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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

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MATHEMATICS **9709/43**

Paper 4 Mechanics **October/November 2024**

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 $10\,\text{m}\,\text{s}^{-2}$.

INFORMATION

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

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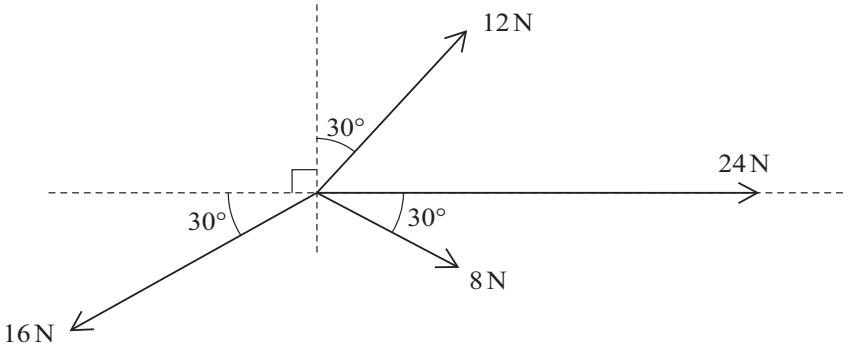
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1 An athlete has mass m kg. The athlete runs along a horizontal road against a constant resistance force of magnitude 24 N. The total work done by the athlete in increasing his speed from $5\,\text{m}\,\text{s}^{-1}$ to $6\,\text{m}\,\text{s}^{-1}$ while running a distance of 50 metres is 1541 J.

Find the value of m. [4]

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Coplanar forces of magnitudes 16 N, 12 N, 24 N and 8 N act at a point in the directions shown in the diagram.

Find the magnitude and direction of the single additional force acting at the same point which will produce equilibrium. [6]

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3 A car of mass 1600 kg travels up a slope inclined at an angle of $\sin^{-1} 0.08$ to the horizontal. There is a constant resistance of magnitude 240 N acting on the car.

(a) It is given that the car travels at a constant speed of $32\,\text{m}\,\text{s}^{-1}$.

Find the power of the engine of the car. [3]

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(b) Find the acceleration of the car when its speed is $24\,\text{m}\,\text{s}^{-1}$ and the engine is working at 95% of the power found in **(a)**. [3]

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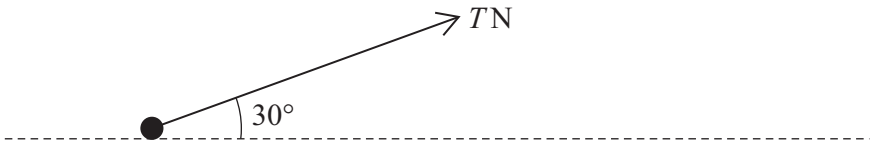
4 Two particles, A and B, of masses 3 kg and 6 kg respectively, lie on a smooth horizontal plane. Initially, B is at rest and A is moving towards B with speed $8\,\text{m}\,\text{s}^{-1}$. After A and B collide, A moves with speed $2\,\text{m}\,\text{s}^{-1}$.

Find the greater of the two possible total losses of kinetic energy due to the collision. [6]

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A particle of mass 12 kg is going to be pulled across a rough horizontal plane by a light inextensible string. The string is at an angle of 30° above the plane and has tension T N (see diagram). The coefficient of friction between the particle and the plane is 0.5 .

(a) Given that the particle is on the point of moving, find the value of T. [5]

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(b) Given instead that the particle is accelerating at $0.2\,\text{m}\,\text{s}^{-2}$, find the value of T. [3]

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6 A particle moves in a straight line. It starts from rest, at time $t = 0$, and accelerates at $0.6t\,\text{m s}^{-2}$ for 4 s, reaching a speed of $V\,\text{m s}^{-1}$. The particle then travels at $V\,\text{m s}^{-1}$ for 11 s, and finally slows down, with constant deceleration, stopping after a further 5 s.

(a) Show that $V = 4.8$. [1]

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(b) Sketch a velocity-time graph for the motion. [3]

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(c) Find an expression, in terms of t, for the velocity of the particle for $15 \leqslant t \leqslant 20$. [2]

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(d) Find the total distance travelled by the particle. [4]

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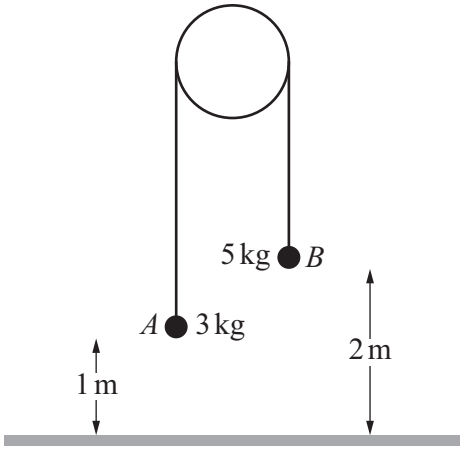
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Two particles, A and B, of masses 3 kg and 5 kg respectively, are connected by a light inextensible string that passes over a fixed smooth pulley. The particles are held with the string taut and its straight parts vertical. Particle A is 1 m above a horizontal plane, and particle B is 2 m above the plane (see diagram).

The particles are released from rest. In the subsequent motion, A does not reach the pulley, and after B reaches the plane it remains in contact with the plane.

(a) Find the tension in the string and the time taken for B to reach the plane. [6]

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(b) Find the time for which A is at least 3.25 m above the plane. [4]

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