

Kinematics of Motion in a Straight Line

Question Paper

Level	Pre U
Subject	Maths
Exam Board	Cambridge International Examinations
Topic	Mechanics-Kinematics of Motion in a Straight Line
Booklet	Question Paper

Time Allowed: 71 minutes

Score: /59

Percentage: /100

Grade Boundaries:

- 1 A particle travels along a straight line. Its velocity $v \text{ ms}^{-1}$ after t seconds is given by

$$v = t^3 - 9t^2 + 20t$$

When $t = 0$, the particle is at rest at P .

- (i) Find the times, other than $t = 0$, at which the particle is at rest. [2]

- (ii) Find the displacement of the particle from P when $t = 2$. [4]

- 2 A particle P is free to move along a straight line Ox . It starts from rest at O and after t seconds its acceleration $a \text{ m s}^{-2}$ is given by $a = 12 - 6t$.

- (i) Find an expression in terms of t for its velocity $v \text{ m s}^{-1}$. Hence find the velocity of P when $t = 4$. [4]

- (ii) Find the displacement of P from O when $t = 4$. [3]

- (iii) Find the velocity of P when it returns to O . [3]

- 3 A particle travels along a straight line. Its velocity $v \text{ m s}^{-1}$ after t seconds is given by

$$v = t^3 - 6t^2 + 8t \text{ for } 0 \leq t \leq 4.$$

When $t = 0$ the particle is at rest at the point P .

- (i) Find the times (other than $t = 0$) when the particle is at rest. Sketch the velocity-time graph for $0 \leq t \leq 4$. [4]

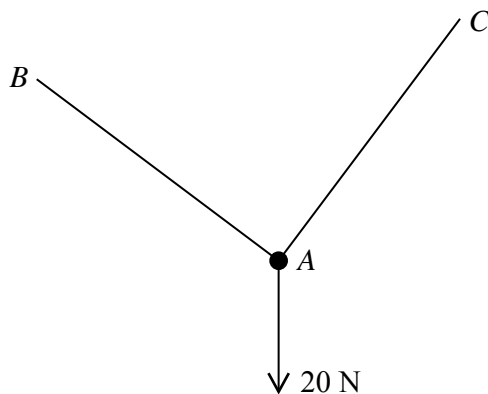
- (ii) Find the acceleration of the particle when $t = 2$. [3]

- (iii) Find an expression for the displacement of the particle from P after t seconds. Hence state its displacement from P when $t = 2$ and find its average speed between $t = 0$ and $t = 2$. [6]

- 4 The points A , B and C lie in a vertical plane and have position vectors $4\mathbf{i}$, $3\mathbf{j}$ and $7\mathbf{i} + 4\mathbf{j}$, respectively.

The unit vectors \mathbf{i} and \mathbf{j} are horizontal and vertically upwards, respectively. The units of the components are metres.

- (i) Show that angle BAC is a right angle. [2]



Strings AB and AC are attached to B and C , and joined at A . A particle of weight 20 N is attached at A (see diagram). The particle is in equilibrium.

- (ii) By resolving in the directions AB and AC , determine the magnitude of the tension in each string. [3]
- (iii) Express the tension in the string AB as a vector, in terms of \mathbf{i} and \mathbf{j} . [3]

- 5 A particle is projected from a point P on an inclined plane, up the line of greatest slope through P , with initial speed V . The angle of the plane to the horizontal is θ .

- (i) If the plane is smooth, and the particle travels for a time $\frac{2V}{g} \cos \theta$ before coming instantaneously to rest, show that $\theta = \frac{1}{4}\pi$. [4]
- (ii) If the same plane is given a roughened surface, with a coefficient of friction 0.5 , find the distance travelled before the particle comes instantaneously to rest. [5]

- 6** A particle moves along a straight line under the action of a variable force. The acceleration is given by

$$a = \begin{cases} 30 - 6t, & \text{for } 0 \leq t \leq 10 \\ 6t - 90, & \text{for } 10 \leq t \leq 20 \end{cases}$$

where time t is measured in seconds and a in m s^{-2} . The particle is at rest at the origin at $t = 0$.

- (i) (a) Find the velocity v of the particle in terms of t . Verify that $v = 0$ when $t = 10$ and $t = 20$. [7]
- (b) Sketch the velocity-time graph for the motion. [2]
- (ii) Calculate the total distance travelled by the particle. [4]