GCE AS/A Level – LEGACY

0980/01

S19-0980-01

MATHEMATICS – M1
Mechanics

TUESDAY, 18 JUNE 2019 – MORNING

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 crate, of mass 28 kg, is placed on the floor of a lift. Calculate, in newtons, the magnitude of the reaction of the floor of the lift on the crate,

(a) when the lift is descending with a deceleration of $3\,\text{ms}^{-2}$, [3]

(b) when the lift is ascending at a constant speed of $5\,\text{ms}^{-1}$. [1]

2. A particle is projected vertically upwards from the top of a cliff which is 80 m high. It reaches its maximum height after 3 seconds.

(a) Show that the speed of projection of the particle is $29{\cdot}4\,\text{ms}^{-1}$. [2]

(b) Find the height of the particle above the top of the cliff 5 seconds after projection. [3]

(c) Calculate the speed of the particle when it hits the ground at the bottom of the cliff. [3]

3. Two spheres *A* and *B*, of equal radii and of masses 7 kg and 5 kg respectively, are moving towards each other on a smooth horizontal surface. Initially, *A* is moving with speed $3\,\text{ms}^{-1}$ and *B* is moving with speed $2\,\text{ms}^{-1}$. The spheres collide directly. The coefficient of restitution between *A* and *B* is $\frac{2}{5}$.

(a) Find the speed of *A* and the speed of *B* immediately after the collision. [7]

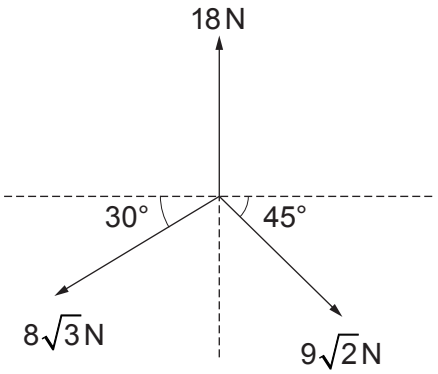
(b) Calculate the magnitude of the impulse exerted by *A* on *B* during the collision, clearly stating your units. [3]

4. A car travels along a straight road. The car leaves the point *A* starting from rest and accelerates for 25 seconds at a constant rate until it reaches a speed of $30\,\text{ms}^{-1}$. The car continues at $30\,\text{ms}^{-1}$ for *T* seconds until it approaches a speed restriction sign when a constant deceleration is applied for 6 seconds until the car slows to a speed of $15\,\text{ms}^{-1}$ as it passes the point *B*. The distance *AB* is 12 km.

(a) Sketch a velocity-time graph for the journey between *A* and *B*. [4]

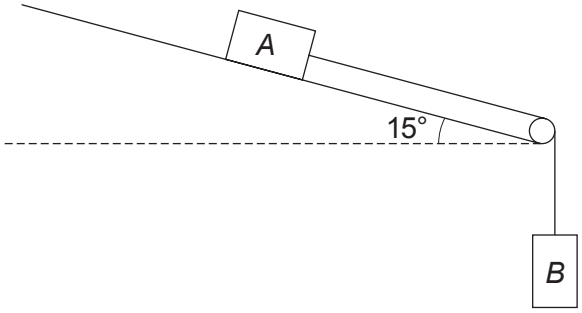
(b) Find the total time of the journey from *A* to *B*. [5]

5. Three horizontal forces of magnitudes 18 N, $9\sqrt{2}$ N and $8\sqrt{3}$ N act at a point in the directions shown in the diagram below.



Find the magnitude of the resultant force and determine the angle it makes with the 18 N force. [8]

6. A light inextensible string connects object *A*, of mass 9 kg, to object *B*, of mass 5 kg. The diagram shows *A* on a plane, inclined at an angle of 15° to the horizontal with the string passing over a smooth light pulley at the edge of the plane so that *B* hangs freely. The coefficient of friction between the object *A* and the plane is μ. Initially, *A* is held at rest with the string just taut. The system is then released from rest.

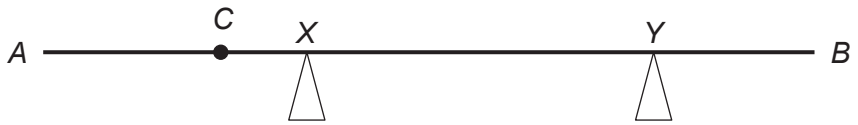


(a) Given that μ = 0, find the magnitude of the acceleration of *A*, and the tension in the string. [7]

(b) Given that the object *A* remains at rest, find the minimum value of μ. Give your answer correct to two decimal places. [6]

TURN OVER

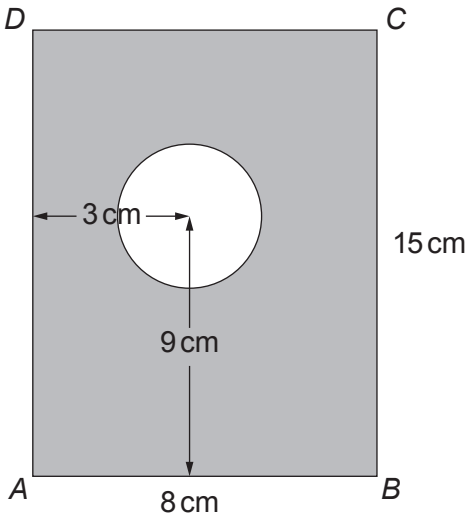
7. The diagram shows a uniform rod *AB*, of mass 3 kg and length 3 m, with a particle, of mass 0·4 kg, attached at a point *C* of the rod, where *AC* = 0·8 m. The rod is resting horizontally in equilibrium on two smooth supports at points *X* and *Y*, where *AX* = 1·2 m and *AY* = 2·4 m.



(a) Calculate the reaction at *X* and the reaction at *Y*. [7]

(b) When an additional particle of mass M kg is attached to the point *C*, the rod is on the point of turning about the support at *X*. Calculate the value of M. [4]

8. The diagram shows a uniform lamina formed by removing a circle, of radius 2 cm, from a rectangular card *ABCD,* where *AB* = 8 cm and *BC* = 15 cm. The centre of the circle is 9 cm from *AB* and 3 cm from *AD*.



(a) Calculate the distances of the centre of mass of the lamina from *AD* and *AB*. Give your answers correct to 3 decimal places. [9]

(b) The lamina is freely suspended from *A* and hangs in equilibrium. Calculate the angle *AB* makes with the vertical. [2]

(c) When the lamina is suspended freely from a point *P* on *DC*, it hangs with *AD* vertical. Write down the length of *DP*. [1]

END OF PAPER

