WJEC
CBAC

GCE AS/A level

980/01

MATHEMATICS M1
Mechanics 1

P.M. FRIDAY, 5 June 2009

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.

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.

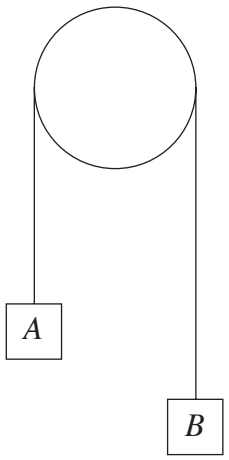
1. A boy throws a pebble from the top of a cliff 70·2 m high with an initial velocity of 14·7 ms^{-1} vertically upwards.

(a) Calculate the speed of the pebble 2 s after it has been thrown. [3]

(b) Calculate the speed of the pebble when it hits the ground at the foot of the cliff. [3]

(c) For how long is the pebble at least 3·969 m above the top of the cliff? [4]

2. Two objects *A*, of mass 2 kg, and *B*, of mass 5 kg, are attached one to each end of a light inextensible string. The string passes over a smooth peg. Initially, the objects are held at rest. The system is released from rest.



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

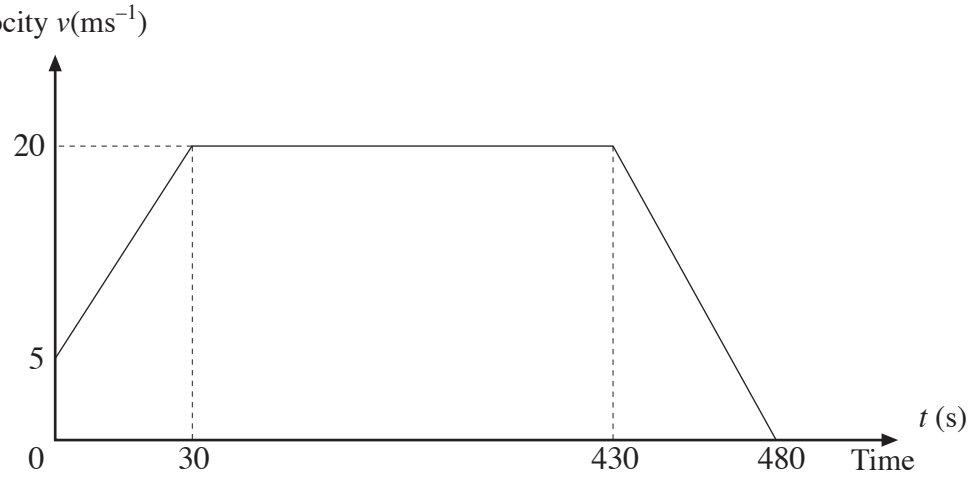
(b) What assumption did the word "inextensible" underlined in the first sentence enable you to make in your solution? [1]

3. A person of mass 65 kg is standing on the floor of a lift of mass 835 kg. The lift is descending with acceleration a ms^{-2} . The tension in the lift cable is 8550 N.

(a) Calculate the value of a. [3]

(b) Find the reaction of the floor on the person. [3]

4.



The diagram, which is not drawn to scale, is a sketch of the velocity-time graph of a train over a period of 480 s.

(a) Find the acceleration of the train at $t = 10$ and at $t = 420$. [3]

(b) Find the velocity of the train at $t = 20$. [2]

(c) Calculate the distance travelled from $t = 0$ to $t = 480$. [4]

5. A parcel of mass 8 kg is placed on a rough plane which is inclined at 25° to the horizontal. The coefficient of friction between the parcel and the plane is 0·3. Find the force that must be applied to the parcel in a direction parallel to a line of greatest slope of the plane so that

(a) the parcel is just prevented from sliding down the plane, [6]

(b) the parcel moves up the plane with an acceleration of 0·6 ms^{-2}. [4]

6. Two particles A and B are on a smooth horizontal surface. The masses of A and B are 2 kg and 0·5 kg respectively. Initially, A is moving with speed 3 ms^{-1} towards B, and B is moving with speed 4 ms^{-1} towards A. The particles collide directly. The coefficient of restitution between A and B is $\frac{2}{7}$.

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

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

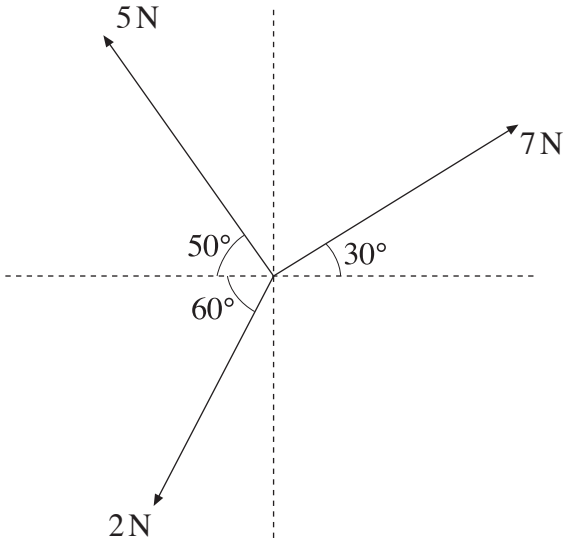
7. The diagram shows a **non-uniform** rod AB, of length 6 m and mass 40 kg, resting horizontally in equilibrium on two smooth supports at P and Q, which are respectively 2·5 m and 5·5 m from A. The point C is the position of the centre of mass of the rod and $AC = x$ m. The forces exerted on the rod by the supports at P and Q are **equal** in magnitude.

(a) Find the magnitude of each of the forces exerted on the rod by the supports at P and Q. [2]

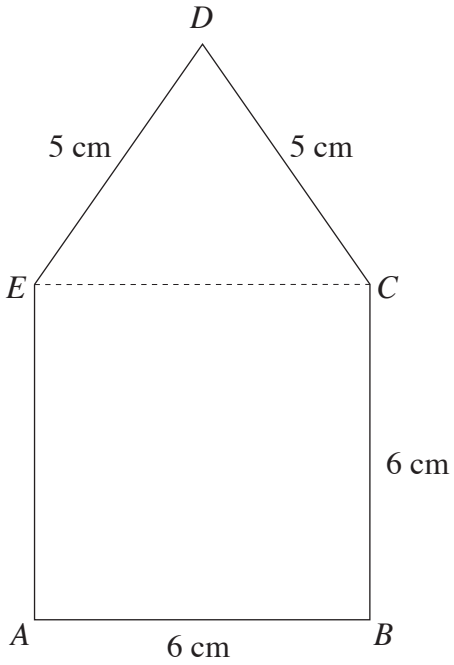
(b) Calculate the value of x. [4]

TURN OVER

8. The diagram shows three horizontal forces, of magnitude 5 N, 7 N and 2 N, acting at a point. Directions are as shown in the diagram. Calculate the magnitude of the resultant of the forces, giving your answer correct to one decimal place. [6]



9. The diagram shows a sign made out of uniform material. The sign consists of a square *ABCE* of side 6 cm and an isosceles triangle *CDE,* where *DC* = *DE* = 5 cm.



(a) Find the distances of the centre of mass of the sign from *AE* and *AB*. [7]

(b) When the sign is suspended freely from *B,* it hangs in equilibrium. Calculate the angle that *BC* makes with the vertical. [3]