Exercise 2  Imagine you are at the bus stop. You do not move, that is, you are “at rest”. When the bus arrives, you get on it and sit down. Then, the bus moves off and you can see out of the window the buildings going past you.

a) Are you still at rest, why?
b) What is in motion: the bus, you, both, the buildings?
c) The bus driver is sitting down at the wheel. Which of the next sentences are correct?

- c1) You are at rest in relation to the driver.
- c2) The bus driver is at rest in relation to you.
- c3) Both of you are at rest.
- c4) Both of you are moving in relation to the bus stop.

Exercise 3  Watch the diagram and describe the trajectory from A to D.

Exercise 4  Keep watching the diagram above. Early in the morning you go on a trip from your village to the mountain.

a) What is the position of your village?
b) If the town is the system of reference, what is your position when you get to C?
c) And when you get to D?
d) If your village is the system of reference, what is your position in C?
e) And when you are in D?

Exercise 5  You already know that distance is how far a moving object travels along the trajectory.

a) What is the distance you have travelled when you get to C?
b) And when you get to the mountain?

Exercise 6  When can we say that a body is in motion?

Exercise 7  Define trajectory, distance covered and displacement.

Exercise 8  Why do we say that the movement is relative?
• Exercise 9  A horse in a merry-go-round is fixed on a circular platform that turns around a central axis. The distance between the horse and the axis of the platform is 5 metres. The horse makes a complete circle:

   a) What is its displacement?
   b) How far has it travelled?
   c) Is a horse on a merry-go-round that is turning around a fixed axis in motion?

• Exercise 10  The diagram shows the journey of a cyclist who went from city A to city B and went back to his starting point by a different road. The scale used in the diagram is 1 cm = 20 km.

   a) Calculate the total distance travelled by the cyclist from city A to city B.
   d) Calculate the cyclist’s displacement from when he leaves city A to when he returns again to city A by the different route.

• Exercise 11  Match the words or expressions in both columns.

<table>
<thead>
<tr>
<th>How far you go</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>How long it takes you</td>
<td>Time</td>
</tr>
<tr>
<td>How fast you go</td>
<td>Distance</td>
</tr>
<tr>
<td>How quickly changes the speed</td>
<td>Acceleration</td>
</tr>
<tr>
<td>How your path (course) is</td>
<td>Reference</td>
</tr>
<tr>
<td>Where you are in relation to the system of reference</td>
<td>Position</td>
</tr>
<tr>
<td>Point from where the moving object is observed</td>
<td>Trajectory</td>
</tr>
</tbody>
</table>

• Exercise 12  Watch the diagram below. Edward set off from spot A at 6 a.m. and Josephine set off from spot B at 7:30 a.m. Both got to the summit of the mountain at 10 a.m. Who was the fastest?

• Exercise 13  An athlete runs 100 m in 10 s. What is his average speed?

• Exercise 14  If a train journey of 150 km takes three hours, what was the average speed of the train? Does this mean that the train travelled at a steady speed for the whole journey?
• Exercise 15  Calculate the average speed of a motorcycle that takes 6 seconds to travel 90 m.

• Exercise 16  Complete the sentence: “To work out an average speed, measurements are needed of the distance travelled and the ________________ “

• Exercise 17  A cyclist is travelling at a speed of 72 km/h, convert this speed into m/s.

• Exercise 18  A truck is moving on a straight road at an average speed of 25 m/s. Convert this unit into km/h.

• Exercise 19  Convert: a) 54 km/h into m/s; b) 35 m/s into km/h

• Exercise 20  Distances travelled and times taken by two cars have been measured. The results are in the table below:

<table>
<thead>
<tr>
<th></th>
<th>Car 1</th>
<th>Car 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (s)</td>
<td>Distance (m)</td>
<td>Time (s)</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

a) What is the distance travelled by the cars in 5 seconds.
b) What is the average speed of each car?
c) Which car travels the same distances in the same times?
d) Which car has a constant speed and which car has a variable speed?

