5.5 Speed time graph

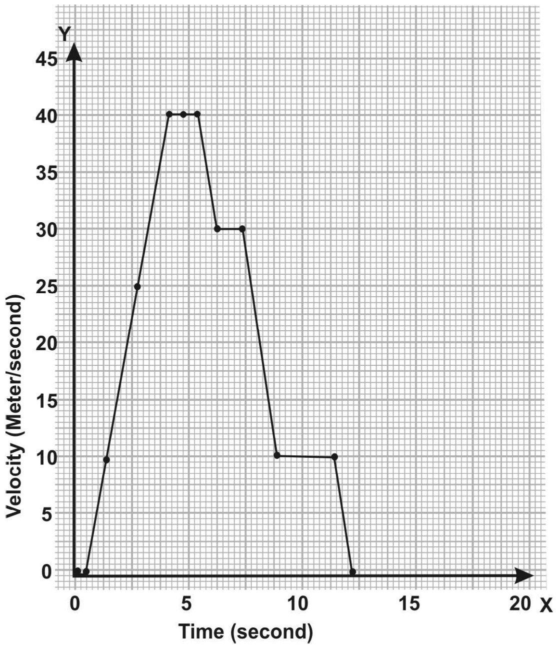
Let's do exercises

1. The graph represents a motorcycle ride.

(i) Mark the point(s) on the graph that shows the motorcycle is at rest.

(ii) Mark the point(s) on the graph that shows motorcycle with constant velocity.

(iii) Complete the given table based on the graph.

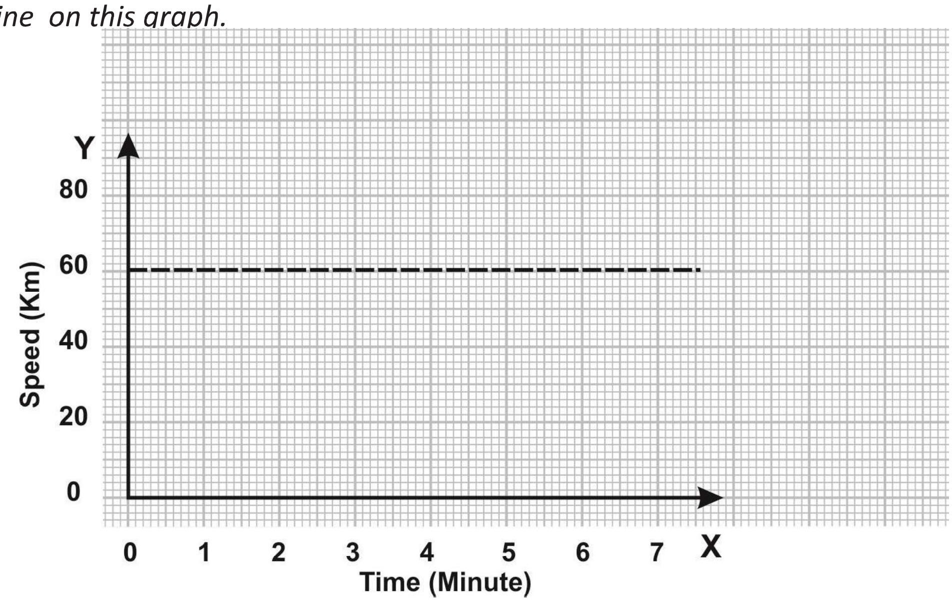


(sec)	Speed (m/s)
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

2. *Police control room receives an information that a black suspicious car is going to pass, please stop it and check it. At 12'o clock the car moves past the front of the station. The police start their patrolling jeep exactly at 12'o clock but for 2 minutes they could not move the jeep due to some engine issues. Please answer:*

   (i) If the car is moving still why the line is running parallel to the x axis horizontally?

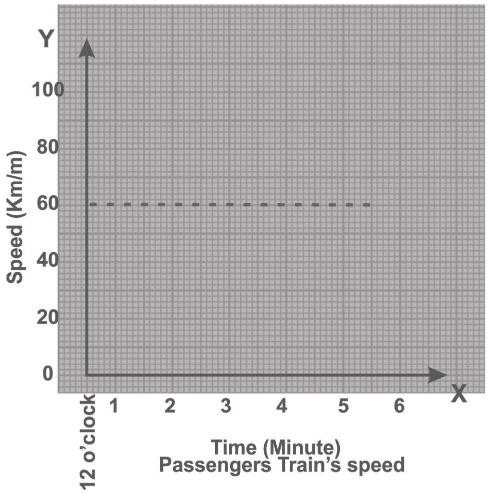
   (ii) Please draw the first 2 minutes of the police jeep when it was not able to move. Draw the line on this graph.

