Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2013

Mathematics

Assessment Unit M1
assessing
Module M1: Mechanics 1

MV18

[AMM11]

MONDAY 13 MAY, AFTERNOON

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

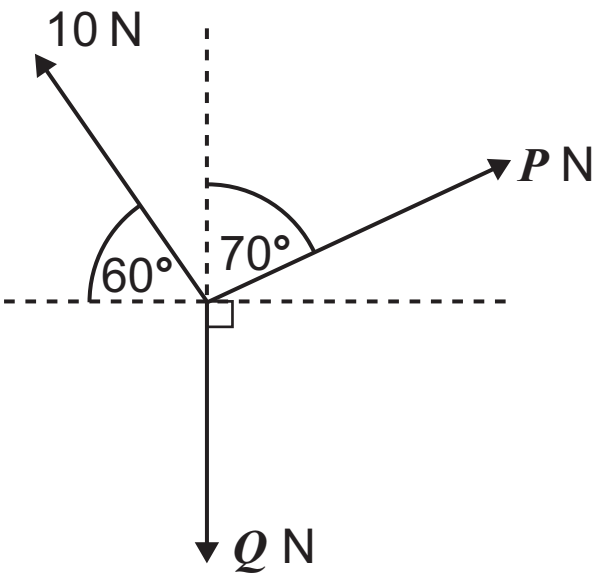
Answer all seven questions.

Show clearly the full development of your answers.

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

1 A particle rests in equilibrium under the action of three forces as shown in **Fig. 1** below.

Fig. 1



Find P and Q. [6 marks]

2 At time $t = 0$ seconds a ball is projected vertically upwards with speed u m s^{-1} from a point O.
When $t = 3$ the ball returns to O.

(i) Find u. [4 marks]

(ii) Find the greatest height above O reached by the ball. [4 marks]

3 A lift has mass 800 kg.

(i) Find the tension in the lift cable when the lift is accelerating **downwards** at 0.9 m s^{-2} without any passengers. [4 marks]

The greatest tension the lift cable can support is 15 000 N.
The average mass of a person travelling in the lift is 80 kg.

(ii) Find the maximum number of passengers that the lift can safely carry when it is accelerating **upwards** at 0.9 m s^{-2} [6 marks]

(iii) Give two modelling assumptions that you have made in answering parts **(i)** and **(ii)**. [2 marks]

4 A particle, P, moves in a straight line such that its velocity, v m s^{-1}, at time t seconds is given by

$$v = 2t^2 - 15t + 18$$

(i) Find the times at which P is momentarily at rest. [3 marks]

When $t = 0$, P is at a fixed origin O.

(ii) Find an expression for the displacement of P from O at any time t. [4 marks]

(iii) Find the distance travelled by P in the interval $1 \leqslant t \leqslant 6$ [5 marks]

5 Two particles A and B are travelling directly towards each other on a smooth horizontal surface.
A has mass 2 kilograms and speed 4 m s^{-1}
A and B collide.
In the collision the magnitude of the impulse exerted by B on A is 18 Ns.

(i) Find the velocity of A after the collision. [4 marks]

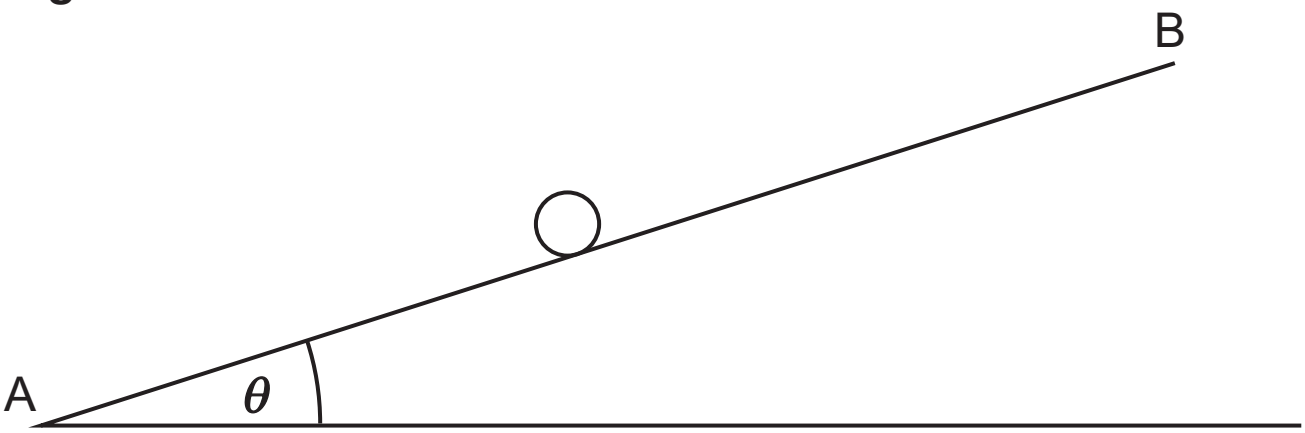
B has mass m kilograms and its speed before the collision is 3 m s^{-1}
After the collision the speed of B is 1.5 m s^{-1}

(ii) Find the two possible values of m. [5 marks]

6 Take g = 10 m s^{-2} in this question.

Fig. 2 below shows a particle of mass M kilograms moving up the line of greatest slope of a rough plane AB.

Fig. 2



The plane is inclined at an angle θ to the horizontal where $\sin\theta = \frac{3}{5}$

The coefficient of friction between the particle and the plane is μ.

(i) Draw a diagram which shows all the forces acting on the particle. [2 marks]

At A the particle has a velocity of U m s^{-1}
T seconds later the particle comes to rest at B.

