Pearson Edexcel International Advanced Level

Wednesday 3 June 2026

Afternoon (Time: 1 hour 30 minutes)

Paper reference **WME02/01A**

Mathematics

International Advanced Subsidiary/Advanced Level
Mechanics M2
Question paper

You must have:
Answer book (sent separately).
Do not return this question paper with the answer book.

Turn over ▶

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P 8 1 2 6 5 A

Pearson

1. Three particles of masses, $2m$, $3m$ and $7m$, are placed at the points with coordinates $(4\lambda, \lambda)$, $(2, 4)$ and $(4, -3)$ respectively, where λ is a constant.

The centre of mass of the three particles is at the point $(\bar{x}, \bar{y})$

(a) Show that $\bar{x} = \dfrac{4\lambda + 17}{6}$

(3)

The centre of mass of the three particles lies at a point on the straight line with equation

$$x - 6y = 6$$

(b) Find the value of λ

(4)

(Total for Question 1 is 7 marks)

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2. A particle P moves on a smooth horizontal surface with velocity $\mathbf{v}\,\text{m}\,\text{s}^{-1}$

At time t seconds, $t \geqslant 0$

$$\mathbf{v} = (t + \sin t)\mathbf{i} + (\cos t - 3)\mathbf{j}$$

At time $t = 0$, the position vector of P relative to a fixed origin O is $2\mathbf{i}\,\text{m}$

(a) Find the exact position vector of P relative to O when $t = \pi$

(4)

The particle P is moving under the action of a single horizontal force, $\mathbf{F}$ newtons.

Given that P has mass $0.5\,\text{kg}$,

(b) show that, at time t seconds, $t \geqslant 0$

$$|\mathbf{F}| = \sqrt{\frac{1 + \cos t}{2}}$$

(5)

(Total for Question 2 is 9 marks)

3. A car of mass 900 kg is moving on a straight road that is inclined at angle θ to the horizontal where $\sin\theta = \frac{1}{15}$

When the car moves **down** the road with constant speed $18\,\text{m s}^{-1}$

- the engine of the car is working at a rate of P watts
- the resistance to the motion of the car is modelled as a constant force of magnitude R newtons

When the car moves **up** the road with constant speed $12\,\text{m s}^{-1}$

- the engine of the car is working at a rate of $6P$ watts
- the resistance to the motion of the car from non-gravitational forces is modelled as a constant force of magnitude R newtons

(a) Find

(i) the value of P

(ii) the value of R

(7)

When the car is moving **up** the road, the speed of the car increases from $12\,\text{m s}^{-1}$ to $16\,\text{m s}^{-1}$

- the car travels a distance of 40 m as its speed increases from $12\,\text{m s}^{-1}$ to $16\,\text{m s}^{-1}$
- the resistance to the motion of the car from non-gravitational forces is still modelled as a constant force of magnitude R newtons

(b) Find the **total** work done by the engine of the car as the speed increases from $12\,\text{m s}^{-1}$ to $16\,\text{m s}^{-1}$

(5)

(Total for Question 3 is 12 marks)

4. [*In this question you may use, without proof, the formula for the centre of mass of a circular arc.*]

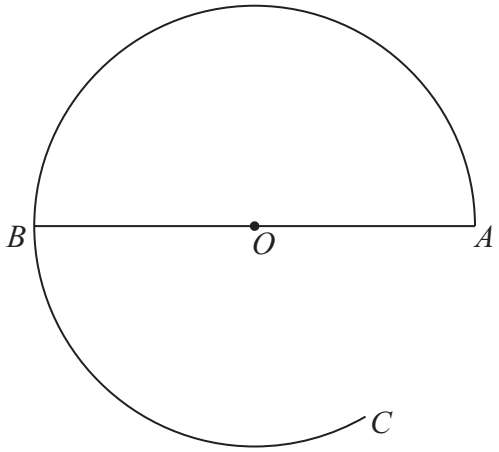

Figure 1

Uniform wire is used to form the **framework** $BOAC$ shown in Figure 1.

In the framework

- BOA is straight and has length $2a$
- ABC is a circular arc of radius a with centre O
- angle $COA = \frac{\pi}{3}$ radians
- the points B, O, A, C and the framework all lie in the same plane

The perpendicular distance of the centre of mass of the framework from BA is $\bar{y}$.

(a) Show that

$$\bar{y} = \frac{3a}{2(5\pi + 6)}$$

(6)

The framework is freely suspended from B and hangs in equilibrium with AB at an angle $\theta°$ to the downward vertical.

(b) Find the value of θ, giving your answer to one decimal place.

(5)

(Total for Question 4 is 11 marks)

5.