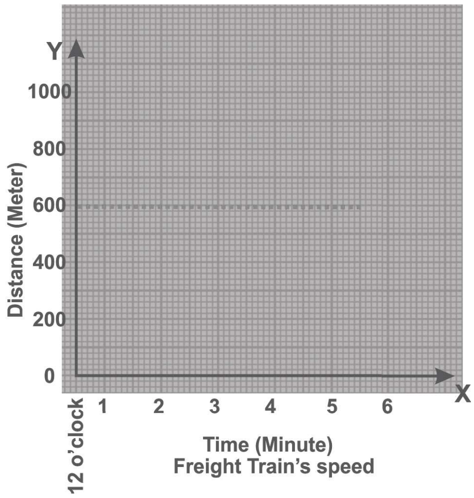


3. *Look at the graph and answer the following:*

   (i) Please identify which train is in motion and which is at rest.

   (ii) Tell us how these graphs are different.

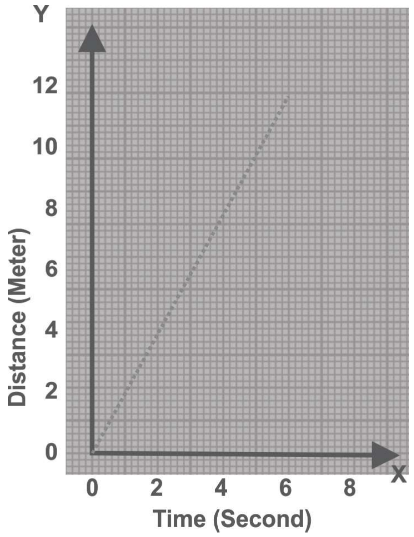


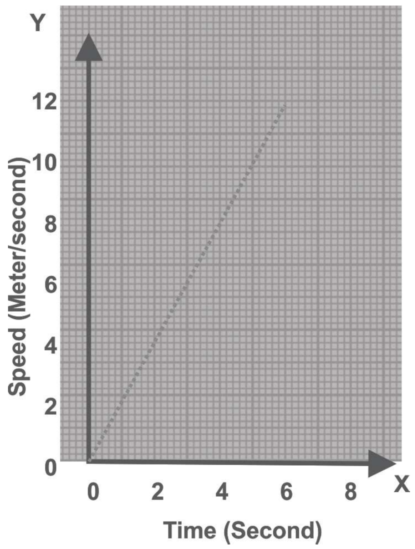


4. *Use the data given in the table below to plot the graph of two objects moving with different velocities.*

Time (sec)	0	1	2	3	4	5	6
Object 1 speed (m/s)	0	2	4	6	8	10	12
Object 2 speed (m/s)	0	1	2	3	4	5	6

5. *Look at these graphs – Do they represent same kind of motion? How do they defer from each other?*





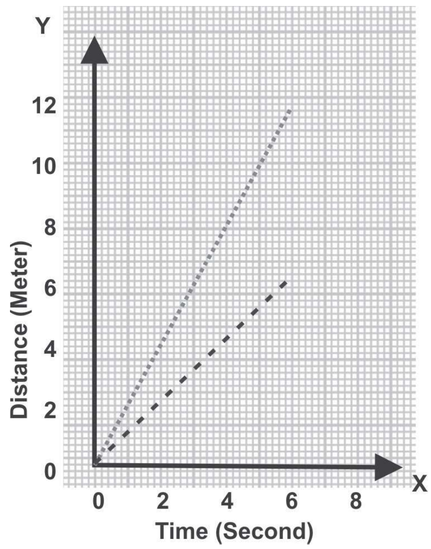
Look at the velocity-time graph of a moving object. The area enclosed by the velocity-time curve and time axis gives you the total distance covered by the moving object. You will learn this in the equation of motion. Please fill up the blanks to get the distance for the graph given below.

Area of a triangle = ½ x a x b

= ½ x......x.......

= 36 unit

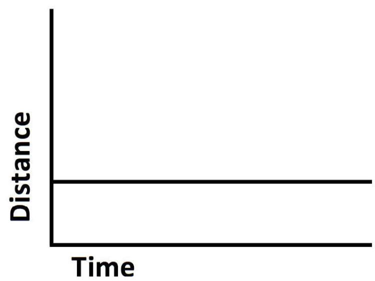
You will use this method to find the distance in section on equation of motion, where you will learn how to relate four quantities to get equations to work out complex problems of motion.



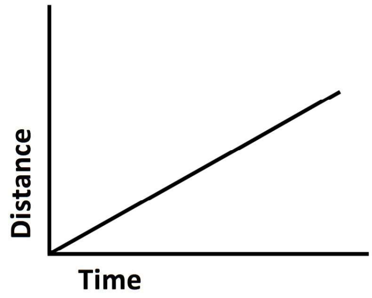
5.6 Let's check

Here are the few questions based on what you have learnt, let's check and try to answer them:

1. What does the graph explain about the state of the object?
   a. Object is at rest
   b. Object is accelerating
   c. Object is moving with a fixed speed
   d. None of the above

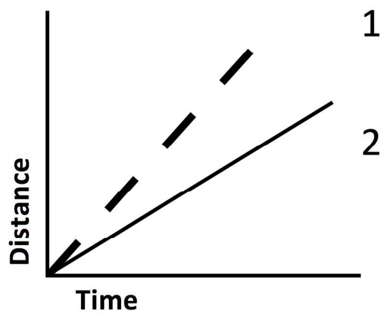


2. Now, what do you think this graph explains about the state of the object?
   a. Object is at rest
   b. Object is accelerating
   c. Object is moving with a fixed speed
   d. Both (B) and (C)

