General Certificate of Education
Advanced Subsidiary/Advanced

980/01

MATHEMATICS M1
Mechanics 1

A.M. TUESDAY, 15 January 2008
(1 ½ 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 $^{-2}$.

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, moving with uniform acceleration along a straight horizontal road, has its speed measured at points A and B on the road. At point A, its speed is $12\,\text{ms}^{-1}$ and at point B, its speed is $20\,\text{ms}^{-1}$. The distance AB is 1000 m.

(a) Show that the acceleration of the vehicle is $0{\cdot}128\,\text{ms}^{-2}$. [3]

(b) Find the time taken for the vehicle to move from A to B. [3]

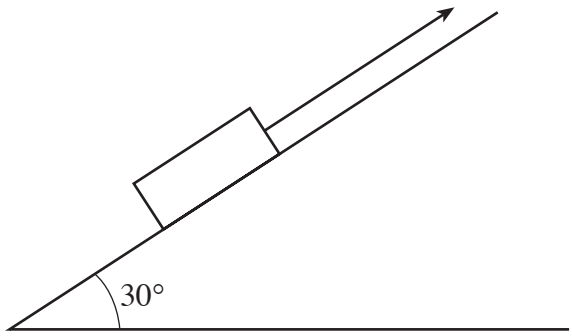
(c) Find the speed of the vehicle 25 s after passing A. [3]

(d) Calculate the distance from A of the vehicle 30 s after it passes A. [3]

(e) Sketch a velocity-time graph for the journey from A to B. [2]

2. A ball is dropped from rest from a height of 3·6 m above a horizontal floor. The coefficient of restitution between the ball and the floor is 0·3. Calculate the speed of the ball immediately after it rebounds from the floor. [5]

3. The diagram shows a sledge on a hill with a rope attached. The hill is modelled as a rough plane inclined at an angle of 30° to the horizontal and the rope is modelled as a light inextensible string parallel to a line of greatest slope of the plane. The sledge is modelled as a particle of mass 15 kg. The coefficient of friction between the sledge and hill is 0·2.



When the tension of the rope is 12 N, the sledge slides **down** the hill. Calculate the magnitude of the acceleration of the sledge, giving your answer correct to one decimal place. [6]

4. A parcel is on the floor of a lift which is ascending with acceleration $0{\cdot}8\,\text{ms}^{-2}$. The mass of the parcel is 20 kg and the mass of the lift is 700 kg.

(a) Calculate the tension in the lift cable. [3]

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

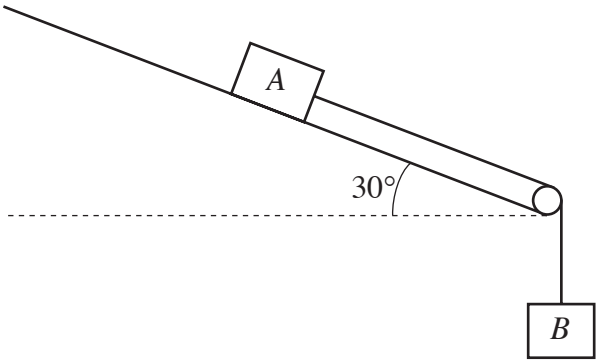
5. Two toy trucks are moving in the same horizontal straight line in the same direction. Truck A, of mass 0·48 kg, is moving with speed 0·075 ms^{-1} and truck B, of mass 0·36 kg, is moving with speed 0·05 ms^{-1}. Truck A catches up with and collides directly with B. After the collision, A continues to move in its original direction and its speed is 0·06 ms^{-1}.

(a) Find the speed of B after the collision. [3]

(b) Calculate the coefficient of restitution between the trucks. [3]

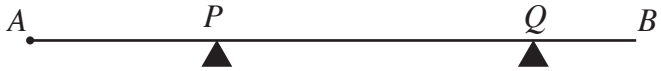
(c) Determine the impulse exerted by A on B. [2]

6. A light inextensible string connects object A, of mass 2 kg, to object B, of mass 3 kg. The diagram shows A on a smooth plane, inclined at an angle of 30° to the horizontal with the string passing over a smooth light pulley at the edge of the plane so that B hangs freely. Initially, A is held at rest with the string taut.



The system is released from rest. Find the magnitude of the acceleration of object A and the tension in the string. [7]

7. The diagram shows a uniform rod AB of length 3 m and mass 9 kg, with a particle, of mass 2 kg, attached at A. The rod is resting horizontally in equilibrium on two smooth supports at points P and Q of the rod, where AP = 1·2 m and AQ = 2·6 m.

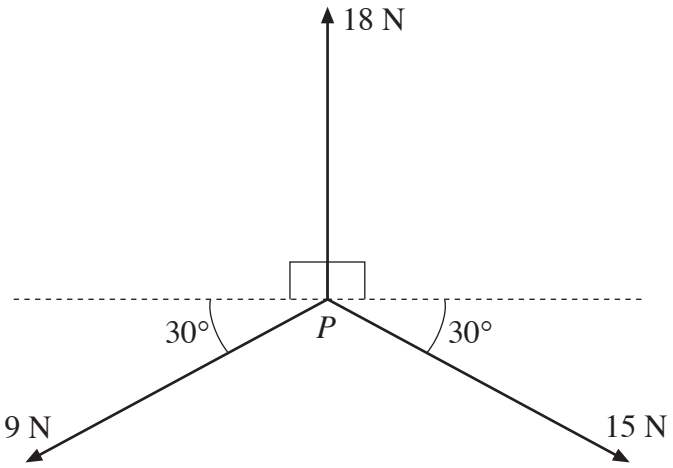


(a) Calculate the reactions at P and Q. [7]

(b) When an additional particle, of mass 3 kg, is attached to the point R of the rod, the rod is on the point of turning about P. Calculate the distance AR. [3]

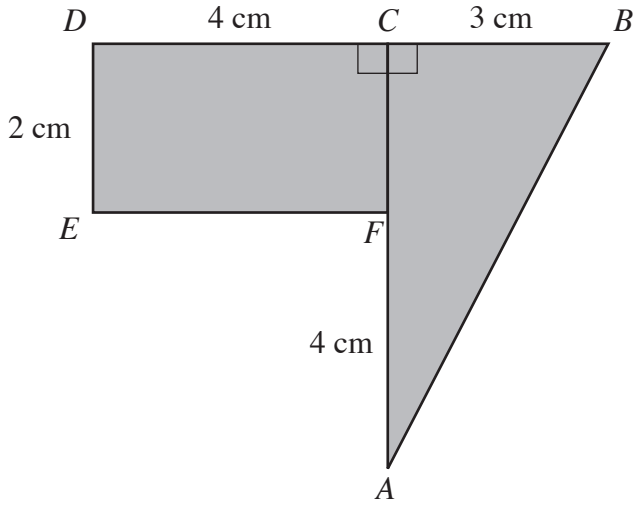
TURN OVER.

8. Three horizontal forces, with magnitudes 18 N, 15 N and 9 N, act at a point P in directions as shown in the diagram.



Calculate the magnitude and direction of the resultant of the forces. [8]

9. The diagram shows a uniform lamina $ABCDEF$. The lamina consists of a triangle ABC right-angled at C and a rectangle $CDEF$. Measurements are shown in the diagram.



(a) Find the distances of the centre of mass of the lamina from DE and DB. [9]

(b) The lamina is suspended freely from D and hangs in equilibrium. Determine the angle DB makes with the vertical. [2]