Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2019

Centre Number

Candidate Number

Mathematics

Assessment Unit M1

assessing

Module M1: Mechanics 1

AMM11

[AMM11]
TUESDAY 28 MAY, MORNING

TIME

1 hour 30 minutes.

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.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen**.
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 down the right-hand side of pages 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 $\ln z \equiv \log_e z$

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

1 Three forces are in equilibrium in a vertical plane, as shown in **Fig. 1** below.

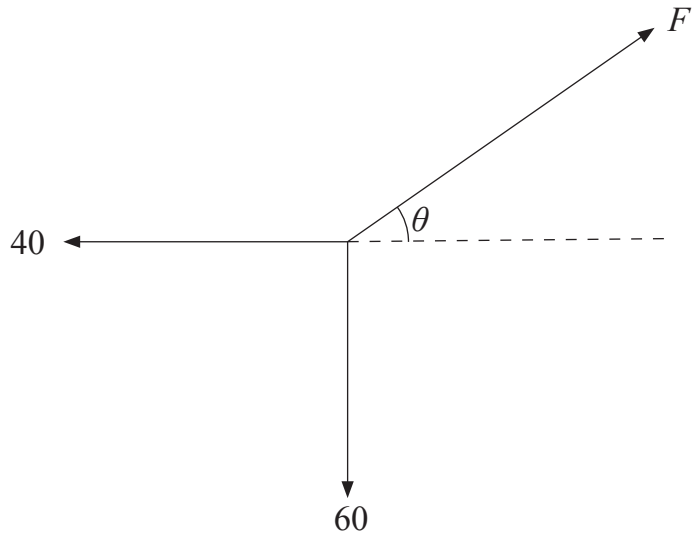

Fig. 1

There is a horizontal force of magnitude 40 N and a vertical force of magnitude 60 N. The third force has magnitude F newtons and acts at an angle of θ above the horizontal.

Find F and θ. [6]

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[Turn over

2 **Fig. 2** below shows a parcel being pulled by a rope along rough horizontal ground.

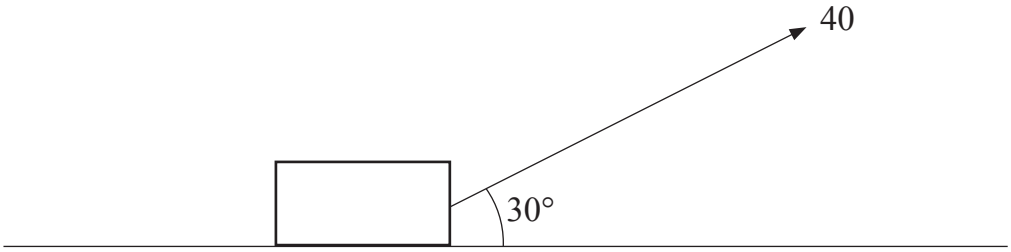

Fig. 2

The parcel has a mass of 25 kg and is accelerating at $0.1\,\mathrm{m\,s^{-2}}$
The tension in the rope is 40 N.
The angle between the rope and the ground is 30°

(i) In the space below, draw a diagram showing the external forces acting on the parcel. [2]

(ii) Find the coefficient of friction between the parcel and the ground. [7]

[Turn over

(iii) State one modelling assumption you have made about the rope. [1]

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(iv) State what would happen to the magnitude of the frictional force if the angle between the rope and the horizontal was increased.
Give a reason for your answer. [2]

