



Virtual University of Pakistan
FEDERAL GOVERNMENT UNIVERSITY

COURSE HANDOUTS

Teaching of General Science

GSC201

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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: Content— "steps" in the process of learning, the process of learning.
- 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 provide an overview of the course, the importance of Pedagogical Content Knowledge (PCK) and its role in teaching science.

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.
- Content— "steps" in the process of learning, the process of learning 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.
- Content— "steps" in the process of learning, the process of learning 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

- **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

Q'x-r• st " st— ",tut r x'—"—wt" p "u" wt x," —z— •ts vt 3U ".,t" "tr xwp• " 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.
- f t'p• ""tprw" r x—ft ""x-r,t p t" wt"— qt,,"u" r x—xwp• "xt,p t "ps •ts 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?

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drawing.

Now light the candle.

R x " 'x x 7h x " " " " " " " "

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:

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:

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 from 1. 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.

Interpreting

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

Process skills/Practices

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. Hypothesizing:

When hypothesizing, learners are:

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

4. Predicting:

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 hypothesis.

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.

Planning and investigating:

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. Interpreting:

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, looking for patterns or trends in the data and making sense of the data in 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.

I x z''' 'Q " " 'g 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.

ctprwt,, "tts " "qt"p p,t "u'rws,,t— " ,x' , " , "t x x-v'xtp l' "u' wt "tp,,-x-v'v"p• "p-s" wt " 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 rws,,t— "x— xx t" —st,, p-sx-v "r—,psx " r x—xw"t "p-p x'—"p-s" wt t"rp—" t"p "p—" 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 studen "x-xp" —st,, p-sx-v"u' wx "r—"ft" .

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 u —sp- t—p",t x x'—" "rws,,t— "x-xp" ,, r ,t3

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 p"u -sp- t-p"rwp-vt "x-rws,t- "st p "p-s",tp -x-v3Upzx-v" wt t "rwp-vt "x"upr xpt s" 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 • t 3c t prwt,, ", "x " wp " 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 t prwt,, ", "x " 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 based on 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

Teacher should encourage children to form and discuss their own questions. This can be done by putting "p" ' t x-"q"p,s "x"-w'r•p ,,"- " "- w'r w'r w's,t—"w" •s'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 develop a 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 inquiries. 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

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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

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 on 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 your skills before you enter the classroom

You must have sufficient knowledge about the content of lecture.

4) **Q “ ” “”x :**

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

I • “” „ “” t pr w" wt "r “-ft” "p " wt " st — "t t •“u"t p,, -x v3

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 chart 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.

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:

At the end teacher compare all her objects with the things around the students in the class and also with her chart of shapes3I ut,," st—" "q t,, p x—"t prwt,,vp t "wt—" "z wt " " analyze their individual understanding.

Lecture No 8

Exploring " " " "n eight

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

- In this lesson students observed the objects primarily using their sense of sight.
- Students categorized materials as opaque, translucent or transparent.
- Students participated in a collective discussion, share ideas, listen to others, agree and disagree.
- Students recorded their findings in a table.
- Students developed an interest and enthusiasm for exploring and investigating properties of materials and objects.
- 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 then 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 p z x-v'pq" " wt "q" r z "r" "p-s" wp"t. 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.

Then 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 properties 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 flowed 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. c “ux-s” “ wt "tp,-t,, "xtp "p " wt " p,, "u"p"“”x"x "p• “p”p,, "u"p t - t—3
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 asse - t—" wt—" t"t p- x-t"r wæs,,t— "tp,-x-v"v“p• "s „x-v" instruction and ask ourselves, are we attaining our learning goals? If that is not happening wp " w“ •s" t"s“““prwt t " w“ t"tp,-x-v"v“p• "- wp "p,t "r wæs,,t— "stt"" -st,, p-sx-v" 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 t p- x-t"r wp-vx-v" wt "t prwx-v"p"",,“prwt "“stt”t—r wæs,,t— " -st,, p-sx-v3

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 assess 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

Q" “q t,, x-v " zx•" t pr wt,, p t " wp B'

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?

Q" r“— — —xp x-v " zx•" t pr wt,, p t " wp "

Do the students:

1. Talk freely about their activities and the ideas 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 educa “,, ” 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 these 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 dimensions “—p•” wp”t “p-s”st ux-t” wt x,”,, “”t,, x 3c t pr wt,, “p t t s” wt “ st — ”,, x“,, 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:

c t pr wt,, t ut,, t s ““” wt “ wp”t “r wp,, “ wxw” wt “wps” — pst “ú“,, “ st — “ —st,, p-sx-v “u” wt “ shapes. She had put the chart on the board. Then 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:

ctprwt,,p zts",tut r x t" t x"—" rw'p " – pzt'p'r w'xt" which shape does your cleaning
 "ps",t t– q•t G " wt 'p• "" p•zts'pq“ " wt 'saut,,t–rt"qt t t n 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 sharin 'z “ ” ” ”“”x 'xy ”

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 two "What's your idea?" and "What's your question?"

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 p " ts"q " wt" rx—x 3ctprwt,,t ts"wt" st— ",x,,xstp "pq" 'yt• 'q 'p zx-v, 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

Making jelly, observing and recording different stages of jelly

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 spreads and 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 for 16 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 observe the change in the state of matter when a solid (jelly powder) is added to a liquid (hot water). The students will observe that the solid disappears and the liquid becomes a new state (jelly). The students will also observe the change in 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

- I •" w' r " "u", t" p, t s " y t • " x w' w' r w s, t — " p— t " —" w t — " t, t " p z t —" " "u" w t " fridge just before the lesson.
- c w' r w p,, " t, t " v x t —" w t " w t p s x —" " „ x t p " p q " — p s t " y t • 3
- 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.
- ❖ c wt " Npx,"c t "Kwp,, " p "" ,t"p,t s"pr r"" ,s xng 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?

k"xz " " " x

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

Concept of Dissolving

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*.

It is a "levels of achievement" test —

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.



j ”R 'x “'R " " ” x x " “” "

63L “—”vx t “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

b“– t ‘L“ ‘p–s‘L“— “‘u‘M p• p x–v‘b st—f “,z

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

93L “—”“ t “,wt “,xp“r“– – t— “xzt” c wx “–tt s ‘x– ”,“ t– t— l” c wx ‘x “qt•“ “ p–sp,s “ “,“ c wx ‘x ‘v““s “qtrp t” wp ‘s“t “– “x–t“,– “wt” st—pq“ “wt–p ,t “‘u’ “,z“t “tr ts” from her/him.

f t” wp•st– “—,p t” wt” “trxx“r“– – t— “wp” w“ •s “qt”– pst “pq“ “rwxes,t— “ “,z

b“– t ‘L“ ‘p–s‘L“— “‘u‘M p• p x–v‘b st—f “,z

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

; 3L “—”qtr“– t” “““q t x t “pq“ “ wt” t “‘u’ “,s ““,,p t,,x“—” wt” st—“– p “wp t” made since they are in the process of building their understanding and abilities

b“– t ‘L“ ‘p–s‘L“— “‘u‘M p• p x–v‘b st—f “,z

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.
- content "tts" "z" "w" "rws,t—" "st,, p-sx-v" "u'r",t" xtp "x" rxt-ft "q xs" 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.
- content "tts" "tp,"w" "p t" "rws,t—" "st t" "x-v" xtp "t,, x-t" p-s"w" " " 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

M "•“ „x-v" wt " „ r „t "“u'p" Npx,"c t

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

Kwæ,s,t— "Y,x'„'S —“ •t s vt

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.

Kwæ,s,t— "Y,x'„'S —“ •t s vt

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 r wt – x p"” „,“”t „, x "x "” „,t 3I ••" wt "rwæ,s,t–"x–t„,„,t t s" ” „,x "p "p" q p–rt" wæw" p "p" ” „,t " “•xs "“ „,x’ xs "wt–rt" wt "rwp,pr t,x t s"v,p–xt " a solid and water a liquid as pure.

Kwæ,s,t— "Y,x'„'S —“ •t s vt

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

Kwes,t— "Y,x'„'S —“ •t s vt

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?

Kwes,t— "Y,x'„'S —“ •t s vt

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

No "t—r“ —t,t,s"wt " “,s " b“• x“—'p-s" b ”t—x“—““r•p xı "wt"— x ,t

No experience of separating the solids from water e.g. salt from water by evaporation and baking soda from water by filtration

Kwes,t— "Y,x'„'S —“ •t s vt

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)

Kwes,t— "Y,x'„'S —“ •t s vt

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

Kwesi, J. — "Y, X, S" — • t s vt

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 °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/

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

Q" w"t prwt,, "t p- x-t"p-s"t p• p t" st— "z—" •tsvt "p-s" z• "p-s"p t "w" "r•" t " 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

Q" w"t prwt,, "t p- x-t"p-s"t p• p t" st— "z—" •tsvt "p-s" z• "p-s"p t "w" "r•" t " 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 focusx-v"-"p"r"-"-"-"-p-upr ,ts "qxr 3"

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 -px-"-x" rwp-vt "u" p t "p" wt "p- t "x- t 3"

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:

Changes of State :

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

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

Four Stages:

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

Research Project

Initiating a research project on properties of materials by focusing on a common

x 'xz "y "z

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 exhibit and giving an oral presentation
- Raising questions/critiquing the findings of their peers using logical reasoning and

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

- I "s,x x-v" t x'—,t•t p—"“" st— "•x t
- 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 ,t t p,rw"qytr "—" "st•"q t,, p x"—"p-s"t pq•x w"p"qp t •x-t",t •p t s " 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

Developing a Tool Kit for Measuring the Temperature

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 balloon 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 balloon, 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 $^{\circ}\text{C}$ and $^{\circ}\text{F}$ scales (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.

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

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

The next step is to show the information on this grid. The vertical and horizontal lines are

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. K““„s x-p t ”px, "p,t "- t p—“u” x-v" wt "

”“x—“ ”wt "v,xs 3

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

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:

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

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.

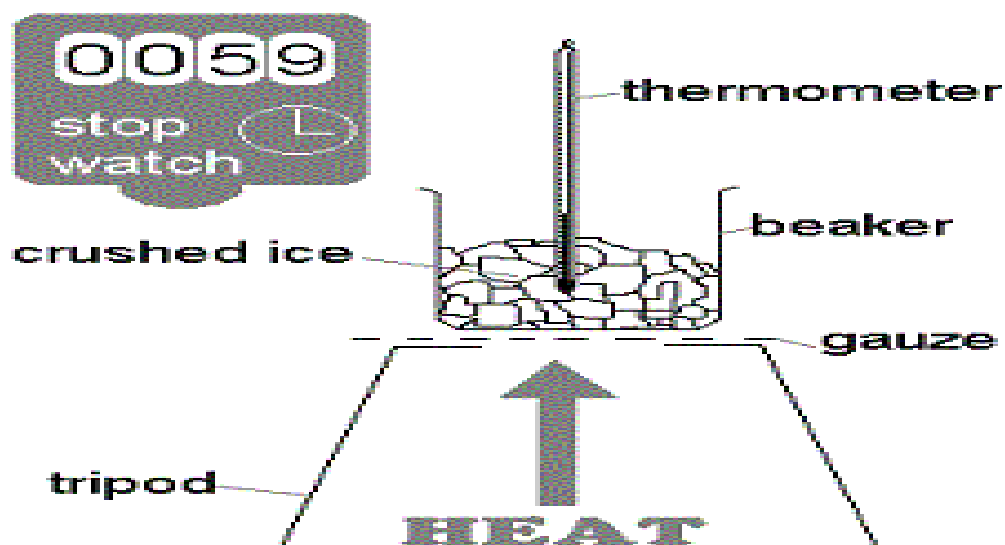
We use all these approaches to empower children to develop the ability to think themselves.

