

Please check the examination details below before entering your candidate information

Candidate surname		Other names	
Centre Number		Candidate Number	
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**Pearson Edexcel Level 3 GCE**

**Friday 17 May 2024**

Afternoon

Paper reference **8FM0/25**

**Further Mathematics**

**Advanced Subsidiary**

**Further Mathematics options**

**25: Further Mechanics 1**

**(Part of options C, E, H and J)**

**You must have:**

Mathematical Formulae and Statistical Tables (Green), 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.
- Unless otherwise indicated, whenever 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 40. 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.

Turn over ►

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1. A particle  $A$  has mass  $2m$  and a particle  $B$  has mass  $3m$ . The particles are moving in opposite directions along the same straight line and collide directly.

Immediately **before** the collision, the speed of  $A$  is  $2u$  and the speed of  $B$  is  $u$ .  
Immediately **after** the collision, the speed of  $A$  is  $0.5u$  and the speed of  $B$  is  $w$ .

Given that the direction of motion of each particle is reversed by the collision,

- (a) find  $w$  in terms of  $u$  (3)
- (b) find the coefficient of restitution between the particles, (3)
- (c) find, in terms of  $m$  and  $u$ , the magnitude of the impulse received by  $A$  in the collision. (3)



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Question 1 continued

Lined area for writing the answer to Question 1.

(Total for Question 1 is 9 marks)



2. A lorry has mass 5000 kg.

**In all circumstances**, when the speed of the lorry is  $v \text{ m s}^{-1}$ , the resistance to motion of the lorry from non-gravitational forces is modelled as having magnitude  $490v$  newtons.

The lorry moves along a straight horizontal road at  $12 \text{ m s}^{-1}$ , with its engine working at a constant rate of 84 kW.

Using the model,

- (a) find the acceleration of the lorry.

(4)

Another straight road is inclined to the horizontal at an angle  $\alpha$  where  $\sin \alpha = \frac{1}{14}$

With its engine again working at a constant rate of 84 kW, the lorry can maintain a constant speed of  $V \text{ m s}^{-1}$  up the road.

Using the model,

- (b) find the value of  $V$ .

(4)



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Question 2 continued

Lined area for writing the answer to Question 2.

(Total for Question 2 is 8 marks)



3.

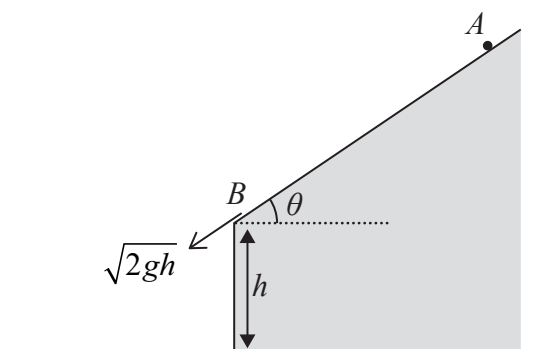


Figure 1

Figure 1 shows part of the end elevation of a building which sits on horizontal ground. The side of the building is vertical and has height  $h$ .

A small stone of mass  $m$  is at rest on the roof of the building at the point  $A$ . The stone slides from rest down a line of greatest slope of the roof and reaches the edge  $B$  of the roof with speed  $\sqrt{2gh}$

The stone then moves under gravity before hitting the ground with speed  $W$ .

In a model of the motion of the stone **from  $B$  to the ground**

- the stone is modelled as a particle
- air resistance is ignored

Using the principle of conservation of mechanical energy and the model,

(a) find  $W$  in terms of  $g$  and  $h$ .

(4)

In a model of the motion of the stone **from  $A$  to  $B$**

- the stone is modelled as a particle of mass  $m$
- air resistance is ignored
- the roof of the building is modelled as a rough plane inclined to the horizontal at an angle  $\theta$ , where  $\tan \theta = \frac{3}{4}$
- the coefficient of friction between the stone and the roof is  $\frac{1}{3}$
- $AB = d$

Using this model,

(b) find, in terms of  $m$  and  $g$ , the magnitude of the frictional force acting on the stone as it slides down the roof,

(3)

(c) use the work–energy principle to find  $d$  in terms of  $h$ .

(5)



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Question 3 continued

Lined area for writing the answer to Question 3.



Question 3 continued

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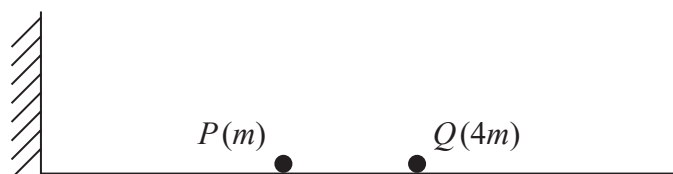
Question 3 continued

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(Total for Question 3 is 12 marks)



4.



## Figure 2

A particle  $P$  of mass  $m$  and a particle  $Q$  of mass  $4m$  are at rest on a smooth horizontal plane, as shown in Figure 2.

Particle  $P$  is projected with speed  $u$  along the plane towards  $Q$  and the particles collide.

The coefficient of restitution between the particles is  $e$ , where  $e > \frac{1}{4}$

As a result of the collision, the direction of motion of  $P$  is reversed and  $P$  has speed  $\frac{u}{5}(4e - 1)$ .

- (a) Find, in terms of  $u$  and  $e$ , the speed of  $Q$  after the collision. (3)

After the collision,  $P$  goes on to hit a vertical wall which is fixed at right angles to the direction of motion of  $P$ .

The coefficient of restitution between  $P$  and the wall is  $f$ , where  $f > 0$

Given that  $e = \frac{3}{4}$

- (b) find, in terms of  $m$ ,  $u$  and  $f$ , the kinetic energy lost by  $P$  as a result of its impact with the wall. Give your answer in its simplest form. (4)

After its impact with the wall,  $P$  goes on to collide with  $Q$  again.

- (c) Find the complete range of possible values of  $f$ . (4)



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Question 4 continued

Lined area for writing the answer to Question 4.



**Question 4 continued**

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**(Total for Question 4 is 11 marks)**

**TOTAL FOR FURTHER MECHANICS 1 IS 40 MARKS**