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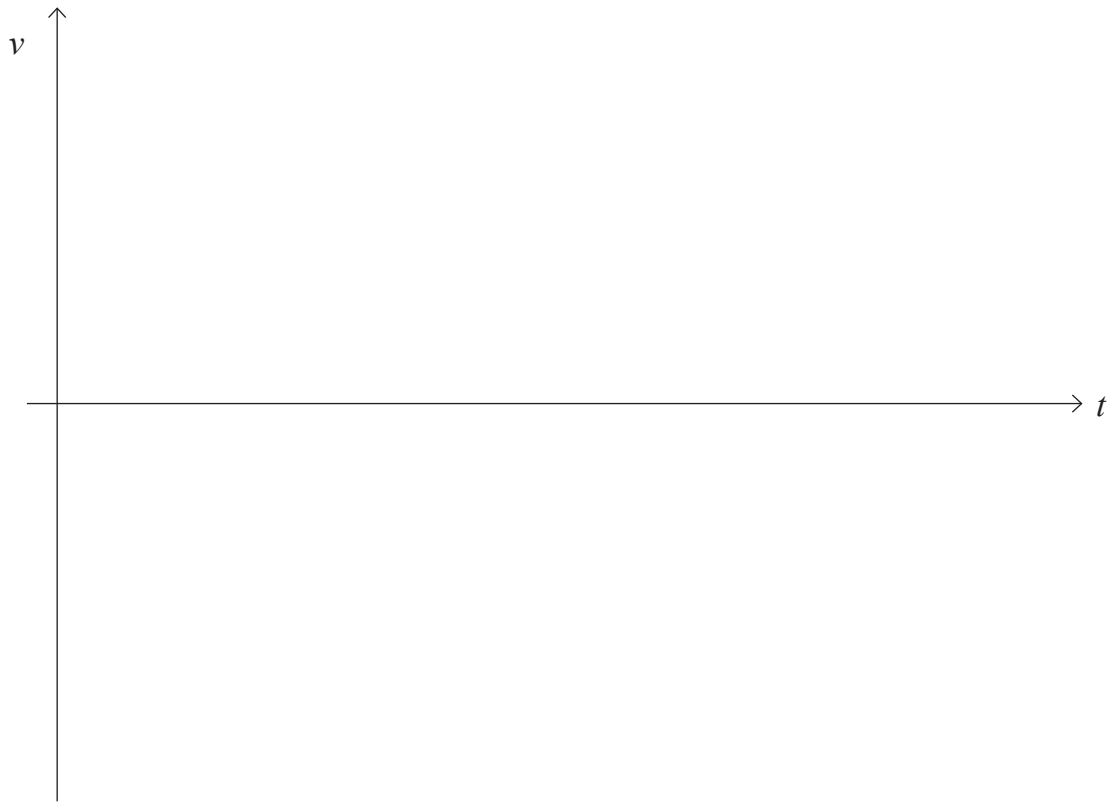
[Turn over

3 A small ball is projected vertically upwards from ground level with a speed of u m s^{-1}. The ball takes 4 seconds to return to ground level.

(i) On the axes below, sketch a velocity–time graph to represent the motion of the ball in these 4 seconds. [2]



The maximum height of the ball above the ground is 19.6 m.

(ii) Find the value of u. [3]

[Turn over

4 A particle P moves along a straight horizontal line passing through a fixed point O. At time t seconds, its displacement, s metres, from O can be modelled by

$$s = t^3 - 4t^2 + 8t + 7$$

(i) Find, in terms of t, the velocity of P. [2]

(ii) Hence, find the minimum velocity of P. [6]

[Turn over

5 A marksman fires a bullet from a rifle with a horizontal speed of $300\,\mathrm{m\,s^{-1}}$
The mass of the rifle is 2 kg, and the mass of the bullet is 0.04 kg.

(i) Find the speed with which the rifle recoils into the marksman's shoulder. [5]

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The rifle comes to rest after $\frac{1}{12}$ s.

(ii) Find the average force that is exerted on the marksman's shoulder by the rifle during this time. [5]

