AQA A-Level Further Maths 2023 Paper 3M

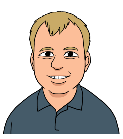
Do not turn over the page until instructed to do so.

This assessment is out of 50 marks and you will be given 60 minutes.

When you are asked to by your teacher write your **full name** below

Name:

Total Marks: / 50



1 Find the impulse on a particle P when a force $F(t) = 0.2t^2 + t$ acts for two seconds

$\dfrac{38}{15}$ $\dfrac{7}{5}$ $\dfrac{14}{15}$ $\dfrac{3}{10}$

[1 mark]

2 The dimensions of pressure are

MLT^{-1} $ML^{-1}T^{-1}$ $ML^{-2}T^{-2}$ $ML^{-1}T^{-2}$

[1 mark]

3 A sports car engine produces a maximum of 520 kW of power and is travelling its maximum speed of 320 km/h.
When travelling at this speed what total resistive force does the car experience?

11700 N	6000 N	5850 N	8580 N

[1 mark]

4 A football is dropped from a height of 1.2 m onto a smooth horizontal floor. It rebounds to a height of 0.75 m. Find the coefficient of restitution for the impact with the floor.

[4 marks]

5 The excess pressure, P, inside a soap bubble is given by the formula $P = 4r^{\alpha}s^{\beta}$ where r is the radius, s is the surface tension and α and β are constants.

Given that surface tension is defined to be force per unit length determine the values of α and β in the model for P.

[5 marks]

6 Use integration to show that the centre of mass of a uniform solid right circular cone of height h lies $\dfrac{h}{4}$ from its base.

[6 marks]

7 An object of mass 2 kg is attached to the end of a light elastic string of length 1 m. The other end of the string is fixed to a point A 3 metres above the floor. The object is held at A and then released. Given that the modulus of elasticity of the string is 40 N find the distance below A that the particle is when it reaches its maximum speed.

[6 marks]

8 A smooth solid hemisphere of radius 5 m and centre O is resting on horizontal ground with its flat face in contact with the ground.

A particle P of mass 2 kg is resting on the hemisphere at the highest point, directly above O.

If the particle starts to roll along the surface of the hemisphere find the angle between OP and OA when the particle leaves the surface of the hemisphere.

[8 marks]

9 A particle moves with constant speed on a circular path of radius 3 metres.

The centre of the circle has position vector $3\mathbf{i}$ metres.

At time $t = 0$, the particle is at the origin and moving in the positive $\mathbf{j}$ direction.

The particle returns to the origin every 4 seconds.

The unit vectors $\mathbf{i}$ and $\mathbf{j}$ are perpendicular.

a) Calculate the angular speed of the particle.

[2 marks]

b) Write down an expression for the position vector of the particle at time t seconds.

Where is the particle when $t = 3$.

[3 marks]

c) Find an expression for the velocity of the particle at time t and the linear speed of the particle.

[3 marks]

10 A ladder has length 3 metres and mass 10 kg.

The ladder rests in equilibrium with one end on a rough horizontal surface and the ladder resting on top of a vertical wall of height 1 m, such that the end of the ladder overhangs the wall.

The angle between the ladder and the horizontal surface is α.

In this position the ladder is on the point of slipping.

The coefficient of friction between the ladder and the wall is $\frac{1}{2}$.

The coefficient of friction between the ladder and the ground is $\frac{3}{4}$.

Stating clearly any assumptions you make, show that

$$\sin(\alpha)\cos(\alpha)\big(2\cos(\alpha) + 11\sin(\alpha)\big) = 4$$

[10 marks]