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.

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

Changes of State Pxz “W” x

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.

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

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:

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

Does water evaporate faster in wind or without wind?

Will water evaporate faster in wind or without wind?

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:

Presentation 6:

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

Scoring Rubric for Cubic Chart

Scoring Rubric for Oral Presentation

Lecture No 33

Concept and Skills to be Assessed

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.

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

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

R” ” 'x'yxz ””x ” ” d ”x ” ”c ”

c wx "tr ,t" x•"ú‘r “—wt"Ywp t" J “u'wt"tp,-x-v" t’ t–ft"t– ”p t3

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

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.

Lecture No 38

R” ” ‘x'yxz “””x ” ” ”x ”” ”” d x

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.

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"

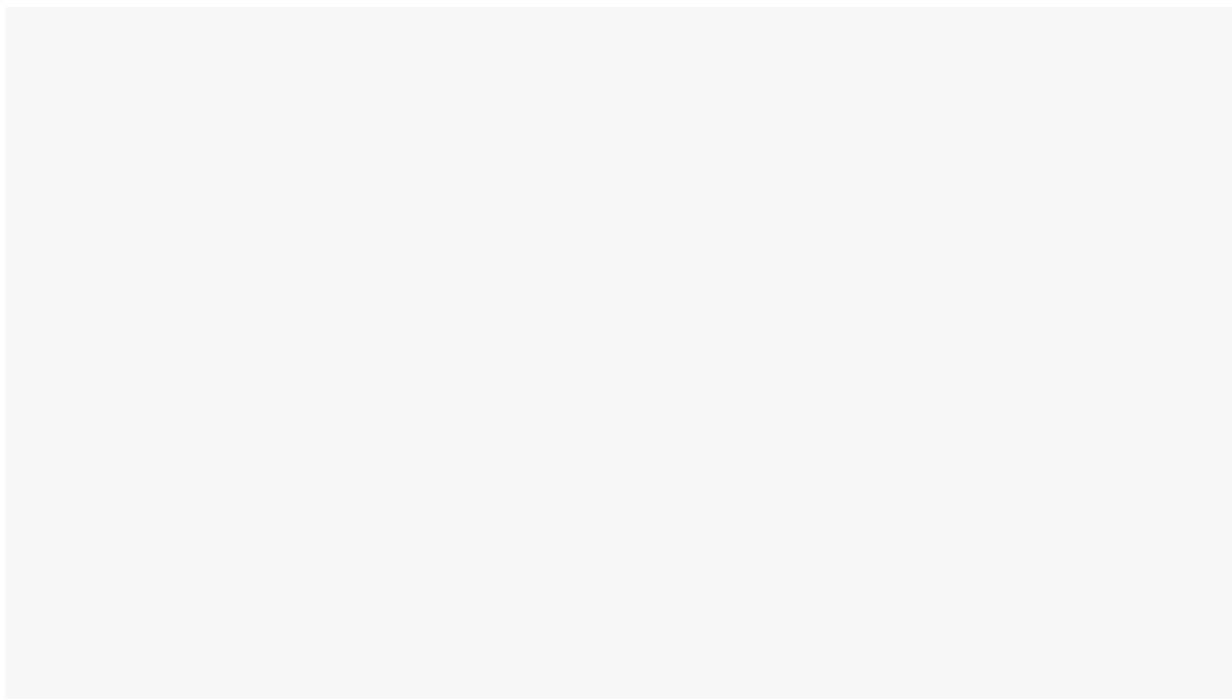
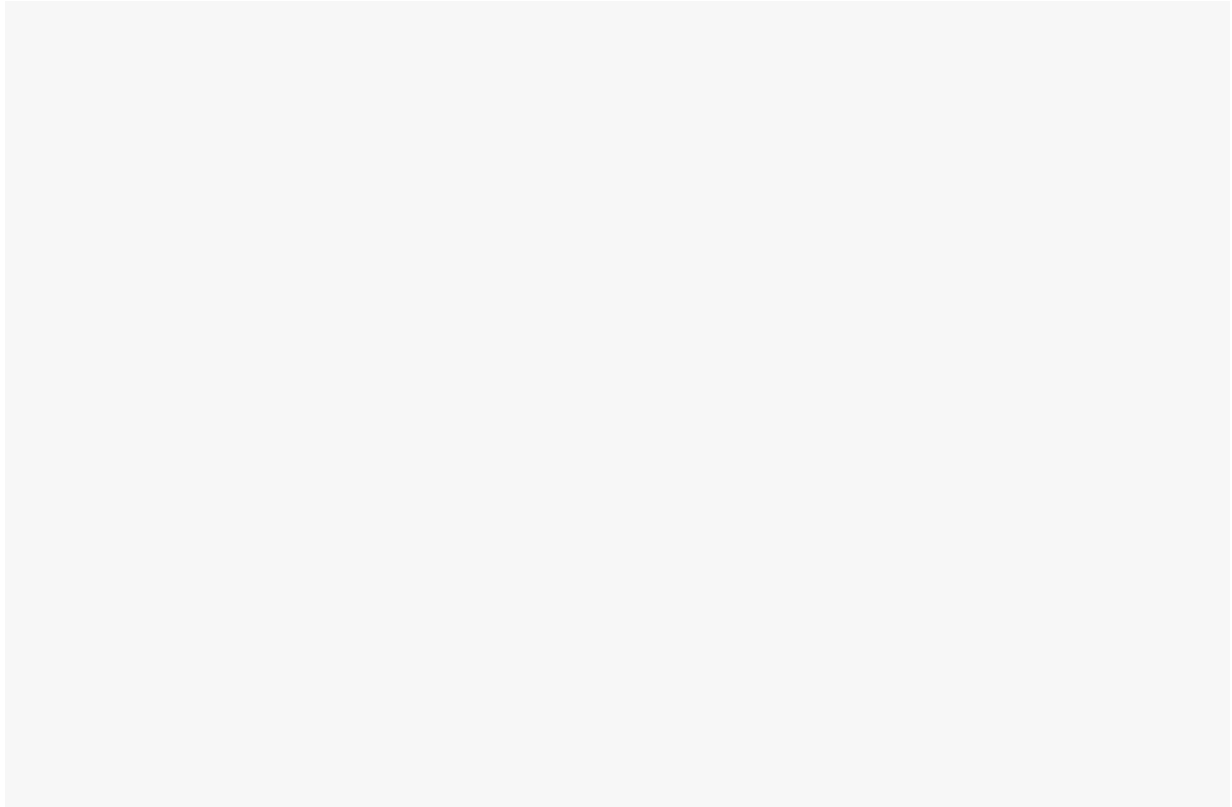
Lecture No 40

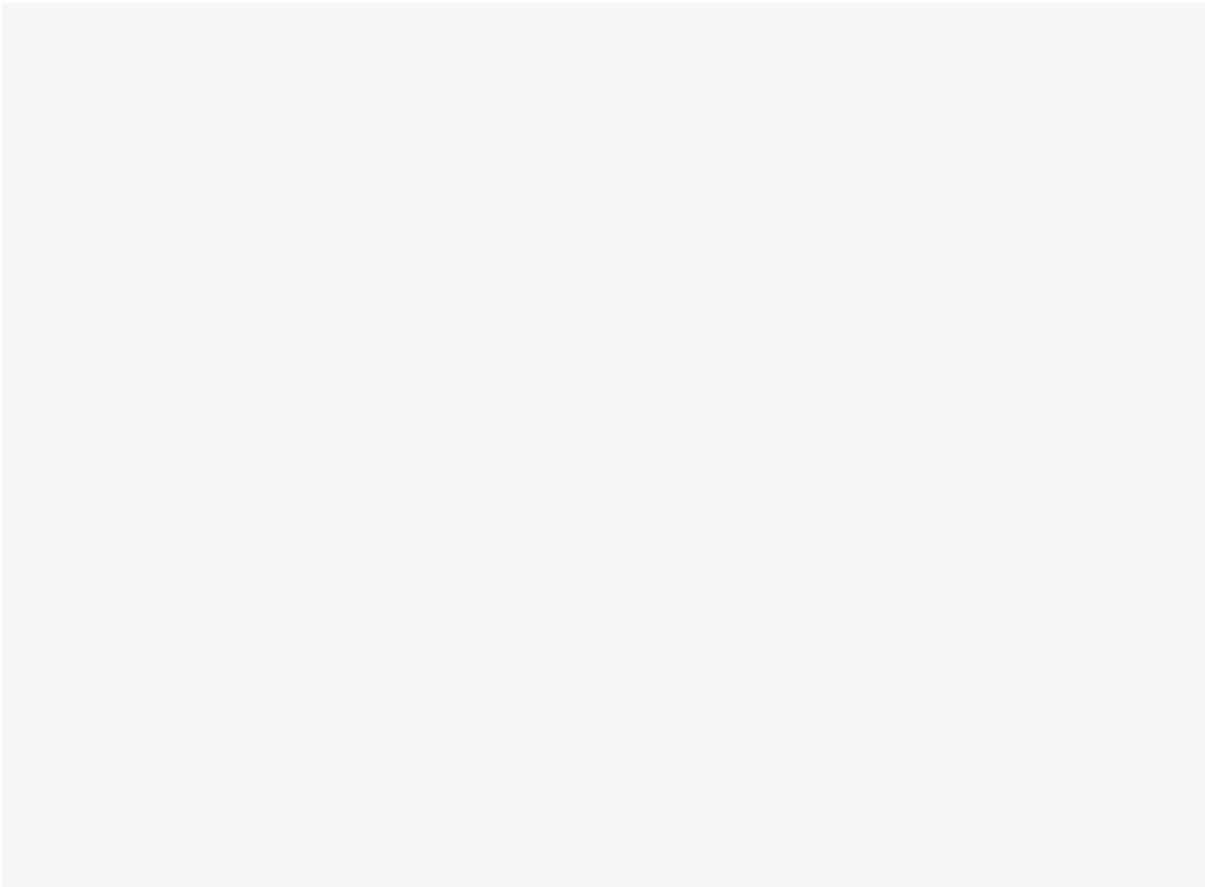
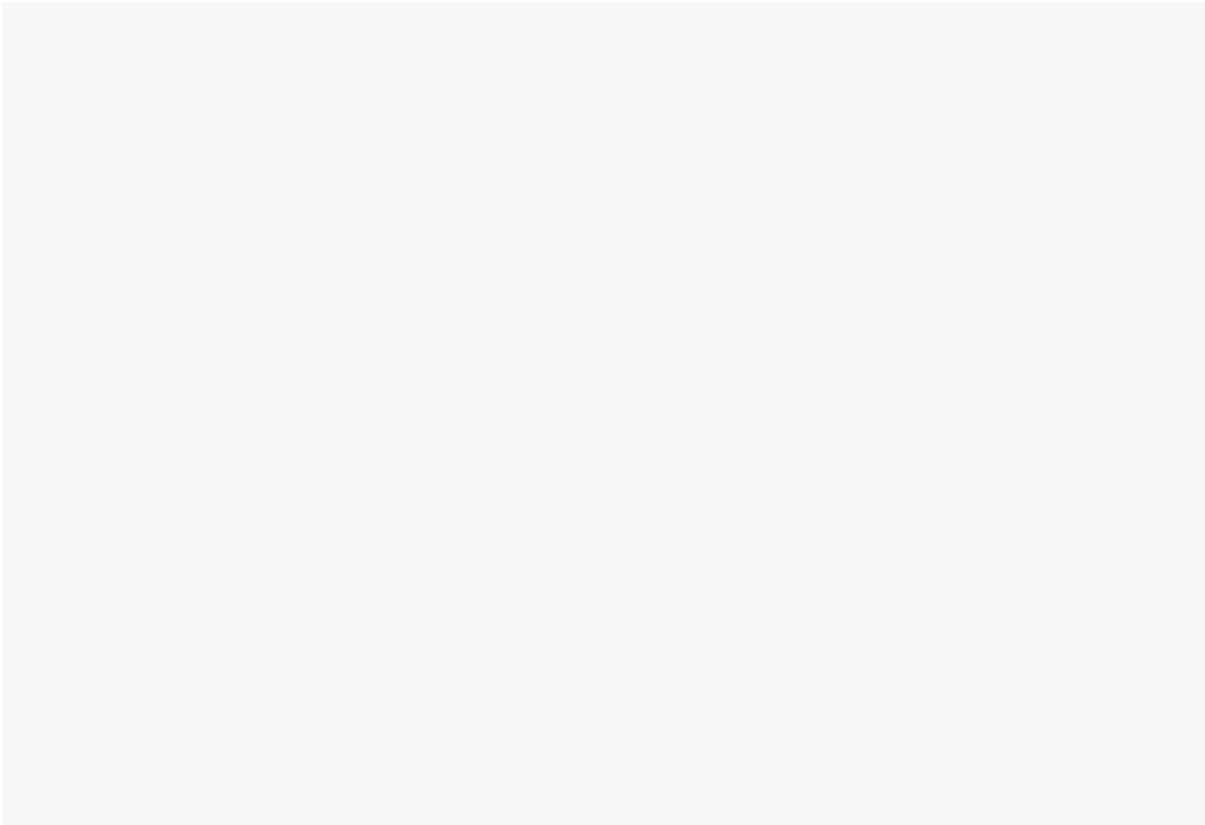
Density measurement activities

