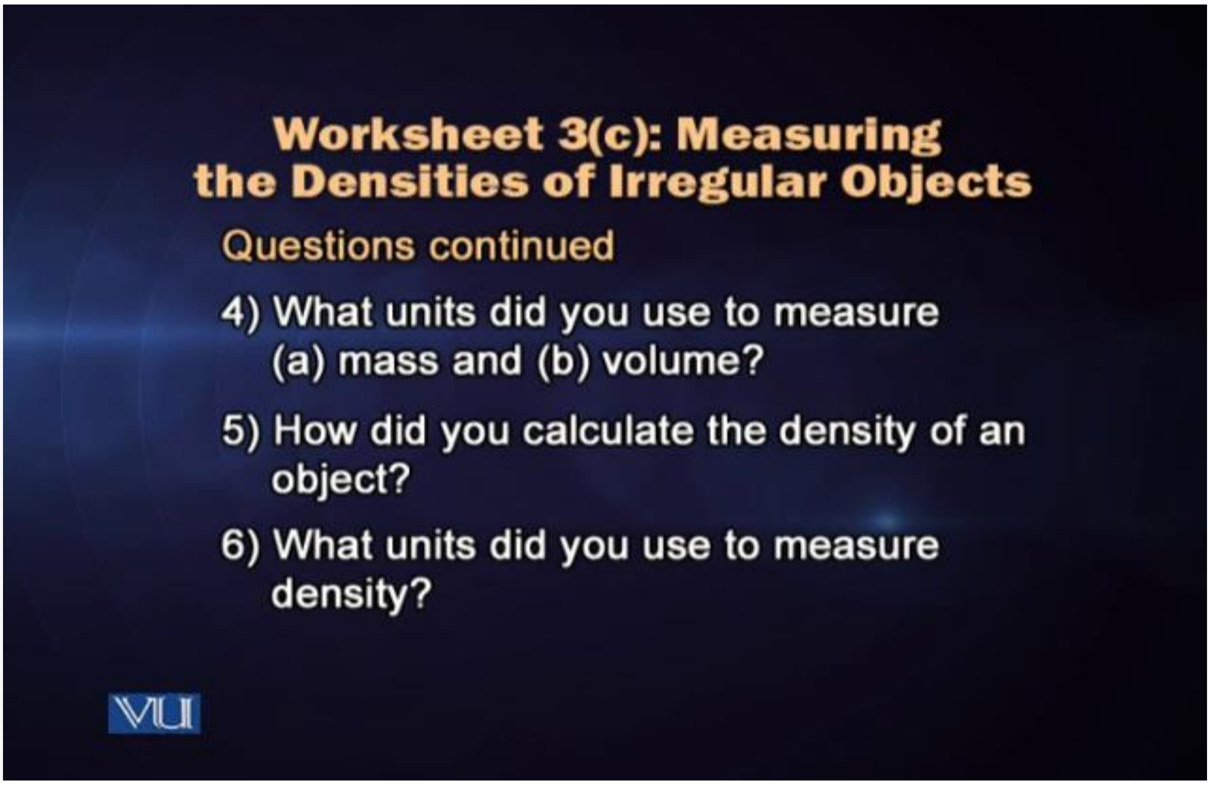

Materials continued
For two groups of three students
1 electronic balance
The entire class
- A chart explaining how to measure the mass of a liquid
- Extra chart paper and markers for recording data
VU

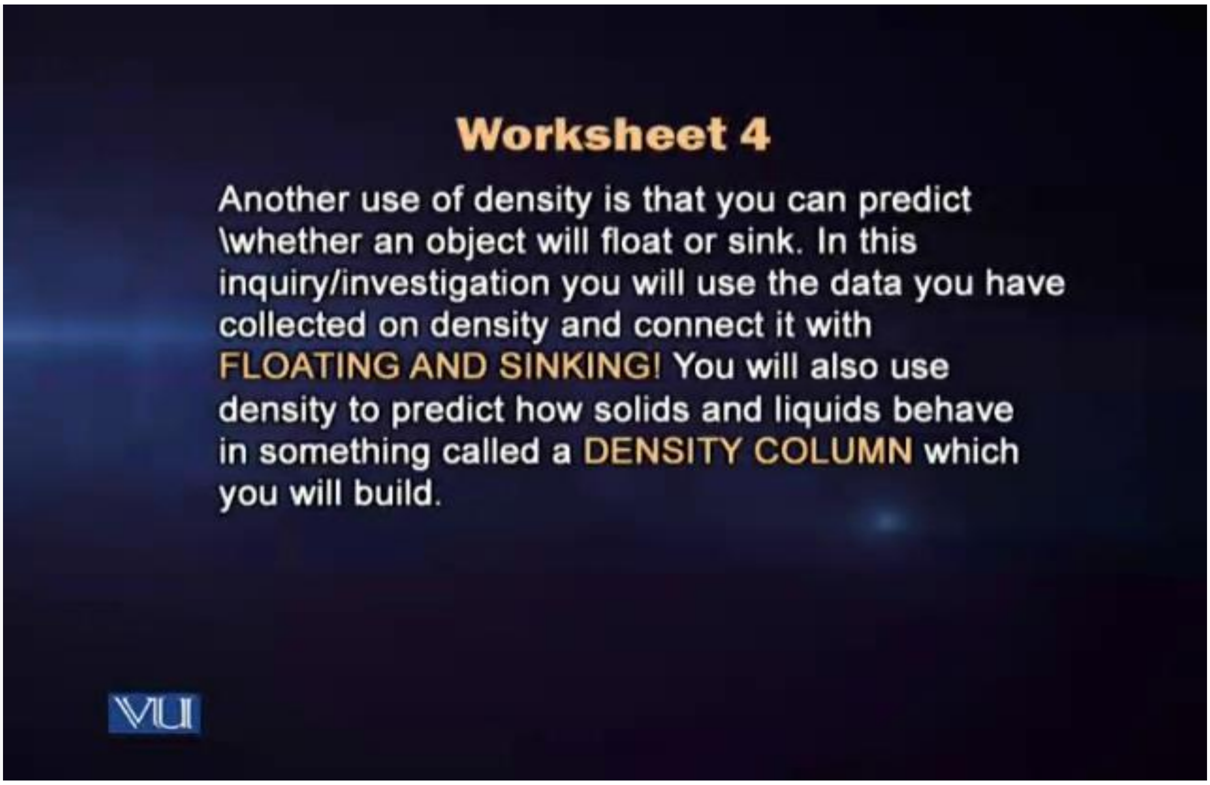

Preparation
Material for 8 groups of students should be arranged before the lesson
Determine the density of water, oil and glycerine
Ensure the charts are pasted in the class in a prominent place – they have been made previously
VU

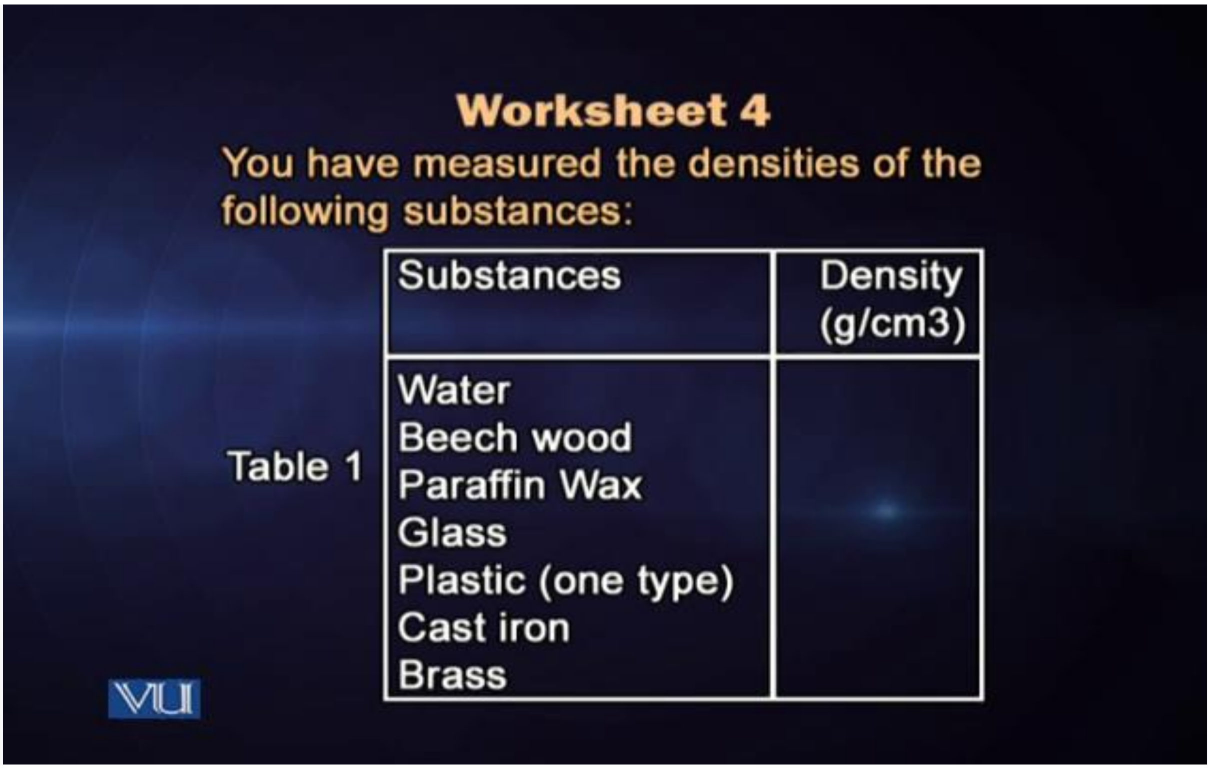

Densities of Other Materials
Compared to the Density of Water
Plastic – some values of density less than the density of water; some greater than the density of water;
Check:
put the plastic die in water
it sank
hence density greater than water
VU

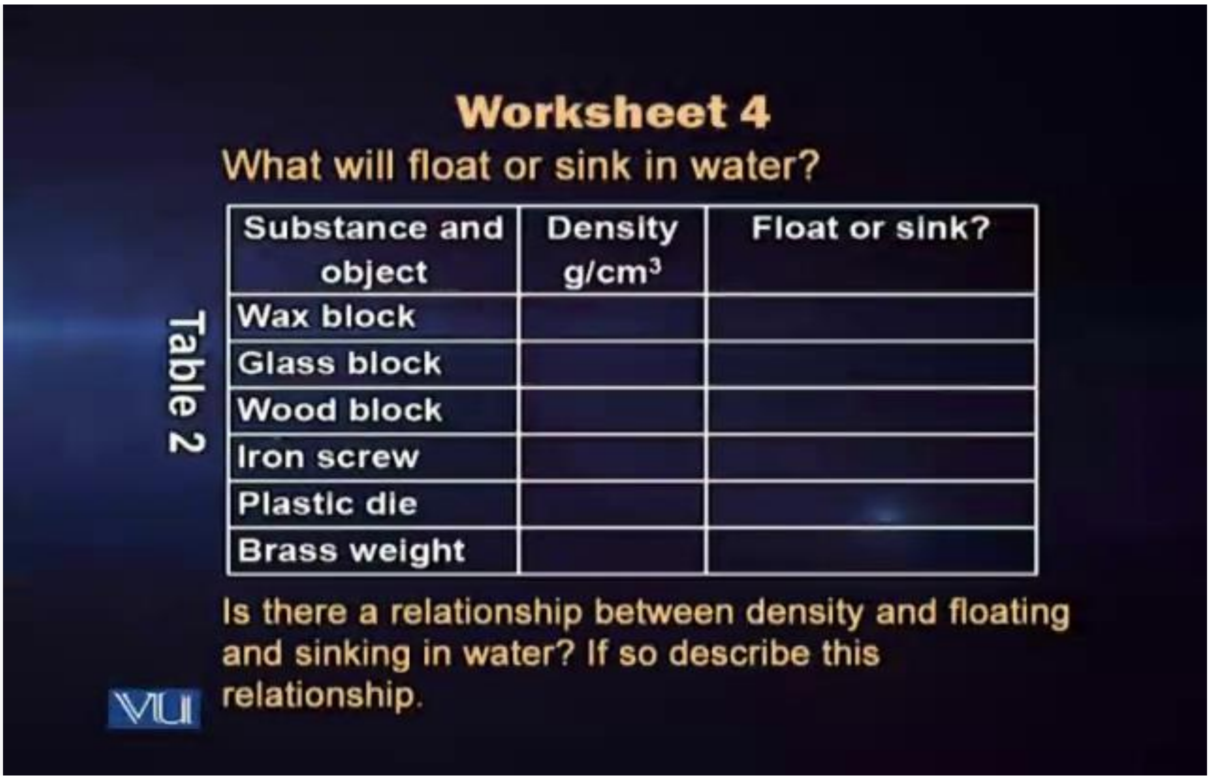

Densities of Other Materials
Compared to the Density of Water
1) Densities of Brass, Iron, Glass, Plastic Greater than Density of Water
2) Densities of Wood and Wax Less than the Density of Water
VU


Worksheet 3(c): Measuring the Densities of Irregular Objects
Questions
1) Are any of the blocks from the previous experiment and the objects from this experiment made out of the same substance? How did you reach your conclusion?
2) How do the densities compare with the density of water?
3) What is the difference between mass and volume
VU


Worksheet 3(c): Measuring the Densities of Irregular Objects
Questions continued
4) What units did you use to measure (a) mass and (b) volume?
5) How did you calculate the density of an object?
6) What units did you use to measure density?
VU


Worksheet 4
Another use of density is that you can predict \whether an object will float or sink. In this inquiry/investigation you will use the data you have collected on density and connect it with FLOATING AND SINKING! You will also use density to predict how solids and liquids behave in something called a DENSITY COLUMN which you will build.
VU


Worksheet 4
You have measured the densities of the following substances:
Table 1
Substances
Density (g/cm3)
Water
Beech wood
Paraffin Wax
Glass
Plastic (one type)
Cast iron
Brass
VU



Worksheet 4

What will float or sink in water?

Table 2

Substance and object	Density g/cm^3	Float or sink?
Wax block		
Glass block		
Wood block		
Iron screw		
Plastic die		
Brass weight		

Is there a relationship between density and floating and sinking in water? If so describe this relationship.

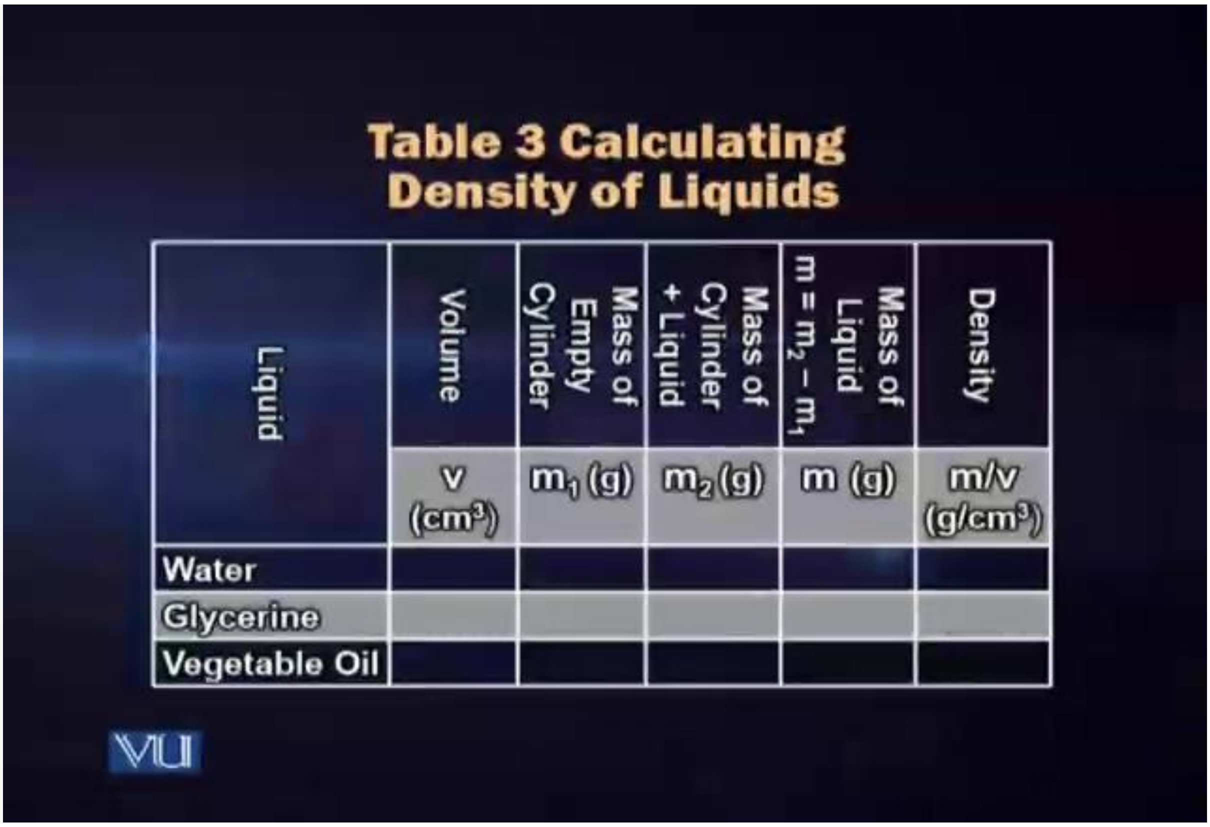
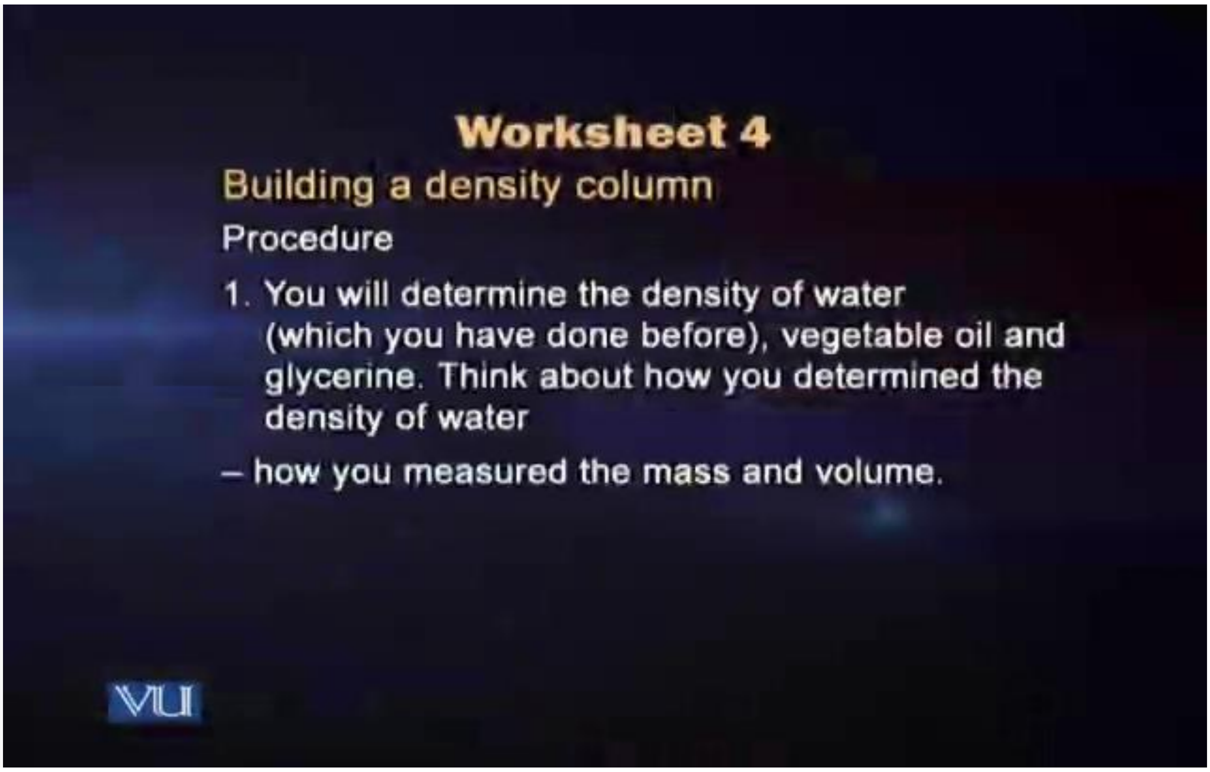
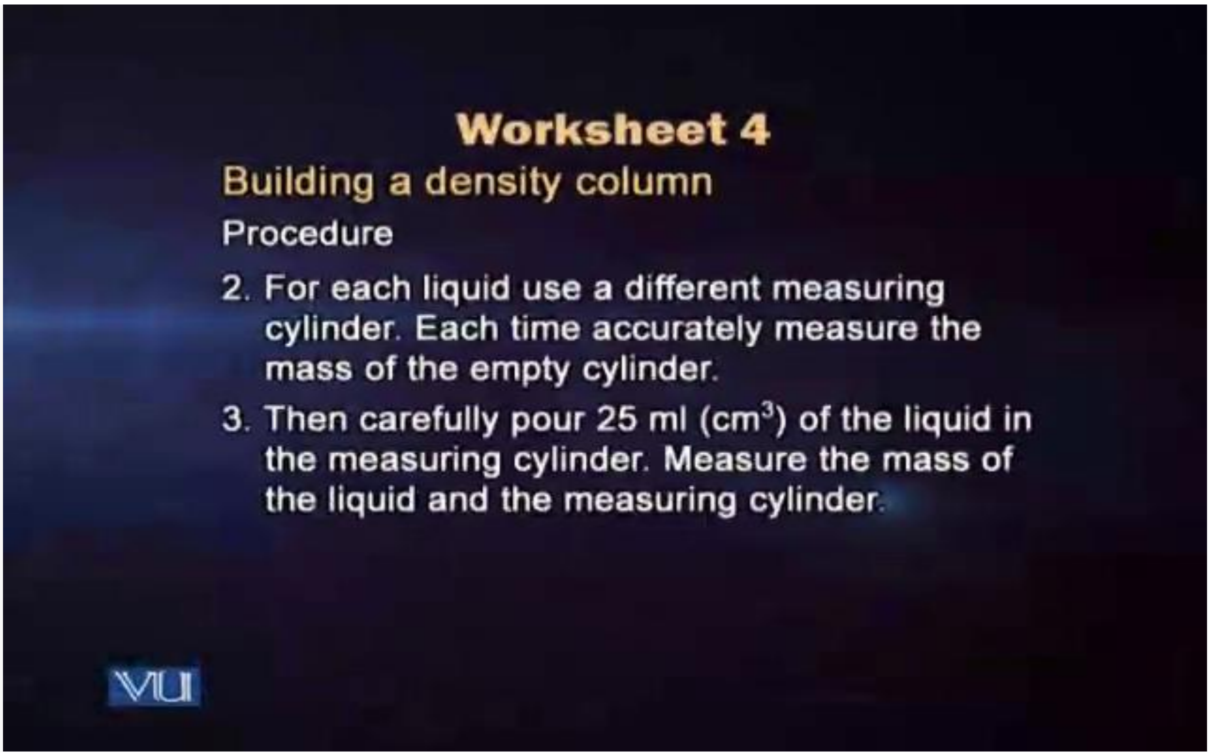


Table 3 Calculating Density of Liquids

Liquid	Volume	Mass of Empty Cylinder	Mass of Cylinder + Liquid	Mass of Liquid $m = m_2 - m_1$	Density
	v (cm^3)	m_1 (g)	m_2 (g)	m (g)	m/v (g/cm^3)
Water					
Glycerine					
Vegetable Oil					


Worksheet 4
Building a density column
Procedure
1. You will determine the density of water (which you have done before), vegetable oil and glycerine. Think about how you determined the density of water
– how you measured the mass and volume.
VU


Worksheet 4
Building a density column
Procedure
2. For each liquid use a different measuring cylinder. Each time accurately measure the mass of the empty cylinder.
3. Then carefully pour 25 ml (cm^3) of the liquid in the measuring cylinder. Measure the mass of the liquid and the measuring cylinder.
VU

Worksheet 4

Building a density column

Procedure

4. Enter the data in the table 3.
5. Find the mass of 25 ml of liquid using the measurements in step 2 and step 3.
6. Calculate the density of the liquid.
7. Repeat the above steps for each liquid.

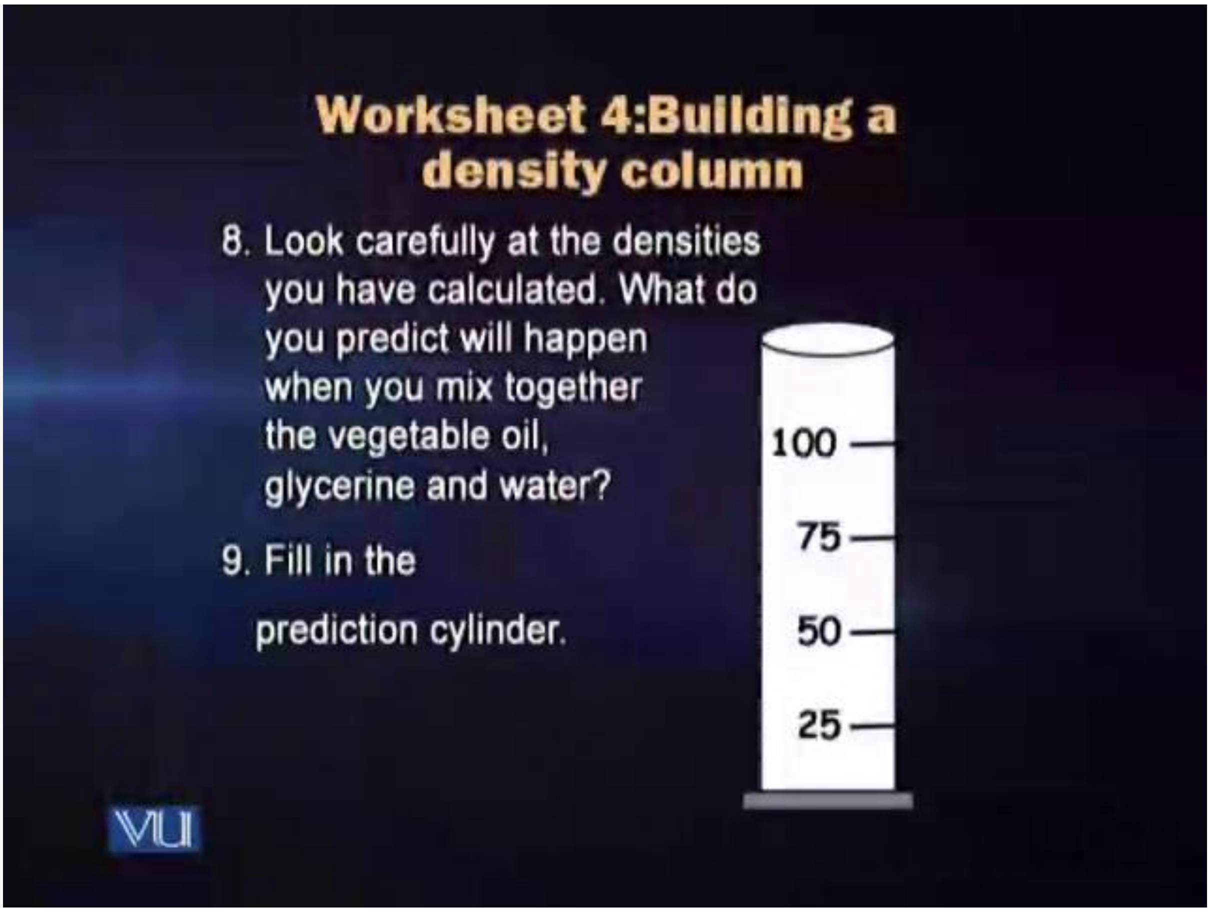
VU

Densities of 3 Different Liquids :

Collective Data of 8 Groups

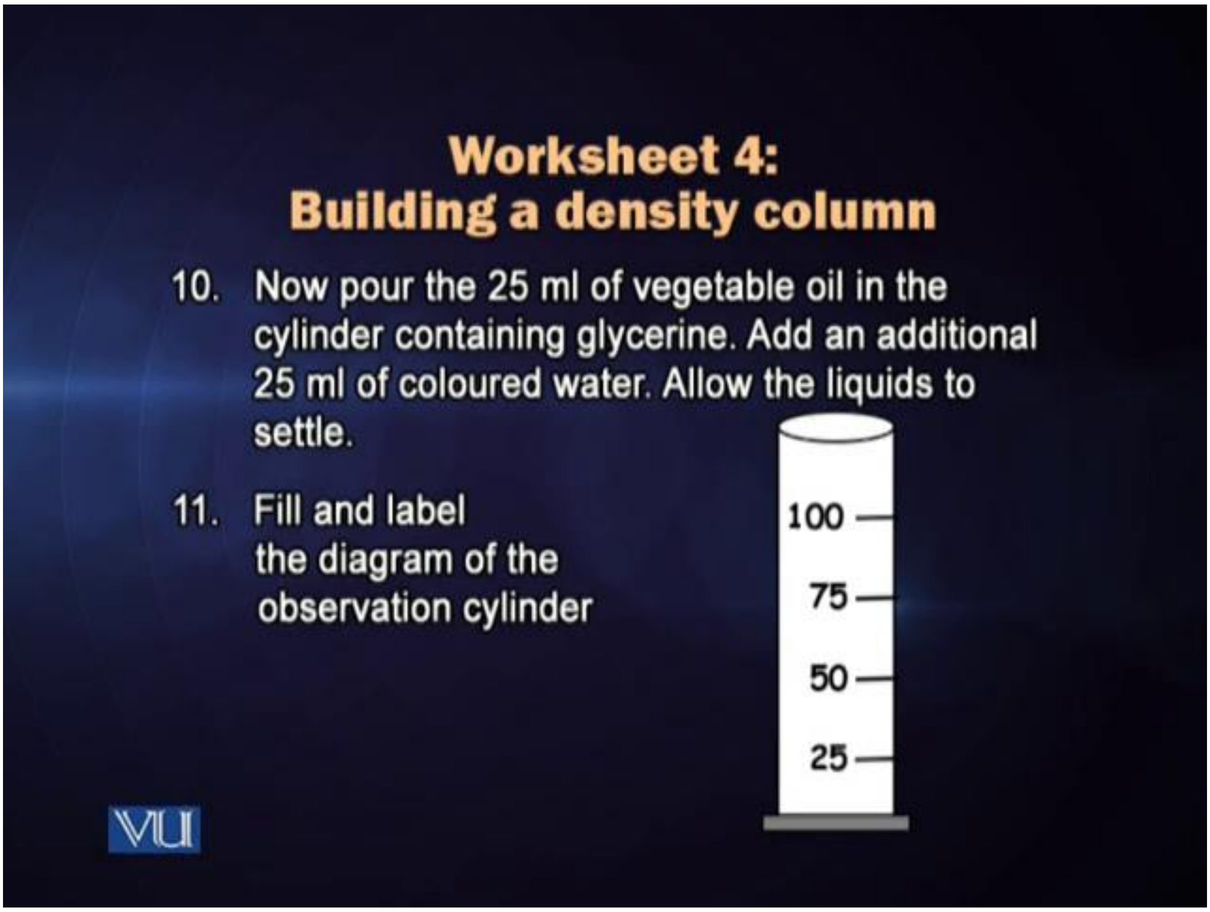
GROUPS	Density (g/cm^3)		
	Glycerine	Oil	Water
1	1.15	0.86	0.99
2	1.19	0.89	0.84
3	1.17	0.88	0.98
4	1.24	0.88	0.95
5	1.24	0.90	1.06
6	1.11	0.79	0.81
7	1.15	0.81	0.80
8	1.28	0.34	0.83

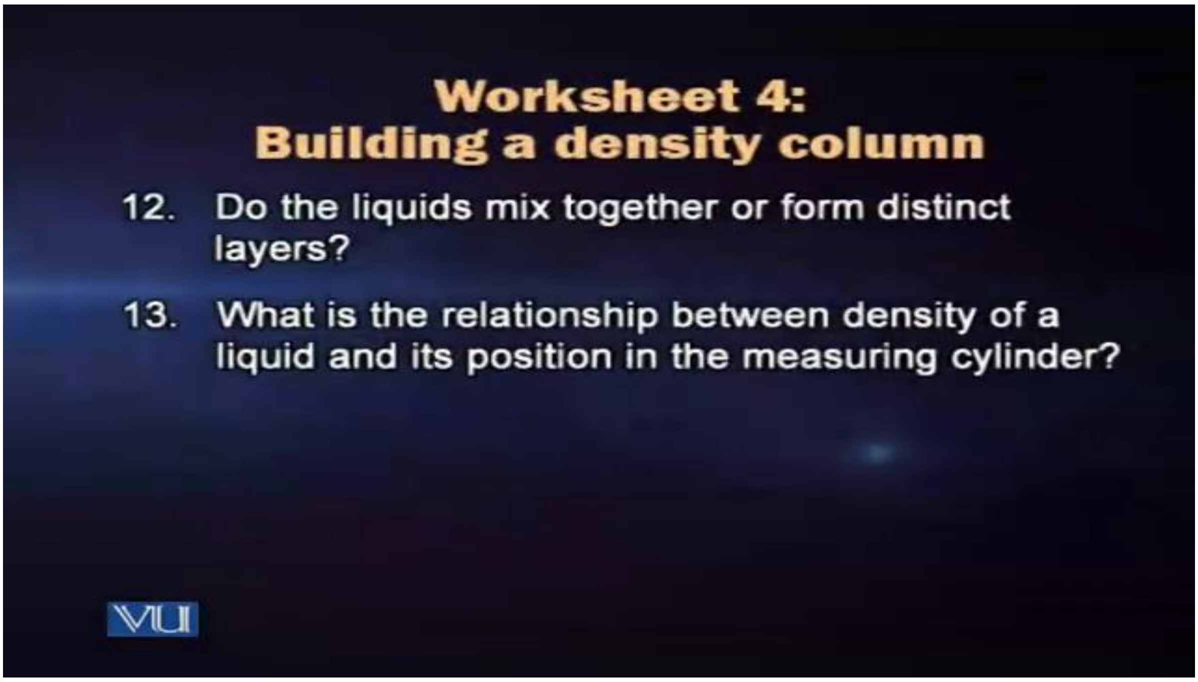
VU

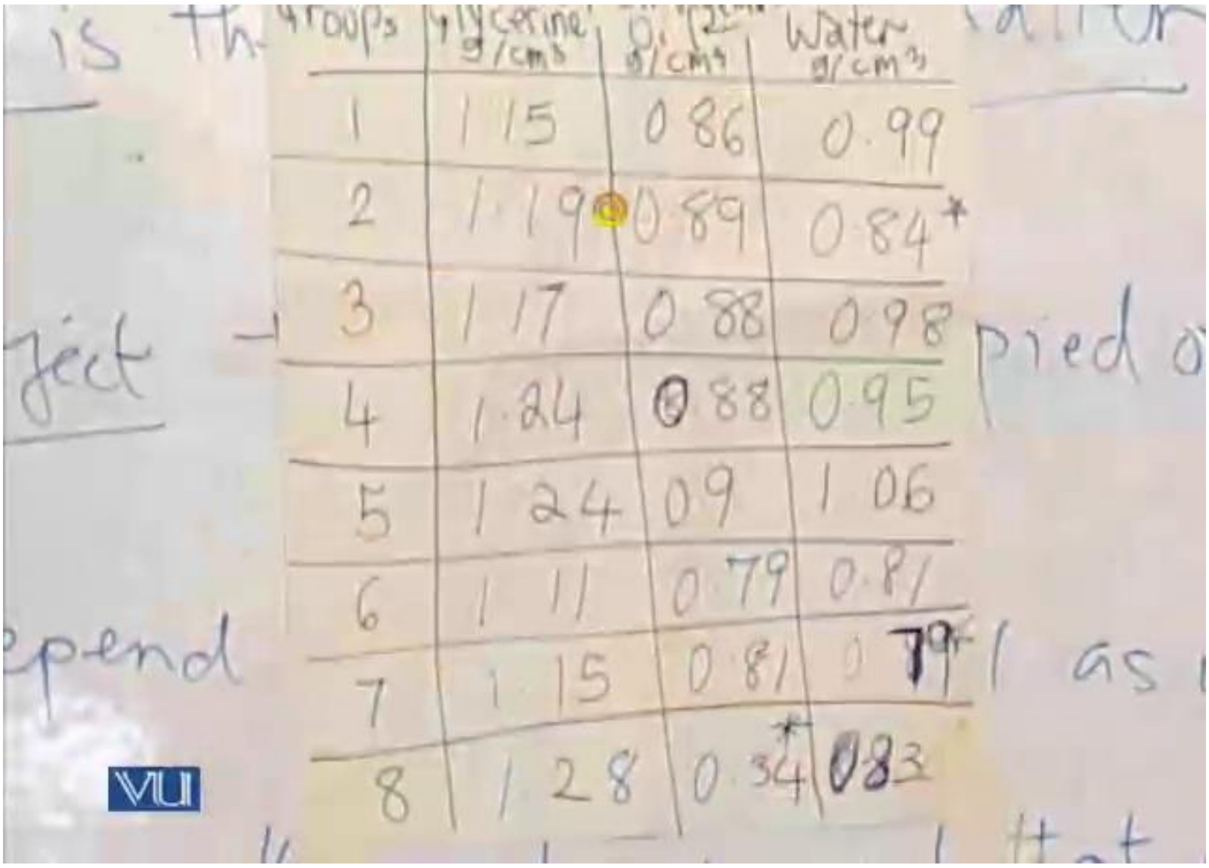

Worksheet 4:Building a density column
8. Look carefully at the densities you have calculated. What do you predict will happen when you mix together the vegetable oil, glycerine and water?
9. Fill in the
prediction cylinder.
100
75
50
25
VU

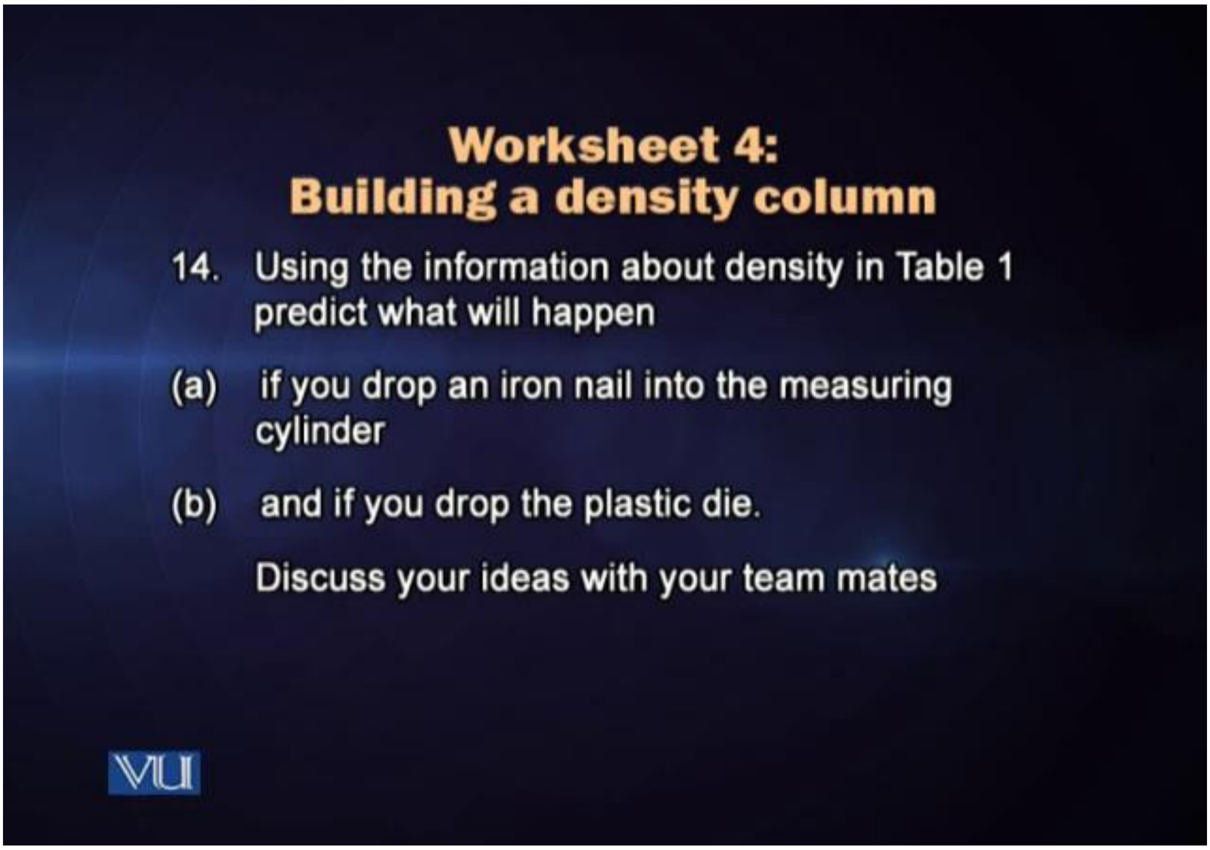
Lecture No 43

Building a Density Column-B



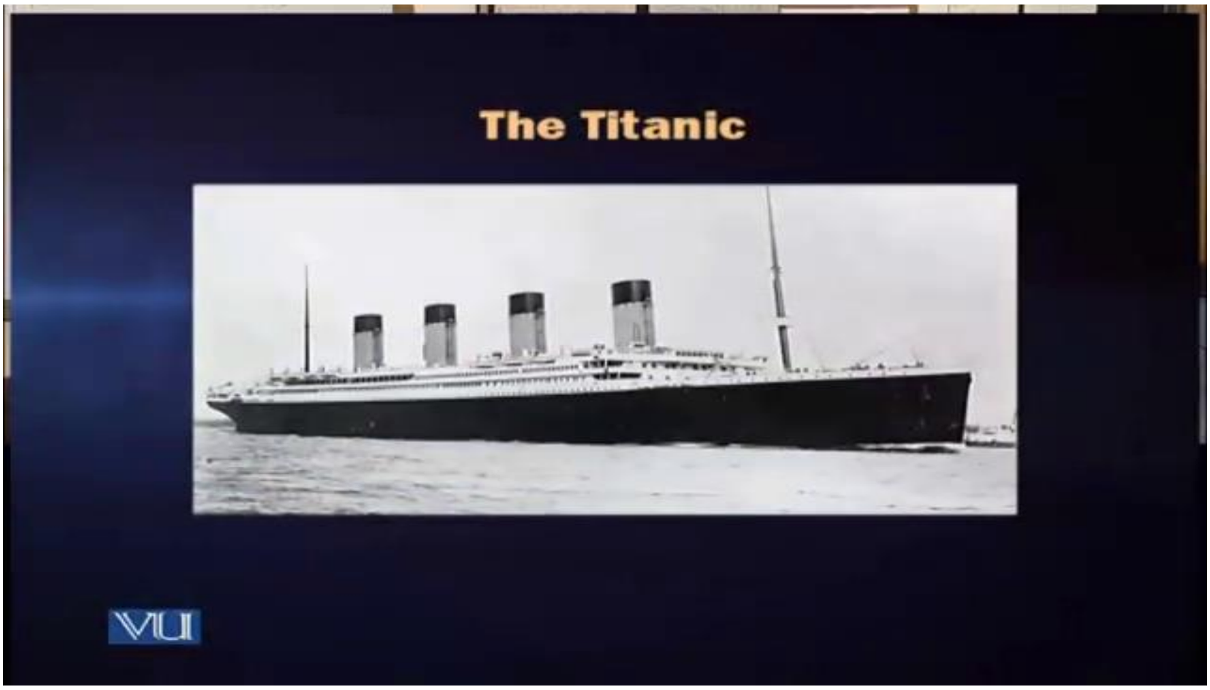

Worksheet 4:
Building a density column
12. Do the liquids mix together or form distinct layers?
13. What is the relationship between density of a liquid and its position in the measuring cylinder?
VU


groups
glycerine g/cm3
oil g/cm3
water g/cm3
1 1 15 0 86 0.99
2 1.19 0.89 0.84*
3 1 17 0 88 0 98
4 1.24 0.88 0.95
5 1 24 0 9 1 06
6 1 11 0 79 0.81
7 1 15 0 81 0 79
8 1 28 0 34 083
VU



