Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2017

Centre Number

Candidate Number

Mathematics

Assessment Unit M1
assessing
Module M1: Mechanics 1

MV18

[AMM11]
WEDNESDAY 24 MAY, MORNING

Time

1 hour 30 minutes, plus your additional time allowance.

Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer **all seven** questions in the spaces provided.
Complete in black ink only.
Questions which require drawing or sketching should be completed using an H.B. pencil.
All working should be clearly shown in the spaces provided.
Marks may be awarded for partially correct solutions. **Answers without working may not gain full credit**.
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.

A copy of the **Mathematical Formulae and Tables booklet** is provided.

Throughout the paper the logarithmic notation used is $\ln z$ where it is noted that $\ln z \equiv \log_e z$

Take $g = 9.8\,m\,s^{-2}$, unless otherwise specified.

1 A rocket is launched from rest at ground level and moves vertically upwards.
It rises 96 m in the first 4 seconds of its motion.
Model the rocket as a particle moving with constant acceleration.

(i) Show that the acceleration of the rocket is $12\,m\,s^{-2}$
[2 marks]

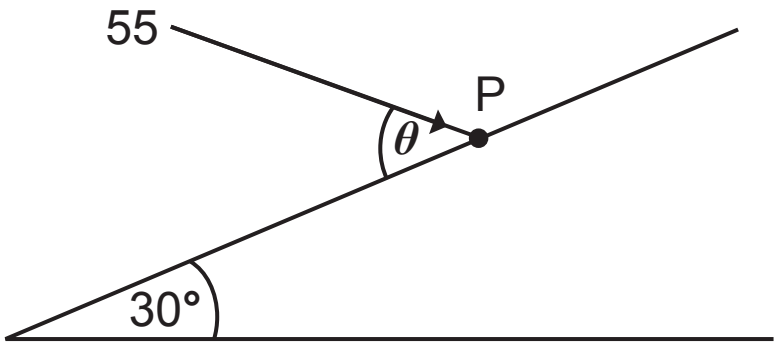
The rocket burns out when it has reached a height of 96 m. It can now be modelled as a particle moving vertically under gravity.

(ii) Find the maximum height above the ground reached by the rocket. [5 marks]

(iii) Find the total time taken for the rocket to reach its maximum height from the moment it is launched.
[3 marks]

2 A particle P of mass 8 kg is being held in equilibrium on an inclined plane by a force of magnitude 55 N.
The plane is smooth and inclined at an angle of 30° to the horizontal.
The 55 N force acts at an angle θ to the plane.

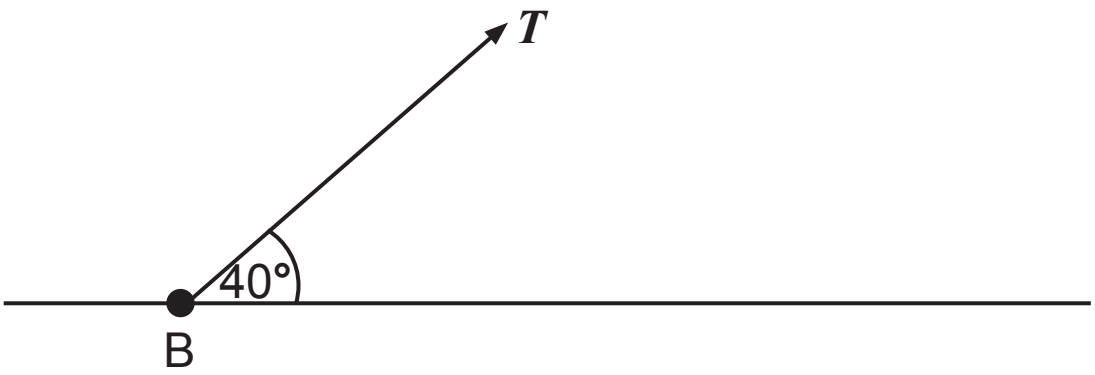
(i) Complete the diagram below to show the external forces acting on P. [2 marks]



(ii) Find θ and the magnitude of the normal reaction between the particle and the plane. [6 marks]

3 A small bead, B, of mass 0.3 kg is threaded onto a fixed, rough, horizontal rod.
The bead is pulled along the rod by a light inextensible string which makes an angle of 40° with the horizontal.
The tension in the string is T newtons.
The coefficient of friction between the bead and the rod is μ.
The string and rod are in the same vertical plane.

