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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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4740410800

MATHEMATICS **9709/41**

Paper 4 Mechanics **May/June 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 [ ].

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

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1 A car starts from rest and accelerates at $2\,m\,s^{-2}$ for 10 s. It then travels at a constant speed for 30 s. The car then uniformly decelerates to rest over a period of 20 s.

(a) Sketch a velocity-time graph for the motion of the car. [2]



(b) Find the total distance travelled by the car. [2]

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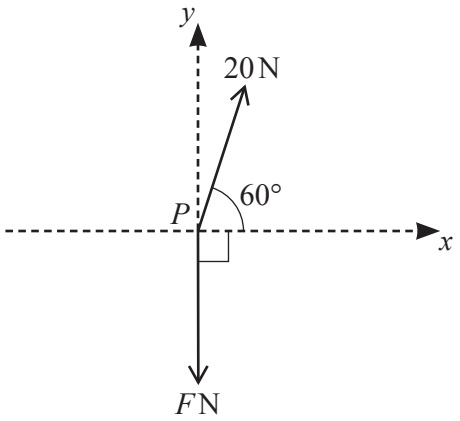
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2



Two forces of magnitudes 20 N and F N act at a point P in the directions shown in the diagram.

(a) Given that the resultant force has no component in the y-direction, calculate the value of F. [2]

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(b) Given instead that $F = 10$, find the magnitude and direction of the resultant force. [5]

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3 A train of mass 180 000 kg ascends a straight hill of length 1.5 km, inclined at an angle of 1.5° to the horizontal. As it ascends the hill, the total work done to overcome the resistance to motion is 12 000 kJ and the speed of the train decreases from $45\,m\,s^{-1}$ to $40\,m\,s^{-1}$.

Find the work done by the engine of the train as it ascends the hill, giving your answer in kJ. [4]

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4 A car of mass 1700 kg is pulling a trailer of mass 300 kg along a straight horizontal road. The car and trailer are connected by a light inextensible cable which is parallel to the road. There are constant resistances to motion of 400 N on the car and 150 N on the trailer. The power of the car's engine is 14 000 W.

Find the acceleration of the car and the tension in the cable when the speed is $20\,\text{m}\,\text{s}^{-1}$. [6]

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5 A straight slope of length 60 m is inclined at an angle of 12° to the horizontal. A bobsled starts at the top of the slope with a speed of $5\,m\,s^{-1}$. The bobsled slides directly down the slope.

(a) It is given that there is no resistance to the bobsled's motion.

Find its speed when it reaches the bottom of the slope. [3]

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(b) It is given instead that the coefficient of friction between the bobsled and the slope is 0.03 .

Find the time that it takes for the bobsled to reach the bottom of the slope. [5]

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6 A particle moves in a straight line, starting from a point O. The velocity of the particle at time t s after leaving O is $v\,\text{m s}^{-1}$. It is given that $v = kt^{\frac{1}{2}} - 2t - 8$, where k is a positive constant. The maximum velocity of the particle is $4.5\,\text{m s}^{-1}$.

(a) Show that $k = 10$. [5]

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(b) (i) Verify that $v = 0$ when $t = 1$ and $t = 16$. [1]

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(ii) Find the distance travelled by the particle in the first 16 s. [5]

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7 A particle P of mass 0.2 kg is projected vertically upwards from horizontal ground with speed $25\,\text{m}\,\text{s}^{-1}$.

(a) Show that the speed of P when it reaches 20 m above the ground is $15\,\text{m}\,\text{s}^{-1}$. [2]

When P reaches 20 m above the ground it collides with a second particle Q of mass 0.1 kg which is moving downwards at $20\,\text{m}\,\text{s}^{-1}$. P is brought to instantaneous rest in the collision.

(b) Find the velocity of Q immediately after the collision. [2]

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When P reaches the ground it rebounds back directly upwards with half of the speed that it had immediately before hitting the ground.

(c) Find the height above the ground at which P and Q next collide. [6]

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Additional page

If you use the following page to complete the answer to any question, the question number must be clearly shown.

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