Worksheet 4:
Building a density column
14. Using the information about density in Table 1 predict what will happen
(a) if you drop an iron nail into the measuring cylinder
(b) and if you drop the plastic die.
Discuss your ideas with your team mates
VU

VU


The Titanic


Titanic hitting an Iceberg

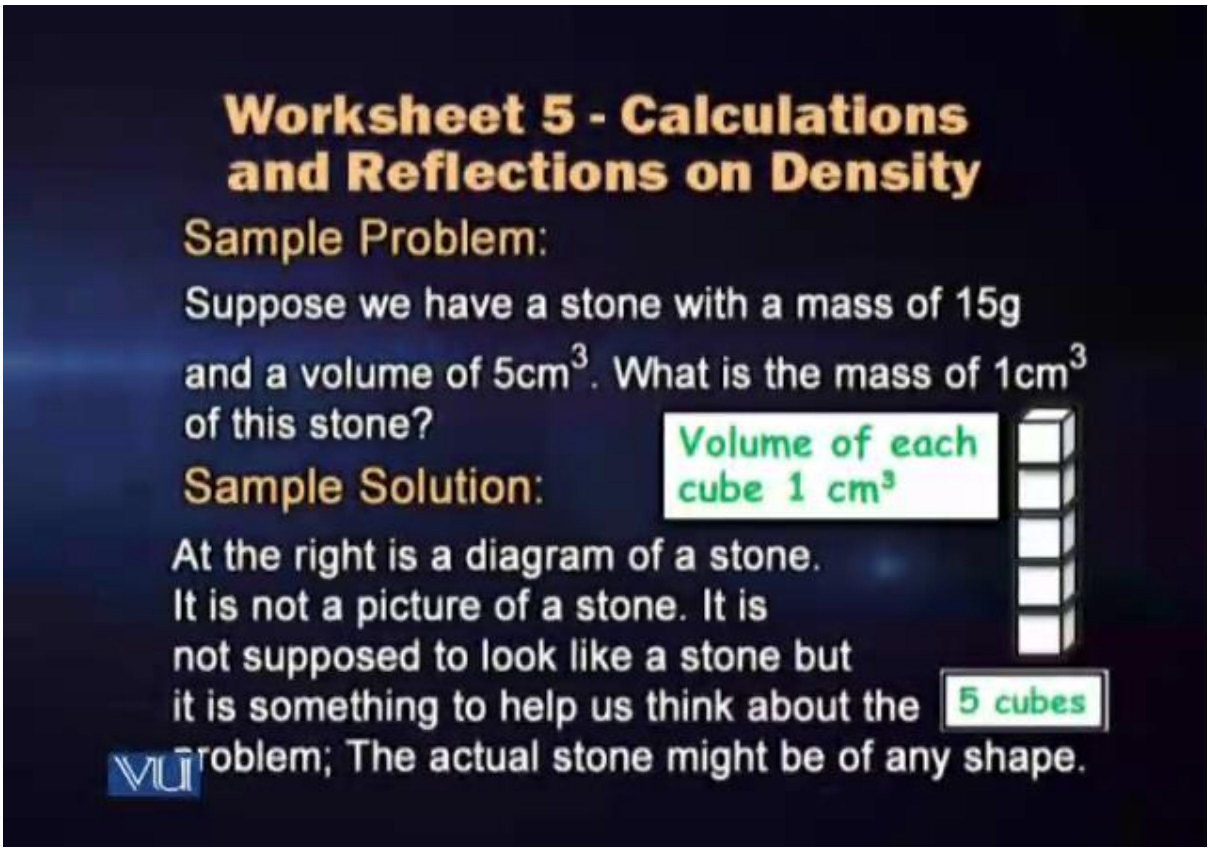
Problems

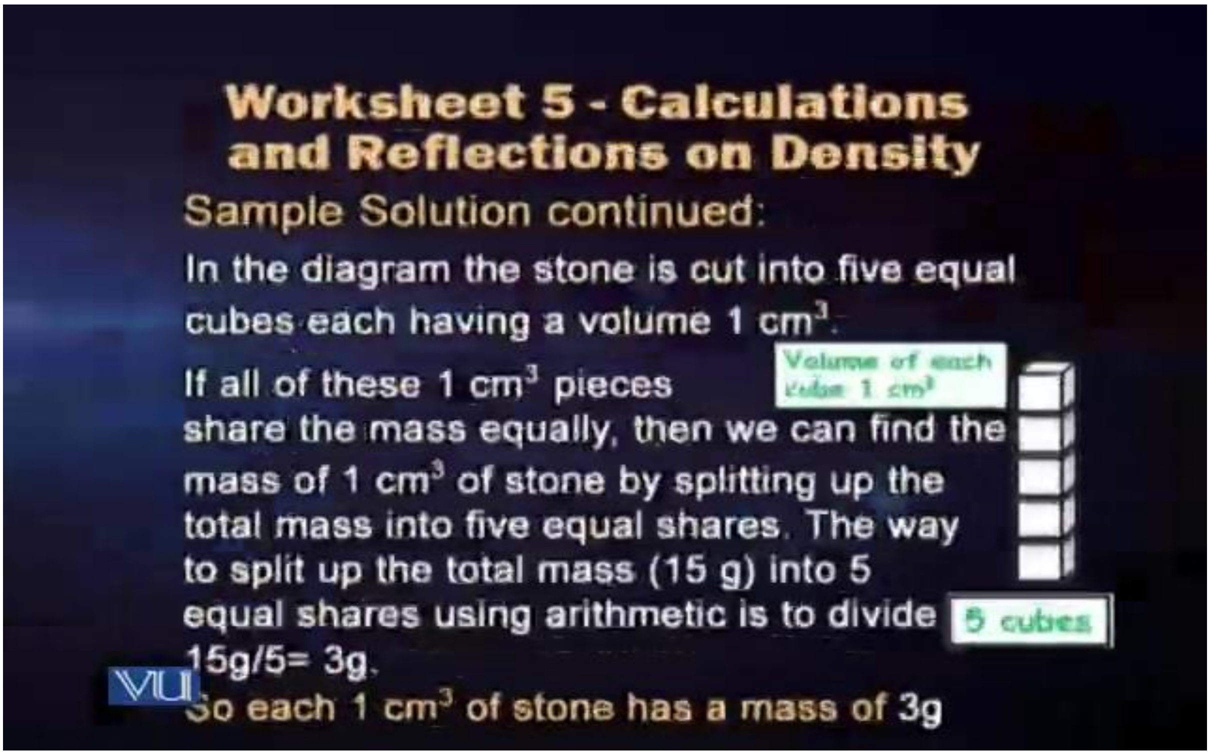
1. A certain piece of metal has a mass of 125 g and a volume of 25 cm^3.
   - (a) What is the mass of 1 cm^3 of this metal?
   - (b) What is its density?
   - (c) What is the volume of 80g of this metal?
   - (d) What is the mass of 40 cm^3 of this metal?

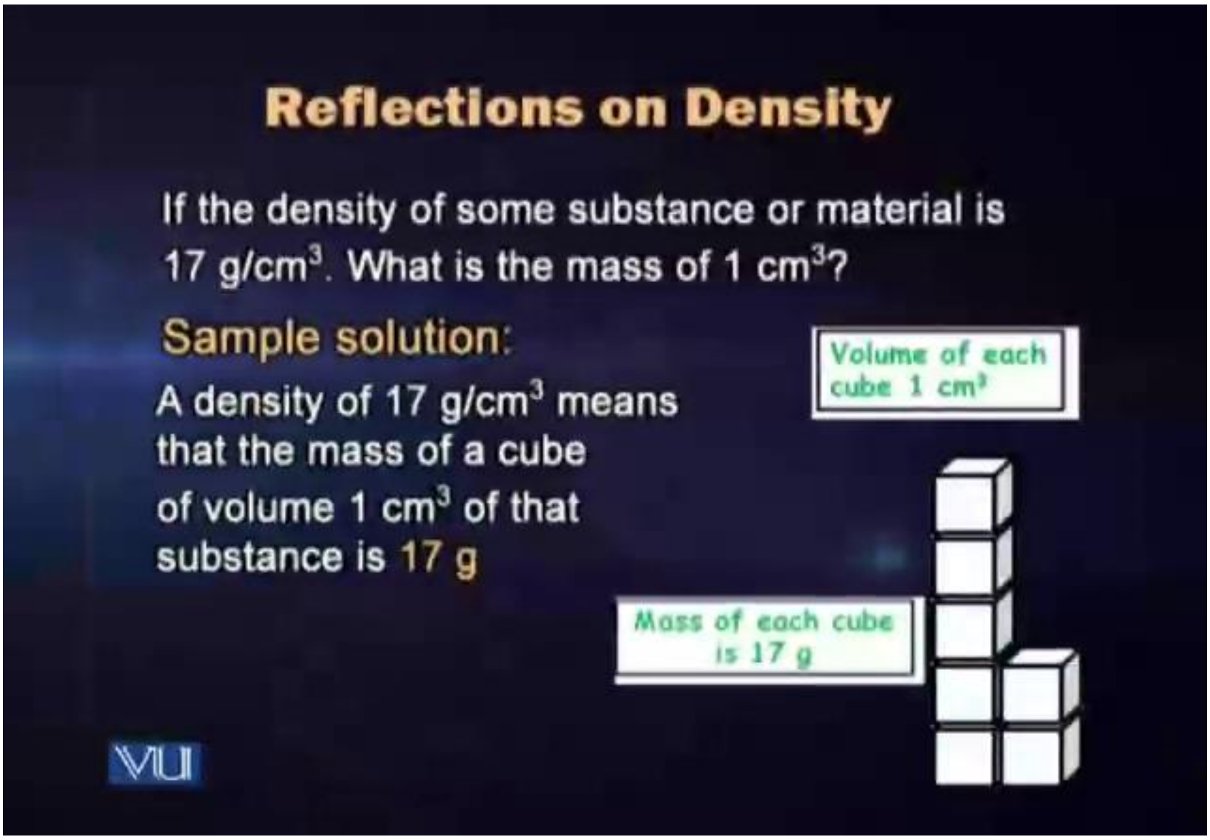
VU

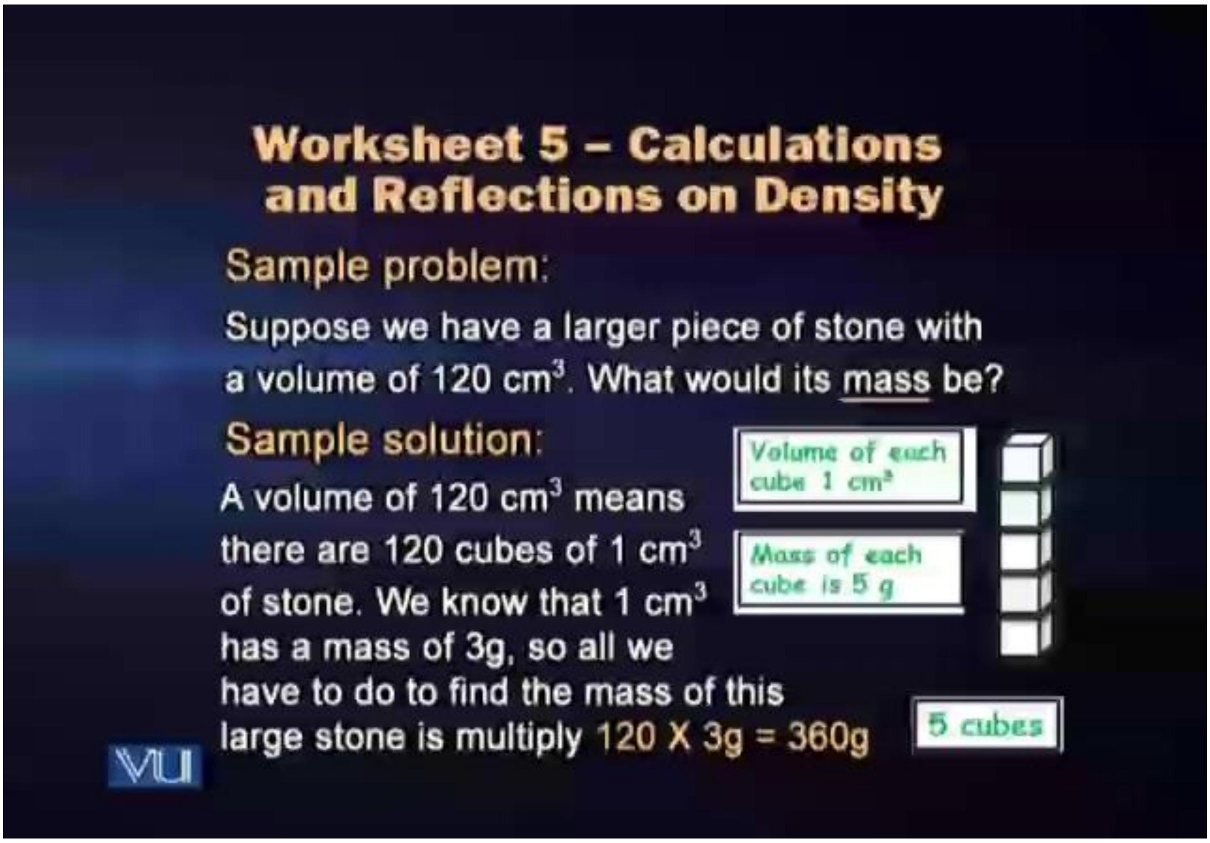
2. A piece of clay has a mass of 14.1 g and a volume of 12.2 cm^3.
   - (a) What is the mass of 1 cm^3 of this clay? Draw a diagram to show our thinking
   - (b) What is its density?
   - (c) What is mass of 15.2 cm^3 of the same type of clay.

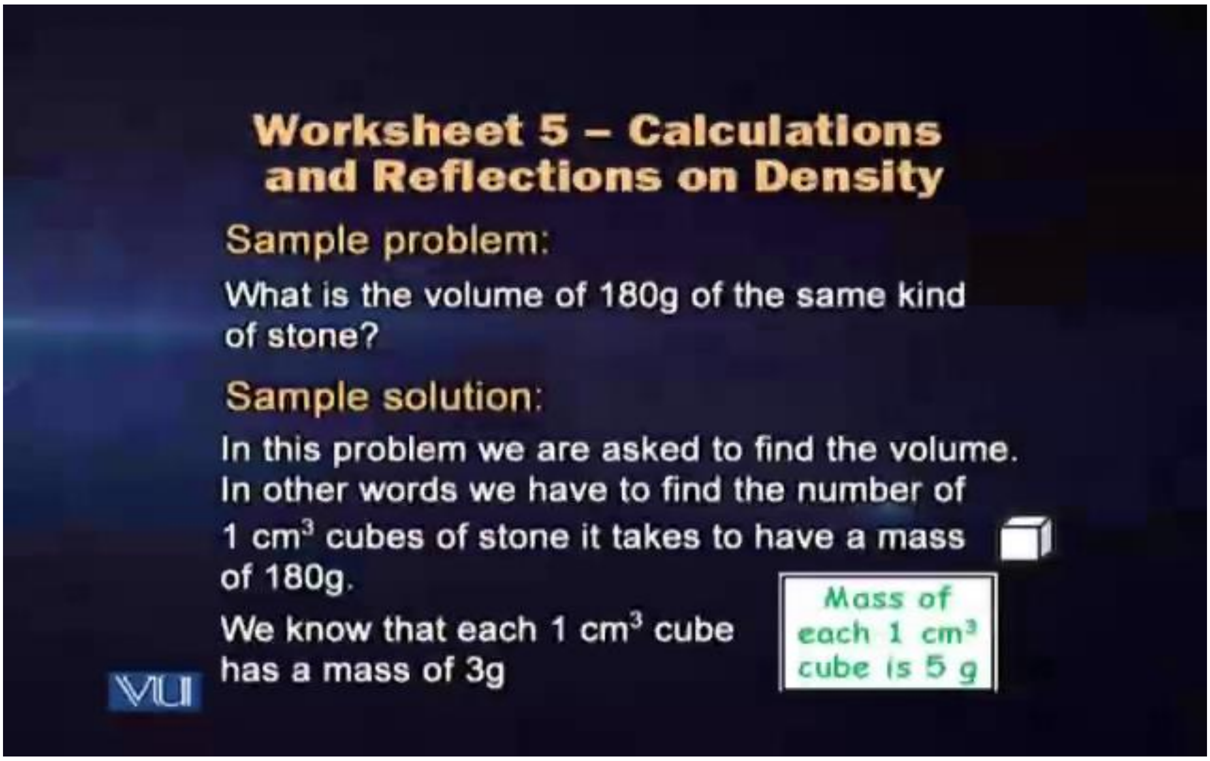
VU

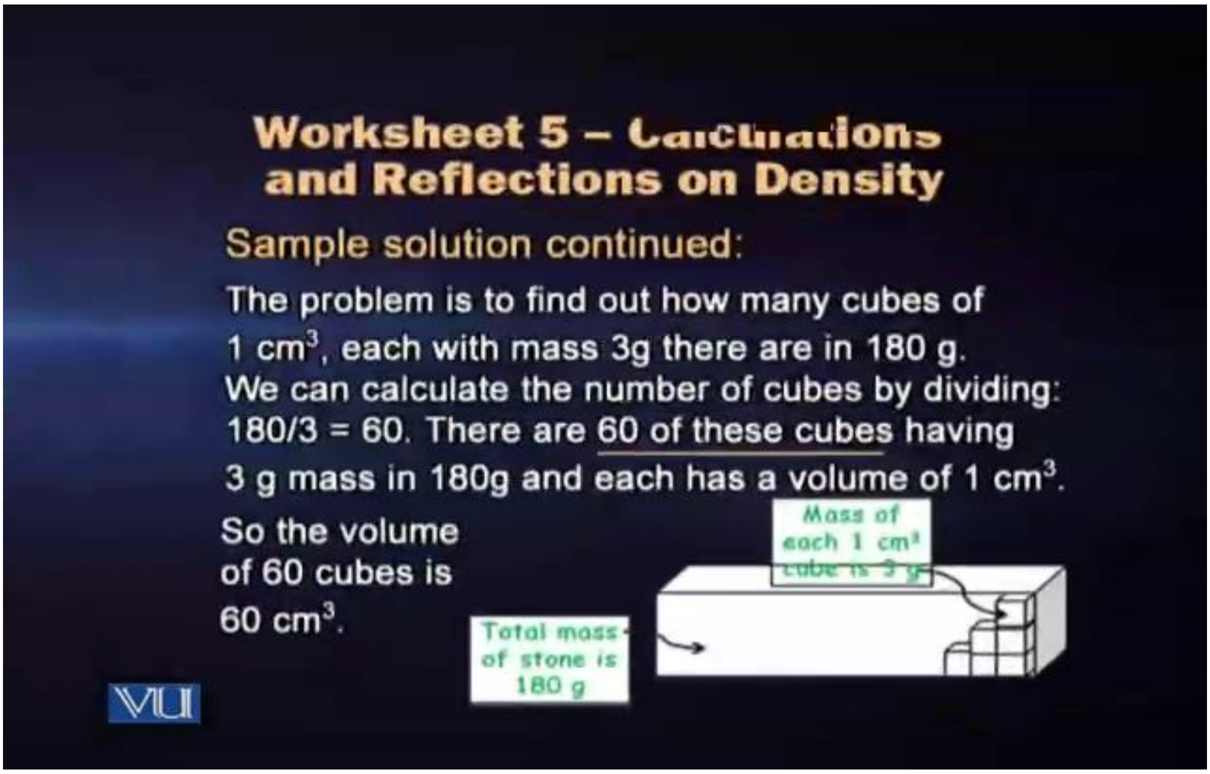

Worksheet 5 - Calculations and Reflections on Density
Sample Problem:
Suppose we have a stone with a mass of 15g and a volume of 5cm^3. What is the mass of 1cm^3 of this stone?
Sample Solution:
Volume of each cube 1 cm^3
At the right is a diagram of a stone. It is not a picture of a stone. It is not supposed to look like a stone but it is something to help us think about the problem; The actual stone might be of any shape.
5 cubes

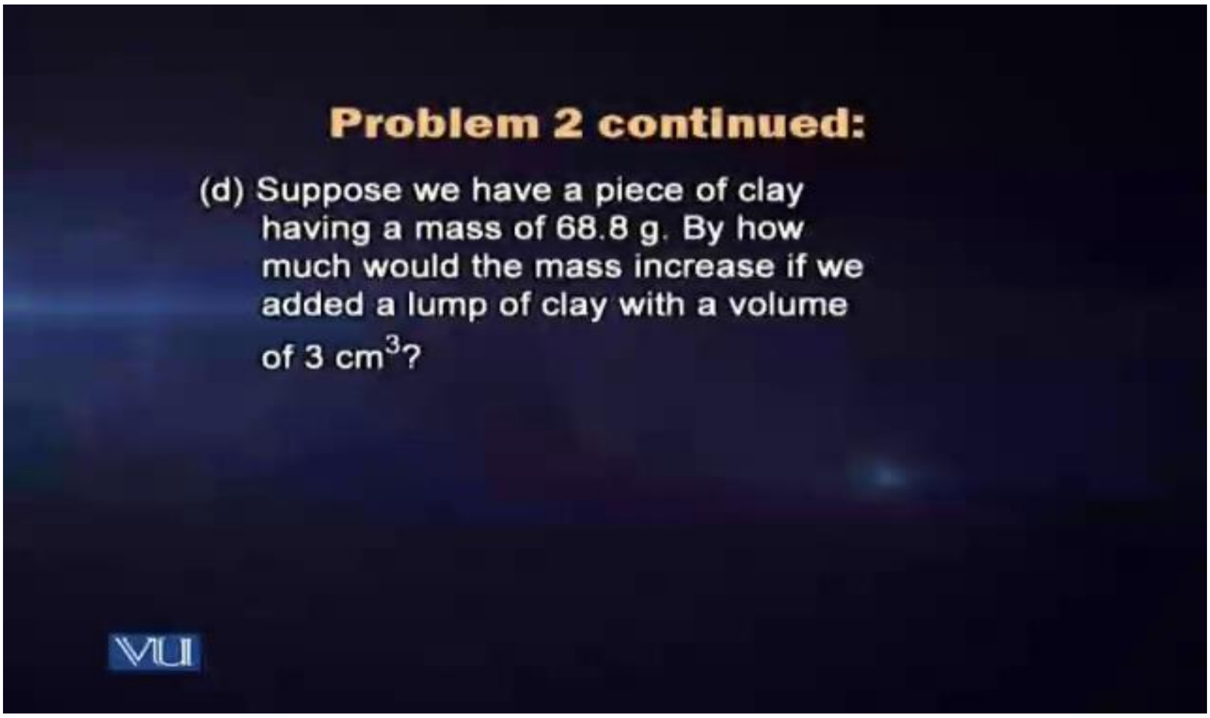

Worksheet 5 - Calculations and Reflections on Density
Sample Solution continued:
In the diagram the stone is cut into five equal cubes each having a volume 1 cm^3.
If all of these 1 cm^3 pieces share the mass equally, then we can find the mass of 1 cm^3 of stone by splitting up the total mass into five equal shares. The way to split up the total mass (15 g) into 5 equal shares using arithmetic is to divide 15g/5= 3g.
So each 1 cm^3 of stone has a mass of 3g
5 cubes


Reflections on Density
If the density of some substance or material is 17 g/cm3. What is the mass of 1 cm3?
Sample solution:
A density of 17 g/cm3 means that the mass of a cube of volume 1 cm3 of that substance is 17 g
Volume of each cube 1 cm3
Mass of each cube is 17 g
VU


Worksheet 5 – Calculations and Reflections on Density
Sample problem:
Suppose we have a larger piece of stone with a volume of 120 cm3. What would its mass be?
Sample solution:
A volume of 120 cm3 means there are 120 cubes of 1 cm3 of stone. We know that 1 cm3 has a mass of 3g, so all we have to do to find the mass of this large stone is multiply 120 X 3g = 360g
Volume of each cube 1 cm3
Mass of each cube is 5 g
5 cubes
VU

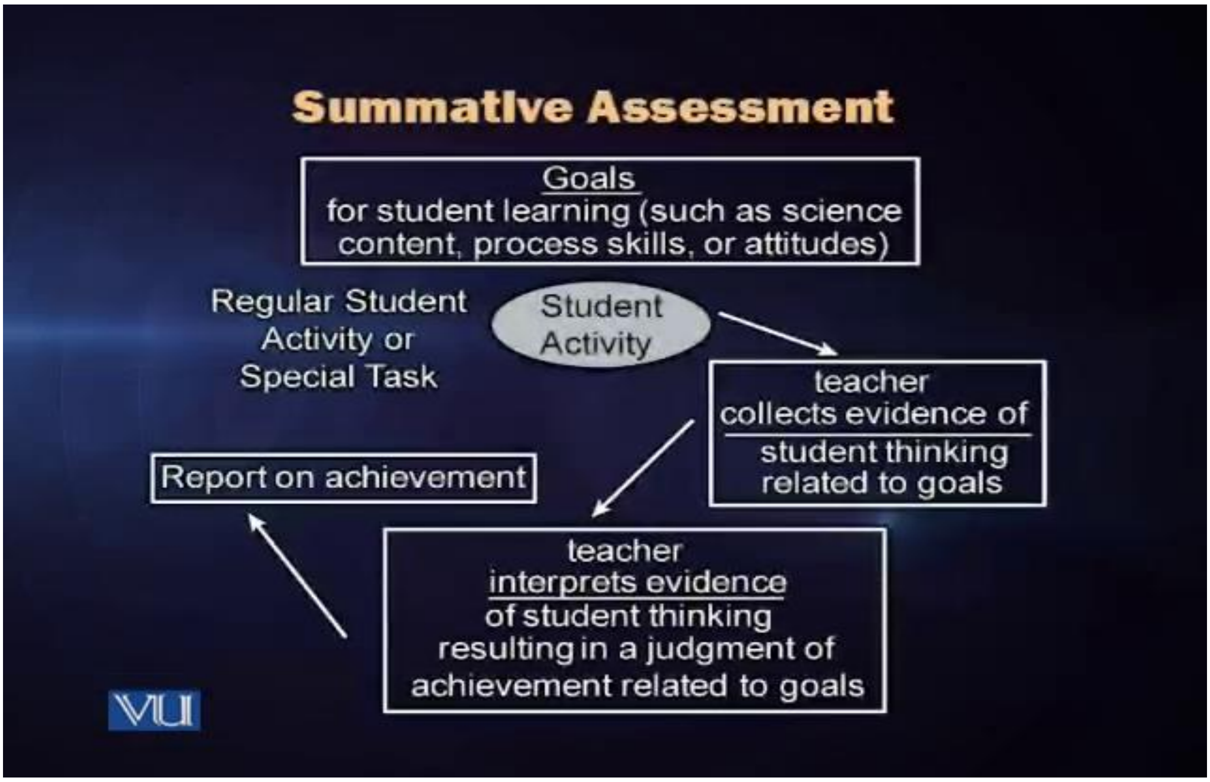

Worksheet 5 – Calculations and Reflections on Density
Sample problem:
What is the volume of 180g of the same kind of stone?
Sample solution:
In this problem we are asked to find the volume. In other words we have to find the number of 1 cm^3 cubes of stone it takes to have a mass of 180g.
We know that each 1 cm^3 cube has a mass of 3g
Mass of each 1 cm^3 cube is 5 g
VU

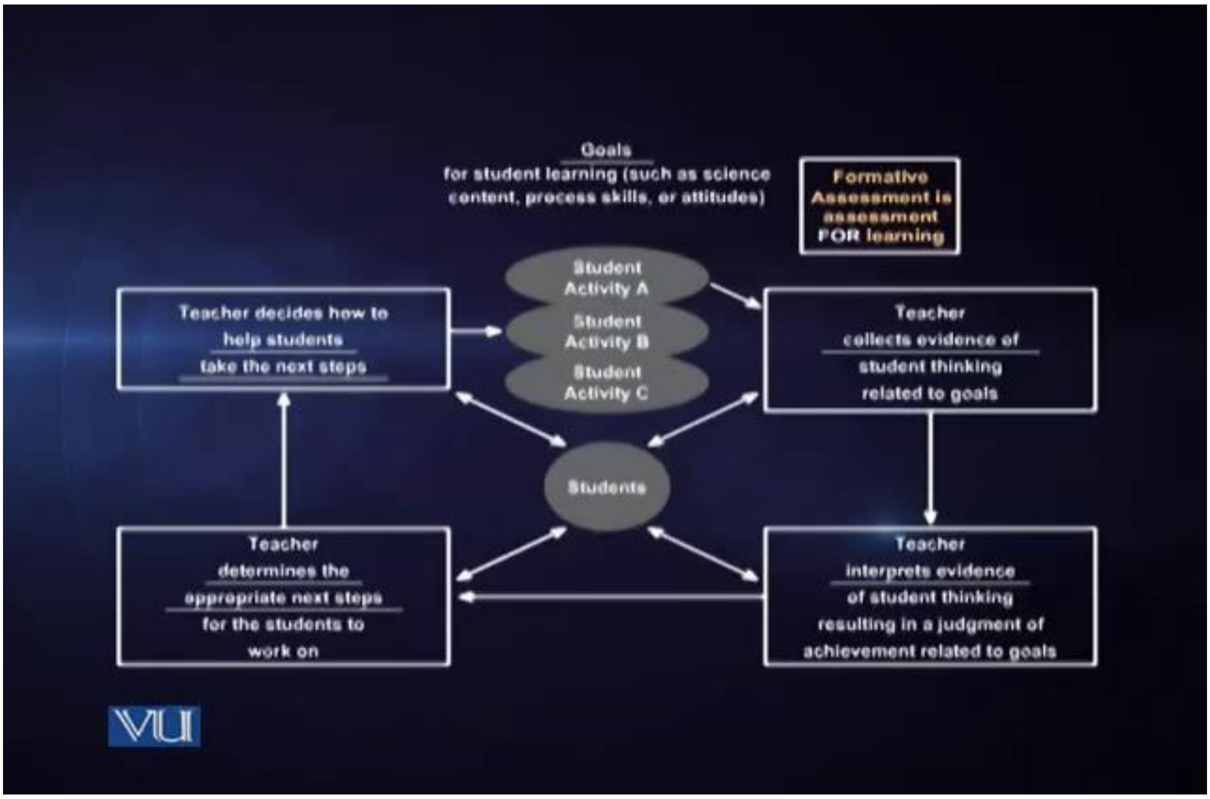

Worksheet 5 – Calculations and Reflections on Density
Sample solution continued:
The problem is to find out how many cubes of 1 cm^3, each with mass 3g there are in 180 g.
We can calculate the number of cubes by dividing: 180/3 = 60. There are 60 of these cubes having 3 g mass in 180g and each has a volume of 1 cm^3.
So the volume of 60 cubes is 60 cm^3.
Mass of each 1 cm^3
Total mass of stone is 180 g
VU


Problem 2 continued:
(d) Suppose we have a piece of clay having a mass of 68.8 g. By how much would the mass increase if we added a lump of clay with a volume of 3 cm^3?

Lecture No 44

Assessment of the Activities of Mass, Volume and Density





Assessment of Your Understanding and Skills Related to Mass, Volume and Density

The Assessment is in two sections.

In section A you will work by yourself to investigate a mystery object. You will use your measurement skills, your knowledge of density, and a data table to determine the substance that makes up your mystery object.

Section A: What substance makes up my mystery object?

Use your apparatus to find the density of the substance making up your mystery object and identify the substance with the help of Table 1.

Table 1

Name of Substance	Approximate Density g/cm^3
Glass	2.3 to 2.7
Rubber	1.5 to 1.7
Iron	6.8 to 8.4
Plastic (Polyethylene)	0.84 to 0.96

Assessment of Your Understanding and Skills Related to Mass, Volume and Density

SECTION A: What substance makes up my mystery object?

MATERIALS

- 1 100 – mL measuring cylinder
- 1 250 – mL beaker with water
- 1 dropper
- 1 mystery object

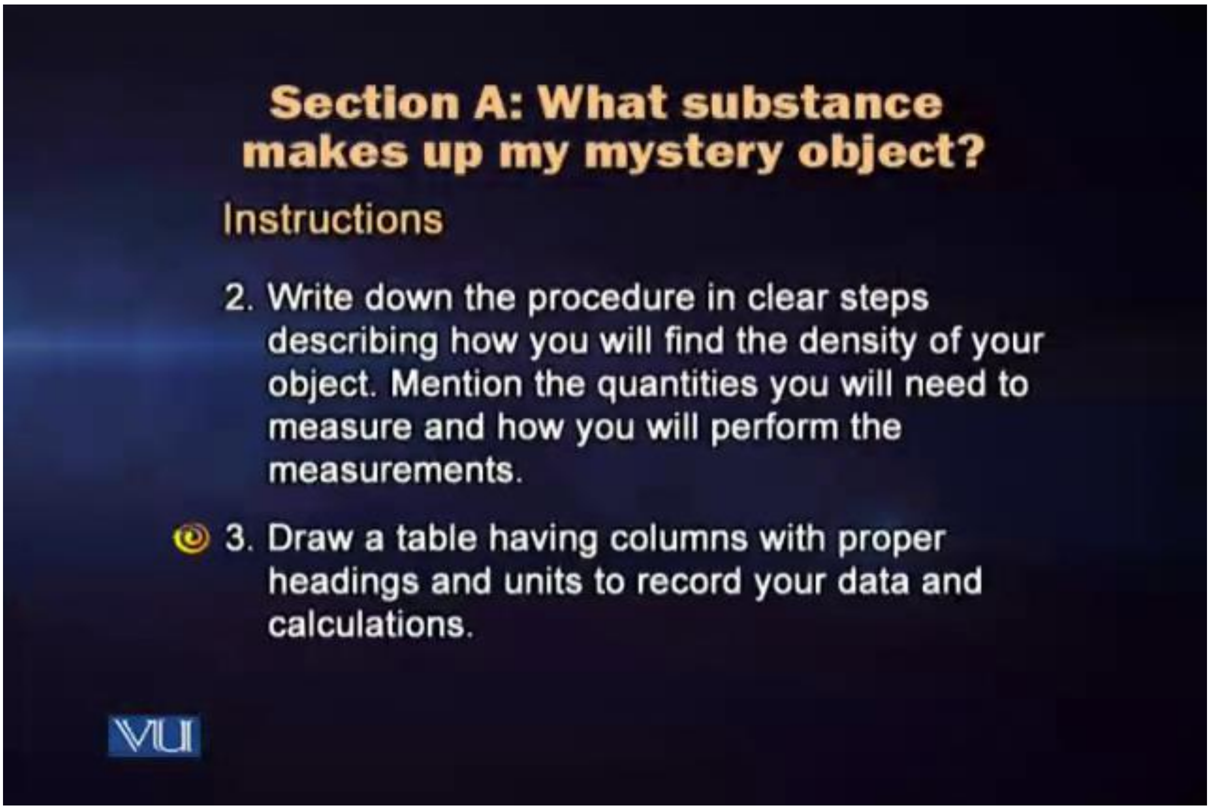
1 electronic balance to be shared with 4 students

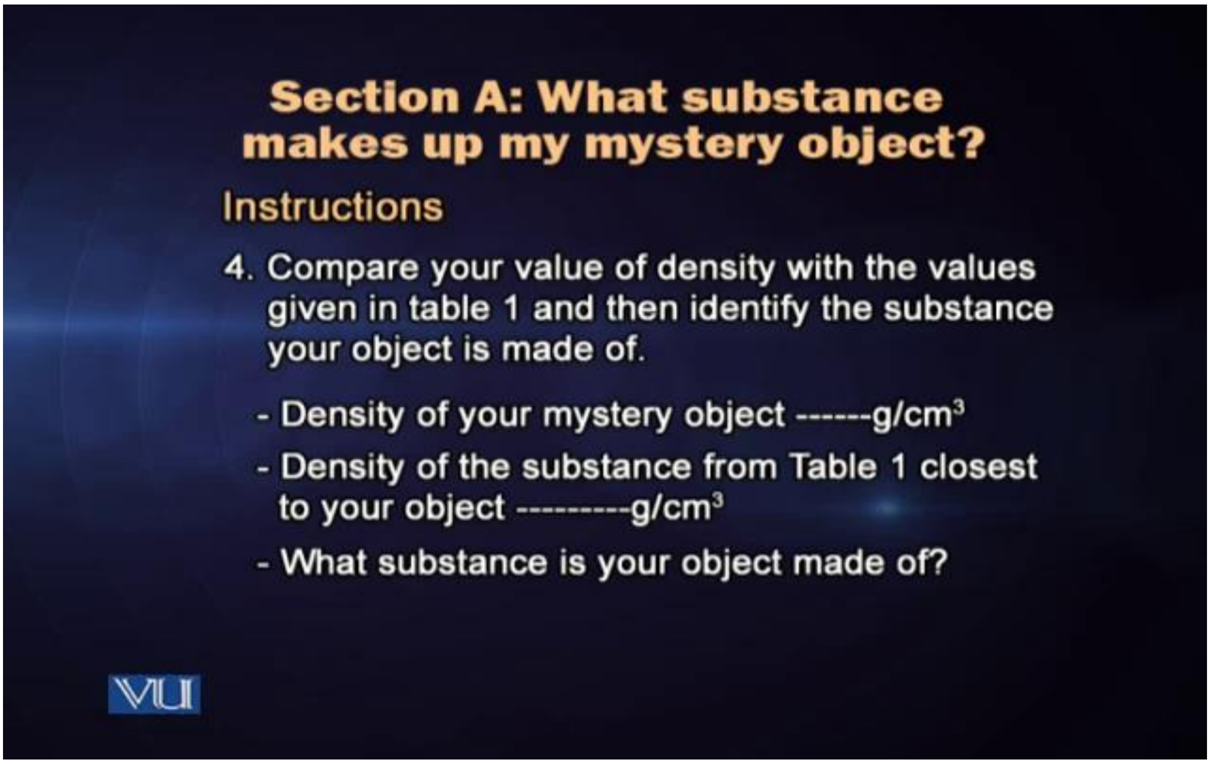
Section A: What substance makes up my mystery object?