• Exercise 21  Work out the quantities that go in the blank spaces in the table. Take care to write the correct unit with your answer.

<table>
<thead>
<tr>
<th></th>
<th>Distance travelled</th>
<th>Time taken</th>
<th>Average speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>300 m</td>
<td>6 s</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>6 cm</td>
<td></td>
<td>4 cm/s</td>
</tr>
<tr>
<td>(c)</td>
<td></td>
<td>5 hours</td>
<td>4 km/h</td>
</tr>
<tr>
<td>(d)</td>
<td>1500 m</td>
<td></td>
<td>25 m/s</td>
</tr>
<tr>
<td>(e)</td>
<td></td>
<td>2 h</td>
<td>2 m/s</td>
</tr>
</tbody>
</table>

• Exercise 22  After finding a good tiny crumb of bread an ant decided to come back to its ants’ nest. In all, the ant took 20 seconds to get home. If its speed was 0’5 m/s, how far was the ant from the ants’ nest.

• Exercise 23  The distance between two underground stations is 500 metres. How long does it take a train to cover this distance at an average speed of 10 km/h.

Exercise 28  Look at the graph opposite and answer the questions in your exercise book.

- How fast is moving the object in segments OA and AB?
- How far does move the object in segment BC?
- How fast is moving the object in segment CD?
- How far has the object moved after 3 hours? And after 6 hours?
- What is the object’s average speed during the whole journey?

Exercise 29  The straight lines A and B on the graph show the movements of two trains: train A departs from Salamanca and train B depart from a station that is 75 km away from Salamanca. Calculate:

- How fast both trains, A and B, are moving.
- How long the trains take to meet.
- How far from Salamanca the trains are when they meet.

Exercise 32  A skulking cat accelerates steadily from 2 m/s to 6 m/s in 5 s. a) Find its acceleration. b) How far does it displace in 5 s?

Exercise 33  What is the difference between cat’s type of movement in exercise 24 and exercise 32. Why?

Exercise 34  A motorbike starts from rest and has a steady acceleration of 5 m/s$^2$.

a) Work out the speed the motorbike has in 5 seconds.

b) How far does it travel while increasing the speed?

Exercise 35  A man travelling in his car at a speed of 54 km/h see a cow quietly crossing the road and quickly press the brakes. If it takes 5 seconds to stop, what has been the stopping acceleration?

Exercise 36  A bus, travelling at 18 m/s brakes and stops in 10 seconds. Find its acceleration.

Exercise 37  A cyclist starts form rest at a steady acceleration of 2 m/s$^2$. What distance will he travel in 0.2 minutes?
• **Exercise 39**  A man swims 100 metres in 58 seconds. If he maintains his speed, how many minutes will it take to swim 250 metres?

• **Exercise 40**  A train travelled the first part of its journey at a steady speed of 36 km/h and the second part of the journey at a steady speed of 27 km/h. If the train took 5 minutes in the first part and 3 minutes in the second part, how far did the train travel?

• **Exercise 41**  a) Watch the graphs opposite and explain what type of movement they are each.  
   b) What is happening in the stages AB and CD in graph 4?  
   c) What is the speed in point E.

• **Exercise 42**  A high speed train travels 700 km in 3 hours. What is its average speed in m/s?

• **Exercise 43**  The speed of light is 300,000 km/s. Work out this speed in km/h and m/s.

• **Exercise 44**  A bus starting from rest has a speed of 5 m/s after 1 second. Find:  
   a) Its acceleration  
   b) The speed after 10 seconds  
   c) How far does it travel in 10 seconds.

• **Exercise 45**  A moving object leaves point O and arrives at point A. It stops at A for a while and then returns to its starting point by the same route and at the same speed. Which of the graphs below represents this journey?

• **Exercise 46**  A stone falls from rest from the top of a high tower. The stone takes 4 seconds to reach the ground. Work out the height of the tower if we know that the acceleration is 9.8 m/s².

• **Exercise 47**  Find the speed of the stone of the previous exercise when it gets to the ground.