Cambridge Assessment International Education

# Cambridge International AS & A Level

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| CANDIDATE NAME | |
| CENTRE NUMBER | |
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*4809895288*

**MATHEMATICS** **9709/42**

Paper 4 Mechanics **May/June 2022**

**1 hour 15 minutes**

You must answer on the question paper.

You will need: List of formulae (MF19)

**INSTRUCTIONS**

- Answer all questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.
- Where a numerical value for the acceleration due to gravity ($g$) is needed, use 10 m s$^{-2}$.

**INFORMATION**

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [ ].



This document has **16** pages. Any blank pages are indicated.

**1** Small smooth spheres $A$ and $B$, of equal radii and of masses 5 kg and 3 kg respectively, lie on a smooth horizontal plane. Initially $B$ is at rest and $A$ is moving towards $B$ with speed $8.5\,\text{m}\,\text{s}^{-1}$. The spheres collide and after the collision $A$ continues to move in the same direction but with a quarter of the speed of $B$.

**(a)** Find the speed of $B$ after the collision. [3]

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**(b)** Find the loss of kinetic energy of the system due to the collision. [2]

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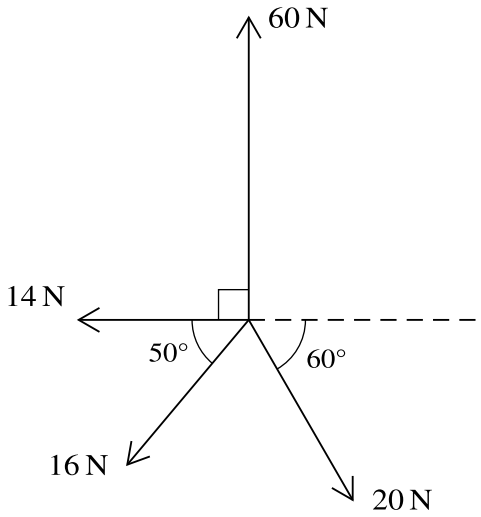
**2**




Coplanar forces of magnitudes 60 N, 20 N, 16 N and 14 N act at a point in the directions shown in the diagram.

Find the magnitude and direction of the resultant force. [6]

**3** Two particles $A$ and $B$, of masses 2.4 kg and 1.2 kg respectively, are connected by a light inextensible string which passes over a fixed smooth pulley. $A$ is held at a distance of 2.1 m above a horizontal plane and $B$ is 1.5 m above the plane. The particles hang vertically and are released from rest. In the subsequent motion $A$ reaches the plane and does not rebound and $B$ does not reach the pulley.

**(a)** Show that the tension in the string before $A$ reaches the plane is 16 N and find the magnitude of the acceleration of the particles before $A$ reaches the plane. [4]

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**(b)** Find the greatest height of $B$ above the plane. [3]

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**4** A particle $A$, moving along a straight horizontal track with constant speed $8\,\text{m s}^{-1}$, passes a fixed point $O$. Four seconds later, another particle $B$ passes $O$, moving along a parallel track in the same direction as $A$. Particle $B$ has speed $20\,\text{m s}^{-1}$ when it passes $O$ and has a constant deceleration of $2\,\text{m s}^{-2}$. $B$ comes to rest when it returns to $O$.

**(a)** Find expressions, in terms of $t$, for the displacement from $O$ of each particle $t$ seconds after $B$ passes $O$. [3]

