Please check the examination details below before entering your candidate information

Candidate surname StemUp Model Solution | Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Monday 13 October 2025

Afternoon (Time: 1 hour 30 minutes) | Paper reference WME01/01

Mathematics

International Advanced Subsidiary/Advanced Level
Mechanics M1

You must have:
Mathematical Formulae and Statistical Tables (Yellow), calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Whenever a numerical value of g is required, take $g = 9.8\ \text{m s}^{-2}$, and give your answer to either 2 significant figures or 3 significant figures.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 7 questions in this question paper. The total mark for this paper is 75.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

Turn over ▶

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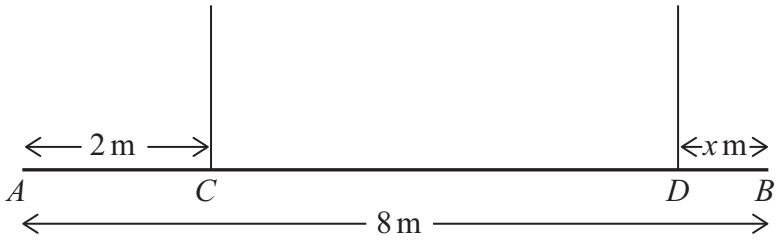


Figure 1

Figure 1 shows a sketch of a beam AB, with weight 240 N and length 8 m.

The beam is held in equilibrium in a horizontal position by two vertical ropes. The ropes are attached to the beam at the points C and D, where $AC = 2$ m and $DB = x$ metres.

The beam is modelled as a uniform rod and the ropes are modelled as light inextensible strings.

The tension in the rope at D is 90 N.

(a) Show that $x = \frac{2}{3}$

(3)

The rope at C will break if its tension exceeds 183 N. The rope at D cannot break. A package of weight W newtons is now attached to the beam at A. The beam remains horizontal and in equilibrium.

The package is modelled as a particle.

It is given that the rope at C does not break.

(b) Find the greatest possible value of W.

(4)

(a) M(C): $240 \times 2 = 90 \times (6 - x)$

$480 = 540 - 90x$

$90x = 60$

$x = \frac{60}{90} = \frac{2}{3}$ as required

(b) $T_C = 183$ at the limit. $DB = \frac{2}{3}$ so $AD = \frac{22}{3}$ m, $CD = \frac{16}{3}$ m, $GD = \frac{10}{3}$ m

M(D): $240 \times \frac{10}{3} + W \times \frac{22}{3} = 183 \times \frac{16}{3}$

$800 + \frac{22}{3}W = 976$

$\frac{22}{3}W = 176$

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Question 1 continued

W = 24 (greatest possible value of W is 24)

Question 1 continued

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Question 1 continued

(Total for Question 1 is 7 marks)

2.

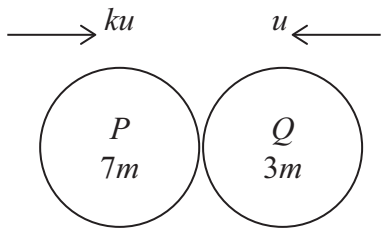


Figure 2

Particle P of mass $7m$ and particle Q of mass $3m$ are moving in opposite directions along the same straight line on a smooth horizontal surface. The particles collide directly.

Immediately **before** the collision, the speed of P is ku and the speed of Q is u, as shown in Figure 2.

Immediately **after** the collision, the speed of P is w and the speed of Q is $2w$.

The direction of motion of Q is reversed by the collision.

The impulse received by Q in the collision has magnitude $\frac{7}{2}mu$.

(a) Find w in terms of u.

(3)

(b) Find the two possible values of k.

(5)

Take the direction of motion of P before the collision as positive.

(a) Impulse on Q: $I = mv - mu$

$\frac{7}{2}mu = 3m(2w - (-u))$

$\frac{7}{6}u = 2w + u \Rightarrow 2w = \frac{1}{6}u$

$w = \frac{1}{12}u$

(b) Impulse on P is $\frac{7}{2}mu$ in the negative direction.