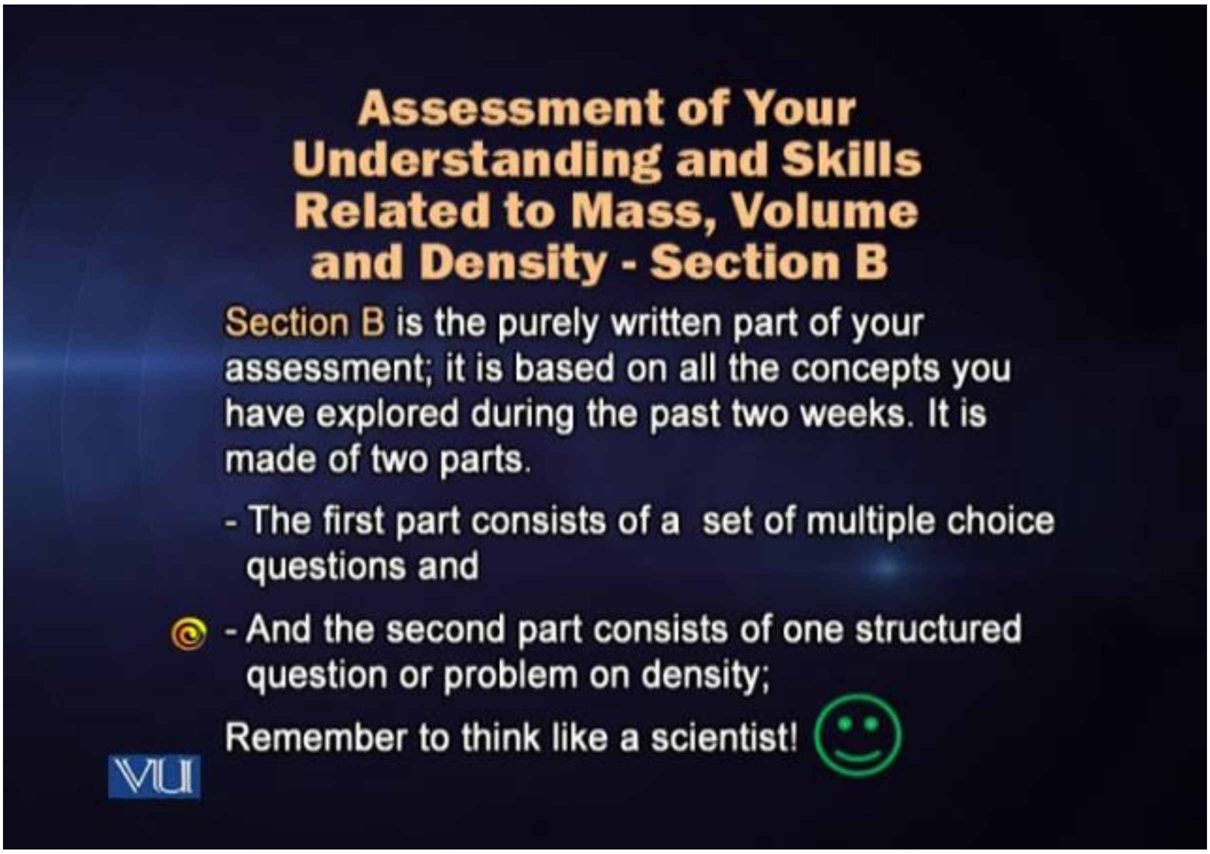
Instructions

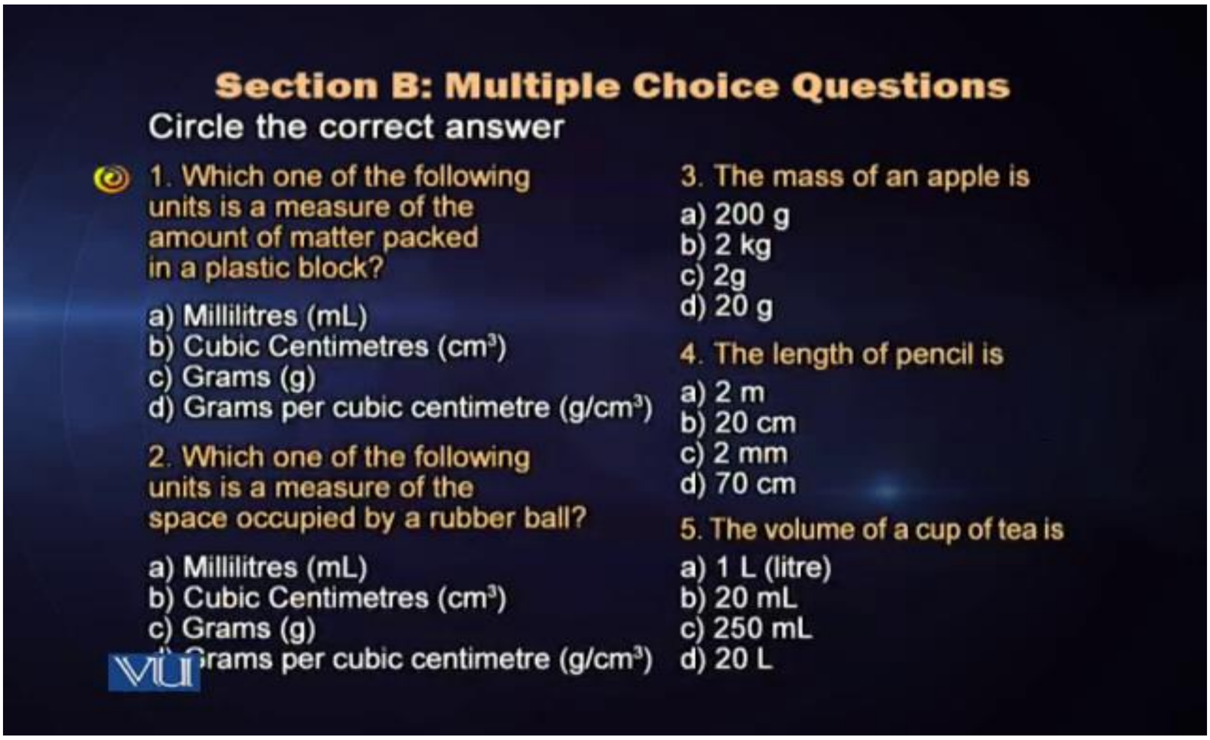
1. Write down the number of your mystery object ---

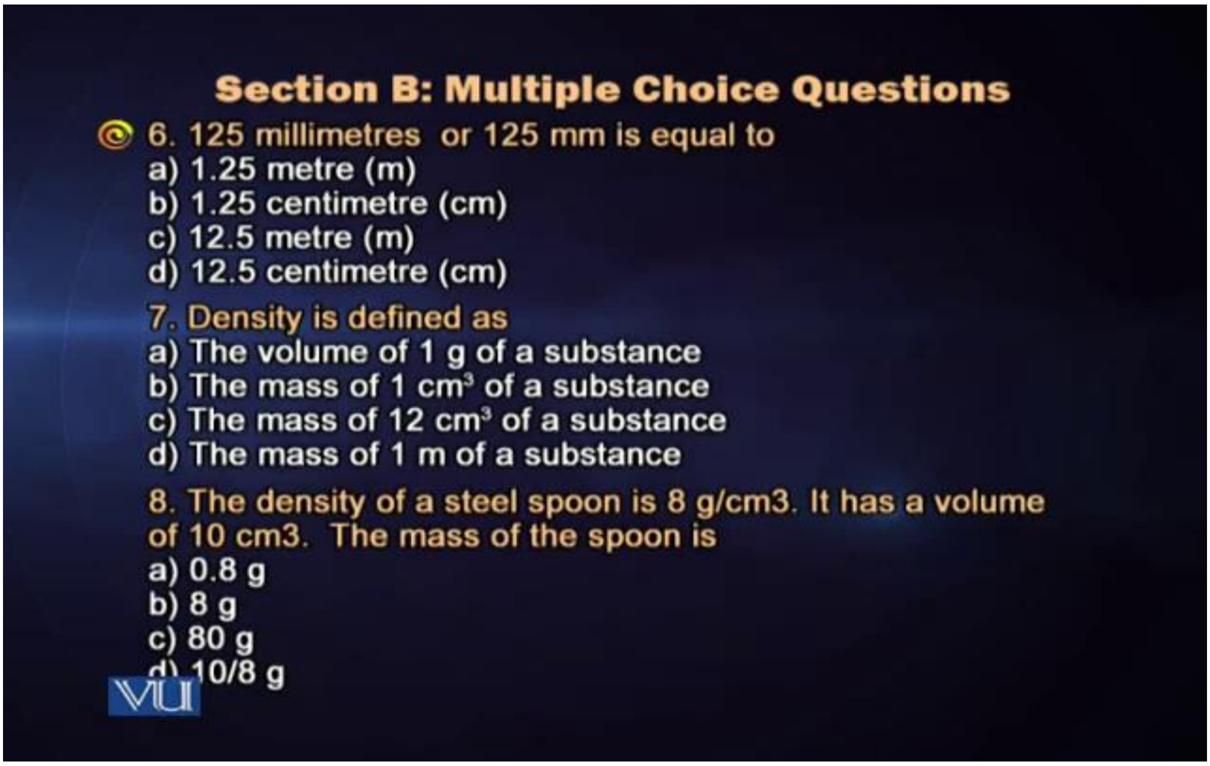
Name of Mystery Object	Number
4 Plastic Cubes	1
4 Marbles	2
1 Rubber Stopper	3
8 Nuts	4

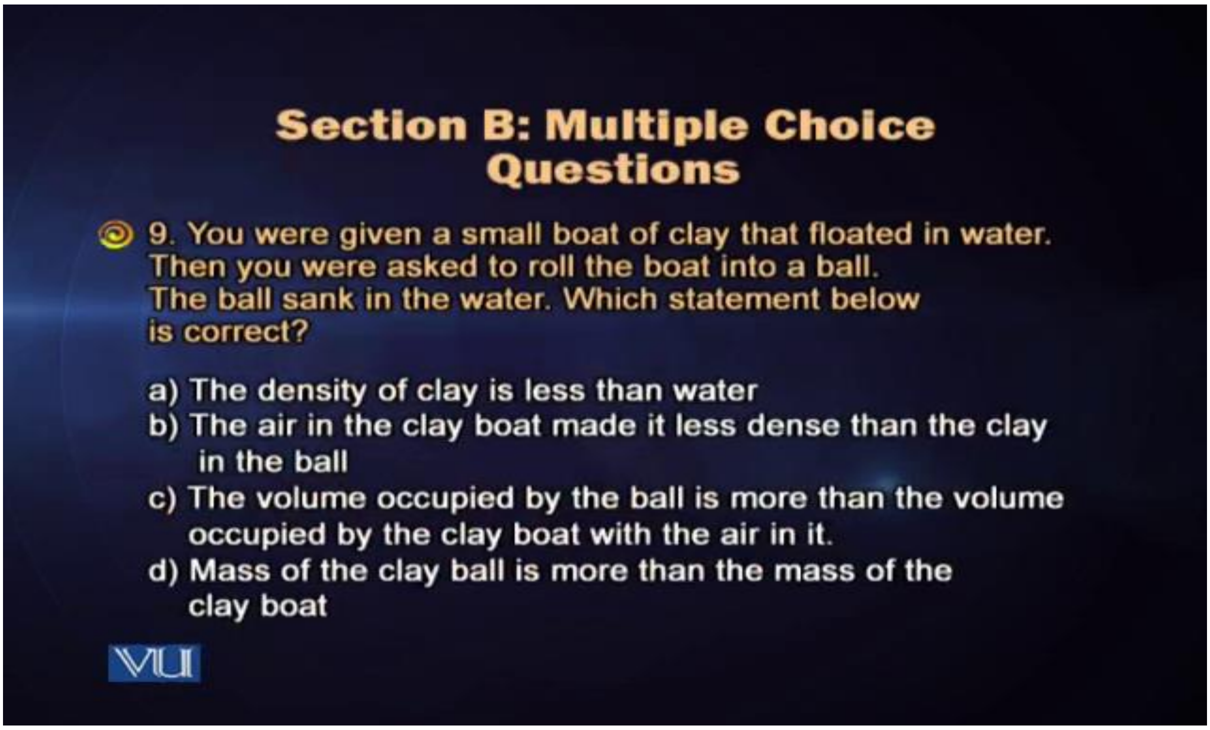

Section A: What substance makes up my mystery object?
Instructions
2. Write down the procedure in clear steps describing how you will find the density of your object. Mention the quantities you will need to measure and how you will perform the measurements.
3. Draw a table having columns with proper headings and units to record your data and calculations.
VU


Section A: What substance makes up my mystery object?
Instructions
4. Compare your value of density with the values given in table 1 and then identify the substance your object is made of.
- Density of your mystery object ------g/cm³
- Density of the substance from Table 1 closest to your object ---------g/cm³
- What substance is your object made of?
VU

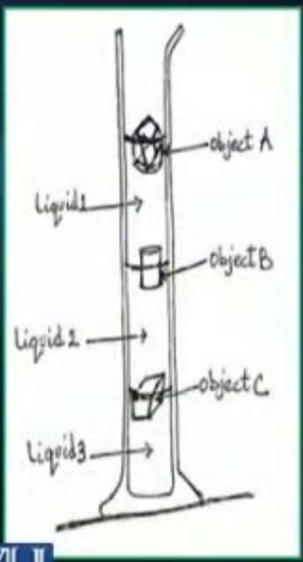

Assessment of Your Understanding and Skills Related to Mass, Volume and Density - Section B
Section B is the purely written part of your assessment; it is based on all the concepts you have explored during the past two weeks. It is made of two parts.
- The first part consists of a set of multiple choice questions and
- And the second part consists of one structured question or problem on density;
Remember to think like a scientist!
VU


Section B: Multiple Choice Questions
Circle the correct answer
1. Which one of the following units is a measure of the amount of matter packed in a plastic block?
a) Millilitres (mL)
b) Cubic Centimetres (cm^3)
c) Grams (g)
d) Grams per cubic centimetre (g/cm^3)
2. Which one of the following units is a measure of the space occupied by a rubber ball?
a) Millilitres (mL)
b) Cubic Centimetres (cm^3)
c) Grams (g)
rams per cubic centimetre (g/cm^3)
3. The mass of an apple is
a) 200 g
b) 2 kg
c) 2g
d) 20 g
4. The length of pencil is
a) 2 m
b) 20 cm
c) 2 mm
d) 70 cm
5. The volume of a cup of tea is
a) 1 L (litre)
b) 20 mL
c) 250 mL
d) 20 L
VU


Section B: Multiple Choice Questions
6. 125 millimetres or 125 mm is equal to
a) 1.25 metre (m)
b) 1.25 centimetre (cm)
c) 12.5 metre (m)
d) 12.5 centimetre (cm)
7. Density is defined as
a) The volume of 1 g of a substance
b) The mass of 1 cm³ of a substance
c) The mass of 12 cm³ of a substance
d) The mass of 1 m of a substance
8. The density of a steel spoon is 8 g/cm3. It has a volume of 10 cm3. The mass of the spoon is
a) 0.8 g
b) 8 g
c) 80 g
d) 10/8 g
VU


Section B: Multiple Choice Questions
9. You were given a small boat of clay that floated in water. Then you were asked to roll the boat into a ball. The ball sank in the water. Which statement below is correct?
a) The density of clay is less than water
b) The air in the clay boat made it less dense than the clay in the ball
c) The volume occupied by the ball is more than the volume occupied by the clay boat with the air in it.
d) Mass of the clay ball is more than the mass of the clay boat
VU

Section B: Multiple Choice Questions



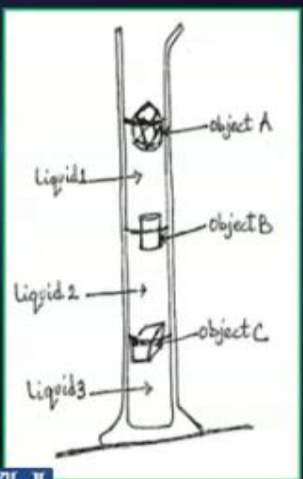
10. The cylinder shown below contains three liquids labelled (named)

1, 2 and 3. The objects (named A, B and C) in the cylinder are made of different substances. Look at the cylinder carefully and answer the following questions 8A, 8B and 8C

A. Which of the following statements is .correct?

a) Object B is less dense than liquid 1
b) Object B is less dense than liquid 3
c) Object A is more dense than liquid 1
d) Objects B and C have the same density

Section B: Multiple Choice Questions



B. Of all the liquids and objects which has the greatest density?

a) Liquid 1
b) Object A
c) Object C
d) Liquid 3

C. Of all the liquids and objects which has the least density?

a) Object B
b) Object A
c) Liquid 1
d) Liquid 2

Section B: Structured Question/Problem

Problem

A block of metal has a mass of 45 g and occupies a volume of 15 cm^3.

- What is the mass of 1 cm^3 of the block?
- What is the density of the metal?
- What is the mass of 8 cm^3 of the metal? Draw a picture to show your reasoning.
- What is the volume occupied 300 g of the metal? Explain your reasoning.

Mark Scheme:

Assessment on Volume, Mass and Density

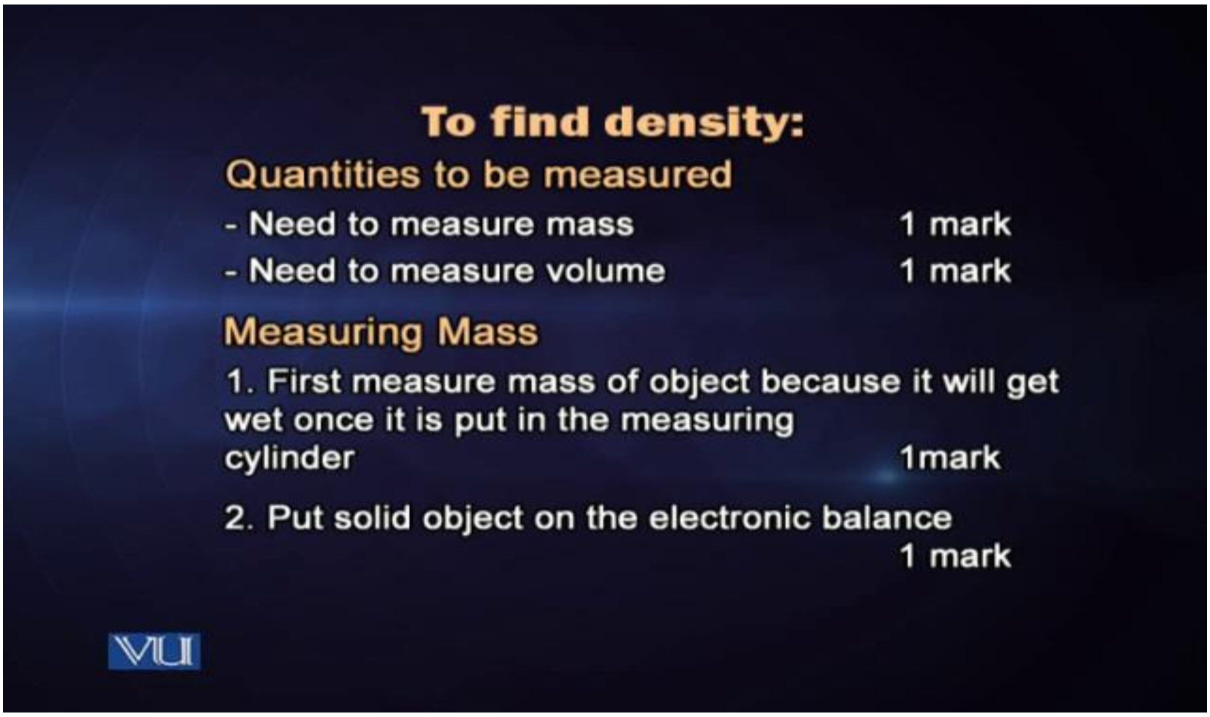
Section A: What substance makes up my mystery object?

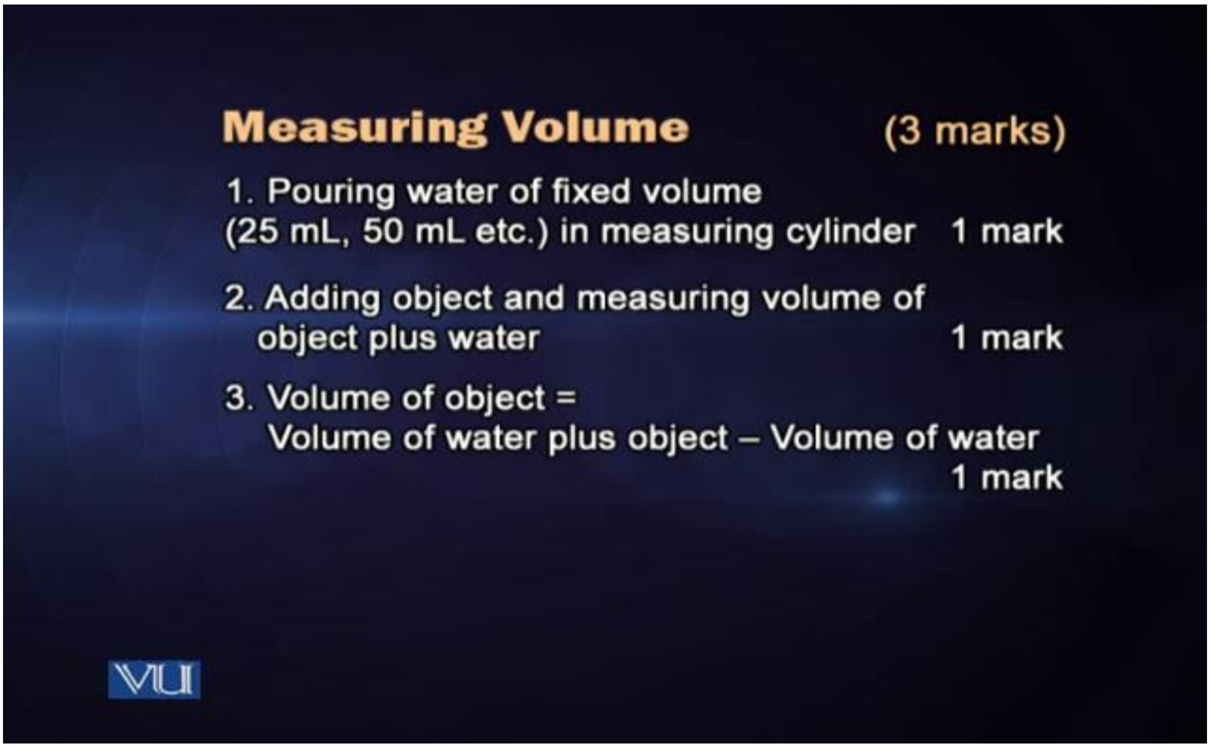
Instructions / Procedure

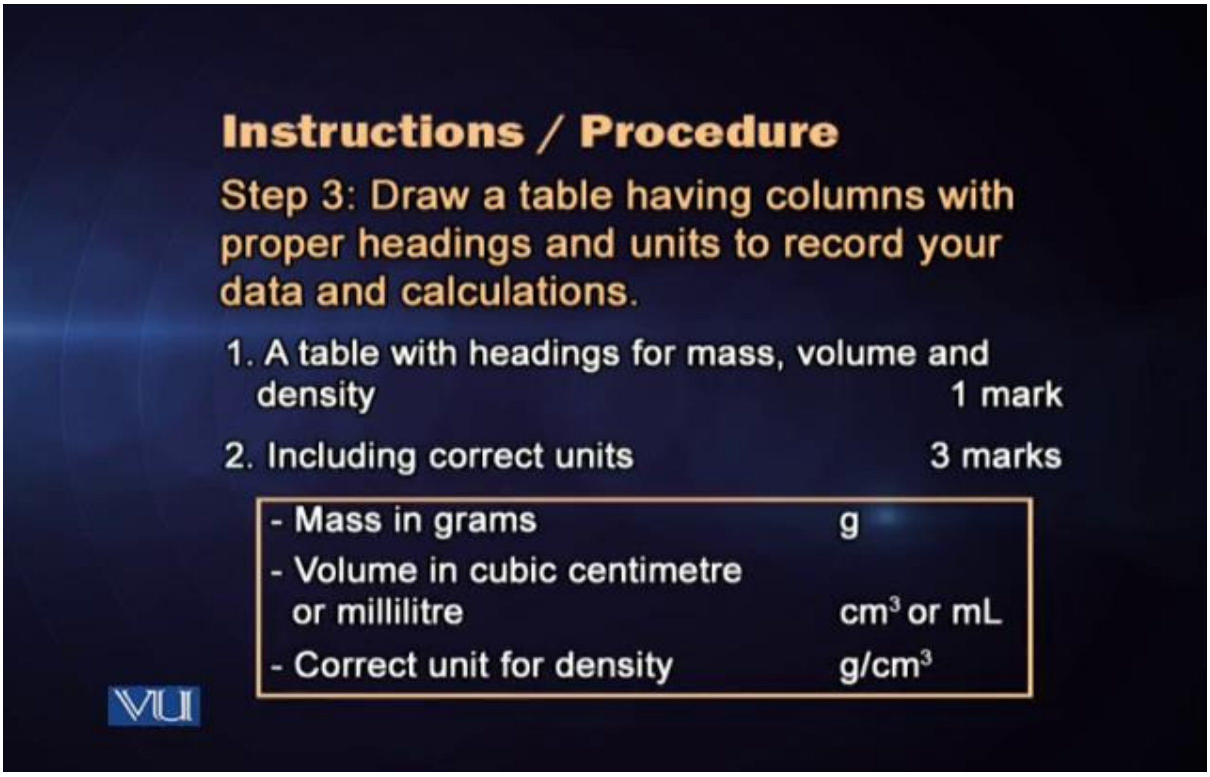
Step 2: Write down the procedure in clear steps describing how you will find the density of your object.

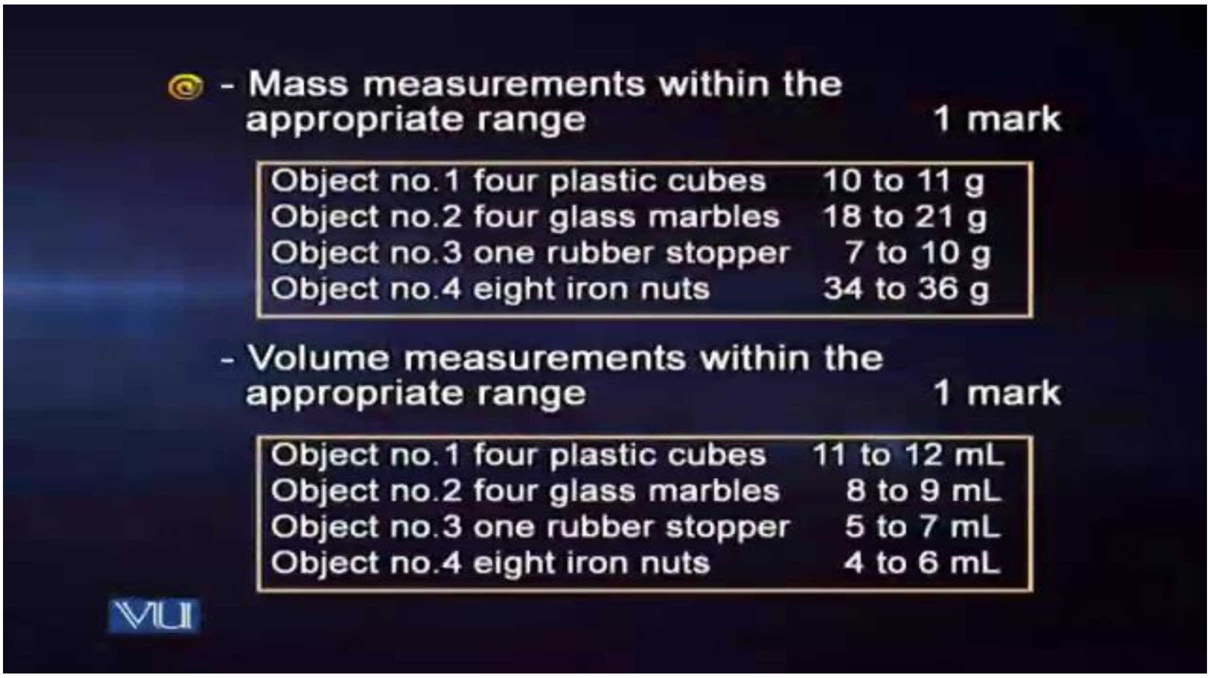
(1) Mention the quantities you will need to measure and

(2) how you will perform the measurements


To find density:
Quantities to be measured
- Need to measure mass 1 mark
- Need to measure volume 1 mark
Measuring Mass
1. First measure mass of object because it will get wet once it is put in the measuring cylinder 1mark
2. Put solid object on the electronic balance 1 mark
VU


Measuring Volume (3 marks)
1. Pouring water of fixed volume (25 mL, 50 mL etc.) in measuring cylinder 1 mark
2. Adding object and measuring volume of object plus water 1 mark
3. Volume of object =
Volume of water plus object – Volume of water 1 mark
VU


Instructions / Procedure
Step 3: Draw a table having columns with proper headings and units to record your data and calculations.
1. A table with headings for mass, volume and density 1 mark
2. Including correct units 3 marks
- Mass in grams g
- Volume in cubic centimetre or millilitre cm^3 or mL
- Correct unit for density g/cm^3
VU

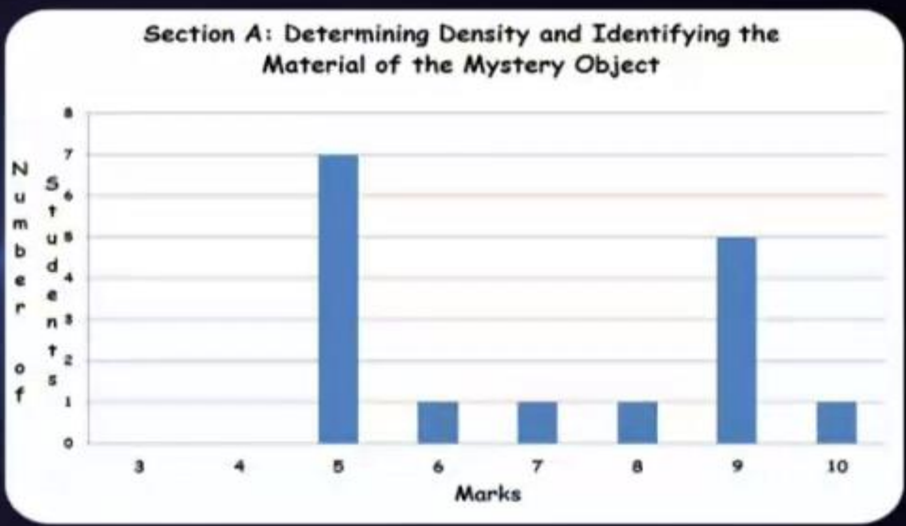

- Mass measurements within the appropriate range 1 mark
Object no.1 four plastic cubes 10 to 11 g
Object no.2 four glass marbles 18 to 21 g
Object no.3 one rubber stopper 7 to 10 g
Object no.4 eight iron nuts 34 to 36 g
- Volume measurements within the appropriate range 1 mark
Object no.1 four plastic cubes 11 to 12 mL
Object no.2 four glass marbles 8 to 9 mL
Object no.3 one rubber stopper 5 to 7 mL
Object no.4 eight iron nuts 4 to 6 mL
VU

- Correct formula for density:
  density = mass/volume 1 mark
- Value of density in appropriate range
  1 mark

Step 4: Compare your value of density with the values given in table 1 and then identify the substance your object is made of.

- Correct Identification of the substance from table 1; or a commenting acknowledging an error if their value is not in the expected range
  1 mark

Total Marks for Section A / Guided Inquiry: 16



Marks rescaled out of 10

Assessment on Volume, Mass and Density

Section A: What substance makes up my mystery object?

- All children have scored 50% and more on the investigation and half the children have scored 70% and above
- Experience with measurements has to deepened further especially when massing objects / substances that cannot be directly placed on the electronic balance
- More work with basic units of length and mass and derived units: volume and density

Section B
Multiple Choice Questions

Units
1. c
2. b

Estimates
3. a
4. b
5. c
6. b

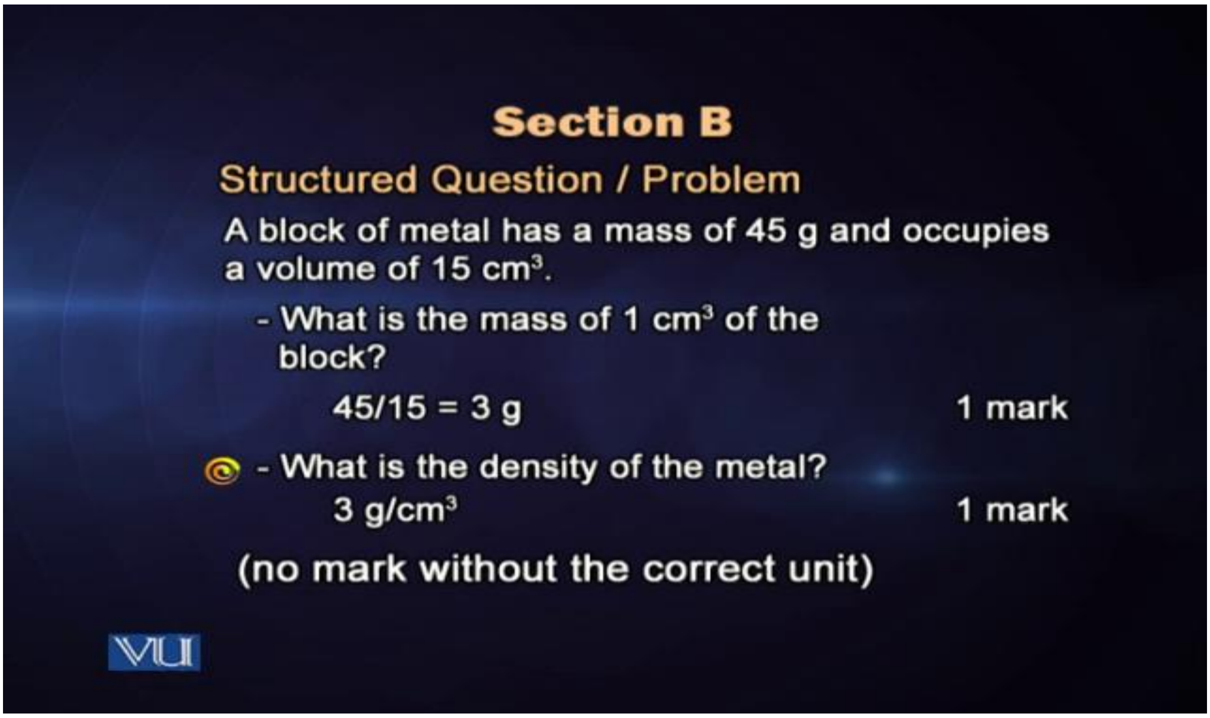
Unit Conversion
6. b

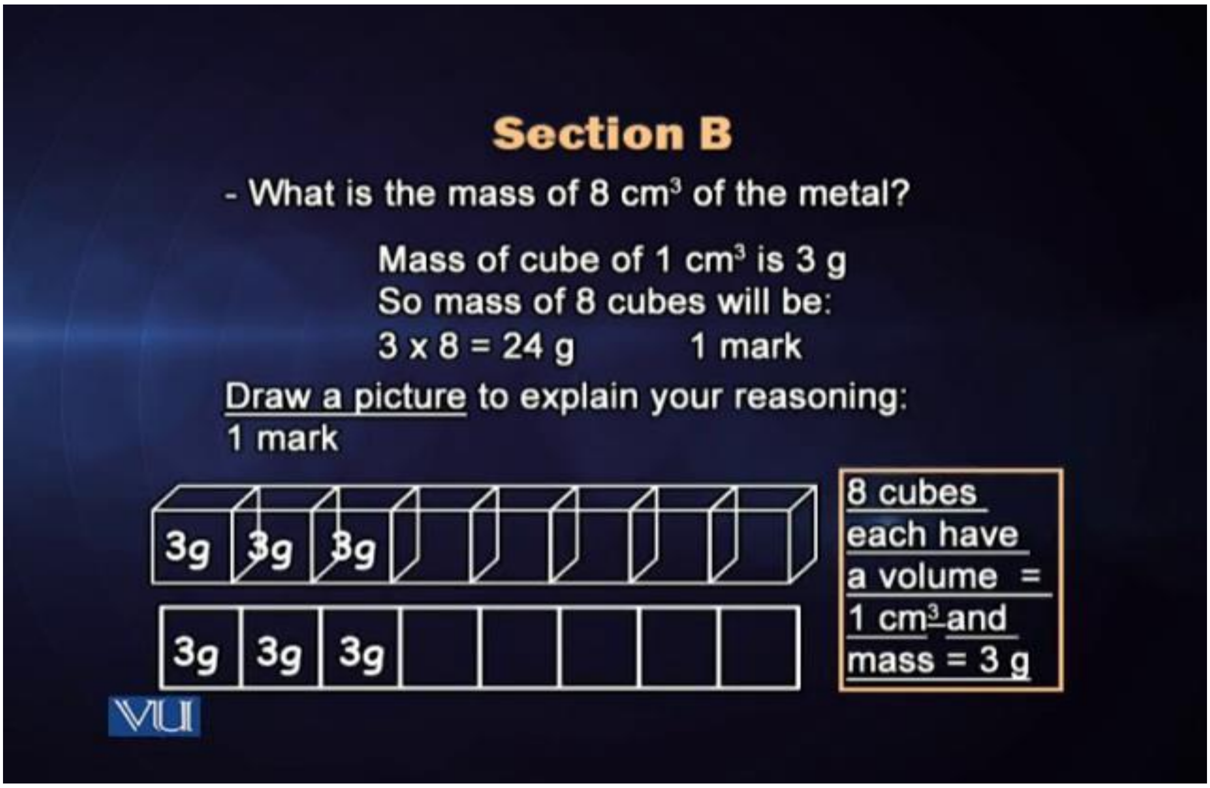
Exploring Density I
7. b
8. c
9. b

Exploring Density II
10 A. b
10 B. d
10 C. b

density columns

1 mark for each correct answer


Section B
Structured Question / Problem
A block of metal has a mass of 45 g and occupies a volume of 15 cm³.
- What is the mass of 1 cm³ of the block?
45/15 = 3 g
1 mark
- What is the density of the metal?
3 g/cm³
1 mark
(no mark without the correct unit)
VU


Section B
- What is the mass of 8 cm³ of the metal?
Mass of cube of 1 cm³ is 3 g
So mass of 8 cubes will be:
3 x 8 = 24 g
1 mark
Draw a picture to explain your reasoning:
1 mark
3g
3g
3g
3g
3g
3g
8 cubes each have a volume = 1 cm³ and mass = 3 g
VU

- What is the volume occupied 300 g of the metal? Explain your reasoning

Density = Mass / Volume

So Volume = Mass / Density

Density = 3 g/cm^3 Mass = 300 g

Volume = 300 ÷ 3 = 100 cm^3 1 Mark

- Reasoning: The problem is to find out how many cubes of 1 cm^3, each with mass 3g there are in 300 g. (or how many 3g cubes fit into 300g)

1 Mark for the above key phrase

VU

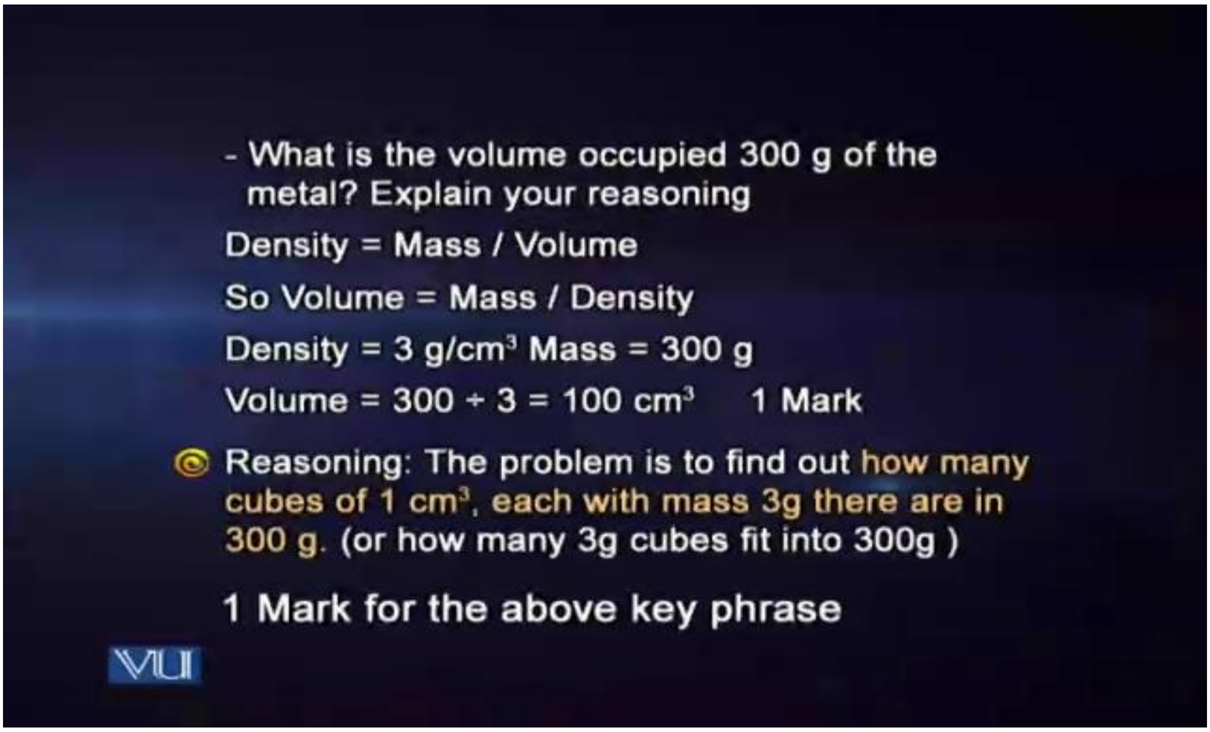
Extended Reasoning:

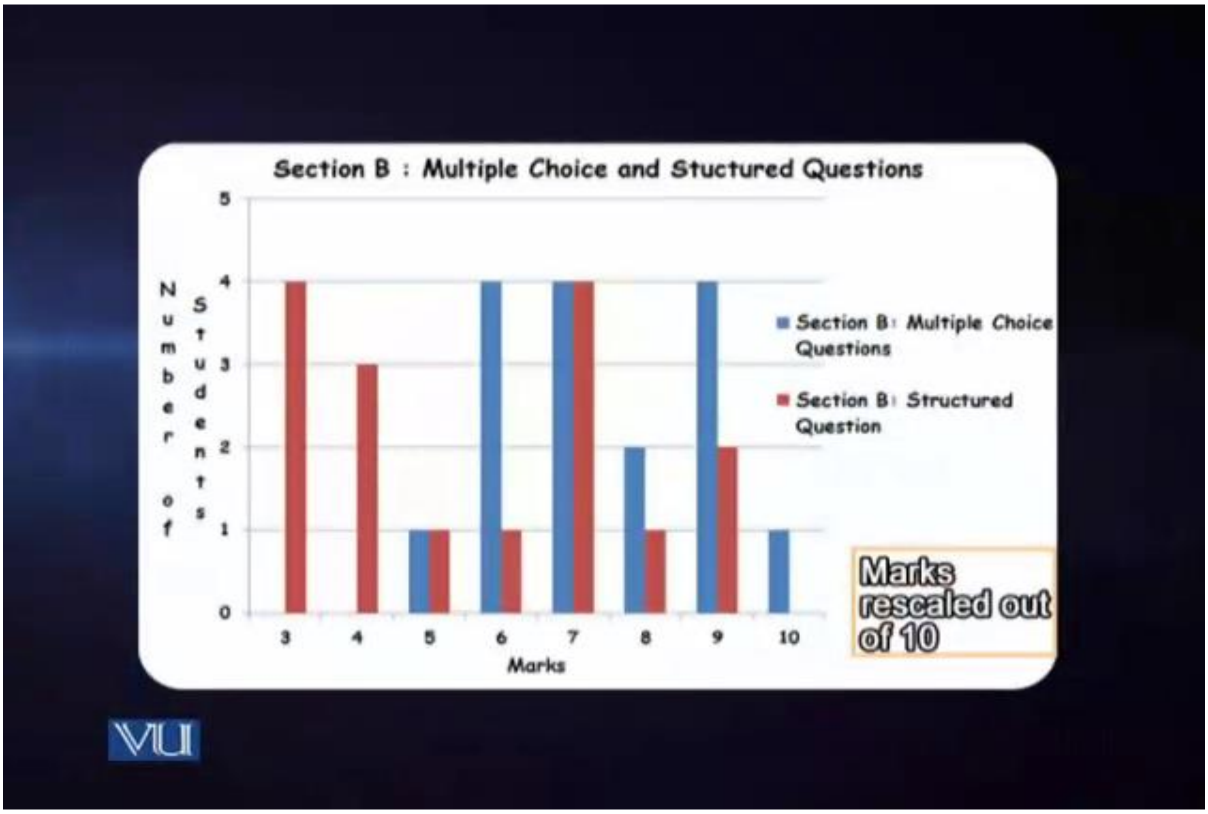
The problem is to find out how many cubes of 1 cm^3, each with mass 3g are packed into 300g. We can calculate the number of cubes by dividing:

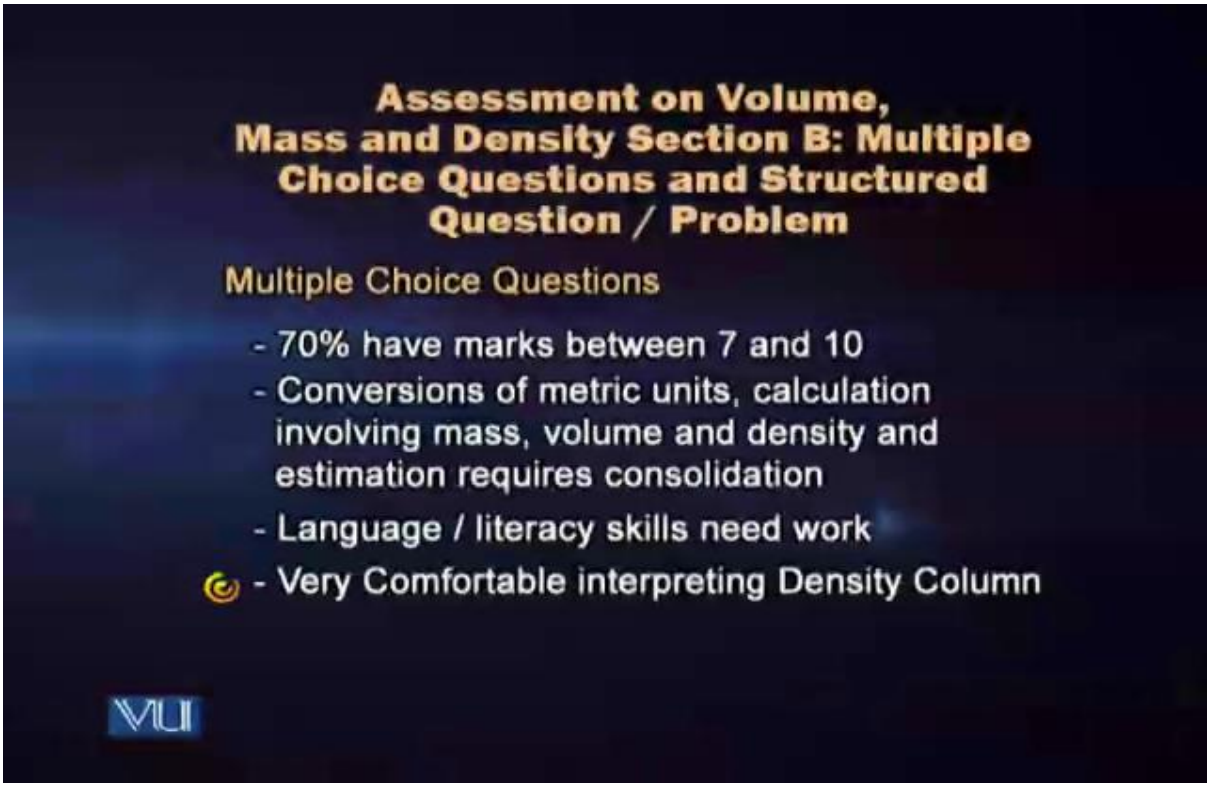
300/3 = 100.

