Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2015

Mathematics

Assessment Unit M1
assessing
Module M1: Mechanics 1

MV18

[AMM11]

THURSDAY 14 MAY, MORNING

TIME

1 hour 30 minutes, plus your additional time allowance.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number on the Answer Booklet provided.
Answer **all eight** questions.
Show clearly the full development of your answers.
Answers should be given to three significant figures unless otherwise stated.
You are permitted to use a graphic or scientific calculator in this paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 75
Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.
Answers should include diagrams where appropriate and marks may be awarded for them.
Take $g = 9.8\ m\,s^{-2}$, unless specified otherwise.
A copy of the **Mathematical Formulae and Tables booklet** is provided.

Answer all eight questions.

Show clearly the full development of your answers.

Answers should be given to three significant figures unless otherwise stated.

1 Two particles A and B are travelling in the same direction along the same line on a smooth horizontal surface as shown in **Fig. 1** below.

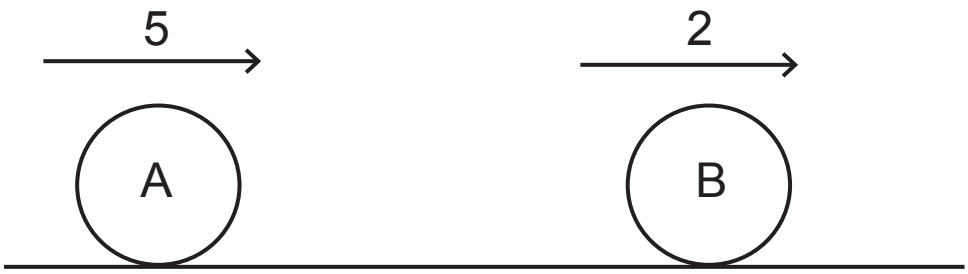

Fig. 1

A has mass 6 kg and is travelling at 5 m s^{-1}
B has mass 4 kg and is travelling at 2 m s^{-1}

The two particles collide and coalesce.

(i) Find the speed of the combined particle after the collision. [4 marks]

(ii) Find the magnitude of the impulse given to B as a result of the collision. [2 marks]

2 A stone is thrown vertically upwards from ground level with a speed of $20\,m\,s^{-1}$

(i) Find the maximum height above the ground reached by the stone. [3 marks]

(ii) Find the time taken for the stone to reach this maximum height. [2 marks]

(iii) Find the distance travelled by the stone during the first three seconds of its motion. [4 marks]

3 A particle P, of mass 10 kg, hangs from a light inextensible string.
The other end of the string is fixed.
P is held against a smooth vertical wall by a force of magnitude 40 N acting at 30° to the horizontal, as shown in **Fig. 2** below.
The string makes an angle of 5° with the wall.