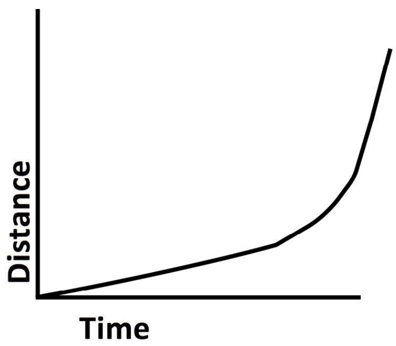


3. Compare the slopes and choose the correct option:

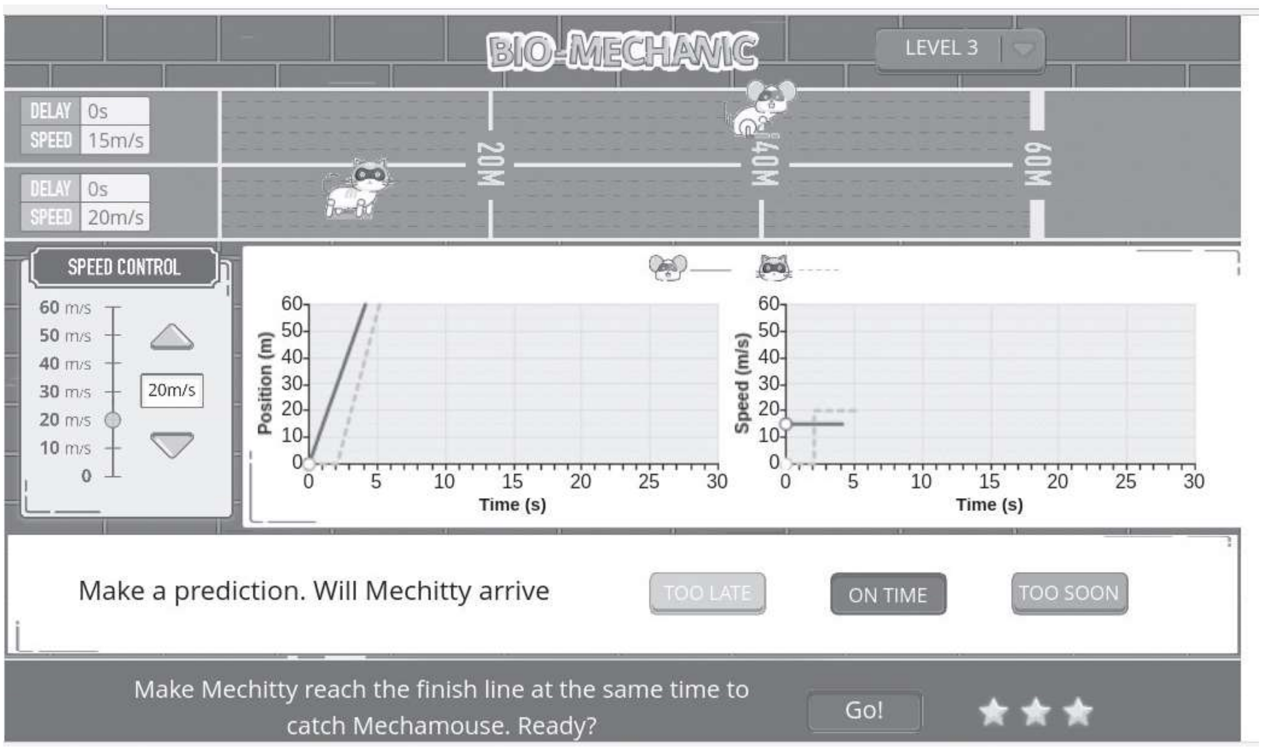
a. (1) is accelerating at a faster rate
   (2) is accelerating at a slower rate
b. (1) is accelerating at a slower rate
   (2) is accelerating at a faster rate
c. (1) is moving at a slower speed
   (2) is moving at a faster speed
d. (1) is moving at a faster speed
   (2) is moving at a slower speed



4. Now, come on... how do you interpret this curve?
   a. None of the above
   b. The object is accelerating for the whole time
   c. The object is stationary for some time then accelerating
   d. The object is moving at a constant speed



Run Kitty Run Game



In the game you had various tools – time (delay), speed and graph to work out the speed of your cat to match the speed of the mouse which was being controlled by the computer itself.

You also got an opportunity in the game to link the motion on the track with the position-time graph.

At some level you also change the slope on the track to change the speed of your kitty.

The game also helped you to check your estimations about the speed or time that the cat would take to catch the mouse.

Hope you enjoyed the game.

How to figure out change in velocity

7.1 A way to investigate motion

Is the cycle moving with the same speed between the two points or is the speed varying?

If the speed of a moving object does not change with time, we call it to be in uniform motion.

