Post Graduate Course in Reflective Teaching with ICT

S03 Interactive Science Teaching

Teacher Coursebook (Understanding Motion)

This coursebook belongs to:

Name: .....

Class: .....

Section: .....

CLIx subject team
Anish Mokashi
Anup Saxena
Arpita Pandey
Deepak Verma
Dinesh Kumar Verma
Honey Singh
Judith Perry
Priyanka Saxena
Sayali Chougale
Umesh K Chouhan
V. V. Binoy

Academic mentor
Arvind Sardana
Bhas Bapat
Prof. Bholeshwar Dube
Himanshu Srivastva
Prof. Kishore Panwar
Rajesh Khindri
Vivek Mehta

Academic support
Amitabh Mukharjee
Anu Gupta
Dr. Ramani Atkuri
Saurav Shome
Dr. Sumit Roy

Production Management
Pallavi Seth

Editors
C. N. Subramaniam
Madhav Kelkar
Praveen Allamsetti
Rashmi Paliwal
Late Rex D. Rozario
Suresh Kosaraju
Sushil Joshi
Tultul Biswas

Translators
Chitti Sreeram
Madhav Kelkar
Lokesh Malti Prakash
Satyamadhvi Nanduri
Shivani Bajaj

Video development support
Deepak Verma
Khizar Mohammad Khan
Kumar Mohit
Pallav Thudgar
Tariq Khan

Software development
Brandon Hanks
Varun Jain

Software Support
Shahid Ahmad

Illustrations
Ankita Thakur
Heera Dhurvay
Khizar Mohammad Khan
Tariq Khan

Design
Ankita Thakur
Gauri Wandalkar
Ishita Biswas
Kanak Shashi

Voice over
Dinesh Kumar Verma
Gaurav Yadav
Honey Singh
Pallavi Seth
Priyanka Saxena
Subeer Kangsabanik
Vandana Pandey

Special Thanks

Arvind Gupta (for straw flute video), Dominic Mazzoni and Roger Dannenberg (for Audacity Software), Eklavya Bal Vigyanik Team (for textbooks).

We would like to sincerely acknowledge all the resources that we have referred to for the development of our modules.

A Note for Teachers

Although we are well familiar with motion, it has been observed that students have difficulties in learning about the physics of motion. Research studies show that they find concepts such as average speed, instantaneous speed, constant speed, acceleration, graphs of motion and the difference between the speed and velocity, etc. difficult to comprehend.

Moreover, they do not understand the context of learning motion. The CLIx module offered here tries to create a context for students to learn about motion. It has activities, riddles, thought experiment, control experiment, multi-representational digital tools and specific tools to analyze the data from an experiment. Activities and experiments are designed in such a manner, it encourage collaborative learning.

The module on Motion has been designed keeping in mind that students already know many things from their experiences of daily life and build various concepts in their mind. Some of the concepts they build may be vague but nonetheless it is important for them to understand how these concepts developed and how newer concepts might be constructed.

The module uses students' own knowledge as entry points into the topic and provides adequate opportunities to reflect on what they are experiencing and learning.

Table of Contents

Student Module Name: Understanding Motion

Section 1: Basic Module Information

Prior Knowledge

Before starting this module your students should know the following:

1. Measurement units like unit of length and time
2. Basic mathematical operations like addition, subtraction, multiplication and division
3. X and Y coordinates of the graph
4. Tabulation of the data

Structure of the Module

Lesson 1: Measurement

1.1 Importance of measurement
1.2 Make your own measuring tape
1.3 Measurement of steps
1.4 Standardisation of scale
1.5 Average length of a step
1.6 Be aware of errors in measurement

Lesson 2: Riddles of Motion

2.1 Riddle 1 - Are we stationary?
2.2 Riddle 2 - Is the boat moving?
2.3 Riddle 3 - At rest or in motion?
2.4 Riddle 4 - Same Path or Different Path?
2.5 Distance and time

