Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

MATHEMATICS **9709/41**

Paper 4 Mechanics **October/November 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 $10\,\text{m}\,\text{s}^{-2}$.

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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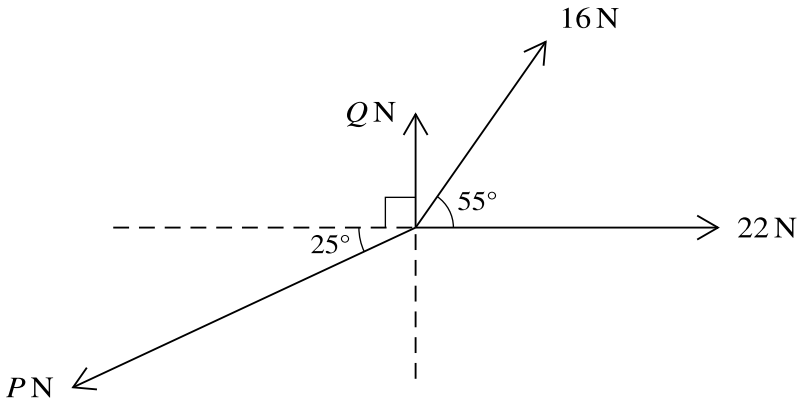
1



Coplanar forces of magnitudes P N, Q N, 16 N and 22 N act at a point in the directions shown in the diagram. The forces are in equilibrium.

Find the values of P and Q. [5]

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2 Small smooth spheres A and B, of equal radii and of masses 6 kg and 2 kg respectively, lie on a smooth horizontal plane. Initially A is moving towards B with speed $5\,\text{m}\,\text{s}^{-1}$ and B is moving towards A with speed $3\,\text{m}\,\text{s}^{-1}$. After the spheres collide, both A and B move in the same direction and the difference in the speeds of the spheres is $2\,\text{m}\,\text{s}^{-1}$.

Find the loss of kinetic energy of the system due to the collision. [5]

3 A constant resistance of magnitude 1400 N acts on a car of mass 1250 kg.

(a) The car is moving along a straight level road at a constant speed of $28\,m\,s^{-1}$.

Find, in kW, the rate at which the engine of the car is working. [2]

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(b) The car now travels at a constant speed up a hill inclined at an angle of θ to the horizontal, where $\sin\theta = 0.12$, with the engine working at 43.5 kW.

Find this speed. [3]

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(c) On another occasion, the car pulls a trailer of mass 600 kg up the same hill. The system of the car and the trailer is modelled as particles connected by a light inextensible cable. The car's engine produces a driving force of 5000 N and the resistance to the motion of the trailer is 300 N. The resistance to the motion of the car remains 1400 N.

Find the acceleration of the system and the tension in the cable. [4]

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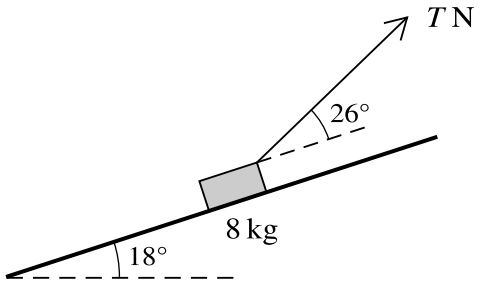

A block of mass 8 kg is placed on a rough plane which is inclined at an angle of 18° to the horizontal. The block is pulled up the plane by a light string that makes an angle of 26° above a line of greatest slope. The tension in the string is T N (see diagram). The coefficient of friction between the block and plane is 0.65.

(a) The acceleration of the block is $0.2\,\text{m}\,\text{s}^{-2}$.

Find T. [7]

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(b) The block is initially at rest.

Find the distance travelled by the block during the fourth second of motion. [2]

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5 A particle P moves on the x-axis from the origin O with an initial velocity of $-20\,\text{m s}^{-1}$. The acceleration $a\,\text{m s}^{-2}$ at time $t\,\text{s}$ after leaving O is given by $a = 12 - 2t$.

(a) Sketch a velocity-time graph for $0 \leqslant t \leqslant 12$, indicating the times when P is at rest. [5]

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(b) Find the total distance travelled by P in the interval $0 \leqslant t \leqslant 12$. [5]

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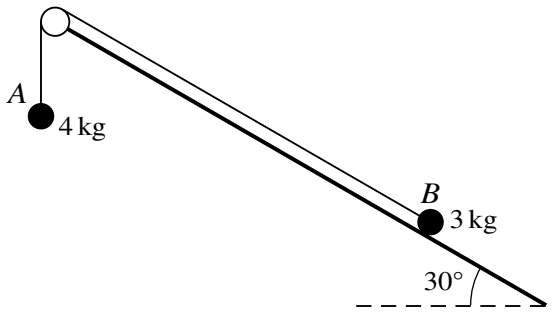

Fig. 6.1

Fig. 6.1 shows particles A and B, of masses 4 kg and 3 kg respectively, attached to the ends of a light inextensible string that passes over a small smooth pulley. The pulley is fixed at the top of a plane which is inclined at an angle of 30° to the horizontal. A hangs freely below the pulley and B is on the inclined plane. The string is taut and the section of the string between B and the pulley is parallel to a line of greatest slope of the plane.

(a) It is given that the plane is rough and the particles are in limiting equilibrium.

Find the coefficient of friction between B and the plane. [6]

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(b)

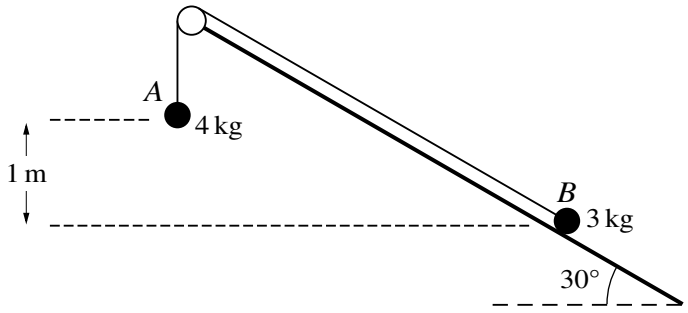

Fig. 6.2

It is given instead that the plane is smooth and the particles are released from rest when the difference in the vertical heights of the particles is 1 m (see Fig. 6.2).

Use an energy method to find the speed of the particles at the instant when the particles are at the same horizontal level. [6]

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Additional Page

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