

Paper Reference 8FM0–25
Pearson Edexcel
Level 3 GCE

Further Mathematics
Advanced Subsidiary
Further Mathematics options
25: Further Mechanics 1
(Part of options C, E, H and J)

Thursday 17 May 2018 – Afternoon

**MATERIALS REQUIRED FOR
EXAMINATION**

**Mathematical Formulae and Statistical
Tables**
Calculator

**ITEMS INCLUDED WITH QUESTION
PAPER**

Diagram Book
Answer Book

Y60206A

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

INSTRUCTIONS

In the boxes on the Answer Book and on the Diagram Book, write 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 Answer Book or on the separate diagrams – there may be more space than you need.

Do NOT write on the Question Paper.

You should show sufficient working to make your methods clear. Answers without working may not gain full credit.

Answers should be given to three significant figures unless otherwise stated.

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.

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.

Answer ALL questions.

Write your answers in the Answer Book.

1. A small ball of mass 0.3 kg is released from rest from a point 3.6 metres above horizontal ground. The ball falls freely under gravity, hits the ground and rebounds vertically upwards.

In the first impact with the ground, the ball receives an impulse of magnitude 4.2 N s

The ball is modelled as a particle.

- (a) Find the speed of the ball immediately after it first hits the ground.

(5 marks)

(continued on the next page)

Turn over

1. continued.

(b) Find the kinetic energy lost by the ball as a result of the impact with the ground.

(3 marks)

(Total for Question 1 is 8 marks)

2. Refer to the diagram for Question 2 in the Diagram Book.

It shows a ramp inclined at an angle θ to the horizontal, where $\sin \theta = \frac{2}{7}$

A parcel of mass **4 kg** is projected, with speed **5 m s^{-1}** , from a point **A** on the ramp.

The parcel moves up a line of greatest slope of the ramp and first comes to instantaneous rest at the point **B**, where **$AB = 2.5$** metres.

The parcel is modelled as a particle.

(continued on the next page)

2. continued.

The total resistance to the motion of the parcel from non–gravitational forces is modelled as a constant force of magnitude R newtons.

- (a) Use the work–energy principle to show that $R = 8.8$**
(4 marks)

(continued on the next page)

2. continued.

After coming to instantaneous rest at B, the parcel slides back down the ramp.

The total resistance to the motion of the particle is modelled as a constant force of magnitude 8.8 newtons.

**(b) Find the speed of the parcel at the instant it returns to A
(3 marks)**

**(c) Suggest two improvements that could be made to the model.
(2 marks)**

(Total for Question 2 is 9 marks)

Turn over

3. A van of mass **750 kg** is moving along a straight horizontal road. At the instant when the van is moving at $v \text{ m s}^{-1}$, the resistance to the motion of the van is modelled as a force of magnitude λv newtons, where λ is a constant.

The engine of the van is working at a constant rate of **18 kW**

At the instant when $v = 15$, the acceleration of the van is 0.6 m s^{-2}

- (a) Show that $\lambda = 50$
(4 marks)

(continued on the next page)

3. continued.

The van now moves up a straight road inclined at an angle to the horizontal, where $\sin \alpha = \frac{1}{15}$

At the instant when the van is moving at $v \text{ m s}^{-1}$, the resistance to the motion of the van from non-gravitational forces is modelled as a force of magnitude $50v$ newtons. When the engine of the van is working at a constant rate of 12 kW , the van is moving at a constant speed $V \text{ m s}^{-1}$

(b) Find the value of V
(5 marks)

(Total for Question 3 is 9 marks)

4. A particle **P** of mass **$3m$** is moving in a straight line on a smooth horizontal floor.

A particle **Q** of mass **$5m$** is moving in the opposite direction to **P** along the same straight line.

The particles collide directly.

Immediately before the collision, the speed of **P** is **$2u$** and the speed of **Q** is **u**

The coefficient of restitution between **P** and **Q** is **e**

(continued on the next page)

4. continued.

(a) Show that the speed of Q immediately after the collision is

$$\frac{u}{8}(9e + 1)$$

(6 marks)

(b) Find the range of values of e for which the direction of motion of P is not changed as a result of the collision.

(2 marks)

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4. continued.

When P and Q collide they are at a distance d from a smooth fixed vertical wall, which is perpendicular to their direction of motion.

After the collision with P , particle Q collides directly with the wall and rebounds so that there is a second collision between P and Q

This second collision takes place at a distance x from the wall.

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4. continued.

Given that $e = \frac{1}{18}$ and the coefficient of restitution between Q and the wall is $\frac{1}{3}$

(c) find x in terms of d

(6 marks)

(Total for Question 4 is 14 marks)

TOTAL FOR FURTHER MECHANICS 1 IS

40 MARKS

END OF PAPER