Lesson 3: Speed

3.1 Scooter Ride Video
3.2 Average speed
3.3 Constant speed
3.4 Instantaneous Speed
3.5 Unit of speed
3.6 Food for Thought
3.7 Let's do the exercise

Lesson 4: Displacement and Velocity

4.1 Distance versus Displacement
4.2 Speed and direction
4.3 Calculating velocity

Lesson 5: Graphs of Motion

5.1 Introduction to Graph
5.2 Let's check
5.3 Interpretation of graph
5.4 Position-time graph
5.5 Speed-time graph
5.6 Let's check

Lesson 6: Run Kitty Run

6.1 Run Kitty Run - A game

Lesson 7: How to Figure Out Change in Velocity

7.1 A way to investigate motion
7.2 Discover your own motion
7.3 Work out change in speed of runner

7.4 Discussion time
7.5 Motion on inclined plane
7.6 Rolling Ball Experiment
7.7 Work out change in speed of ball

Lesson 8: Acceleration

8.1 Video Analysis Tool
8.2 Defining acceleration
8.3 Calculating acceleration
8.4 Unit of acceleration

Expected Timeline

Preparation time: 4 hours
Teachers should spend 2 hours on the digital tools (Video analysis player and Run Kitty Run game) to get familiar with them. They would further require two hours of self-study and preparation for classroom instructions.

Timeline for classroom implementation:

1. Lesson 1 - One hour-long Block Teaching Period
2. Lesson 2 (includes digital activity) - Two 30 Minutes Period or one hour-long Block Teaching Period
3. Lesson 3 (includes digital activity) - Two 30 Minute Period or one hour-long Block Teaching Period
4. Lesson 4 - Two 30 Minutes Period or one hour-long Block Teaching Period
5. Lesson 5 - one hour-long Block Teaching Period and one 30 Minute
6. Lesson 6 (includes digital activity) - one hour-long Block Teaching Period
7. Lesson 7 - Two block teaching periods of an hour each
8. Lesson 8 (includes digital activity) - Two 30 Minutes Period or 1 hour-long Block Teaching Period

Thus, the entire module is planned for ten hours (three weeks) that is it requires ten hours to implement the module in the class.

Time for Assignment: 1 week

Requirements

Please make sure of the following:

1. Assign a notebook (which we call a journal) to yourself. You may write your reflections, experiences and learnings. You can share these with us via the Telegram messenger app or email.
2. You need to have a smartphone to receive messages which you will receive daily on Telegram.
3. You need to have access to a computer that has a browser, audio and video player and internet connection.
4. You will need the following material for 'Make your own measuring tape' activity:
    a. Three A-4 size paper sheets (one side used paper will do)
    b. A sketch pen
    c. Scissors
    d. A meter scale
5. You will also need following material for 'Graphs of Motion' lesson:
    a. Notebook
    b. Graph Papers
    c. Pen/pencil
6. You will need following material for 'Running race' activity:
    a. Find a track at least 40 meter long
    b. Measuring tape or meter scale to measure the track
    c. stopwatches per group to record the time
    b. Paper and pen to note down the data
7. You will need following material for 'Rolling ball experiment':
    a. An aluminum angle of length 160 cm
    b. A marble or a steel ball of 1 inch diameter
    c. Stopwatches

Section 2: Pedagogic Approach

Pedagogic Pillars
This module is designed by keeping the three pedagogic pillars in mind.

Collaboration: In scientific endeavour the collaboration is uniquely important. Peer review and replication of studies are standard practice in scientific research. The scientific community is dependent on one another for generation of valid scientific knowledge. Hence , it is important to provide opportunity for collaboration while learning science.

In both, the physical as well as the digital activities, students need to engage with their peers. All activities of the Motion module have been designed to be done in a group. Group size may vary from activity to activity. For example, students need to work collaboratively in the measurement activities. A group of 4 members is ideal for the activity 'Make your own tape' of measurement lesson. Run Kitty Run digital game is designed as a two player game, where one player can make a bet and other would see if the one was right or not.

