

980/01

MATHEMATICS M1

Mechanics 1

A.M. THURSDAY, 7 June 2007

(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.

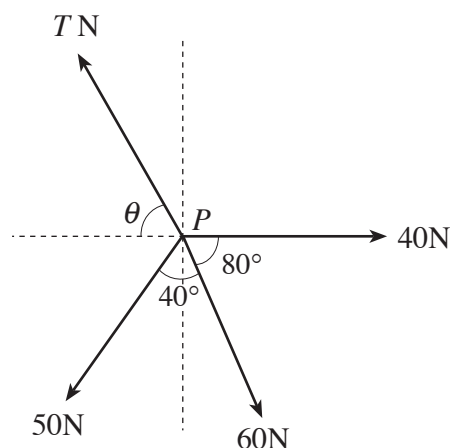
Take g as 9.8 ms^{-2} .

INFORMATION FOR CANDIDATES

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

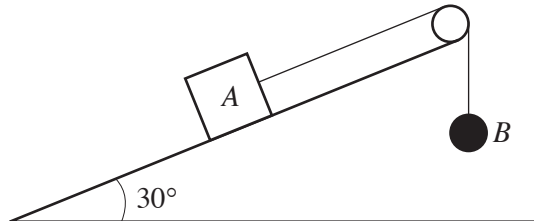
You are reminded of the necessity for good English and orderly presentation in your answers.

1. A train is travelling along a straight horizontal track and its speed as it passes a signal box A is 5 ms^{-1} . Immediately after passing A the train accelerates at a rate of 0.6 ms^{-2} for 25 s ; it then travels at a constant speed of $V \text{ ms}^{-1}$ before it finally decelerates uniformly for 30 s , coming to rest at station B . The total time taken by the train to travel from A to B is 12 minutes .
- (a) Calculate the value of V . [3]
- (b) Sketch a velocity-time graph for the journey from A to B . [3]
- (c) Determine the magnitude of the deceleration of the train in the last 30 s of the journey. [2]
- (d) Find the distance between A and B . [3]
2. A ball is hit vertically up into the air from a point A , which is 1.75 m above the ground. The ball hits the ground for the first time after 2.5 s . Ignoring air resistance,
- (a) show that the initial speed of the ball is 11.55 ms^{-1} , [2]
- (b) find the greatest height above the ground reached by the ball, [3]
- (c) calculate the speed of the ball as it hits the ground, [3]
- (d) calculate the speed of the ball immediately after the first bounce if the coefficient of restitution between the ball and the ground is 0.8 . [2]
3. The diagram shows four horizontal forces acting at a point P .



Given that the forces are in equilibrium, calculate the value of T and the size of the angle θ . Give each of your answers correct to one decimal place. [9]

4. The diagram shows a block A of mass 8 kg on a smooth plane inclined at an angle of 30° to the horizontal. The block is connected to a body B , of mass 6 kg , by means of a light inextensible string passing over a light smooth pulley fixed at the top of the plane.

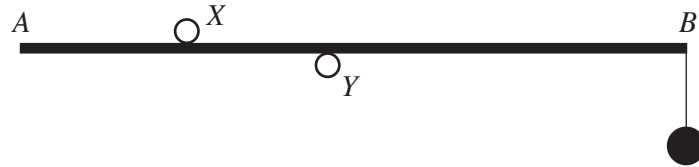


Initially, the system is held at rest with the string taut. The system is then released.

- (a) Calculate the magnitude of the acceleration of A and the tension in the string. [7]
- (b) What assumption did the word ‘inextensible’, underlined above, enable you to make in your solution? [1]
5. Two objects A and B are sliding towards each other on a smooth horizontal surface and collide directly. Object A has mass 49 kg and Object B has mass 56 kg . Just before collision, A has speed 1.6 ms^{-1} and B has speed 0.9 ms^{-1} . Immediately after the collision, A has a speed of 0.24 ms^{-1} in the direction of its original motion.
- (a) Show that the speed of B immediately after the collision is 0.29 ms^{-1} . [3]
- (b) Calculate the coefficient of restitution between A and B . [3]
- (c) Determine the magnitude of the impulse exerted by A on B during the collision. State your units clearly. [3]
- (d) Write down one modelling assumption you have made in your solution. [1]
6. A **horizontal** force, of magnitude $T\text{ N}$, acts on a body of mass 0.8 kg on a rough plane inclined at an angle α to the horizontal, where $\sin \alpha = \frac{3}{5}$. The coefficient of friction between the body and the plane is 0.4 . Given that the body is on the point of moving up the plane, calculate the value of T . [8]

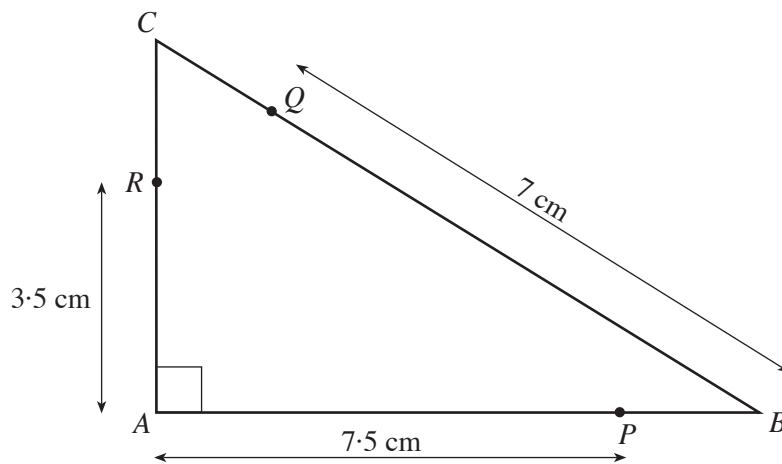
TURN OVER

7. The diagram shows a uniform rod AB , of length 1.6 m and mass 8 kg, held horizontally in equilibrium by means of two small smooth cylindrical pegs X and Y , such that $AX = XY = 0.3$ m. A body of mass 5 kg is attached to the rod at point B .



Find the magnitude of each of the forces exerted on the rod by the pegs X and Y . [7]

8. The diagram shows three particles P , Q , R attached to **light** rods AB , BC , CA respectively. The rods are rigidly joined together so that ABC is a right-angled triangle with $AB = 8$ cm, $AC = 6$ cm and $\hat{CAB} = 90^\circ$. The masses (in kg) of P , Q , R , are $2m$, $3m$, $5m$ respectively and $AP = 7.5$ cm, $BQ = 7$ cm, $AR = 3.5$ cm.



- (a) Find the distance of the centre of mass of the system from
- AC ,
 - AB .
- [9]
- (b) The system is freely suspended from B and hangs in equilibrium. Calculate the angle that AB makes with the vertical. [3]