Linear Motion under a Variable Force

Question Paper 3

Level	International A Level
Subject	Maths
Exam Board	CIE
Topic	Linear Motion under a Variable Force
Sub Topic	
Booklet	Question Paper 3

Time Allowed: **62 minutes**

Score: **/51**

Percentage: **/100**

Grade Boundaries:

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

1 A particle P of mass 0.6 kg is projected horizontally with velocity $2\,\text{m s}^{-1}$ from a point O on a smooth horizontal surface. A horizontal force of magnitude $0.3x$ N acts on P in the direction OP, where x m is the distance of P from O. Calculate the velocity of P when $x = 8$. [4]

2 A particle P of mass 0.25 kg moves in a straight line on a smooth horizontal surface. At time t s the velocity of P is $v\,\text{m s}^{-1}$. A variable force of magnitude $3t$ N opposes the motion of P.

(i) Given that P comes to rest when $t = 3$, find v when $t = 0$. [4]

(ii) Calculate the distance travelled by P in the interval $0 \leqslant t \leqslant 3$. [3]

3 A particle P of mass 0.2 kg is projected horizontally from a fixed point O, and moves in a straight line on a smooth horizontal surface. A force of magnitude $0.4x$ N acts on P in the direction PO, where x m is the displacement of P from O.

(i) Given that P comes to instantaneous rest when $x = 2.5$, find the initial kinetic energy of P. [4]

(ii) Find the value of x on the first occasion when the speed of P is $2\,\text{m s}^{-1}$. [2]

4 A ball of mass 0.05 kg is released from rest at a height h m above the ground. At time t s after its release, the downward velocity of the ball is $v\,\text{m s}^{-1}$. Air resistance opposes the motion of the ball with a force of magnitude $0.01v$ N.

(i) Show that $\frac{\text{d}v}{\text{d}t} = 10 - 0.2v$. Hence find v in terms of t. [6]

(ii) Given that the ball reaches the ground when $t = 2$, calculate h. [4]

5 A particle P of mass 0.4 kg is projected horizontally with velocity 8 m s^{-1} from a point O on a smooth horizontal surface. The motion of P is opposed by a resisting force of magnitude $0.2v^2$ N, where v m s^{-1} is the velocity of P at time t s after projection.

(i) Show that $v = \dfrac{8}{1+4t}$. [4]

(ii) Calculate the distance OP when $t = 1.5$. [4]

6 A particle P starts from rest at a point O and travels in a straight line. The acceleration of P is $(15 - 6x)$ m s^{-2}, where x m is the displacement of P from O.

(i) Find the value of x for which P reaches its maximum velocity, and calculate this maximum velocity. [5]

(ii) Calculate the acceleration of P when it is at instantaneous rest and $x > 0$. [2]

7 A particle P of mass 0.4 kg moves in a straight line on a horizontal surface and has velocity v m s^{-1} at time t s. A horizontal force of magnitude $k\sqrt{v}$ N opposes the motion of P. When $t = 0$, $v = 9$ and when $t = 2, v = 4$.

(i) Express $\dfrac{\mathrm{d}v}{\mathrm{d}t}$ in terms of k and v, and hence show that $v = \frac{1}{4}(t-6)^2$. [5]

(ii) Find the distance travelled by P in the first 3 seconds of its motion. [4]