A student would have to explain their decisions to their peers. This would serve a dual purpose. The peers would be able to identify gaps in their own understanding and correct it at the same time. They would also receive feedback from their peers about their own work, which would be an additional benefit.

Learning from mistakes: Mistakes and misunderstandings are important sources of learning. We all have intuitive explanations for the phenomena around us. For example, one might think that a moving object stops moving because the force acting on it becomes gradually lesser and after a point it is no longer able to push the object. Examining our mistakes and misunderstandings opens the door to critical understanding of the scientific concepts.

The module has digital and hands-on activities that give students a chance to learn from their mistakes. In the 'Run Kitty Run' game students can play the same level again and again until they succeed. They can apply their learning to catch the mouse at the finish line. As they learn from their mistakes they move forward and complete the next set of attempts of the same level in lesser time. Similarly for rolling ball experiment, the inconvenience in recording the data due to higher slope of the v-shaped channel can be undertaken as soon as the experiment is done.

Authentic learning: In the Motion module students record the data which is supposed to be analysed by him/her to arrive at a conclusion. There are activities which allow students to understand the need for average value, to prepare their own measuring tape to measure the shorter distances, and to have the data of their own speed for the run of 40 meters. The examples used in the lessons are contextualized to make them more relevant to the student.

The notion of motion is very intuitive to all of us. We all have experienced varied speeds. We know that it is hard to maintain constant speed. We have the experience of accelerated motion when a bus or a train picks up speed or reduces speed suddenly and we feel a jerk. We have seen the clouds floating in the sky, the sun rising from one direction and setting in the other direction etc. These and other similar amazing phenomena occur around us every day.

The module on motion sets the context and scope for the discussion about such phenomena. These modules explain motion with specific examples that contextualize the concepts of relative motion and the qualitative description of motion.

An investigative approach has been used to delve deeper into the topic. Moving forward with this approach, students will learn to differentiate between speed, average speed, instantaneous speed, distance and displacement, velocity and acceleration. At places students are given a context to revise their understanding of plotting graphs of motion and reading slopes. It allows them to deduce their prediction, comparing it to observations, comparing different analyses/outcomes and revising them as they are important aspects of theory construction and testing in science.

The module includes a game where students can enhance their understanding of the concept of motion by playing it repetitively. The digital tools help them to apply their previous knowledge and learning and provides a platform where they can test their learning on their own.

Section 3: Notes for Implementing Student Module

Lesson 1: Measurement

Learning Objectives
After going through this lesson, students will be able to:

1. Understand the importance of the units of measurement
2. Identify the need for standardized scales
3. Recognize the errors in measurement
4. Calculate average distance
5. Recognize the importance and the use of the average value

Materials required

1. Three A-4 size paper sheets (one side used paper will do), a sketch pen, scissors, a meter scale, a notebook.
2. Computer lab is not required to complete activities of the lesson. The activities can be performed in the classroom.

Approach

- Students will prepare a 2-meter-long tape using one sided waste paper or newspaper.
- They will measure of distance of 10 meters using this tape. They will count their steps for this distance and then take the average.
- The average length of one step now becomes their scale to measure various distances i.e. distance from school to home, from their class for Head-master's room.
- Some, who have a wrist watch can also keep time to cover these distances. These data set can be used to work out average speed in steps/minute.

Through these activities the students would understand the need to calculate average values. Teachers can explicitly discuss the use of average values. This can be linked with 'Lesson 3: Speed' to reinforce the need and method to calculate the average speed.

Another important concept explored in this lesson is errors in measurement. This is an essential component of learning and doing science. You can ask students to compare the paper tape of one group with another. You can ask them to measure the earlier measured length again, you can ask them to measure the width of the blackboard again and again. They may find it surprising that these numbers will change slightly. You can ask them about the reason for this variance. Repeating the measurement of a given length will give you a value which is better than the last value. You can take them to the point that variance will exist. That is why the need for taking an average emerges.

