WJEC
CBAC

GCE AS/A level

980/01

MATHEMATICS M1
Mechanics 1

A.M. MONDAY, 2 June 2008

1½ hours

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

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

INSTRUCTIONS TO CANDIDATES

Answer **all** questions.

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

Take g as 9·8 ms $^{-2}$.

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 train is travelling along a straight horizontal track. As the train passes point *A*, its speed is $18\,\text{ms}^{-1}$ and immediately after passing point *A*, it decelerates uniformly for 9 s until its speed is $12\,\text{ms}^{-1}$. The train then accelerates at $0{\cdot}5\,\text{ms}^{-2}$ until it reaches a speed of $22\,\text{ms}^{-1}$. The train maintains the speed of $22\,\text{ms}^{-1}$ for the next 31 s at which time it passes the point *B*.

(a) Find the time taken for the acceleration. [2]

(b) Draw a sketch of the velocity-time graph for the journey between *A* and *B*. [4]

2. A stone is projected vertically upwards from a point *A* at the top of a tower 70 m high. It reaches the highest point of its path after 2·5 s.

(a) Show that the speed of projection of the stone is $24{\cdot}5\,\text{ms}^{-1}$. [2]

(b) Find the height of the stone above *A* 4 s after projection. [3]

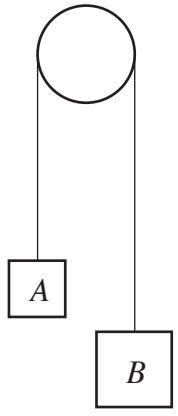
(c) Calculate the speed of the stone when it reaches the ground. [3]

3. The mass of a lift is 430 kg. When a man, of mass 70 kg, is standing in the lift and the tension in the cable is 4800 N, the lift is descending with acceleration $a\,\text{ms}^{-2}$.

(a) Find the value of *a*. [3]

(b) Determine the reaction of the floor of the lift on the man. [3]

4. Two particles *A* and *B,* of mass 5 kg and 9 kg respectively, are connected by a light inextensible string passing over a smooth light pulley, as shown in the diagram.



Initially, the particles are held at rest with the string taut. The system is then released. Calculate the magnitude of the acceleration of the particle *A* and the tension in the string. [6]

5. An object of mass 0·7 kg is moving on a smooth horizontal floor towards a vertical wall. The velocity of the object is 5 ms^{-1} in a direction which is perpendicular to the wall. Before the object reaches the wall, it is given an impulse after which it is moving in the same direction with speed 2 ms^{-1}.

(a) Calculate the magnitude and direction of the impulse, stating your units clearly. [4]

After the impulse, the object collides with the wall. The coefficient of restitution between the object and the wall is 0·6.

(b) Find the speed of the object after the impact with the wall. [2]

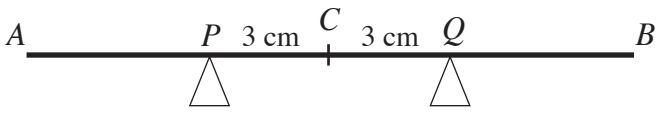
6. An object, of mass 6·5 kg, moves on a slope inclined at an angle α to the horizontal, where $\sin \alpha = \frac{5}{13}$. The coefficient of friction between the object and the slope is $\frac{1}{5}$.

(a) The object is sliding freely down a line of greatest slope. Find the magnitude of the acceleration of the object. [7]

(b) The object is being pulled up the slope at a constant speed by means of a rope parallel to a line of greatest slope. Find the tension in the rope. [4]

7. A sphere *A*, of mass 7 kg, moving with speed 5 ms^{-1}, collides directly with another sphere *B*, of mass 5 kg, moving in the opposite direction with speed 3 ms^{-1}. The coefficient of restitution between the spheres is 0·2. Calculate the speeds of the spheres after the collision, clearly indicating their directions of motion. [8]

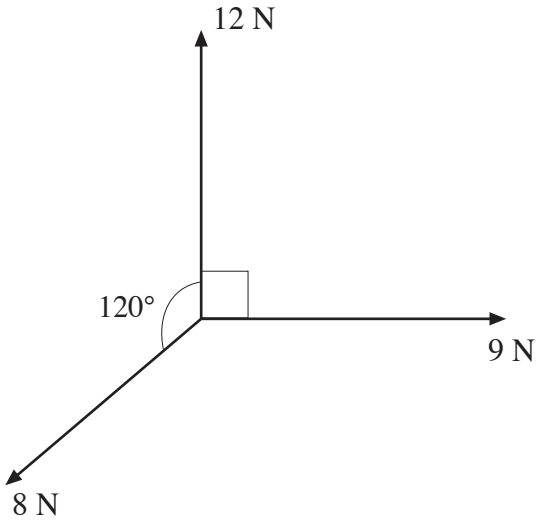
8. A uniform rod *AB*, of length 20 cm and weight 6 N, is supported by two smooth supports at *P* and *Q*, one on each side of its centre *C*, with $PC = CQ = 3$ cm, as shown in the diagram.



A body, of weight 5 N, is placed on the rod at a point which is *x* cm from the centre *C* of the rod. Find the greatest value of *x* if equilibrium is maintained. [5]

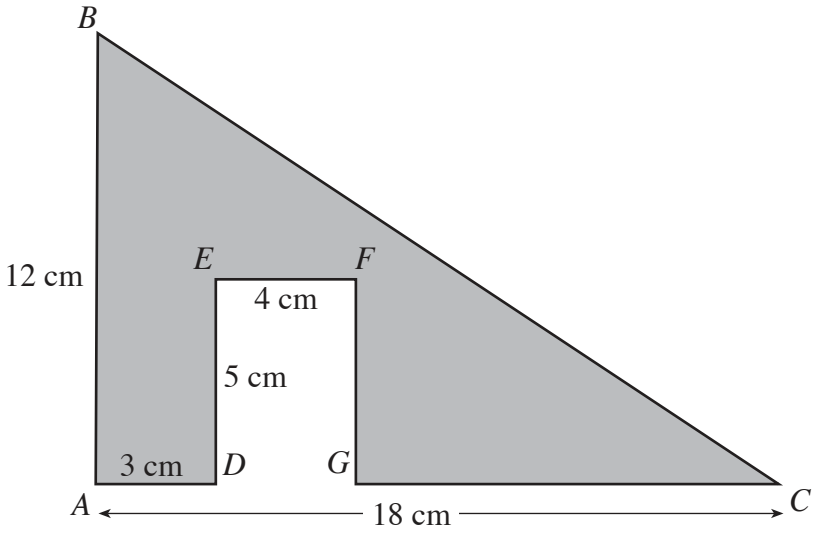
TURN OVER

9. Three horizontal forces of magnitudes 8 N, 12 N and 9 N act at a point in directions as shown in the diagram.



Find the magnitude of the resultant of these three forces and the angle between the resultant and the 9 N force. [8]

10. The diagram shows a uniform lamina *ABCGFED* consisting of triangle *ABC* with rectangle *DEFG* removed. Triangle *ABC* is right-angled at *A* with *AB* = 12 cm and *AC* = 18 cm. Rectangle *DEFG* has sides *DE* = 5 cm and *EF* = 4 cm. Distance *AD* = 3 cm.



(a) Calculate the distances of the centre of mass of the lamina from *AB* and *AC*, giving your answers correct to 3 significant figures. [9]

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