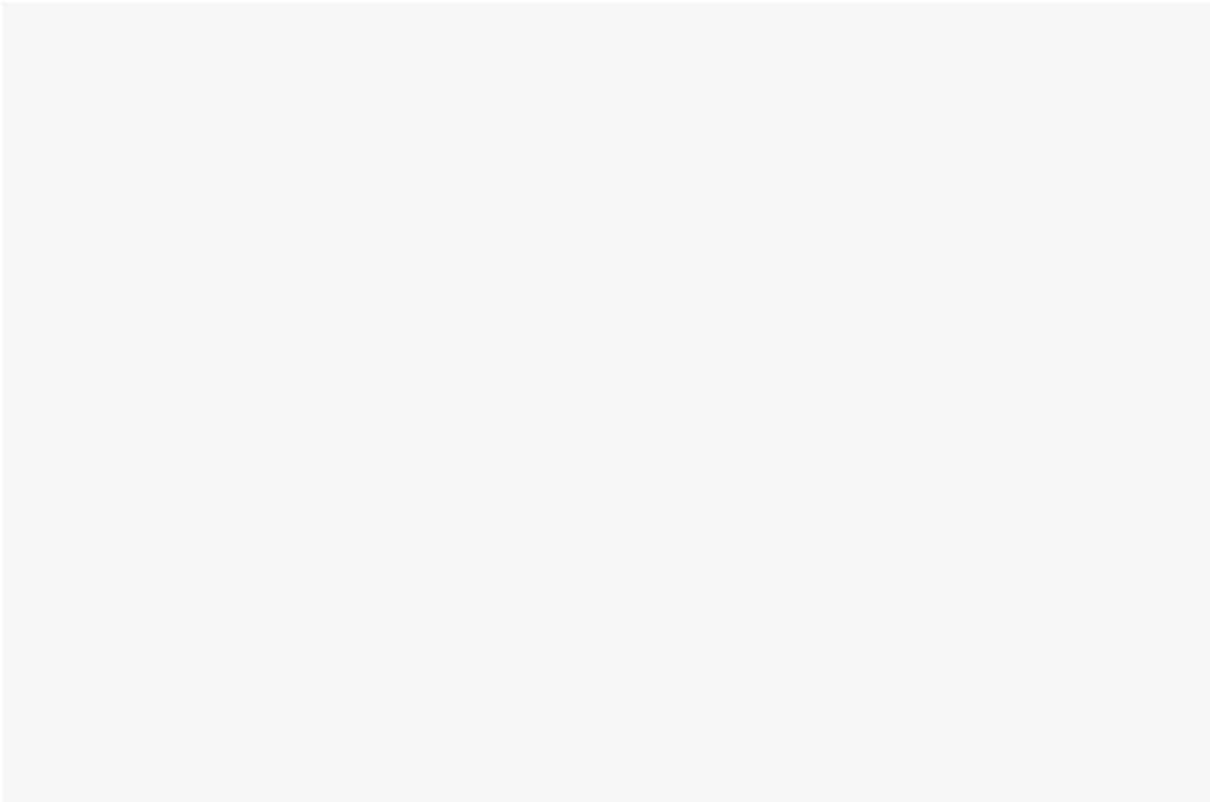
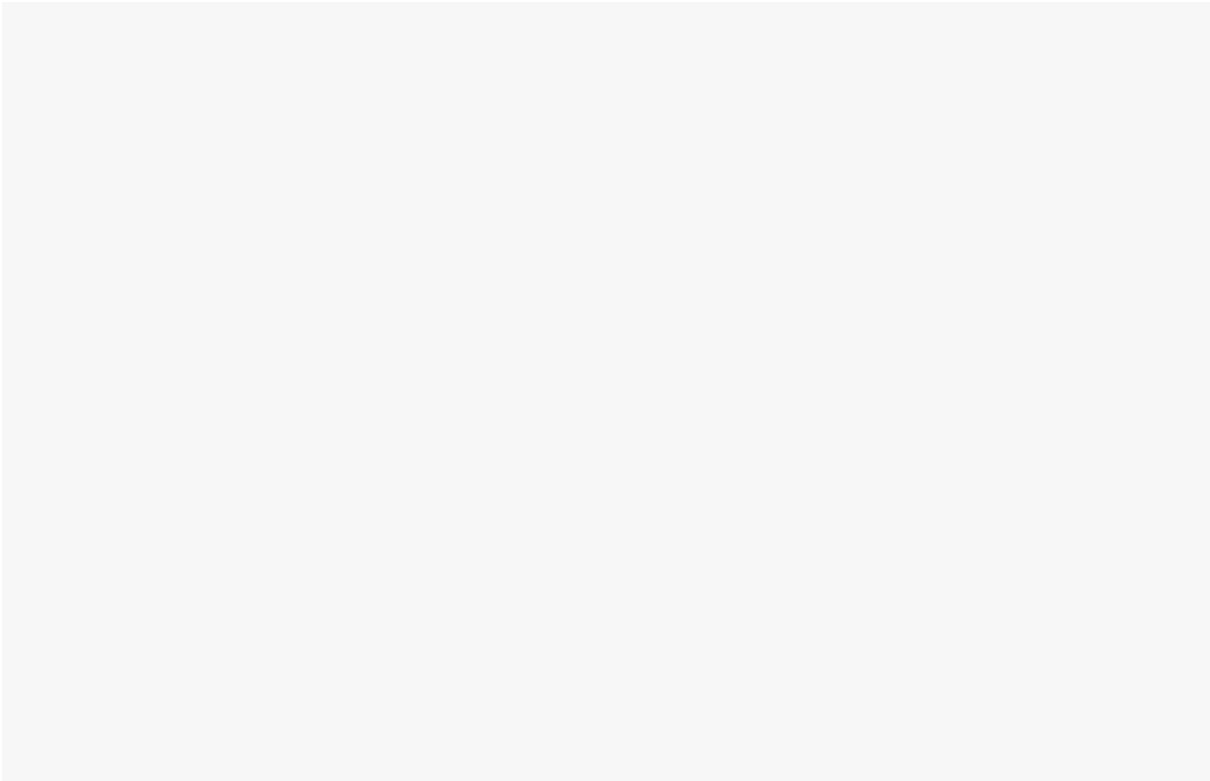
Lecture No 41

