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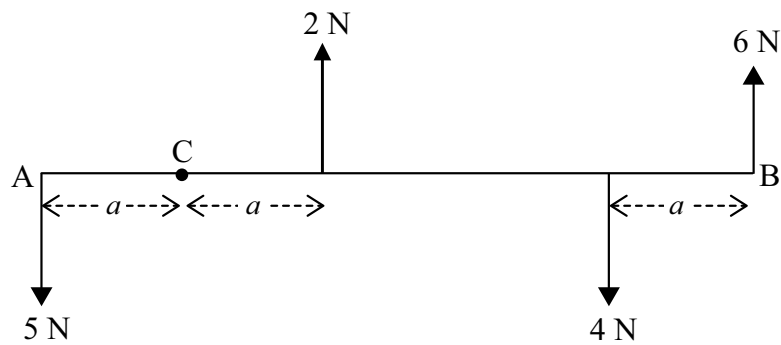**Fig. 1** below shows a system of coplanar forces acting at right angles to AB.

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.
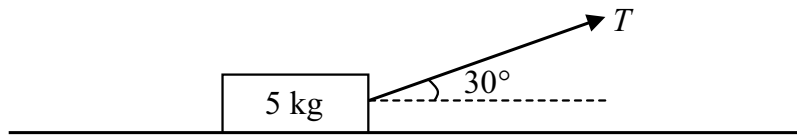

Fig. 2

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 $2\,\mathrm{m\,s^{-2}}$

(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 $\mathrm{m\,s^{-1}}$ and jogs towards B with a uniform acceleration of 0.15 $\mathrm{m\,s^{-2}}$
Also at $t = 0$, Victoria passes the point B, and jogs with a constant speed of 2 $\mathrm{m\,s^{-1}}$ towards A. The distance AB = 90 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.

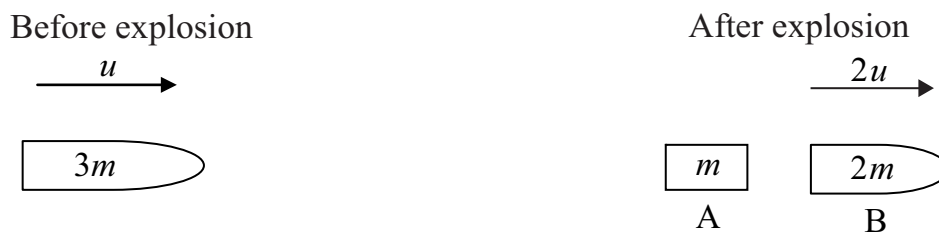After the explosion, the direction of B has not changed, but its speed is now $2u$ m s^{-1}

Before explosion   After explosion

u → $2u$ →

| $3m$ ⟩ | | m | | $2m$ ⟩ |
                                      A   B

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.
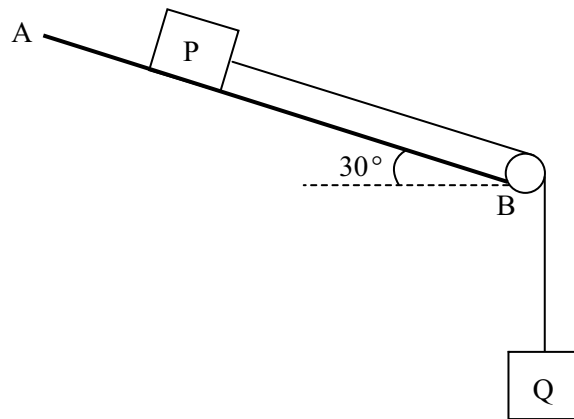

Fig. 5

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 m s^{-2} is given by

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

(i) Show that at $t = 3$ P is travelling with a speed of 24 m s^{-1} [4]

(ii) Find t $(t > 0)$ when P is again at rest. [4]

(iii) Find the distance travelled by P in the interval $0 \leqslant t \leqslant 9$ [7]

7 **[In this question take g = 10 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.

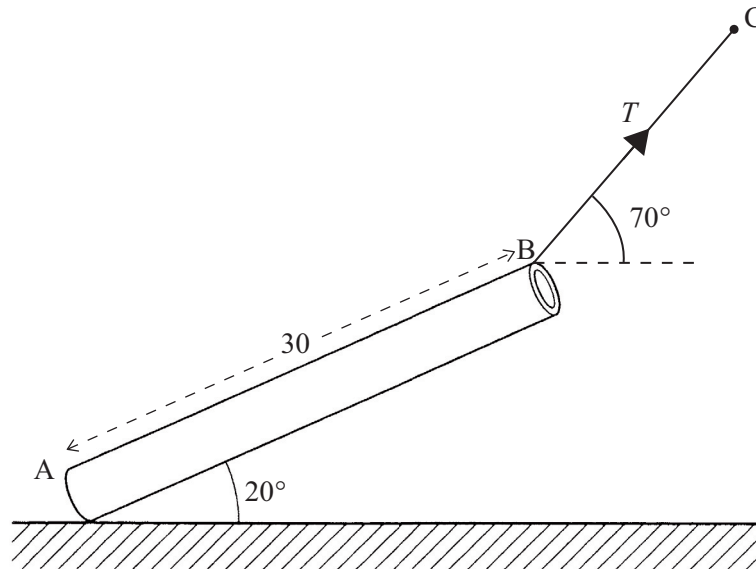
C
T
70°
B
30
A
20°

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

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