# Mock Exam 2

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

**MATHEMATICS** **9709**

Paper 4 Mechanics 1 **(M1)** **1 hour 15 minutes**

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF9)

**READ THESE INSTRUCTIONS FIRST**

Write your centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** the questions in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
Where a numerical value for the acceleration due to gravity is needed, use $10\,\mathrm{m\,s^{-2}}$.
The use of an electronic calculator is expected, where appropriate.
You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 50.

# List of formulae and tables of the normal distribution (MF9)

## MECHANICS

*Uniformly accelerated motion*

$$v = u + at, \qquad s = \tfrac{1}{2}(u+v)t, \qquad s = ut + \tfrac{1}{2}at^2, \qquad v^2 = u^2 + 2as$$

*Motion of a projectile*

Equation of trajectory is:

$$y = x\tan\theta - \frac{gx^2}{2V^2\cos^2\theta}$$

*Elastic strings and springs*

$$T = \frac{\lambda x}{l}, \qquad E = \frac{\lambda x^2}{2l}$$

*Motion in a circle*

For uniform circular motion, the acceleration is directed towards the centre and has magnitude

$$\omega^2 r \quad \text{or} \quad \frac{v^2}{r}$$

*Centres of mass of uniform bodies*

Triangular lamina: $\frac{2}{3}$ along median from vertex

Solid hemisphere of radius $r$: $\frac{3}{8}r$ from centre

Hemispherical shell of radius $r$: $\frac{1}{2}r$ from centre

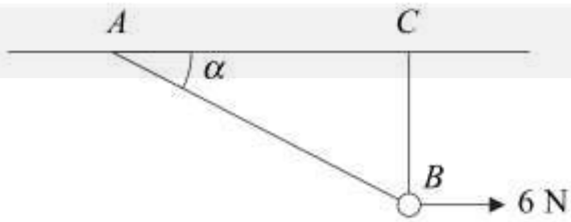
Circular arc of radius $r$ and angle $2\alpha$: $\frac{r\sin\alpha}{\alpha}$ from centre

Circular sector of radius $r$ and angle $2\alpha$: $\frac{2r\sin\alpha}{3\alpha}$ from centre

Solid cone or pyramid of height $h$: $\frac{3}{4}h$ from vertex

**Q1:**

**Figure 1**

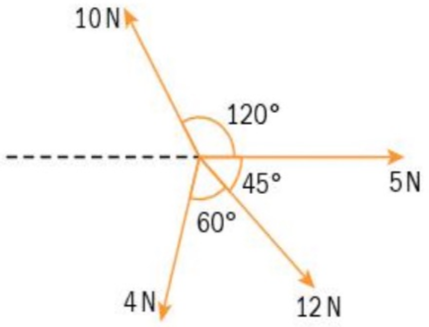



A smooth bead $B$ is threaded on a light inextensible string. The ends of the string are attached to two fixed points $A$ and $C$ on the same horizontal level. The bead is held in equilibrium by a horizontal force of magnitude 6 N acting parallel to $AC$. The bead $B$ is vertically below $C$ and $\angle BAC = \alpha$, as shown in Figure 1. Given that $\tan\alpha = \frac{3}{4}$, find

(a) the tension in the string, **[2]**

(b) the weight of the bead. **[2]**

**2.**




Four coplanar forces act at a point. The magnitude of the forces are 10 N, 5 N, 12 N and 4 N, and the directions in which the forces act are shown in the diagram. Calculate the magnitude and direction of the resultant of the four forces. [4]

**3.** The resistance to the motion of a lorry of mass 5 tonnes is $kv$, where $v$ m s$^{-1}$ is the lorry's speed. With the engine working at 66 kW the lorry can attain a greatest steady speed of 12 m s$^{-1}$ up a straight road that is inclined at $\sin^{-1}\frac{1}{20}$ to the horizontal.

