Kirk Hallam Community Academy

A-Level Further Mathematics Year 13
Mechanics Mock 1

AQA Specification

Name: .....

Class: .....

Mark: / 50

1 A point on the edge of a record is rotating at 40 rpm. Given that the diameter of the record is 30 cm, the speed of the point is

12 ms^{-1} 0.63 ms^{-1} 2.63 ms^{-1} 1.26 ms^{-1}

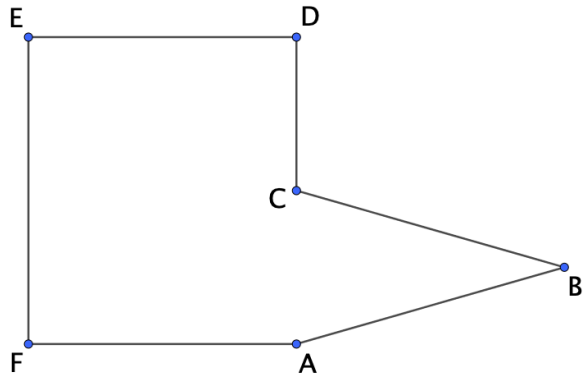
[1 mark]

2 A particle of mass 2 kg experiences a force of 3 N for 2 seconds. It was initially moving at 2 ms^{-1}. Its speed once the force is removed is

4 ms-1 2 ms^{-1} 3 ms^{-1} 1 ms^{-1}

[1 mark]

3 A uniform lamina is shown below



where

$$|AF| = |ED| = 3$$
$$|EF| = 4$$
$$|DC| = 2$$
$$|AB| = |BC| = 3$$

a) Find the distance of the centre of mass of the lamina from

i) EF
ii) AF

[6 marks]

b) The lamina is now suspended from F. Find the angle the side EF makes with the vertical.

[3 marks]

4 An elastic string has natural length 1.5 m and modulus of elasticity 12 N. Calculate the energy stored in the string when it is stretched to a length of 2.3 m.

[3 marks]

5 A particle of mass 3 kg is placed on a smooth plane inclined at $30°$ to the horizontal.
It is released from rest at a point A and moves in a straight line down the plane. It moves past the point B which is 6 m down the plane from A. It subsequently passes the point C which is further down the plane. When at C the speed of the particle is $\sqrt{110}$ ms^{-1}.

Find the distance BC.

[6 marks]

6 Newton's Law of Gravitation states that the attractive force, F, between two point bodies is directly proportional to the product of their masses, m_1 and m_2, and inversely proportional to the square of the distance, r, between them. The constant of proportionality is known as G.

Find the dimensions of G for the formula

$$F = \frac{Gm_1m_2}{r^2}$$

[3 marks]

7 **a)** Use integration to prove that the centre of mass of a solid cone of radius r, and height h lies $\frac{1}{4}$ of the way from the base to the vertex.

[5 marks]

b) Explain, without calculation why the centre of mass must lie along the perpendicular from the base to the vertex.

[1 mark]

8 A small smooth ball of mass 1.5 kg is moving in XY plane and collides with a smooth fixed vertical wall containing the y - axis.
The velocity of the ball just before impact is $\mathbf{u} = -5\mathbf{i} - 2\mathbf{j}$ and just after it is $\mathbf{v} = \frac{5}{4}\mathbf{i} - 2\mathbf{j}$.

a) Find the speed of the ball before and after impact.

[2 marks]

b) Find the loss of kinetic energy as a result of the impact.

[2 marks]

c) Find the angle of deflection of the ball.

[3 marks]

d) Show that the coefficient of restitution between the ball and the wall is $\frac{1}{4}$.

[2 marks]

9 Sophie is investigating how the speed, v, of waves on a string depends on the mass, m, and length, l, of the string and the tension, t, in the string.
She conjectures a relationship of the form,

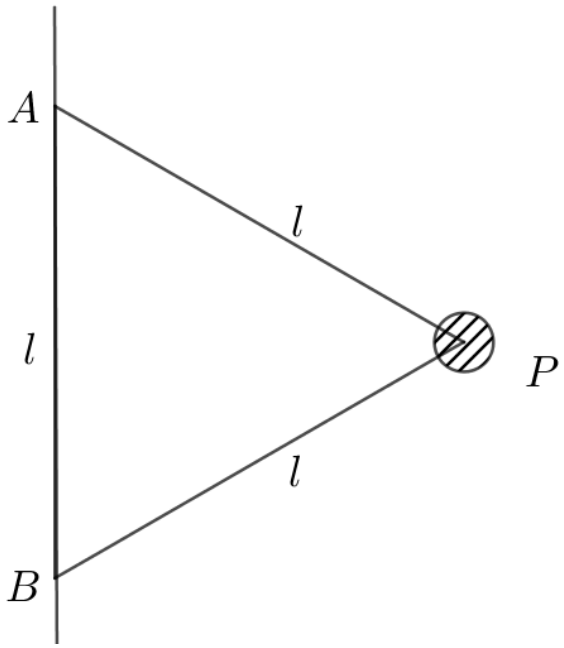
$$v = km^{\alpha}l^{\beta}t^{\gamma},$$

where k is a dimensionless constant.

Determine the values of α, β, and γ.

[5 marks]

10 A child's clacker consists of a small sphere, Q of mass $2m$ which is joined to two light rods AQ and BQ, each of length l.
The other ends of the rods AQ and BQ are at a distance l apart on a third rod as shown below



AQ and BQ can freely rotate about AB.

Find the tension in both AQ and BQ when the sphere P is moving in a horizontal circle with speed $\sqrt{5gl}$.

[7 marks]