Unit 3 · Kinematics

HARDER PRACTICE QUESTIONS

Full marks 34

Write your answers on separate paper. Show your working. Take $g = 9.8\ m/s^2$ and ignore air resistance.

1 Spot the error [3]

Find the mistake in the working and correct it.

A ball is thrown straight up at 14.7 m/s from the ground. Sangam finds how long it is in the air: "At the top $v = 0$, so $0 = 14.7 - 9.8t$, $t = \mathbf{1.5\ s}$. The ball is in the air for 1.5 s."

2 Read the graph [4]

Answer from the data.

A scooter's velocity, read from its speedometer, goes up steadily from 0 to 12 m/s in the first 4 s, stays at 12 m/s until $t = 10$ s, then falls steadily to zero at $t = 14$ s.

i. Sketch its velocity–time graph and find its acceleration in each stage.
ii. Find the distance it covers in the 14 s.
iii. Pasang says its average speed was 12 m/s, its top speed. Correct him.

3 How deep is the well? [5]

Take the speed of sound as 340 m/s.

Abinash drops a stone into an old well in Bhaktapur and hears the splash 2.5 s after letting go.

i. Find the depth of the well, allowing for the time the sound takes to come up.
ii. His friend ignores the sound's time and says the well is $\frac{1}{2}g(2.5)^2$ deep. How much too deep is the friend's answer?

4 Work backwards [3]

Rain falls vertically. Gyanu, walking at 3 m/s, finds she must tilt her umbrella 30° forward from the vertical.

i. How fast is the rain falling?
ii. At what angle must she tilt it if she runs at 6 m/s?

5 Predict, then explain [3]

Write your prediction first, then explain it.

From the top of a cliff, Kriti drops one stone and at the same instant throws another horizontally at 10 m/s. Which stone reaches the level ground first? Which is moving faster as it lands?

6 Two ways to the same spot [4]

A hose sends water out at 10 m/s from ground level.

i. What is the farthest the water can reach on level ground?
ii. At which two angles does it land 8.0 m away?
iii. Which of the two jets reaches the spot sooner? Find both times.

7 Distance or displacement? [4]

A particle moves along a line with position $x = 2t^3 - 6t^2 + 5$ (x in meters, t in seconds).

i. Find its velocity and acceleration at any time.
ii. When is it at rest, and what is its acceleration then?
iii. Find its displacement and the distance it travels from t = 0 to t = 3 s.

8 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

Bibek wrote: "A negative acceleration always means the body is slowing down. At the top of its path a thrown ball has no acceleration, because it stops for a moment. And in a vacuum a heavy ball falls faster than a light one."

9 Think [3]

A ball falls from rest. Show that the distances it falls in the 1st, 2nd and 3rd seconds are in the ratio 1 : 3 : 5. What would the ratio be for a ball rolling from rest down a gentle slope, with a much smaller acceleration?

10 Make your own [2]

Make up a problem about a ball kicked from level ground that lands 40 m away: give its speed and angle, and show that it lands 40 m away (take g = 9.8 m/s^2).