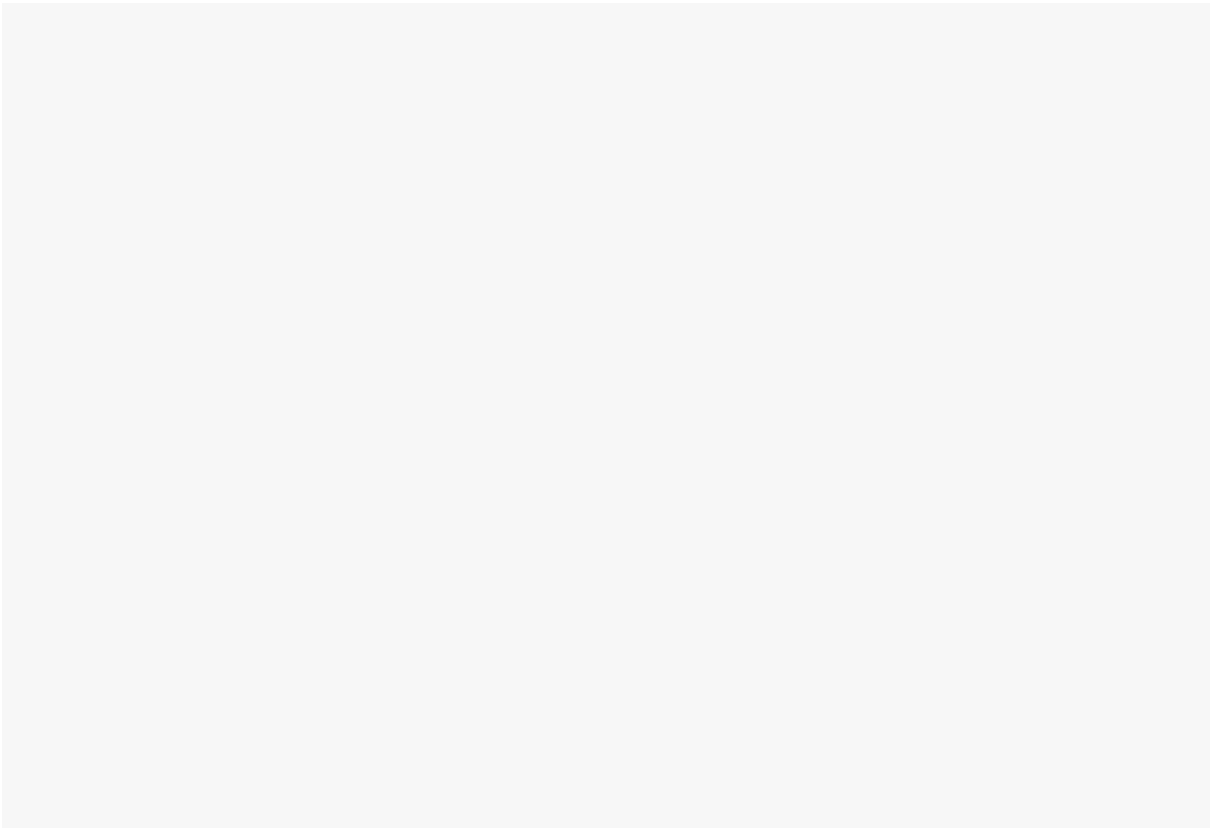
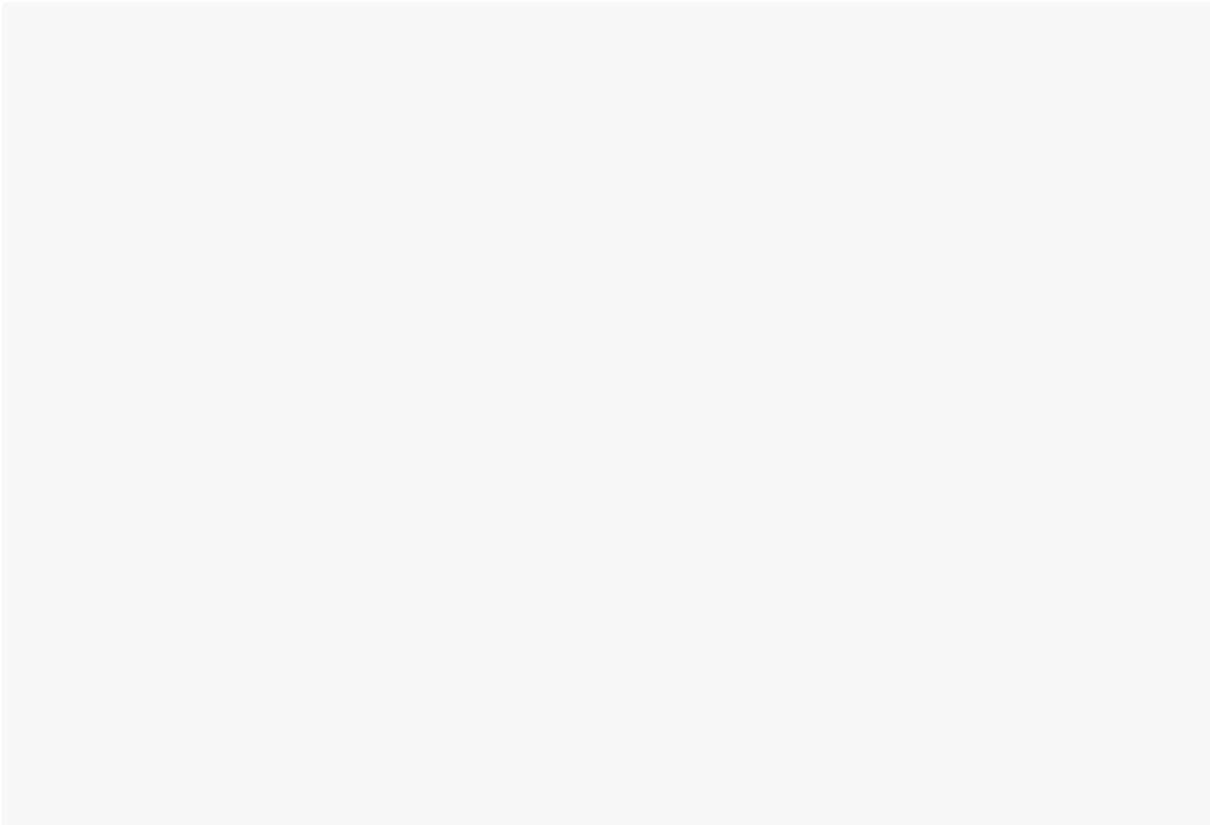
Measurment the Density of Irregular Objects

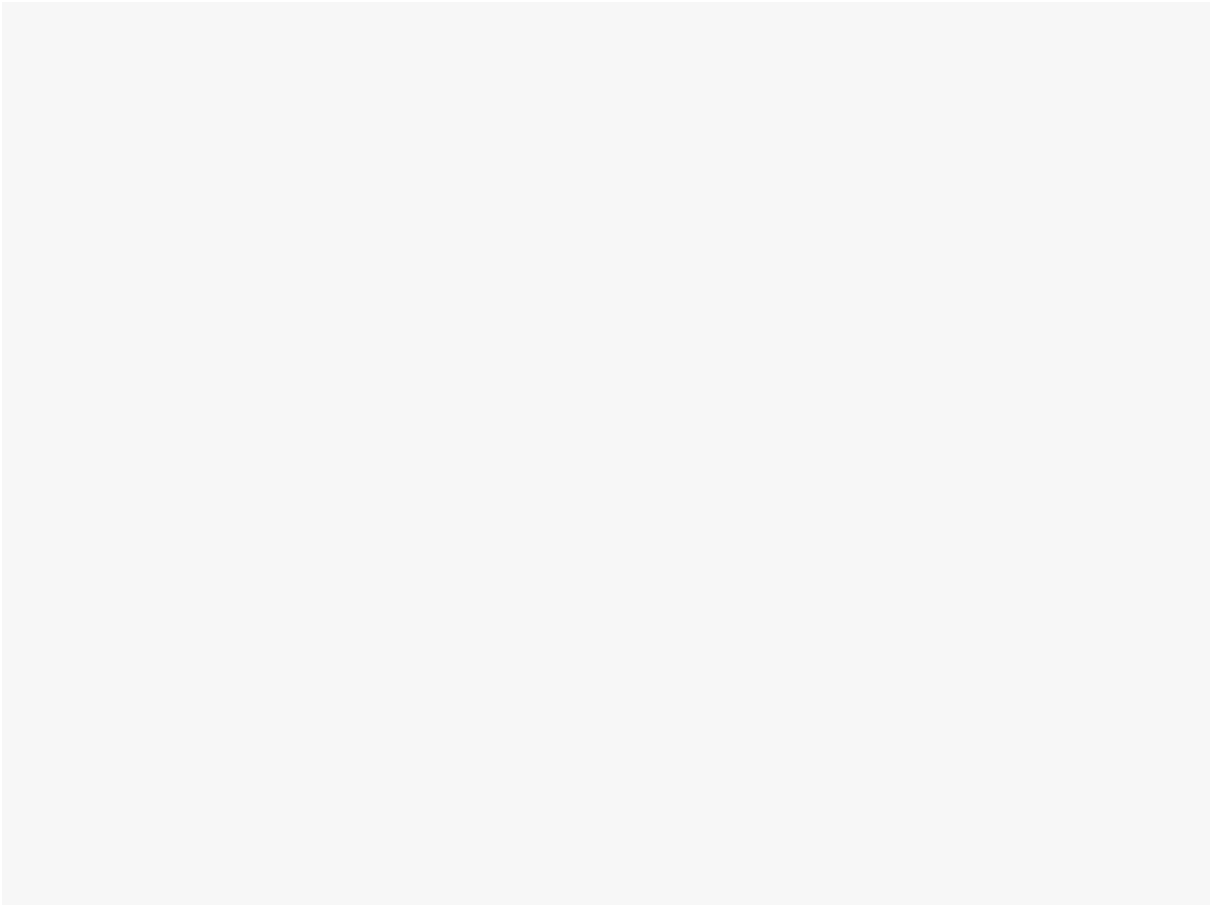
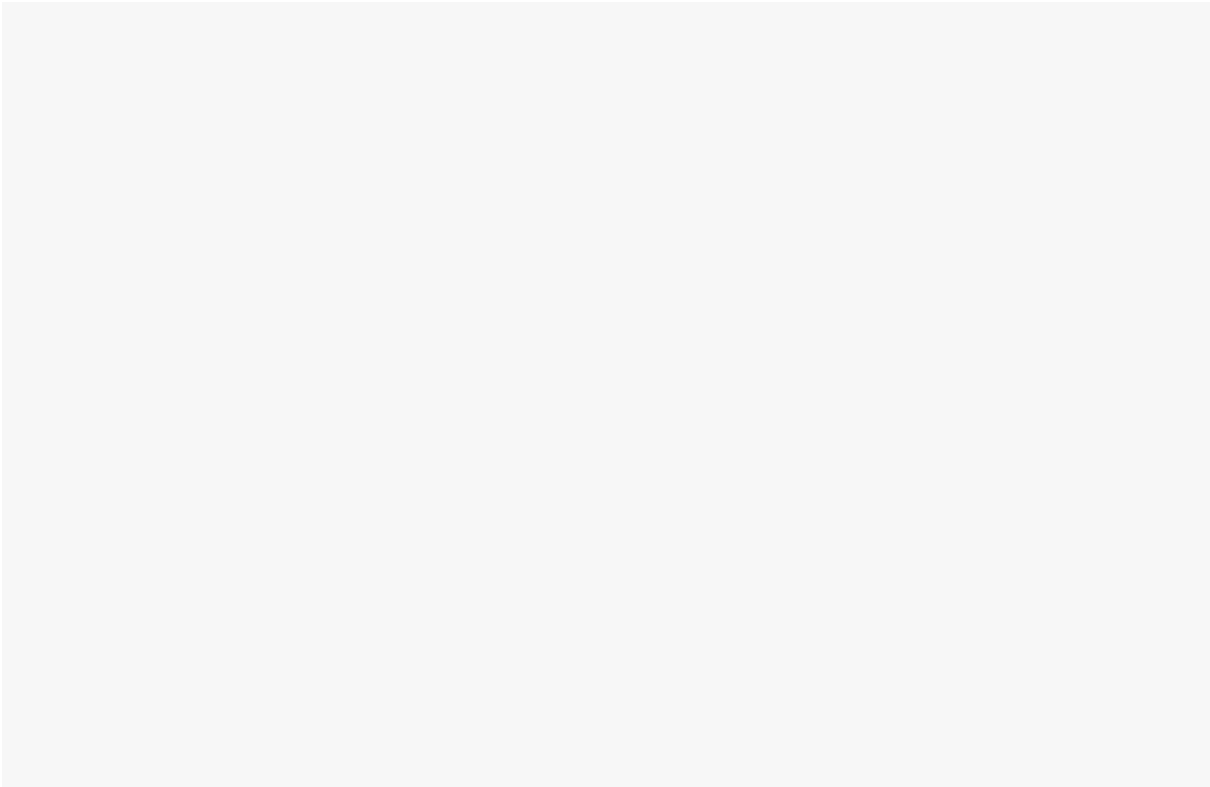
Lecture No 42

