Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2014

Mathematics

Assessment Unit M1

assessing

Module M1: Mechanics 1

ML

[AMM11]

MONDAY 19 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 seven** 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 $g = 9.8\,m\,s^{-2}$, unless specified otherwise.
A copy of the **Mathematical Formulae and Tables booklet** is provided.

Answer all seven questions.

Show clearly the full development of your answers.

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

1 Look at **Fig. 1** below. It shows an aircraft about to take off along a runway AB which is 3 km long.
The aircraft starts from rest at a point A and accelerates at $1.8\,m\,s^{-2}$ to a take-off speed of $72\,m\,s^{-1}$ at the point C.

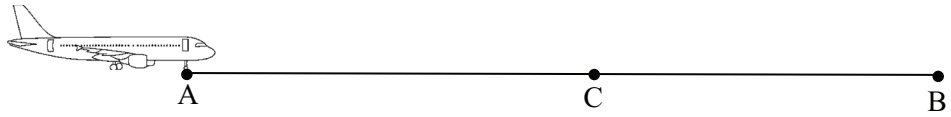

Fig. 1

(i) Find the time taken for the aircraft to accelerate from A to C. [2]

(ii) Find the distance AC. [2]

The aircraft reaches its take-off speed at C. Due to a technical fault the pilot has to abort take-off, and decelerates to bring the aircraft to rest at the point B.

(iii) Find, in $m\,s^{-2}$, the deceleration of the aircraft from C to B. [3]

2 Three boys are each pulling on a school bag, S, with forces of magnitudes and directions as shown in **Fig. 2** below.
All forces are concurrent and horizontal.

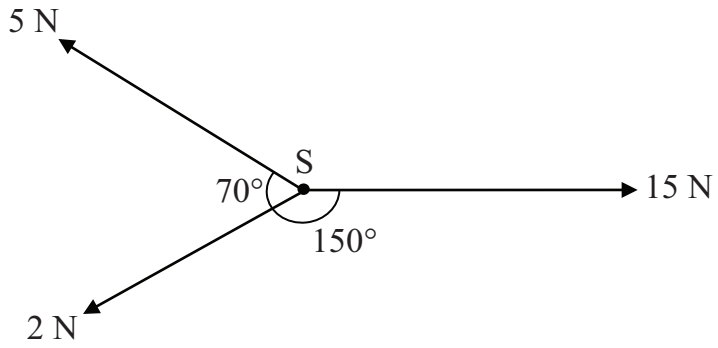

Fig. 2

(i) Find the magnitude of the resultant force on S. [6]

The mass of the school bag is 4 kg.

(ii) Find the acceleration with which S starts to move. [2]

(iii) Find the direction in which S moves. [2]

3 Look at **Fig. 3** below. It shows two particles A and B attached to the ends of a light inextensible string which passes over a smooth fixed pulley.
A has mass m_1 kg and B has mass m_2 kg where $m_1 > m_2$
To start with, A is suspended 2 m above a horizontal surface, and B is on the surface.
The string is tight.

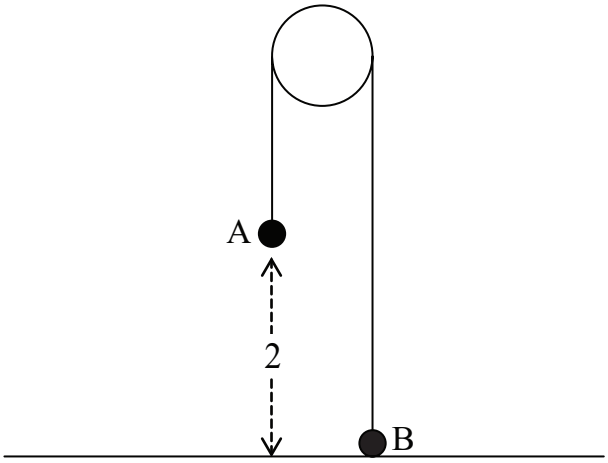

Fig. 3

The particles are released from rest.

(i) Given that the particle A hits the horizontal surface at $3\,\text{m}\,\text{s}^{-1}$, find the acceleration of the system. [2]

(ii) Draw a diagram showing the external forces acting on A and B. [2]

While the string is tight, the tension in the string is 15.1 N.

(iii) Find m_1 and m_2 [5]

4 Look at **Fig. 4** below. It shows Mark trying to pull a box of mass 100 kg up a rough inclined slope.
The slope is inclined at an angle of 30° to the horizontal and the coefficient of friction between the box and the slope is 0.4
Mark pulls a rope attached to the box with a constant force P newtons which acts up and parallel to the slope.

