



QUESTION WORKBOOK

Kinematics with variable acceleration

Mechanics · Year 12–13

7 questions · 32 marks

PRINT EDITION

SECTION A · Warm-up

- A1** Explain why the suvat equations cannot be used when the acceleration depends on time, and state the calculus relationships between displacement, velocity and acceleration. [3]

- A2** A particle moves in a straight line with velocity $v = 4t^3 - 6t$ m s⁻¹ at time t seconds. Find its acceleration at $t = 2$. [3]

SECTION B · Standard

- B1** A particle starts at the origin and moves in a straight line with velocity $v = 8t - 2t^2$ m s⁻¹ at time t seconds. Find its maximum velocity, and its displacement from the origin at $t = 3$. [5]

- B2** A particle moves in a straight line with acceleration $a = 6t - 12 \text{ m s}^{-2}$ at time t seconds, and has velocity 9 m s^{-1} when $t = 0$. Find v in terms of t , and the times at which the particle is at rest. [4]

- B3** A particle moves in a straight line with velocity $v = 3t^2 - 12t + 9 \text{ m s}^{-1}$ at time t seconds, starting from the origin. Find its displacement from the origin at $t = 3$, and the total distance it has travelled by that time. [6]

SECTION C · Stretch

- C1** A particle P moves in a plane so that at time t seconds its velocity is $\mathbf{v} = (3t^2 - 4)\mathbf{i} + 6t\mathbf{j} \text{ m s}^{-1}$. At $t = 0$, P has position vector $(2\mathbf{i} - \mathbf{j}) \text{ m}$. Find the position vector of P at $t = 2$, and the speed of P at that instant. [6]

- C2** A particle moves along a straight line so that its displacement from the origin O at time t seconds is $x = t^3 - 9t^2 + 24t$ metres, $t \geq 0$. Find the times at which the particle is instantaneously at rest, and show that the particle never returns to O after $t = 0$. [5]