When students encounter errors, initiate a discussion with them instead of reprimanding them. Discussions about best practices could be held to avoid errors. Students also need to recognize that there are certain errors they cannot avoid. For example, you cannot measure a value lesser than the least count of the instrument.

Lesson 2: Riddles of Motion

Learning Objectives: After going through this lesson, students will be able to:

1. Recognize that motion of objects are described relative to frame(s)
2. Identify the effect of choosing a frame of references on the perceived motion

Materials required

1. A notebook to note down the reflection or discussion points (students may also use notebook feature of the platform).
2. Computer lab is required to complete the activities of the lesson.

Approach
The idea of relative motion, frame of reference and the role of an observer are important concepts to help analyze motion quantitatively and qualitatively. These concepts require a fair amount of

contextualization to build deeper understanding.

In this unit students are asked to think about the concepts without using these terms. We have used a set of videos to create a real context to bring these concepts to the fore. They are in the form of riddles. Students will watch the video and the teacher will conduct the discussion based on observation from videos. The teacher can use a projector to show the video.

Riddle1 - Some things around us appear to be at rest e.g. buildings, trees, mountains etc. while others appear to be moving e.g. moving cars, animals, trains etc. But can we say that the things that are at rest are actually at rest? We know the earth rotates around its axis and revolves around the sun. So the things that appear to be at rest to us would appear to be moving to an astronaut who is looking down from space.

This riddle raises two questions -

1. Why don't we feel the motion of the earth?
2. Why do we consider mountains, building etc. stationary?

To answer the first question imagine a perfectly silent and vibration free vehicle in the form of a train, car or airplane. This vehicle is moving at a constant speed. You have a glass of water. Would the water in the glass appear to be moving? By just looking at the water in the glass can you say the vehicle is moving. Since the vehicle is moving at a constant speed everything inside it appears to be at rest. If the brakes are applied suddenly the water would come out of the glass. The earth's orbit is not perfectly circular. Hence it does not revolve at a constant speed. But the change of speed is very gradual. Hence, we don't feel the motion of the earth.

To answer the second question, imagine you are inside a train. A person sitting on the ground might describe the motion of the train from east to west or she might refer to some stationary object i.e., from one building to another. But if asked, you will describe the motion inside the train with reference to the objects inside the train that are at rest with respect to the train. For example, the rat went under the seat. It is easier and it serves your purpose. Similarly on earth, we usually describe motion with reference to things that are stationary with respect to the earth. For example, ground, buildings, mountains, etc.

Riddle 2 – Ask students if the boat is moving? Further, ask for the reference point of the movement. Is it moving with reference to the water? Would it appear to be moving with reference to the boatman or any object that is on the boat?
Then the discussion should move towards why is it difficult to figure out from the video if the boat is moving or not. Ask them if seeing the shore would have made it easier to tell if the boat was moving? Why? Why are we not able tell if the boat is moving by looking at the water only.

Riddle 3 – Begin with asking the question if the boats are moving. In response to students' answers, ask in reference to what the boat is moving. The discussion should move towards the issue of defining rest and motion – how to define the state of rest or motion if both objects move in the same direction with the same speed. Is their position changing with respect to one another? Can we say that they are stationary with respect to one another? Is the boat moving with respect to the land? Would the boat appear to be moving with respect to a boat moving at a different speed or in a different direction? (the third video)

Riddle 4 – It brings out the role of the observer in describing an event. The video captures an event from the perspective of two observers who are at different frame of reference with respect to each other and with respect to the event too. As the event appears to them differently they also describe it differently.

Lesson 3: Speed

Lesson Objectives: After going through this lesson, students will be able to:

1. Calculate average speed using total distance covered and the time taken to cover it
2. Differentiate between average speed and instantaneous speed
3. Differentiate between constant speed and average speed
4. Recognize the use of average speed and instantaneous speed in daily lives
5. Identify the units of speed

Materials required

1. A notebook to note down the reflection or discussion points (students may also use notebook feature of the platform).
2. Computer lab is required to complete the activities of the lesson.

