GCE AS/A Level – LEGACY

0980/01

S18-0980-01

MATHEMATICS – M1
Mechanics

TUESDAY, 19 JUNE 2018 – AFTERNOON

1 hour 30 minutes

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

- a WJEC pink 16-page answer booklet;
- a Formula Booklet;
- a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Answer **all** questions.

Take g as $9{\cdot}8\,\text{ms}^{-2}$.

Sufficient working must be shown to demonstrate the **mathematical** method employed.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

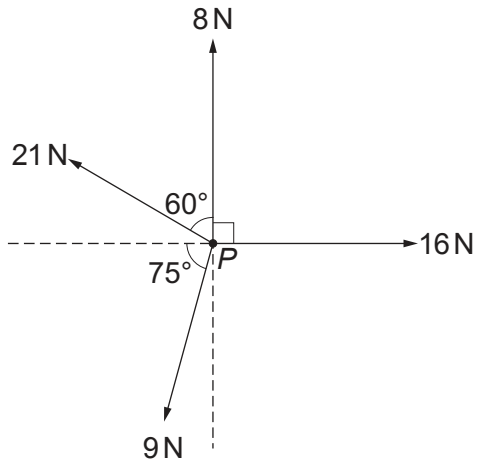
1. *(a)* A lift, of mass 1200 kg, is moving upwards. Find the tension in the lift cable when the lift is moving with

(i) an acceleration of $2\,\text{ms}^{-2}$,

(ii) constant speed. [4]

(b) A person of mass M kg stands in a lift which is moving downwards with an acceleration of $3\,\text{ms}^{-2}$. The reaction of the floor of the lift on the person is 442 N. Determine the value of M. [3]

2. The diagram shows four horizontal forces of magnitude 16 N, 9 N, 21 N and 8 N acting at a point *P*. Directions are as shown in the diagram.



Calculate the magnitude of the resultant of the forces acting at *P*. Determine the angle the resultant makes with the 8 N force. Give your answers correct to one decimal place. [8]

3. A uniform rod *AB* is resting in horizontal equilibrium on two smooth supports at *P* and *Q*. The length of the rod is 2 m and its mass is 24 kg. Supports *P* and *Q* are such that *AP* = 0·3 m and *PQ* = 1·1 m. A person of mass 36 kg stands on the rod at the end *A*. Find the magnitude of the reactions at *P* and at *Q*. [7]

4. Two particles *P* and *Q*, of masses 3 kg and 5 kg respectively, are attached one to each end of a light inextensible string which passes over a smooth peg. Initially, the particles are held at rest with the string just taut and with both hanging parts of the string vertical. The particles are then released from rest.

(a) Find the magnitude of the acceleration of *P* and the tension in the string. [7]

(b) What assumption does the word 'light', in the description of the string, enable you to make in your solution? [1]

(c) What assumption does the word 'smooth', in the description of the peg, enable you to make in your solution? [1]

5. When a cricket ball of mass 0·16 kg reaches a batsman it has horizontal velocity 12 ms^{-1}. It is driven straight back such that, as it leaves the bat, it has horizontal velocity 20 ms^{-1}.

(a) Find the impulse exerted by the bat on the ball. [2]

(b) Given that the bat and the ball were in contact for $\frac{1}{8}$s, find the average force between the bat and the ball. [2]

6. A raindrop *A* falls freely from rest from the top of a cliff. After it has fallen a distance 0·1 m, a second raindrop *B* begins to fall from rest from the top of the same cliff. The height of the cliff is 40 m.

(a) Find the velocity of *A* at the instant *B* begins to fall. [3]

(b) Find the velocity of *A* at the instant it reaches the ground. [2]

(c) Calculate the distance between the raindrops when the first raindrop *A* hits the ground. [7]

7. Two small smooth spheres *A* and *B*, of equal mass and equal radii, are moving in the same straight line and in the same direction. The speed of *A* is 4 ms^{-1} and the speed of *B* is 2 ms^{-1}. The spheres collide directly. After collision, their directions of motion remain unchanged, but the speed of *A* is v ms^{-1} and the speed of *B* is $1{\cdot}4v$ ms^{-1}.

(a) Calculate the value of v and the coefficient of restitution between the spheres. [6]

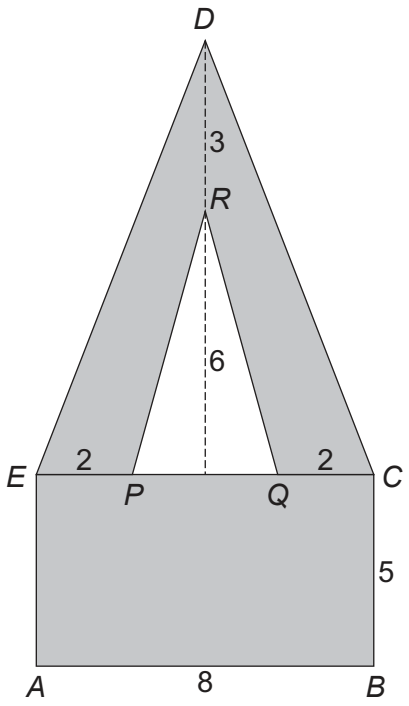
(b) After colliding with *A*, sphere *B* collides with a smooth vertical wall which is perpendicular to its direction of motion. The coefficient of restitution between *B* and the wall is 0·6. Determine the speed of *B* after the collision with the wall. [2]

(c) Given that after colliding with *A*, sphere *B* collides with the wall 5 seconds later, find the time that elapses between *B* colliding with the wall and its second collision with *A*. [3]

8. A particle of mass 10 kg is at rest on a rough plane inclined at an angle α to the horizontal. When a force of magnitude 98 N, acting **upwards** parallel to a line of greatest slope of the plane, is applied to the particle, it is on the point of moving up the plane. When a force of magnitude 49 N, acting **downwards** parallel to a line of greatest slope of the plane, is applied to the particle, it is on the point of moving down the plane. Find $\sin\alpha$ and the coefficient of friction between the particle and the plane. [9]

TURN OVER

9. The diagram shows a lamina *ABCDE*, made of uniform material. It consists of a rectangle *ABCE* and an isosceles triangle *ECD* with *ED* = *DC*. An isosceles triangle *PQR,* with *PR* = *RQ*, is removed. Dimensions, in cm, are as shown in the diagram.



Find the distance of the centre of mass of the lamina *ABCDE* from

(a) *AE*, [1]

(b) *AB*. [7]

END OF PAPER

