Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

MATHEMATICS **9709/42**

Paper 4 Mechanics **May/June 2020**

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 **12** pages. Blank pages are indicated.

1 A tram starts from rest and moves with uniform acceleration for 20 s. The tram then travels at a constant speed, V m s^{-1}, for 170 s before being brought to rest with a uniform deceleration of magnitude twice that of the acceleration. The total distance travelled by the tram is 2.775 km.

(a) Sketch a velocity-time graph for the motion, stating the total time for which the tram is moving. [2]

.....

.....

(b) Find V. [2]

.....

.....

.....

.....

.....

.....

(c) Find the magnitude of the acceleration. [2]

.....

.....

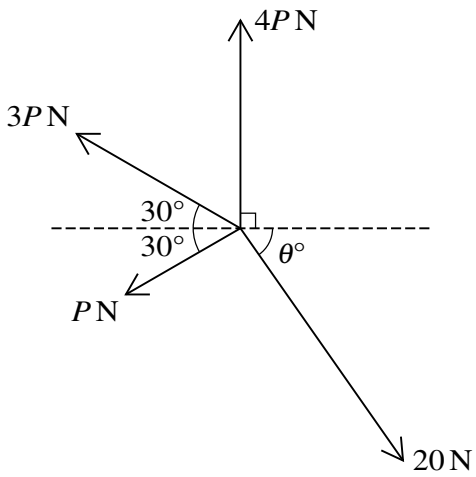
.....

.....

.....

.....

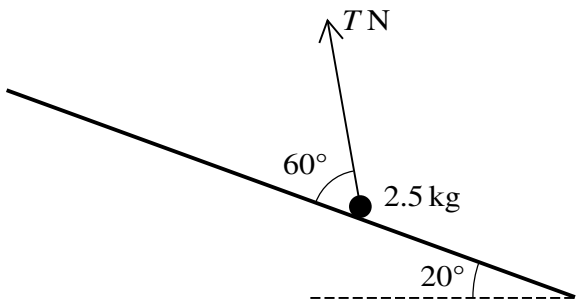
2



Coplanar forces of magnitudes 20 N, P N, $3P$ N and $4P$ N act at a point in the directions shown in the diagram. The system is in equilibrium.

Find P and θ. [6]

3



A particle of mass 2.5 kg is held in equilibrium on a rough plane inclined at 20° to the horizontal by a force of magnitude T N making an angle of 60° with a line of greatest slope of the plane (see diagram). The coefficient of friction between the particle and the plane is 0.3.

Find the greatest and least possible values of T. [8]

4 Small smooth spheres A and B, of equal radii and of masses 4 kg and 2 kg respectively, lie on a smooth horizontal plane. Initially B is at rest and A is moving towards B with speed $10\,\text{m}\,\text{s}^{-1}$. After the spheres collide A continues to move in the same direction but with half the speed of B.

(a) Find the speed of B after the collision. [2]

A third small smooth sphere C, of mass 1 kg and with the same radius as A and B, is at rest on the plane. B now collides directly with C. After this collision B continues to move in the same direction but with one third the speed of C.

(b) Show that there is another collision between A and B. [3]

.....

.....

.....

.....

.....

.....

.....

(c) *A* and *B* coalesce during this collision.

Find the total loss of kinetic energy in the system due to the three collisions. [5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

5 A car of mass 1250 kg is moving on a straight road.

(a) On a horizontal section of the road, the car has a constant speed of 32 m s^{-1} and there is a constant force of 750 N resisting the motion.

(i) Calculate, in kW, the power developed by the engine of the car. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(ii) Given that this power is suddenly decreased by 8 kW, find the instantaneous deceleration of the car. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) On a section of the road inclined at $\sin^{-1} 0.096$ to the horizontal, the resistance to the motion of the car is $(1000 + 8v)$ N when the speed of the car is $v\,\mathrm{m\,s^{-1}}$. The car travels up this section of the road at constant speed with the engine working at 60 kW.

Find this constant speed. [5]

6 A particle P moves in a straight line. The velocity v m s^{-1} at time t s is given by

$$\begin{aligned} v &= 2t + 1 \qquad \text{for } 0 \leqslant t \leqslant 5, \\ v &= 36 - t^2 \qquad \text{for } 5 \leqslant t \leqslant 7, \\ v &= 2t - 27 \qquad \text{for } 7 \leqslant t \leqslant 13.5. \end{aligned}$$

(a) Sketch the velocity-time graph for $0 \leqslant t \leqslant 13.5$. [3]

(b) Find the acceleration at the instant when $t = 6$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Find the total distance travelled by P in the interval $0 \leqslant t \leqslant 13.5$. [5]

Additional Page

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....