Class 9 Physics

Chapter 2 — Kinematics

Constructed Response Questions (Exercise C) — Solved

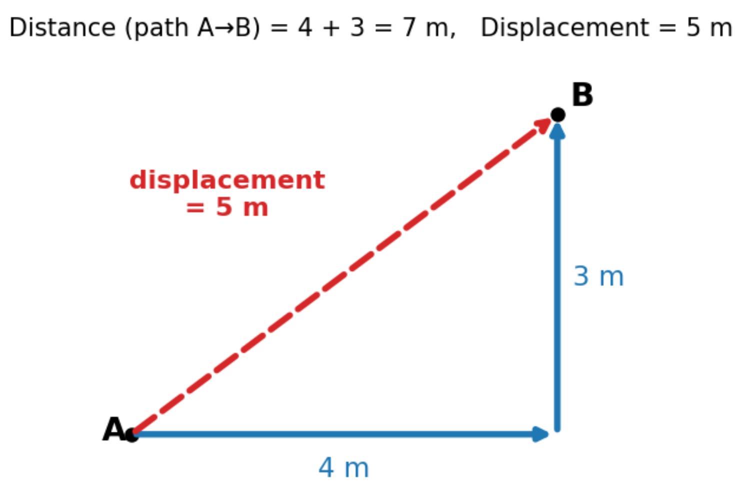
C 2.1 Distance and displacement may or may not be equal in magnitude. Explain this statement.

Distance is the length of the actual path covered (a scalar); displacement is the shortest straight-line distance from the initial to the final position (a vector). When a body moves in a straight line without changing direction, the path length equals the straight gap, so distance = displacement. But along a curved or zig-zag path (or on reversing), the actual path is longer than the straight gap, so distance > displacement.

For example, going 4 m east then 3 m north, the distance is 4 + 3 = 7 m, while the displacement is the straight line from start to end:

$$\textbf{displacement} = \sqrt{(4^2 + 3^2)} = 5\ \textbf{m}$$

If the body returns to its starting point, displacement = 0 while distance ≠ 0. Hence distance and displacement are equal only for one-way straight-line motion, and unequal otherwise.



C 2.2 A longer barrel gives a lesser muzzle velocity. In which gun is the bullet's acceleration larger?

The bullet starts from rest (u = 0) and reaches the muzzle velocity v over the barrel length S. From the third equation of motion:

$$\mathbf{v^2 = u^2 + 2aS \quad \rightarrow \quad a = v^2 \div (2S)\ (u = 0)}$$

The shorter-barrel gun has a smaller S but a larger muzzle velocity v (as given). Since a increases when v is larger and S is smaller, both factors make the acceleration greater for the shorter barrel. Therefore, the bullet's acceleration is larger in the shorter-barrelled gun. The longer barrel, though it acts on the bullet for more time, produces a smaller acceleration because $v^2/(2S)$ is smaller.

C 2.3 A trip's average velocity is positive. Can the instantaneous velocity be negative at some instant?

Yes, it is possible. Average velocity depends only on the net displacement between the start and end points:

average velocity = total displacement ÷ total time

Instantaneous velocity is the velocity at a single instant and can point either way. During the trip the body may momentarily move backward (opposite to the net direction), giving a negative instantaneous velocity at that moment, yet still finish with a net positive displacement. Example: a car moves forward, briefly reverses, then continues forward past its start — its average velocity is positive, but its instantaneous velocity was negative while reversing. So, a positive average velocity does not forbid negative instantaneous values.

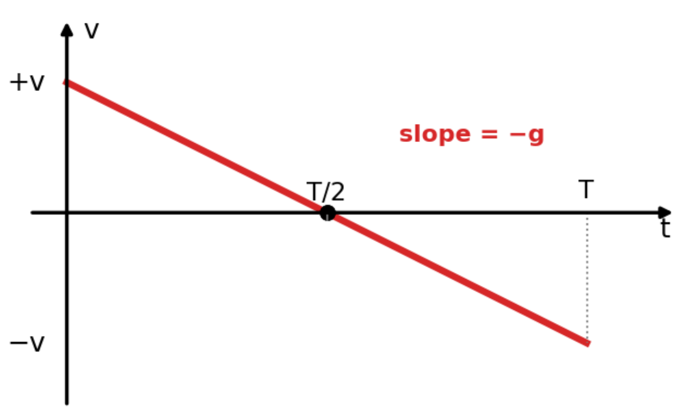
C 2.4 A ball is thrown up with velocity v and returns in time T. Which velocity-time graph is correct?