(ii) Find, in terms of μ, the acceleration of the particle up the plane. [8 marks]

(iii) Show that $U = (6 + 8\mu)T$ [3 marks]

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(Questions continue overleaf)

7 **Fig. 3** below shows a pole vaulter Tom, at rest, holding a pole **AB** of length 5 m and mass 4 kg.

Fig. 3

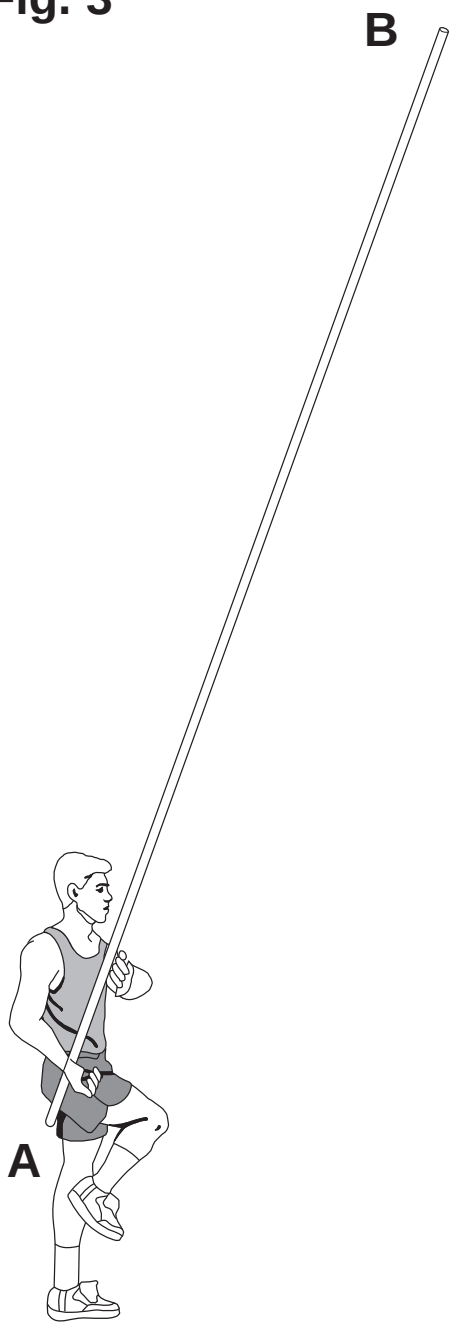


Fig. 4 opposite shows this pole held at 70° to the horizontal. Tom's hands are placed at two points **C** and **D** on the pole where **AC =** 0.2 m and **CD =** 0.5 m.
Tom exerts a force P newtons, at right angles to the pole, at **C** and a force Q newtons at **D**.

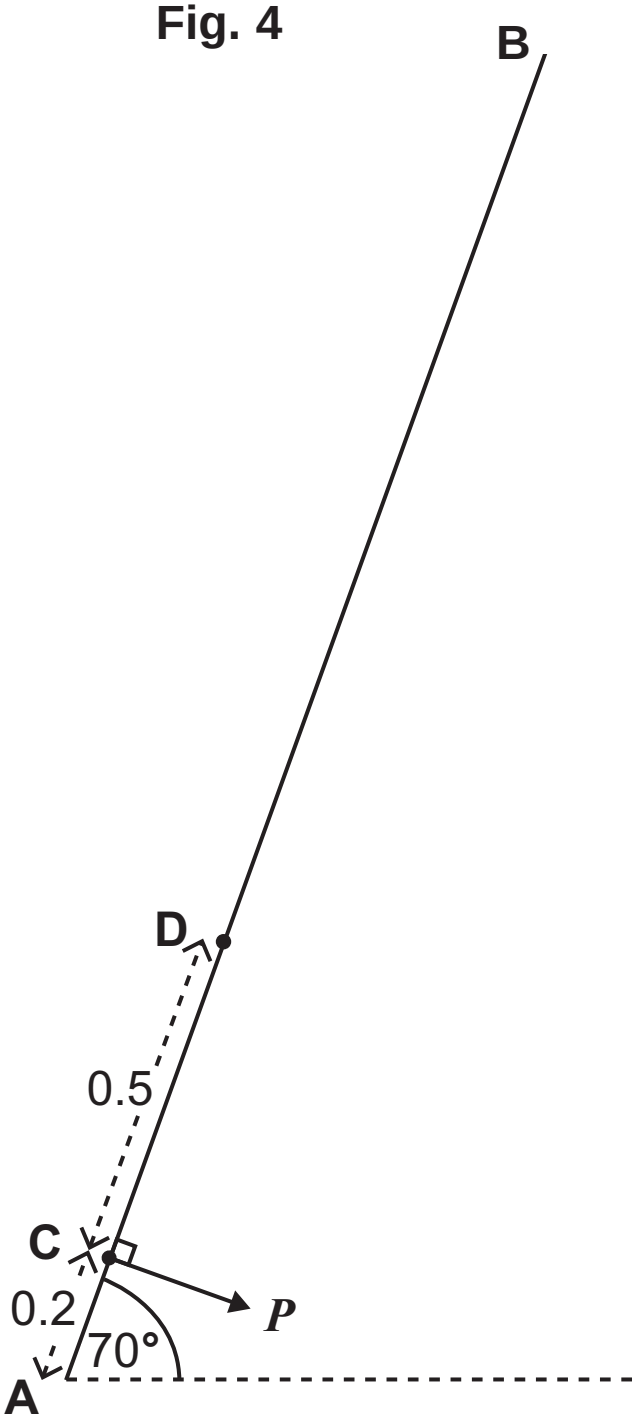
Model the pole as a uniform rod.

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

(ii) By taking moments about **D**, find P. [5 marks]

(iii) Find the magnitude of Q and the angle it makes with the pole. [8 marks]

Fig. 4



THIS IS THE END OF THE QUESTION PAPER