

AQA AS-Level Further Maths 2026
Paper 2M (Mechanics)

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

This assessment is out of 40 marks and you will be given 45 minutes.

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

Name:

Total Marks: / 40

- 1 A cricket ball of 160 grams is bowled with an energy of 82 Joules.

What is its speed to the nearest m/s.

32 m/s

1 m/s

22 m/s

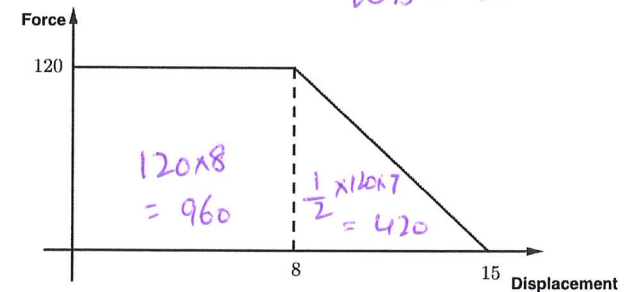
31 m/s

[1 mark]

$$82 = \frac{1}{2} \times 0.16 \times v^2$$

- 2 A sled experiences a resistance force as shown in the graph below.

This force slows the sled down to rest over 15 metres.



1400 J

1380 J

1800 J

960 J

[1 mark]

3 A light string of natural length 0.5 m is extended to a length of 0.7 m by a force of 30 N.

What is the stiffness, k , of the spring in Nm^{-1}

6

750

300

150

[1 mark]

$$T = kx$$

$$30 = 0.2k$$

4 Two particles A and B are moving on a smooth horizontal surface.

Particle A has mass 2 kg and is moving with velocity $\begin{pmatrix} 2 \\ 3 \end{pmatrix} \text{ms}^{-1}$.

Particle B has mass 4 kg and is moving with velocity $\begin{pmatrix} a \\ b \end{pmatrix} \text{ms}^{-1}$.

After colliding they coalesce and form a single particle moving with velocity $\begin{pmatrix} 5 \\ 4 \end{pmatrix} \text{ms}^{-1}$.

Find the speed of B before collision.

[4 marks]

$$2 \begin{pmatrix} 2 \\ 3 \end{pmatrix} + 4 \begin{pmatrix} a \\ b \end{pmatrix} = 6 \begin{pmatrix} 5 \\ 4 \end{pmatrix}$$

$$4a = 26 \quad a = 6.5$$

$$4b = 18 \quad b = 4.5$$

$$\text{velocity of } B = \begin{pmatrix} 6.5 \\ 4.5 \end{pmatrix}$$

$$\begin{aligned} \text{speed} &= \sqrt{6.5^2 + 4.5^2} \\ &= 7.91 \text{ ms}^{-2} \text{ (3sf)} \end{aligned}$$

- 5 A car is travelling round a bend on a horizontal circular path of radius 80 metres.

The car is prevented from skidding by a frictional force. This frictional force has a maximum value of 13500 Newtons and the car weighs 1200 kg.

Assuming the car maintains a constant speed around the bend.

- a) What is the greatest speed, in km h^{-1} at which the car can travel round a bend.

[4 marks]

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

$$13500 = \frac{1200 \times v^2}{80}$$

$$v^2 = 900$$

$$v = 30 \text{ ms}^{-1}$$

$$= 108 \text{ km h}^{-1}$$



- b) State one limitation of this model.

[1 marks]

Radius is not always constant when the car travels around the bend.

- 6 A HGV of mass 40 tonnes is travelling on a straight horizontal road.

When the HGV is travelling at a speed of $v \text{ ms}^{-1}$ it experiences a resistive force of magnitude $40v$ newtons.

The HGV has a maximum speed of 90 km h^{-1} on the straight road.

Find the maximum power output of the HGV.

Fully justify your answer.

[5 marks]

At max speed, $a = 0$

\therefore Resultant force = 0

$$F = 40v$$

$$P = Fv$$

$$P = (40v)v$$

$$P = 40 \times 25 \times 25$$

$$P = 25000 \text{ W}$$

$$90 \text{ km h}^{-1} = 25 \text{ ms}^{-1}$$

- 7 Tanya is investigating the how the velocity, v , of a wave on a violin string depends on the mass, m , of the string, the length, l , of the string and the tension F in the string.

She believes the relationship has the form

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

- a) State an assumption we can make about k .

[1 marks]

k is a dimensionless constant

- b) Determine the values of α , β and γ .

[5 marks]

$$[k] = 1$$

$$[v] = [M]^{\alpha} [L]^{\beta} [F]^{\gamma}$$

$$LT^{-1} = M^{\alpha} \cdot L^{\beta} [MLT^{-2}]^{\gamma}$$

$$LT^{-1} = M^{\alpha+\gamma} L^{\beta+\gamma} T^{-2\gamma}$$

$$\alpha + \gamma = 0$$

$$\beta + \gamma = 1$$

$$-2\gamma = -1 \Rightarrow \gamma = \frac{1}{2}$$

$$\beta = \frac{1}{2}$$

$$\alpha = -\frac{1}{2}$$

- 8 A light elastic string of natural length 2 m and modulus of elasticity 150 newtons.

One end of the string is attached to a fixed point A on a smooth plane inclined at 30° to the horizontal.

The other end of the string is attached to a mass of 2 kg which rests on the plane.

The mass is pulled down the plane to a distance 4 m down from A before being released.

