LRN International AS/A Level: Mathematics (7138)

Candidate Name	
Candidate Number	
Centre Name	
Centre Number	

AS-A-Level Mathematics

Paper 2: Mechanics **For Examination December 2023**

(1 hour 15 minutes)

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 spaces at the top of the page.
- 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 $9.81 ms^{-2}$.

Information

The Total for this paper is **50**

The number of marks for each question or part question is shown in brackets.

1 A bus moves from rest with constant acceleration for 12 s. It then moves with constant speed for 30 s before decelerating uniformly to rest in a further 6 s. The total distance travelled is 585 m.

(a) Find the constant speed of the bus. [2]

(b) Find the magnitude of the deceleration. [1]

2 Two small smooth spheres A and B, of equal radii and of masses km kg and m kg respectively, where $k > 1$, are free to move on a smooth horizontal plane. A is moving towards B with speed 6 m s^{-1} and B is moving towards A with speed 2 m s^{-1}. After the collision A and B coalesce and move with speed 4 m s^{-1}.

(a) Find k. [3]

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(b) Find, in terms of m, the loss of kinetic energy due to the collision. [2]

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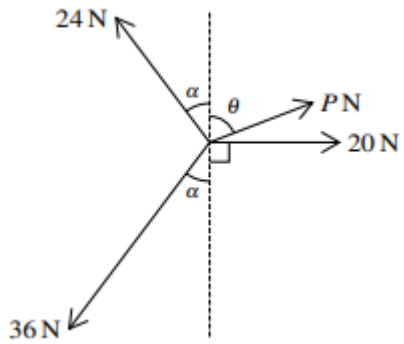

Coplanar forces of magnitudes 24 N, *P* N, 20 N and 36 N act at a point in the directions shown in the diagram. The system is in equilibrium.

Given that sin α = 3/5 , find the values of P and θ. [6]

4 A particle of mass 12 kg is stationary on a rough plane inclined at an angle of 25 to the horizontal. A force of magnitude P N acting parallel to a line of greatest slope of the plane is used to prevent the particle sliding down the plane. The coefficient of friction between the particle and the plane is 0.35.

(a) Draw a sketch showing the forces acting on the particle. [1]

(b) Find the least possible value of P. [5]

5 A car of mass 1600 kg travels at constant speed 20 m s^{-1} up a straight road inclined at an angle of $\sin^{-1} 0.12$ to the horizontal.

(a) Find the change in potential energy of the car in 30 s. [3]

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(b) Given that the total work done by the engine of the car in this time is 1960 kJ, find the constant force resisting the motion. [3]

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

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(d) Given that this power is suddenly decreased by 15%, find the instantaneous deceleration of the car. [3]

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6 A particle P moves in a straight line starting from a point O and comes to rest 14 s later. At time t s after leaving O, the velocity v m s^{-1} of P is given by

$$v = pt^2 - qt \qquad 0 \leq t \leq 6,$$
$$v = 63 - 4.5t \qquad 6 \leq t \leq 14,$$

where p and q are positive constants.

The acceleration of P is zero when $t = 2$.

(a) Given that there are no instantaneous changes in velocity, find p and q. [3]

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

(c) Find the total distance travelled by P during the 14 s. [5]

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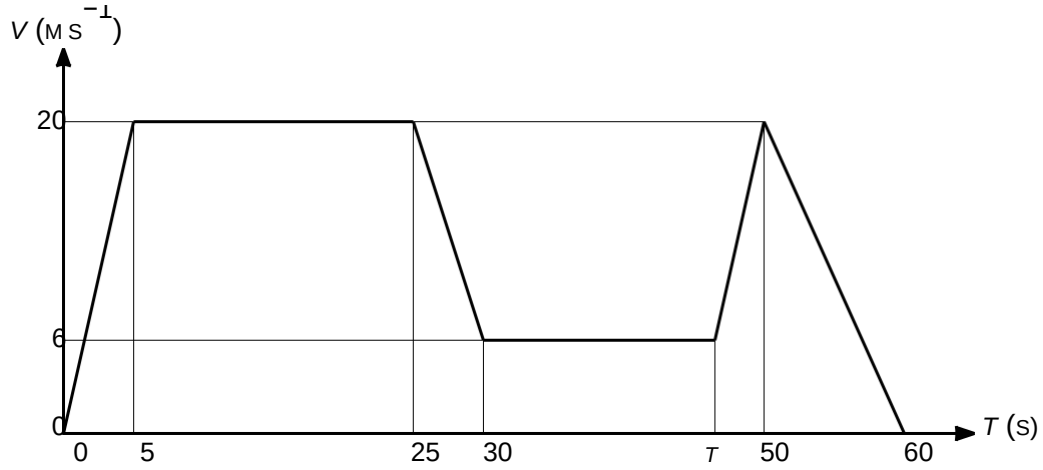

The diagram shows a velocity-time graph which models the motion of a car. The graph consists of six straight line segments. The car accelerates from rest to a speed of 20 m s^{-1} over a period of 5 s, and then travels at this speed for a further 20 s. The car then decelerates to a speed of 6 m s^{-1} over a period of 5 s. This speed is maintained for a further $T - 30$ s. The car then accelerates again to a speed of 20 m s^{-1} over a period of $50 - T$ s, before decelerating to rest over a period of 10 s.

i) Given that during the two stages of the motion when the car is accelerating, the accelerations are equal, find the value of T. [2]

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

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8 A van of mass 3600 kg is towing a trailer of mass 1200 kg along a straight horizontal road using a light horizontal rope. There are resistance forces of 700 N on the van and 300 N on the trailer.

i) The driving force exerted by the van is 2500 N.

Find the tension in the rope. [4]

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End of Paper