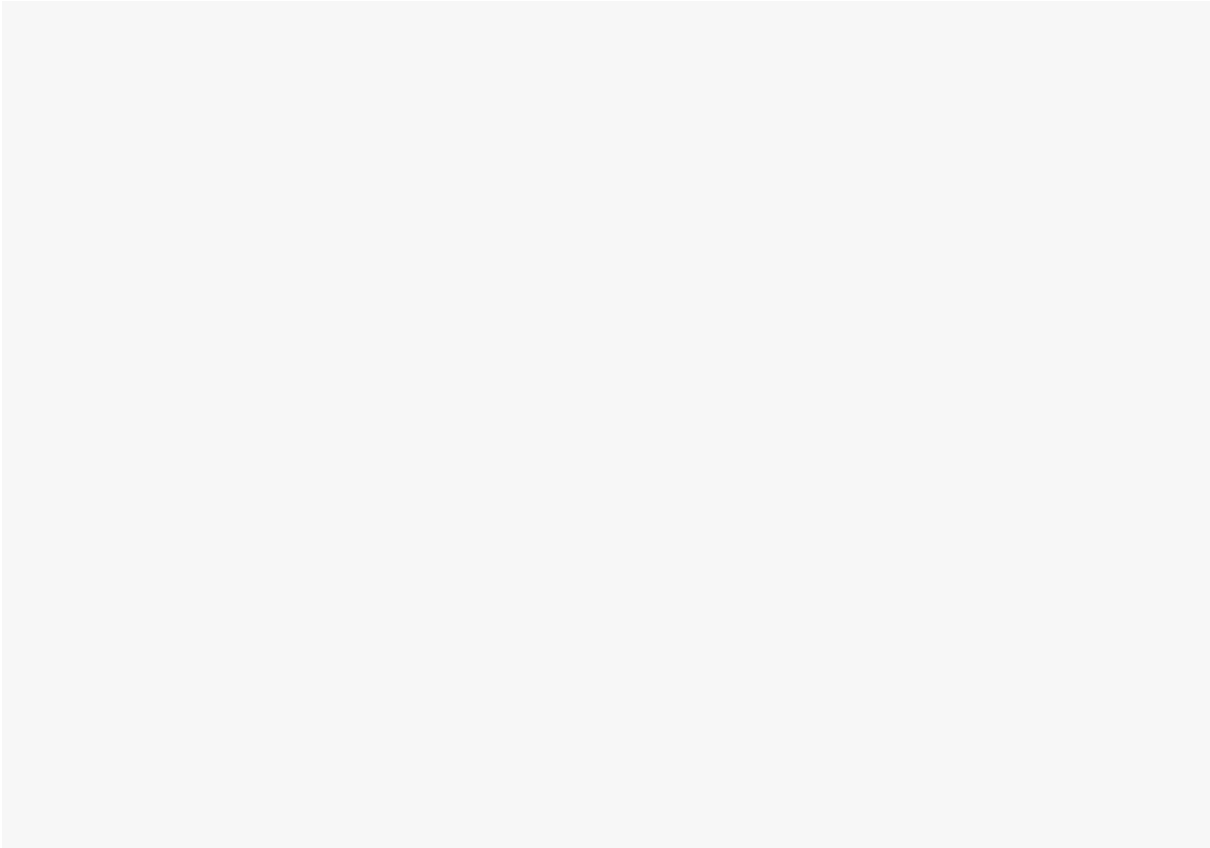
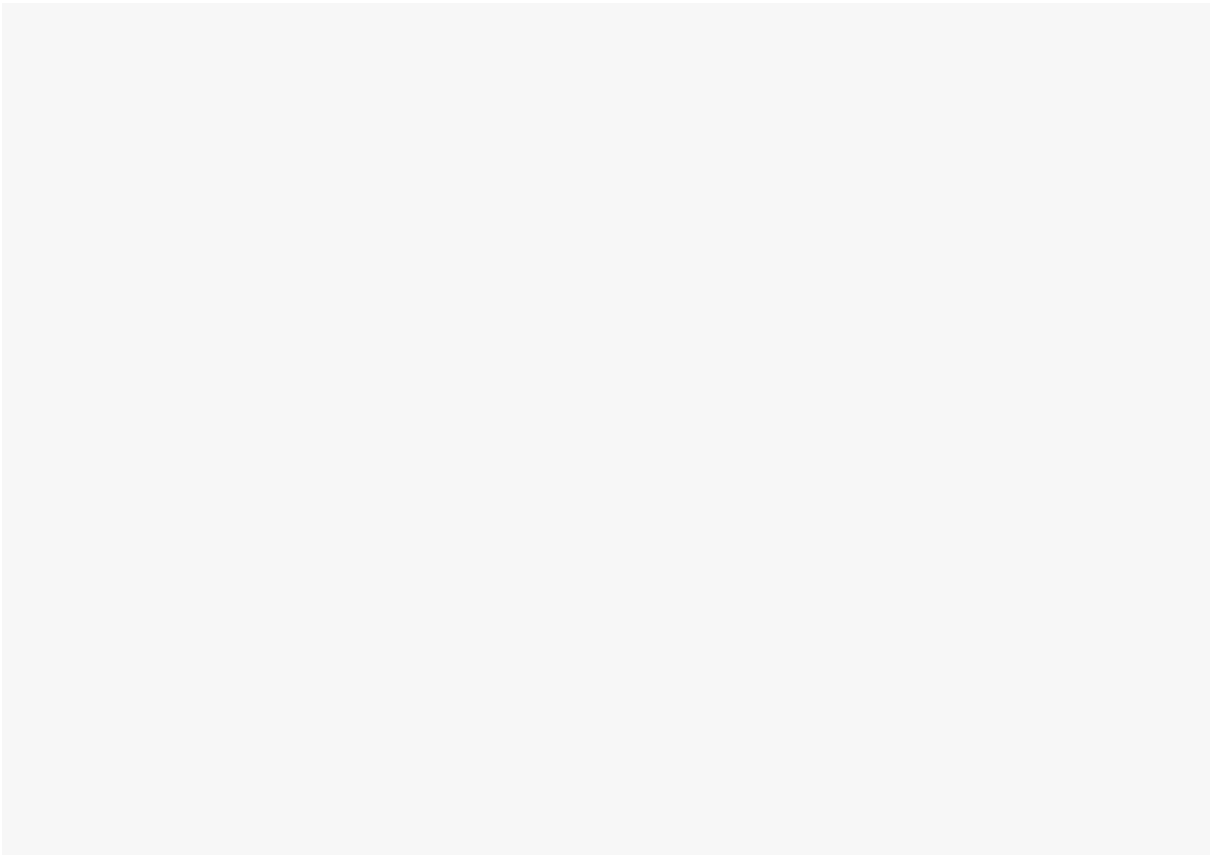
Density of Liquids-A

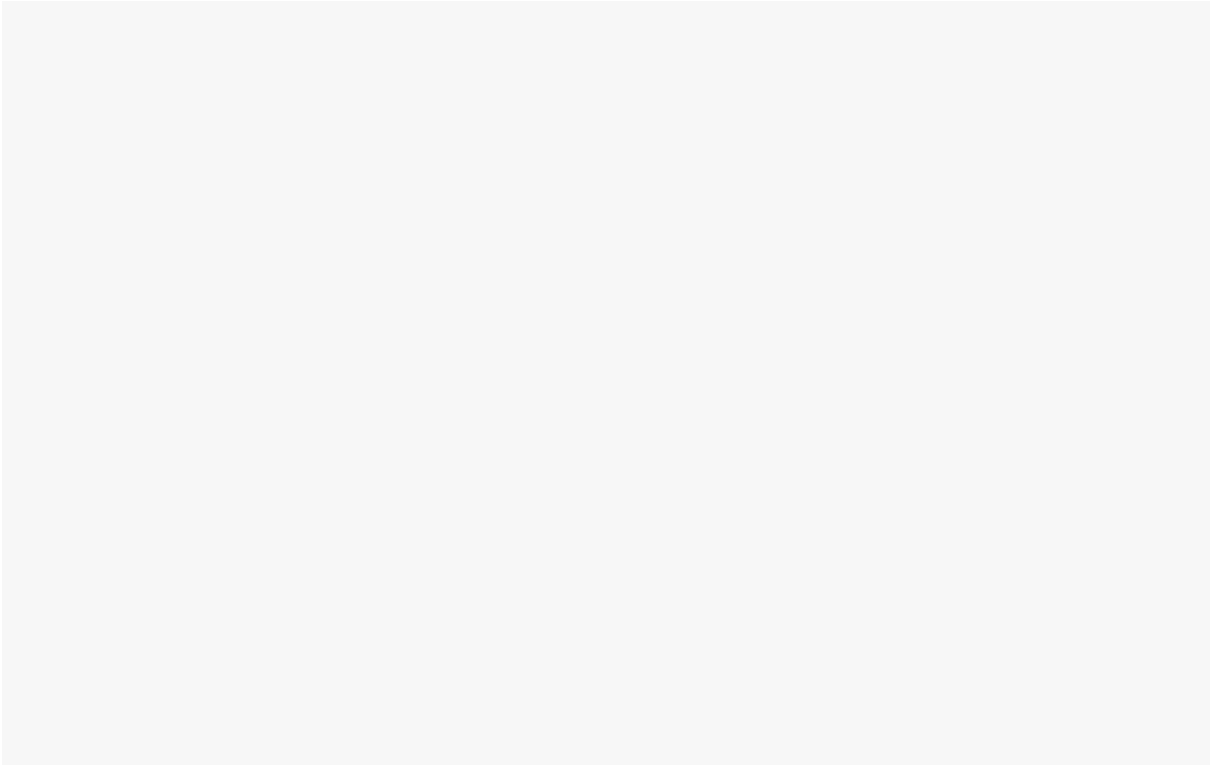
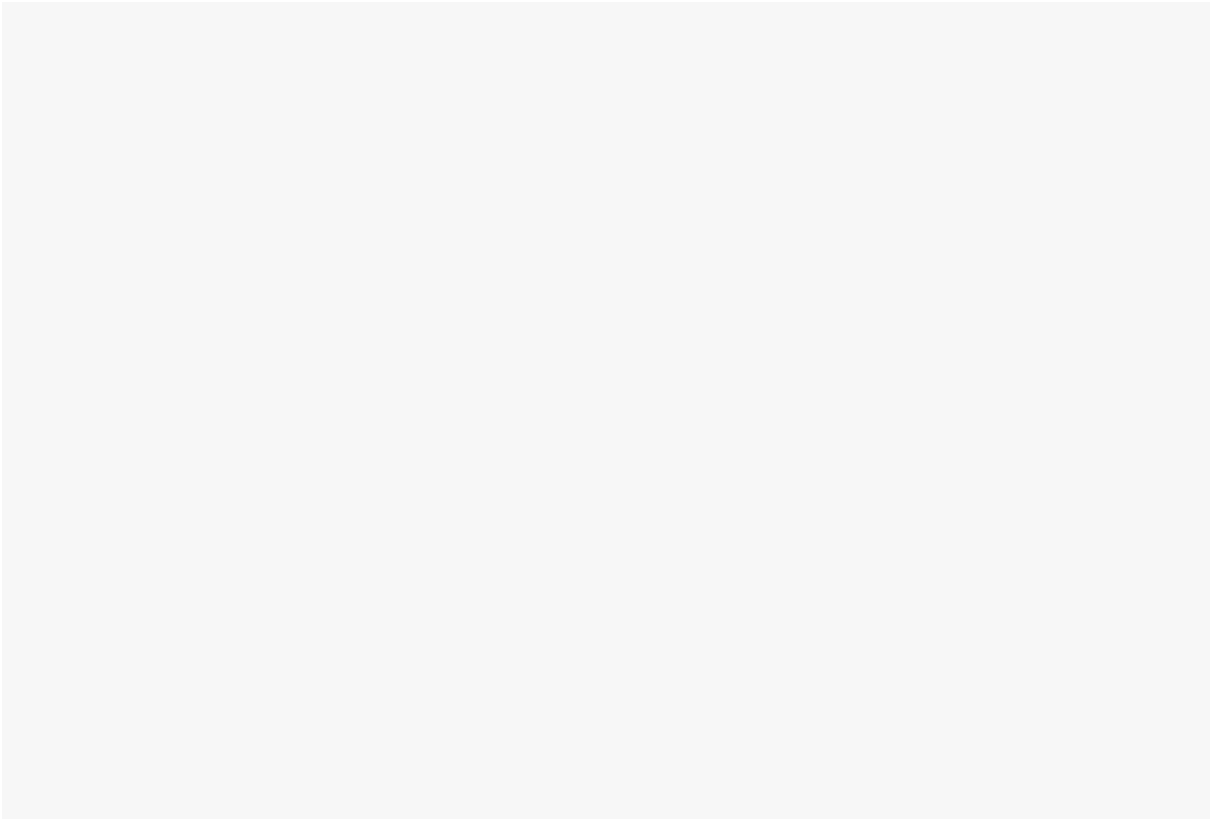