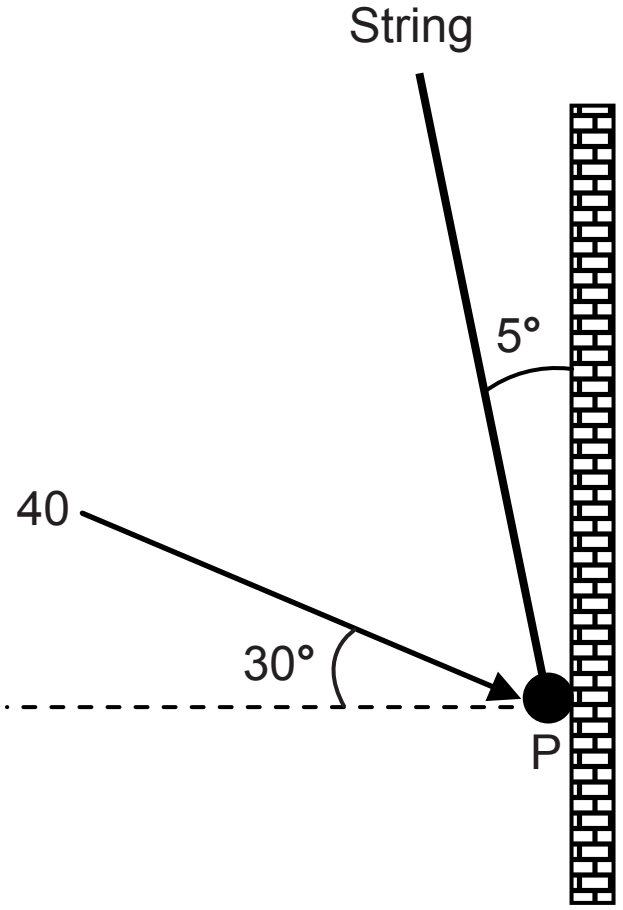

Fig. 2

P is in equilibrium.

(i) Draw a diagram showing the external forces acting on P. [2 marks]

(ii) Find the tension in the string. [4 marks]

(iii) Find the magnitude of the reaction of the wall on P. [3 marks]

4 At time $t = 0$ seconds, a freight train passes through a station with a constant velocity of $15\,\text{m s}^{-1}$
Four minutes later, an express train sets off from rest from the same station, and accelerates at $2\,\text{m s}^{-2}$ in the same direction of travel as the freight train.
The express train accelerates to a maximum velocity of $40\,\text{m s}^{-1}$ and then maintains this velocity.

(i) On the same diagram, sketch a velocity–time graph for each of the two trains. [3 marks]

(ii) Find the value of t at which the express train reaches its maximum velocity. [3 marks]

(iii) Find the value of t at which the express train overtakes the freight train.
[You may assume that the express train reaches its maximum velocity before it overtakes the freight train.]
[5 marks]

5 At time $t = 0$ seconds, a particle P passes through a fixed point O with velocity $4\ \text{m s}^{-1}$
P moves along a straight horizontal line so that its acceleration $a\ \text{m s}^{-2}$ at any time t is given by

$a = 6t - 8$

(i) Find the velocity of P at $t = 4$ [4 marks]

(ii) Find the displacement of P from O when $a = 10$
[5 marks]

6 In this question take g = 10 m s^{-2}

Fig. 3 below shows two boxes X and Y connected to either end of a light inextensible string which passes over a smooth fixed pulley, P.

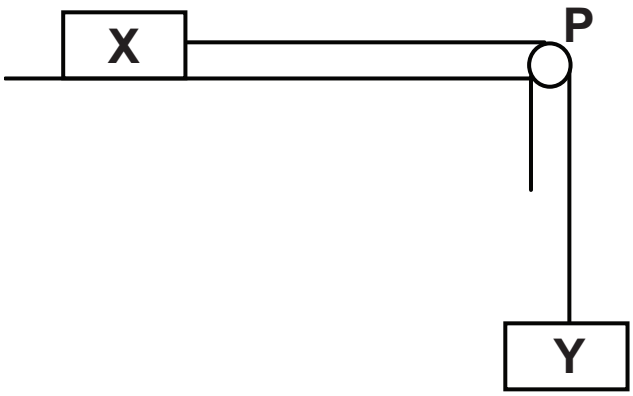

Fig. 3

X has mass 2*m* kg and is on a horizontal surface.
Y has mass 3*m* kg and hangs freely.

X is being pulled along the surface by a constant horizontal force *F* newtons.
A constant force of *m*g newtons resists the motion of X.
Y is rising vertically.

(i) Draw a diagram showing the external forces acting on the boxes. [2 marks]

(ii) Find, in terms of *F* and *m*, an expression for the acceleration of the system. [4 marks]

(iii) Find, in terms of *F* and *m*, an expression for the tension in the string. [2 marks]

(iv) Find, in terms of *F* and *m*, an expression for the resultant force acting on the pulley. [4 marks]

7 Noel needs to do some repairs to the flat roof of his garage. To gain access to the roof, he places a uniform ladder AB against the roof of the garage as shown in **Fig. 4** below.