Say, if an ant covers 1 cm distance in one second and continues to cover same 1 cm distance in every second we can say it is in uniform motion.

If the speed of a moving object changes with time, we call it to be in non-uniform motion.

Say, if another ant covers 1 cm in first second, 2 cm in the next second, 1.5 cm in the third second we can say it is in non-uniform motion.

Non-uniform motion is quite common, everyday examples including a bus traveling on the road, birds flying, breeze blowing, water flowing. It is difficult to find the examples of uniform motion around us.

To be precise, we need to get some data to prove our point in science. Simply saying something does not work in science.

So how do you prove if a motion is Uniform or Non-Uniform?

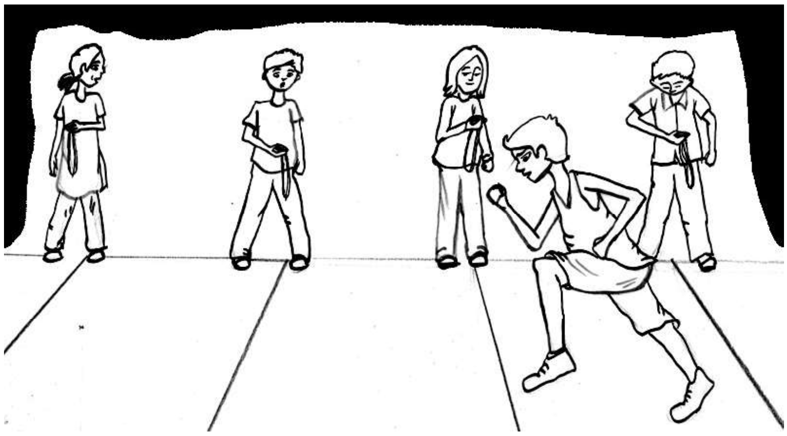
Before we learn a method to investigate motion, let us try to answer the following questions:

Suppose you run a 50-meter race. Could you estimate whether you will run from start to finish at the same speed or whether your speed will vary?

You may have also ridden a bicycle down a slope without pedalling. Did its speed increase as it rolled downhill? Did the speed keep on increasing?

7.2 Discover your own motion

A running race activity



Investigating motion of a runner in a race and analysing whether the motion of a runner is uniform or non-uniform.

You need to organize a running race event. The entire class will participate in it in groups of six members each.

Following are the details of the activity to be conducted.

Material required to perform the activity:

1. Measuring tape or meter scale; to measure the track
2. Four stopwatches per group; to record the time
3. Paper and pen; to note down the data

Process to do the activity:

1. Find a track at least 40 meter long and divide it into four equal segments. For example a 40 meter track could be marked at the intervals of 10, 20, 30 and 40 meters.
2. Place one of the group members as a timekeeper with a stopwatch at each segment to record the time.
3. Set a starting point and ask one of the group members to run till the end point.
4. Note down the data for the run.

With a loud sound "Start" the person starts the race. All timekeepers keep their stopwatches to zero. Once the runner passes the first segment, the first timekeeper standing there stops his stopwatch. The same process is observed for each segment till the runner crosses the end segment point.

7.3 Workout change in speed of runner

Change in speed: running race activity

Collate data of the running race activity and calculate the average speed of the runner. This will give you an insight whether the speed of runner is uniform or non-uniform throughout the race and if there is any variation of speed through the various segments.

Hope all of you have looked at your data. Now let us reflect on the following questions before moving ahead.

Table 7.3 (a): Time Taken **Note: You may also choose a track of different length and change the table accordingly.**

Username of the participant	Time taken (sec) for Segment 1 (0-10 meter)	Time taken (sec) for Segment 2 (10-20 meter)	Time taken (sec) for Segment 3 (20-30 meter)	Time taken (sec) for Segment 4 (30-40 meter)

Table 7.3 (b): Average Speed

Username of the participant	Average Speed for Segment 1	Average Speed for Segment 2	Average Speed for Segment 3	Average Speed for Segment 4

Did you take same time to run each segment? Was your run uniform or non-uniform?

You can use the following equation to calculate the average speed. Do not forget to write the unit of speed.

$\Delta V = d_1 - d_0 / t_1 - t_0$

7.4 Discussion time

You have done the activity and collected the data. You may have experienced something that you might not have thought of. Here are few questions for you to analyse what you have done.

Do you have same average speed in the different segments of the track? If no, then what could be the reason(s).

If you had only initial and end points, would your average speed give you any indication of the way your speed varied while you were running?

Is the speed maximum at the end point of the race? Did you run so that your speed kept increasing from the beginning to end?

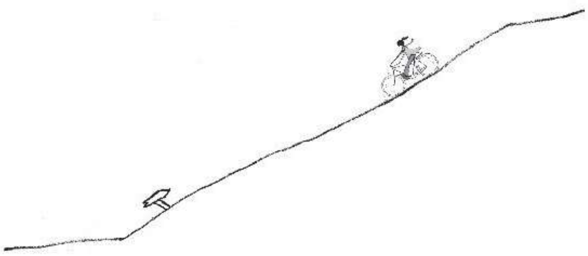
Did you take the same time to run each segment? In the race, did you run with constant speed?

