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ADVANCED SUBSIDIARY (AS)  
General Certificate of Education  
2015

# Mathematics

Assessment Unit M1

*assessing*

Module M1: Mechanics 1



[AMM11]

THURSDAY 14 MAY, MORNING

## TIME

1 hour 30 minutes.

## 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 down the right-hand side of pages indicate the marks awarded to each question or part question.

Answers should include diagrams where appropriate and marks may be awarded for them.

Take  $g = 9.8 \text{ m s}^{-2}$ , unless specified otherwise.

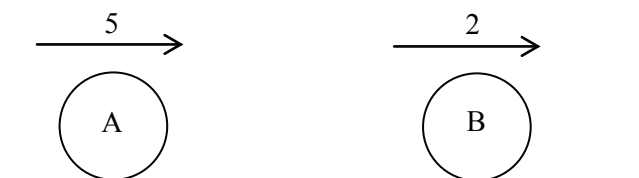
A copy of the **Mathematical Formulae and Tables** booklet is provided.

**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  $5 \text{ m s}^{-1}$

B has mass 4 kg and is travelling at  $2 \text{ m s}^{-1}$

The two particles collide and coalesce.

- (i) Find the speed of the combined particle after the collision. [4]
  - (ii) Find the magnitude of the impulse given to B as a result of the collision. [2]
- 2** A stone is thrown vertically upwards from ground level with a speed of  $20 \text{ m s}^{-1}$
- (i) Find the maximum height above the ground reached by the stone. [3]
  - (ii) Find the time taken for the stone to reach this maximum height. [2]
  - (iii) Find the distance travelled by the stone during the first three seconds of its motion. [4]

- 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  $30^\circ$  to the horizontal, as shown in **Fig. 2** below. The string makes an angle of  $5^\circ$  with the wall.

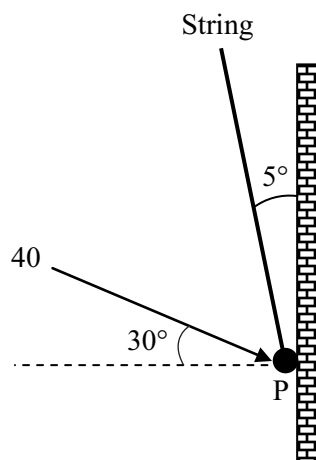


Fig. 2

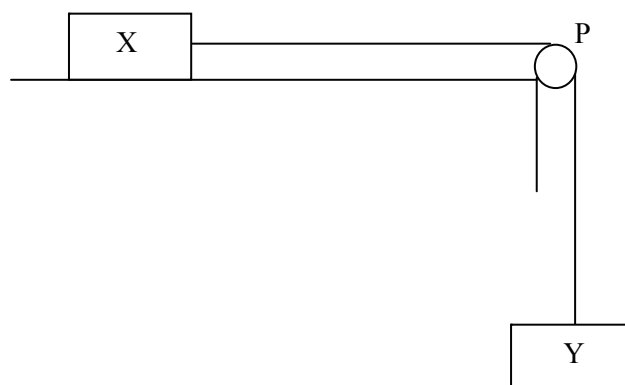
P is in equilibrium.

- (i) Draw a diagram showing the external forces acting on P. [2]
- (ii) Find the tension in the string. [4]
- (iii) Find the magnitude of the reaction of the wall on P. [3]

- 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]
- (ii) Find the value of  $t$  at which the express train reaches its maximum velocity. [3]
- (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]
- 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]
- (ii) Find the displacement of P from O when  $a = 10$  [5]

**6 In this question take  $g = 10 \text{ m s}^{-2}$**

**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  $2m$  kg and is on a horizontal surface.

Y has mass  $3m$  kg and hangs freely.

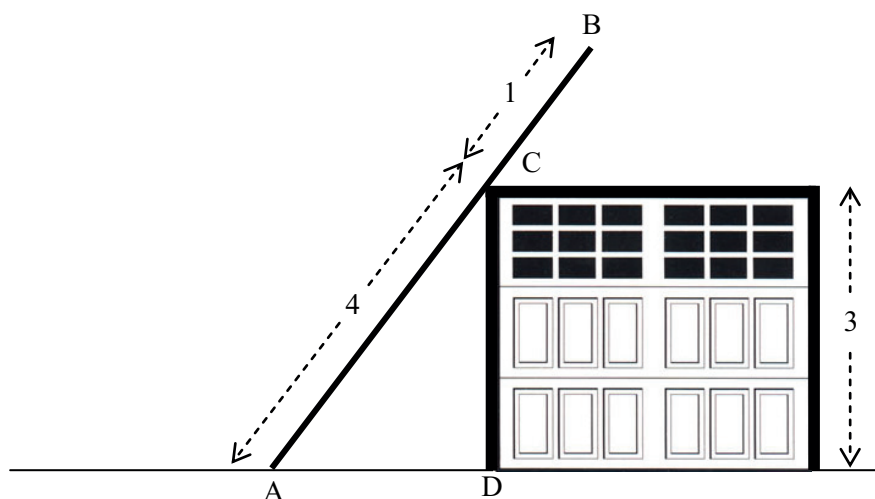
X is being pulled along the surface by a constant horizontal force  $F$  newtons.

A constant force of  $mg$  newtons resists the motion of X.

Y is rising vertically.

- (i) Draw a diagram showing the external forces acting on the boxes. [2]
- (ii) Find, in terms of  $F$  and  $m$ , an expression for the acceleration of the system. [4]
- (iii) Find, in terms of  $F$  and  $m$ , an expression for the tension in the string. [2]
- (iv) Find, in terms of  $F$  and  $m$ , an expression for the resultant force acting on the pulley. [4]

- 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]
- (ii) Find the magnitude of the reaction at C. [5]
- (iii) Find the magnitude of the normal reaction at A. [3]

- 8 A parcel of mass 8 kg is placed on a rough slope inclined at  $30^\circ$  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  $1.2 \text{ m s}^{-2}$

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

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

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**THIS IS THE END OF THE QUESTION PAPER**

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