Case 1: P continues in the same direction with speed w

$-\frac{7}{2}mu = 7m\left(\frac{u}{12} - ku\right)$

$-\frac{1}{2} = \frac{1}{12} - k \Rightarrow k = \frac{7}{12}$

Case 2: P reverses direction, velocity $-w$

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Question 2 continued

$-\frac{7}{2}mu = 7m\left(-\frac{u}{12} - ku\right)$

$-\frac{1}{2} = -\frac{1}{12} - k \Rightarrow k = \frac{5}{12}$

So $k = \frac{7}{12}$ or $k = \frac{5}{12}$

(Total for Question 2 is 8 marks)

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3. [*In this question* **i** *and* **j** *are horizontal perpendicular unit vectors.*]

A particle P of mass 2 kg moves on a smooth horizontal surface under the action of two forces $\mathbf{F}_1$ and $\mathbf{F}_2$, where $\mathbf{F}_1 = (-2\mathbf{i} + 3\mathbf{j})$ N and $\mathbf{F}_2 = (4\mathbf{i} + 2\mathbf{j})$ N.

(a) Find the acceleration of P.

(3)

At time $t = 0$, the velocity of P is $(3\mathbf{i} - 4\mathbf{j})\,\text{m s}^{-1}$

(b) Find the speed of P when $t = 3$ seconds.

(4)

An additional force, $\mathbf{F}_3 = (b\mathbf{i} + c\mathbf{j})$ N, is applied to P.

The resultant of $\mathbf{F}_1$, $\mathbf{F}_2$ and $\mathbf{F}_3$ is equal to $\lambda(\mathbf{i} + \mathbf{j})$ N, where λ is a constant.

(c) Show that $b - c = 3$

(3)

The resultant of $\mathbf{F}_1$, $\mathbf{F}_2$ and $\mathbf{F}_3$ has magnitude $10\sqrt{2}$ N.

(d) Find the two possible $\mathbf{F}_3$ forces.

(4)

(a) $R = F_1 + F_2 = (-2i + 3j) + (4i + 2j) = (2i + 5j)$ N

$F = ma$: $2i + 5j = 2a$

$a = (i + 2.5j)$ m s^{-2}

(b) $v = u + at = (3i - 4j) + 3(i + 2.5j)$

$v = (6i + 3.5j)$ m s^{-1}

speed $= \sqrt{(6^2 + 3.5^2)} = \sqrt{48.25} = 6.9462...$

speed $= 6.95$ m s^{-1} (3 s.f.)

(c) $F_1 + F_2 + F_3 = (2 + b)i + (5 + c)j = \lambda(i + j)$

$\Rightarrow$ $2 + b = \lambda$ and $5 + c = \lambda$

$2 + b = 5 + c$

$\therefore$ $b - c = 3$ as required

(d) $|\lambda(i + j)| = 10\sqrt{2} \Rightarrow \lambda^2 + \lambda^2 = (10\sqrt{2})^2 = 200$

$\lambda^2 = 100 \Rightarrow \lambda = 10$ or $\lambda = -10$

$\lambda = 10$: $2 + b = 10$, $5 + c = 10 \Rightarrow b = 8$, $c = 5$

$\lambda = -10$: $2 + b = -10$, $5 + c = -10 \Rightarrow b = -12$, $c = -15$

$F_3 = (8i + 5j)$ N or $F_3 = (-12i - 15j)$ N

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Question 3 continued

Question 3 continued

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Question 3 continued

(Total for Question 3 is 14 marks)

4. The point A is 10 m above horizontal ground.
At time $t = 0$, a particle P is projected vertically upwards with speed $5\,\text{m s}^{-1}$ from A.
Particle P moves freely under gravity.

(a) Find the greatest height above A reached by P.

(3)

The point B is on the ground, vertically below A.
At time $t = 1$ second, a particle Q is projected vertically upwards with speed $7\,\text{m s}^{-1}$ from B.
Particle Q moves freely under gravity.

Particles P and Q collide at time $t = T$ seconds.

(b) Find the value of T.

(4)

(c) Find the speed of P at the instant immediately before the particles collide.