If the motion for a particular time interval is uniform, what is the possibility of the motion becoming non-uniform if the time interval is shortened?

In principle, we can make the time interval shorter and shorter. But in reality, there is a limit to what we can measure. So the time interval should always be clearly specified.

If we analyse the data of all the runners in your class, we can find out who the fastest runner is and who is fastest in each segment. The running example gives you an idea about one kind of non-uniform motion where the change in velocity is irregular.

7.5 Motion in inclined plane



How do you run on a slope

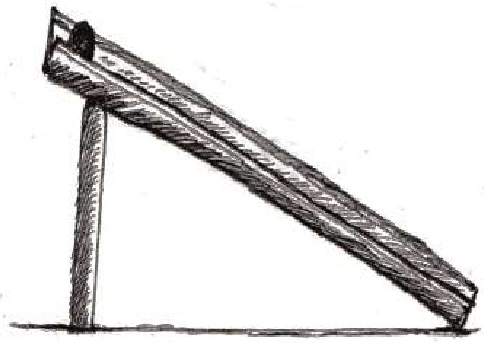
Suppose you are riding a bicycle on a hilly road. From the running race activity, you know that to predict the nature of motion we need to record the distance covered by an object in shorter and equal time intervals.

For a cycle on a real road, it will be difficult to record data – there will be other people and vehicles on the road, it will be difficult to find the right place to sit and spot the cycle etc.

In that case, there is a need of designing an experiment that recreates the same event in your classroom. Using this you can observe some parameters of the event and make a close guess about the real life event.

This in general is called a control experiment or a model of a real life situation.

7.6 Rolling ball experiment



Control experiments help scientists study a system in great detail

Now, let us design a control experiment that will be similar to the bicycle ride on the slope. It will help you to record data with better accuracy. Here we are replacing road with an aluminium or wooden plate and cycle with a steel ball or a marble. We are calling it as "Inclined Plane Experiment".

Material required to perform the experiment:

1. *An aluminium angle of length 160 cm*
2. *A marble or a steel ball of diameter 1 inch*
3. *Stopwatches*

Setting up the experiment:

Place one end side of the aluminium angle at a higher point to give it an inclined slope. If the ball is moving too fast, then it will be difficult to take precise measurements. For this, you need to figure out just the right height for the ball to roll down smoothly from the beginning to end.

Process to do the experiment:

1. *Choose any one end of the angle and mark a line across its width at 1 or 2 cm. This is your starting point or zero point at 0 cm mark.*
2. *Now measure the rest of the angle's length and divide it such that each segment is of length 30 cm. (You will get around 5 segments).*
3. *Raise one side just enough so that if you leave the steel ball from top, it smoothly rolls down till the end.*

4. Use stopwatches to record the time it takes to cover each segment.

Note: Please coordinate in your group so that everyone gets a chance to record the time.

7.7 Work out the change in speed of ball

Change in speed: rolling ball experiment

Here is the table to record the data of the experiment. Repeat the experiment as many times as needed to be able to record the time for each segment of 30 cm for at least four different runs.

Let us reflect on what we have done in order to analyse the speed of the ball:

Was it easy to record the time?

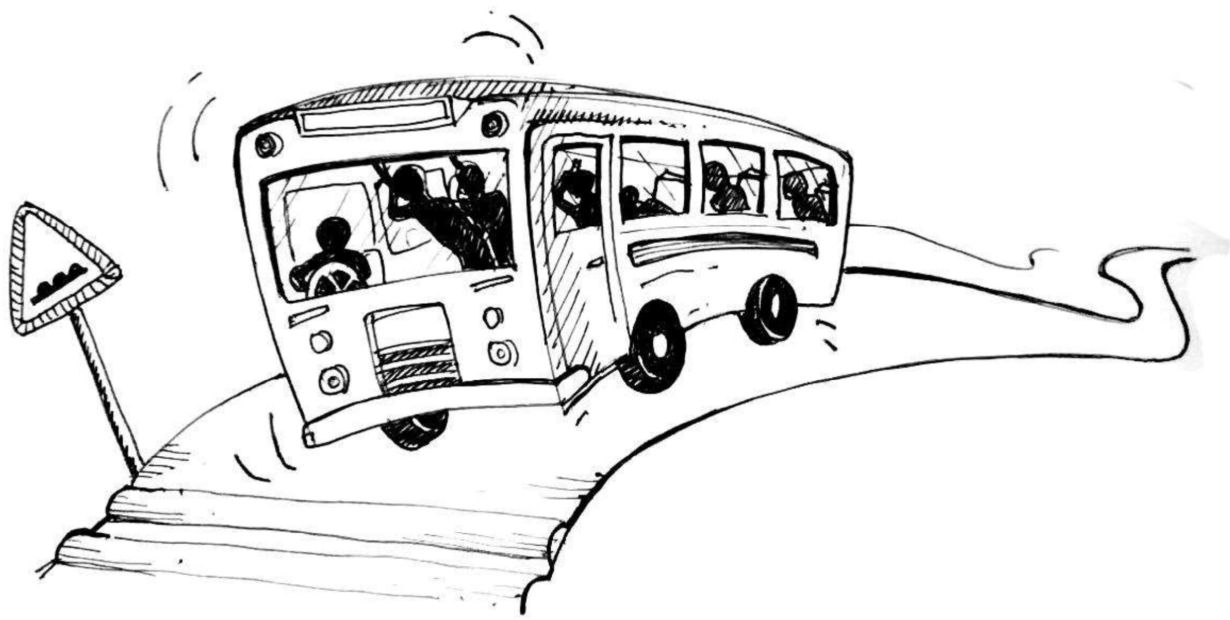
Was the error manageable or high?