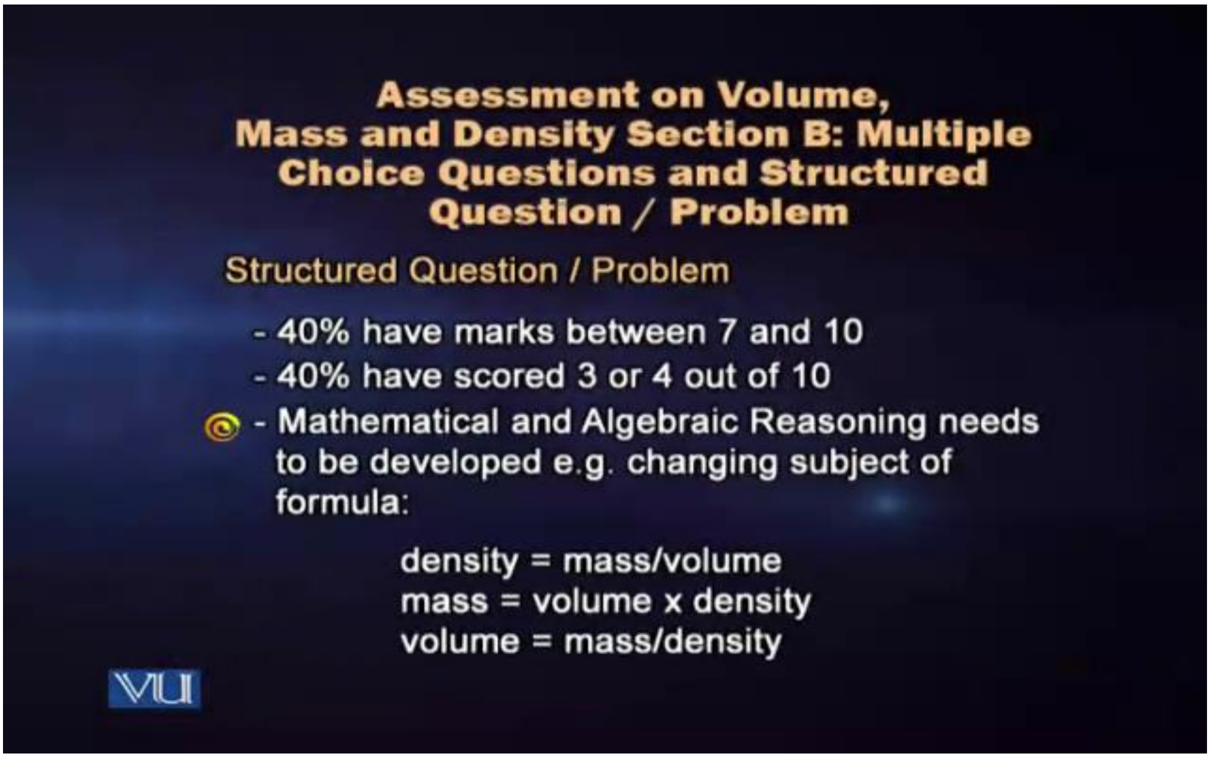
So there are 100 of these cubes and Each has a volume of 1 cm^3. So the volume of 100 cubes is 100 cm^3 And that is the volume occupied by 300g of the metal.

VU


- What is the volume occupied 300 g of the metal? Explain your reasoning
Density = Mass / Volume
So Volume = Mass / Density
Density = 3 g/cm³ Mass = 300 g
Volume = 300 ÷ 3 = 100 cm³ 1 Mark
Reasoning: The problem is to find out how many cubes of 1 cm³, each with mass 3g there are in 300 g. (or how many 3g cubes fit into 300g)
1 Mark for the above key phrase
VU


Section B : Multiple Choice and Stuctured Questions
Number of Students
0
1
2
3
4
5
3
4
5
6
7
8
9
10
Marks
Section B: Multiple Choice Questions
Section B: Structured Question
Marks rescaled out of 10
VU


Assessment on Volume, Mass and Density Section B: Multiple Choice Questions and Structured Question / Problem
Multiple Choice Questions
- 70% have marks between 7 and 10
- Conversions of metric units, calculation involving mass, volume and density and estimation requires consolidation
- Language / literacy skills need work
- Very Comfortable interpreting Density Column
VU


Assessment on Volume, Mass and Density Section B: Multiple Choice Questions and Structured Question / Problem
Structured Question / Problem
- 40% have marks between 7 and 10
- 40% have scored 3 or 4 out of 10
- Mathematical and Algebraic Reasoning needs to be developed e.g. changing subject of formula:
density = mass/volume
mass = volume x density
volume = mass/density
VU

Assessment on Volume, Mass and Density Section B: Multiple Choice Questions and Structured Question / Problem

Structured Question / Problem

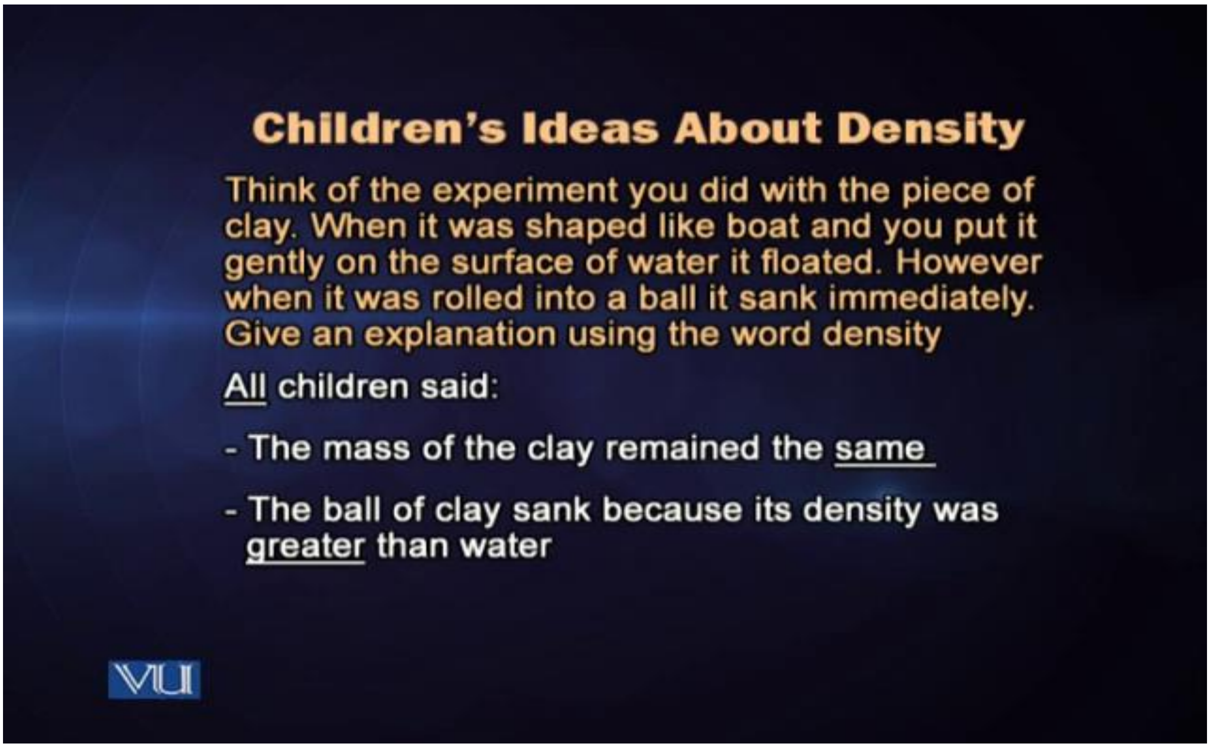
- Language / literacy skills need work – not comfortable with explanations may have done a better job in mother tongue
- A lot of exposure to solving problems is required with focus on the process and not the final answer

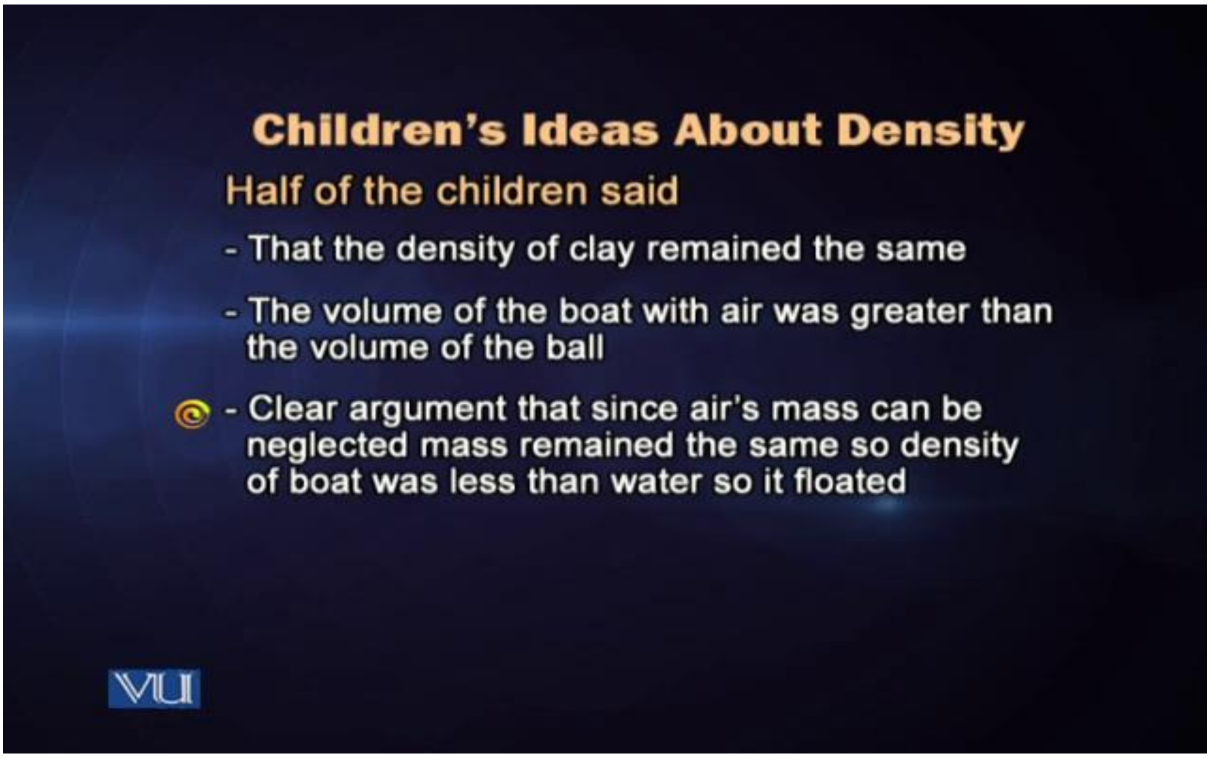
Children's Ideas About Density

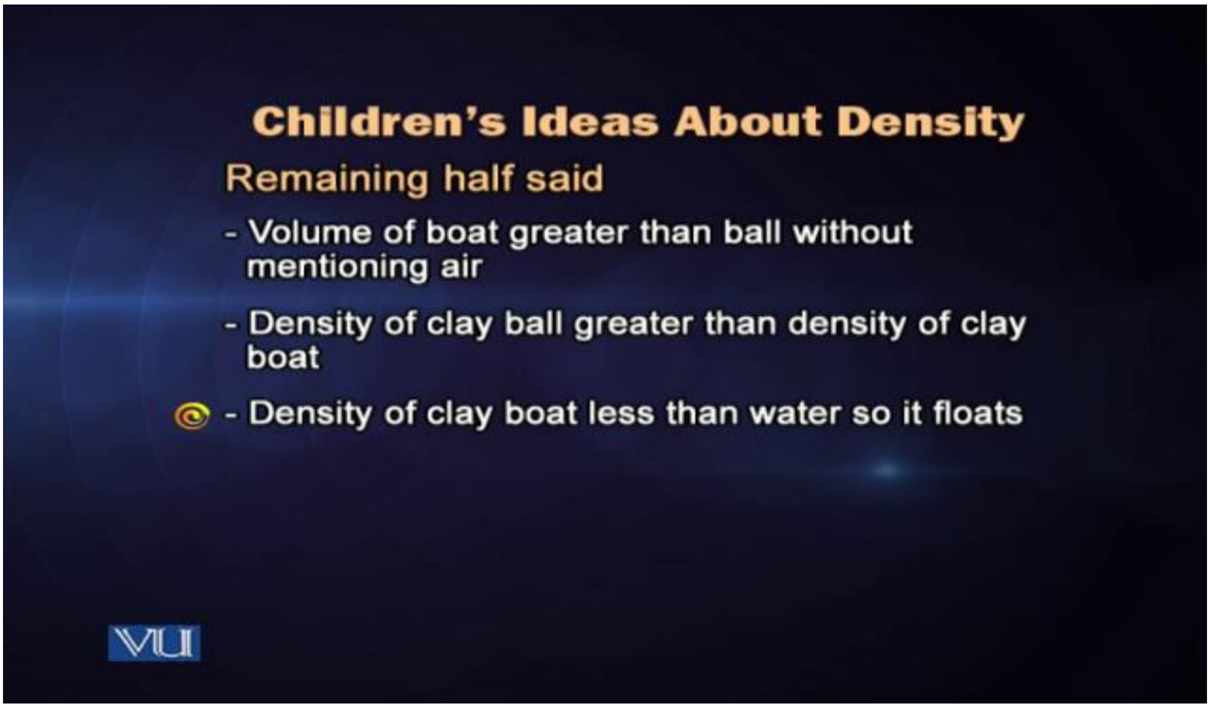
Write a short paragraph explaining your observations about the density column; make sure you use the word density in your observations

All children could describe the density column in terms of density with most dense substance – iron nuts at the bottom then others appearing with decreasing density i.e. glycerine, plastic die, water and the least dense substance, oil, at the top

- most stating clearly, some in broken English

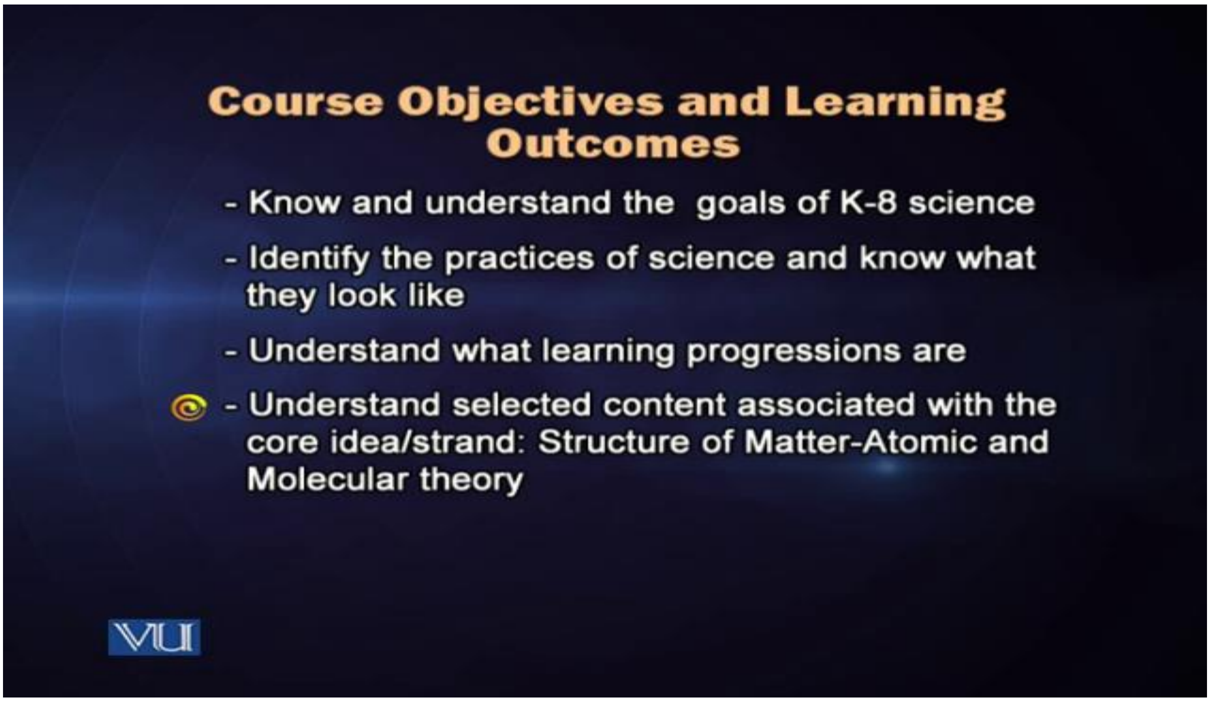

Children's Ideas About Density
Think of the experiment you did with the piece of clay. When it was shaped like boat and you put it gently on the surface of water it floated. However when it was rolled into a ball it sank immediately. Give an explanation using the word density
All children said:
- The mass of the clay remained the same
- The ball of clay sank because its density was greater than water
VU

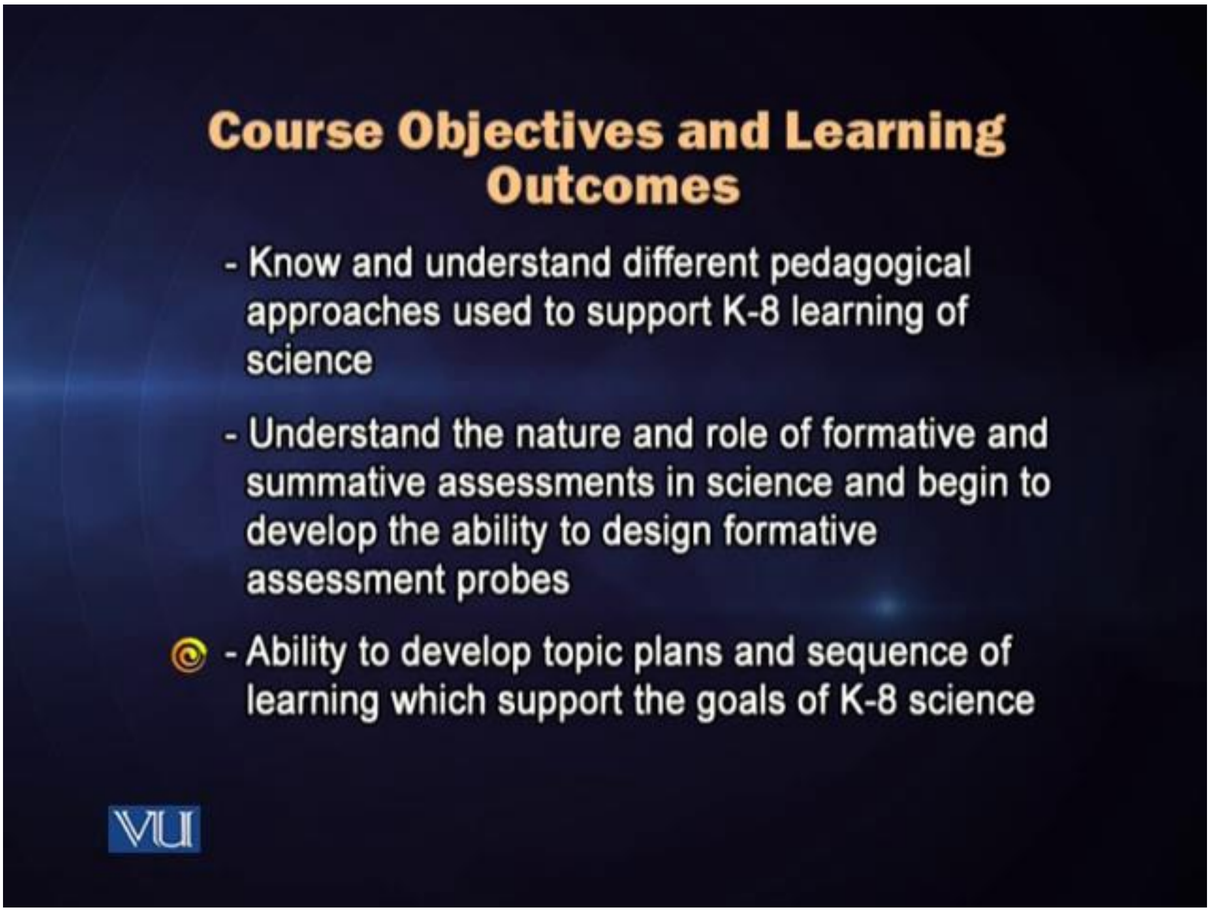

Children's Ideas About Density
Half of the children said
- That the density of clay remained the same
- The volume of the boat with air was greater than the volume of the ball
- Clear argument that since air's mass can be neglected mass remained the same so density of boat was less than water so it floated
VU

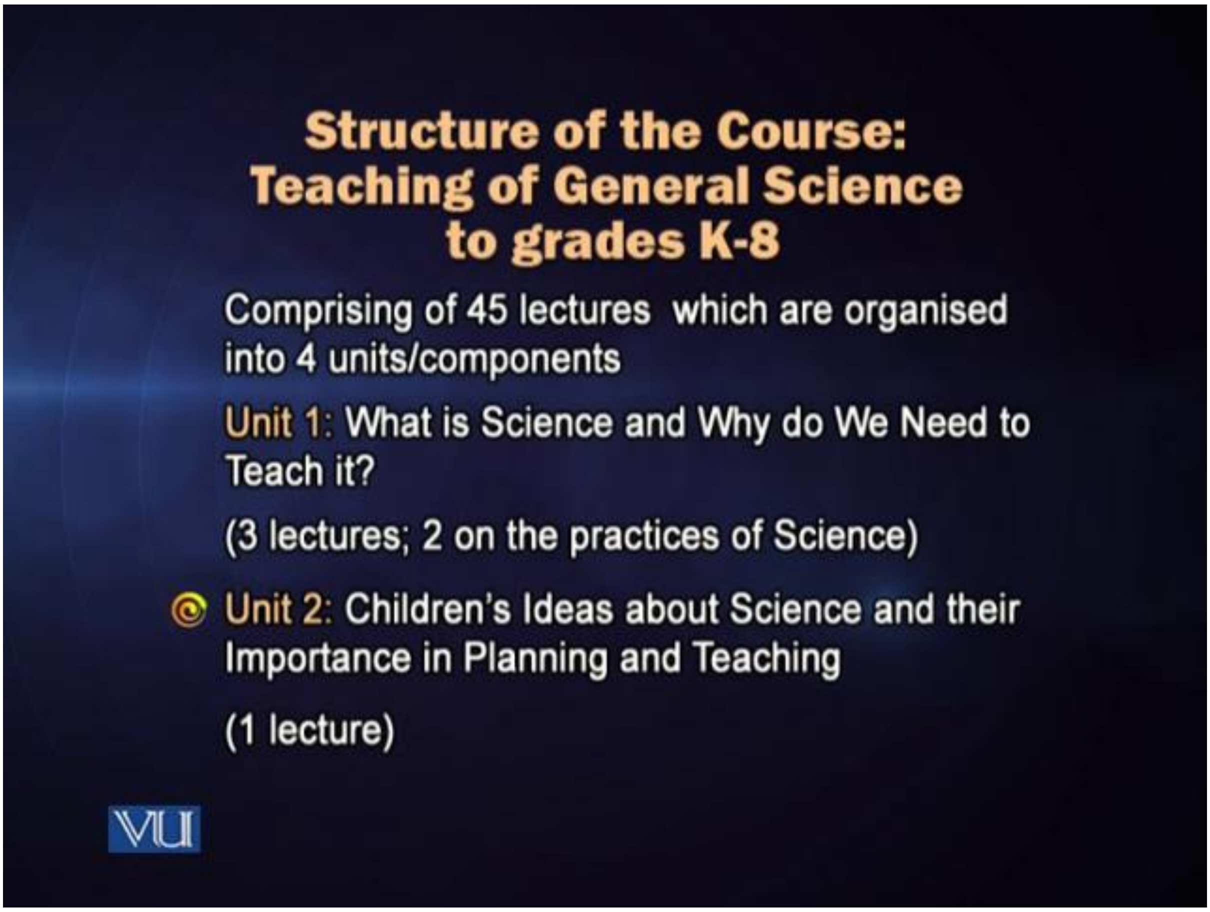

Children's Ideas About Density
Remaining half said
- Volume of boat greater than ball without mentioning air
- Density of clay ball greater than density of clay boat
- Density of clay boat less than water so it floats
VU

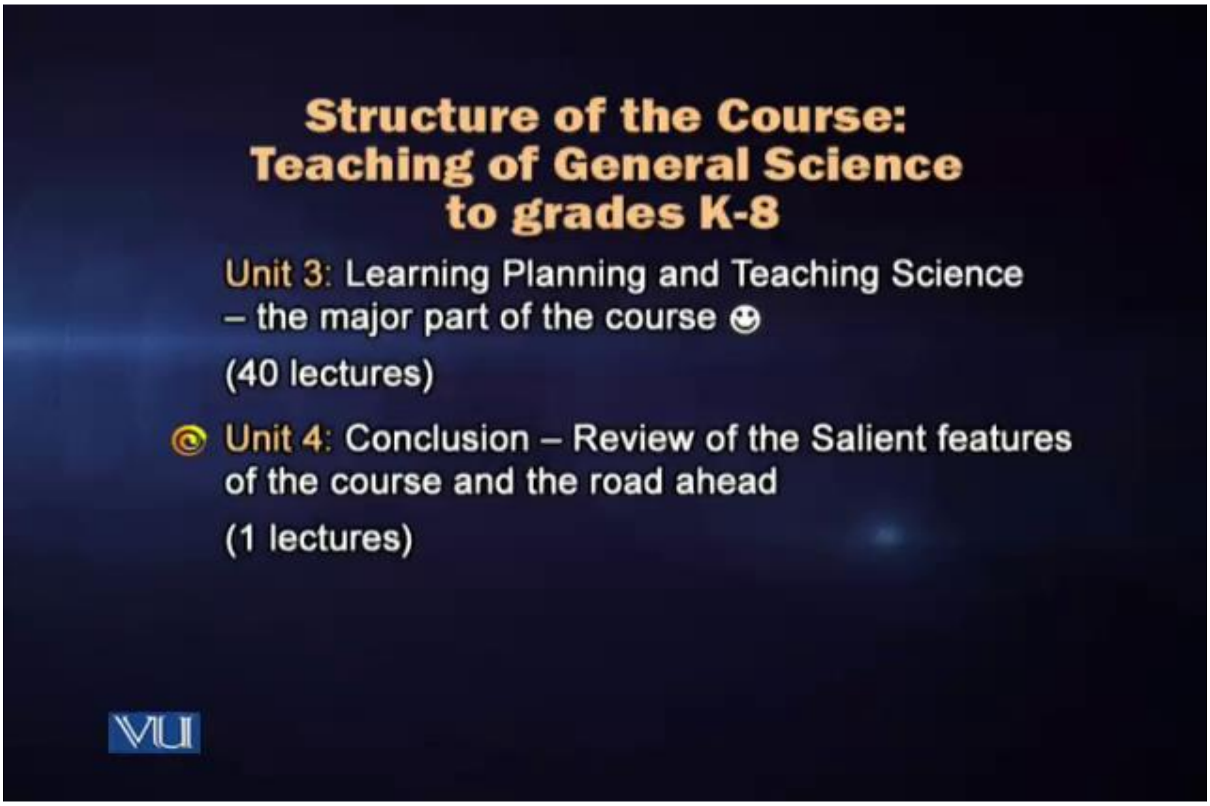
Lecture No 45

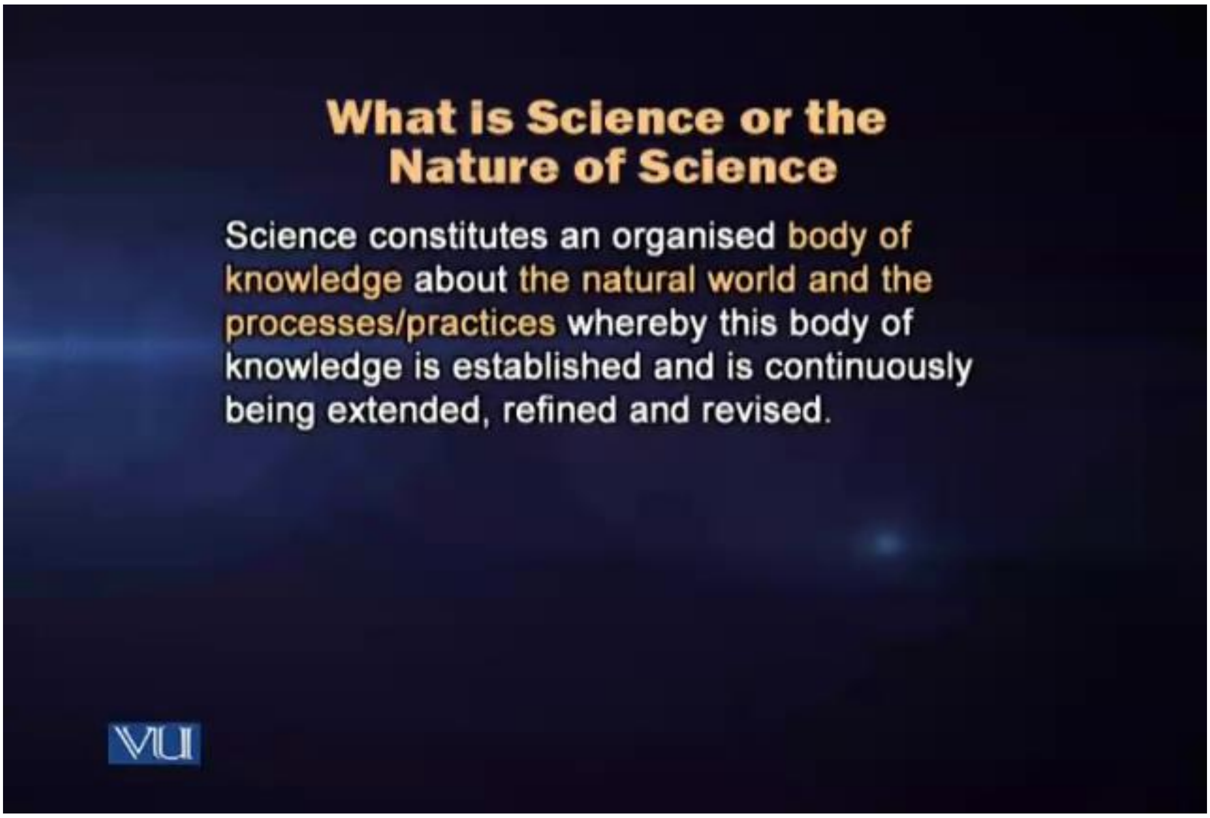
Review of the Course of Teaching of General Science

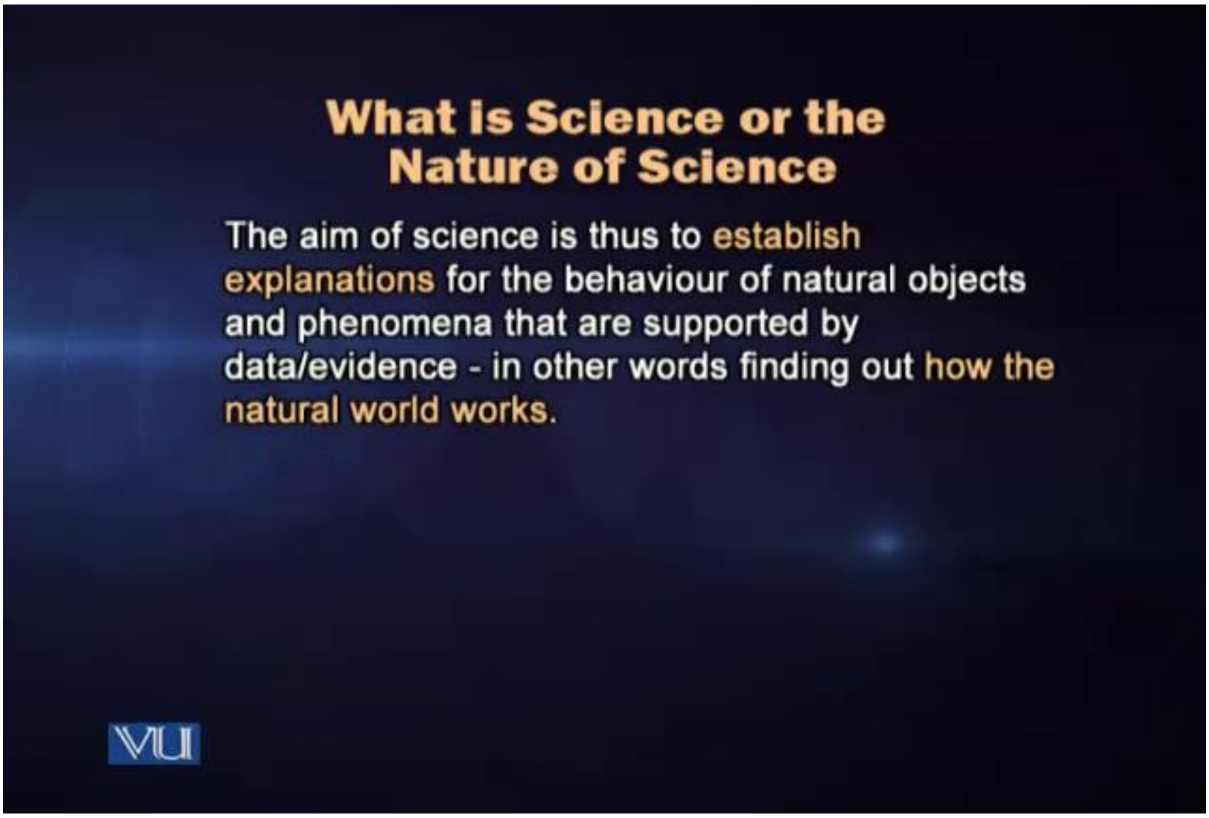


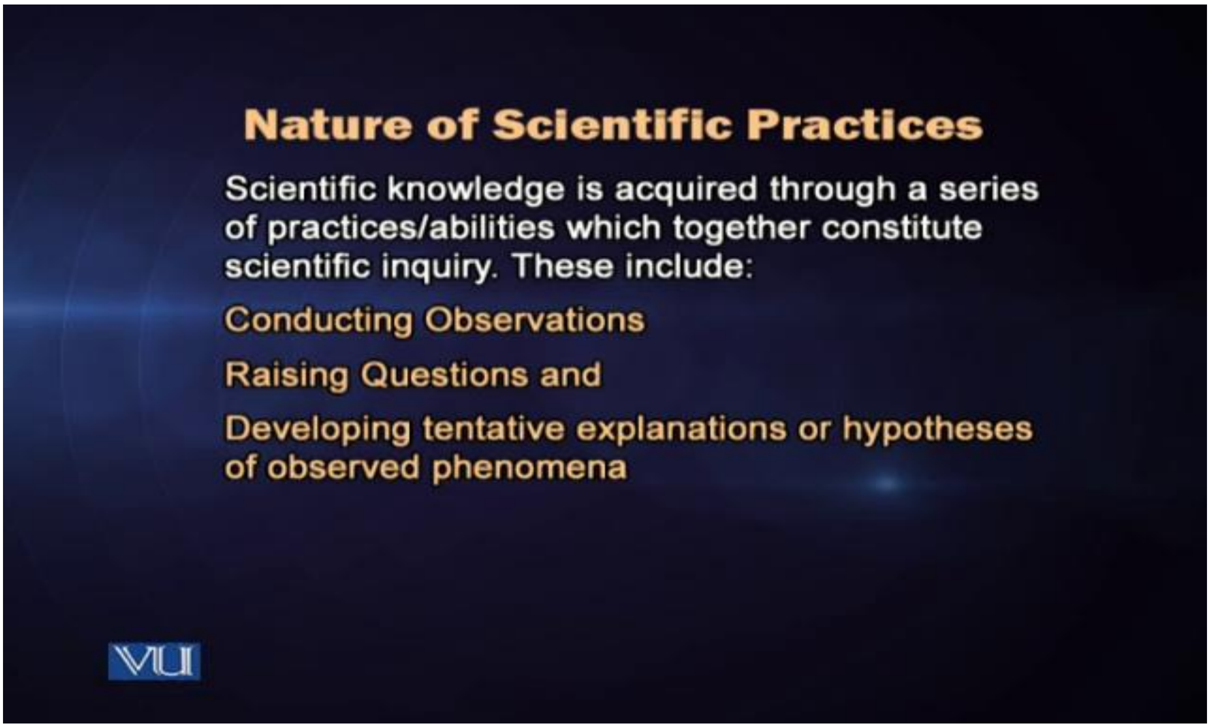



Structure of the Course:
Teaching of General Science
to grades K-8
Comprising of 45 lectures which are organised into 4 units/components
Unit 1: What is Science and Why do We Need to Teach it?
(3 lectures; 2 on the practices of Science)
Unit 2: Children's Ideas about Science and their Importance in Planning and Teaching
(1 lecture)
VU