Take upward as positive. The ball leaves with +v, and gravity gives it a constant downward acceleration $a = -g$, so the velocity changes uniformly:

$$v(t) = v - g\,t \text{ (a straight line, slope} = -g)$$

At $t = T/2$ (the highest point) the velocity is zero; afterwards the ball moves downward, so the velocity becomes negative and reaches $-v$ at $t = T$. The correct graph is therefore a single straight line from +v, sloping down at a constant rate, crossing zero at T/2 and reaching −v at T — this is graph (c). Graphs where the velocity stays positive or bends are wrong, because the acceleration is constant and the velocity must reverse sign at the top.

Correct velocity–time graph (option c): straight line +v → −v



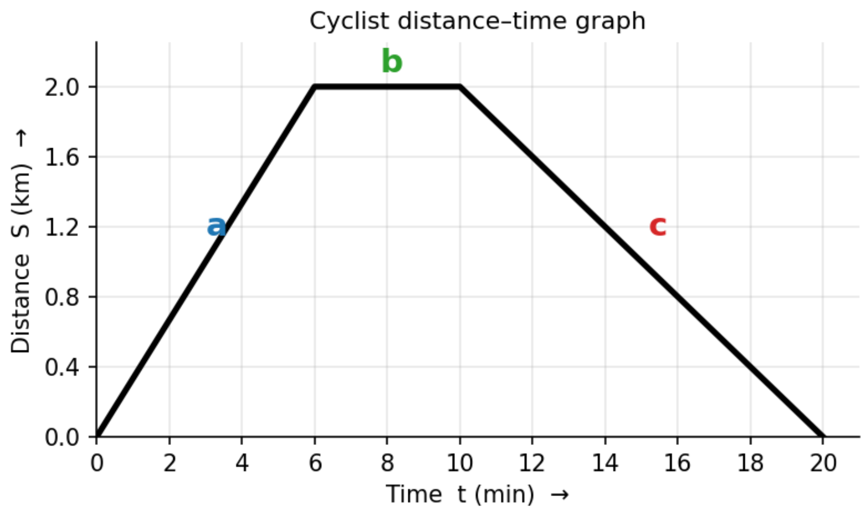
C 2.5 The distance-time graph of a cyclist is shown. Find the velocities for segments a, b and c.

On a distance-time graph, velocity = slope = $\Delta S \div \Delta t$. From the figure:

Segment a (0 → 6 min): rises 0 → 2.0 km. v = 2.0 km ÷ 6 min = 20 km/h ≈ 5.6 m/s (moving away at uniform velocity).

Segment b (6 → 10 min): flat at 2.0 km, $\Delta S = 0$. v = 0 (the cyclist is at rest).

Segment c (10 → 20 min): falls 2.0 → 0 km. v = (0 − 2.0) ÷ (20 − 10) = −0.2 km/min = −12 km/h ≈ −3.3 m/s; the minus sign shows the cyclist returns toward the start.



C 2.6 Can the velocity of a body be zero at an instant while its acceleration is not zero? Give an example.

Yes. Velocity and acceleration are independent quantities (a = Δv ÷ t), so the velocity can be zero at an instant while it is still changing. The best example is a ball thrown vertically upward: at its highest point its velocity is momentarily zero, but gravity still acts on it, so its acceleration is g (≈ 9.8 m s^{-2}) directed downward at that very instant — which is exactly why it does not stay at the top and begins to fall. Similarly, a body released from rest has zero velocity at t = 0 but an acceleration g. So, a zero velocity never means a zero acceleration.