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MUSLIM ACADEMY

Islamic and Academic Education

YEARS 7 TO 9 · SCIENCE

Motion

Average speed against speed at an instant, reading a distance-time graph, and what motion is measured against.

WHAT IS INSIDE

- Average speed and speed at an instant
- Speed, distance, time, and reading a graph
- Relative motion
- Speed, graphs and what motion is measured against
- How each one is answered

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1 sets · a hint on every question

Written for a parent teaching at home. No training assumed, and nothing else to buy.

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Average speed and speed at an instant

Read this, then answer the questions on it.



AVERAGE SPEED AND SPEED AT AN INSTANT

In everyday language most people use the words speed and velocity interchangeably. In physics they do not have the same meaning and they are distinct concepts.

Average speed is the distance travelled divided by the elapsed time. The matching quantity for velocity has a warning on it: the average velocity of an object does not tell us anything about what happens to it between the starting point and the ending point.

Instantaneous speed is the speed at one moment, which is what a speedometer shows. OpenStax puts it the other way round: shrink the interval and the average velocity becomes the instantaneous velocity, the velocity at a specific instant. The instant is the velocity at a specific instant.

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Relative motion

Read this, then answer the questions on it.



RELATIVE MOTION

A velocity is always relative to some reference frame, and velocities given that way are called relative velocities. The velocity of an aeroplane relative to the air it flies through is different from its velocity relative to the ground, and both are quite different again from its velocity relative to its passengers, which should be close to zero.

That last figure is the useful one. Relative to the aeroplane they are sitting in, the passengers are very nearly not moving at all, while relative to the ground they are moving as fast as the aeroplane. Both numbers are right, and they are different, which is why the source says it is crucial to correctly specify the velocities relative to the observer.

In one-dimensional motion the velocities add like ordinary numbers. A hockey player moving at 5 metres per second towards the goal who drives the ball at 30 metres per second relative to her body sends it at 35 metres per second relative to the goalkeeper standing still in front of it. Relative velocities are one aspect of relativity, the study of how different observers moving relative to each other measure the same phenomenon.

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How each one is answered

Mark it together. Where a question asks for a list, the order does not matter.



SPEED, GRAPHS AND WHAT MOTION IS MEASURED AGAINST

1. Give the difference between average speed and instantaneous speed.

1. Average speed is the whole distance divided by the whole time.
2. Instantaneous speed is the speed at one particular moment, which is what a speedometer shows.

Answer: **average is total distance over total time; instantaneous is the speed at one moment**

2. How does the source describe the link between the two?

1. Over a shrinking interval, the average velocity becomes the instantaneous velocity, the velocity at a specific instant.

Answer: **as the interval shrinks, the average becomes the instantaneous velocity**

3. A cyclist covers 24 km in 2 hours. Give the average speed, and say what an average velocity does not tell you.

1. 24 ÷ 2 = 12 kilometres per hour.
2. The average velocity of an object does not tell us anything about what happens to it between the starting point and the ending point.

Answer: **12 km/h, and an average velocity says nothing about what happened between the start and the end**

4. On a graph of position against time, say what the slope is, and what a straight line and a curve each tell you.

1. The slope is the average velocity, since slope equals rise over run.
2. A straight line means the acceleration is zero, so the velocity is constant.
3. Where the line curves, the velocity is changing.

Answer: **the slope is the average velocity; a straight line means constant velocity and a curve means it is changing**

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