Linear Motion under a Variable Force

Question Paper 2

Level	International A Level
Subject	Maths
Exam Board	CIE
Topic	Linear Motion under a Variable Force
Sub Topic	
Booklet	Question Paper 2

Time Allowed: **60 minutes**

Score: **/50**

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 0.8 kg moves along the x-axis on a horizontal surface. When the displacement of P from the origin O is x m the velocity of P is v m s^{-1} in the positive x-direction. Two horizontal forces act on P. One force has magnitude $4e^{-x}$ N and acts in the positive x-direction. The other force has magnitude $2.4x^2$ N and acts in the negative x-direction.

(i) Show that $v\frac{dv}{dx} = 5e^{-x} - 3x^2$. [2]

(ii) The velocity of P as it passes through O is 6 m s^{-1}. Find the velocity of P when $x = 2$. [5]

2 A particle P of mass 0.5 kg is released from rest at a point O and falls vertically. When P has downward displacement x m from O, the velocity of P is v m s^{-1}. A resisting force of magnitude $0.015x^2$ N acts on P.

(i) Show that $v\frac{dv}{dx} = 10 - 0.03x^2$. [2]

(ii) Find the value of x when the velocity of P is greatest. [1]

(iii) Calculate the greatest value of v. [4]

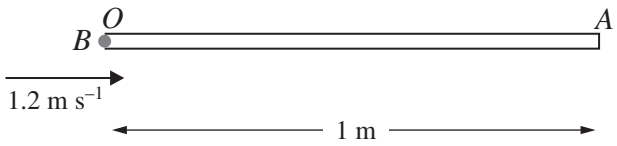
3 A particle P of mass 0.5 kg moves in a straight line on a smooth horizontal surface. The velocity of P is v m s^{-1} when the displacement of P from O is x m. A single horizontal force of magnitude $0.16e^x$ N acts on P in the direction OP. The velocity of P when it is at O is 0.8 m s^{-1}.

(i) Show that $v = 0.8e^{\frac{1}{2}x}$. [6]

(ii) Find the time taken by P to travel 1.4 m from O. [4]

4 A small ball B of mass 0.2 kg moves in a narrow fixed smooth cylindrical tube OA of length 1 m, closed at the end A. When the ball has displacement x m from O, it has velocity v m s^{-1} in the direction OA and experiences a resisting force of magnitude $\frac{k}{1-x}$ N.

(i)



The tube is fixed in a horizontal position and B is projected from O towards A with velocity 1.2 m s^{-1} (see diagram). Given that B comes to instantaneous rest after travelling 0.55 m, show that $k = 0.1803$, correct to 4 significant figures. [6]

(ii) The tube is now fixed in a vertical position with O above A. The ball B is released from rest at O. Calculate the speed of B after it has descended 0.1 m. [4]

5 A particle P of mass 0.2 kg is released from rest and falls vertically. At time t s after release P has speed v m s^{-1}. A resisting force of magnitude $0.8v$ N acts on P.

(i) Show that the acceleration of P is $(10 - 4v)$ m s^{-2}. [2]

(ii) Find the value of v when $t = 0.6$. [5]

6 A particle P of mass 0.4 kg is released from rest at the top of a smooth plane inclined at 30° to the horizontal. The motion of P down the slope is opposed by a force of magnitude $0.6x$ N, where x m is the distance P has travelled down the slope. P comes to rest before reaching the foot of the slope. Calculate

(i) the greatest speed of P during its motion, [7]

(ii) the distance travelled by P during its motion. [2]