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Pearson Edexcel Level 3 GCE

Paper reference	8MA0/22
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Mathematics

Advanced Subsidiary

PAPER 22: Mechanics

<p>You must have:</p> <p>Mathematical Formulae and Statistical Tables (Green), calculator</p>	<p>Total Marks</p>
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Candidates may use any calculator allowed 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.
- Unless otherwise indicated, wherever a 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.
- The total mark for this part of the examination is 30. There are 4 questions.
- 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.

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Q:1/1/1/




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1. The point A is 1.8 m vertically above horizontal ground.

At time $t = 0$, a small stone is projected vertically upwards with speed $U\text{ m s}^{-1}$ from the point A .

At time $t = T$ seconds, the stone hits the ground.

The speed of the stone as it hits the ground is 10 m s^{-1}

In an initial model of the motion of the stone as it moves from A to where it hits the ground

- the stone is modelled as a particle moving freely under gravity
- the acceleration due to gravity is modelled as having magnitude 10 m s^{-2}**

Using the model,

- (a) find the value of U , (3)
- (b) find the value of T . (2)
- (c) Suggest one refinement, apart from including air resistance, that would make the model more realistic. (1)

In reality the stone will not move freely under gravity and will be subject to air resistance.

- (d) Explain how this would affect your answer to part (a). (1)

$$(a) \quad 10^2 = U^2 + 2 \times 10 \times 1.8$$

$$U = \sqrt{10^2 - 2 \times 10 \times 1.8}$$

$$U = 8$$

$$(b) \quad 10 = -8 + 10T \rightarrow T = \frac{18}{10} = 1.8$$

(c) use a less rounded value for gravity (g)

(d) U would be greater



- (e) State one limitation of the model which could affect your answers to parts (b) and (c).



Question 2 continued

(c) 0.63

(d) at $t = 5.12$

$$25 - 32 \times \frac{5}{32} = 20 \text{ m/s}^2$$

(e) The train cannot instantaneously change acceleration



3. A fixed point O lies on a straight line.

A particle P moves along the straight line.

At time t seconds, $t \geq 0$, the distance, s metres, of P from O is given by

$$s = \frac{1}{3}t^3 - \frac{5}{2}t^2 + 6t$$

- (a) Find the acceleration of P at each of the times when P is at instantaneous rest.

(6)

- (b) Find the total distance travelled by P in the interval $0 \leq t \leq 4$

(3)

$$v = \frac{ds}{dt} = t^2 - 5t + 6 = 0$$

$$(t-3)(t-2) = 0$$

$$t = 2 \text{ and } t = 3$$

$$a = \frac{dv}{dt} = 2t - 5$$

$$\text{when } t = 2 \quad a = -1 \text{ m/s}^2$$

$$\text{when } t = 3 \quad a = 1 \text{ m/s}^2$$

$$(b) \quad \text{when } t = 2 \quad S_2 = \frac{1}{3}(2)^3 - \frac{5}{2}(2)^2 + 6(2) = \frac{14}{3}$$

$$\text{when } t = 3 \quad S_3 = \frac{1}{3}(3)^3 - \frac{5}{2}(3)^2 + 6(3) = \frac{9}{2}$$

$$\text{when } t = 4 \quad S_4 = \frac{1}{3}(4)^3 - \frac{5}{2}(4)^2 + 6(4) = \frac{16}{3}$$

$$\text{Total distance: } \frac{14}{3} - \left(\frac{9}{2} - \frac{14}{3} \right) + \left(\frac{16}{3} - \frac{9}{2} \right)$$

$$= 5.7 \text{ metres}$$

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4.

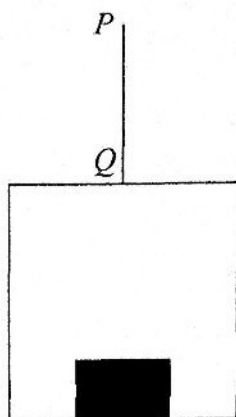


Figure 1

A vertical rope PQ has its end Q attached to the top of a small lift cage.

The lift cage has mass 40 kg and carries a block of mass 10 kg , as shown in Figure 1.

The lift cage is raised vertically by moving the end P of the rope vertically upwards with constant acceleration 0.2 m s^{-2}

The rope is modelled as being light and inextensible and air resistance is ignored.

Using the model,

(a) find the tension in the rope PQ

(3)

(b) find the magnitude of the force exerted on the block by the lift cage.

(3)

$$(a) \quad T - 40g - 10g = 50 \times 0.2$$

$$T = 20 + 50g = 500\text{ N}$$

$$(b) \quad R - 10g = 10 \times 0.2$$

$$R = 2 + 10g = 100\text{ N}$$