(i) Complete the diagram below to show the external forces acting on the bead. [2 marks]



When T = 1.2 N, the bead moves along the rod at a constant speed.

(ii) Find μ. [7 marks]

4 **Fig. 1** below shows a breakdown truck of mass 1700 kg towing a car of mass 800 kg along a straight horizontal road.

Fig. 1

The vehicles are joined by a light rigid horizontal tow bar.
The truck and the car experience constant resistances to motion of magnitude 700 N and 300 N respectively.
The truck's engine produces a constant horizontal force of magnitude 2000 N.
Model the car and the truck as particles.

(i) Draw a diagram showing the external forces acting on the truck and on the car. [3 marks]

(ii) Find the common acceleration of the car and the truck and the tension in the tow bar. [5 marks]

When the speed of the car is $8\,m\,s^{-1}$, the tow bar breaks. Assume the resistance to the motion of the car remains as before.

(iii) Find the distance moved by the car from the moment the tow bar breaks until the car comes to rest.
[4 marks]

5 **Fig. 2** below shows two particles P and Q moving on a smooth horizontal plane.

Fig. 2

The mass of P is $2m$ kg and the mass of Q is m kg.
The particles are moving along the same line but in opposite directions.
Immediately before they collide the speed of P is $2u$ m s^{-1} and the speed of Q is $3u$ m s^{-1}
When the particles collide the magnitude of the impulse received by each particle is $3.5mu$ N s.

(i) Find, in terms of u, the speed of P immediately after the collision. [4 marks]

(ii) Find, in terms of u, the speed of Q immediately after the collision. [2 marks]

6 In this question take $g = 10\,m\,s^{-2}$

Fig. 3 below shows a plank AB suspended by two vertical ropes attached to the plank at the points P and Q.

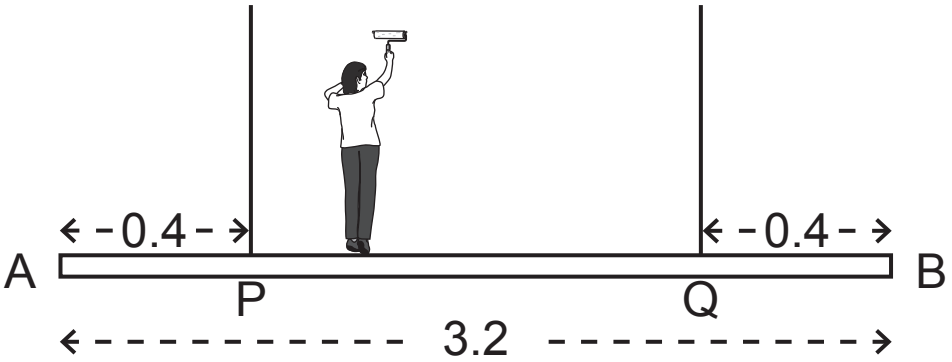


Fig. 3

The plank has length 3.2 m and mass 40 kg.
The distances AP = BQ = 0.4 m.
To paint a wall, Peter, of mass 60 kg, stands on the plank at a point C between P and Q.
PC = x metres.
The plank rests in equilibrium.
Model the plank as a uniform rod and Peter as a particle.

(i) State one modelling assumption you will make about the ropes. [1 mark]

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

(iii) Find, in terms of x, expressions for the tensions in the two ropes. [7 marks]

(iv) As Peter moves from P to Q, find the range of values of the tension in the rope at Q. [3 marks]

7 At time $t = 0$ seconds, a particle P is at rest at a fixed point O.
P starts to move in a straight line and after t seconds its velocity v m s^{-1} is given by

$$v = \begin{cases} 5t & 0 \leqslant t < 1 \\ t + \frac{4}{t^2} & 1 \leqslant t \leqslant 3 \\ 3\frac{4}{9} & t > 3 \end{cases}$$

(i) Find the least speed of P in the interval $1 \leqslant t \leqslant 3$
[6 marks]

(ii) On the axes below sketch the velocity–time graph to show the motion of P in the interval $0 \leqslant t \leqslant 6$
[3 marks]

(iii) Find the distance travelled by P in the interval $0 \leqslant t \leqslant 6$
[8 marks]

THIS IS THE END OF THE QUESTION PAPER

For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
Total Marks	

Examiner Number