(2)

(a) At the greatest height $v = 0$: $v^2 = u^2 + 2as$

$0 = 5^2 - 2 \times 9.8 \times h$

$h = \frac{25}{19.6} = 1.2755...$

greatest height above A = 1.28 m

(b) Height of P above the ground at time $t = T$:

$h_P = 10 + 5T - \frac{1}{2}gT^2$

Height of Q above the ground (Q in the air for $(T - 1)$ s):

$h_Q = 7(T - 1) - \frac{1}{2}g(T - 1)^2$

Collide when $h_P = h_Q$:

$10 + 5T - \frac{1}{2}gT^2 = 7(T - 1) - \frac{1}{2}g(T - 1)^2$

$10 + 5T - 4.9T^2 = 7T - 7 - 4.9T^2 + 9.8T - 4.9$

$21.9 = 11.8T$

$T = \frac{21.9}{11.8} = 1.8559... \Rightarrow T = 1.86$

(c) $v = u + at = 5 - 9.8 \times 1.8559...$

$v = -13.187...$ (moving downwards)

speed of P = 13.2 m s^{-1}

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Question 4 continued

Question 4 continued

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Question 4 continued

(Total for Question 4 is 9 marks)

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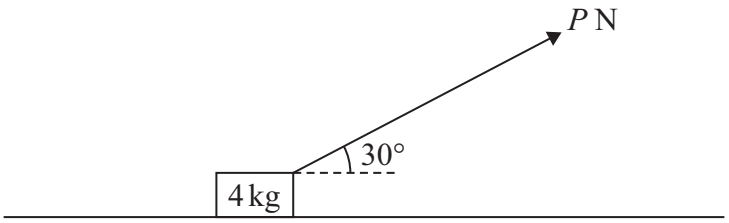


Figure 3

A box of mass 4 kg is placed on a rough horizontal surface.

A force of magnitude P newtons, acting at 30° to the horizontal, is applied to the box, as shown in Figure 3.

The coefficient of friction between the box and the surface is $\frac{2}{3}$

The box is modelled as a particle.

(a) Find the value of P when the box is on the point of sliding along the surface.

(6)

The value of P is now increased to 25 and the box moves along the surface.

Find

(b) the acceleration of the box,

(5)

(c) the speed of the box when it has moved 1.5 m.

(2)

(a) Limiting friction $F = \mu R = \frac{2}{3}R$

$R(\rightarrow)$: $P\cos 30° = F$

$R(\uparrow)$: $P\sin 30° + R = 4g \Rightarrow R = 4g - \frac{1}{2}P$

$P \times \frac{\sqrt{3}}{2} = \frac{2}{3}\left(4g - \frac{1}{2}P\right)$

$\frac{\sqrt{3}}{2}P + \frac{1}{3}P = \frac{8}{3}g$

$P = \frac{8g \,/\, 3}{\sqrt{3} \,/\, 2 + 1 \,/\, 3} = \frac{26.133\ldots}{1.1993\ldots} = 21.789\ldots$

$P = 21.8$

(b) $R(\uparrow)$: $25\sin 30° + R = 4g \Rightarrow R = 39.2 - 12.5 = 26.7$ N

$F = \frac{2}{3} \times 26.7 = 17.8$ N

N2L $(\rightarrow)$: $25\cos 30° - F = 4a$

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Question 5 continued

$25 \cos 30° - \frac{2}{3}(4g - 25 \sin 30°) = 4a$

$21.650... - 17.8 = 4a$

$a = 0.96265...$ $\Rightarrow$ acceleration $= 0.963 \text{ m s}^{-2}$

(c) $v^2 = u^2 + 2as = 0 + 2 \times 0.96265... \times 1.5$

$v^2 = 2.8879...$ $\Rightarrow$ $v = 1.6994...$

speed $= 1.70 \text{ m s}^{-1}$

Question 5 continued

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Question 5 continued

(Total for Question 5 is 13 marks)