Does the speed of the ball change with time?

Table 7.7: Rolling Ball Experiment

Segment	Time t for 1st run (s)	Time t for 2nd run (s)	Time t for 3rd run (s)	Time t for4th run (s)	Average time (s)	Average Speed (m/s)
0-30 cm						
30-60 cm						
60-90 cm						
90-120 cm						
120-150 cm						

Acceleration



In the previous lesson you have done the running race activity and rolling ball experiment. You observed that the speed of ball was not constant over the different length segments of the angular channel. To verify, you may refer the data you have collected. You worked out the change in speed in one second by analysing the data you recorded.

In this lesson, you went through a video analysis tool which allowed you to record the position of the ball at every 30th part of a second and further analyse its motion. It also generated position time curve for every set of data. In this way you analysed acceleration of the runner and the ball rolling down on a channel.

Further, the story of a bus was depicted on a velocity-time graph. The graph showed the accelerated, unaccelerated and decelerated motion of the bus.

At the end, you have also gone through an example of the train whose speed decreases to zero on applying the brake. It showed retardation.

SOUND

Notion of sound is prevalent around us so to laid foundation of sound is important. Hearing, speaking or producing sound is more familiar to us but do we really know what is sound, how is this produced, how does it propagate. Sound is intangible and could only be indirectly perceived/felt. Sound is common but physics of sound is not trivial.

Content

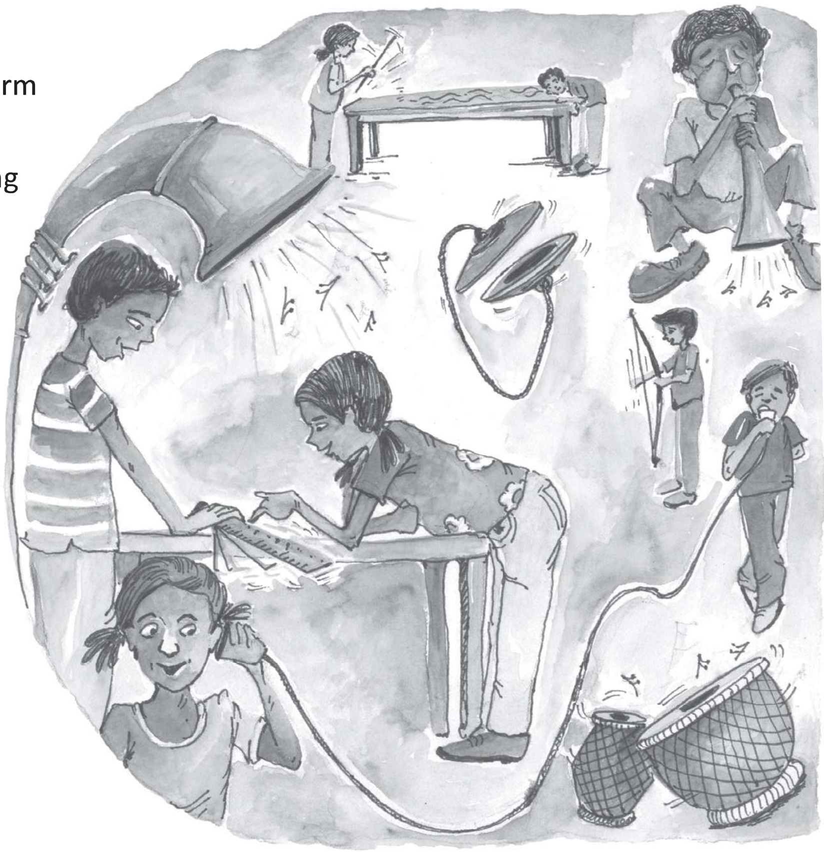
Sounds Around us

1.1 Introduction

All of you are familiar with the term 'sound', right!

You might have heard the chirping of birds, the rustling of leaves, the honking of vehicles, the melody of flute or any musical instrument i.e guitar, harmonium, tabla, dhol, the whistle of train, the bell of a cycle, the alarm clock, etc. We perceive all such sounds through our hearing sense, with the help of the organ-ear.

Let us explore and understand the sounds that we hear. What is sound? How is it produced? How does it travel?



1.2 Where are these sounds coming from?

Listen to the audio clip in the ***computer lab***. Identify the different sources of sound and list them down in your notebook.