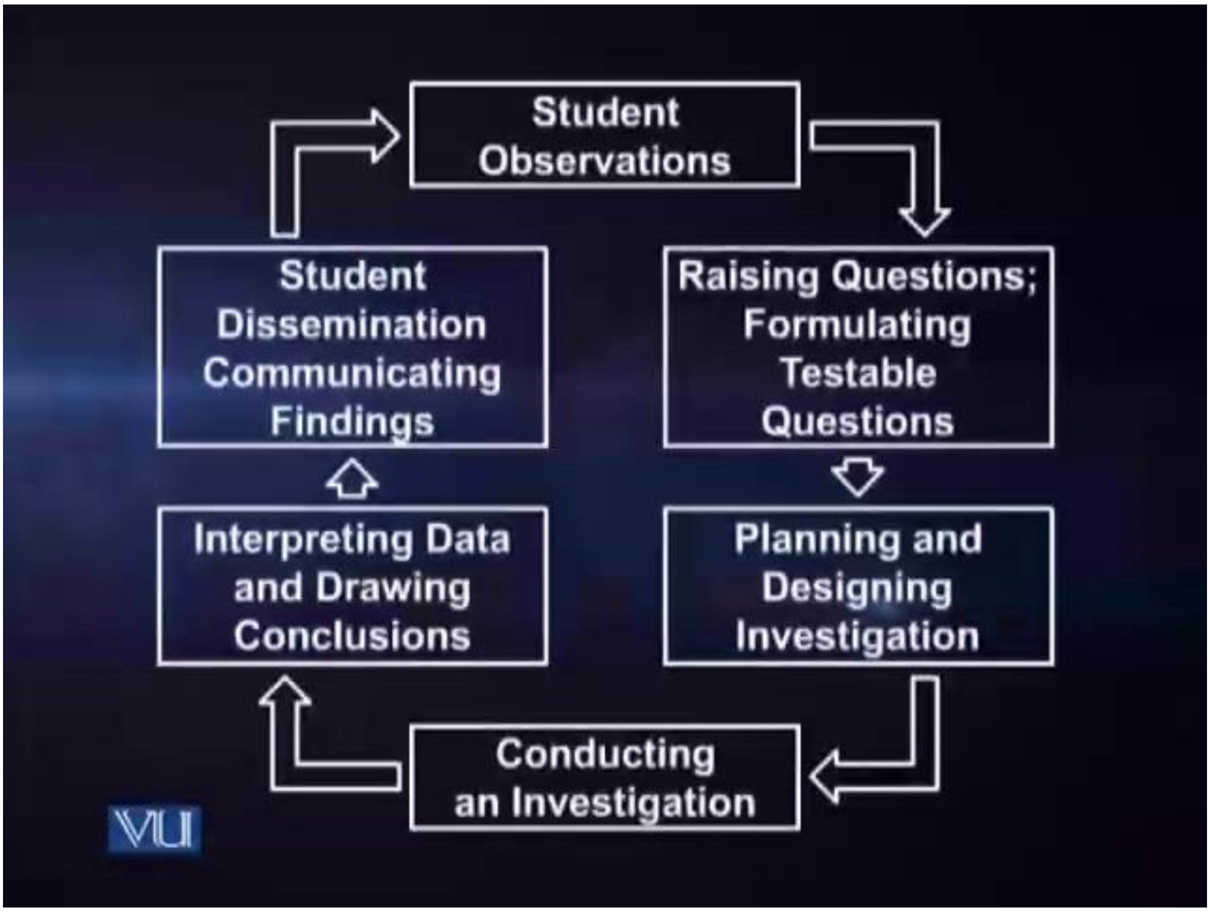

Structure of the Course:
Teaching of General Science
to grades K-8
Unit 3: Learning Planning and Teaching Science – the major part of the course ☻
(40 lectures)
Unit 4: Conclusion – Review of the Salient features of the course and the road ahead
(1 lectures)
VU

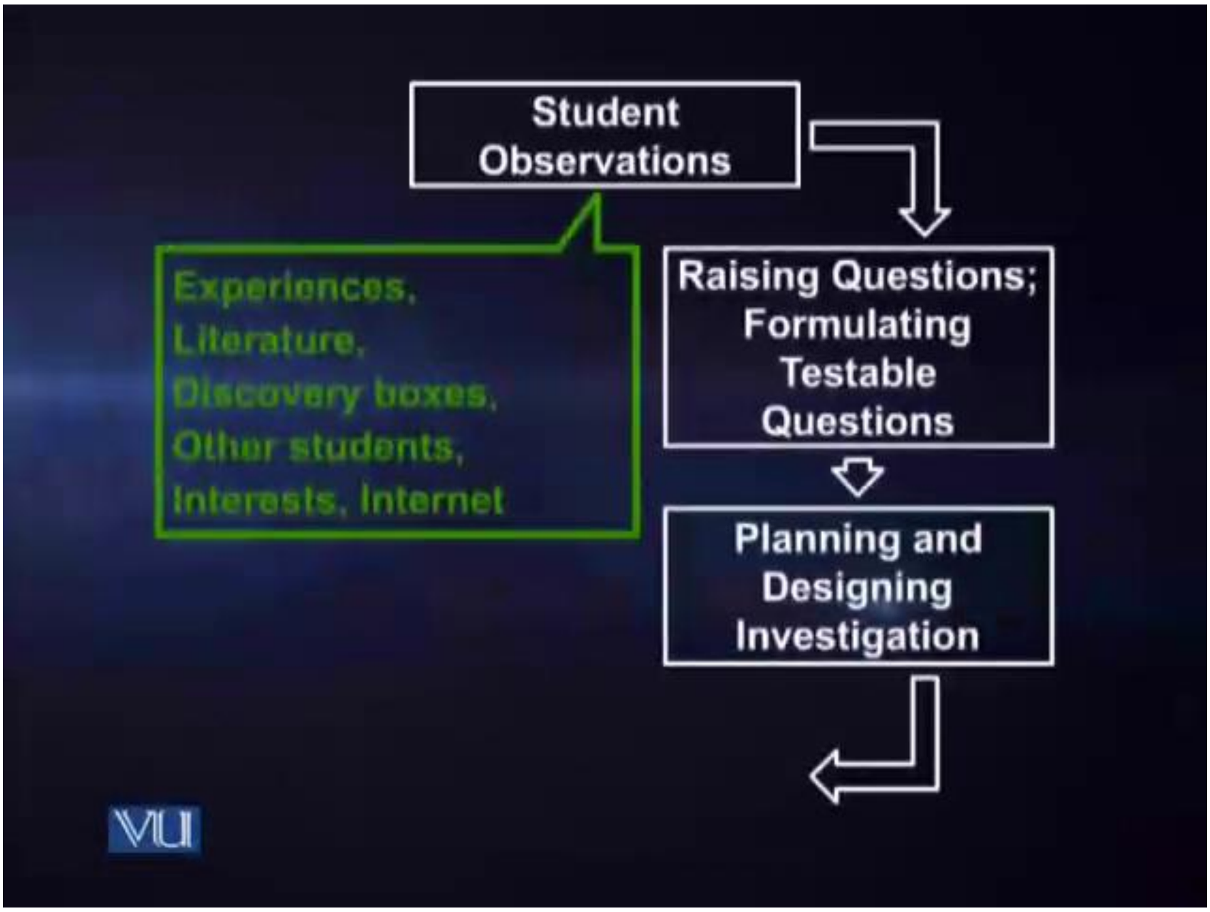

What is Science or the Nature of Science
Science constitutes an organised body of knowledge about the natural world and the processes/practices whereby this body of knowledge is established and is continuously being extended, refined and revised.
VU

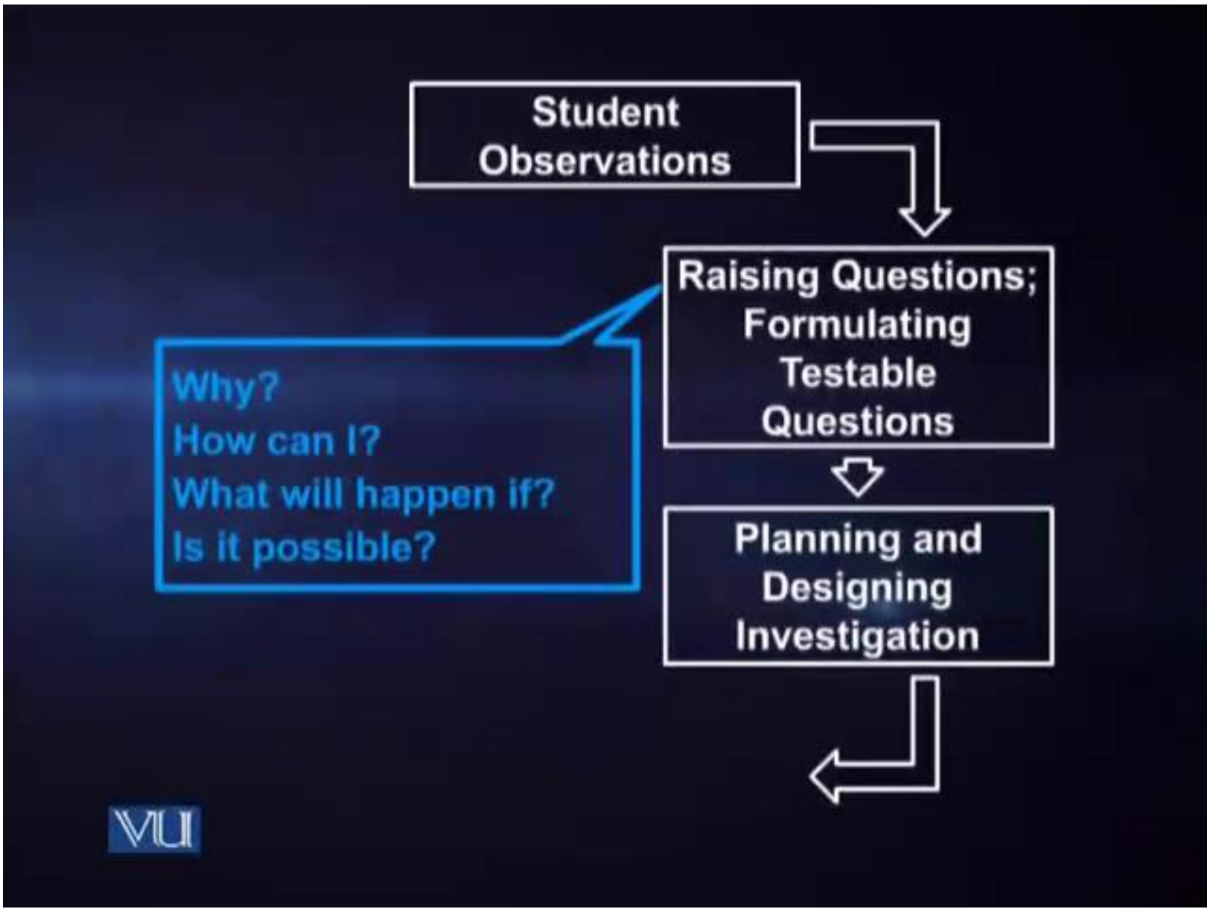

What is Science or the Nature of Science
The aim of science is thus to establish explanations for the behaviour of natural objects and phenomena that are supported by data/evidence - in other words finding out how the natural world works.
VU

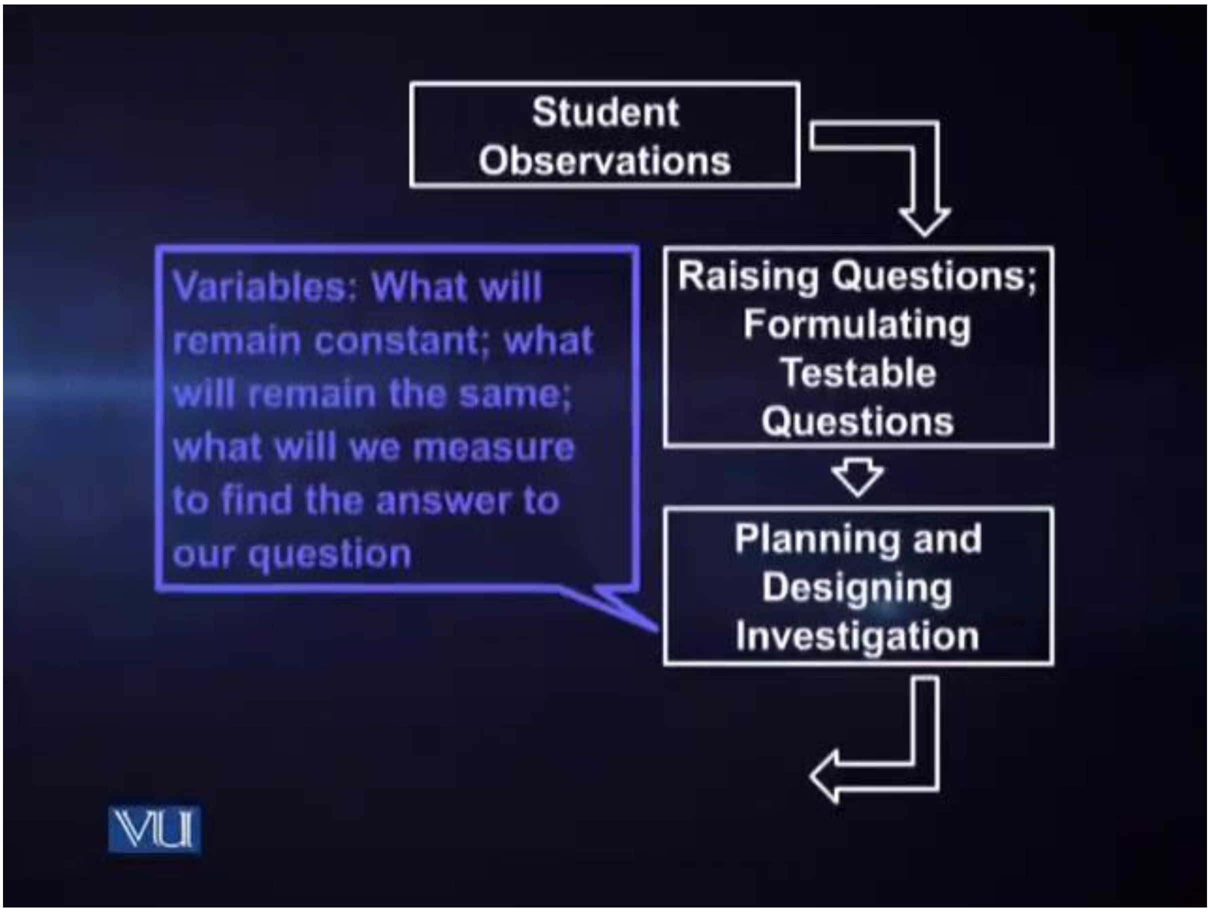

Nature of Scientific Practices
Scientific knowledge is acquired through a series of practices/abilities which together constitute scientific inquiry. These include:
Conducting Observations
Raising Questions and
Developing tentative explanations or hypotheses of observed phenomena
VU

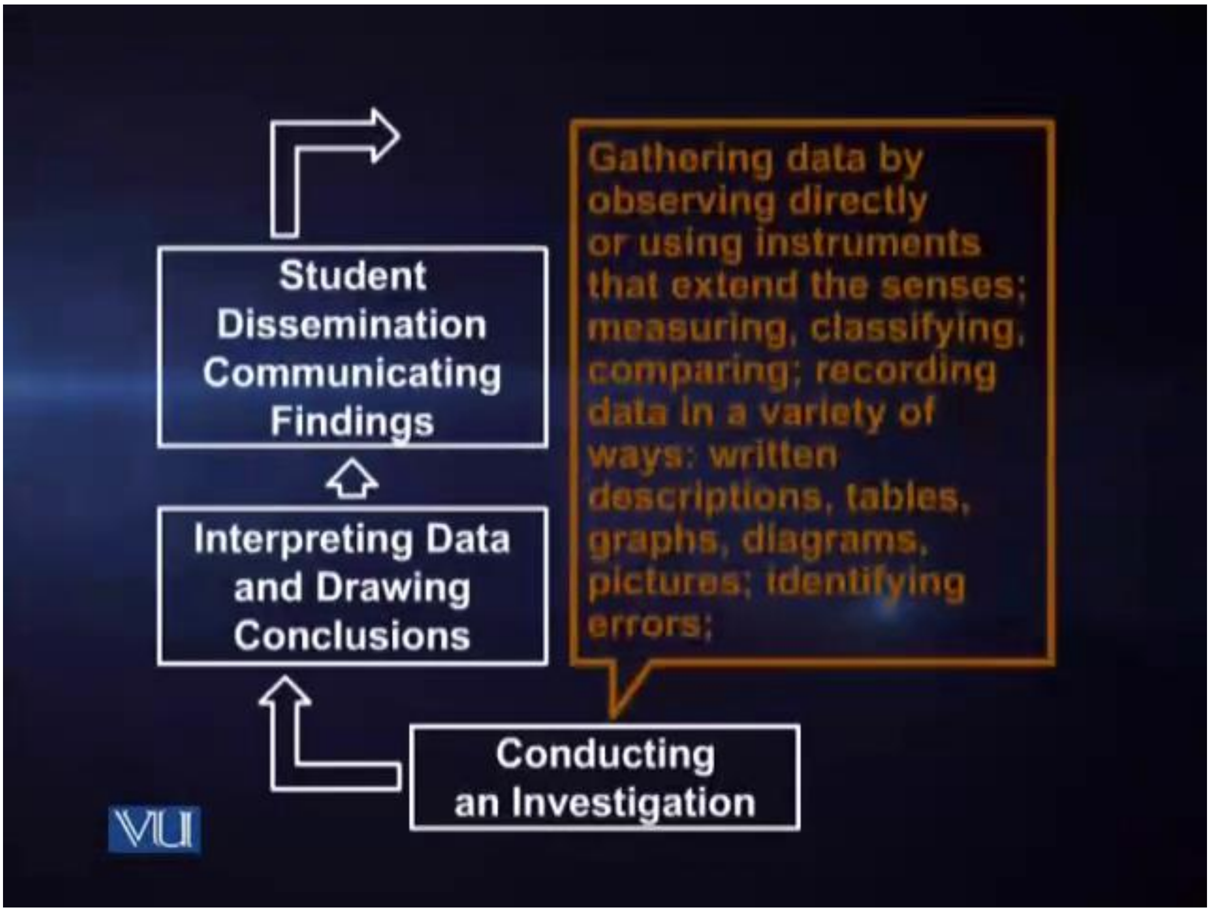

Nature of Scientific Practices
- Making predictions based on the hypotheses or tentative explanations
- Planning and carrying out empirical investigations
- Collecting, interpreting, analysing data and evaluating knowledge claims.
- Communicate findings to larger peer group for critical review
VU


Student Observations
Raising Questions; Formulating Testable Questions
Planning and Designing Investigation
Conducting an Investigation
Interpreting Data and Drawing Conclusions
Student Dissemination Communicating Findings
VU

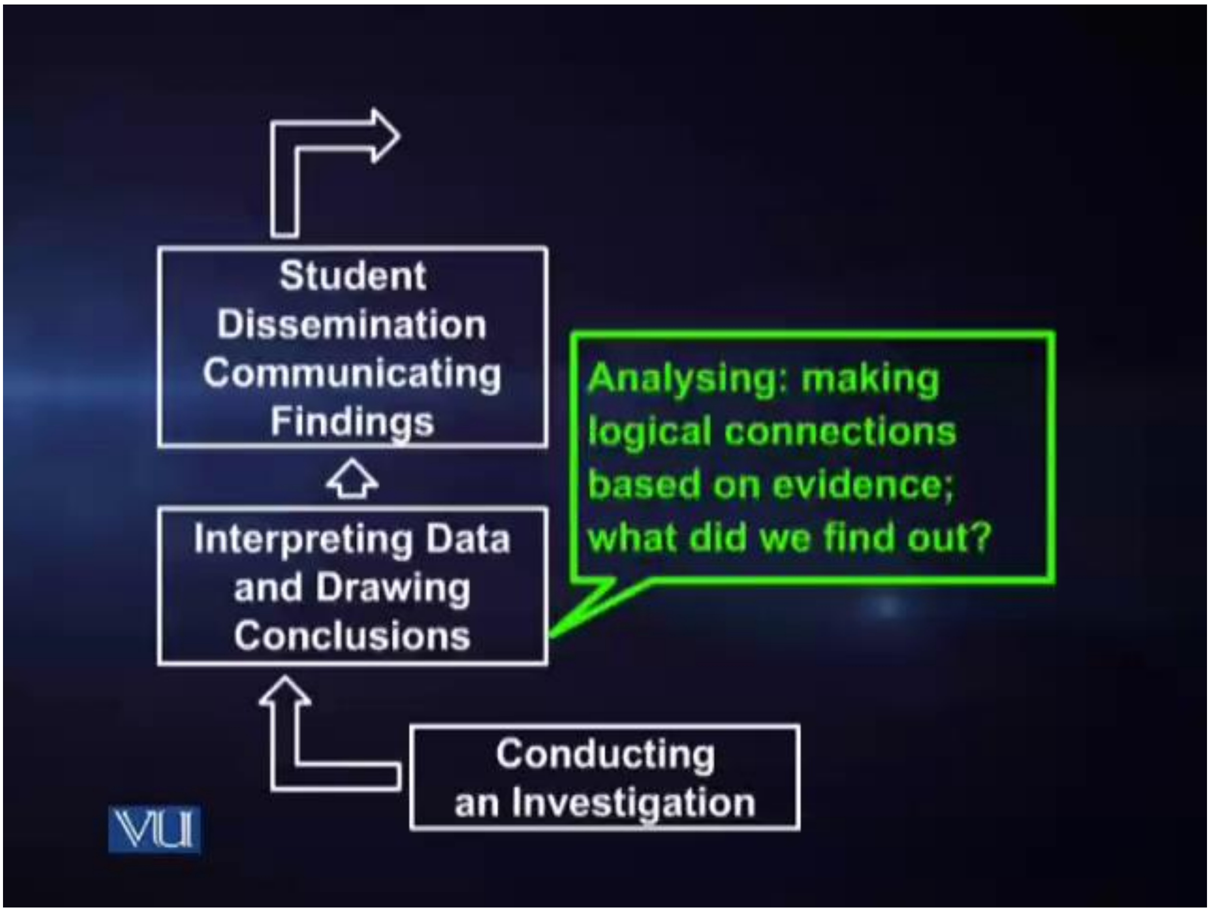

Student Observations
Experiences,
Literature,
Discovery boxes,
Other students,
Interests, Internet
Raising Questions; Formulating Testable Questions
Planning and Designing Investigation
VU


Student Observations
Raising Questions; Formulating Testable Questions
Planning and Designing Investigation
Why?
How can I?
What will happen if?
Is it possible?
VU

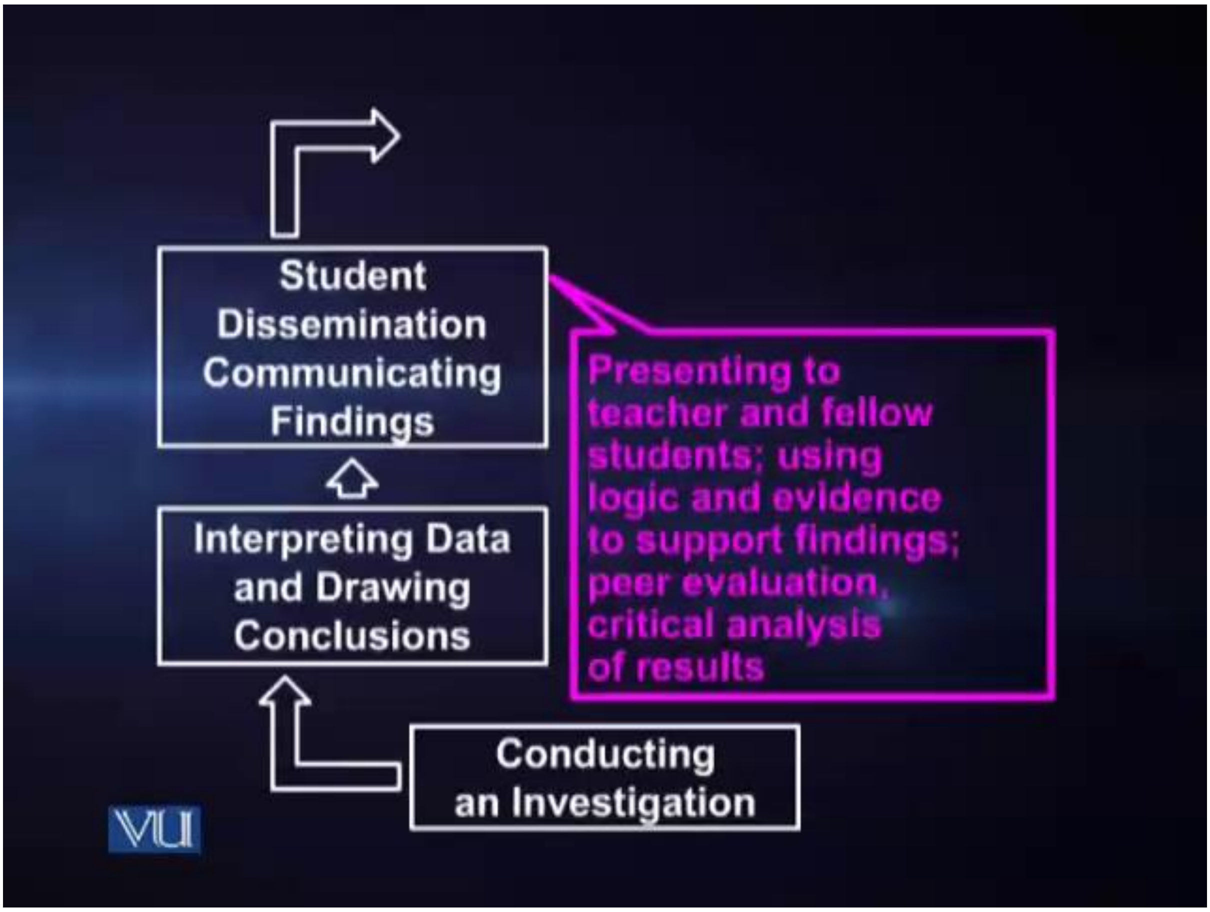

Student Observations
Raising Questions; Formulating Testable Questions
Planning and Designing Investigation
Variables: What will remain constant; what will remain the same; what will we measure to find the answer to our question
VU

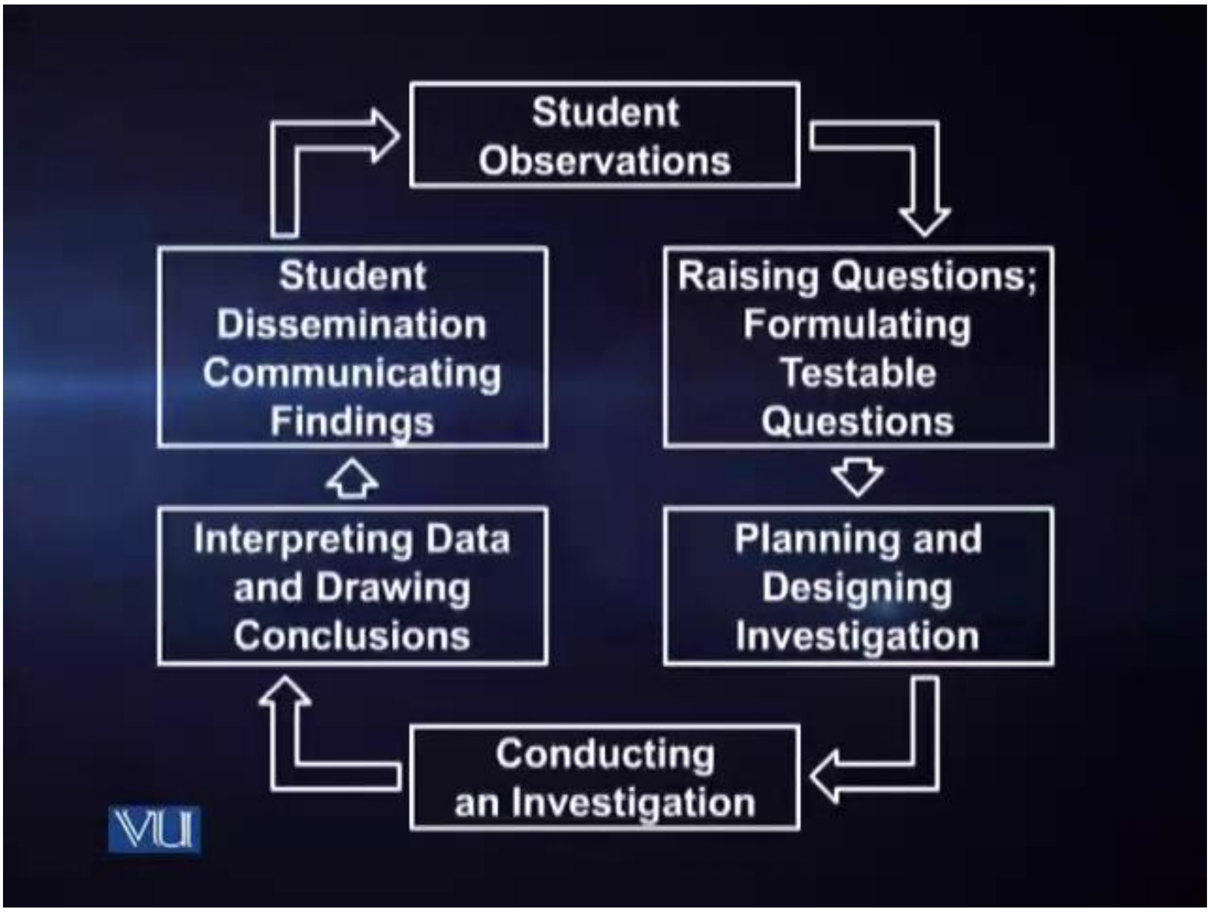


Student Dissemination Communicating Findings
Interpreting Data and Drawing Conclusions
Conducting an Investigation
Gathering data by observing directly or using instruments that extend the senses; measuring, classifying, comparing; recording data in a variety of ways: written descriptions, tables, graphs, diagrams, pictures; identifying errors;
VU

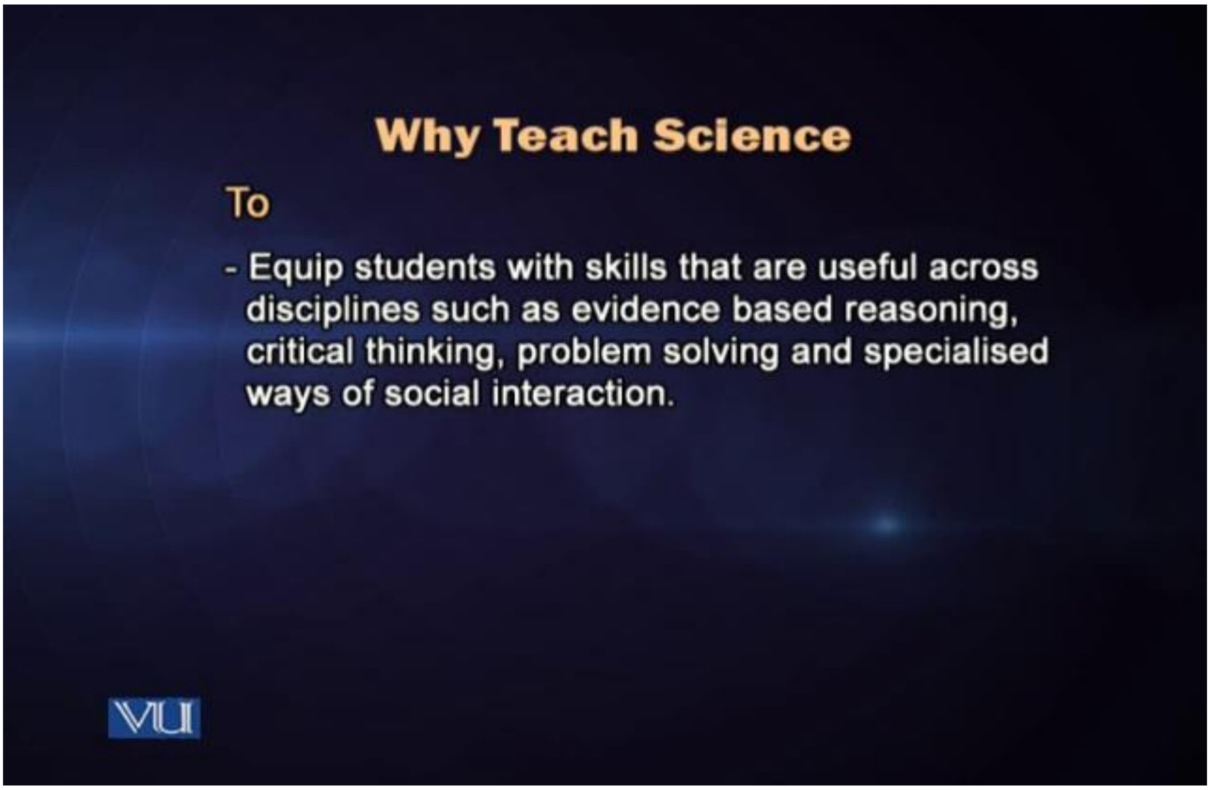


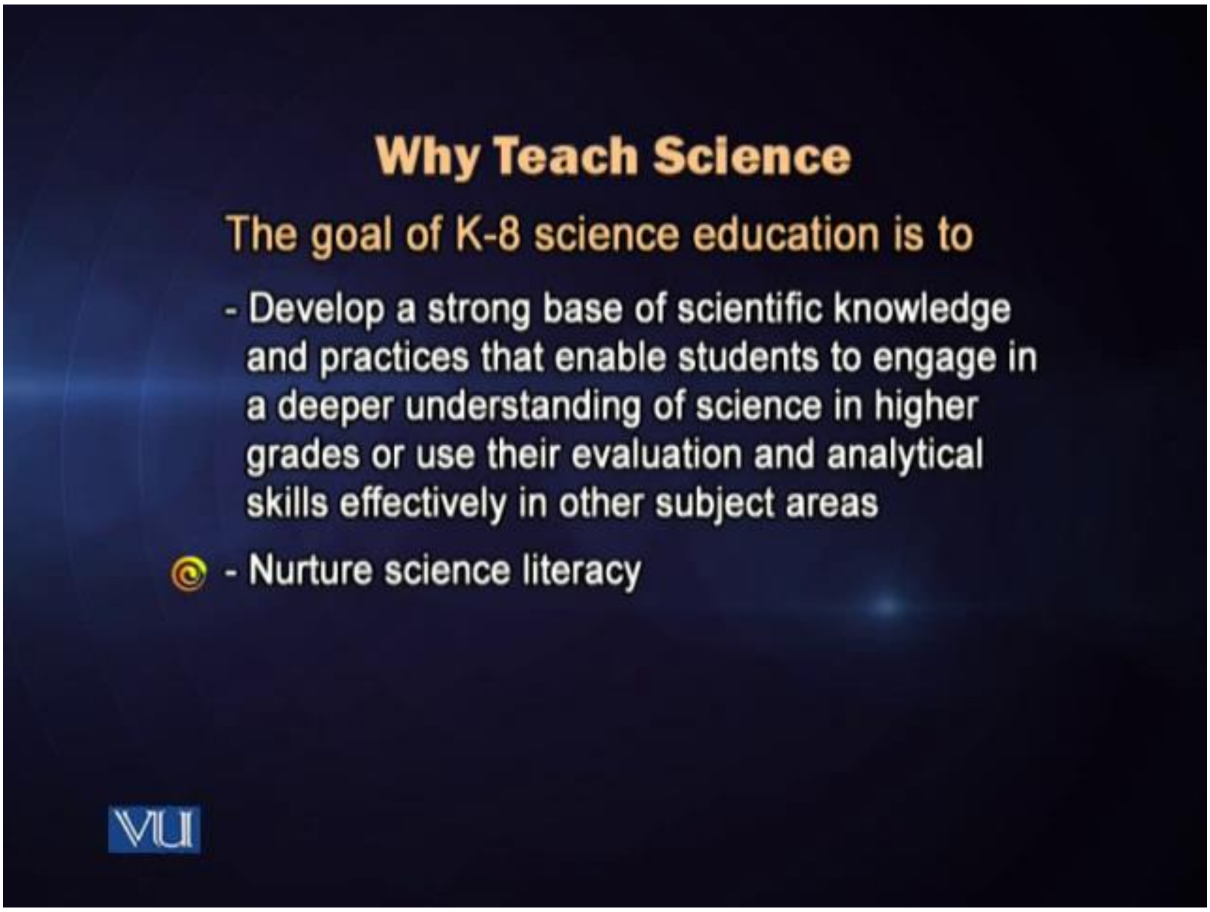
Student Dissemination Communicating Findings
Analysing: making logical connections based on evidence; what did we find out?
Interpreting Data and Drawing Conclusions
Conducting an Investigation
VU

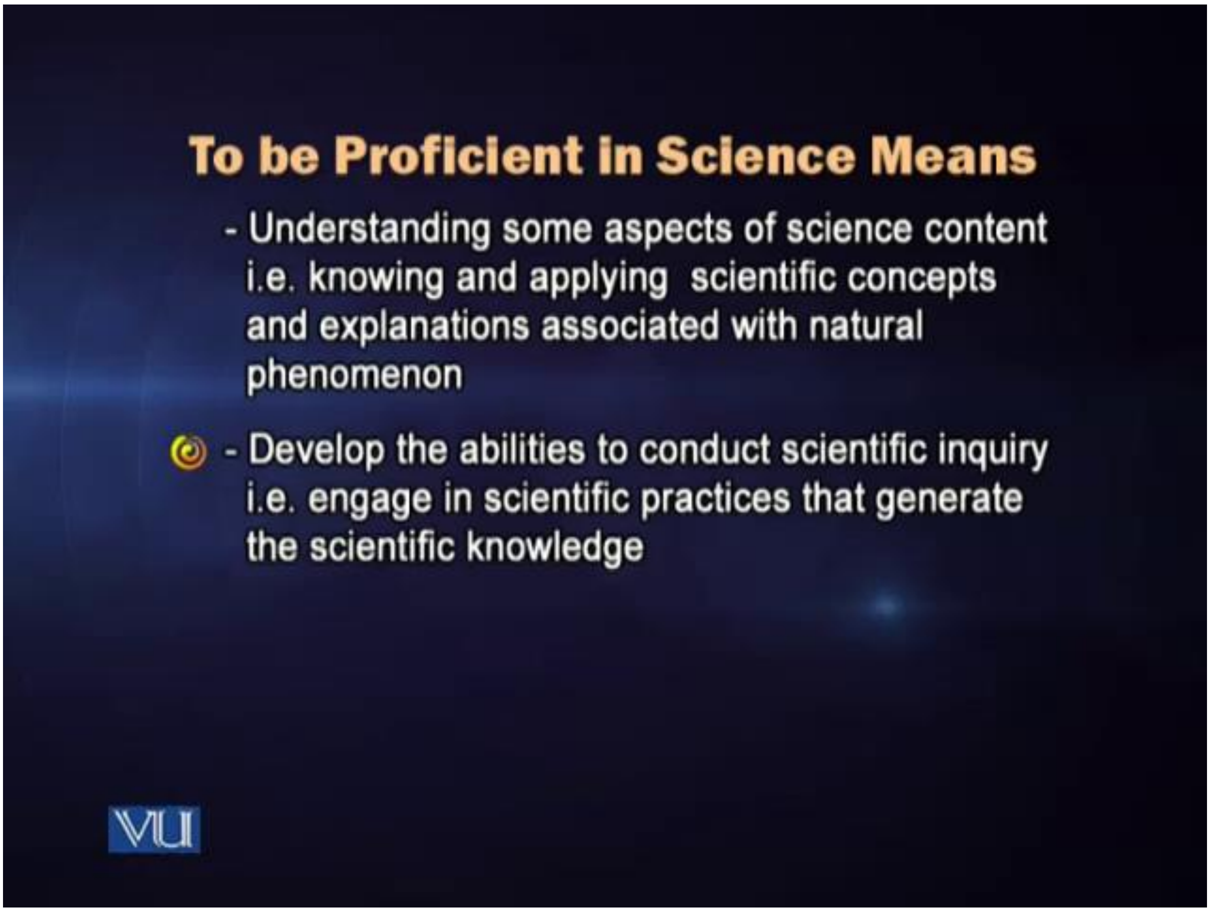

Student
Dissemination
Communicating
Findings
Presenting to teacher and fellow students; using logic and evidence to support findings; peer evaluation, critical analysis of results
Interpreting Data and Drawing Conclusions
Conducting an Investigation
VU


Student Observations
Student
Dissemination
Communicating
Findings
Raising Questions; Formulating Testable Questions
Interpreting Data and Drawing Conclusions
Planning and Designing Investigation
Conducting an Investigation
VU


Why Teach Science
To
- Nurture future scientists, technologists, and engineers
- Increase the number of "scientifically literate" adults in society and hence improve a public understanding of science. Science education is essential for all students if they are to participate fully in a society/world that places increasing reliance on science and technology;
VU


Why Teach Science
To
- Equip students with skills that are useful across disciplines such as evidence based reasoning, critical thinking, problem solving and specialised ways of social interaction.
VU


Why Teach Science
The goal of K-8 science education is to
- Develop a strong base of scientific knowledge and practices that enable students to engage in a deeper understanding of science in higher grades or use their evaluation and analytical skills effectively in other subject areas
- Nurture science literacy
VU


To be Proficient in Science Means
- Understanding some aspects of science content i.e. knowing and applying scientific concepts and explanations associated with natural phenomenon
- Develop the abilities to conduct scientific inquiry i.e. engage in scientific practices that generate the scientific knowledge
VU

To be Proficient in Science Means

- Understanding the nature of scientific knowledge and how it is developed
- Understanding and participating in science as a social activity
  Participation in scientific discourse in the classroom helps students advance their abilities to argue scientifically

VU

Structure of the Course: Teaching of General Science to grades K-8

Comprising of 45 lectures which are organised into 4 units/components

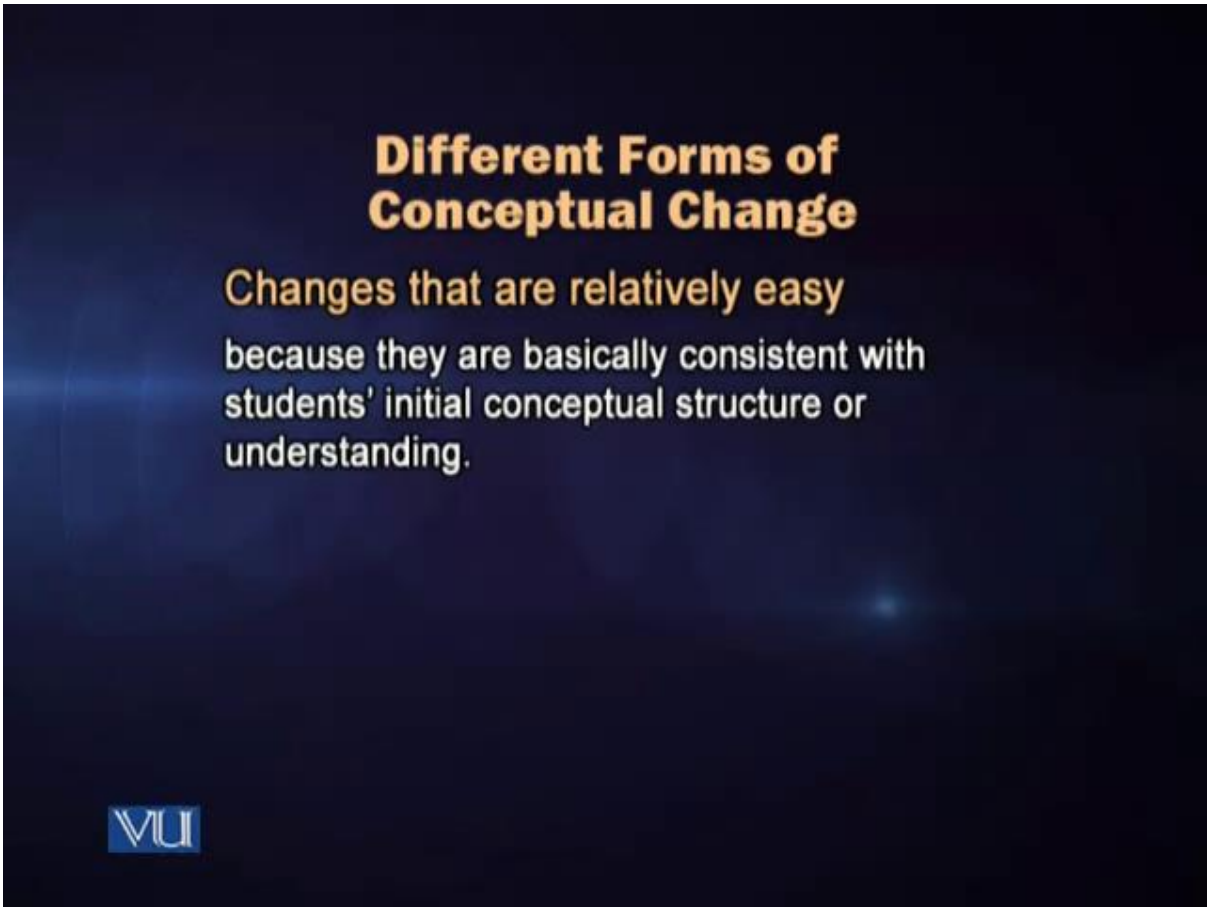
Unit 1: What is Science and Why do We Need to Teach it?