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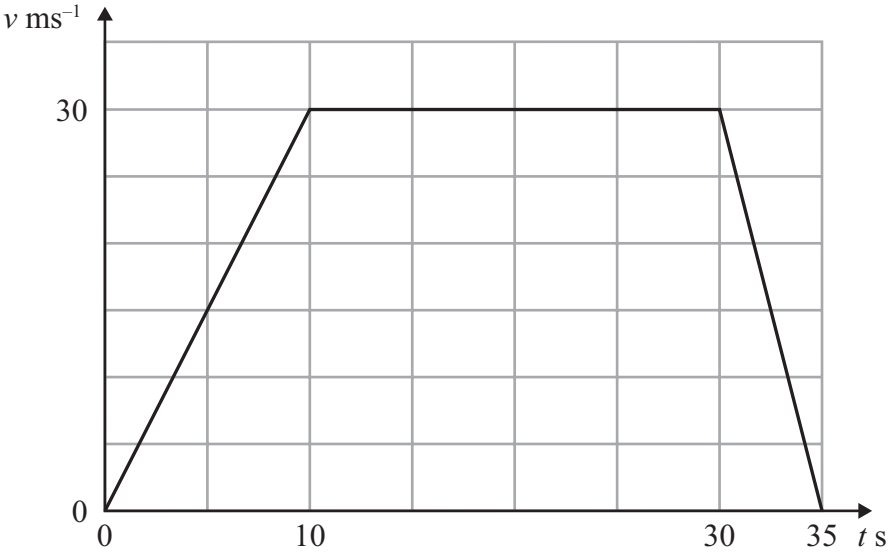


Figure 4

The point O lies on a straight horizontal road.
At time $t = 0$, a car leaves O and travels along the road.

The velocity-time graph in Figure 4 shows the velocity, $v\,\text{m s}^{-1}$, of the car at time t seconds for the first 35 seconds of its journey.

(a) Find

(i) the acceleration of the car for the period $0 \leqslant t \leqslant 10$

(ii) the deceleration of the car for the period $30 \leqslant t \leqslant 35$

(2)

(b) Sketch an acceleration-time graph for the car for the period $0 \leqslant t \leqslant 35$

(2)

(c) Find the distance travelled by the car for the period $0 \leqslant t \leqslant 35$

(2)

When $t = 5$, a motorcycle starts from rest at O.
The motorcycle travels along the same road as the car and in the same direction.

For the period $5 \leqslant t \leqslant 20$, the acceleration of the motorcycle is $A\,\text{m s}^{-2}$, where A is a positive constant.

The motorcycle catches up with the car when $t = 20$

(d) Find the value of A.

(4)

(a)(i) acceleration $= \frac{30}{10} = 3\ \text{m s}^{-2}$

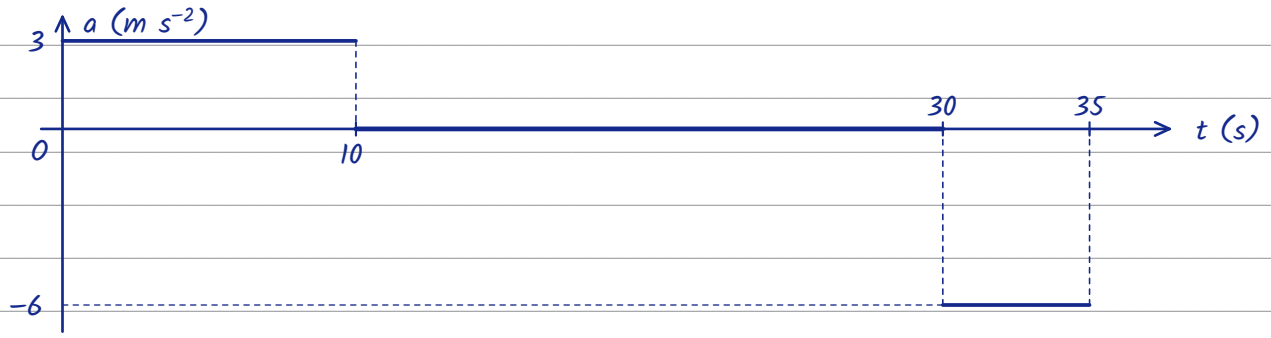
(ii) deceleration $= \frac{30}{5} = 6\ \text{m s}^{-2}$

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Question 6 continued

(b)



