Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2015

Mathematics

Assessment Unit M1

assessing

Module M1: Mechanics 1

ML

[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 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. This is shown in **Fig. 1** below.

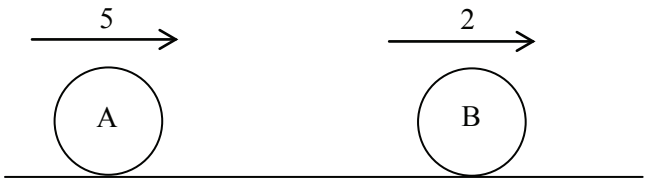

Fig. 1

Particle A has mass 6 kg and is travelling at $5\,m\,s^{-1}$
Particle 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]

(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 $20\,m\,s^{-1}$

(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 string. This string is light and inextensible.
The other end of the string is fixed.
Particle P is held against a smooth vertical wall by a force of magnitude 40 N acting at 30° to the horizontal. This is shown in **Fig. 2** below.
The string makes an angle of 5° with the wall.

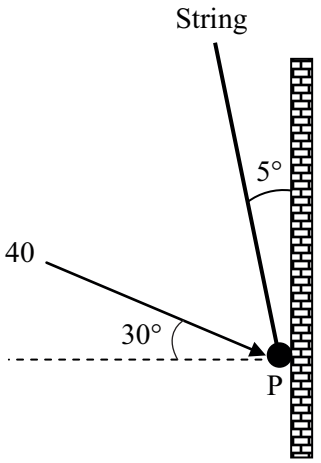

Fig. 2

P is in equilibrium.

(i) Draw a diagram that shows 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. It 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) Sketch a velocity–time graph for each of the two trains. Do this on the same diagram. [3]

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

(iii) Find the value of t when 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 m s^{-2}

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

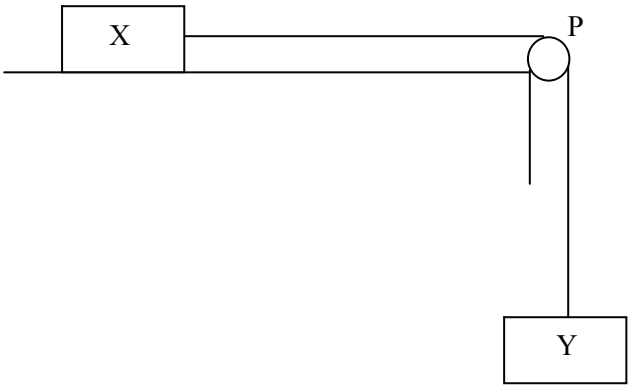

Fig. 3

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 that shows 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 A man needs to do some repairs to the flat roof of his garage.
To get onto the roof, he places a uniform ladder AB against the roof of the garage.
This is shown in **Fig. 4** below.

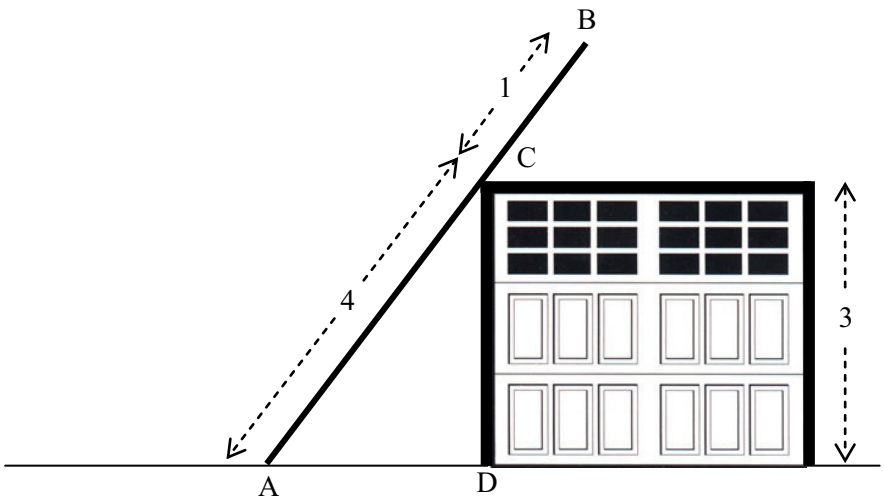

Fig. 4

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 is on rough horizontal ground.

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

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

THIS IS THE END OF THE QUESTION PAPER