Exercise

Sit somewhere in your house. For two minutes, close your eyes and listen to the different sounds that you can hear. Now draw a map showing these different sources of sound in your notebook or on a piece of paper. Please note down the time when you listened to these sounds.

1.3 A science classroom like yours

In the ***computer lab***, watch a video in which a teacher is dealing with the topic of 'sound' . To start with, she wrote on blackboard 'What do you want to know about sound?'.

Exercise

You might also have questions/queries regarding sound. Write your question(s) below.

1.4 Make sound(s)

(i) Make sound(s) with things around you

1. Make a group of 5 members.
2. Make a sound(s) using things around you - e.g. in the classroom/in your bag/ pocket. You have 1 minute to do this. It should be different from other groups.
3. Show it to the class.

(ii) Make sound(s) with things given to you

1. Work in the same group.
2. Make a sound(s) using the thing(s) given to you. You can combine two or more things and you can also use them separately. You have 5 minutes for doing this.
3. You can also use things other than what are given to you.
4. Show it to the class and explain the following:
   (a) How is the sound produced in the design that you made? Is it by blowing, hitting, plucking or in some other way?
   (b) Identify which part of the design is making the sound?

1.5 Sound is vibration

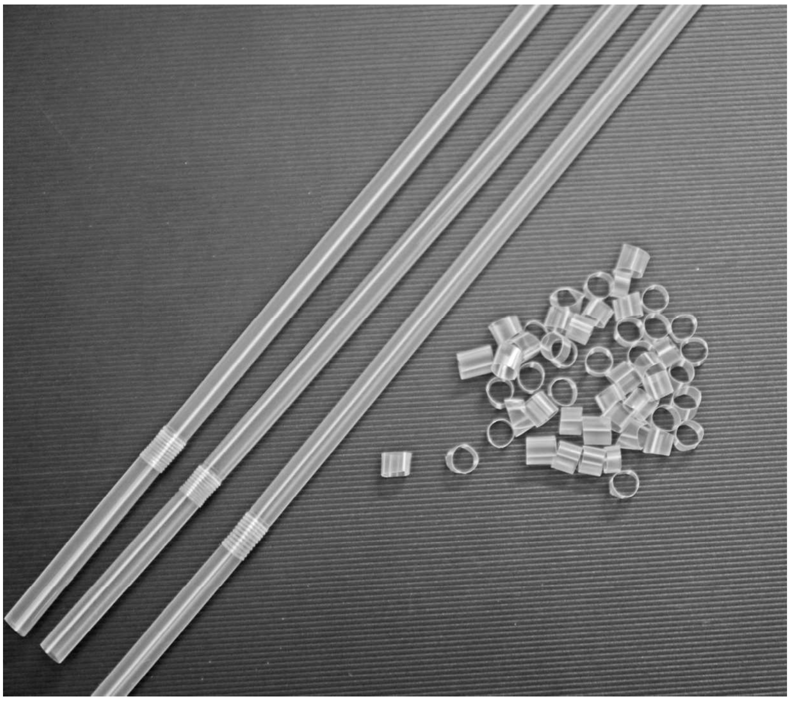
You noticed that sound, in most of the designs, is generally produced by blowing, hitting or plucking. When two objects hit each other, they vibrate and the vibrations produce sound.

For further exploration
Some vibrations stay for a longer time, that is why we are able to listen to the sound for a longer time example- vibrations of a bell and of a steel plate. Other vibrations die out quickly and their sound stops immediately like the banging of the table, the stamping of your foot on the ground, the splashing of water on the floor. What other examples can you think of?

Try it out
If we ring a bicycle bell and cover it with our palm, the vibrations stop immediately. Why do you think this happens?

1.6 Seeing vibrations

We can directly see things vibrating or we can feel the vibrations by touching things. Let's do an activity to see vibrations when we make a sound.



Activity

Dancing rings on the base of the cup

1. *Hold a paper cup in an inverted position*
2. *Cut a straw to get rings (as shown in the figure)*
3. *Now put the rings on the base of the paper cup*
4. *Hold the cup with both hands close to the mouth and shout into it.*

Why do the straw rings jump around?

You can feel vibrations by touching. You can do this using the paper cup itself. Hold the paper cup inverted and shout. Ask your friend to touch the base of the cup while you are shouting into it.

You can also feel the vibration of your voice. Place your fingers gently against your throat and say 'aaaahhh' or 'hmmmm' or 'hooooo' or any sound- and say it a little loudly.

Where are the vibrations?

You may have experienced that sound is produced by moving a palm of your hand briskly near your ear, by moving a long stick briskly, by jerking a towel, by waving a flag, by clapping, by hitting of a stone on the ground etc. Here you can hear sound but it's hard to see the vibrations.

So, it is possible that sound is produced but you cannot see the vibration or vice versa.

Think of such examples where we do not see two things hitting each other but they produce sound and write about them here.

For further exploration
Hold a bottle opening near your ear and listen. Now fill some water in it and listen. Did the sound change? Now hold a glass or a vessel to your ear. What do you notice? How is the sound produced?