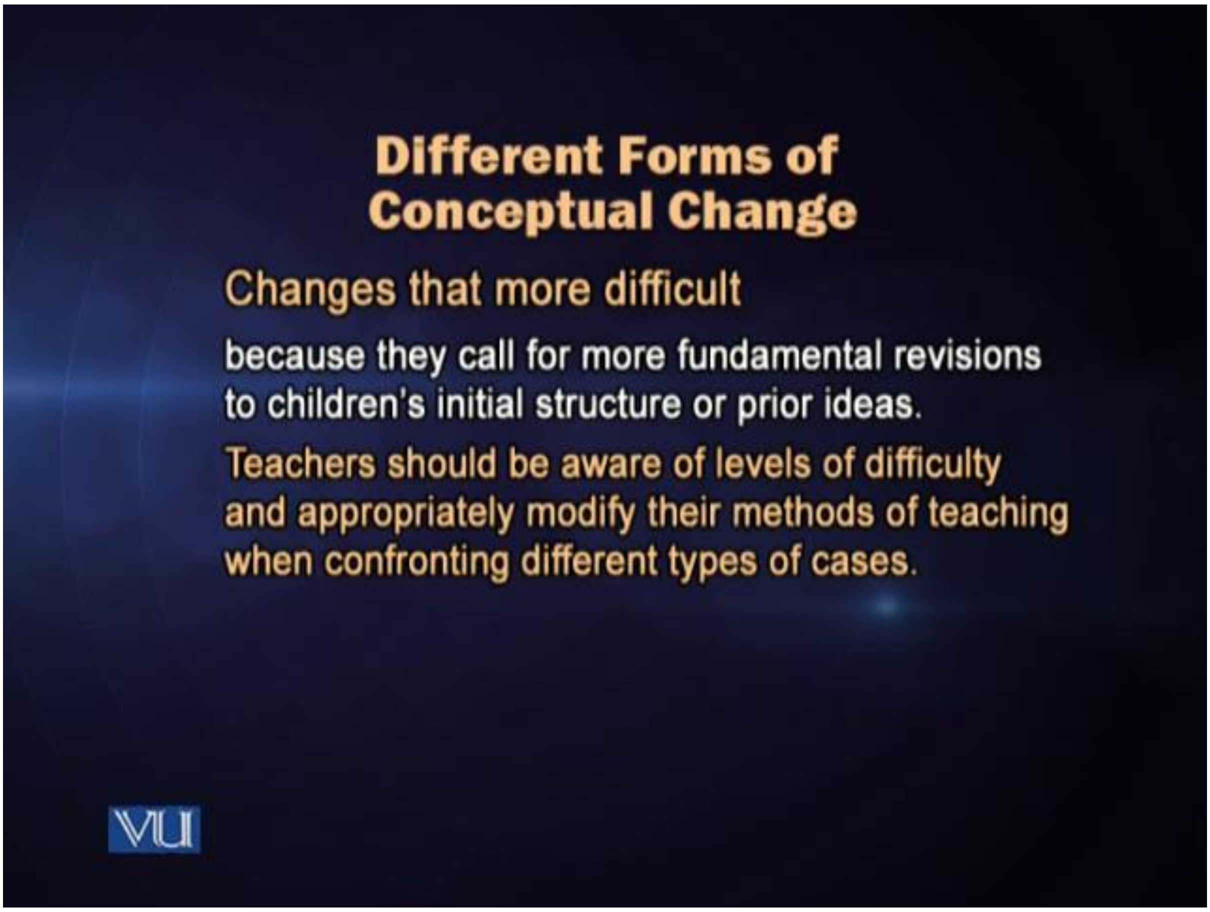
(3 lectures; 2 on the practices of Science)

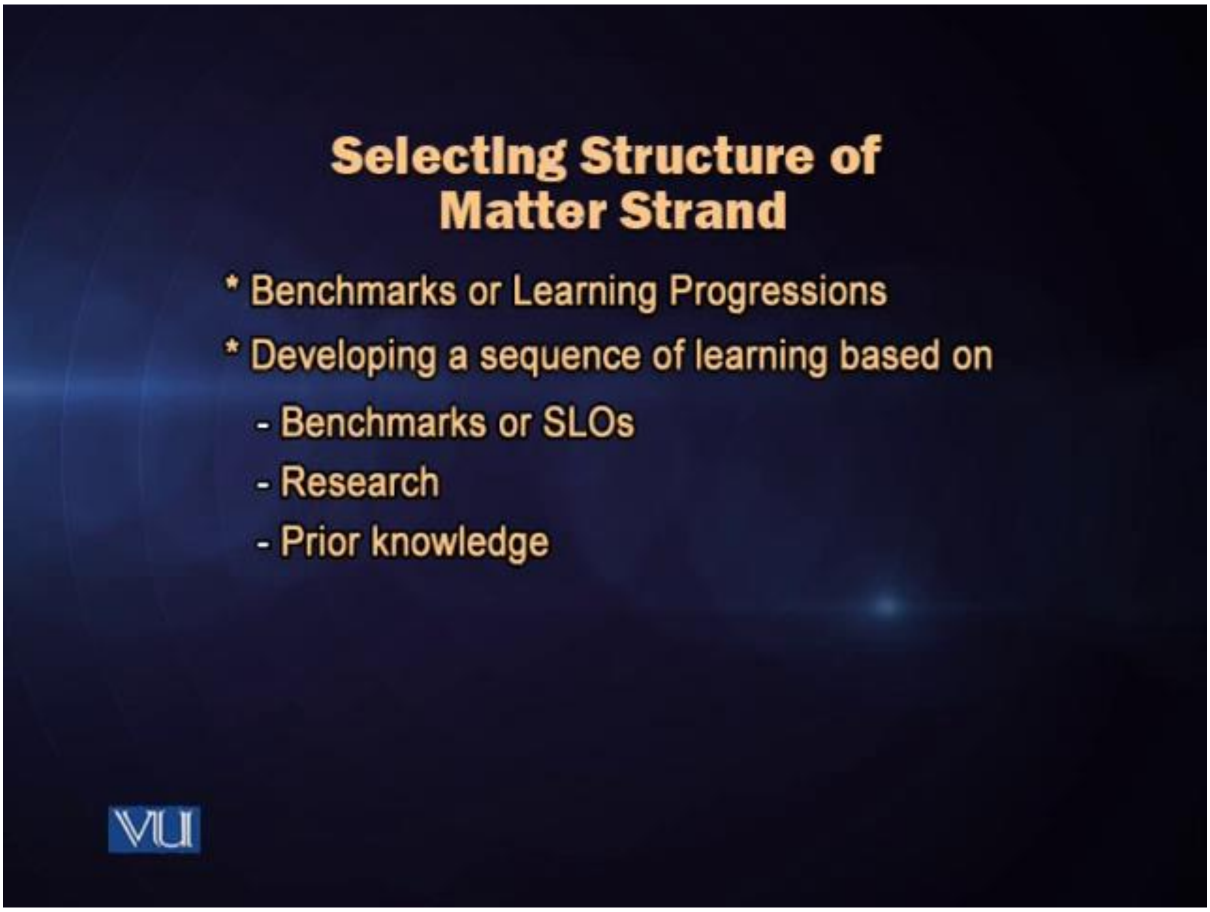
- Unit 2: Children's Ideas about Science and their Importance in Planning and Teaching

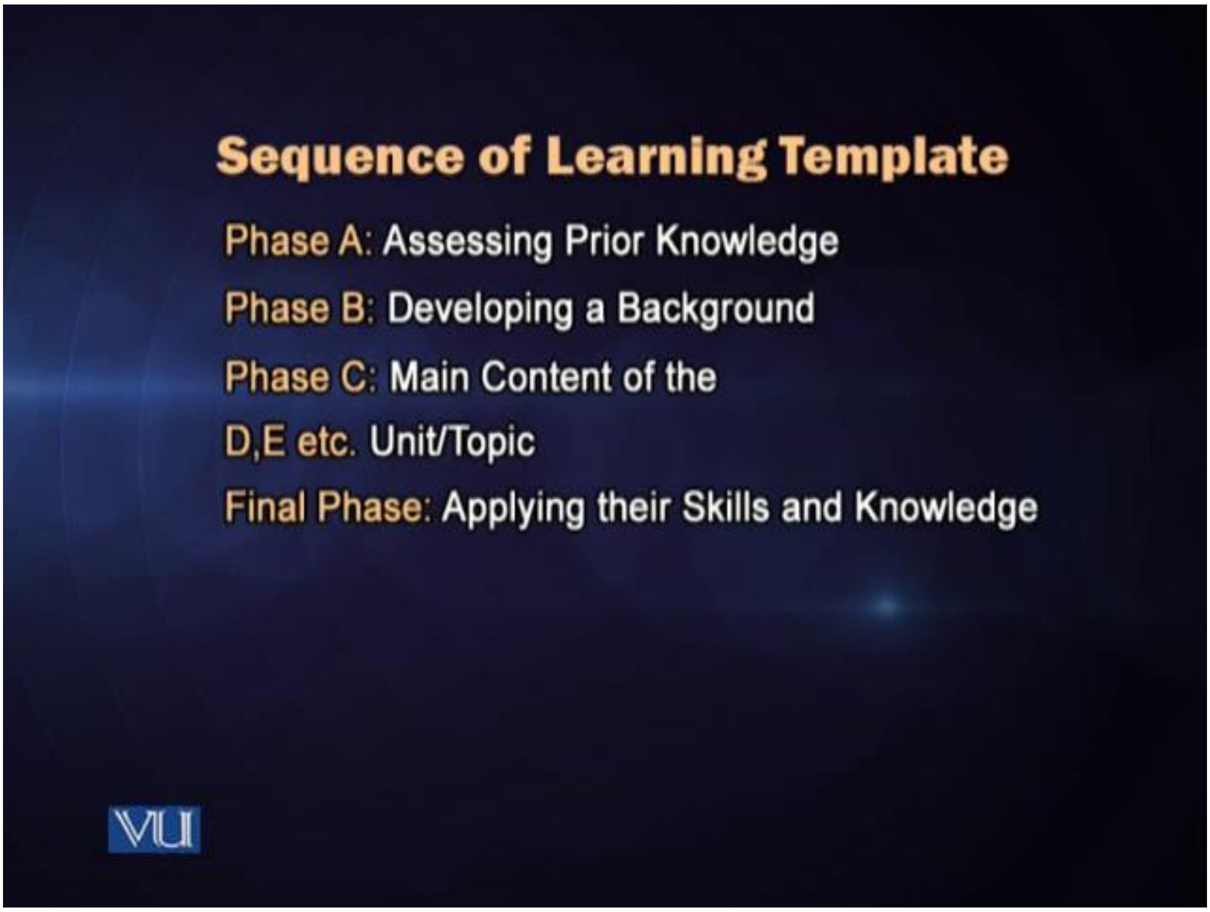
(1 lecture)

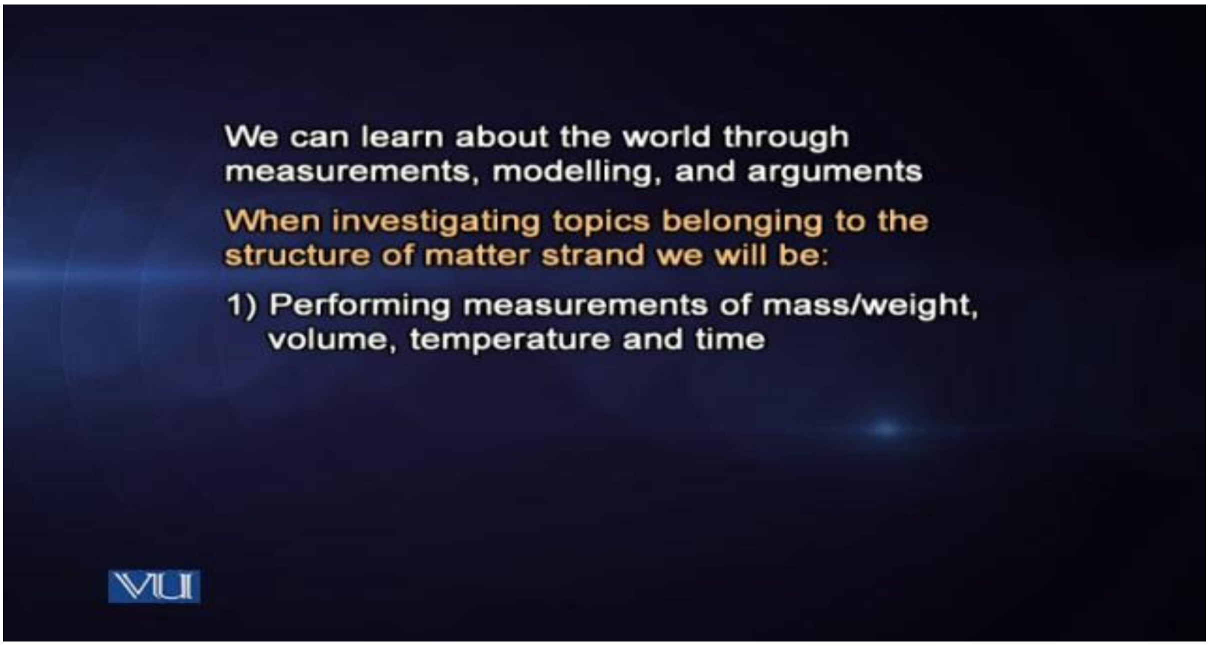
VU

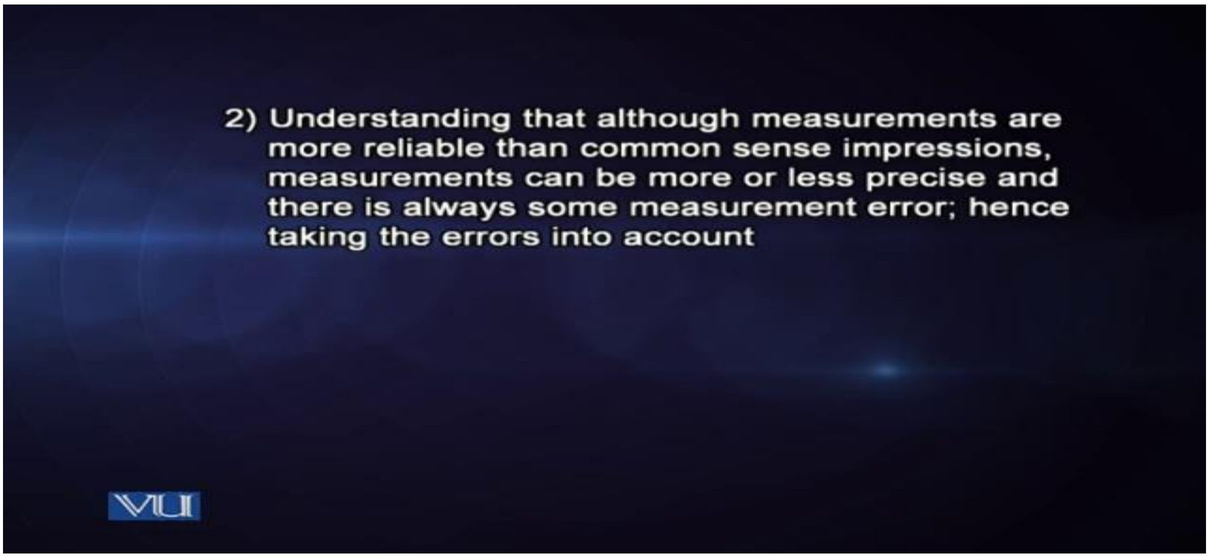

Different Forms of Conceptual Change
Changes that are relatively easy
because they are basically consistent with students' initial conceptual structure or understanding.
VU

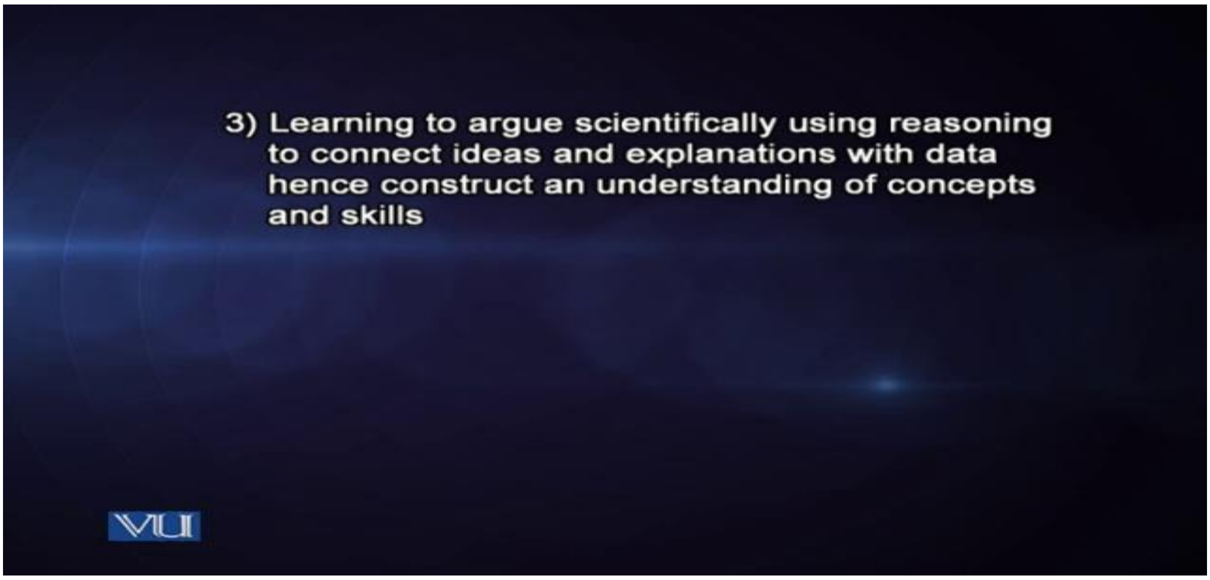

Different Forms of Conceptual Change
Changes that more difficult
because they call for more fundamental revisions to children's initial structure or prior ideas.
Teachers should be aware of levels of difficulty and appropriately modify their methods of teaching when confronting different types of cases.
VU

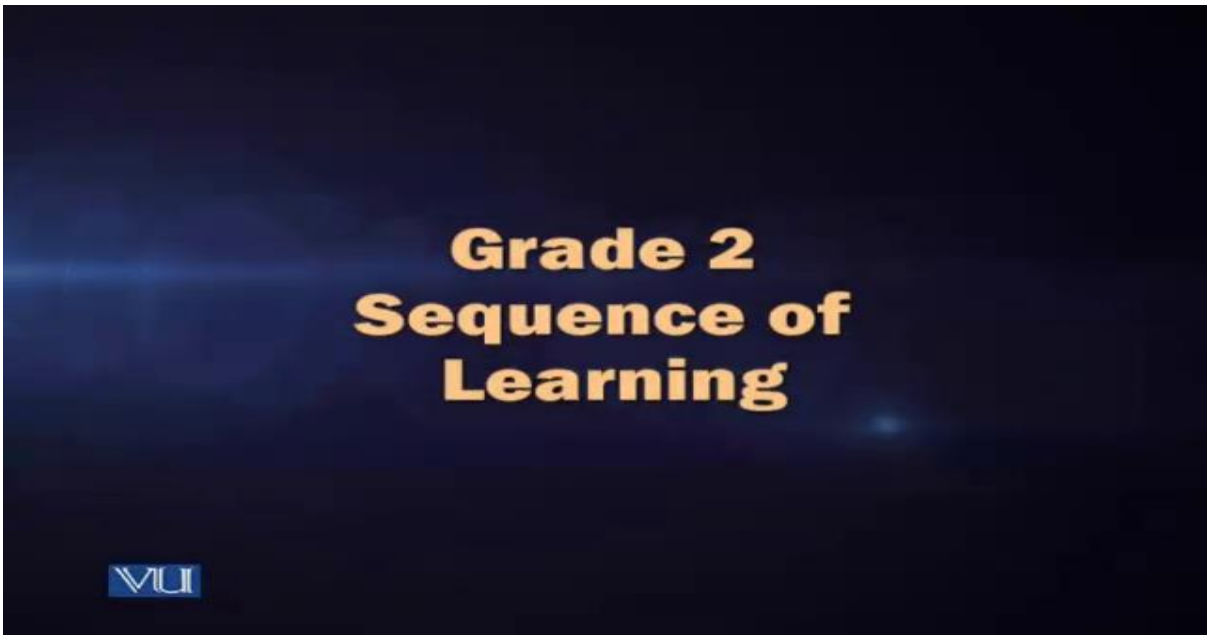

Selecting Structure of Matter Strand
* Benchmarks or Learning Progressions
* Developing a sequence of learning based on
- Benchmarks or SLOs
- Research
- Prior knowledge
VU

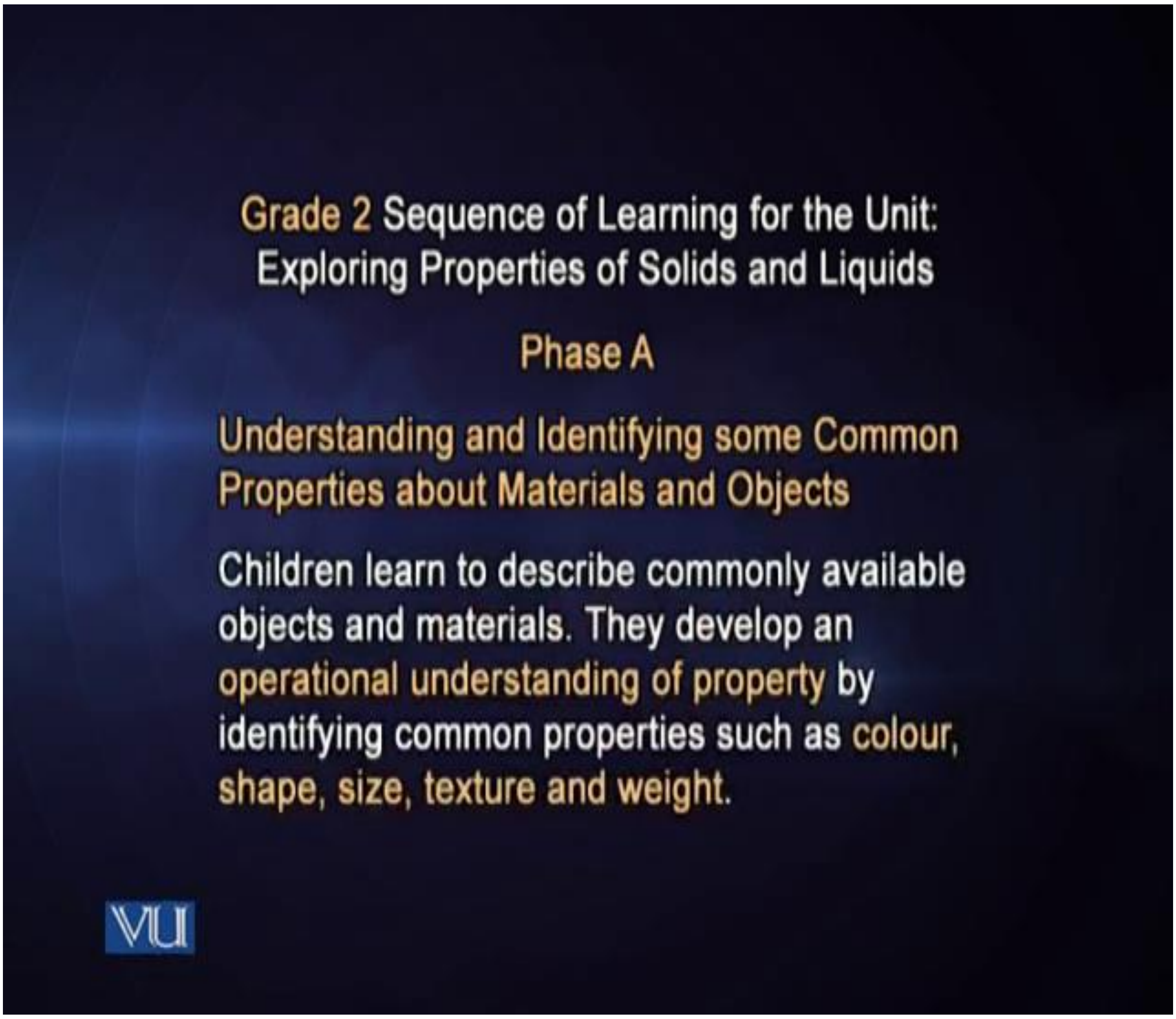

Sequence of Learning Template
Phase A: Assessing Prior Knowledge
Phase B: Developing a Background
Phase C: Main Content of the
D,E etc. Unit/Topic
Final Phase: Applying their Skills and Knowledge
VU

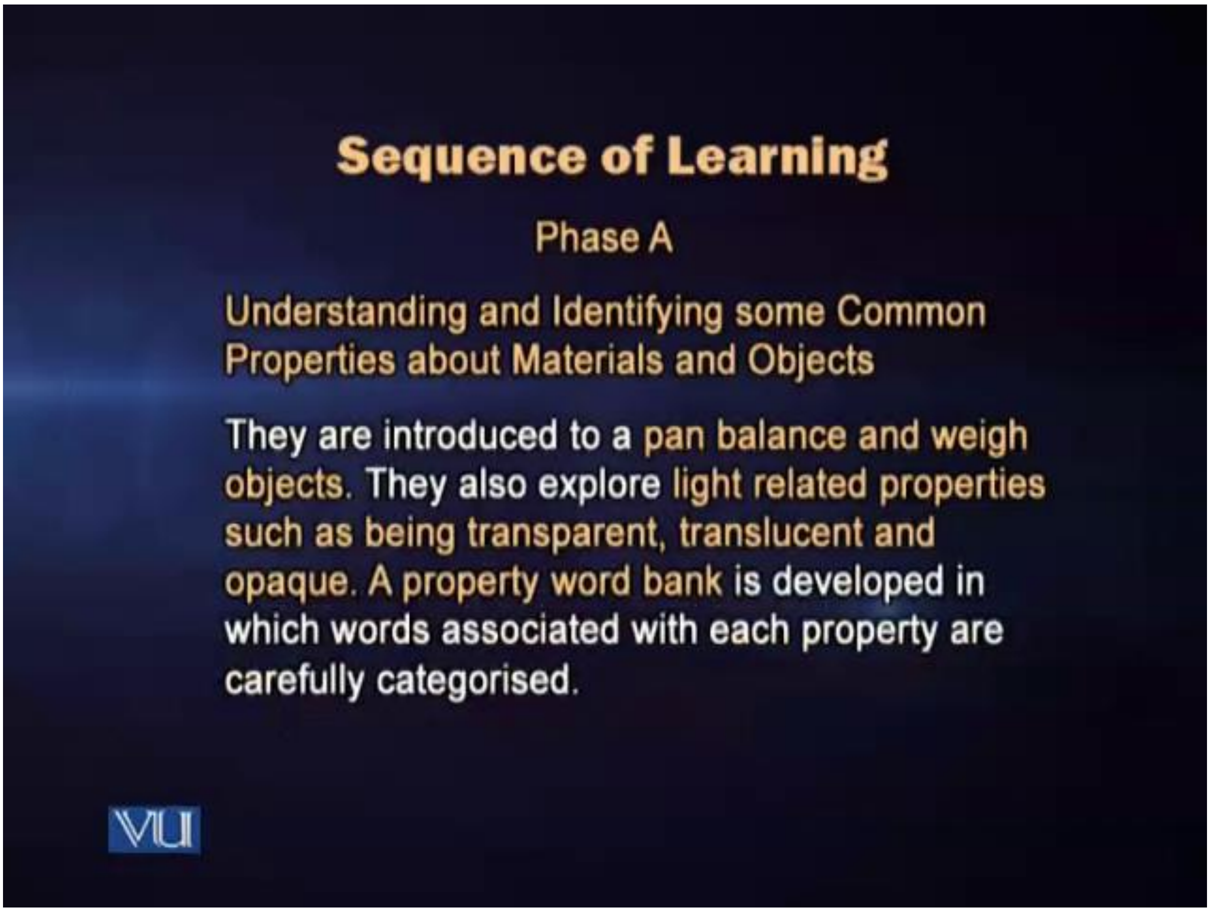

We can learn about the world through measurements, modelling, and arguments
When investigating topics belonging to the structure of matter strand we will be:
1) Performing measurements of mass/weight, volume, temperature and time
VU

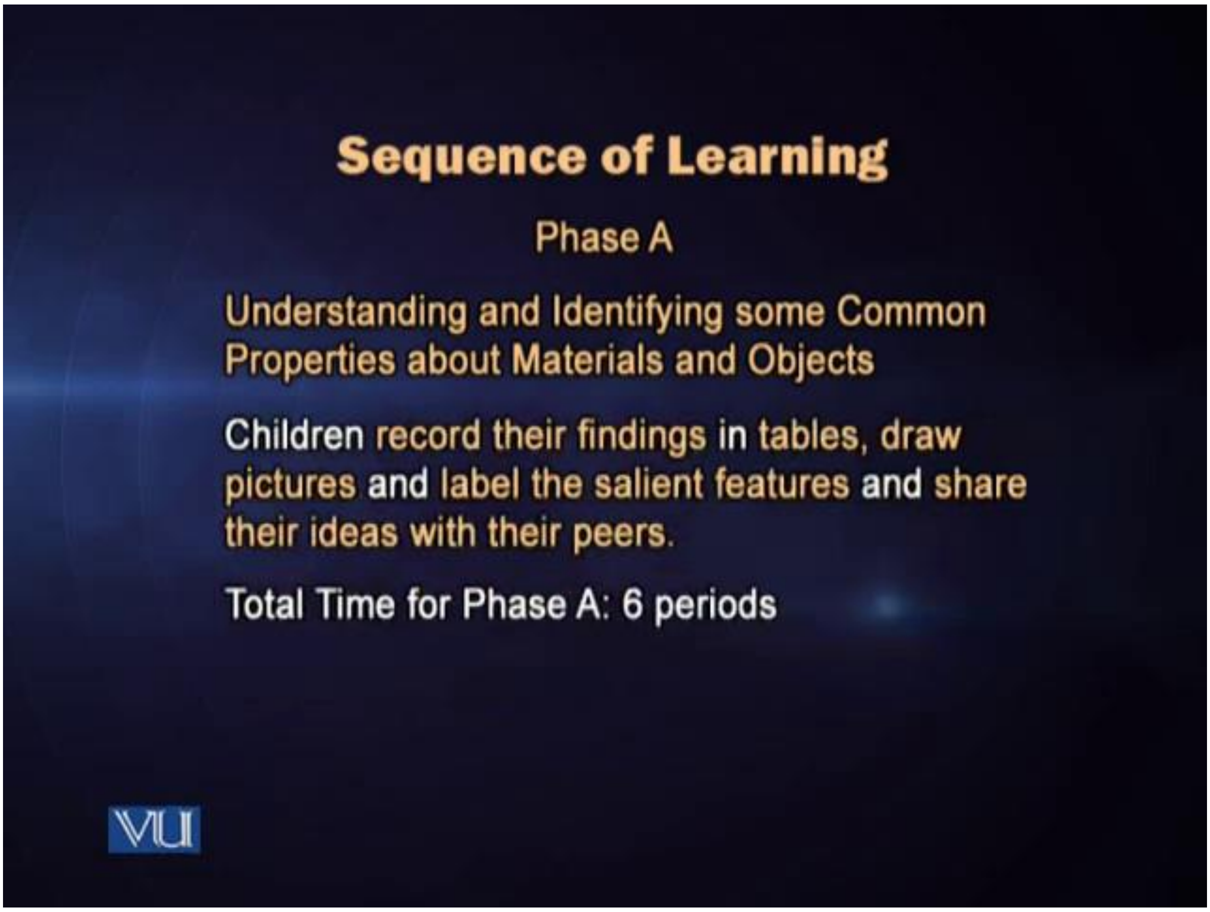

2) Understanding that although measurements are more reliable than common sense impressions, measurements can be more or less precise and there is always some measurement error; hence taking the errors into account
VU

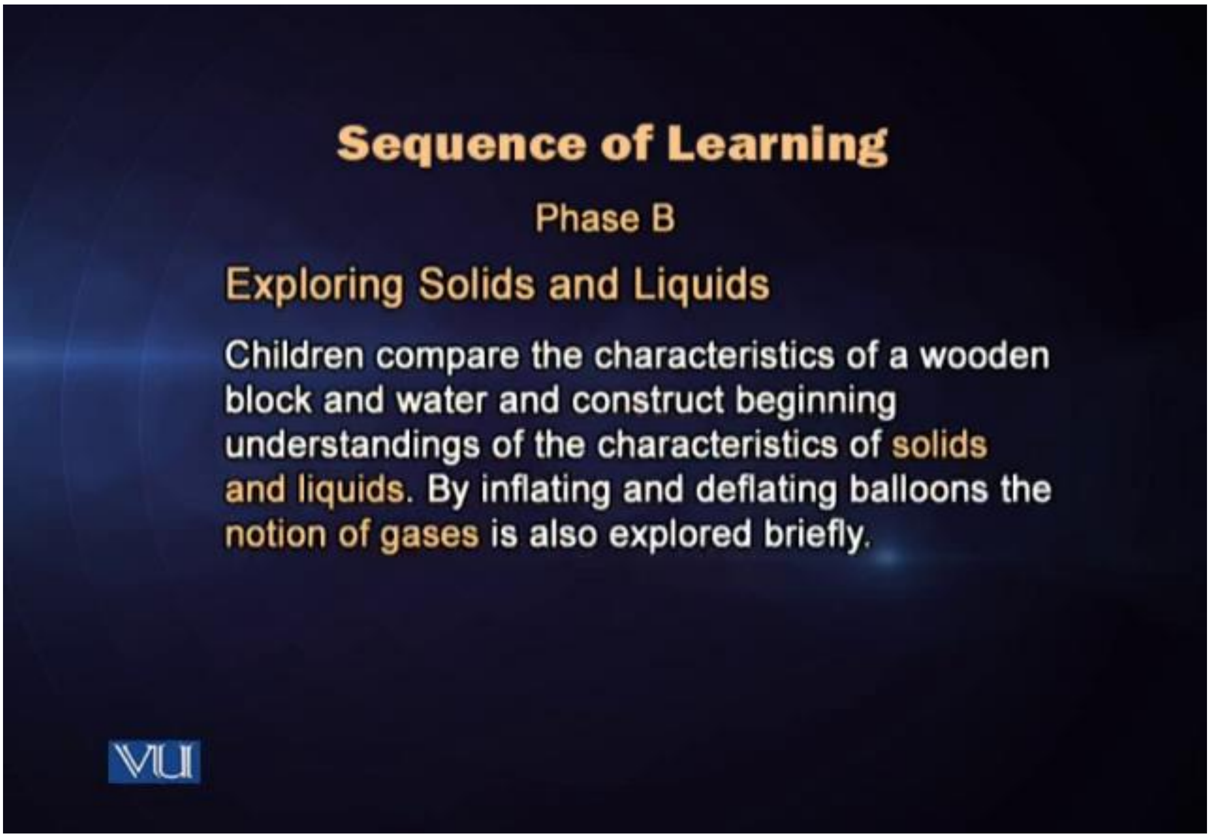

3) Learning to argue scientifically using reasoning to connect ideas and explanations with data hence construct an understanding of concepts and skills
VU

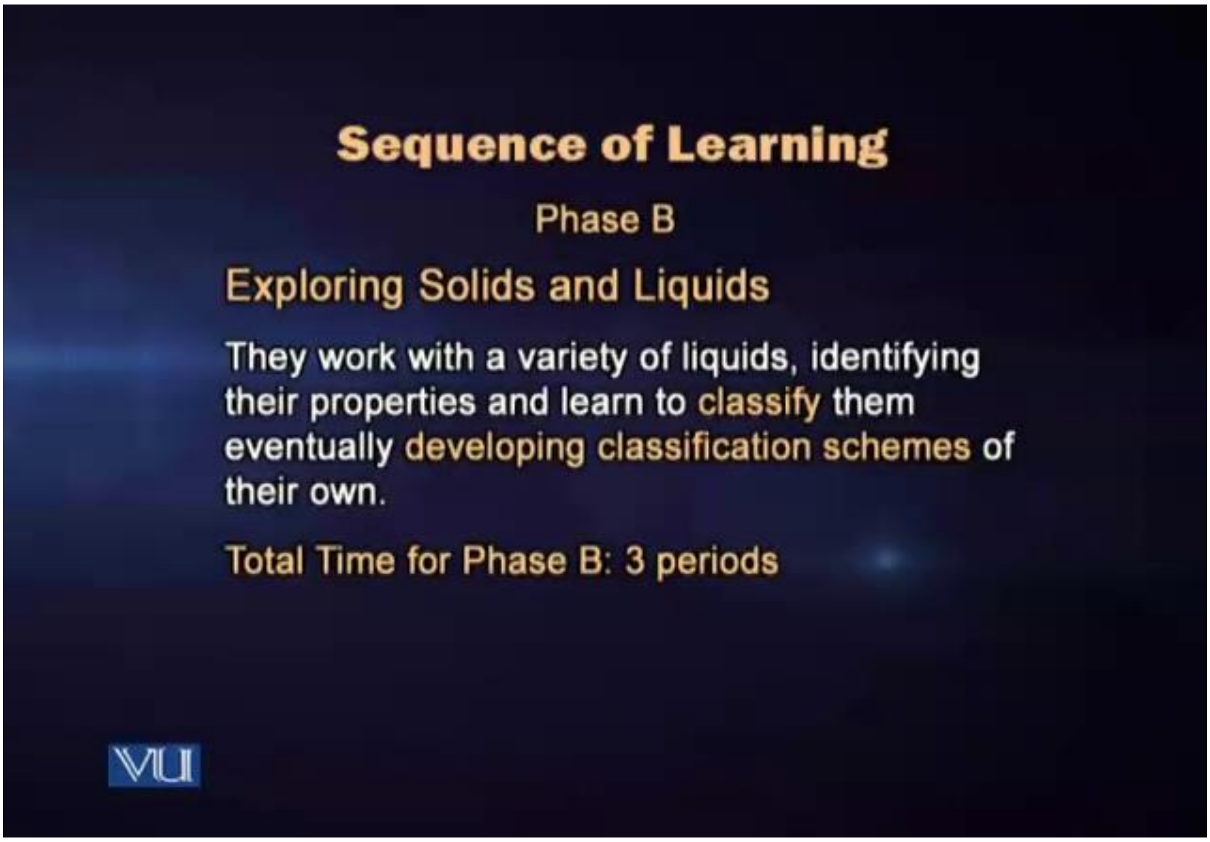

Grade 2
Sequence of
Learning
VU

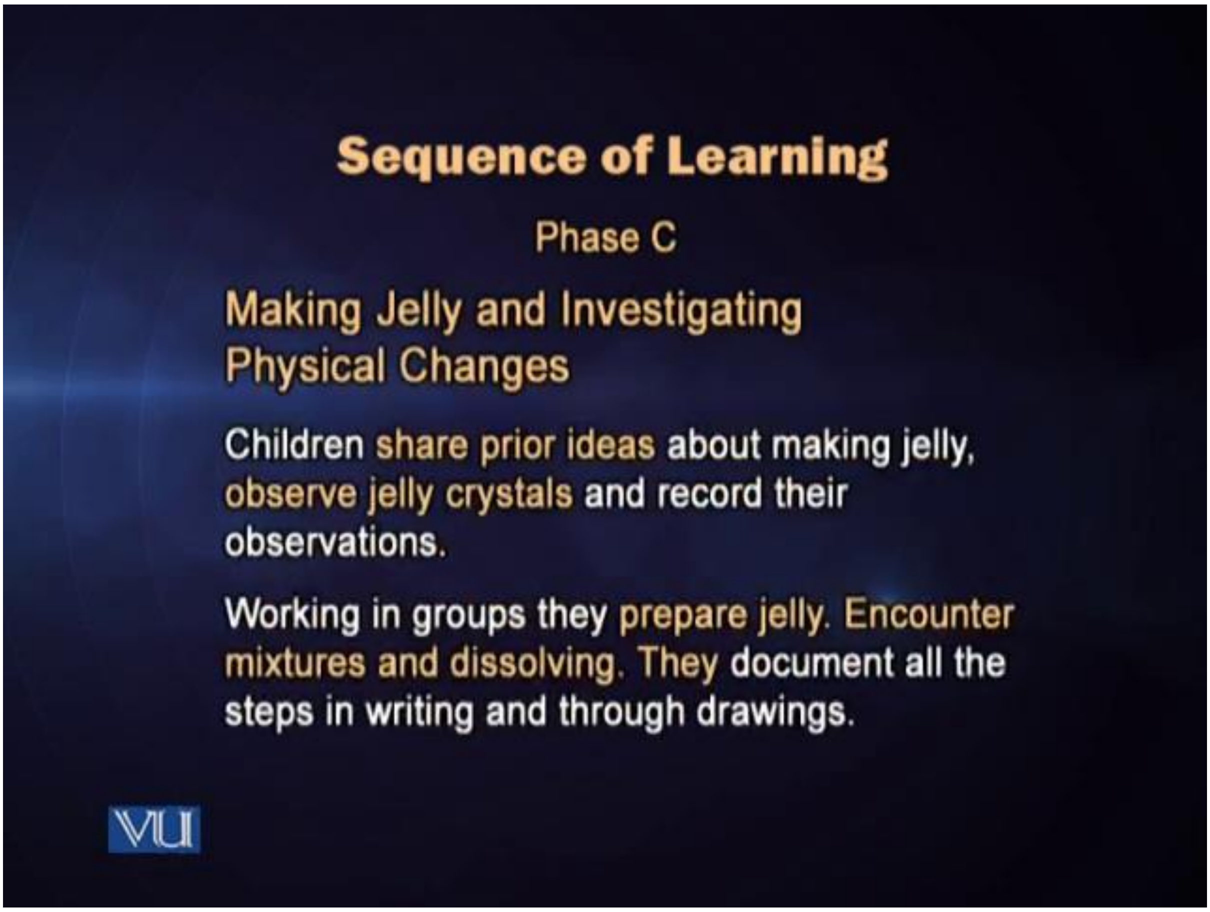

Grade 2 Sequence of Learning for the Unit:
Exploring Properties of Solids and Liquids
Phase A
Understanding and Identifying some Common Properties about Materials and Objects
Children learn to describe commonly available objects and materials. They develop an operational understanding of property by identifying common properties such as colour, shape, size, texture and weight.
VU