Approach

The lesson contains a video of a scooter ride, it has some information about the distance and time the rider takes to complete a journey. In the video, use the milestones as a reference for the distance and watch for the time. At some points the speedometer of the scooter is focused upon in the video to highlight varying speed of the scooter and the speed at particular point of time i.e. instantaneous speed.

Students are supposed to find this out themselves from the video. This data set is further computed to derive the average speed equation.

There is a small assessment attached with the first page of the lesson. This will help students to reflect on the data and do some mental calculation. Teachers could use the blackboard to help students recall the data that they have collected from the video. Teachers could also explain the assessment question if the students find it difficult.

At the end of the lesson students should be able to learn about the average speed, constant speed and instantaneous speed. The students should recognize that a vehicle travelling at the average speed of X km/hour during a journey does not indicate that it was travelling at the constant speed of X km/hour throughout the journey. Also from the instantaneous speed we won't be able to calculate the average speed; we would need to find out the distance covered and the time taken to cover it.

Link it with the data of the paper tape activity in lesson 1. Students can use the average speed formula, to compute their average speed to reach school from home by referring to the data set generated in the lesson 1 exercise. You can further discuss with them the reason for this speed varying from one day to another.

Lesson 4: Displacement and Velocity

Lesson Objectives: After going through this lesson, students will be able to

1. Differentiate between distance and displacement
2. Differentiate between speed and velocity
3. Calculate velocity velocity using displacement and the time taken for the displacement

Materials required

1. A notebook to note down the reflection or discussion points (students may also use notebook feature of the platform).
2. Computer lab is required to complete the activities of the lesson.

Approach

This lesson is more on the application side. Hence, make students work on the computer for this lesson. Students will work in pairs to complete this section.

Velocity has been elaborated here in detail. There are animated examples to help students to visually understand what does it mean when we say velocity is "speed with direction".

Context have been built where velocity has been worked systematically out of a given problem.

Lesson 5: Graphs of Motion

Lesson Objectives: After going through this lesson, students will be able to

1. Recall their basic understanding of graphs
2. Interpret the nature of motion from distance-time graph
3. Plot motion on distance-time graphs
4. Interpret the nature of motion from speed-time graph

5. Plot motion on speed-time graphs

Materials required

1. A notebook to note down the reflection or discussion points (students may also use notebook feature of the platform), graph papers, and pen/pencil
2. Computer lab is required to complete the activities of the lesson.

Approach

Students are to work on computer in pairs. They should also use their notebook while working on the computer.

Graphs are one of the most important tools in science to display information. In this lesson we detail two types of graphs – distance-time (or position-time) graph and speed (or velocity-time) graph. The first one helps us see how position of a moving object is changing with respect to time. In the second we get to see how speed is changing with respect to time.

We have well described event in the module around which graphs have been built. In some exercises students will find out the missing data after reading the slope and in some they will use the data to fill up the missing slope piece on the graph.

You can use it to revise the graph with students, which is essential to learn about motion. Graph literacy also helps them in learning about equations of motion.
Student should be able to read the slope easily and say what type of motion it represents.

The section has some assessment pieces too. They will help teachers learn whether students have developed a grasp over the concept or not.

Lesson 6: Run Kitty Run

Lesson Objectives: After going through this lesson, students will be able to

1. Apply and test his/her understanding of speed
2. Apply and test his/her understanding of graphs of motion

Materials required

1. A notebook to note down the reflection or discussion points (students may also use notebook feature of the platform).
2. Computer lab is required to complete activities of the lesson (One computer per two students is Ideal).

Approach

"Run Kitty Run" is a two player game. Students have to ensure that the kitty catches the mouse on time. The game involves player 1 altering the settings of the game so that the cat catches the mouse right on the finish line. This earns the player one star. If the cat catches the mouse early or is not able to catch it at finish line then she loses. After player 1 has fixed her settings, player 2 has to bet if the cat would catch the mouse 'early' 'on time' or 'late'. On making the correct prediction player 2 earns one star.