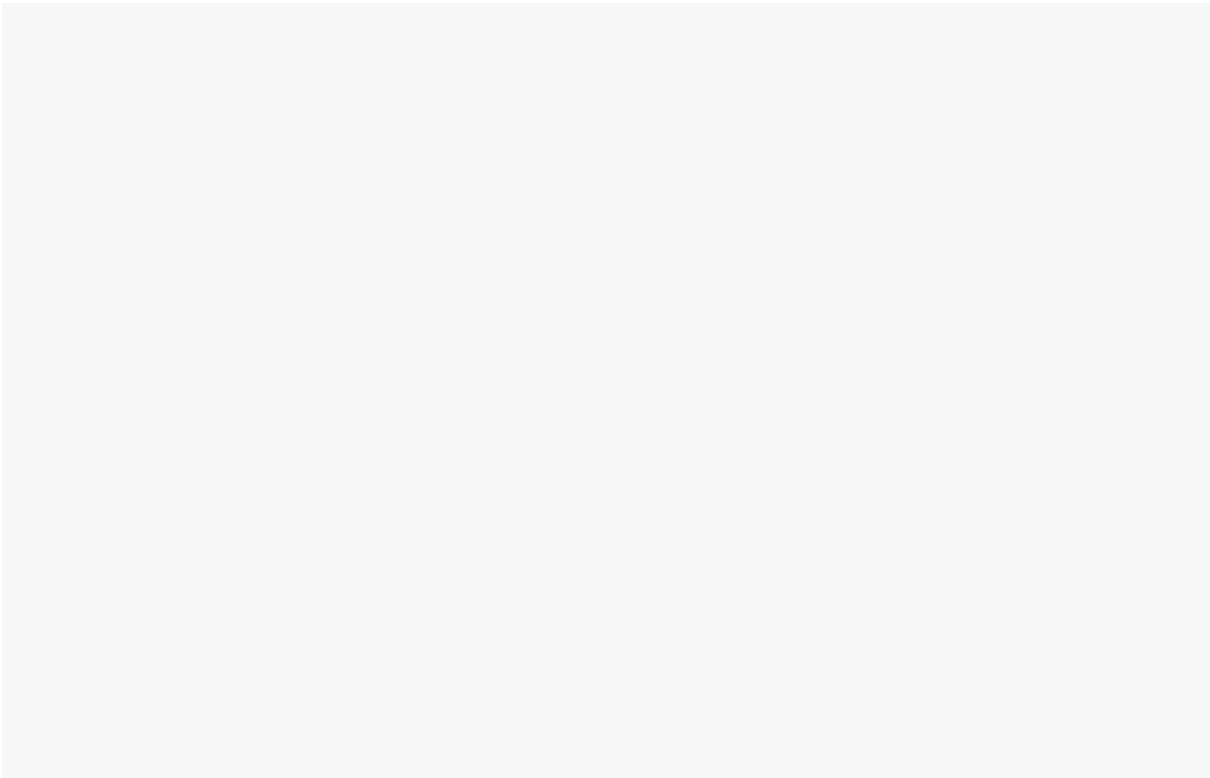
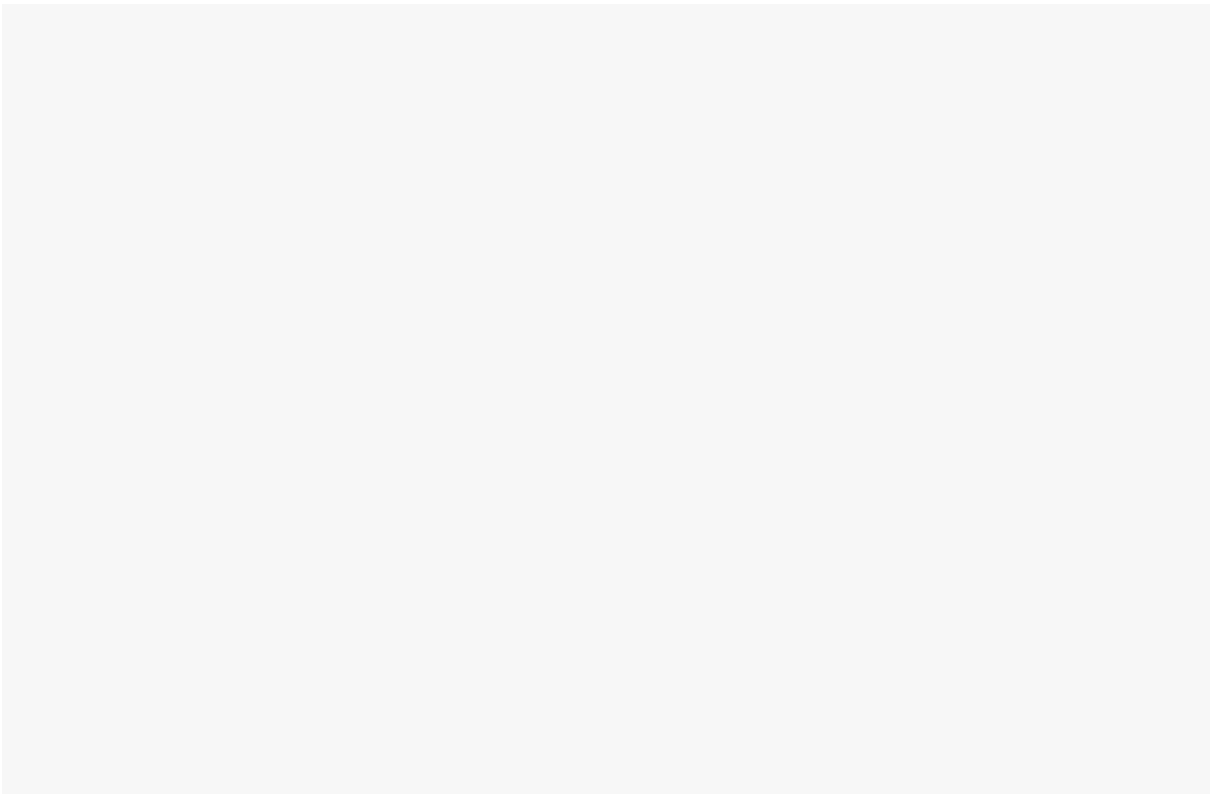


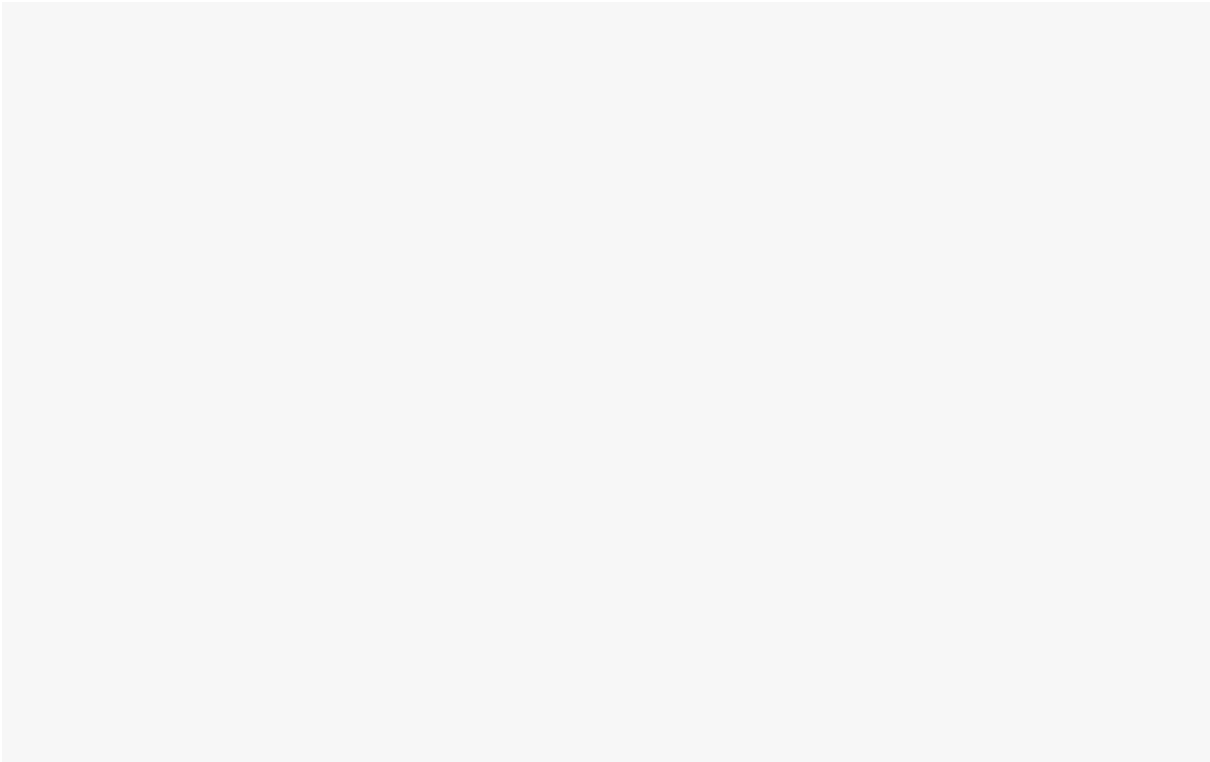
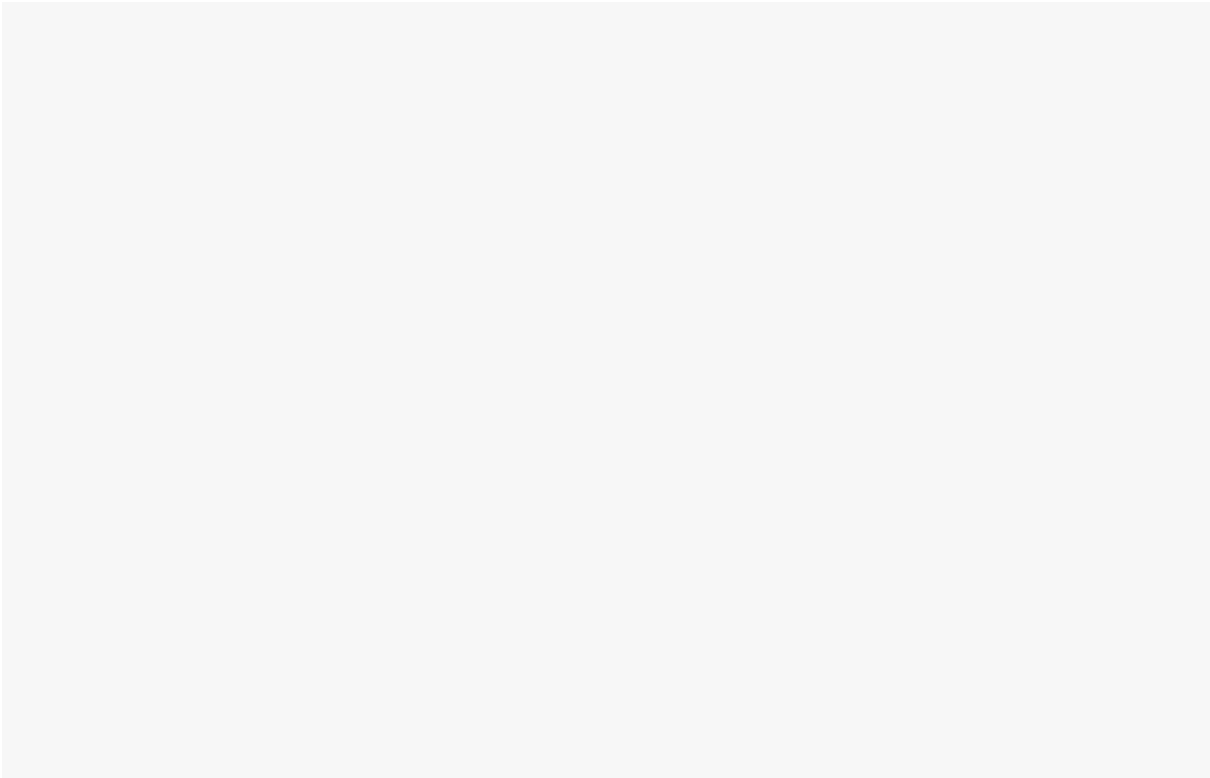


