



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} .

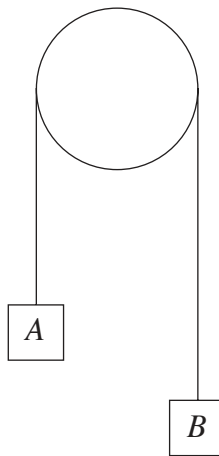
Sufficient working must be shown to demonstrate the **mathematical** method employed.

INFORMATION FOR CANDIDATES

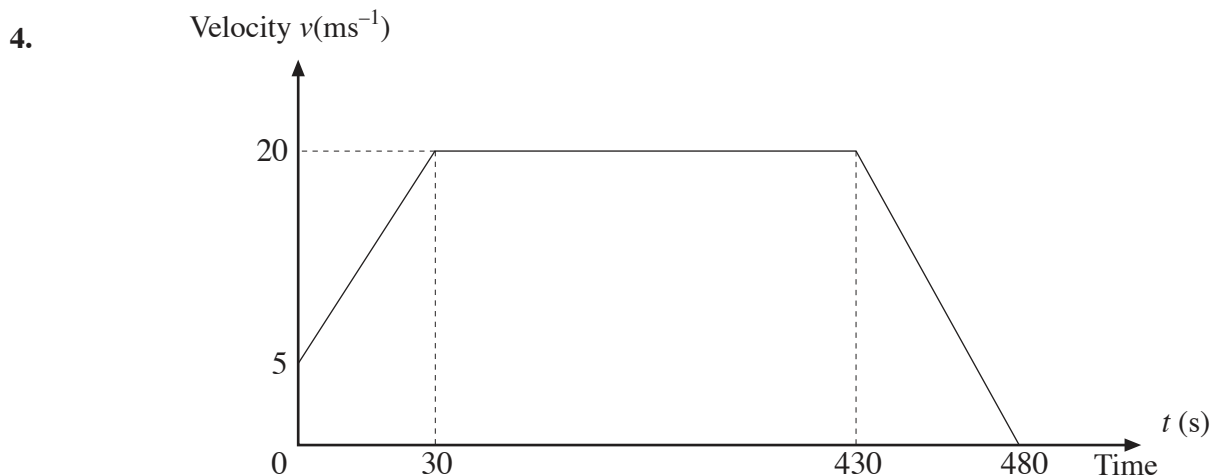
The number of marks is given in brackets at the end of each question or part-question.

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 $a \text{ ms}^{-2}$. 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]



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.

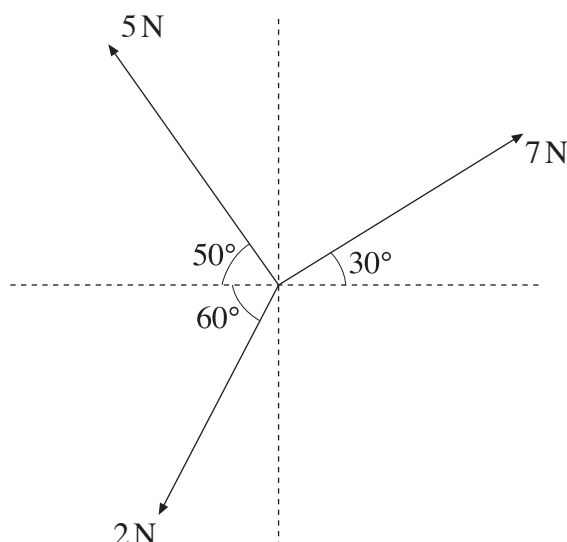
- (a) Find the acceleration of the train at $t = 10$ and at $t = 420$. [3]
 - (b) Find the velocity of the train at $t = 20$. [2]
 - (c) Calculate the distance travelled from $t = 0$ to $t = 480$. [4]
5. A parcel of mass 8 kg is placed on a rough plane which is inclined at 25° to the horizontal. The 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.



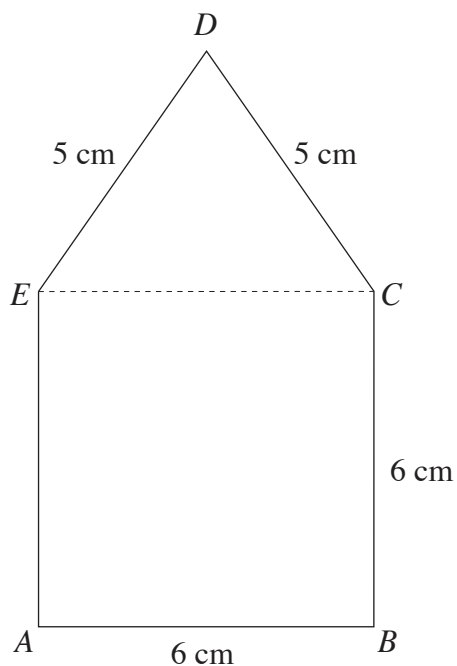
- (a) Find the magnitude of each of the forces exerted on the rod by the supports at P and Q . [2]
- (b) Calculate the value of x . [4]

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. [7]



- (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]