The game has a tutorial and 7 levels. The students can go through the tutorial. If the teacher explains it then this can be skipped. At level 1, the mouse goes first. The player 1 adjusts the speed of the cat which goes after a delay of some seconds. At all levels, the task of player 2 remains as described in the first paragraph. At level 2, the students do the same thing as level 1. In addition they can check the effect of changing the speed of the kitty on the Position-time and Speed-time graph. At level 3, the graphs appear after the race is completed. So the student have to make the prediction first but they can check where they went wrong graphically after the race ends. At level 4, the speed of the kitty is fixed, the students have to set the time delay so that the kitty catches the mouse. Level 5 is similar to level 2 but the difficulty level is higher. Level 6 is similar to level 2 but students are provided only with speed-time graph. At level 7, student are provided with the position-time graph. The kitty and the mouse start together without any delay. Player 1 can increase and decrease kitty's speed but she can't see its exact value. The players are

provided with a position-time graph. The player has to set the speed using the graph.

'Run Kitty Run' is a multi-representation game which will allows students to apply their knowledge of speed as well as the position-time and speed-time graphs. This will help students to contextualize graphs of motion and enable them to practice their knowledge under different circumstances that the game creates.

Lesson 7: How to figure out change in velocity

Lesson Objectives: After going through this lesson, student will be able to

1. Differentiate between uniform and nonuniform motion
2. Identify if a motion is uniform or non-uniform by collecting segment-wise data
3. Find out change in average speed of a ball rolling down on an inclined plane

Materials required

1. A long track to run (24 meters long at least), stopwatch, v-shaped aluminium channel, steel ball or marble, marker (sketch pen/chalk or something), meter tape/scale and A notebook to note down the recorded data and reflection or discussion points (students may also use notebook feature of the platform).
2. Computer lab is not required to complete the activities of the lesson. Activities can be performed in the classroom.

Approach

In this part of the chapter we try to understand uniform and non-uniform motion. Till now we have discussed to analyze and describe manner in a qualitative manner. But in this lesson we would engage with motion in a quantitative manner. The students will carefully record data and analyse it to arrive at their conclusion. They need to record both position and time precisely.

We use a real life example here.

A. A short sprint – minimum 40 meters, maximum 60 meter.
B. A bicycle rolling down the slope.

Preparation: a teacher need to prepare for the activities. The material needed here is as follows:

1. Set of stopwatches or mobile phones – 4 per group; they can be rotated among different groups. You can also take the help of another teacher to manage more group of students this way.

2. Form a group of at least 6 students, give every group a name. this way identification becomes easy if you have large number of students.

3. Roles – before they start the activity – please explain to them and one student will become the record keeper with table to record the data. 4 will stand on the four segment points of the running track – they will be called the time keepers. And one runner will run. All students will have to run. Therefore, once the first person's race is over, she will replace one of the 5 members from their assigned role and take their role. At the end of activity every student would have played the role of timekeeper, record keeper and the runner.

Every student will run for minimum three times.

4. Table to fill up the data – the table is given in the student module. Please ask every student to make it in their notebook.

5. Place arrangement – you need a place for students to run. A minimum length of 24 meter will work – please ask students to measure it and divided into four equal parts and mark these points.

Students should be given some time to practice with stopwatches.

Work in the classroom: The first session of this chapter begins in the class.

You would present them with the following scenario ask them to write their answer answers in their notebook. This answer will become a reference point for them to compare their finding from the activities:

1. Suppose you are running a 60-meter race. Could you try to imagine how would you run this race from start to finish? With the same speed? Will you speed vary? How will it vary?
2. If you rolling down a bicycle on the slope, without pedaling, if the motion of bicycle change or not? If no, why? If yes, how from start to finish?

Then they will conduct the activity.

Running race activity: Using the data, they can plot their position-time graph and compare each other's slopes. They can also work out the average speed for each segment, compare which one was faster in which segment and whether anyone has the same average speed in each segment or in every segment the average speed was varying?

