



Attempt questions first; check the separate key afterward. Take $g = 10 \text{ m/s}^2$ where needed. Neglect air resistance unless stated.

A. Very short answers - 1 mark each

1. Can displacement be zero while distance is non-zero? Illustrate.
2. What does the slope of a position-time graph represent?
3. What is represented by the signed area under a velocity-time graph?
4. Can a particle have zero velocity and non-zero acceleration? Give an example.
5. When are average speed and magnitude of average velocity equal?
6. What is an inertial frame of reference in the context of straight-line motion?

B. Short answers / practice - 2 marks each

7. A person walks 60 m east and then 20 m west in 40 s. Find average speed and average velocity.
8. A car accelerates uniformly from 5 m/s to 25 m/s in 10 s. Find its acceleration and displacement.
9. A train moving at 20 m/s stops with constant acceleration -2 m/s^2 . Find stopping time and distance.
10. A stone is dropped from 80 m. Find the time to reach the ground and its impact speed.
11. A ball is projected upwards at 30 m/s. Find its greatest height and time to return to the launch level.
12. Two cars move east at 18 m/s and 12 m/s. Find the first car's velocity relative to the second; repeat if the second moves west.
13. For $x = 2t^3 - 3t^2 + 4$ (SI units), find velocity and acceleration at $t = 2 \text{ s}$.
14. Can average velocity exceed average speed in magnitude?
15. A body starts at 2 m/s and accelerates at 3 m/s^2 for 4 s. Find displacement.
16. A ball is dropped for 2 s. Find distance fallen.
17. Explain the meaning of a negative slope on a position-time graph.
18. Find acceleration when velocity changes from 8 to 2 m/s in 3 s.

C. Application / reasoning - 3 marks each

19. A particle has $v = 6 - 2t$ (SI units). Find its displacement and distance travelled from $t = 0$ to 5 s.

20. A vehicle accelerates from rest to 12 m/s in 4 s, maintains this speed for 6 s, then stops uniformly in 3 s. Sketch its v-t graph and find total distance.

21. A parcel is released from a balloon rising at 10 m/s when 60 m above ground. Find the time to hit the ground and impact velocity.

22. A car starts from rest with acceleration 2 m/s^2 as a truck passes it at 8 m/s. Find when and where the car next catches the truck.

23. An object covers equal distances at 20 m/s and 30 m/s. Find its average speed. Compare with equal time intervals at these speeds.

24. A stone is thrown downwards at 5 m/s from 100 m. Find the time of flight and the distance covered during the last second.

25. Given $a = 4t$ (SI units), $v(0) = 2 \text{ m/s}$ and $x(0) = 0$, obtain $v(t)$, $x(t)$ and displacement in 3 s.

26. An x-t graph is specified by $x = 4t$ for 0-3 s and $x = 24 - 4t$ for 3-6 s. Sketch it and find distance, displacement and average velocity.

D. Extended practice - 5 marks each

27. Using a velocity-time graph, derive the three equations of uniformly accelerated motion. Explain the assumptions and meanings of the graph's slope and area.
28. Use calculus to derive $v = u + at$ and $v^2 = u^2 + 2as$ for constant a . A body speeds up from 4 to 12 m/s over 32 m; find a and time.
29. A ball is thrown upwards at 20 m/s from a 25 m building. Find greatest height above ground, time to hit the ground and impact speed. Sketch its v-t graph.
30. For $x = t^3 - 6t^2 + 9t$ (SI units), find the times of rest in 0-4 s. Determine the direction of motion in each interval and total distance travelled.

ANSWER KEY - Numerical / closed questions

- 1) Yes; any round trip. 4) Yes; at the highest point of vertical projection. 7) 2 m/s; 1 m/s east. 8) 2 m/s^2 ; 150 m. 9) 10 s; 100 m. 10) 4 s; 40 m/s downward. 11) 45 m; 6 s. 12) 6 m/s east; then 30 m/s east. 13) 12 m/s ; 18 m/s^2 . 14) No. 15) 32 m. 16) 20 m. 18) -2 m/s^2 . 19) 5 m; 13 m. 20) 114 m. 21) $1 + \sqrt{13} \approx 4.61 \text{ s}$; $-10\sqrt{13} \approx -36.06 \text{ m/s}$. 22) 8 s; 64 m. 23) 24 m/s; equal-time average 25 m/s. 24) 4 s; 40 m in last second. 25) $v = 2 + 2t^2$; $x = 2t + (2/3)t^3$; 24 m. 26) 24 m; 0; 0. 28) $a = 2 \text{ m/s}^2$; $t = 4 \text{ s}$. 29) 45 m; 5 s; 30 m/s downward. 30) Rest at 1, 3 s; positive before 1 and after 3, negative between; total distance 12 m.