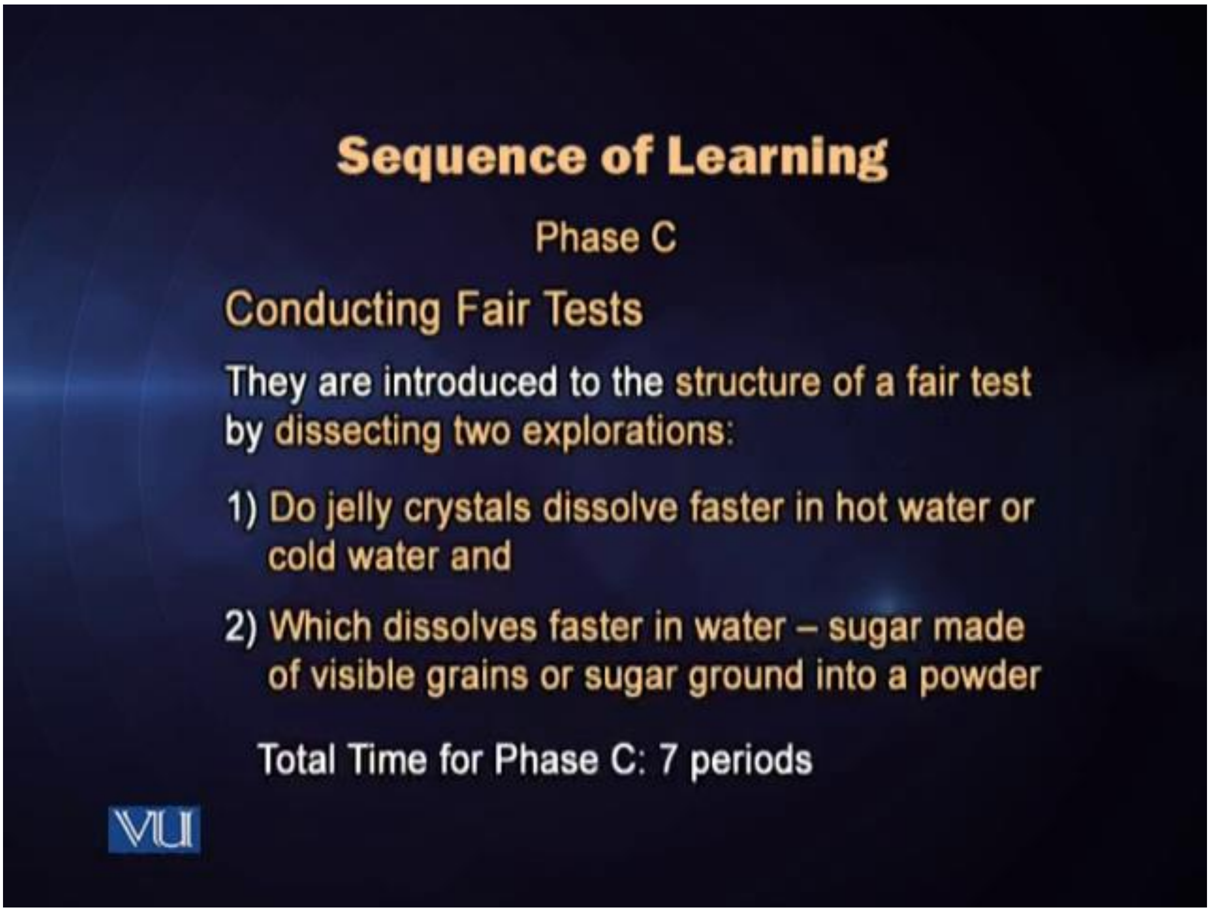

Sequence of Learning
Phase A
Understanding and Identifying some Common Properties about Materials and Objects
They are introduced to a pan balance and weigh objects. They also explore light related properties such as being transparent, translucent and opaque. A property word bank is developed in which words associated with each property are carefully categorised.

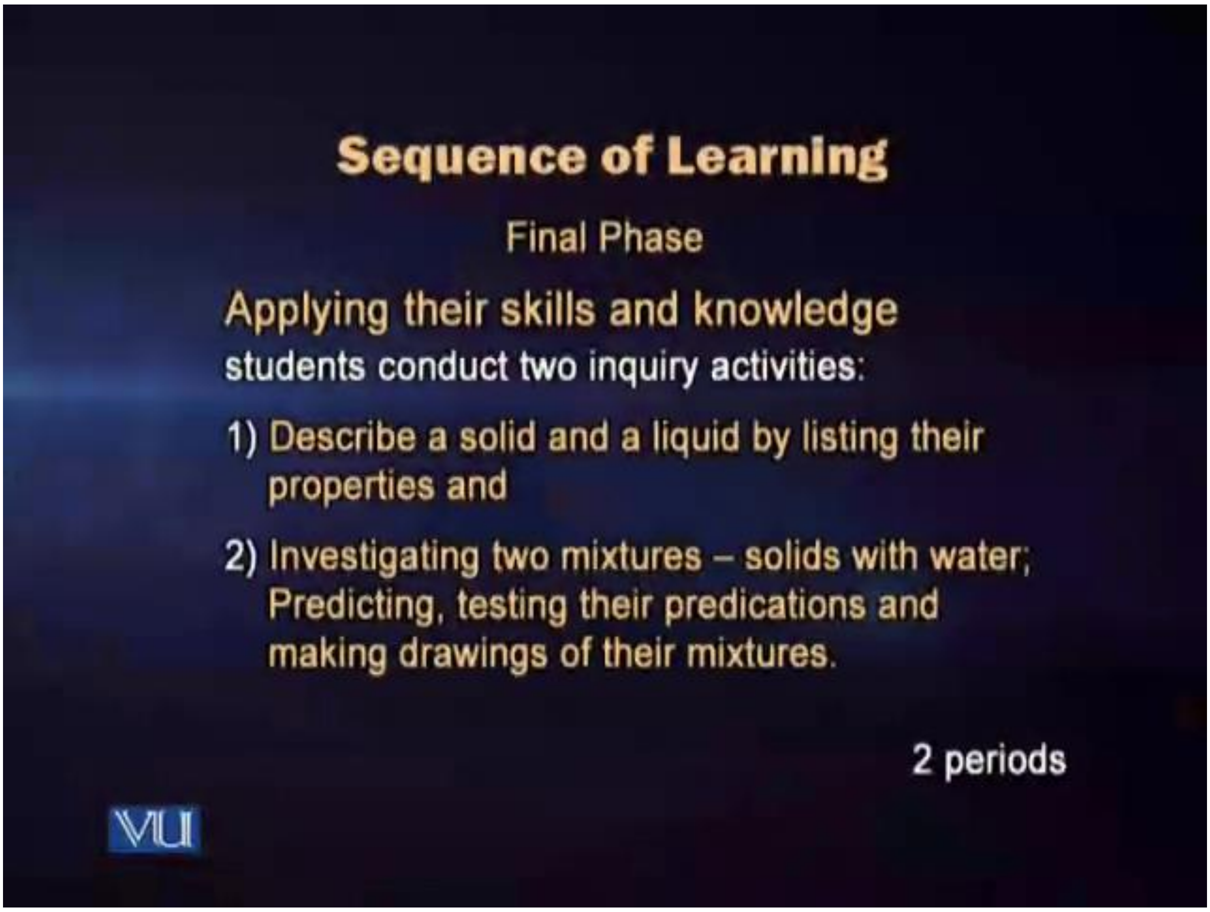

Sequence of Learning
Phase A
Understanding and Identifying some Common Properties about Materials and Objects
Children record their findings in tables, draw pictures and label the salient features and share their ideas with their peers.
Total Time for Phase A: 6 periods

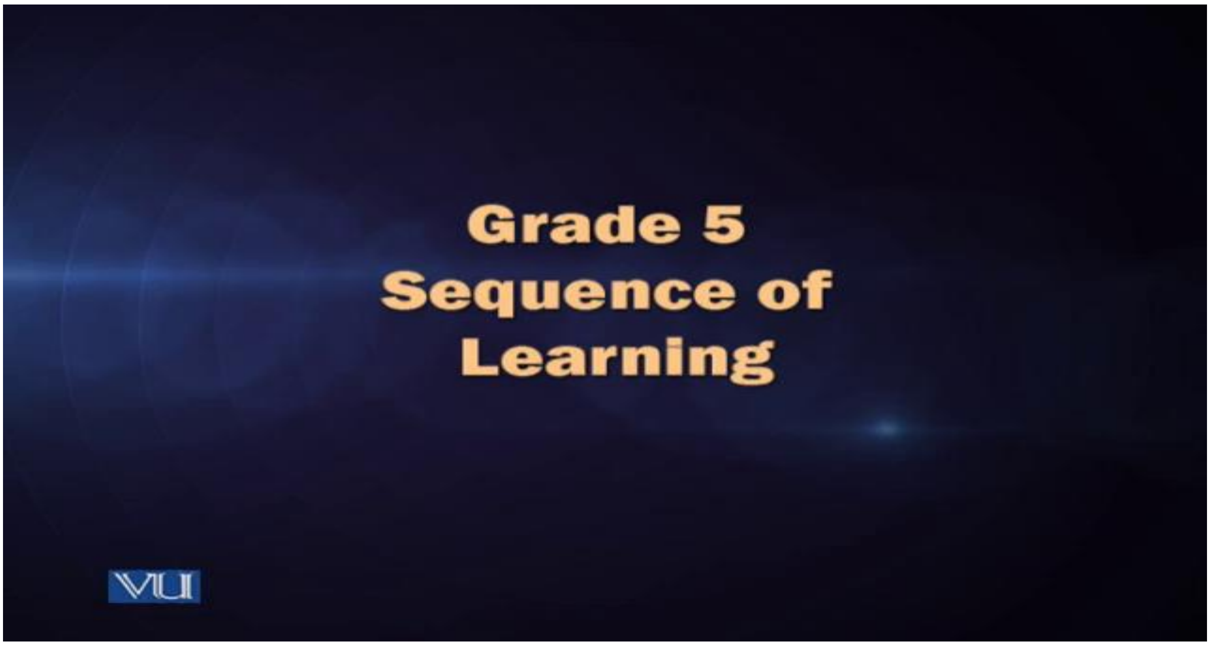

Sequence of Learning
Phase B
Exploring Solids and Liquids
Children compare the characteristics of a wooden block and water and construct beginning understandings of the characteristics of solids and liquids. By inflating and deflating balloons the notion of gases is also explored briefly.
VU

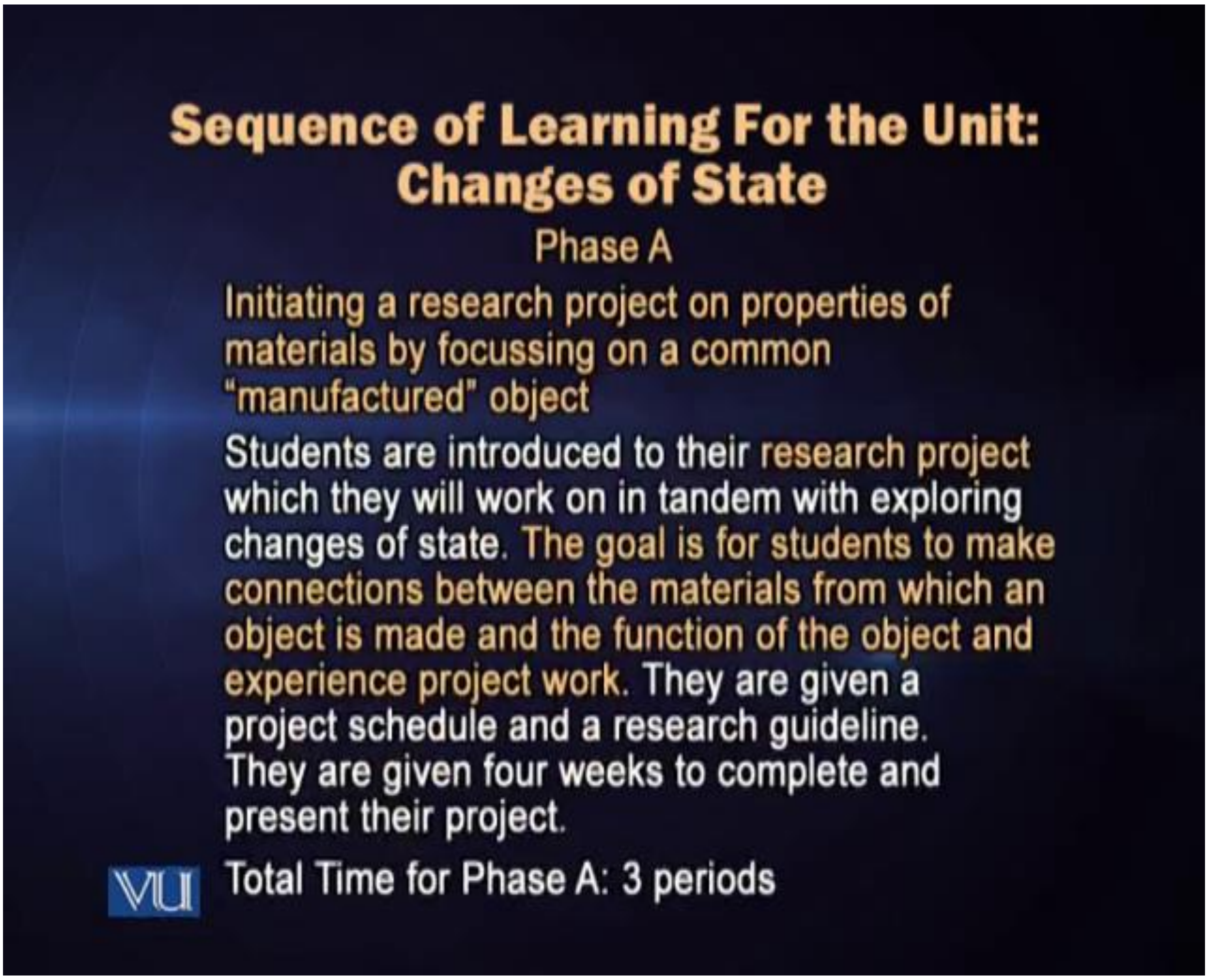

Sequence of Learning
Phase B
Exploring Solids and Liquids
They work with a variety of liquids, identifying their properties and learn to classify them eventually developing classification schemes of their own.
Total Time for Phase B: 3 periods
VU


Sequence of Learning
Phase C
Making Jelly and Investigating Physical Changes
Children share prior ideas about making jelly, observe jelly crystals and record their observations.
Working in groups they prepare jelly. Encounter mixtures and dissolving. They document all the steps in writing and through drawings.
VU


Sequence of Learning
Phase C
Conducting Fair Tests
They are introduced to the structure of a fair test by dissecting two explorations:
1) Do jelly crystals dissolve faster in hot water or cold water and
2) Which dissolves faster in water – sugar made of visible grains or sugar ground into a powder
Total Time for Phase C: 7 periods
VU


Sequence of Learning
Final Phase
Applying their skills and knowledge
students conduct two inquiry activities:
1) Describe a solid and a liquid by listing their properties and
2) Investigating two mixtures – solids with water; Predicting, testing their predications and making drawings of their mixtures.
2 periods
VU


Grade 5
Sequence of
Learning


Sequence of Learning For the Unit:
Changes of State
Phase A
Initiating a research project on properties of materials by focussing on a common "manufactured" object
Students are introduced to their research project which they will work on in tandem with exploring changes of state. The goal is for students to make connections between the materials from which an object is made and the function of the object and experience project work. They are given a project schedule and a research guideline. They are given four weeks to complete and present their project.
Total Time for Phase A: 3 periods

Sequence of Learning

Phase B

Developing Background for Investigating Changes of State

Students are taught how to use thermometers, stopwatches and plot coordinate graphs.

(1) Students understand how liquid in glass thermometers work; are introduced to the Celsius scale and learn to measure temperature

(2) They are introduced to coordinates, plot points and finally plot line graphs using data sets. They learn to interpret graphs.

(3) They are introduced to the digital stopwatch and time simple events.

Total Time for Phase B: 6 periods

Sequence of Learning

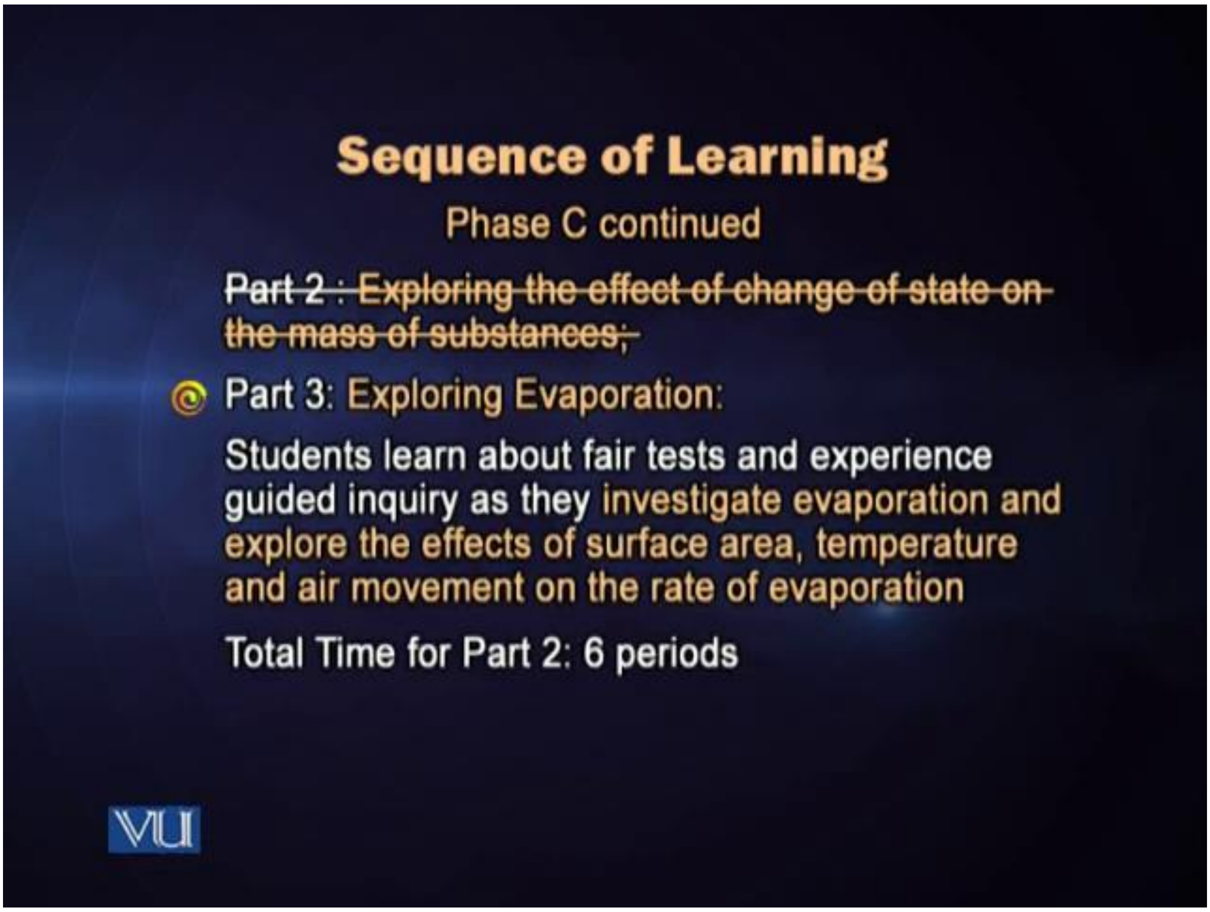
Phase C

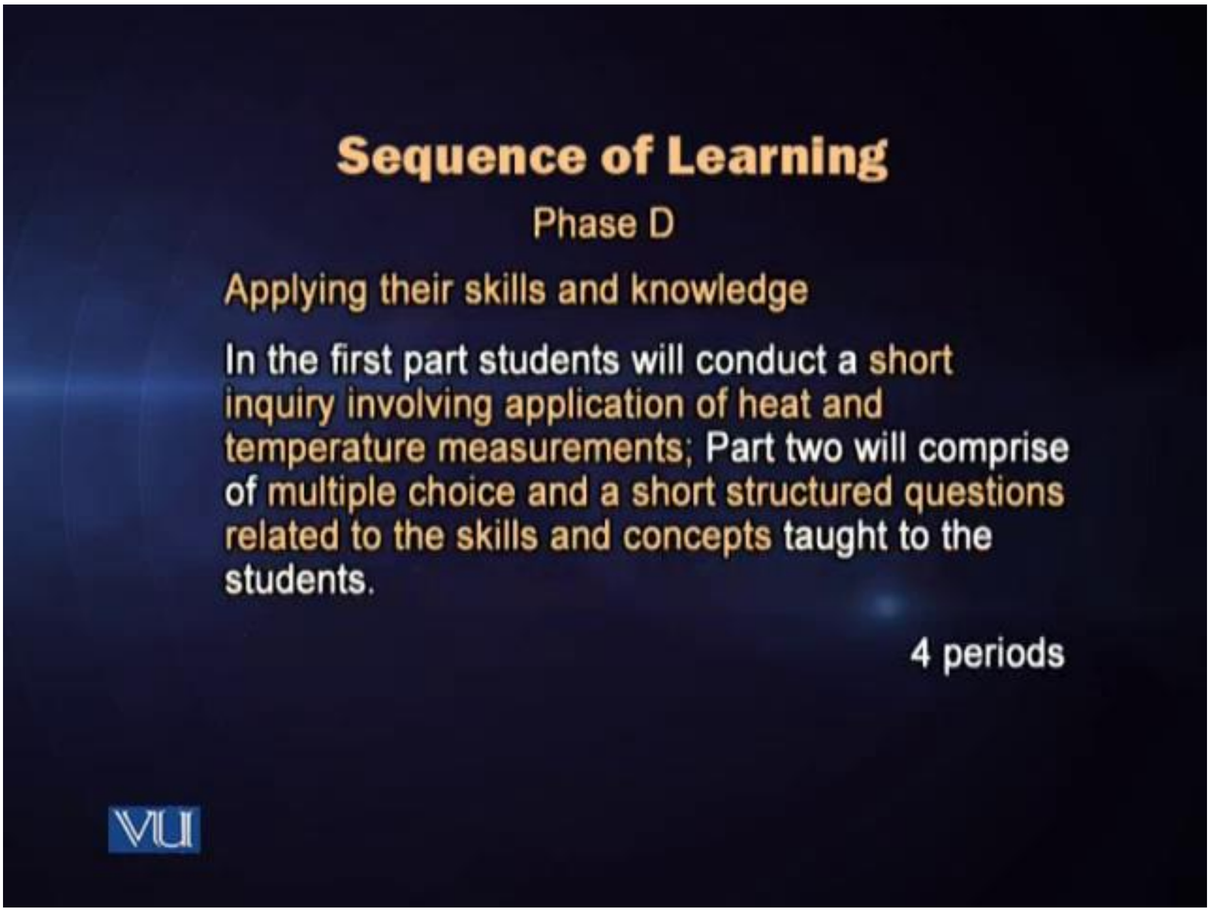
The core concepts of the unit are developed in three stages or parts.

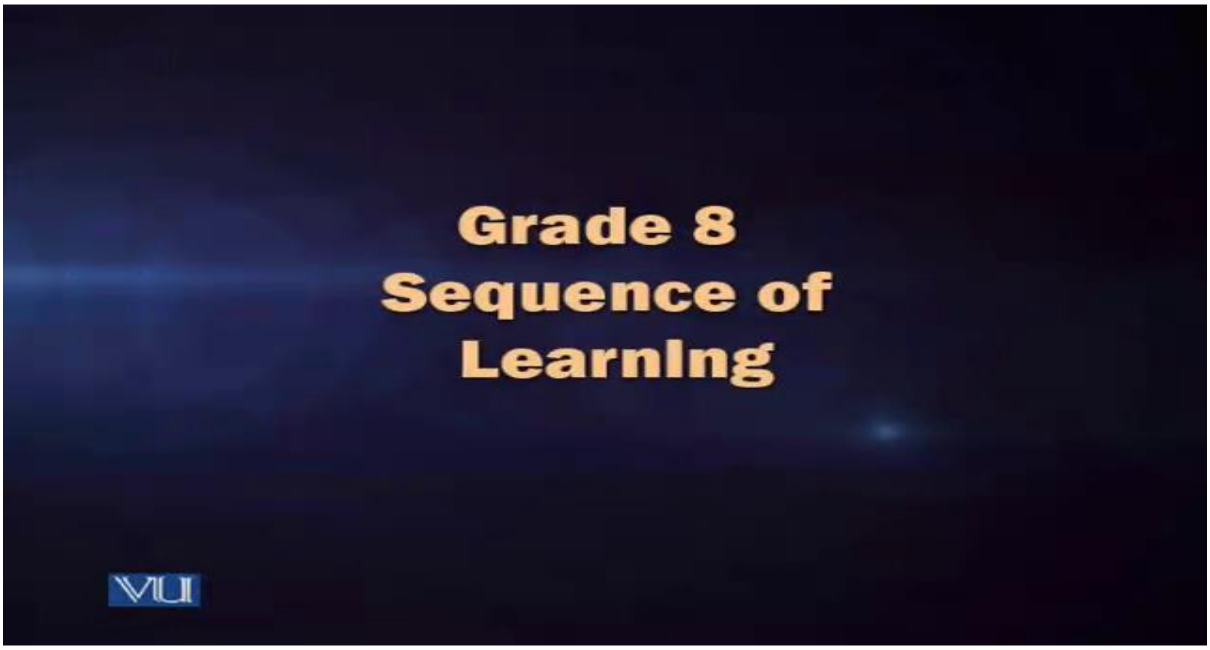
Part 1: Observing Changes of State by Heating Ice;

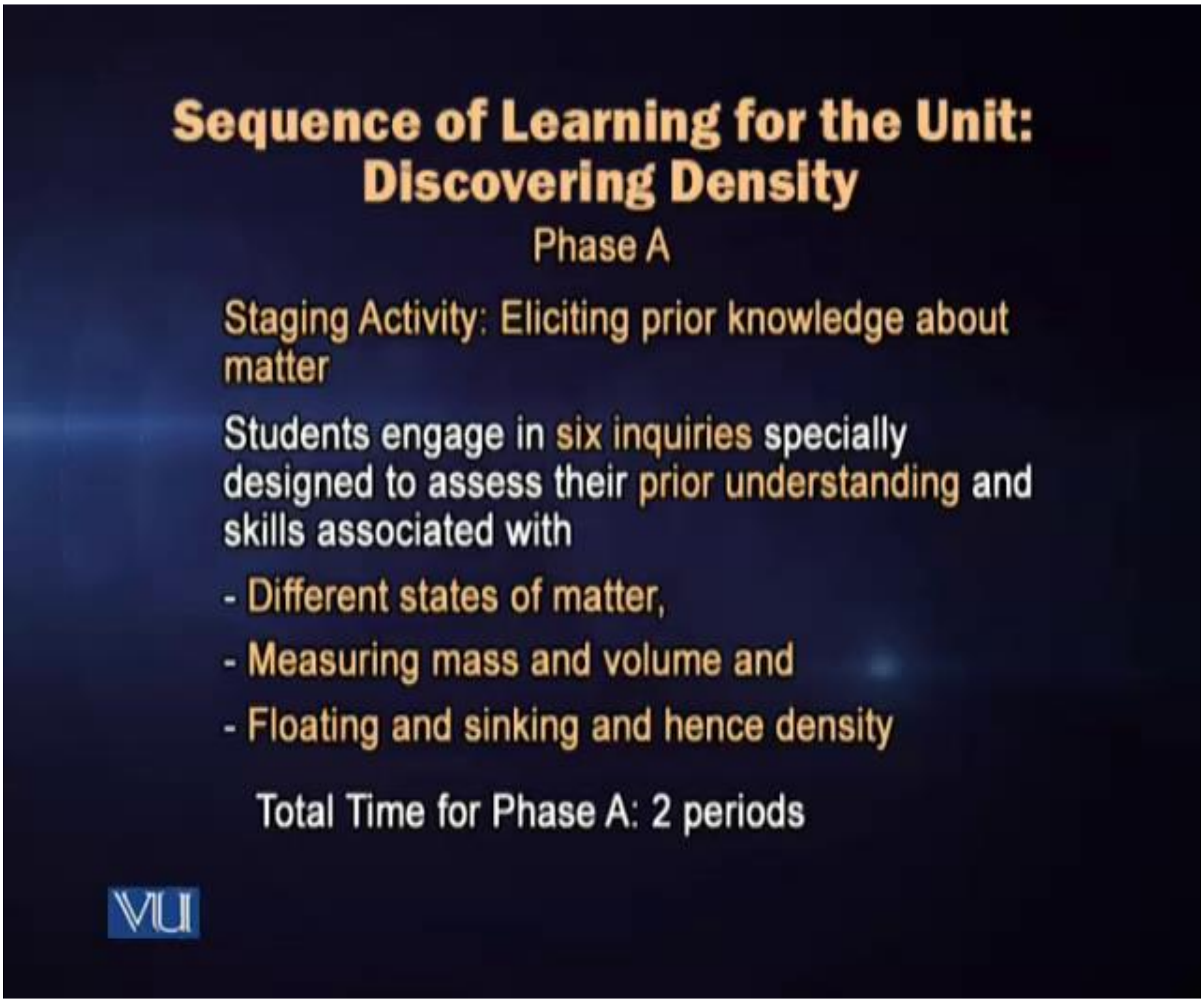
Students discuss what they already know about changes of state; observe changes of state as ice is heated; measure the temperature of ice and water as it is heated; plot a graph of measurements taken and interpret the graph and other observations in terms of changes of state

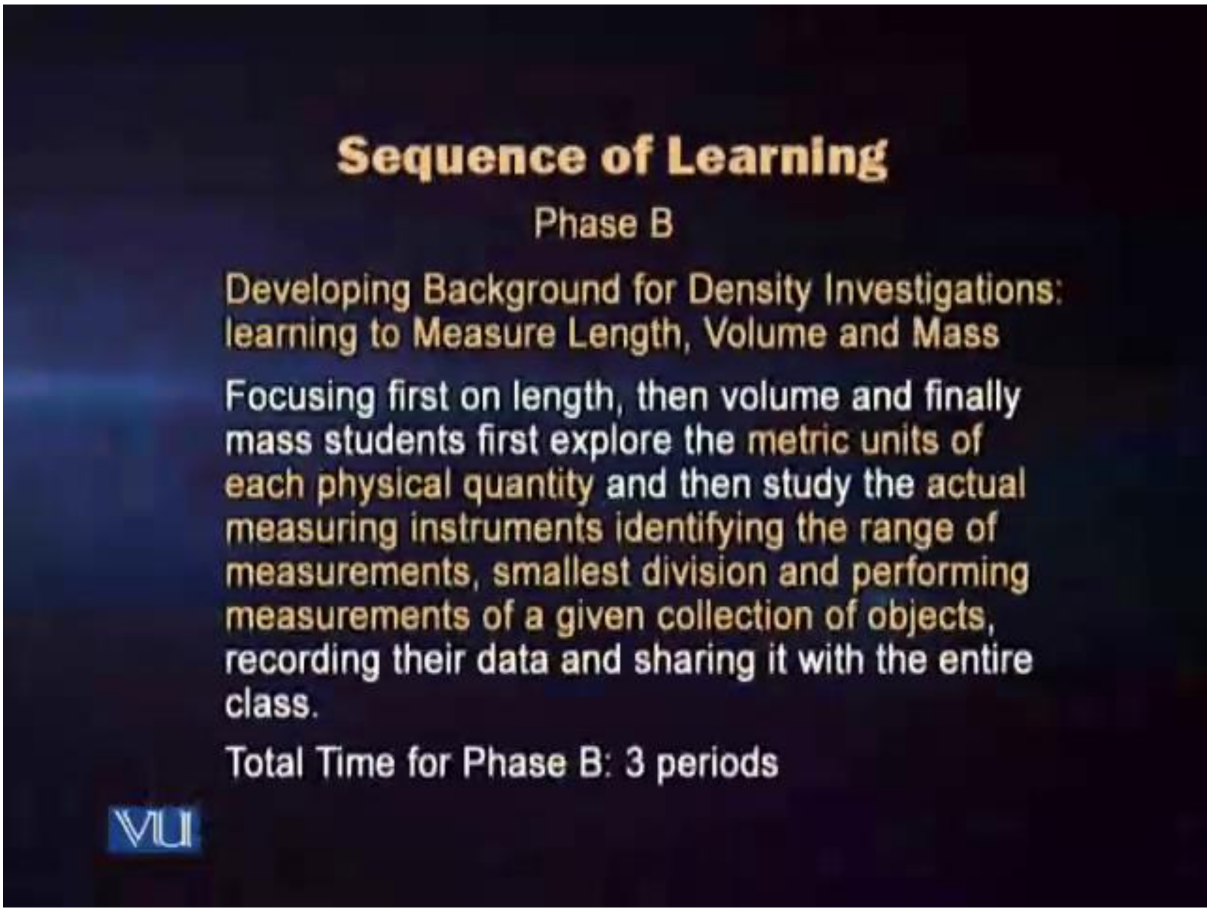
Total Time for Part 1: 4 periods

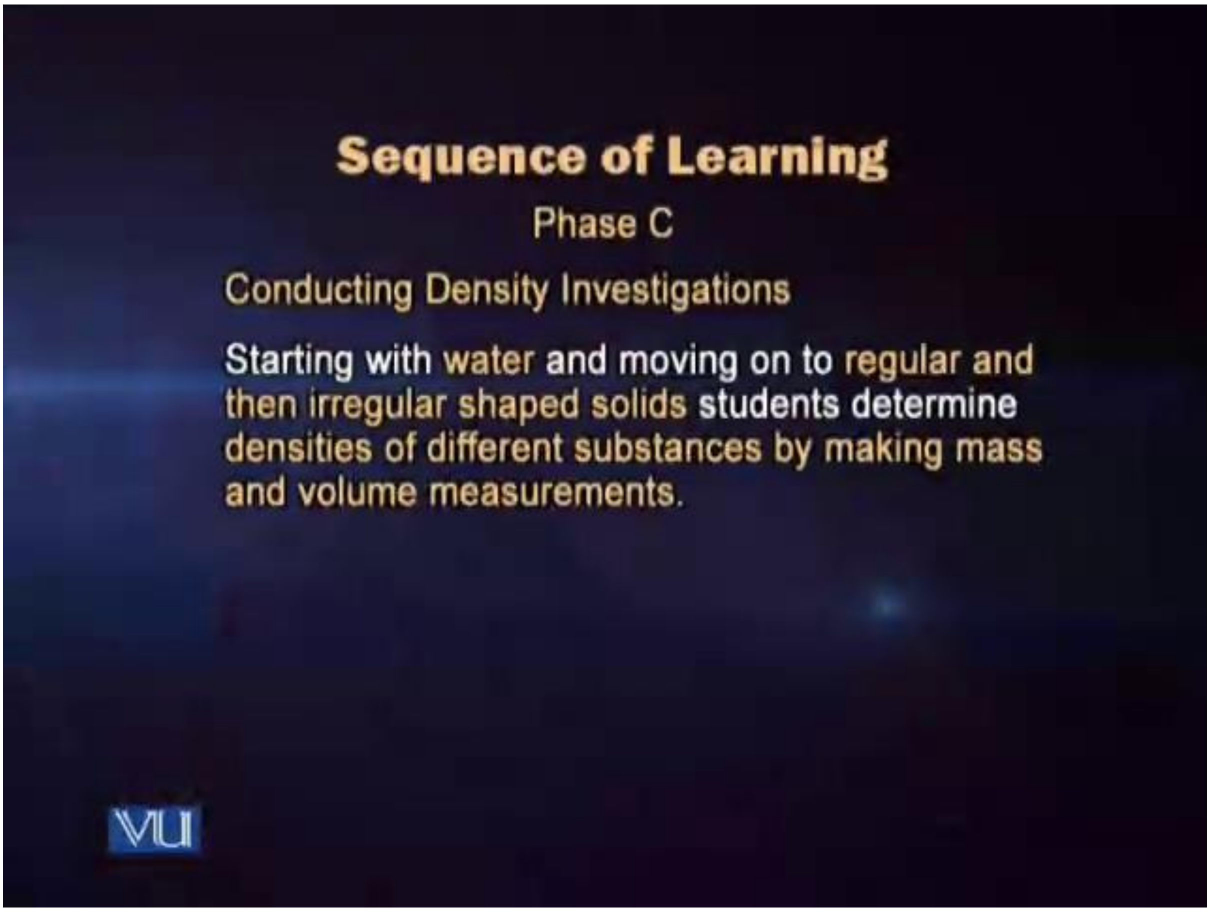

Sequence of Learning
Phase C continued
~~Part 2 : Exploring the effect of change of state on the mass of substances;~~
Part 3: Exploring Evaporation:
Students learn about fair tests and experience guided inquiry as they investigate evaporation and explore the effects of surface area, temperature and air movement on the rate of evaporation
Total Time for Part 2: 6 periods
VU