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[Turn over

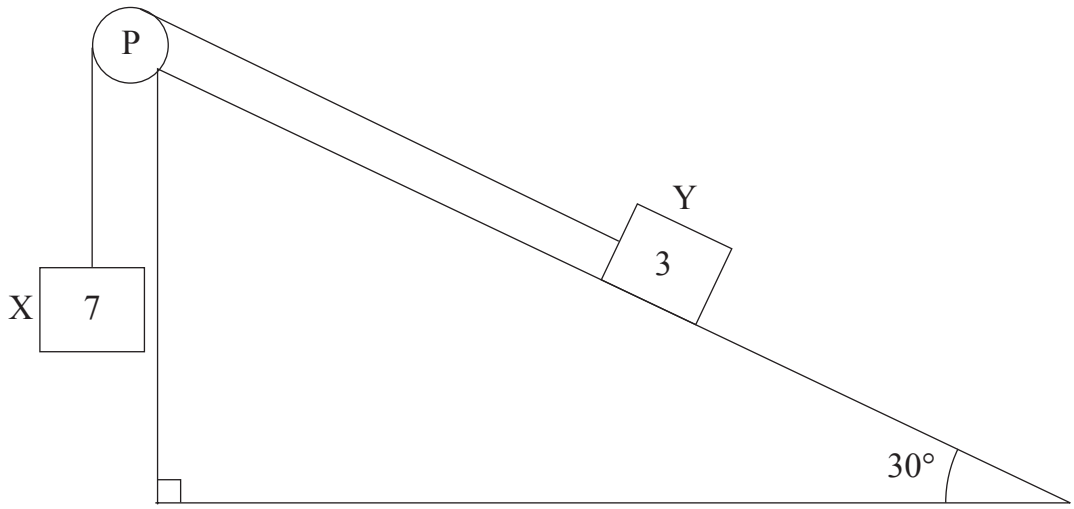
6 The diagram below shows two particles X and Y of masses 7 kg and 3 kg respectively, attached to a light inextensible string which passes over a smooth fixed pulley P.

Initially, Y is held at rest on a rough plane inclined at 30° to the horizontal.
The part of the string from Y to P is parallel to the line of greatest slope.
X hangs freely below P.

The coefficient of friction between Y and the plane is $\frac{2}{3}$

The particles are released from rest with the string taut and Y moves up the plane.

(i) On the diagram below show the external forces acting on X and Y. [2]



(ii) Find the acceleration of Y immediately after release. [9]

[Turn over

(iii) When Y has moved 1 m up the plane, the string breaks.

Find the time between the instants when the string breaks and when Y comes to instantaneous rest.

[You may assume that X has not hit the ground when the string breaks and that Y will not reach P.] [6]

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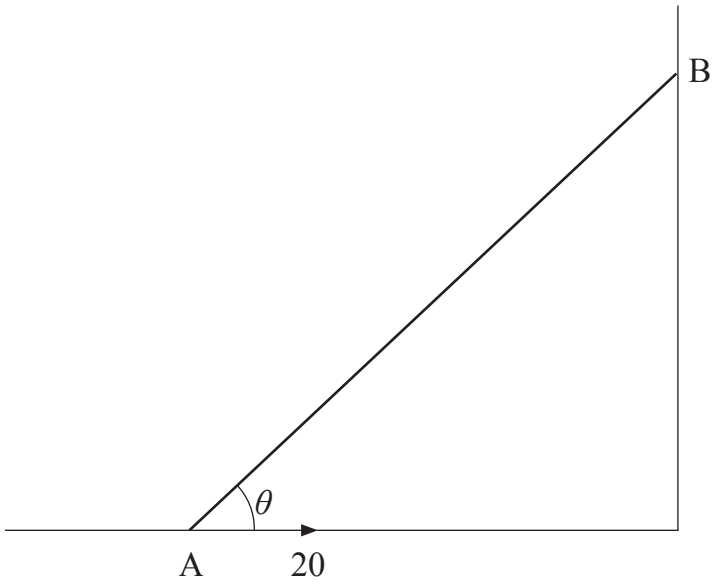
7 A uniform ladder AB, of length 8 m and weight W newtons, rests with end A on smooth horizontal ground and end B against a rough vertical wall.

The coefficient of friction between the ladder and the wall is μ.
A horizontal force of 20 N is applied to the ladder at A and acts towards the wall.
When the ladder is about to slip down the wall, the ladder makes an angle of θ with the ground.

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



(ii) Find, in terms of W and μ, an expression for the normal reaction at A. [6]

[Turn over

(iii) By taking moments about A, show that

$$\tan\theta = \frac{W}{40} - \mu$$

[7]

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(iv) Hence if $\mu = 0.4$, show that $W > 16$ [2]

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Question Number	**Marks**
1	
2	
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Total Marks	

Examiner Number

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