

# Displacement/ Velocity/ Acceleration

## Question Paper 4

<b>Level</b>	International A Level
<b>Subject</b>	Maths
<b>Exam Board</b>	CIE
<b>Topic</b>	Kinematics of motion in a straight line
<b>Sub Topic</b>	Displacement, velocity, acceleration
<b>Booklet</b>	Question Paper 4

**Time Allowed:** 55 minutes

**Score:** /46

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

- 1 Two cyclists  $P$  and  $Q$  travel along a straight road  $ABC$ , starting simultaneously at  $A$  and arriving simultaneously at  $C$ . Both cyclists pass through  $B$  400 s after leaving  $A$ . Cyclist  $P$  starts with speed  $3 \text{ m s}^{-1}$  and increases this speed with constant acceleration  $0.005 \text{ m s}^{-2}$  until he reaches  $B$ .

(i) Show that the distance  $AB$  is 1600 m and find  $P$ 's speed at  $B$ . [3]

Cyclist  $Q$  travels from  $A$  to  $B$  with speed  $v \text{ m s}^{-1}$  at time  $t$  seconds after leaving  $A$ , where

$$v = 0.04t - 0.0001t^2 + k,$$

and  $k$  is a constant.

(ii) Find the value of  $k$  and the maximum speed of  $Q$  before he has reached  $B$ . [6]

Cyclist  $P$  travels from  $B$  to  $C$ , a distance of 1400 m, at the speed he had reached at  $B$ . Cyclist  $Q$  travels from  $B$  to  $C$  with constant acceleration  $a \text{ m s}^{-2}$ .

(iii) Find the time taken for the cyclists to travel from  $B$  to  $C$  and find the value of  $a$ . [4]

- 2  $A$  and  $B$  are two points which are 10 m apart on the same horizontal plane. A particle  $P$  starts to move from rest at  $A$ , directly towards  $B$ , with constant acceleration  $0.5 \text{ m s}^{-2}$ . Another particle  $Q$  is moving directly towards  $A$  with constant speed  $0.75 \text{ m s}^{-1}$ , and passes through  $B$  at the instant that  $P$  starts to move. At time  $T$  s after this instant, particles  $P$  and  $Q$  collide. Find

(i) the value of  $T$ , [4]

(ii) the speed of  $P$  immediately before the collision. [1]

- 3 A particle  $P$  moves on a straight line, starting from rest at a point  $O$  of the line. The time after  $P$  starts to move is  $t$  s, and the particle moves along the line with constant acceleration  $\frac{1}{4} \text{ m s}^{-2}$  until it passes through a point  $A$  at time  $t = 8$ . After passing through  $A$  the velocity of  $P$  is  $\frac{1}{2}t^{\frac{2}{3}} \text{ m s}^{-1}$ .

(i) Find the acceleration of  $P$  immediately after it passes through  $A$ . Hence show that the acceleration of  $P$  decreases by  $\frac{1}{12} \text{ m s}^{-2}$  as it passes through  $A$ . [4]

(ii) Find the distance moved by  $P$  from  $t = 0$  to  $t = 27$ . [3]

4 A small ball of mass 0.4 kg is released from rest at a point 5 m above horizontal ground. At the instant the ball hits the ground it loses 12.8 J of kinetic energy and starts to move upwards.

(i) Show that the greatest height above the ground that the ball reaches after hitting the ground is 1.8 m. [4]

(ii) Find the time taken for the ball's motion from its release until reaching this greatest height. [3]

5 The top of a cliff is 40 metres above the level of the sea. A man in a boat, close to the bottom of the cliff, is in difficulty and fires a distress signal vertically upwards from sea level. Find

(i) the speed of projection of the signal given that it reaches a height of 5 m above the top of the cliff, [2]

(ii) the length of time for which the signal is above the level of the top of the cliff. [2]

The man fires another distress signal vertically upwards from sea level. This signal is above the level of the top of the cliff for  $\sqrt{17}$  s.

(iii) Find the speed of projection of the second signal. [3]

6 An aeroplane moves along a straight horizontal runway before taking off. It starts from rest at  $O$  and has speed  $90 \text{ m s}^{-1}$  at the instant it takes off. While the aeroplane is on the runway at time  $t$  seconds after leaving  $O$ , its acceleration is  $(1.5 + 0.012t) \text{ m s}^{-2}$ . Find

(i) the value of  $t$  at the instant the aeroplane takes off, [4]

(ii) the distance travelled by the aeroplane on the runway. [3]