**i)** Show that $k = 250$. [3]

**ii)** Determine the greatest steady speed that the lorry can go down this slope with the engine still working at 66 kW. [4]

**4.** A block of mass 25 kg is dragged 30 m up a slope inclined at 5° to the horizontal by a rope inclined at 20° to the slope. The tension in the rope is 100 N and the resistance to the motion of the block is 70 N. The block is initially at rest. Calculate

i) the work done by the tension in the rope [2]

ii) the change in the potential energy of the block [2]

iii) the speed of the block after it has moved 30 m up the slope. [3]

**5.**

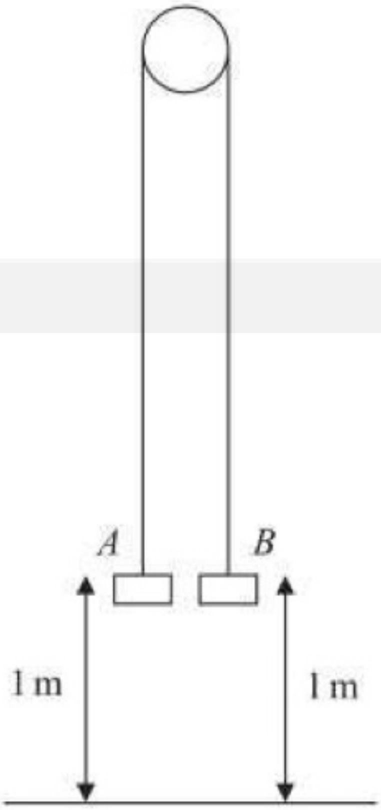



**Figure** 4

Two particles $A$ and $B$ have mass 0.4 kg and 0.3 kg respectively. The particles are attached to the ends of a light inextensible string. The string passes over a small smooth pulley which is fixed above a horizontal floor. Both particles are held, with the string taut, at a height of 1 m above the floor, as shown in Figure 4 The particles are released from rest and in the subsequent motion $B$ does not reach the pulley.

(a) Find the tension in the string immediately after the particles are released. **[2]**

(b) Find the acceleration of $A$ immediately after the particles are released. **[2]**

When the particles have been moving for 0.5 s, the string breaks.

(c) Find the further time that elapses until $B$ hits the floor. **[4]**

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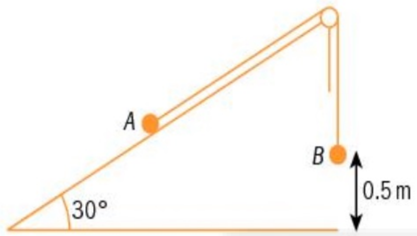
**6.**




Particles $A$ of mass 0.6 kg and $B$ of mass 0.9 kg are connected by a light inextensible string that passes over a smooth pulley that is fixed at the top of a smooth sloping flat surface that is inclined at an angle of 30° to the horizontal. Particle $A$ lies on the slope and particle $B$ is released from rest and falls 0.5 m to the floor, where it remains at rest. Particle $A$ then continues to move up the slope.

**i)** Show that the acceleration of the particles is $4\,\text{m}\,\text{s}^{-2}$ before $B$ hits the floor and find the tension in the string. [3]

**ii)** Calculate the speed of the particles just before particle $B$ reaches the floor. [2]

**iii)** Assuming that it does not reach the pulley, calculate the further distance that particle $A$ travels up the slope. [4]

**7.** A car moves on a straight road. As the driver passes a point $A$ on the road with a speed of $20\,\text{ms}^{-1}$, he notices an accident ahead at a point $B$. He immediately applies the brakes and the car moves with an acceleration of $a\,\text{ms}^{-2}$, where $a = \frac{3t}{2} - 6$ and $t$ s is the time after passing $A$. When $t = 4$, the car passes the accident at $B$. The car then moves with a constant acceleration of $2\,\text{ms}^{-2}$ until the original speed of $20\,\text{ms}^{-1}$ is regained at a point $C$. Find

**(i)** the speed of the car at $B$, [4]

**(ii)** the distance $AB$, [3]

**(iii)** the time taken for the car to travel from $B$ to $C$. [2]

Sketch the velocity-time graph for the journey from $A$ to $C$. [2]

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