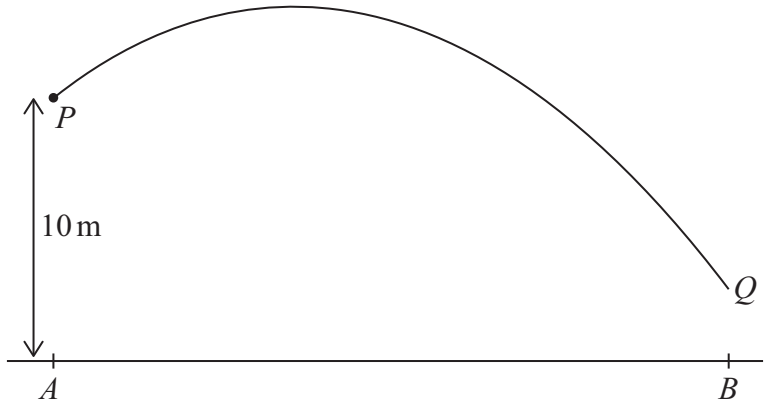

Figure 2

Figure 2 shows the points A and B on horizontal ground.

The point P is 10 m vertically above A.

The point Q is vertically above B.

A ball is projected from P with speed $10.5\,\text{m s}^{-1}$ and passes through the point Q with speed $14\,\text{m s}^{-1}$

The ball is modelled as a particle moving freely under gravity.

(a) Use the principle of conservation of mechanical energy to find the distance BQ.

(3)

Given that

- the ball is projected from P at an angle α above the horizontal
- the direction of motion of the ball at Q is perpendicular to the direction of motion of the ball at P

(b) show that $\tan\alpha = \frac{3}{4}$

(3)

A remote control car, modelled as a particle, is at rest at A.

At the instant when the ball is projected from P, the remote control car leaves A.

The remote control car accelerates uniformly as it moves in a straight line directly from A to B.

At the instant when the ball is at Q, the car is at B.

(c) Find the acceleration of the car.

(5)

(Total for Question 5 is 11 marks)

6.

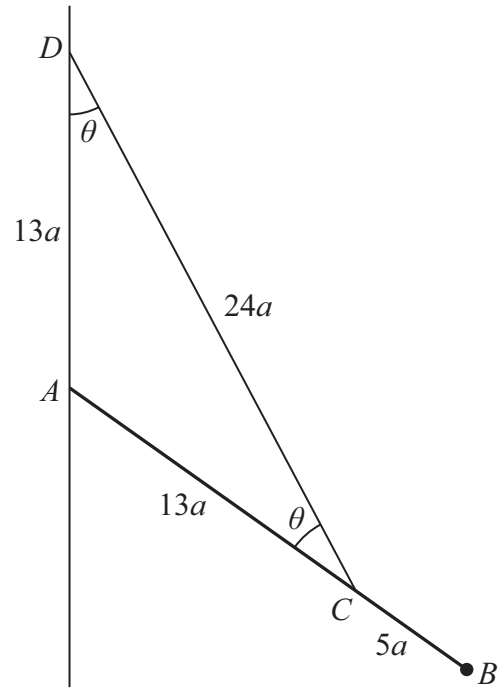

Figure 3

A **non-uniform** pole AB has length $18a$.
The end A of the pole is freely hinged to a fixed point on a vertical wall.
One end of a cable of length $24a$ is attached to the pole at the point C, where $AC = 13a$.
The other end of the cable is attached to the wall at the point D, where D is above A and $AD = 13a$.
Angle ADC = Angle $ACD = \theta$
A particle is attached to the pole at B, as shown in Figure 3.

The pole rests in equilibrium in a vertical plane that is perpendicular to the wall.

The pole is modelled as a non-uniform rod and the cable is modelled as being light and inextensible.

Given that

- the weight of the pole is W
- the weight of the particle is $\frac{1}{3}W$
- the tension in the cable is $\frac{6}{5}W$

use the model to,

(a) find, in terms of a, the exact distance of the centre of mass of AB from A.

(4)

(b) find, in terms of W, the magnitude of the resultant force exerted on the rod by the hinge at A.

(6)

(Total for Question 6 is 10 marks)

7. Particle A has mass $3m$ and particle B has mass $2m$.

The particles are moving in the **same** direction along the same straight line on a smooth horizontal surface.

Particle A collides directly with particle B.

Immediately before the collision, the speed of A is $2u$ and the speed of B is u.

Immediately after the collision, the direction of motion A is unchanged.

The coefficient of restitution between A and B is e.

(a) Show that the speed of B immediately after the collision is $\frac{u}{5}(8 + 3e)$

(5)

Given that $e = \frac{1}{4}$

(b) find the percentage of kinetic energy lost in the collision.

(5)

After the collision, B hits a smooth fixed vertical wall that is perpendicular to the direction of motion of B.

Particle B rebounds and there is a second collision between A and B.

- the first collision between A and B occurs at a distance d from the wall
- the time between the two collisions between A and B is $\frac{60d}{91u}$

The coefficient of restitution between B and the wall is f.

(c) Find the value of f.

(5)

(Total for Question 7 is 15 marks)

TOTAL FOR PAPER IS 75 MARKS

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