You can ask them to compare their assumption about the way they run with real time data? How does it differ? Can they confidently speak about the nature of their run? What helped them speak confidently? Was it the data?

Students may come to the conclusion that their motion on the track was non-uniform. Data tells them so. Without data we could not have described this motion precisely.

Similarly, many of the real life motion events are non-uniform in nature. But the only way we can conclusively say about them if we either break the whole motion path in smaller equal segments and record the time of each segment or if we record the distance covered in every second? Please emphasize on this method to be used to describe motion in detail.

The smaller the segment the more conclusive our description would be.

A bicycle rolling down the slope: It is difficult to get real time data of the bicycle on the road. Here we introduce the concept of a control experiment. Instead of doing the original experiment, we do a similar experiment that is easier to perform. The road becomes the aluminium angle and the bicycle becomes the marble or steel ball. Students divide the distance into 5 segments of 30 cm each and record the time to cover each segment.

If you have 5 stop watches then the entire activity can be done in one go. One person will leave the ball while 5 timekeepers will record the time as the ball passes from each segment.

If you have one stopwatch one student can drop the ball while the other can record the time, one by one for different segments.

They fill the data in their notebook. The table is given in the student module.

They will process the data, work out the average speed for each segment and then try to describe the change in motion using this data.

May be they describe that speed of the ball was increasing as the ball was rolling down the plan.

Compare it with a running race. For example, in a running race, the average speed was varying unevenly – in some it was high, whereas in some it was slow, whereas in the rolling down the speed was getting gradually higher. Both are examples of non-uniform motion.

Lesson 8: Acceleration

Learning Objectives: After going through this lesson, students will be able to

1. Define acceleration
2. Calculate acceleration of a ball rolling down an inclined plane by video analysis
3. Identify units of acceleration

Materials required

1. A notebook to note down the reflection or discussion points (students may also use notebook feature of the platform).
2. Computer lab is required to complete the activities of the lesson (One computer per two students is Ideal).

Approach

The video analysis player (a digital tool) is used to analyse the motion of the ball. By this time students would have done the rolling ball experiment. Continuing the same experiment, students can analyse the acceleration of the ball using the video analysis player. Five videos of the rolling ball experiment are given in the resources section on the TISSx platform.

To browse the video, first go to the resources, then go to the 'Rolling ball' video new, click any of the experiment videos out of five. Download the video.

You have to make sure that while playing with video analysis player, you need to set the frames as 30 fps. The tutorial (video) of how to use video analysis player is given in the student module.

Before we start acceleration, we should appreciate that it is one of the most difficult concepts for students to understand in this section. We need to deal with it carefully. Students are generally familiar with the term, accelerator, as they use it often in the context motorbikes or vehicles. In Chhattisgarh, students responded by saying that accelerator is used to give 'race' to the vehicle. You can also ask them what happens when there is a sudden change in speed – increase or decrease, race up or race down? Then you talk to them about a situation like the following: you are on a bus going at a constant speed/motion. For 10 minutes it goes like this, then suddenly the driver speeds up, the speed change goes for a minute, then again a 10-minute patch of smooth ride, then again a one-minute patch of sudden speed down. In dealing with acceleration we are interested in those parts of the motion where there is change in speed/velocity. One of the major problems for students is how to compute acceleration and why it has the unit of time appearing twice.

So stepwise this is how we should progress

1. Help them figure out how do we feel acceleration and what happens with respect to the speed at those points
2. Use the video and clock to help them understand that we are concerned about the change in speed in given interval of time. Speed is already a ratio/rate of distance over unit time. Acceleration is a further rate of – distance over time over time.
3. Initially you help them understand km/h/minute (using video); meter/minute/sec
4. Then bring them to the unit which is generally used – meter/sec/sec which is also written as meter/sec 2 .

Here we generally use examples of uniform acceleration for students to first help them understand and to enable them to calculate it easily.