Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2012

Mathematics

Assessment Unit M1

assessing

Module M1: Mechanics 1

[AMM11]

AMM11

WEDNESDAY 16 MAY, MORNING

TIME

1 hour 30 minutes.

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 a 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 $g = 9.8\,\text{m}\,\text{s}^{-2}$, 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 The four forces shown in **Fig. 1** below are in equilibrium.

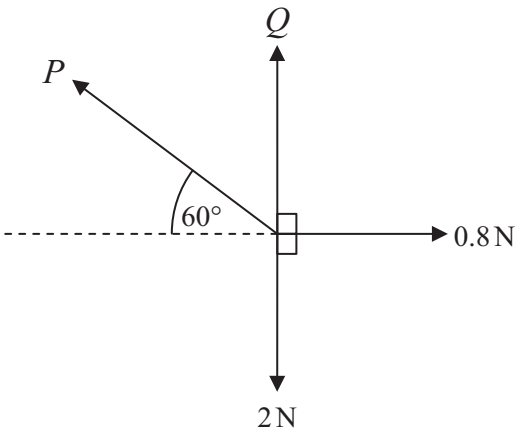

Fig. 1

Find P and Q. [6]

2 **Fig. 2** below shows a car of mass 1300 kg ascending a hill inclined at an angle of 20° to the horizontal.

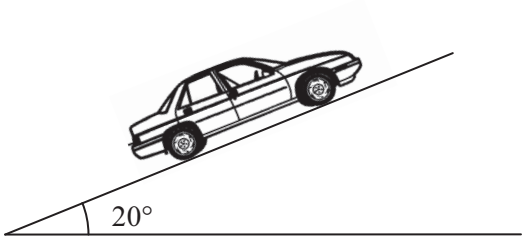

Fig. 2

The coefficient of friction between the car and the hill is 0.25
The tractive force produced by the engine of the car is 12 000 N.

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

(ii) Find the acceleration of the car. [7]

3 In a shooting competition an Olympic competitor fires a bullet from a rifle with a speed of $330\,\text{m}\,\text{s}^{-1}$
The mass of the gun is 6 kg and the mass of the bullet is 0.2 kg.

(i) Find the **speed** of recoil of the gun on the competitor's shoulder. [5]

The gun comes to rest after 0.1 s.

(ii) Find the average force exerted by the gun on the competitor's shoulder during this time. [5]

4 At time $t = 0$ seconds, a stone A is thrown vertically upwards from ground level, with speed $u\,\text{m}\,\text{s}^{-1}$
The greatest height above the ground reached by A is 2.5 m.

(i) Find u. [3]

When $t = 1$, a stone B is thrown vertically upwards from ground level, with speed $5\,\text{m}\,\text{s}^{-1}$

(ii) Find t when A and B collide. [6]

5 At time t seconds, $t \geqslant 0$, the acceleration a m s^{-2} of a particle P, which is moving in a straight line, is given by

$$a = 2t - 10$$

At time $t = 0$, P has velocity 21 m s^{-1} and is at the fixed point O.

(i) Find an expression for the velocity of P at any time t. [4]

(ii) Find the times at which P is instantaneously at rest. [3]

(iii) Find an expression for the displacement of P from O at any time t. [3]

(iv) Find the total distance travelled by P between $t = 2$ and $t = 6$ [4]

6 A uniform ladder of weight 150 N and length 4 m rests in equilibrium.
The end A rests on rough horizontal ground and the end B rests against a smooth vertical wall, as shown in **Fig. 3** below.
The coefficient of friction between the ground and the ladder is μ.
The ladder makes an angle of θ with the horizontal, where $\tan\theta = \frac{12}{5}$

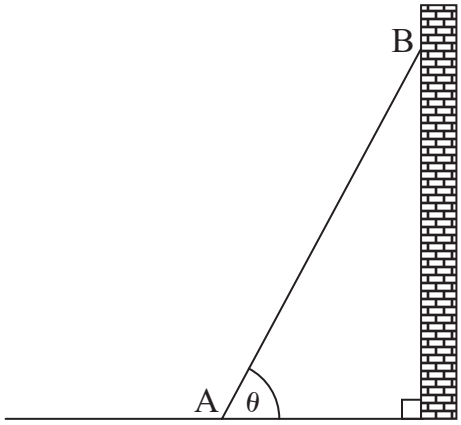

Fig. 3

When a man of weight 800 N stands on the ladder, 1 m from the end B, the ladder is about to slip.

(i) Draw a diagram to show all the external forces acting on the ladder. [2]

(ii) By taking moments about A, find the normal reaction at B. [5]

(iii) Hence find μ. [5]

7 A light inextensible string passes over a smooth fixed pulley as shown in **Fig. 4** below. Particles P and Q of masses $3m$ kg and $2m$ kg respectively are attached to each end.

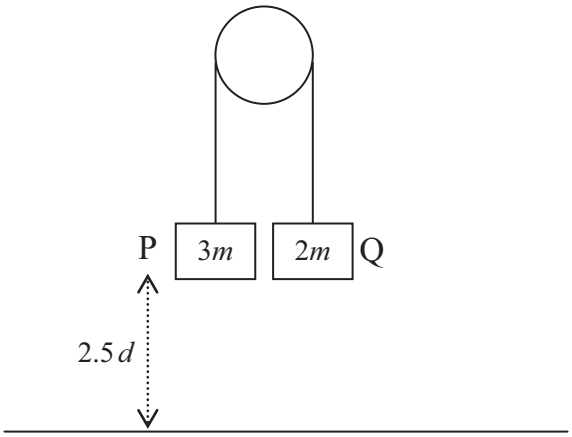

Fig. 4

At time $t = 0$ seconds, the system is released from rest, with the particle P at a height of $2.5d$ metres above the horizontal floor.

(i) Draw a diagram showing the forces acting on the particles P and Q. [2]

(ii) Find, in terms of g, the acceleration of the particles. [5]

Given that Q does not reach the pulley, find, in terms of g and d:

(iii) the speed with which P hits the floor; [2]

(iv) the value of t at which the string becomes taut again. [6]

THIS IS THE END OF THE QUESTION PAPER