IYGB GCE

Mathematics FM1

Advanced Level

Practice Paper Q

Difficulty Rating: 3.3200/1.4925

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

The vectors $\mathbf{i}$ *and* $\mathbf{j}$ *are horizontal unit vectors perpendicular to each other.*

Two smooth uniform spheres A and B with equal radii are moving on a smooth horizontal surface.

The mass of A is 2 kg and the mass of B is 3 kg.

The velocity of A is $(2\mathbf{i}+\mathbf{j})$ ms^{-1} and the velocity of B is $(-\mathbf{i}-\mathbf{j})$ ms^{-1}.

The spheres collide when the line joining their centres is parallel to $\mathbf{j}$.

Given further that the coefficient of restitution between A and B is 0.5, find kinetic energy lost as a result of the collision. **(10)**

Question 2

A particle of mass 2 kg is dragged by a constant force of 49 N, up the line of greatest slope of a rough plane, inclined at an angle of $30°$ to the horizontal. This force is also acting in the line of greatest slope of the plane. The coefficient of friction between the particle and the plane is 0.5.

The particle passes through two points on the plane A and B which are 4 m apart, and point B is at a higher level on the plane than point A.

Given that the particle is passing through A with a speed of 10 ms^{-1}, use work and energy considerations to find the speed of the particle as it passes through B. **(7)**

Question 3

A particle P of mass 0.5 kg is attached to a light spring of natural length 0.6 m and modulus of elasticity 47 N. The other end of the spring is attached to a fixed point O on a ceiling, so that P is hanging at rest vertically below O. The particle is pulled vertically downwards so that $|OP| = 1.16$ m and released from rest.

Ignoring any external resistances, find the speed of P when $|OP| = 0.88$ m. **(8)**

Question 4

A smooth sphere A of mass m is moving with speed u on a smooth horizontal plane when it collides directly with a smooth sphere B of mass $3m$ which is initially at rest. The direction of motion of A is reversed as a result of the collision.

The spheres are modelled as particles and the coefficient of restitution between the two spheres is e.

a) Find, in terms of e and u, the speeds of the two spheres after their collision. **(6)**

b) Find the range of the possible values of the speed of B. **(5)**

Consequently sphere B strikes at right angles a fixed smooth vertical wall, and rebounds at right angles. The coefficient of restitution between B and the wall is $\frac{1}{4}$.

c) Given there is another collision between the spheres show clearly that

$$\frac{1}{3} < e < \frac{5}{11}. \quad \textbf{(6)}$$

Question 5

A motorbike, which is modelled as a particle of mass 300 kg, is travelling on a straight road with its engine working at its maximum rate of 54 kW.

When in motion the motorbike experiences non gravitational resistances of magnitude $a + bv$ N, where v ms^{-1} is its speed.

When travelling on a horizontal stretch of the road, at maximum power, the maximum speed of the motorbike is 60 ms^{-1}.

When travelling, at maximum power, on a stretch of the road inclined at $\arcsin\left(\frac{4}{49}\right)$ to the horizontal, the maximum speed of the motorbike is 50 ms^{-1}.

Determine the acceleration of the motorbike when travelling on a horizontal stretch of the road, at maximum power, at the instant when its speed is 30 ms^{-1}. **(12)**

Question 6

Tom, of mass 50 kg, is initially standing still on a stationary skateboard, on level horizontal ground.

He jumps off the skateboard and initially moves with a horizontal speed 1.2 ms^{-1}. The skateboard moves with a speed of 15 ms^{-1} in a direction opposite to that of Tom.

William then stands still on the same skateboard. He jumps off the skateboard and initially moves with a horizontal speed 1 ms^{-1} while the skateboard moves with a speed of 14 ms^{-1} in a direction opposite to that of William.

Find the mass of William. **(6)**

Question 7

A uniform rod AB, of length 6 m and mass 12 kg is smoothly hinged at A on a vertical wall. An elastic string connects a point C on the rod to a point D on the wall which is 1.5 m vertically above A. The distance AC is 1.5 m.

The rod lies undisturbed in equilibrium so that $\angle DAB = 60°$.

Given further that the natural length of the string is 1 m, determine the modulus of elasticity of the string. **(7)**

Question 8

In this question $\mathbf{i}$ *and* $\mathbf{j}$ *are mutually perpendicular unit vectors.*

A particle of mass 0.5 kg is moving on a smooth horizontal plane with velocity $14\mathbf{i}$ ms^{-1} when it receives an impulse $\lambda(\mathbf{i}+\mathbf{j})$ Ns, where λ is a positive constant.

Immediately after receiving the impulse the particle is moving with speed 34 ms^{-1}, in a direction which makes an acute angle α with the vector $\mathbf{i}$.

a) Calculate the value of α, correct to the nearest degree. **(4)**

b) Determine the value of λ. **(4)**