Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2014

Mathematics

Assessment Unit M1

assessing

Module M1: Mechanics 1

[AMM11]

MONDAY 19 MAY, MORNING

MV18

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 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 seven questions.

Show clearly the full development of your answers.

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

1 **Fig. 1** below 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 $1.8\,\mathrm{m\,s^{-2}}$ to a take-off speed of $72\,\mathrm{m\,s^{-1}}$ at the point **C**.

Fig. 1

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

(ii) Find the distance **AC**. [2 marks]

The aircraft reaches its take-off speed at **C**, but 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 $\mathrm{m\,s^{-2}}$, the deceleration of the aircraft from **C** to **B**. [3 marks]

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.

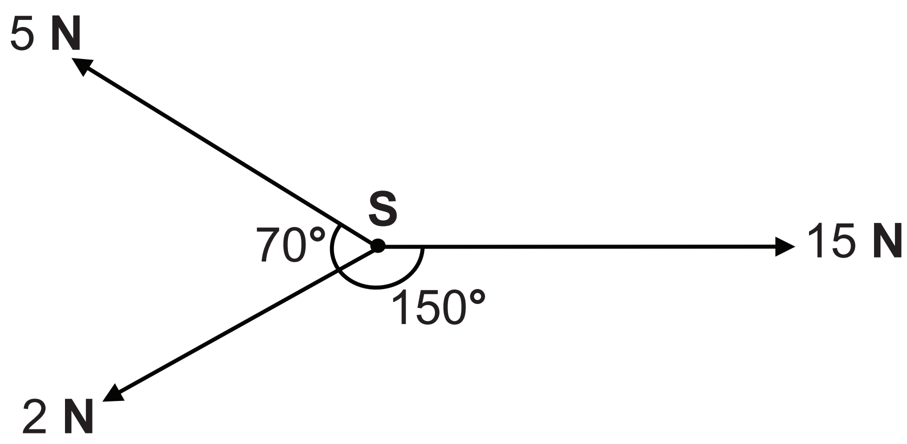

Fig. 2

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

The mass of the school bag is 4 kg.

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

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

3 **Fig. 3** below 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 $m_1 > m_2$
Initially, **A** is suspended 2 m above a horizontal surface, and **B** is on the surface.
The string is taut.

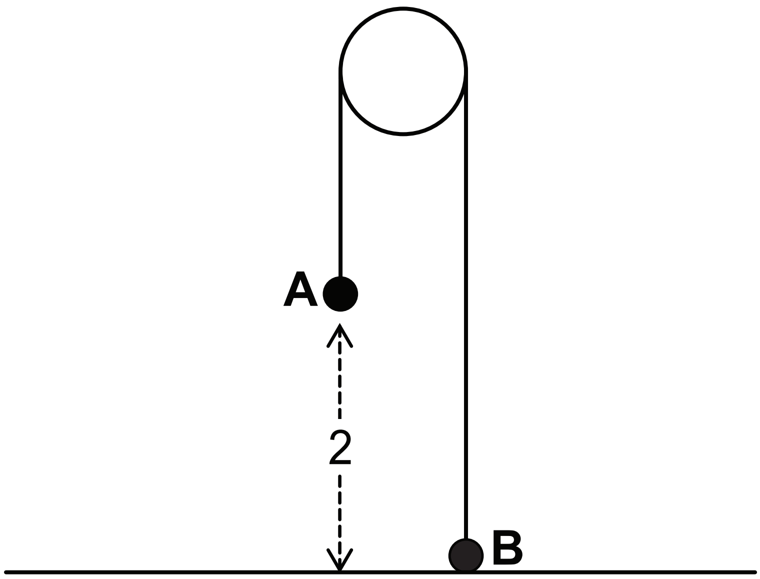

Fig. 3

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 marks]

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

While the string is taut, the tension in the string is 15.1 **N**.

(iii) Find m_1 and m_2 [5 marks]

4 **Fig. 4** below 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 $\boldsymbol{P}$ newtons which acts up and parallel to the slope.

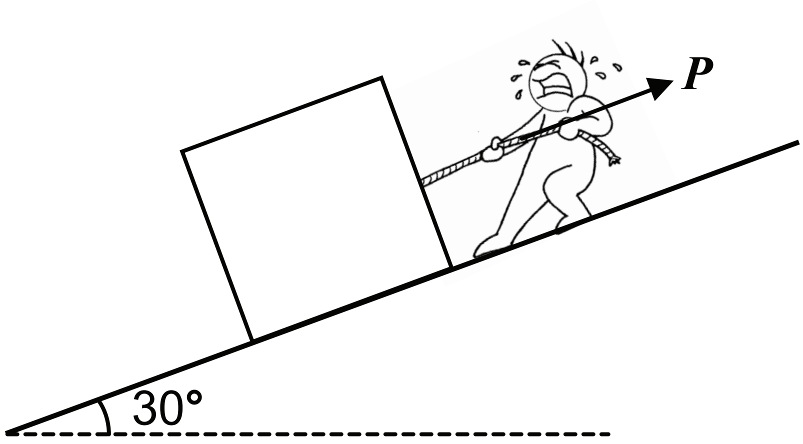

Fig. 4

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 mark]

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

(iii) Find $\boldsymbol{P}$. [7 marks]

Bert now joins Mark to help him move the box up the slope. Bert 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.

