



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2014

Mathematics

Assessment Unit M1

assessing

Module M1: Mechanics 1

[AMM11]



FRIDAY 24 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 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 $g = 9.8 \text{ m s}^{-2}$, 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** AB is a line segment of length $5a$.
C is a point on this line where $AC = a$.

Fig. 1 below shows a system of coplanar forces acting at right angles to AB.

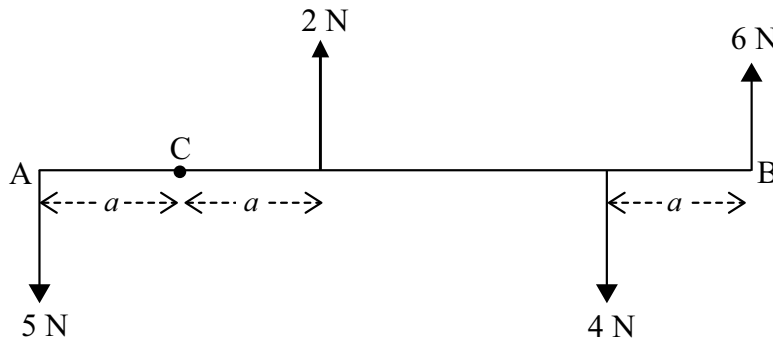


Fig. 1

By taking moments about C, find, in terms of a , the resultant moment of this system. [4]

- 2 **Fig. 2** below shows a crate being pulled along a rough horizontal surface by a light inextensible rope inclined at 30° to the horizontal.

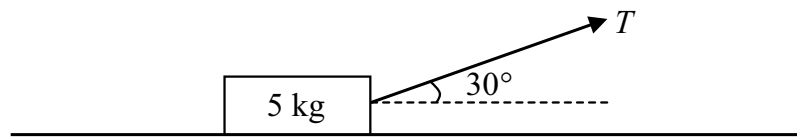


Fig. 2

The crate has a mass of 5 kg and the tension in the rope is T newtons. The coefficient of friction between the crate and the surface is μ .

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

When $T = 15$ N, the crate is in limiting equilibrium.

- (ii) Find μ . [6]

T is now increased so that the crate accelerates along the surface at 2 m s^{-2}

- (iii) Find the new value of T . [5]

- 3 The points A and B lie on a straight horizontal track as shown in **Fig. 3** below.



Fig. 3

At time $t = 0$ seconds, Kathryn passes the point A with a speed of 1 m s^{-1} and jogs towards B with a uniform acceleration of 0.15 m s^{-2}

Also at $t = 0$, Victoria passes the point B, and jogs with a constant speed of 2 m s^{-1} towards A. The distance $AB = 90 \text{ m}$.

- (i) Find the value of t at which Kathryn and Victoria meet. [8]

- (ii) On the **same** diagram, sketch the displacement–time graphs for Kathryn and Victoria from $t = 0$ to the time at which they meet. [2]

- 4 **Fig. 4** below shows a shell of mass of $3m$ kg moving horizontally in a straight line with a speed of u m s^{-1} . A few seconds into its motion, the shell explodes into two parts A and B of mass m kg and $2m$ kg respectively. A and B continue to move along the **same** line. After the explosion, the direction of B has not changed, but its speed is now $2u$ m s^{-1} .

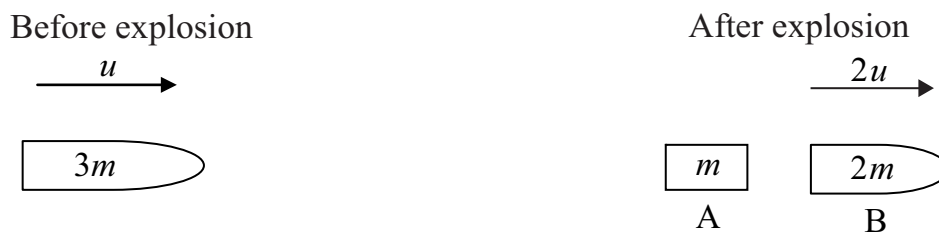


Fig. 4

- (i) Find, in terms of u , the velocity of A after the explosion. [3]
- (ii) State clearly how you know the direction of A after the explosion. [1]
- (iii) Find, in terms of m and u , the impulse given to B as a result of the explosion. [3]

- 5 Fig. 5 below shows two boxes P and Q connected by a light inextensible string which passes over a smooth fixed pulley at B.