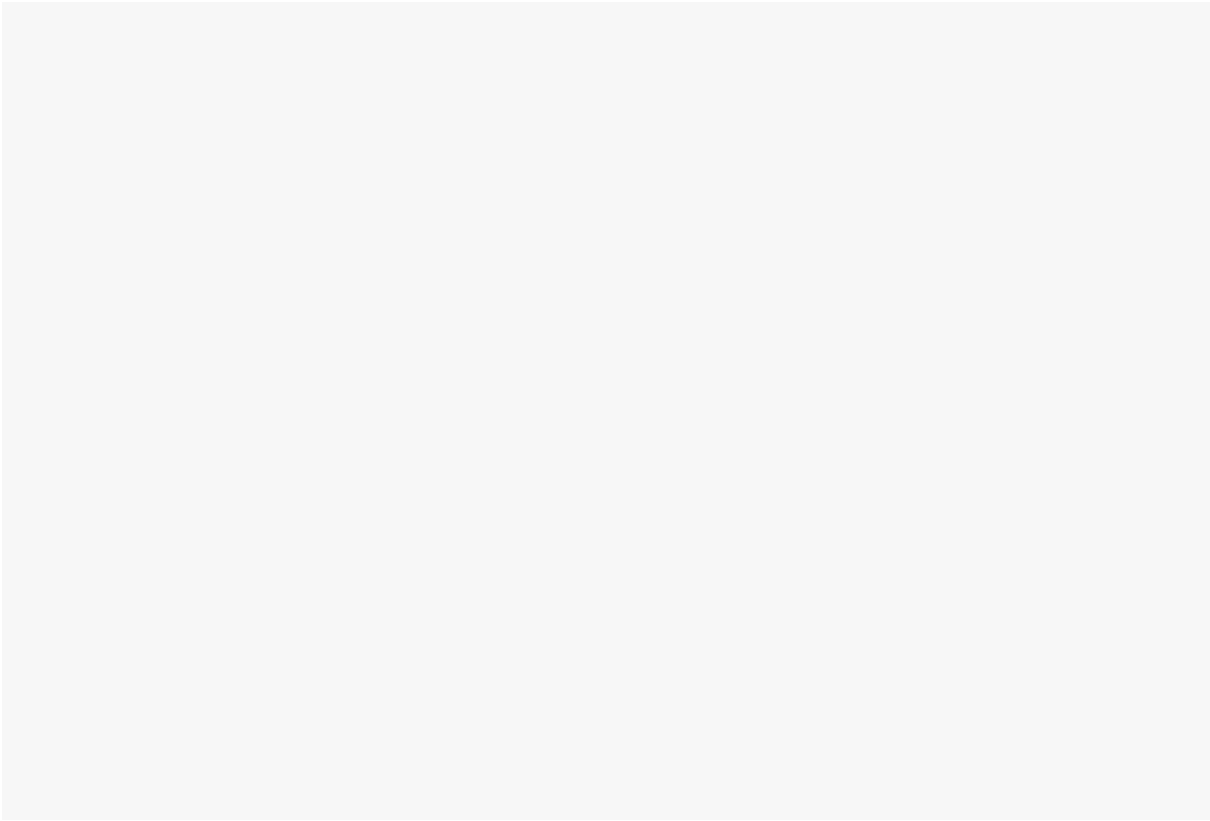
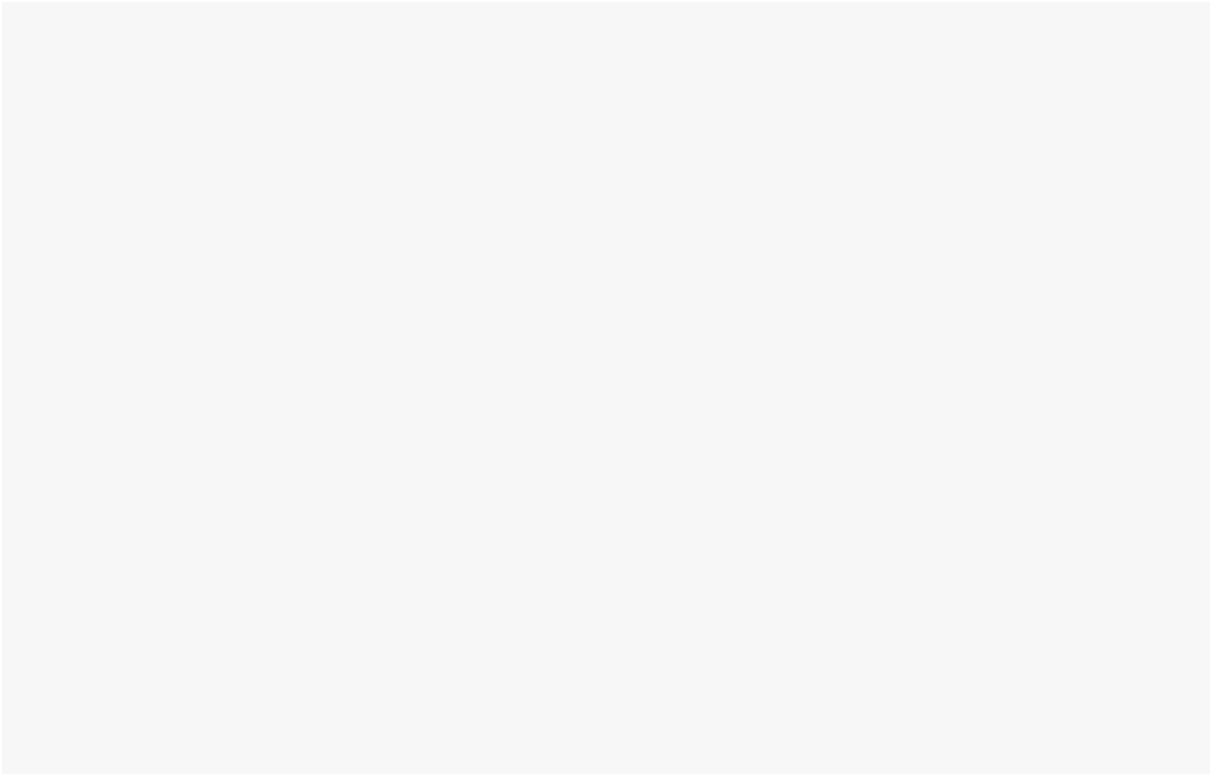


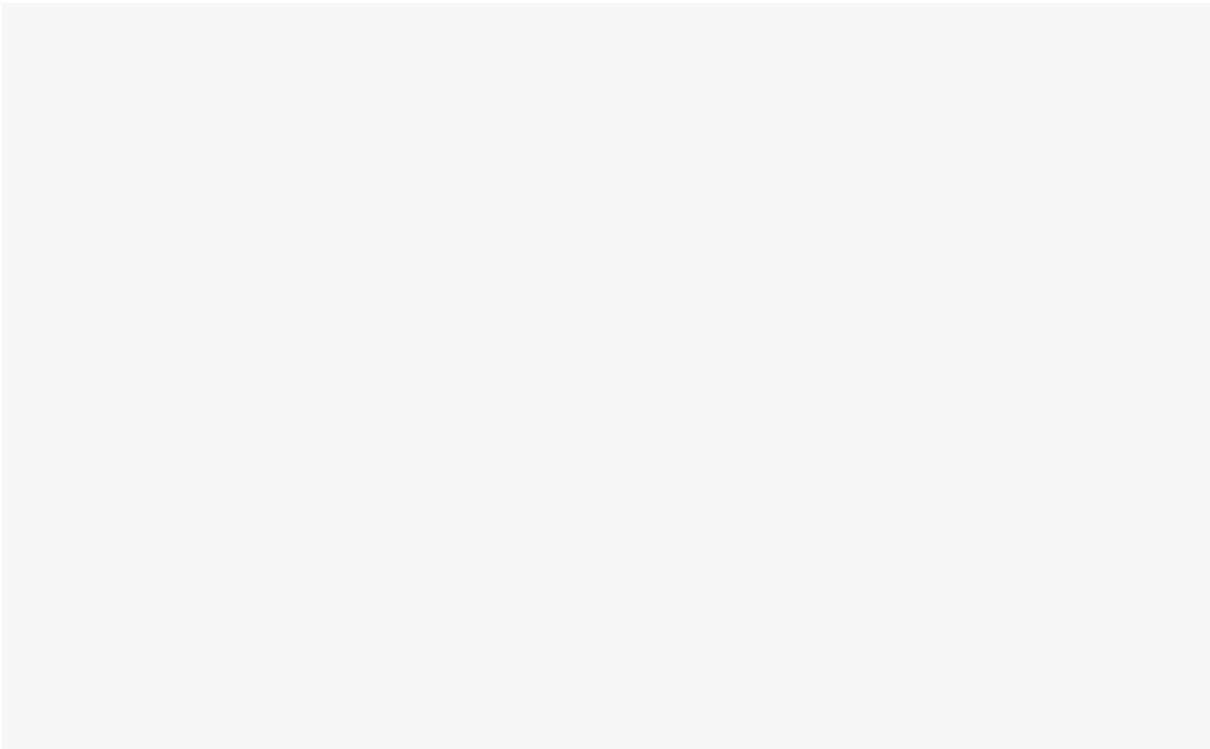
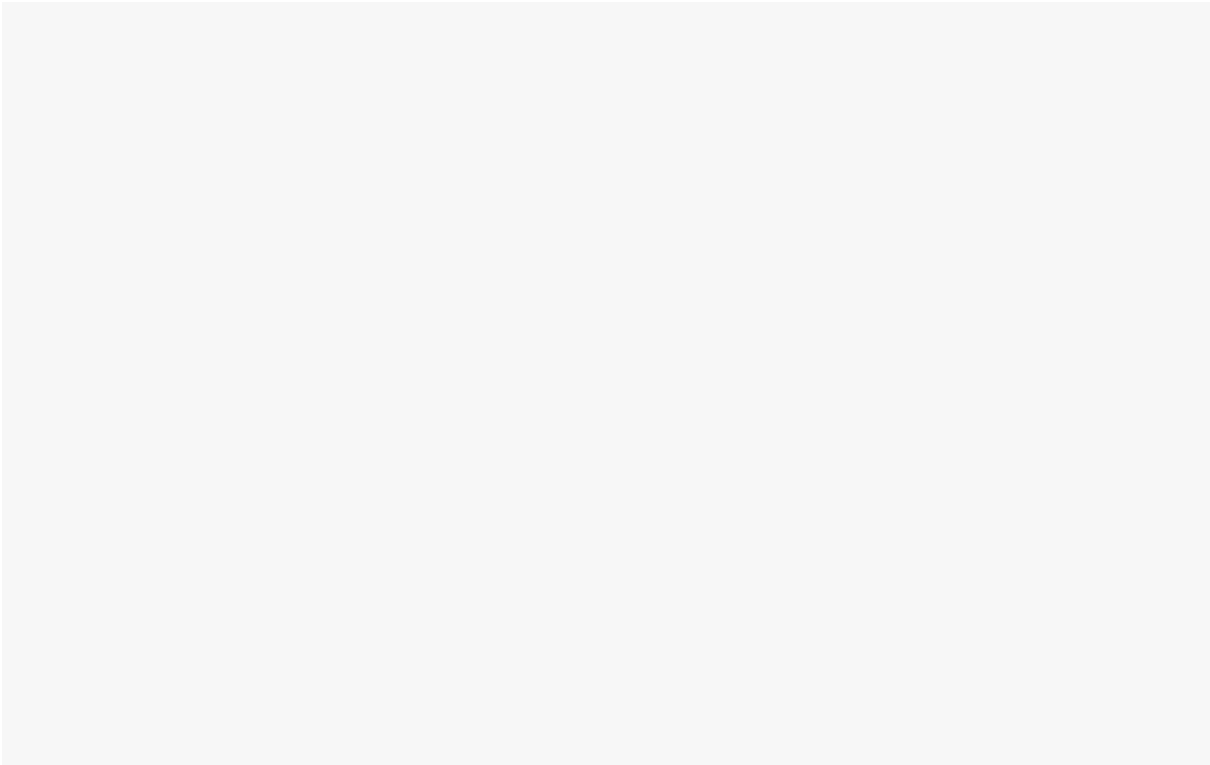