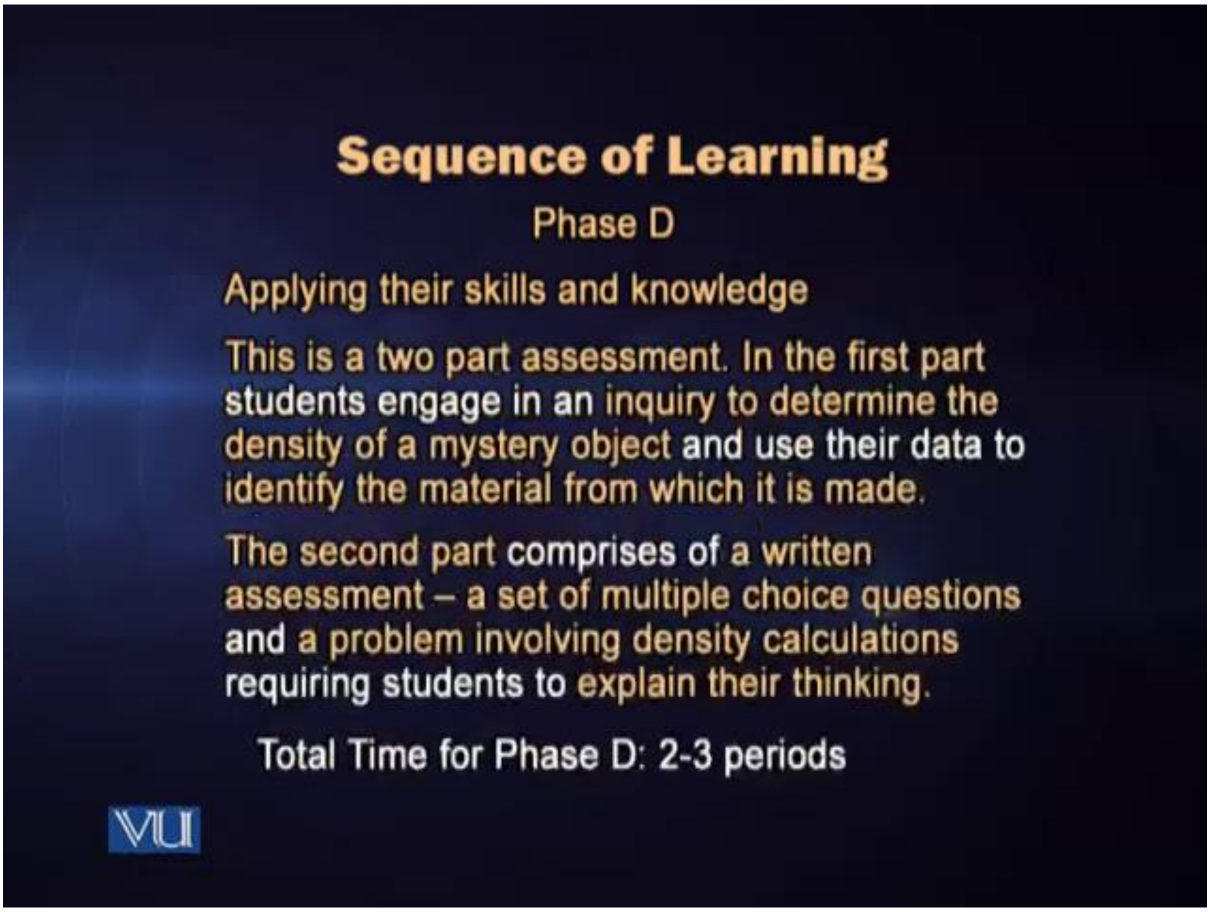

Sequence of Learning
Phase D
Applying their skills and knowledge
In the first part students will conduct a short inquiry involving application of heat and temperature measurements; Part two will comprise of multiple choice and a short structured questions related to the skills and concepts taught to the students.
4 periods
VU

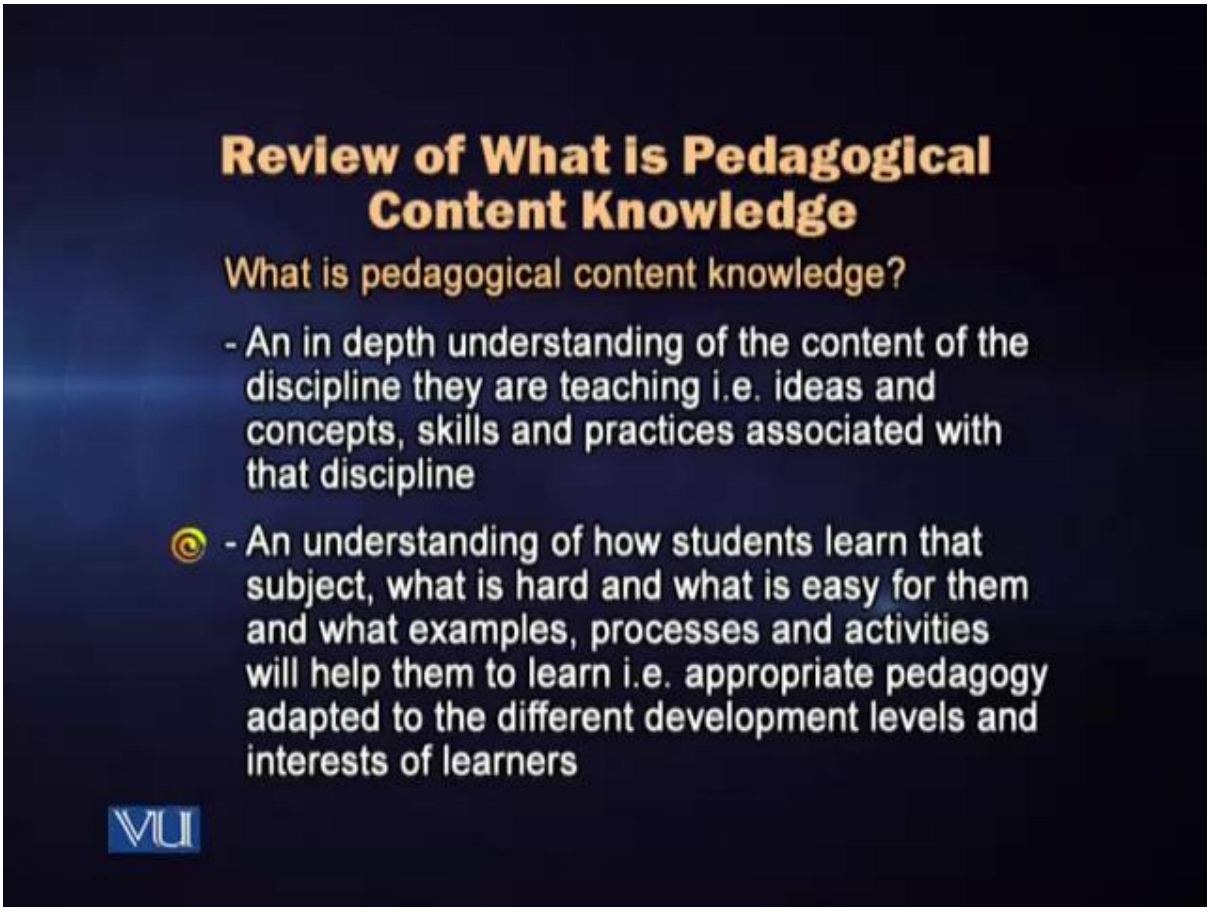

Grade 8
Sequence of
Learning

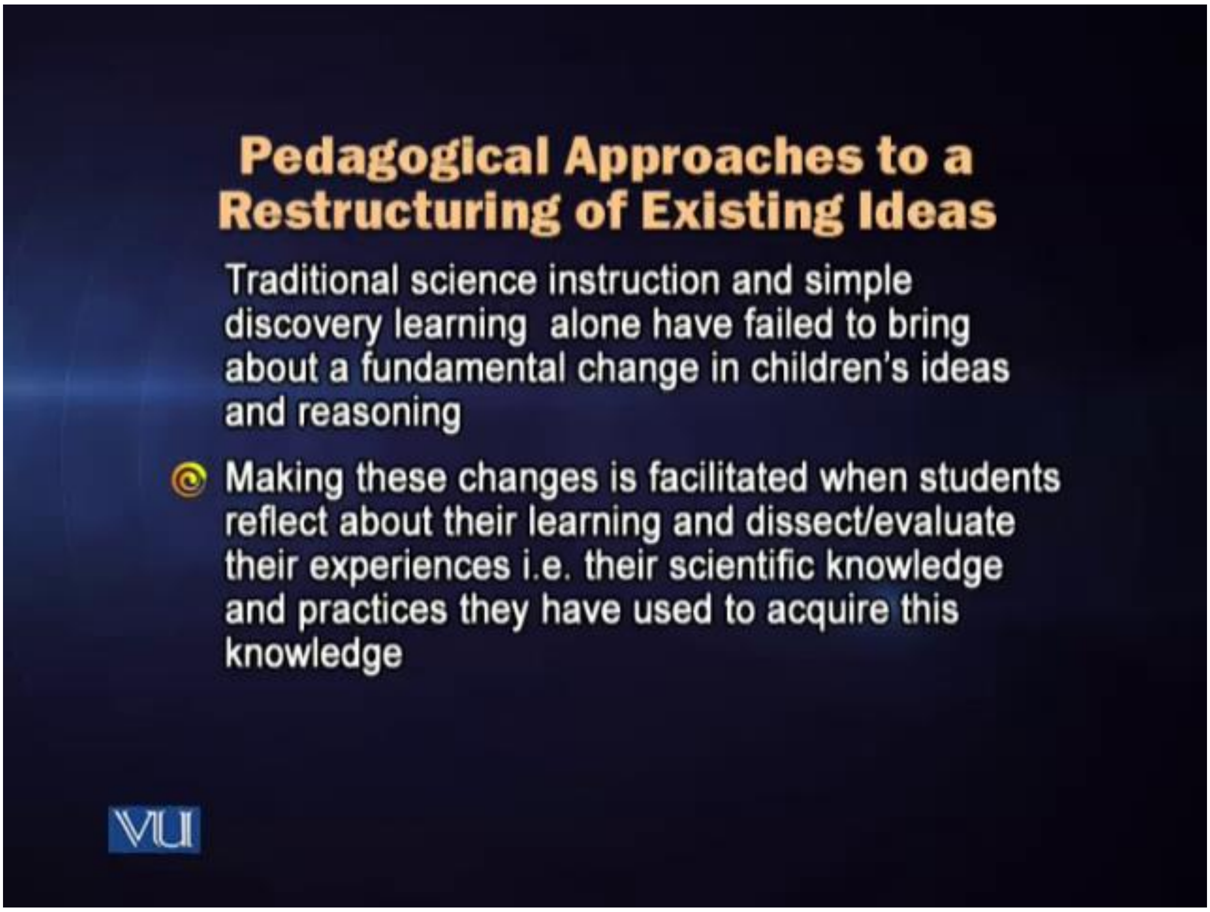

Sequence of Learning for the Unit:
Discovering Density
Phase A
Staging Activity: Eliciting prior knowledge about matter
Students engage in six inquiries specially designed to assess their prior understanding and skills associated with
- Different states of matter,
- Measuring mass and volume and
- Floating and sinking and hence density
Total Time for Phase A: 2 periods

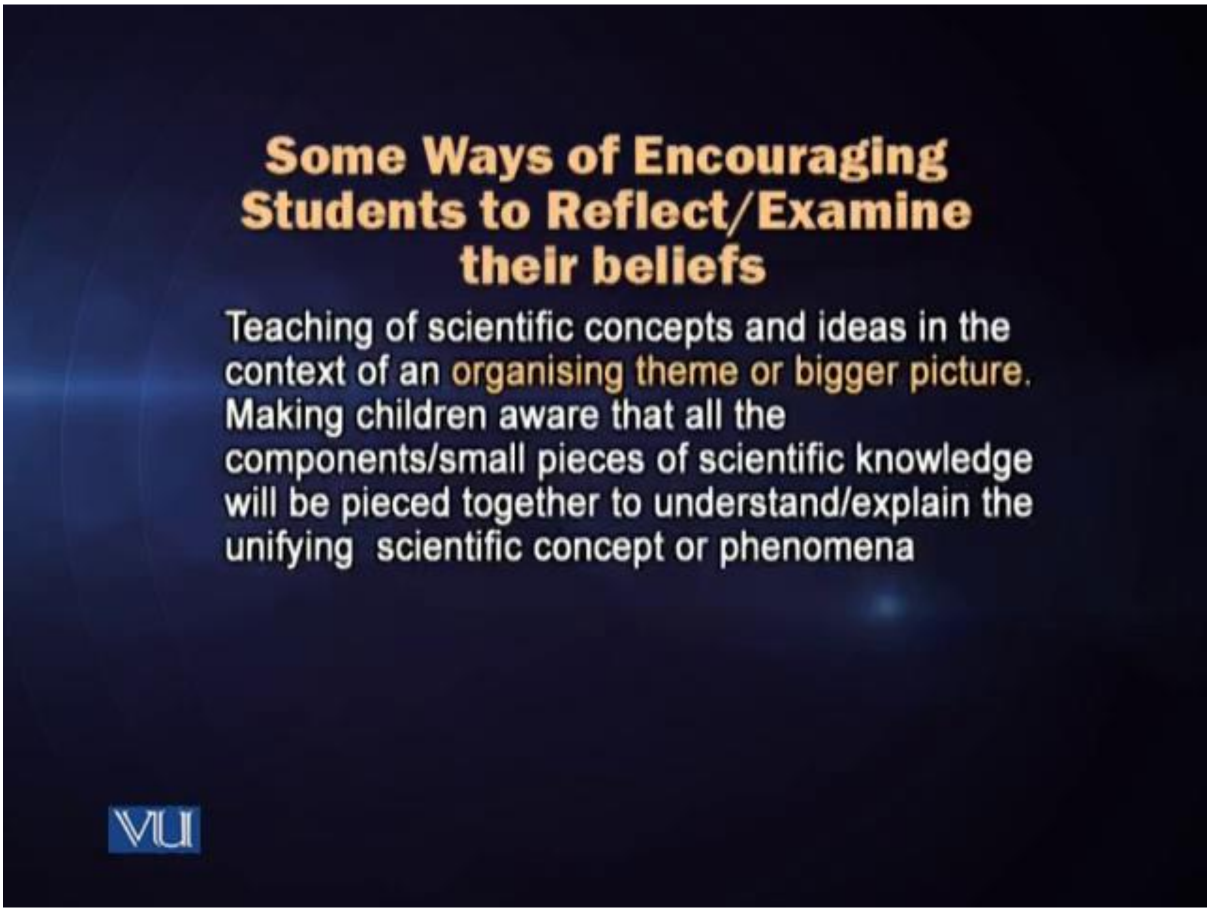

Sequence of Learning
Phase B
Developing Background for Density Investigations: learning to Measure Length, Volume and Mass
Focusing first on length, then volume and finally mass students first explore the metric units of each physical quantity and then study the actual measuring instruments identifying the range of measurements, smallest division and performing measurements of a given collection of objects, recording their data and sharing it with the entire class.
Total Time for Phase B: 3 periods
VU

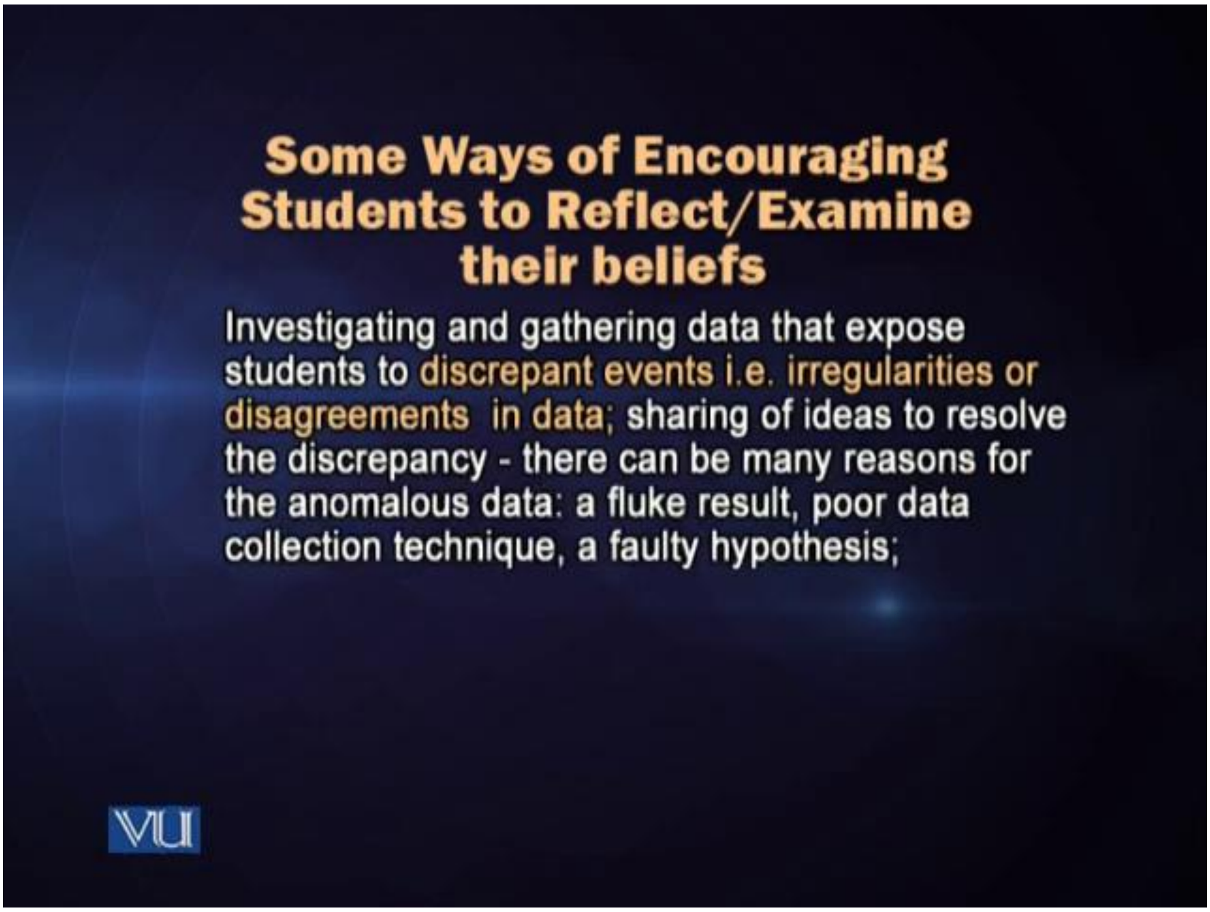

Sequence of Learning
Phase C
Conducting Density Investigations
Starting with water and moving on to regular and then irregular shaped solids students determine densities of different substances by making mass and volume measurements.
VU

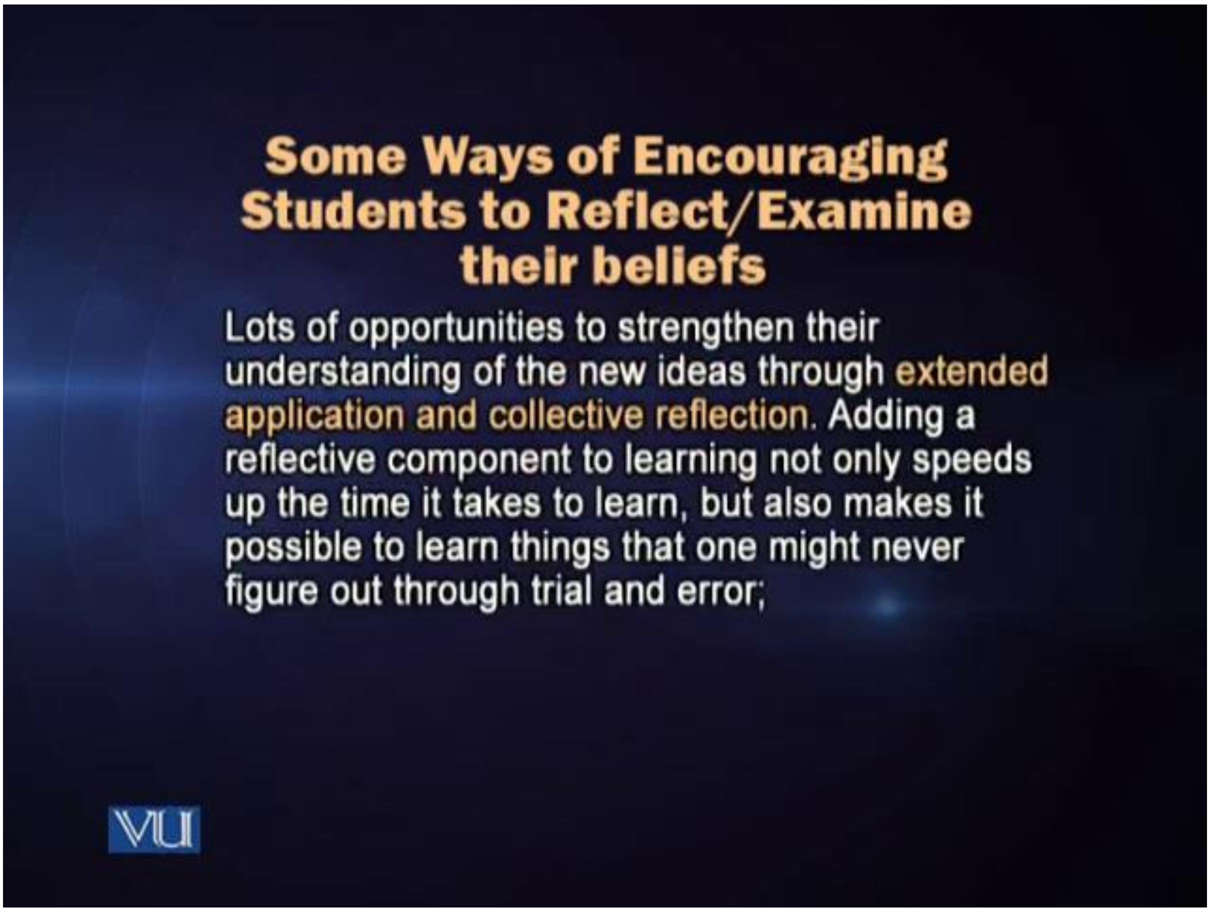

Sequence of Learning
Phase D
Applying their skills and knowledge
This is a two part assessment. In the first part students engage in an inquiry to determine the density of a mystery object and use their data to identify the material from which it is made.
The second part comprises of a written assessment – a set of multiple choice questions and a problem involving density calculations requiring students to explain their thinking.
Total Time for Phase D: 2-3 periods
VU


Review of What is Pedagogical Content Knowledge
What is pedagogical content knowledge?
- An in depth understanding of the content of the discipline they are teaching i.e. ideas and concepts, skills and practices associated with that discipline
- An understanding of how students learn that subject, what is hard and what is easy for them and what examples, processes and activities will help them to learn i.e. appropriate pedagogy adapted to the different development levels and interests of learners
VU


Pedagogical Approaches to a Restructuring of Existing Ideas
Traditional science instruction and simple discovery learning alone have failed to bring about a fundamental change in children's ideas and reasoning
Making these changes is facilitated when students reflect about their learning and dissect/evaluate their experiences i.e. their scientific knowledge and practices they have used to acquire this knowledge
VU


Some Ways of Encouraging Students to Reflect/Examine their beliefs
Teaching of scientific concepts and ideas in the context of an organising theme or bigger picture.
Making children aware that all the components/small pieces of scientific knowledge will be pieced together to understand/explain the unifying scientific concept or phenomena
VU


Some Ways of Encouraging Students to Reflect/Examine their beliefs
Investigating and gathering data that expose students to discrepant events i.e. irregularities or disagreements in data; sharing of ideas to resolve the discrepancy - there can be many reasons for the anomalous data: a fluke result, poor data collection technique, a faulty hypothesis;
VU

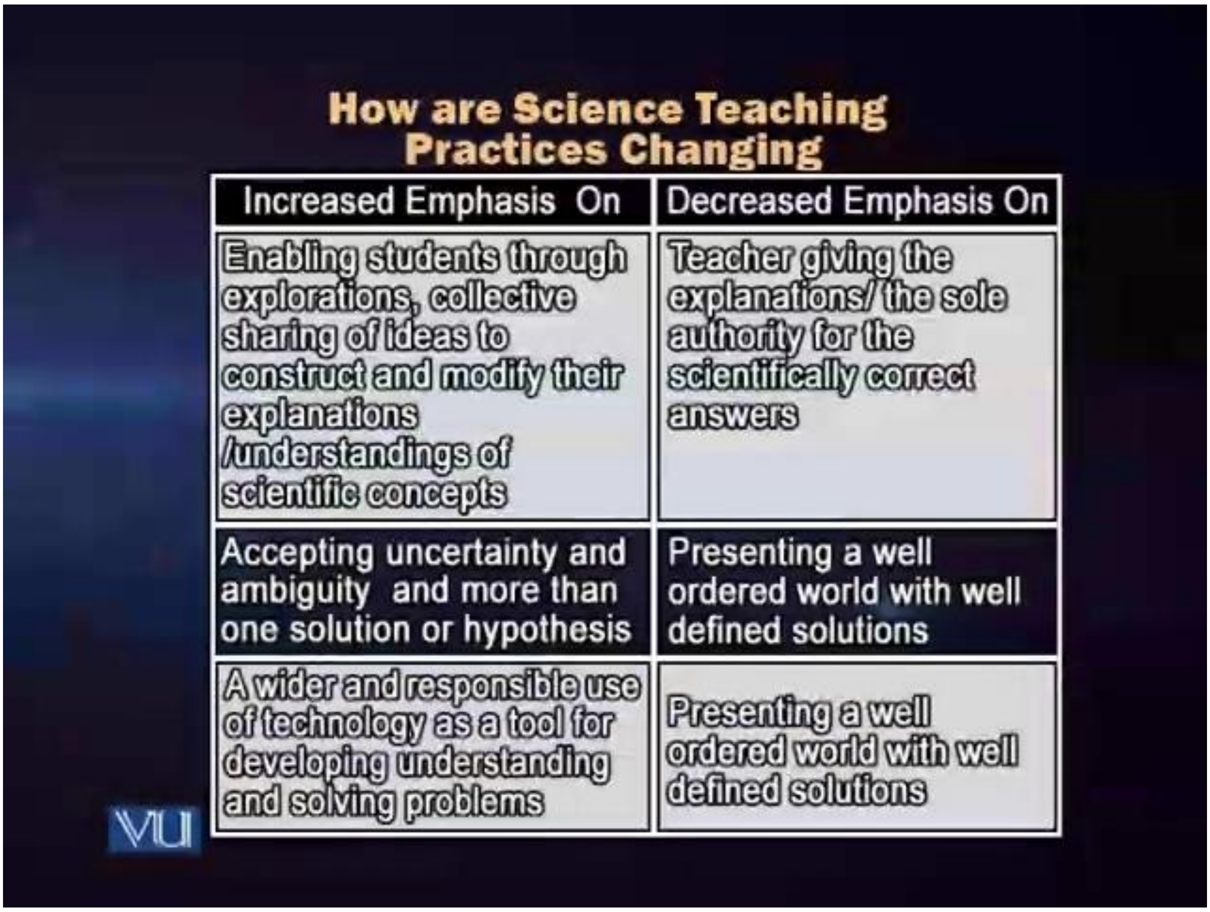

Some Ways of Encouraging Students to Reflect/Examine their beliefs
Lots of opportunities to strengthen their understanding of the new ideas through extended application and collective reflection. Adding a reflective component to learning not only speeds up the time it takes to learn, but also makes it possible to learn things that one might never figure out through trial and error;
VU

How are Science Teaching Practices Changing

Increased emphasis on	Decreased emphasis on
Eliciting students prior knowledge and designing instruction based on students ideas	using written curriculum to inform instruction only
Instruction that recognises that science is explanations/understandings about the physical and natural world and the practices/processes that enable scientists to acquire these understandings	Instruction that recognises science as a collection of facts about the physical and natural world

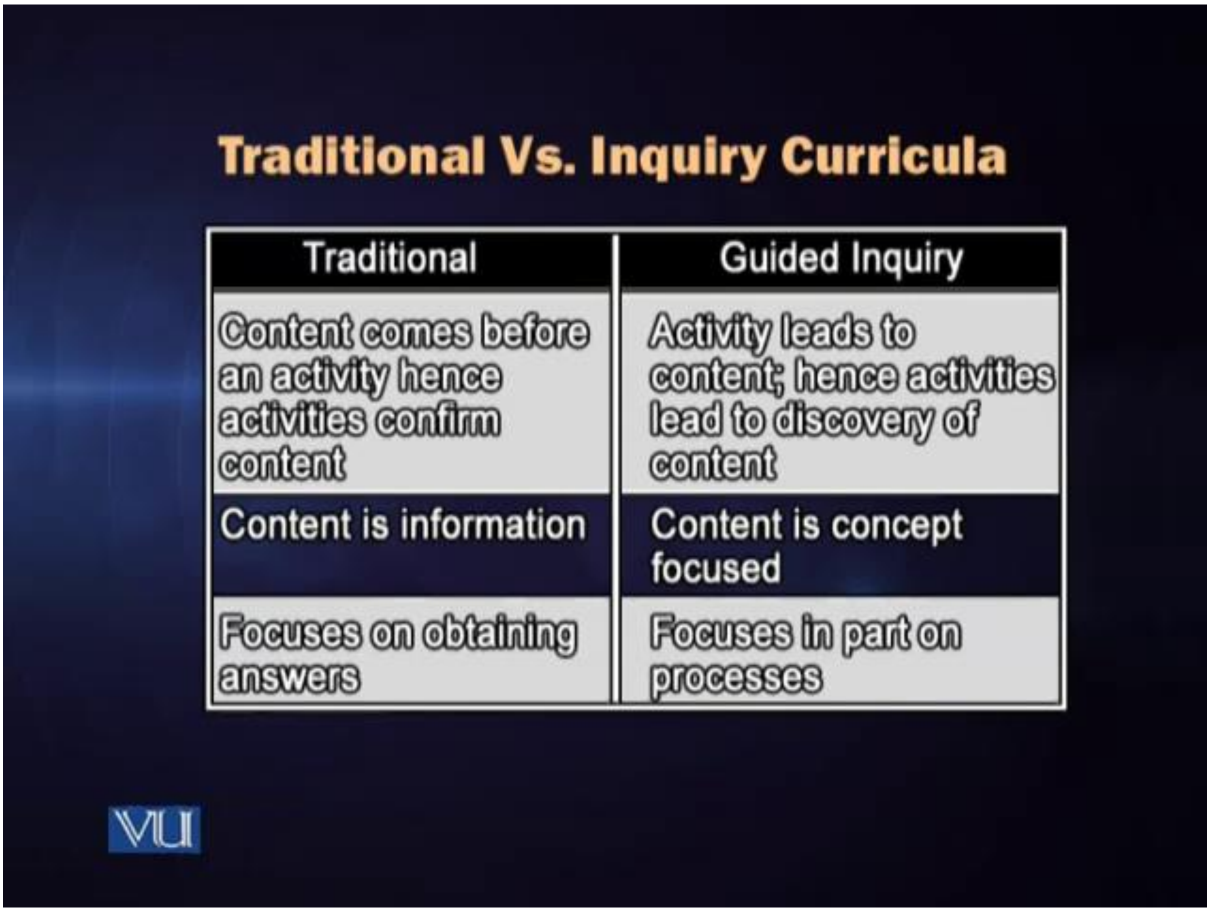
How are Science Teaching Practices Changing

Increased emphasis on	Decreased emphasis on
Inquiry as the context of learning/anchoring to immediate world; Providing opportunities for hands-on-learning to ensure that students experience the practices/processes skills of science	Textbook as the context of learning; Teacher demonstrations and strict adherence to teacher defined and controlled activities



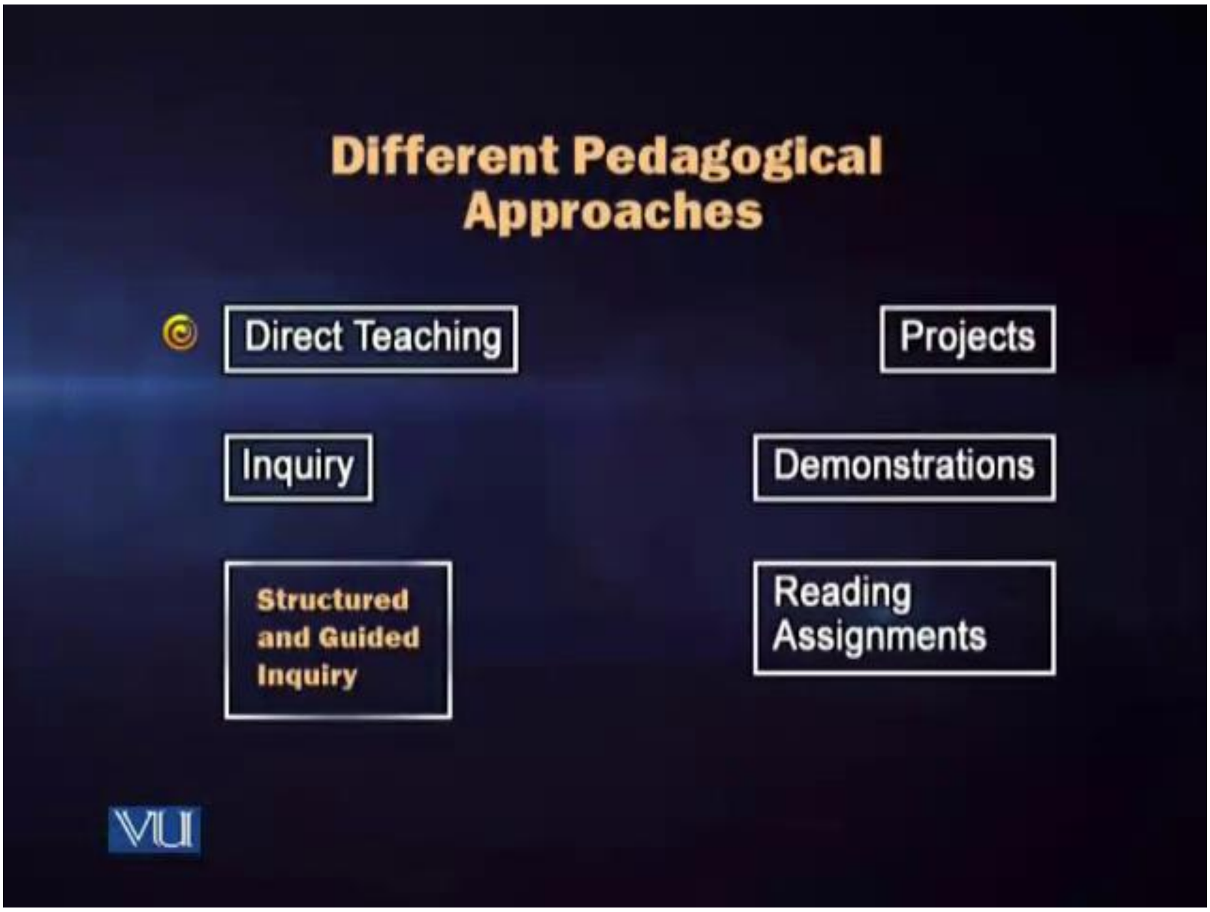
How are Science Teaching Practices Changing

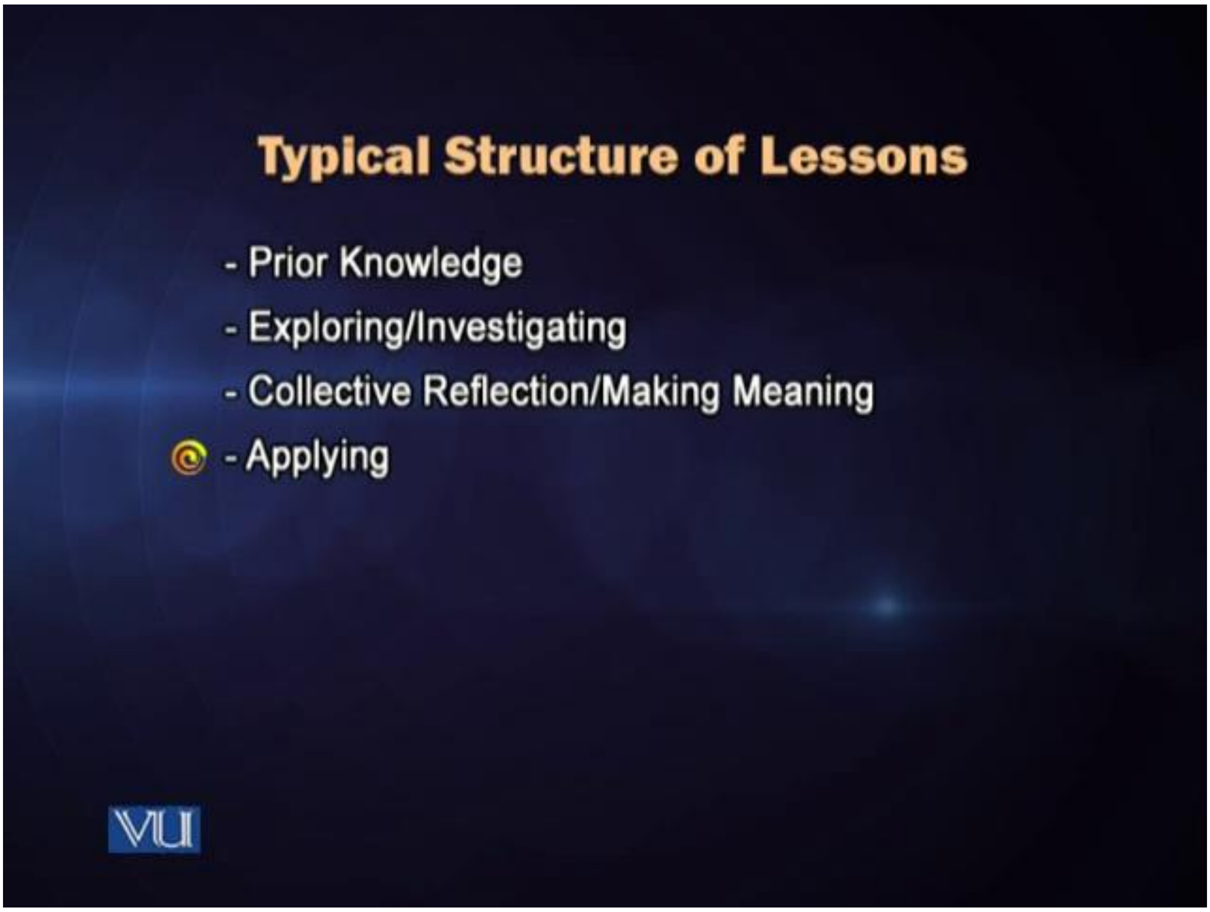
Increased Emphasis On	Decreased Emphasis On
Enabling students through explorations, collective sharing of ideas to construct and modify their explanations /understandings of scientific concepts	Teacher giving the explanations/ the sole authority for the scientifically correct answers
Accepting uncertainty and ambiguity and more than one solution or hypothesis	Presenting a well ordered world with well defined solutions
A wider and responsible use of technology as a tool for developing understanding and solving problems	Presenting a well ordered world with well defined solutions

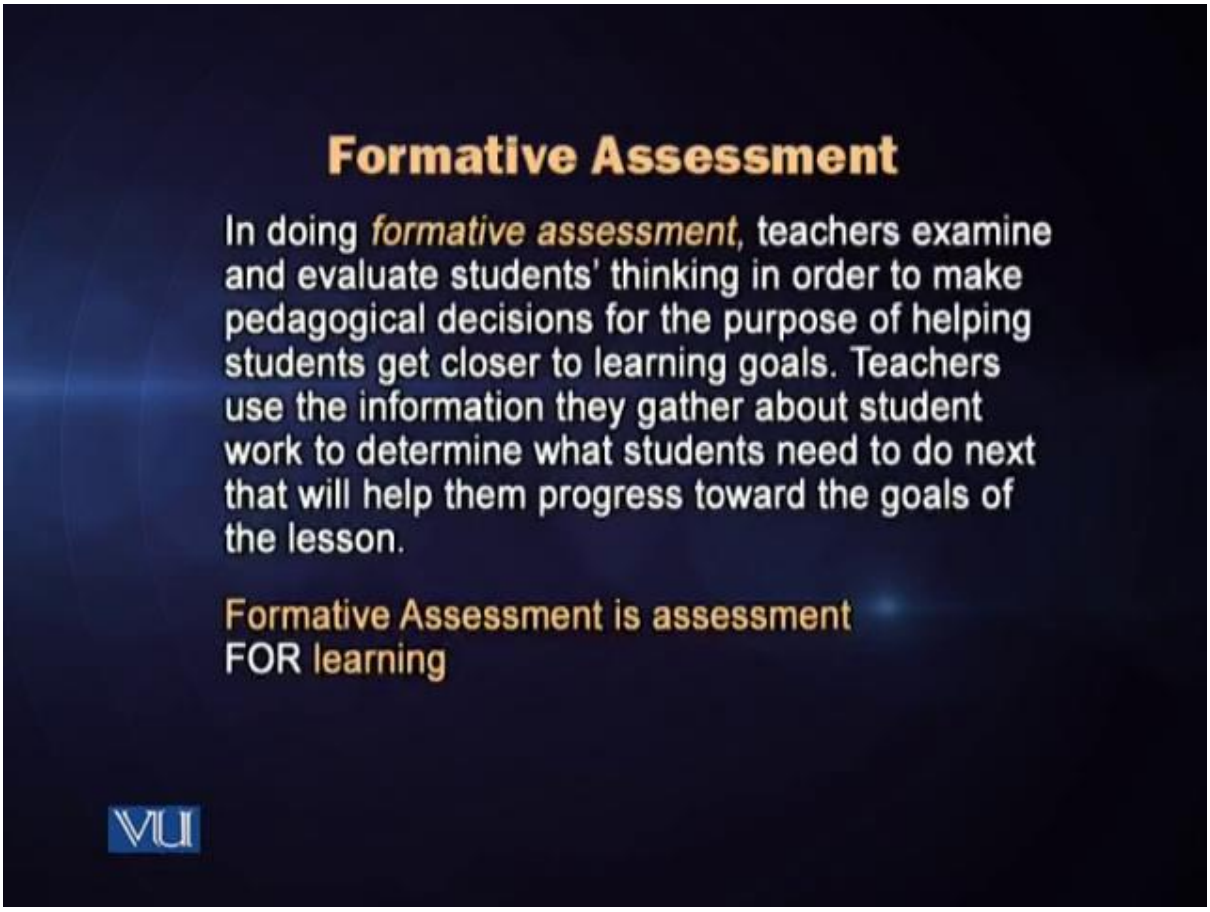


Traditional Vs. Inquiry Curricula

Traditional	Guided Inquiry
Content comes before an activity hence activities confirm content	Activity leads to content; hence activities lead to discovery of content
Content is information	Content is concept focused
Focuses on obtaining answers	Focuses in part on processes


Different Pedagogical Approaches
Direct Teaching
Projects
Inquiry
Demonstrations
Structured and Guided Inquiry
Reading Assignments


Typical Structure of Lessons
- Prior Knowledge
- Exploring/Investigating
- Collective Reflection/Making Meaning
- Applying


Formative Assessment
In doing formative assessment, teachers examine and evaluate students' thinking in order to make pedagogical decisions for the purpose of helping students get closer to learning goals. Teachers use the information they gather about student work to determine what students need to do next that will help them progress toward the goals of the lesson.
Formative Assessment is assessment FOR learning