IYGB GCE

Mathematics FM1

Advanced Level

Practice Paper P

Difficulty Rating: 3.4867/1.5915

Time: 1 hour 30 minutes

Candidates may use any calculator allowed by the regulations of this examination.

Information for Candidates

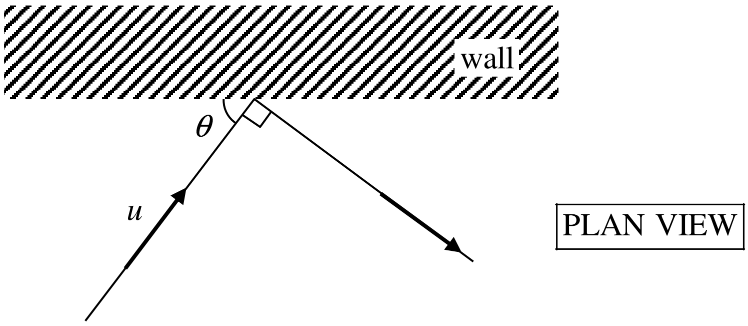
This practice paper follows closely the Pearson Edexcel Syllabus, suitable for first assessment Summer 2018.

The standard booklet "Mathematical Formulae and Statistical Tables" may be used.
Full marks may be obtained for answers to ALL questions.
The marks for the parts of questions are shown in round brackets, e.g. (**2**).
There are 8 questions in this question paper.
The total mark for this paper is 75.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner.
Answers without working may not gain full credit.
Non exact answers should be given to an appropriate degree of accuracy.
The examiner may refuse to mark any parts of questions if deemed not to be legible.

Question 1



A ball is moving on a smooth horizontal surface, bouncing off a smooth vertical wall, where the coefficient of restitution between the wall and the ball is e.

The speed of the ball before hitting the wall is u ms^{-1} and makes an acute angle θ with the wall. After the collision with wall the path of the ball turns by a right angle as shown in the figure above.

a) Show clearly that

$$\tan\theta = \frac{1}{\sqrt{e}}. \qquad (6)$$

b) Hence determine the range of possible values of θ. **(3)**

Question 2

A piston of mass 1.5 kg, enclosed in a fixed vertical tube, has one of its ends attached to a light spring of natural length 0.2 m and modulus of elasticity 2000 N. The other end of the spring is attached to the bottom of the vertical tube, so that the piston can oscillate inside the tube in a vertical direction. The motion of the piston inside the cylinder is subject to a constant resistance of 5.3 N.

The piston is pushed downwards so that the spring has length 0.1 m and released from rest. By modelling the piston as a particle determine the speed of the piston when the spring reaches its natural length.

(8)

Question 3

Two particles P and Q of respective masses 2 kg and 3 kg move on a smooth horizontal surface in the same direction along a straight line.

The speeds of P and Q are 4 ms^{-1} and 2.5 ms^{-1}, respectively.

a) Given that when P and Q collide they coalesce into a single particle R, determine the speed of R after the collision. **(3)**

After the collision R continues in a straight line and collides directly with a third particle S of mass 15 kg which was initially at rest. After their collision R and S move in opposite directions with equal speeds.

b) Find the distance between R and S, 3.6 s after their collision. **(5)**

Question 4

Two particles, A and B, of respective masses m and km, where k is a positive constant, lie on a smooth horizontal surface. Initially the particles are at rest at some point on the surface between a pair of fixed, smooth, parallel vertical walls.

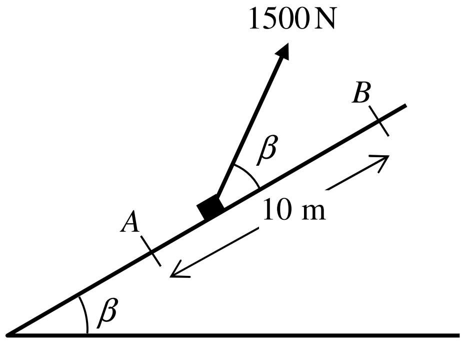
A and B are simultaneously projected, with respective speeds u and $2u$, away from each other in directions perpendicular to the walls. After rebounding from the walls, A and B collide directly with each other.

The coefficient of restitution between **all** collisions in this question is taken to be e.

Given further that the direction of motion of A is **not** reversed after colliding with B, show that

$$e < \frac{1-2k}{3k}.$$ **(12)**

Question 5



The figure above shows a box of mass 120 kg being pulled up the line of greatest slope of the plane inclined at an angle β to the horizontal, by an electrically operated cable. The cable is supplying a constant tension of 1500 N and is inclined at an angle β to the plane.

The box passes through the point A with speed 5 ms^{-1} and through the point B which is higher up the plane with speed v ms^{-1}. The distance AB is 10 m.

There is a constant non gravitational resistance of 180 N acting on the box.

The box is modelled as a particle and the cable as a light inextensible string.

Given that $\tan\beta = \frac{3}{4}$ find the value of v. **(8)**

Question 6

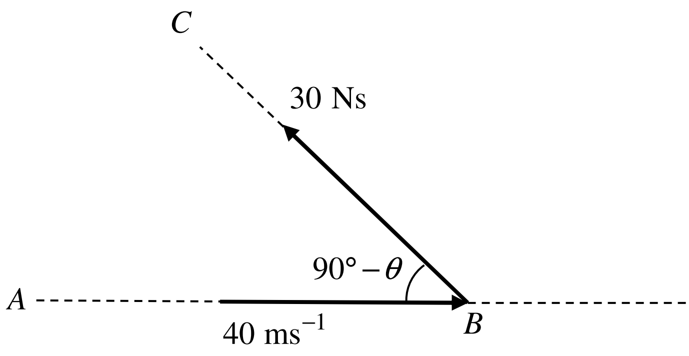
A car, of mass 1500 kg, is travelling up the line of greatest slope of a hill inclined at an angle θ to the horizontal, where $\sin\theta = \frac{2}{49}$. The engine of the car is working at a constant rate of P W.

The motion of the car is subject to a **constant** non gravitational resistance.

At some instant during the climb, the car is accelerating at 0.3 ms^{-2} when its speed is 16 ms^{-1}, reaching a maximum speed of 23.2 ms^{-1}.

Determine the value of P **(12)**

Question 7



The points A, B and C, which lie on the same horizontal plane. A ball of mass 0.5 kg is travelling along AB with speed 40 ms^{-1} when it receives an impulse I of magnitude 30 Ns, in the direction BC.

The angle ABC is $90° - \theta$, as shown in the figure, where $\tan\theta = \frac{4}{3}$.

The ball is modelled as a particle moving without any resistance.

a) Find the magnitude of the velocity of the ball, immediately after it receives I. **(5)**

b) Determine the acute angle the velocity of the ball makes with the direction AB, immediately after it receives I. **(3)**

Question 8

A light elastic string is fixed to a point A on a level horizontal ceiling.

When a particle of mass m is attached to the other end of the string B and hangs in equilibrium, the length AB is x.

When a different particle of mass M, $M > m$, is attached to B and hangs in equilibrium, the length AB is y.

Find an expression for the natural length of the string, in terms of m, M, x and y and hence deduce that

$$Mx > my.$$

(10)