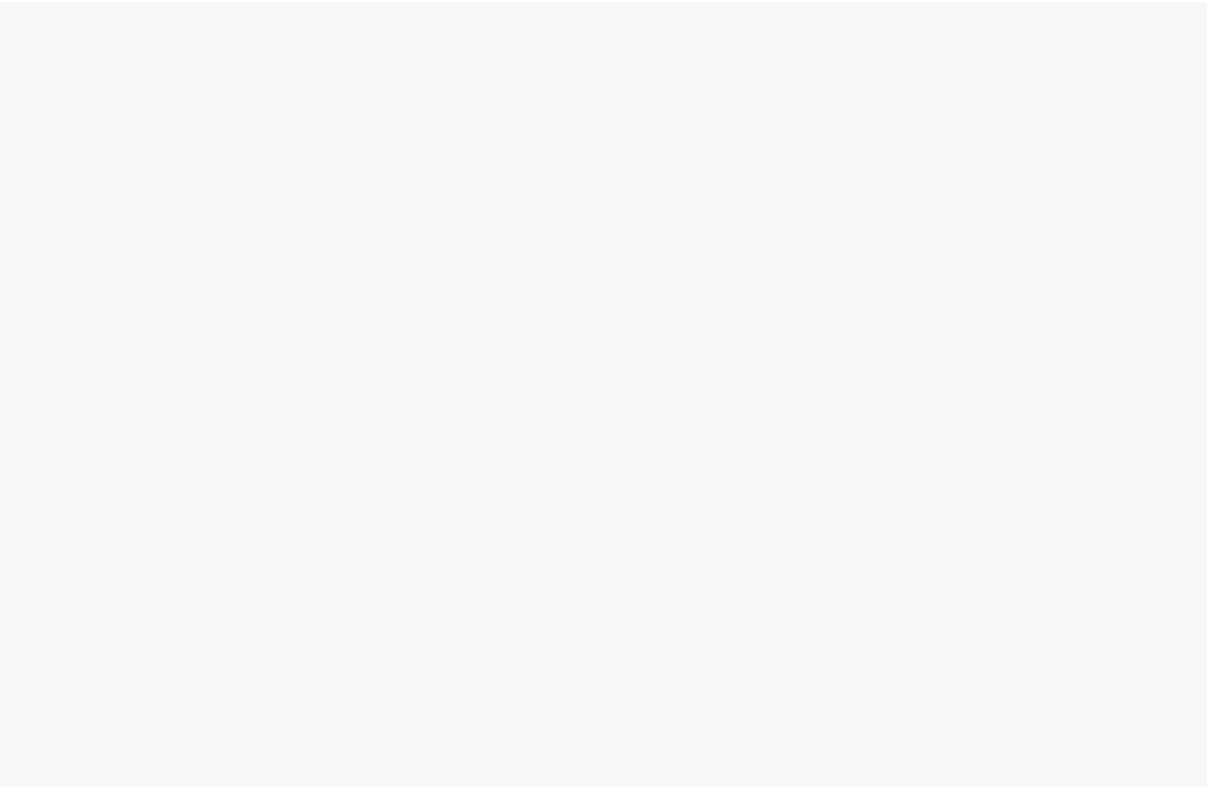
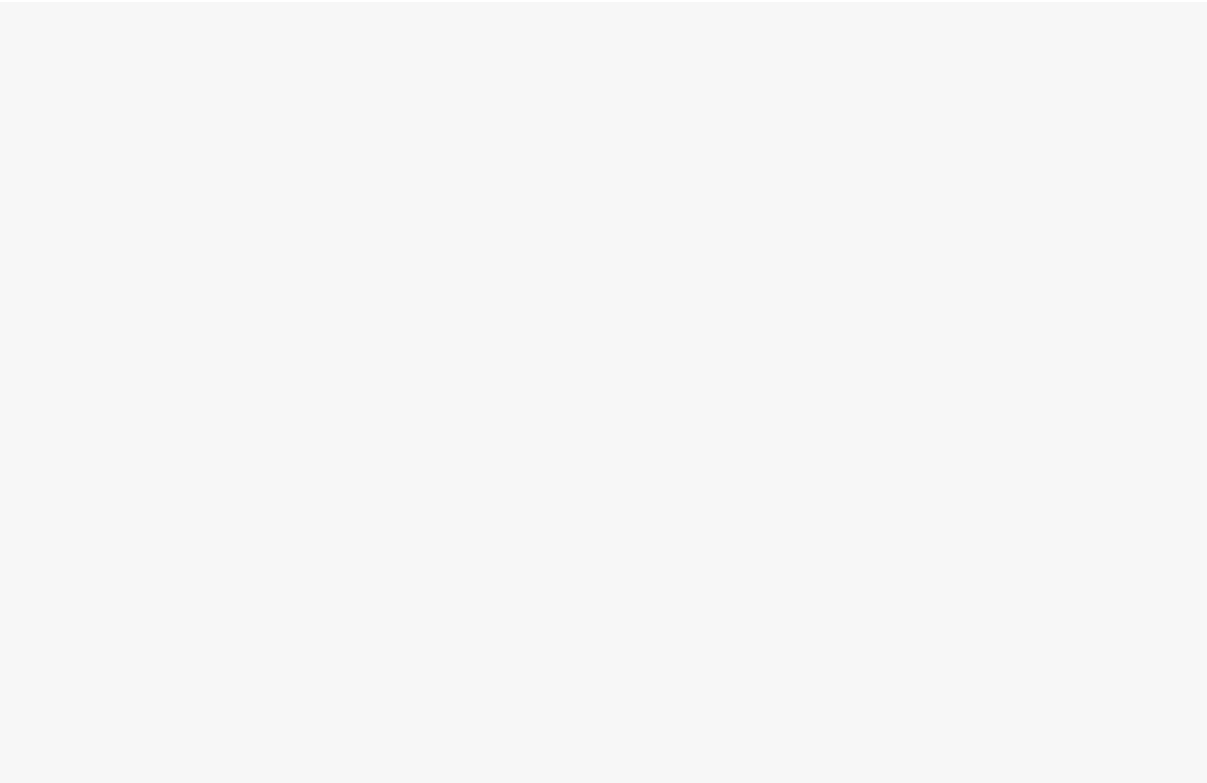


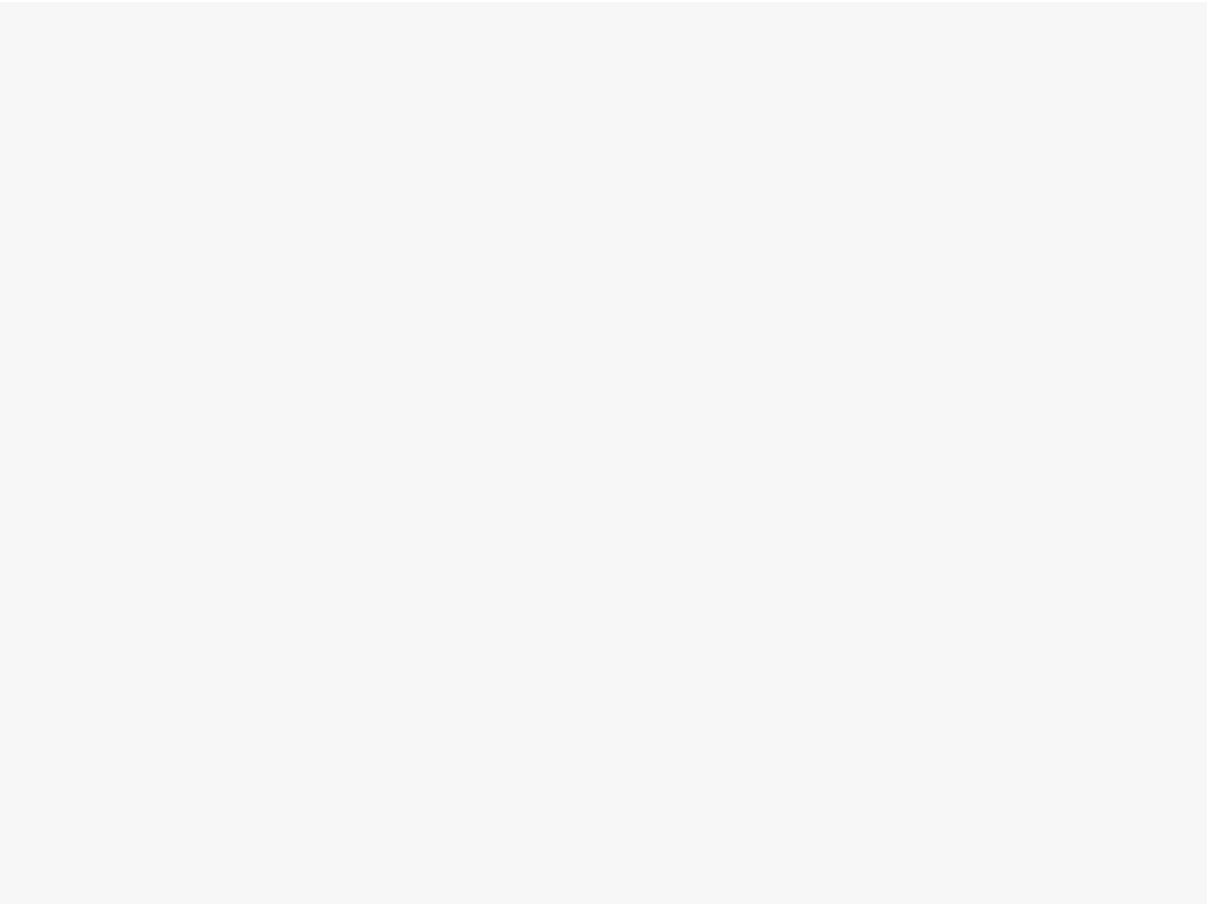












Lecture No 43

Building a Density Column-B

Lecture No 44

Assessment of the Activities of Mass, Volume and Density

Lecture No 45

Review of the Course of Teaching of General Science