Knowing more about sound

2.1 Loudness

Loudness of the sound corresponds to its amplitude.

In the ***computer lab***, you can watch a video to see the amplitude of three balls moving to and fro from their mean position.

Amplitude is the maximum displacement of the vibrating particle from its mean position.

Amplitude using Audacity

In the computer lab, we will use a tool to “see” sound on the computer screen. There are several buttons at the top left corner of the tool. We are going to use the “record” and “stop” button in the tool. Keep the microphone close to the source of sound.

Suppose you choose to snap your fingers. Now press the “record” button. Snap your fingers gently and then snap them hard. Click on the “stop” button.

You can see that the louder sound has a bigger wiggle and the lower sound has a smaller wiggle.

You can say that the louder sound has higher amplitude than the lower sound.

Now choose the sounds that you want to “see”. For example you can clap or bang the table or say “aaa” - change the volume of the sound and observe the amplitude of higher and lower volume. You can also look at the wiggle for the sound made by your design in section 1.4.

Changing volume means you are changing amplitude.

For Further exploration
What does the wiggle stand for? It shows the electrical signal that the microphone sends to the computer through the wires. But how does a microphone work? Are the ears our body’s microphones? Do they also send a wiggle to our brain through the nerves?

2.2 Pitch

A shrill or piercing sound is also called a high-pitch sound.

We use one more term for shrillness - that is pitch. Shriller the sound higher the pitch. For example compare the sound of buffalo and of goat. Goat's sound is shriller than buffalo's sound. So, we can say that the goat has a high pitched voice and the buffalo has a low pitched voice.

In the computer lab, watch a video in which you can see the difference between a less shrill and a more shrill sound.

We saw that sound is vibrations. The number of times a particle/object vibrates in a second is called frequency. If it vibrates more number of times in a given time, we say that its frequency is higher. Frequency of vibrations decides the pitch of the sound. Higher the frequency higher the pitch, lower the frequency lower the pitch.

For further exploration

What is the frequency of the rotation of the ceiling fan?

As a ceiling fan speeds up, beyond a point we are not able to see its blades. This is a limitation of our eyes - we can't see things that move too quickly. The sound vibrations also occur too rapidly for us to observe them. For example, if we look at a speaker (watch the video in 4.1), we can see that it vibrates but we are not able to count the number of times it vibrates in a given time.

2.3 World of music

Music is the combination of different sounds i.e. sounds of different frequencies and amplitudes.

Sing a song that you like or speak something into the microphone and record it. Look at the wiggles on Audacity. What do the shapes of the wiggles tell us? Compare the wiggles of loud and low voice.

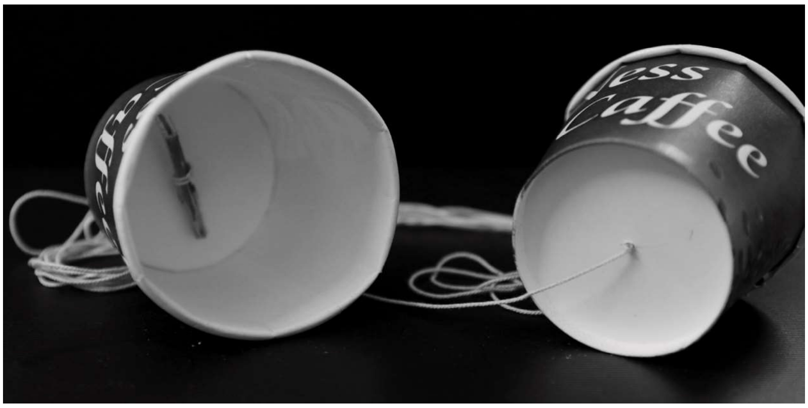
Project: Making your own music

Now you will create a small 10 second music track of your own by recording sounds on Audacity. You have played around with different objects in Section 1.4 to make various kinds of sounds. You can also create newer sounds by clapping or whistling or some other action. Decide the rhythm and the tempo. A group of sounds (For example, snapping fingers and hitting a plate with a spoon) can be your drum or tabla. A tune that fits in that rhythm will complete the music track - you can hum, sing, whistle, or make music using a design that you made in section 1.4.

In the music track that you have just recorded on Audacity, identify the wiggles corresponding to each sound that you used.

Sound Travels

3.1 Paper cup telephone



The end of the thread is passed through a hole and tied to a small ball of paper or a matchstick. This way the paper cup will not tear.

We will make a paper cup telephone using two paper cups and a thread (at least 10 meters long). We will work in a group of 4.

Hold the cups with thread stretched taut between them. Ask your friend to speak softly in one paper cup and listen to it at the other end by putting the second cup on your ear.

Can you hear your friend's voice?

Does your friend's voice change when you listen through the cup?

Can you still hear your friend's voice if the string is not taut?

Can you hear even if the thread is wet?

Is the sound different if you use cups of different sizes?

3.1 (A) Paper cup telephone

Now ask a member of your group to touch the thread gently while the person who is holding the cup near his/her mouth is speaking. Keep the thread stretched taut.