AS · CIE · Maths

50 mins 8 questions

Practice Paper 4 (Mechanics)

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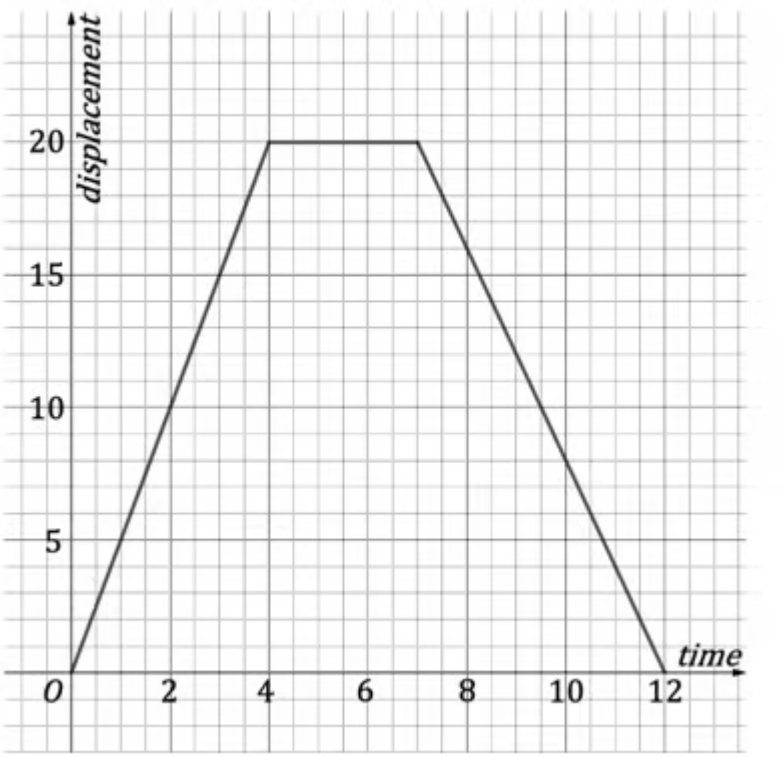
Total Marks **/50**

1 The displacement of a particle is shown in the displacement-time graph below. Displacement is measured in metres from its starting position and time is measured in seconds.



(i) Find the displacement of the particle from its starting position after 3 seconds.

(ii) For how long was the particle stationary?

(iii) Find the velocity of the particle for the last 5 seconds of its motion.

(4 marks)

2 (a) Two spheres A and B are of equal radius and have masses $5\ kg$ and $m\ kg$ respectively. A and B are moving in the same direction in a straight line on a smooth horizontal surface when they collide directly. Immediately before the collision, A and B are moving with speeds $12\ m\ s^{-1}$ and $2\ m\ s^{-1}$ respectively. Immediately after the collision, the speed of A is $2\ m\ s^{-1}$, the speed of B is $4\ m\ s^{-1}$ and the direction of motion of B is unchanged.

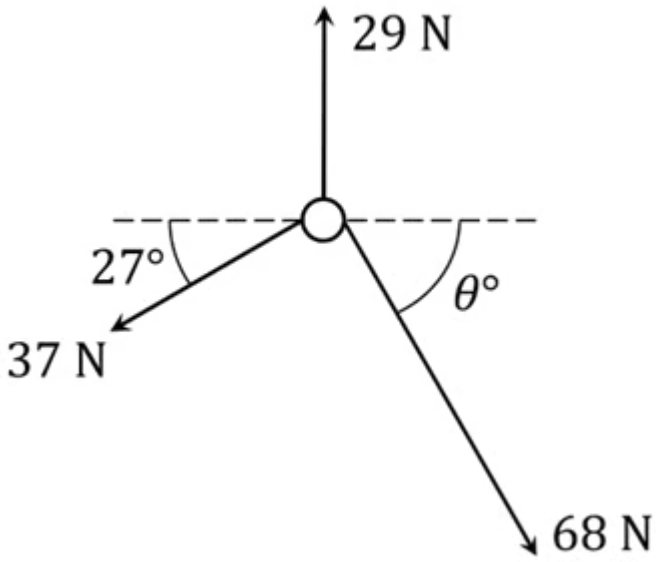
Find the two possible values of m.

(4 marks)

(b) Show that the minimum total kinetic energy lost in the collision is $140\ \text{J}$.

