Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2012

Mathematics

Assessment Unit M1

assessing

Module M1: Mechanics 1

[AMM11]

AMM11

FRIDAY 20 JANUARY, AFTERNOON

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.

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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 a right-angled triangle ABC with $C\hat{A}B = 40°$
Forces of magnitude 3 N, 4 N and 8 N respectively act along the sides BA, BC and AC of the triangle.

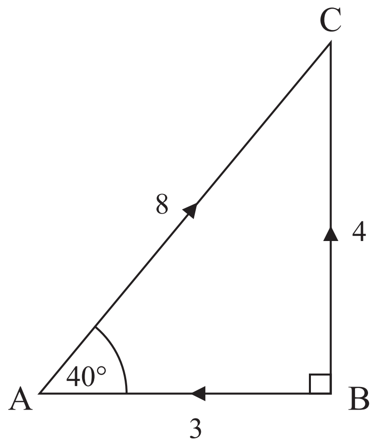

Fig. 1

Find the magnitude of the resultant force. [7]

2 Sally is driving her car along a smooth straight horizontal road at $20\,\mathrm{m\,s^{-1}}$ when she sees a junction 200 m ahead.
She applies the brakes and decelerates for 10 s at $1.5\,\mathrm{m\,s^{-2}}$
Sally then releases the brakes for 4 s and travels at a steady speed.
She brakes again so that her car comes to rest just as it reaches the junction.
This is illustrated by the velocity-time graph in **Fig. 2** below.

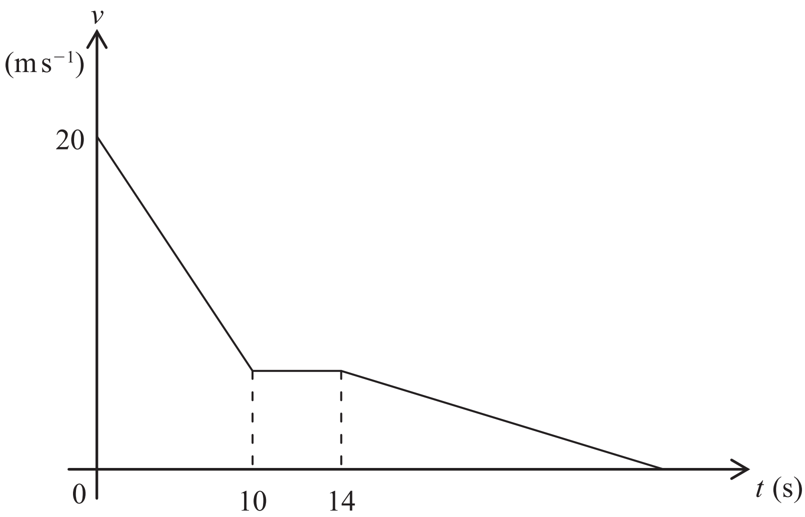

Fig. 2

(i) Find the velocity when $t = 10$ [2]

(ii) Find the distance travelled between $t = 0$ and $t = 10$ [3]

(iii) Find the total time taken for the car to reach the junction. [4]

3 **Fig. 3** below shows a boy on a sledge being pulled by a rope up a rough slope inclined at 15° to the horizontal.
The rope is parallel to the slope.
The boy is moving at a steady speed when the tension in the rope is 240 N.

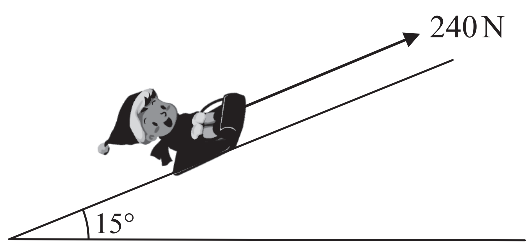

Fig. 3

The coefficient of friction between the sledge and the slope is μ.
Model the boy and the sledge as a particle of mass 50 kg.

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

(ii) Find the value of μ. [8]

4 **Fig. 4** below shows a car of mass 1000 kg towing a trailer of mass 800 kg along a straight horizontal road.
The resistances to the motion of the car and trailer are 650 N and 250 N respectively.
The car's engine produces a horizontal driving force of 2250 N.

