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| **Pearson Edexcel Level 3** |
| **GCE Further Mathematics** **Advanced Subsidiary** **Paper 2: Further Mathematics options****Option 2E: Further Mechanics 1** |
| **Sample assessment material for first teaching September 2017** **Time: 40 minutes** | **Paper Reference(s)** |
| **8FM0/2E** |
| **You must have:** **Mathematical Formulae and Statistical Tables** **Calculator** |

**Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic 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 the 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.

• Inexact answers should be given to three significant figures unless otherwise stated.

**Information**

• A booklet ‘Mathematical Formulae and Statistical Tables’ is provided.

• There are 8 questions in this question paper. The total mark for this paper is 80.

• 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.

**SECTION B**

**Answer ALL questions.**

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| Unless otherwise indicated, whenever a numerical value of g is required, take g = 9.8 m s–2 and give your answer to either 2 significant figures or 3 significant figures. |

**5.** A small ball of mass 0.1 kg is dropped from a point which is 2.4 m above a horizontal floor. The ball falls freely under gravity, strikes the floor and bounces to a height of 0.6 m above the floor. The ball is modelled as a particle.

(*a*) Show that the coefficient of restitution between the ball and the floor is 0.5.

**(6)**

(*b*) Find the height reached by the ball above the floor after it bounces on the floor for the second time.

**(3)**

(*c*) By considering your answer to part (*b*), describe the subsequent motion of the ball.

**(1)**

 **(Total for Question 5 is 10 marks)**

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**6.** A small stone of mass 0.5 kg is thrown vertically upwards from a point *A* with an initial speed of 25 m s–1. The stone first comes to instantaneous rest at the point *B* which is 20 m vertically above the point *A*. As the stone moves it is subject to air resistance. The stone is modelled as a particle.

(*a*) Find the energy lost due to air resistance by the stone, as it moves from *A* to *B*.

**(3)**

The air resistance is modelled as a constant force of magnitude *R* newtons.

(*b*) Find the value of *R*.

**(2)**

(*c*) State how the model for air resistance could be refined to make it more realistic.

**(1)**

 **(Total for Question 6 is 6 marks)**

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**7.** [In this question use *g* = 10 m s–2]

A jogger of mass 60 kg runs along a straight horizontal road at a constant speed of
4 m s–1. The total resistance to the motion of the jogger is modelled as a constant force of magnitude 30 N.

(*a*) Find the rate at which the jogger is working.

**(3)**

The jogger now comes to a hill which is inclined to the horizontal at an angle *α*, where
sin*α* = . Because of the hill, the jogger reduces her speed to 3 m s–1 and maintains this constant speed as she runs up the hill. The total resistance to the motion of the jogger from non-gravitational forces continues to be modelled as a constant force of magnitude 30 N.

(*b*) Find the rate at which she has to work in order to run up the hill at 3 m s–1.

 **(5)**

 **(Total for Question 7 is 8 marks)**

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**8.** A particle *P* of mass 3*m* is moving in a straight line on a smooth horizontal table.

A particle *Q* of mass *m* 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 *u* and the speed of *Q* is 2*u*. The velocities of *P* and *Q* immediately after the collision, measured in the direction of motion of *P* before the collision, are *v* and *w* respectively. The coefficient of restitution between *P* and *Q* is *e*.

(*a*) Find an expression for *v* in terms of *u* and *e*.

**(6)**

Given that the direction of motion of *P* is changed by the collision,

(*b*) find the range of possible values of *e*.

**(2)**

(*c*) Show that *w* = (1 + 9*e*).

**(2)**

Following the collision with *P*, the particle *Q* then collides with and rebounds from a fixed vertical wall which is perpendicular to the direction of motion of *Q*. The coefficient of restitution between *Q* and the wall is *f*.

Given that *e* = , and that *P* and *Q* collide again in the subsequent motion,

(*d*) find the range of possible values of *f* .

 **(6)**

**(Total for Question 8 is 16 marks)**

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**TOTAL FOR SECTION B IS 40 MARKS**

**TOTAL FOR PAPER IS 80 MARKS**