(3 marks)

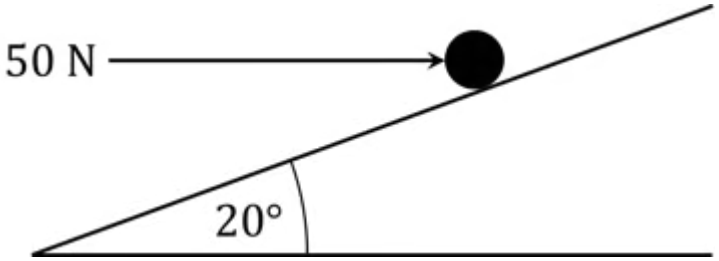
3 The following force diagram shows three forces acting on a particle:



Given that the resultant force on the particle in the vertical direction is 44.8 N downwards, find the size of the angle θ. Give your answer in degrees correct to 3 significant figures.

(5 marks)

4 (a) A particle of mass 12 kg is being pushed up a smooth slope by a force of 50 N that acts horizontally. The slope is inclined at 20° to the horizontal, as shown in the diagram below:



Calculate the acceleration of the particle up the slope.

(3 marks)

(b) Calculate the normal reaction force of the slope on the particle.

(3 marks)

5 (a) A train consisting of an engine and five carriages moves forwards on a straight horizontal track. The couplings that connect the carriages can be modelled as light and inextensible. A constant resistive force of 2800 N acts on the engine and a constant resistive force of 500 N acts on each of the five carriages. The maximum speed of the train on the track is 35 m s^{-1}.

Find the maximum power output of the engine.

(5 marks)

(b) Find the maximum acceleration of the train at the instant when it is travelling at a speed of 20 m s^{-1}. The mass of the engine is 15 tonnes, and the mass of each carriage is 7 tonnes.

(3 marks)

6 (a) A home-made rocket is launched from rest at ground level with time $t = 0$ seconds.

The acceleration of the rocket, measured in metres per square second, is modelled by the equation

$$a = 40 + 6t - t^2 \qquad t \geq 0$$

(i) Write down the acceleration of the rocket at launch.

(ii) Find the acceleration of the rocket after 9 seconds.

(3 marks)

(b) (i) Find an expression for the velocity of the rocket at time *t*.

(ii) Find an expression for the displacement of the rocket at time *t*.

(4 marks)

7 (a) A particle moving along a straight line has velocity $v \text{ m s}^{-1}$, at time t seconds, and its motion is described the equation

$$v = t^2 - 4t + 4$$

(i) Write down the initial velocity of the particle.

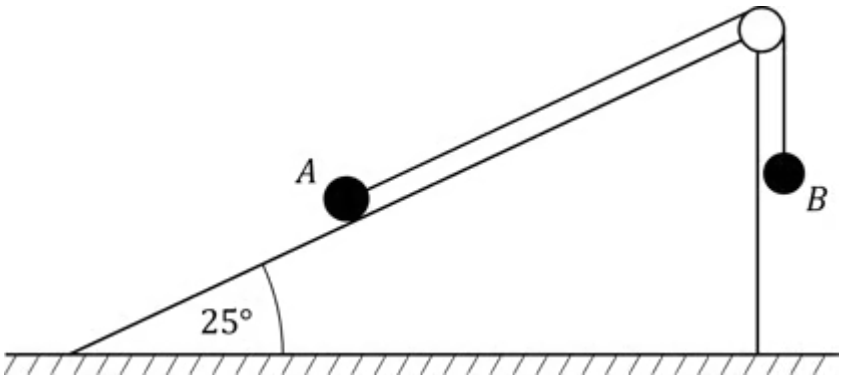
(ii) Find the time at which the particle is instantaneously stationary.

(3 marks)

(b) Show that the acceleration of the particle is negative for the first 2 seconds of its motion.

(2 marks)

8 Two particles A and B, of masses 2.7 kg and 2.2 kg respectively, are connected by means of a light inextensible string. Particle A is held motionless on a rough fixed plane inclined at 25° to the horizontal. The string passes over a smooth light pulley fixed at the top of the plane so that B is hanging vertically downwards as shown in the diagram below:



The string between A and the pulley lies along a line of greatest slope of the plane, and B hangs freely from the pulley. The coefficient of friction between particle A and the plane is μ.

The system is released from rest with the string taut. Given that particle B descends 1.82 m in the first 3 seconds after it is released, find the value of μ.

(8 marks)