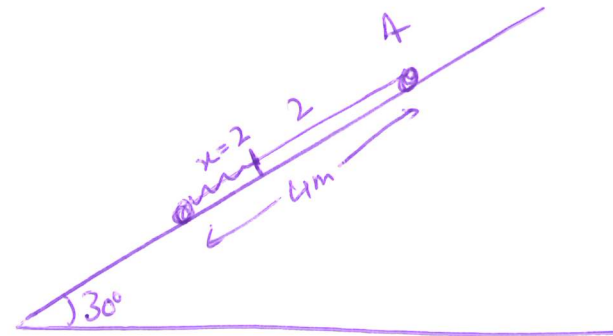
- a) Find the elastic potential energy stored in the string at the point of release.

$$\begin{aligned} \text{EPE} &= \frac{\lambda x^2}{2l} && [1 \text{ mark}] \\ &= \frac{150 \times 2^2}{2 \times 2} = 150 \text{ J} \end{aligned}$$

- b) Calculate the speed of the mass when the string goes slack.

[4 marks]

$$\begin{aligned} \text{EPE}_1 + \text{KE}_1 + \text{GPE}_1 &= \text{EPE}_2 + \text{KE}_2 + \text{GPE}_2 \\ 150 &= \frac{1}{2} \times 2 \times v^2 + 2 \times 9.8 \times 2.5 \sin 30^\circ \\ v^2 &= 130.4 \\ v &= 11.4 \dots \\ &= 11 \text{ m s}^{-1} \text{ (2 s.f.)} \end{aligned}$$



- c) Determine whether, in the subsequent motion, the mass will reach A .

[3 marks]

$$\begin{aligned} \text{GPE required to reach A} &= 2 \times 9.8 \times 4 \sin 30^\circ \\ &= 39.2 \text{ J} \\ \text{EPE at the start} &= 150 \text{ J} \\ 150 &> 39.2 \\ \therefore \text{the particle reaches A.} \end{aligned}$$

- 9 A particle A of mass 2 kg is moving on a smooth horizontal surface at a speed of $5u\text{ ms}^{-1}$.

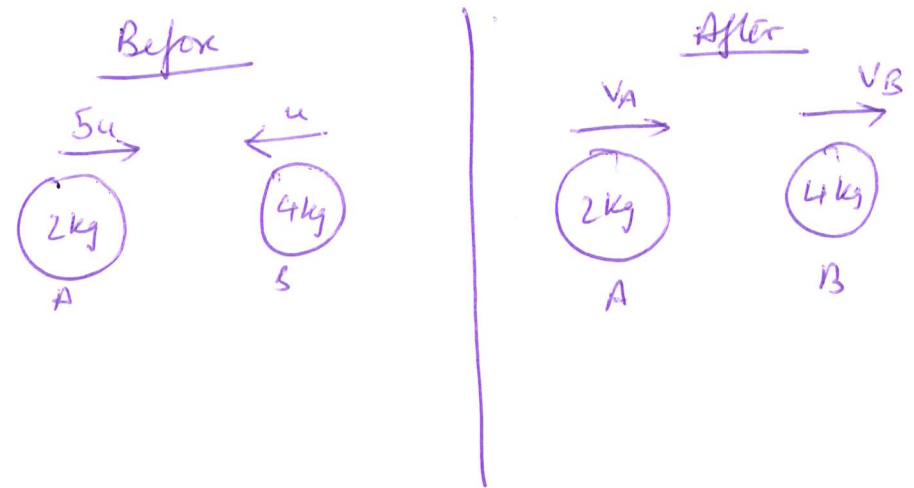
Particle B is also on the surface and moving directly towards A with speed $u\text{ ms}^{-1}$. Particle B has mass 4 kg .

The coefficient of restitution between the particles is e .

After collision A has speed $v_A\text{ ms}^{-1}$ and particle B has speed $v_B\text{ ms}^{-1}$.

- a) Draw a before and after momentum diagram.

[1 mark]



- d) How would your calculation for (c) change if it was a spring instead of a string.

[1 mark]

We will need to consider EPE at A as the spring will be under compression.

- b) Find the speed of A and B after the collision.

[5 marks]

COM:

$$2(5u) + 4(-u) = 2v_A + 4v_B$$

$$2v_A + 4v_B = 6u$$

$$v_A + 2v_B = 3u \quad \text{--- (1)}$$

NLR!

$$e = \frac{V_B - V_A}{5u - (-u)}$$

$$e = \frac{V_B - V_A}{6u}$$

$$V_B - V_A = 6eu \quad \text{--- (1)}$$

$$V_A + 2V_B = 3u \quad \text{--- (1)}$$

$$-V_A + V_B = 6eu \quad \text{--- (2)}$$

$$3V_B = 3u + 6eu$$

$$V_B = u + 2ue //$$

$$V_A = 3u - 2V_B$$

$$V_A = 3u - 2(u + 2ue)$$

$$V_A = u - 4ue$$

$$V_A = u(1 - 4e) //$$

- c) Given that the direction of A is reversed after the collision find a range of values for e .

[2 marks]

$V_A < 0$ if A is reversed

$$u(1 - 4e) < 0$$

$$1 - 4e < 0$$

$$4e > 1$$

$$e > \frac{1}{4}$$

but $0 \leq e \leq 1$

$$\therefore \frac{1}{4} < e \leq 1 //$$