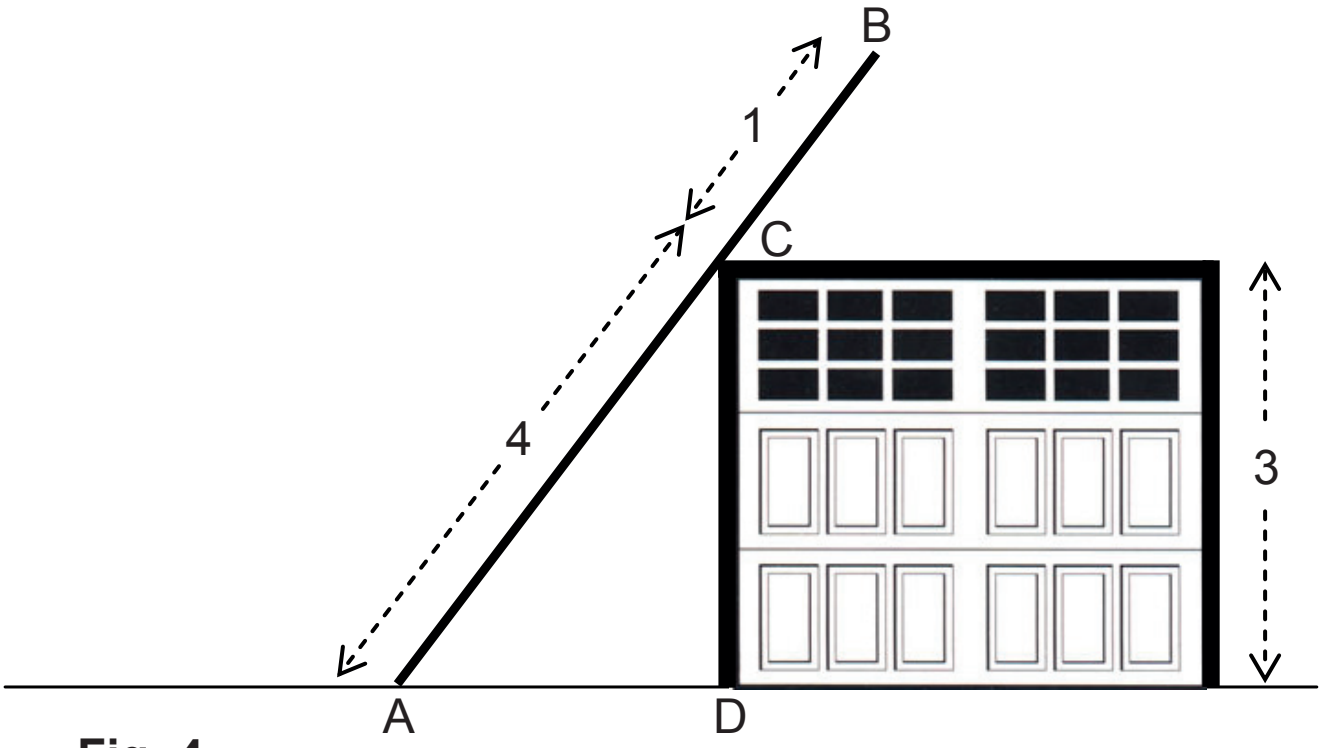

Fig. 4

The ladder is 5 m long and has mass 10 kg.
The ladder rests against the smooth edge of the roof at the point C, where AC = 4 m.
The wall CD is vertical and 3 m high.
End A rests on rough horizontal ground.

(i) Draw a diagram showing the forces acting on the ladder. [2 marks]

(ii) Find the magnitude of the reaction at C. [5 marks]

(iii) Find the magnitude of the normal reaction at A. [3 marks]

8 A parcel of mass 8 kg is placed on a rough slope inclined at 30° to the horizontal.
The coefficient of friction between the parcel and the slope is 0.2
A horizontal force X newtons acts on the parcel causing it to accelerate up the slope at 1.2 $m\,s^{-2}$

(i) Draw a diagram showing the external forces acting on the parcel. [2 marks]

(ii) Find the magnitude of X. [7 marks]

THIS IS THE END OF THE QUESTION PAPER

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