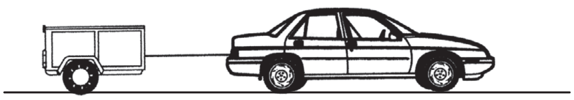

Fig. 4

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

(ii) Find the acceleration of the car and trailer and the tension in the tow bar. [7]

When the car and trailer are travelling at 15 $\mathrm{m\,s^{-1}}$ the tow bar breaks.
The resistance to the motion of the trailer remains unchanged.

(iii) Find the distance travelled by the trailer before it comes to rest. [5]

5 A particle P moves along a straight horizontal line, such that its displacement s metres from a fixed point, at any time t seconds, is given by

$$s = \frac{1}{4}t^4 - 2t^3$$

(i) Find an expression for the velocity of P at any time t. [3]

(ii) Find an expression for the acceleration of P at any time t. [2]

(iii) Find the minimum velocity of P. [5]

6 **Fig. 5** below shows three spheres A, B and C moving along a smooth horizontal groove.

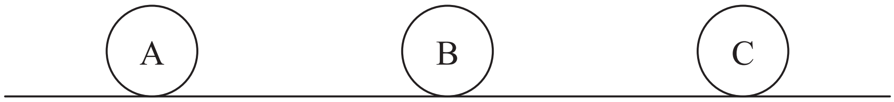

Fig. 5

Fig. 6 below shows A and B moving towards each other.
A has mass $3m$ kg and is travelling at u m s^{-1}
B has mass $2m$ kg and is travelling at $2u$ m s^{-1}

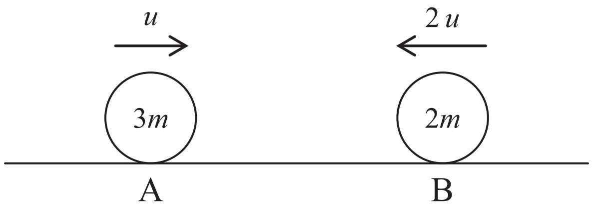

Fig. 6

A collides directly with B.
Immediately after the collision B is travelling at u m s^{-1} and has reversed its direction.

(i) Find, in terms of u, the velocity of A after the collision. [4]

Fig. 7 below shows B and C moving towards each other.
C has mass $4m$ kg and is travelling at u m s^{-1}
B collides directly with C and they coalesce.

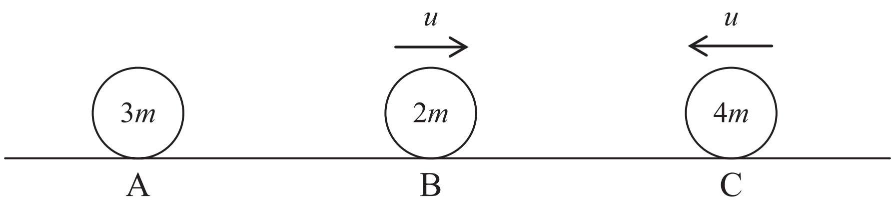

Fig. 7

(ii) Find, in terms of u, the **speed** of the combined spheres. [4]

(iii) State whether the combined spheres collide with A. Justify your answer. [2]

7 **Fig. 8** below shows a uniform metal rod AB of length 30 cm and weight 10 N.
The rod is hinged to a smooth vertical wall at the point A.
A light horizontal cable attaches B to a point C on the wall vertically above A.
A flower basket of weight 40 N is attached to B.
The rod AB makes an angle of 60° with the wall.

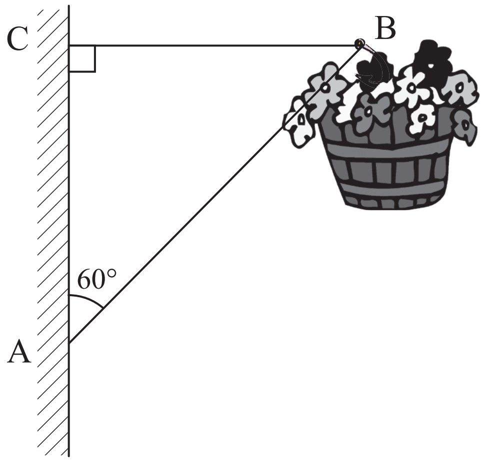

Fig. 8

The system is in equilibrium.

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

(ii) Find the tension in BC. [6]

(iii) Find the magnitude and direction of the reaction at the hinge A. [7]

THIS IS THE END OF THE QUESTION PAPER