GCE AS/A level

0980/01

MATHEMATICS – M1
Mechanics

P.M. FRIDAY, 24 January 2014

1 hour 30 minutes

0980
010001

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

- a 12 page answer book;
- a Formula Booklet;
- a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Answer **all** questions.

Take g as 9·8 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 vehicle travels on a straight horizontal road. As it passes a point A at time $t = 0$, it is moving with a constant velocity of $18\,\text{ms}^{-1}$. It continues travelling at this velocity for 48 seconds. It then decelerates at a constant rate for the next 12 s until it passes a point B with velocity $3\,\text{ms}^{-1}$.

(a) Sketch a velocity-time graph for the motion of the vehicle between A and B. [2]

(b) Find the magnitude of the deceleration of the vehicle. [2]

(c) Determine the distance between A and B. [3]

2. A pebble is projected vertically upwards with a speed of $7\,\text{ms}^{-1}$ from the top of a cliff. It hits the ground at the bottom of the cliff 4 seconds later.

(a) Calculate the time for the pebble to reach its maximum height. [3]

(b) Determine the height of the cliff. [3]

3. A man of mass 65 kg stands in a lift which is ascending with acceleration $1{\cdot}2\,\text{ms}^{-2}$. Find the magnitude of the reaction of the floor of the lift on the man. [3]

4. An object of mass 60 kg lies on a rough plane inclined at an angle of 25° to the horizontal. The coefficient of friction between the plane and the object is denoted by μ. Initially, the object is held at rest. It is then released.

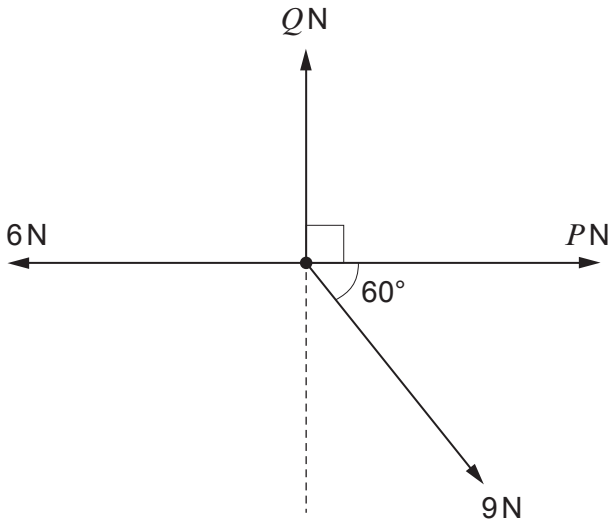
(a) When $\mu = 0{\cdot}3$, the object slides down the plane. Calculate

(i) the magnitude of the frictional force,

(ii) the acceleration of the object. [5]

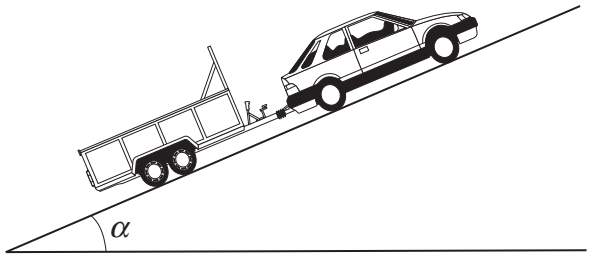
(b) Given that when the object is released it remains stationary, calculate the least possible value of μ. [3]

5. Four horizontal forces of magnitude 6 N, 9 N, P N and Q N acting at a point are in equilibrium. Directions are as shown in the diagram.



Find the value of P and the value of Q. [5]

6. The diagram below shows a car of mass 1500 kg connected to a trailer of mass 600 kg by means of a rigid tow bar. The car is moving upwards along a slope inclined at an angle α to the horizontal, where $\sin \alpha = \frac{7}{25}$. A constant resistance of magnitude 400 N acts on the car and a constant resistance of 300 N acts on the trailer. The car's engine produces a constant forward force of 8400 N.



(a) Calculate the acceleration of the car, giving your answer correct to three decimal places. [5]

(b) Determine the tension in the tow bar. [4]

TURN OVER

7. A uniform plank AB, of length 4·8 m and mass M kg, is resting on two smooth supports at points X and Y, such that $AX = BY = 1{\cdot}2$ m.

(a) A person of mass 84 kg stands on the plank at a point which is 0·8 m from B. The reaction of the support at X is of magnitude 156·8 N.
Find

(i) the value of M,

(ii) the magnitude of the reaction of the support at Y. [6]

(b) The person of mass 84 kg walks along the plank towards A. At the instant that the plank starts to tilt about X, find

(i) the magnitude of the reaction of the support at X,

(ii) the distance of the person from X. [5]

8. An object of mass 1·8 kg moving with speed 3 ms^{-1} on a smooth horizontal surface collides directly with another object of mass 0·2 kg, which is stationary. After the collision, the two objects move together.

(a) (i) Show that the speed of the combined object after the collision is 2·7 ms^{-1}.

(ii) Write down the value of the coefficient of restitution between the objects. [4]

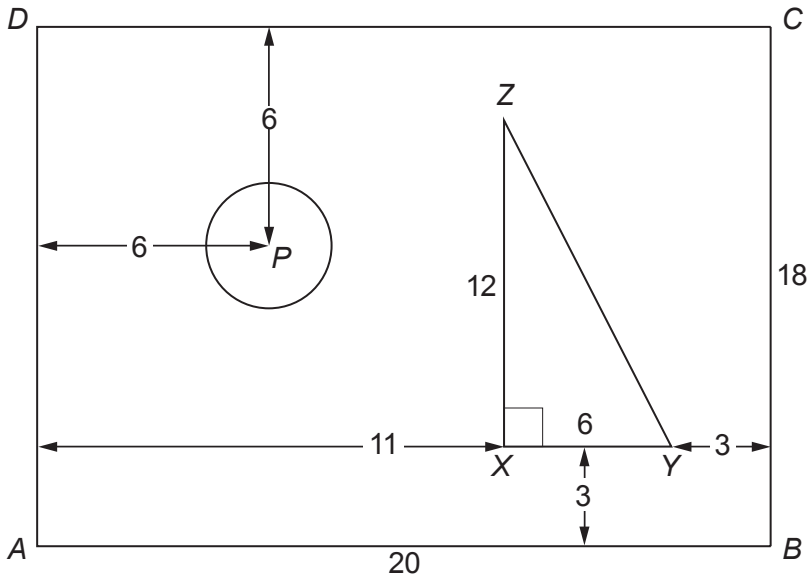
(b) The resistance to motion of the combined object is 8 N.

(i) Find the magnitude of the deceleration of the combined object.

(ii) Calculate the speed of the combined object 0·5 seconds after the collision.

(iii) Determine the distance of the combined object from the point of collision when its speed is 2 ms^{-1}. [8]

9. The diagram shows a lamina formed by **removing** a circle with centre P from a rectangle $ABCD$ made of a uniform material, and **adding** a right-angled triangle XYZ made of the same uniform material.
The area of the circle is $21\,\text{cm}^2$.
The line XY is parallel to AB and $\hat{YXZ} = 90°$.
Dimensions, in cm, are as shown in the diagram.



(a) Find the distance of the centre of mass of the lamina from

(i) AD,

(ii) AB. [10]

(b) When the lamina is suspended freely from a point Q on DC, it hangs in equilibrium with DC making an angle of 45° with the vertical. Find the possible distances of Q from D. [4]

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