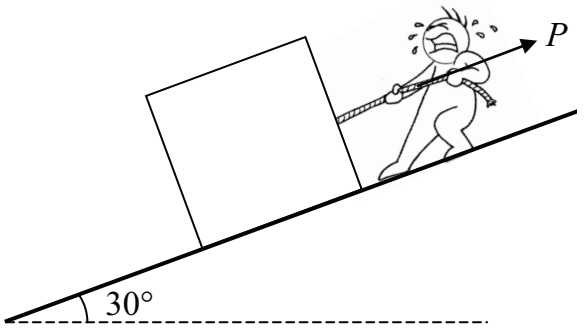

Fig. 4

The box is on the point of sliding **down** the slope.
Model the box as a particle.

(i) State one modelling assumption you are going to make about the rope. [1]

(ii) Draw a diagram showing the external forces acting on the box. [2]

(iii) Find P. [7]

Peter now joins Mark to help him move the box up the slope.
Peter pushes the box with a force of 500 N up and parallel to the slope, as shown in **Fig. 5** below.
Mark pulls the rope in the same direction as before, but now with a force of Q newtons.

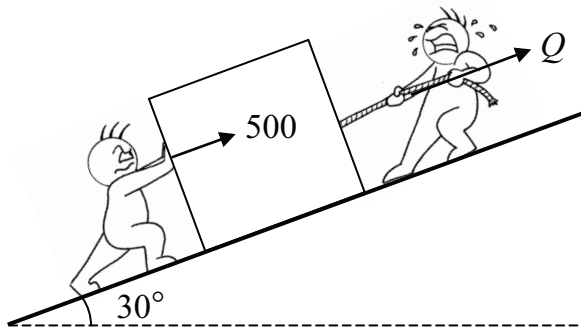

Fig. 5

The box is now on the point of sliding **up** the slope.

(iv) Find Q. [3]

5 A vertical post of mass 9 kg is to be driven into the ground.
A pile driver of mass 75 kg is released from rest from a height of 2.5 m vertically above the top of the post, as shown in **Fig. 6** below.

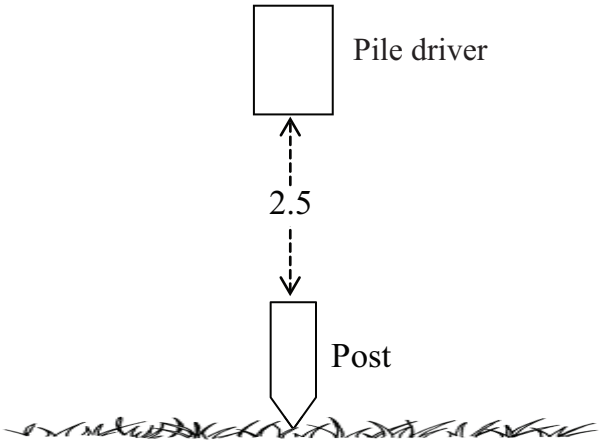

Fig. 6

When the pile driver hits the post, they remain in contact throughout the subsequent motion.

(i) Show that the pile driver hits the post with a speed of $7\,\text{m s}^{-1}$ [2]

(ii) Find the speed of the post as it enters the ground. [3]

After the impact, the combined mass comes to rest after 0.256 seconds.

(iii) Find the magnitude of the constant resistance exerted by the ground. [6]

6 A particle P moves along a straight horizontal line such that its velocity $v\,\text{m s}^{-1}$ at any time t seconds, $t \geqslant 0$, after passing a fixed point O, is given by

$$v = 2t^2 - 7t + 3$$

(i) Find the values of t at which the particle comes to rest. [3]

(ii) Find the minimum velocity of P. [6]

(iii) Sketch the velocity–time graph for P in the interval $0 \leqslant t \leqslant 4$ [3]

7 Look at **Fig. 7** below. It shows a uniform beam AB of length 8 m and mass 30 kg.
The beam is smoothly hinged to a vertical post at the point C where AC = 3 m.
A mass of 60 kg is attached to the end A.
A rope is attached to the end B and held at right angles to the beam.
The beam makes an angle of 30° with the horizontal.

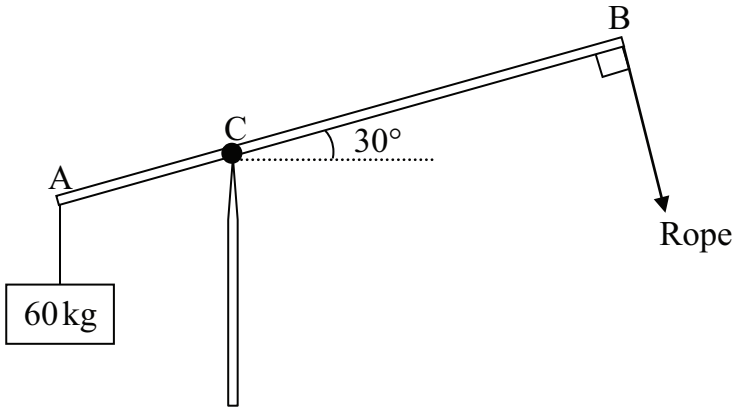

Fig. 7

The system is in equilibrium.

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

(ii) Find the tension in the rope and the magnitude of the reaction at C. [11]

THIS IS THE END OF THE QUESTION PAPER