(c) distance = area under v–t graph = $\frac{(20 + 35)}{2} \times 30$

distance = 825 m

(d) Car at t = 20: $\frac{1}{2} \times 10 \times 30 + 10 \times 30 = 150 + 300 = 450$ m

Motorcycle travels for 15 s from rest: $s = \frac{1}{2} \times A \times 15^2 = \frac{225A}{2}$

Equal distances: $\frac{225A}{2} = 450$

$A = 4$

Question 6 continued

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Question 6 continued

(Total for Question 6 is 10 marks)

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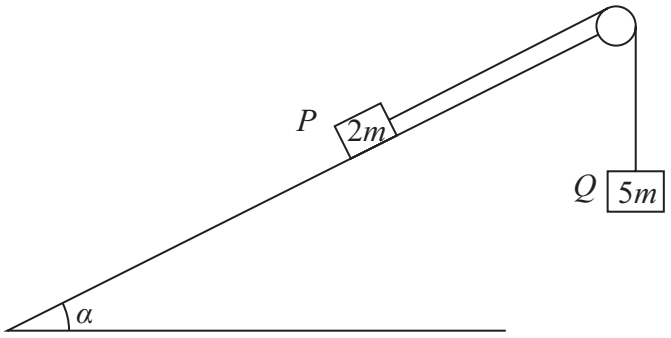


Figure 5

A block P of mass $2m$ is held at rest on a fixed rough plane.

The plane is inclined to the horizontal at an angle α, where $\tan\alpha = \frac{5}{12}$

One end of a light inextensible string is attached to P.
The string is parallel to a line of greatest slope of the plane and passes over a smooth light pulley which is fixed at the top of the plane.
The other end of the string is attached to a block Q of mass $5m$.
Block Q hangs vertically below the pulley, as shown in Figure 5.

The system is released from rest with the string taut and block P moves up the plane.

Immediately after the system is released, the tension in the string is T and the acceleration of the blocks is a.

The blocks are modelled as particles and air resistance is ignored.

(a) Write down an equation of motion for Q.

(2)

The coefficient of friction between P and the plane is $\frac{1}{8}$

(b) Find T in terms of m and g.

(7)

(c) State how the solution to part (b) uses the fact that the string is inextensible.

(1)

The magnitude of the force exerted on the pulley by the string is kmg.

(d) Find the value of k to 3 significant figures.

(4)

(a) N2L for Q (downwards): $5mg - T = 5ma$

(b) $\tan\alpha = \frac{5}{12} \Rightarrow \sin\alpha = \frac{5}{13}, \cos\alpha = \frac{12}{13}$

R(⊥ plane) for P: $R = 2mg\cos\alpha = 2mg \times \frac{12}{13} = \frac{24}{13}mg$

$F = \mu R = \frac{1}{8} \times \frac{24}{13}mg = \frac{3}{13}mg$

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Question 7 continued

N2L for P (up the plane): $T - F - 2mg\sin\alpha = 2ma$

$T - \frac{3}{13}mg - \frac{10}{13}mg = 2ma \Rightarrow T - mg = 2ma$

Combine with $5mg - T = 5ma$:

$\times 2$: $10mg - 2T = 10ma$ and $\times 5$: $5T - 5mg = 10ma$

$10mg - 2T = 5T - 5mg \Rightarrow 7T = 15mg$

$T = \frac{15mg}{7}$

(c) The accelerations of P and Q are the same (both equal to a), so the same a is used in both equations of motion.

(d) Angle between the two parts of the string at the pulley $= 90° - \alpha$

Force on pulley $= 2T\cos\left(\frac{90° - \alpha}{2}\right)$

$\alpha = \tan^{-1}\left(\frac{5}{12}\right) = 22.619...° \Rightarrow \frac{90° - \alpha}{2} = 33.690...°$

Force $= 2 \times \frac{15mg}{7} \times \cos 33.690...° = 2 \times \frac{15}{7} \times 0.83205...\ mg$

Force $= 3.5659...\ mg$

$k = 3.57$ (3 s.f.)

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Question 7 continued

Question 7 continued

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TOTAL FOR PAPER IS 75 MARKS

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