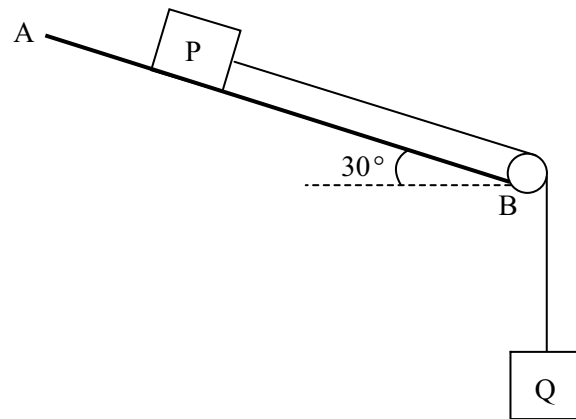


Fig. 5

AB is rough and inclined at 30° to the horizontal.

Box P has mass 8 kg and the coefficient of friction between P and the slope AB is 0.7

Box Q has mass 3 kg and hangs freely.

The boxes P and Q are released from rest and the string remains taut throughout the motion.

- (i) Draw a diagram showing the external forces acting on P and Q. [2]
- (ii) Find the magnitude of the frictional force between P and the plane AB. [3]
- (iii) Find the acceleration of P. [6]
- 6 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 acceleration $a \text{ ms}^{-2}$ is given by

$$a = \begin{cases} 4t + 2 & 0 \leq t \leq 3 \\ -4 & t > 3 \end{cases}$$

- (i) Show that at $t = 3$ P is travelling with a speed of 24 ms^{-1} [4]
- (ii) Find t ($t > 0$) when P is again at rest. [4]
- (iii) Find the distance travelled by P in the interval $0 \leq t \leq 9$ [7]

7 [In this question take $g = 10 \text{ m s}^{-2}$]

Fig. 6 below shows a uniform water pipe AB being held in limiting equilibrium by a light inextensible cable attached to B and to a fixed point C.

The pipe is of length 30 m and mass 250 kg.

End A of the pipe rests on rough horizontal ground.

The angle between the pipe and the ground is 20°

The cable BC makes an angle of 70° with the horizontal.

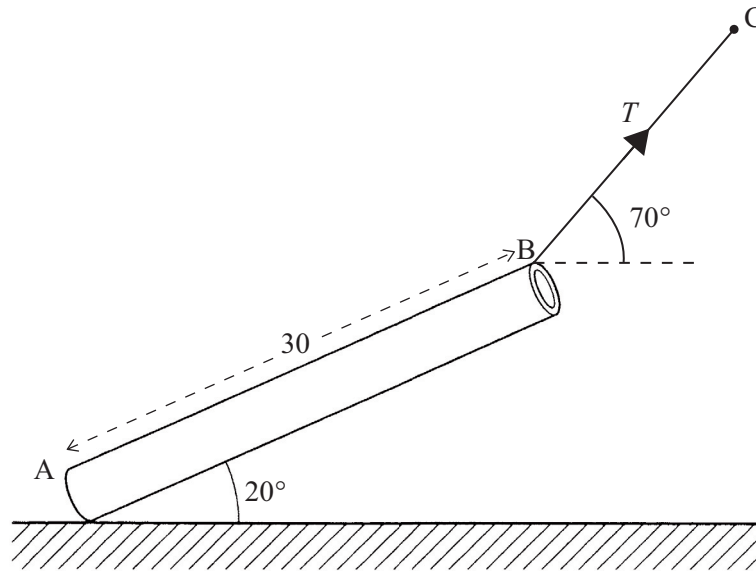


Fig. 6

The tension in the cable is T newtons.

- (i) Draw a diagram showing the external forces acting on the pipe. [2]
- (ii) State **one** modelling assumption you will make about the pipe. [1]
- (iii) Find T correct to 3 significant figures. [5]
- (iv) Hence find the magnitude of the reaction at A. [7]

THIS IS THE END OF THE QUESTION PAPER
