Motion of a Projectile

Question Paper 6

Level	International A Level
Subject	Maths
Exam Board	CIE
Topic	Motion of a Projectile
Sub Topic	
Booklet	Question Paper 6

Time Allowed: **57 minutes**

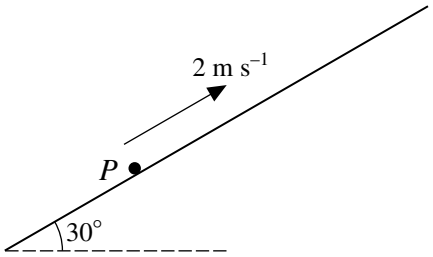
Score: **/47**

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 0.2 kg is projected with velocity 2 m s^{-1} upwards along a line of greatest slope on a plane inclined at 30° to the horizontal (see diagram). Air resistance of magnitude $0.5v$ N opposes the motion of P, where v m s^{-1} is the velocity of P at time t s after projection. The coefficient of friction between P and the plane is $\frac{1}{2\sqrt{3}}$. The particle P reaches a position of instantaneous rest when $t = T$.

(i) Show that, while P is moving up the plane, $\frac{dv}{dt} = -2.5(3 + v)$. [3]

(ii) Calculate T. [4]

(iii) Calculate the speed of P when $t = 2T$. [5]

2 A particle is projected from a point O on horizontal ground. The velocity of projection has magnitude 20 m s^{-1} and direction upwards at an angle θ to the horizontal. The particle passes through the point which is 7 m above the ground and 16 m horizontally from O, and hits the ground at the point A.

(i) Using the equation of the particle's trajectory and the identity $\sec^2\theta = 1 + \tan^2\theta$, show that the possible values of $\tan\theta$ are $\frac{3}{4}$ and $\frac{17}{4}$. [4]

(ii) Find the distance OA for each of the two possible values of $\tan\theta$. [3]

(iii) Sketch in the same diagram the two possible trajectories. [2]

3 A particle is projected horizontally with speed $12\,\text{m s}^{-1}$ from the top of a high cliff. Find the direction of motion of the particle after 2 s. [3]

4 Two particles P and Q are projected simultaneously with speed $40\,\text{m s}^{-1}$ from a point O on a horizontal plane. Both particles subsequently pass at different times through the point A which has horizontal and vertically upward displacements from O of 40 m and 15 m respectively.

satisfies the equation $\tan^2\theta - 8\tan\theta + 4 = 0$. [3]

(ii) Calculate the distance between the points at which P and Q strike the plane. [5]

5 A particle is projected from a point O with speed $V\,\text{m s}^{-1}$ at an angle θ above the horizontal. After 0.3 s the particle is moving with speed $25\,\text{m s}^{-1}$ at an angle $\tan^{-1}\left(\frac{7}{24}\right)$ above the horizontal.

(i) Show that $V\cos\theta = 24$. [2]

(ii) Find the value of $V\sin\theta$, and hence find V and θ. [5]

6 A particle P of mass 0.1 kg is projected vertically upwards from a point O with speed $20\,\text{m s}^{-1}$. Air resistance of magnitude $0.1v$ N opposes the motion, where $v\,\text{m s}^{-1}$ is the speed of P at time t s after projection.

(i) Show that, while P is moving upwards, $\dfrac{1}{v+10}\dfrac{\mathrm{d}v}{\mathrm{d}t} = -1$. [2]

(ii) Hence find an expression for v in terms of t, and explain why it is valid only for $0 \leqslant t \leqslant \ln 3$. [6]

(iii) Find the initial acceleration of P. [2]