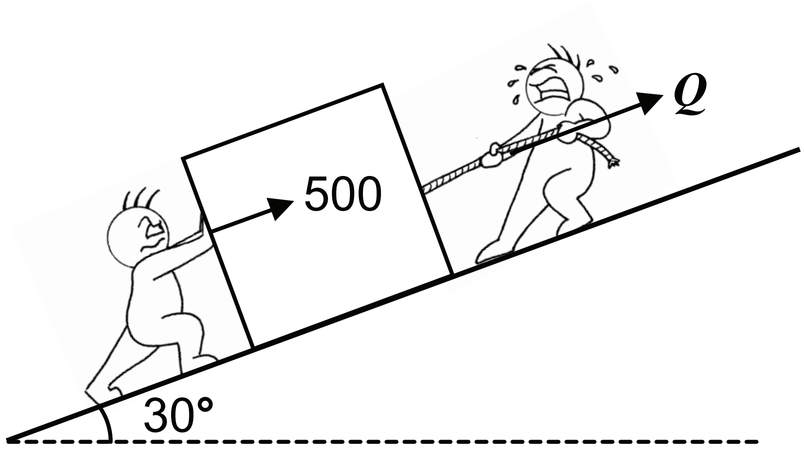

Fig. 5

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

(iv) Find Q. [3 marks]

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.

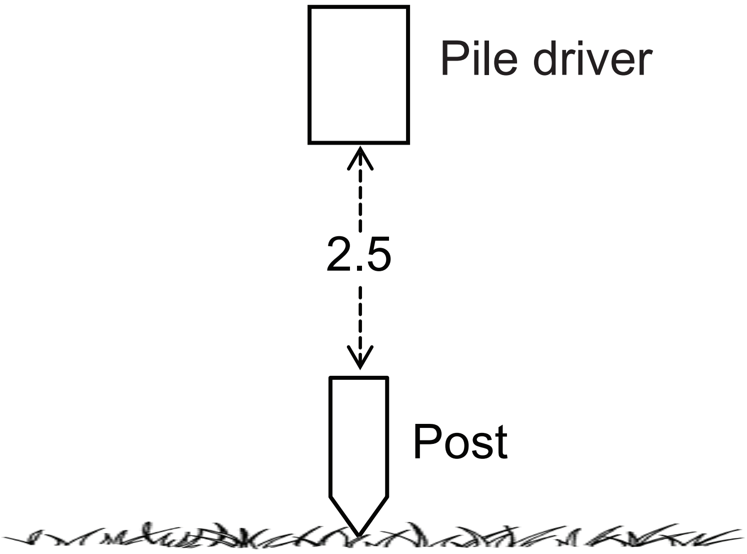

Fig. 6

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 $7\,\mathrm{m\,s^{-1}}$ [2 marks]

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

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 marks]

6 A particle P moves along a straight horizontal line such that its velocity v 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 marks]

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

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

7 **Fig. 7** below 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.

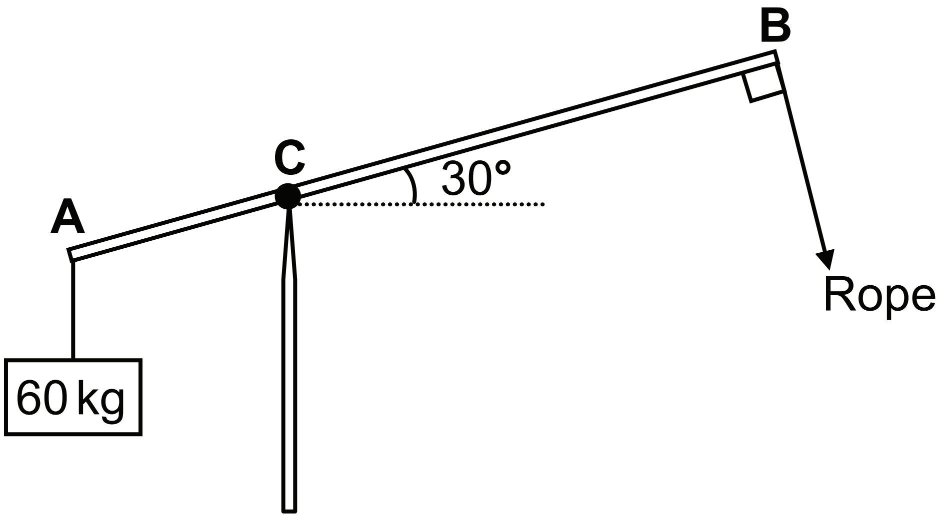

Fig. 7

The system is in equilibrium.

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

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

THIS IS THE END OF THE QUESTION PAPER