**(b)** Find the values of $t$ when the particles are the same distance from $O$. [3]

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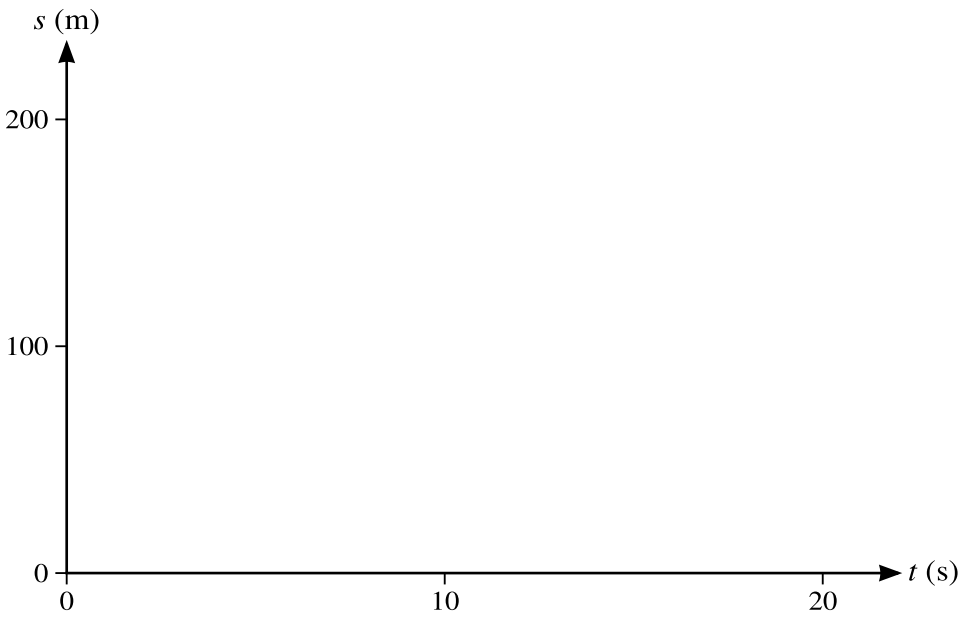
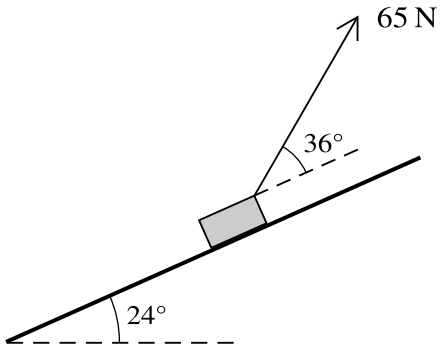
**(c)** On the given axes, sketch the displacement-time graphs for both particles, for values of $t$ from 0 to 20. [3]



**5**




A block of mass 12 kg is placed on a plane which is inclined at an angle of 24° to the horizontal. A light string, making an angle of 36° above a line of greatest slope, is attached to the block. The tension in the string is 65 N (see diagram). The coefficient of friction between the block and plane is $\mu$. The block is in limiting equilibrium and is on the point of sliding up the plane.

Find $\mu$. [6]

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**6** A car of mass 900 kg is moving up a hill inclined at $\sin^{-1} 0.12$ to the horizontal. The initial speed of the car is $11\,\text{m s}^{-1}$. After 12 s, the car has travelled 150 m up the hill and has speed $16\,\text{m s}^{-1}$. The engine of the car is working at a constant rate of 24 kW.

**(a)** Find the work done against the resistive forces during the 12 s. [5]

The car then travels along a straight horizontal road. There is a resistance to the motion of the car of $(1520 + 4v)$ N when the speed of the car is $v\,\text{m}\,\text{s}^{-1}$. The car travels at a constant speed with the engine working at a constant rate of 32 kW.

**(b)** Find this speed. [3]

**7** A particle $P$ moves in a straight line. The velocity $v\,\text{m s}^{-1}$ at time $t$ seconds is given by

$$v = 0.5t \qquad \text{for} \quad 0 \leqslant t \leqslant 10,$$
$$v = 0.25t^2 - 8t + 60 \qquad \text{for} \quad 10 \leqslant t \leqslant 20.$$

**(a)** Show that there is an instantaneous change in the acceleration of the particle at $t = 10$. [3]

**(b)** Find the total distance covered by $P$ in the interval $0 \leqslant t \leqslant 20$. [6]

## Additional Page

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