A Level · CIE · Maths

50 mins 8 questions

Practice Paper 4 (Mechanics)

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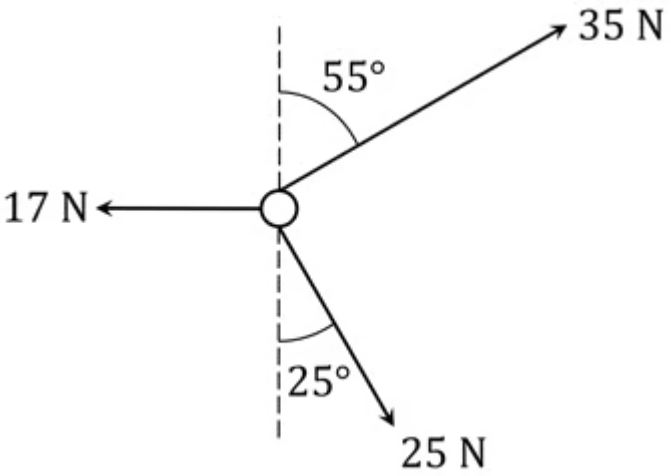
Total Marks /50

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



Find the magnitude and direction of the resultant forces acting on the particle in the horizontal and vertical directions.

(5 marks)

2 (a) A child is pulling a cart along a horizontal path by means of a horizontal rope attached to its front end. The cart has a total mass of 15 kg, and as it moves it experiences a constant resistance to motion of magnitude 2 N. The cart starts at rest and accelerates at a constant rate, and after 5 seconds it has reached a speed of $2\ \text{m s}^{-1}$.

Find:

the acceleration of the cart

(3 marks)

(b) the tension in the rope.

(2 marks)

3 (a) As part of a stage show, a singer is lifted up into the air by a cable attached to a special harness. The singer has a mass of 54 kg, and at the start of the lift is standing stationary on the floor. The singer accelerates vertically upwards at a constant rate, and after 2 seconds has reached a height of 3 metres.

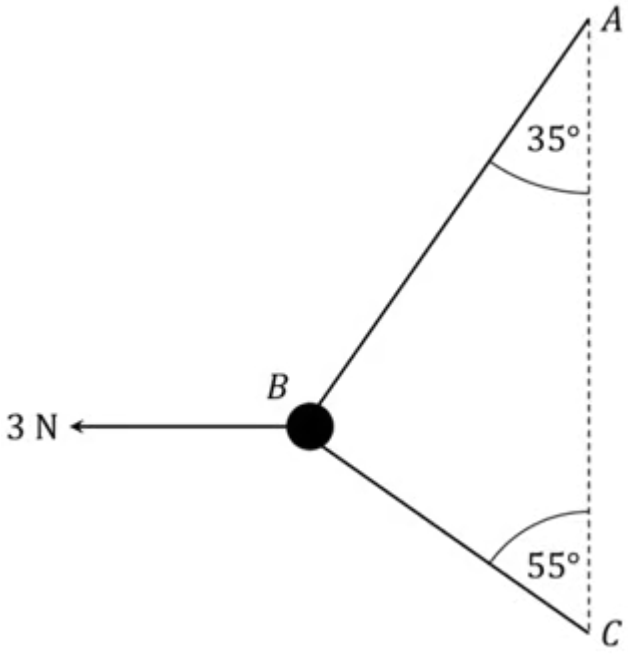
By using the appropriate *suvat* formula, determine the acceleration experienced by the singer during the lift.

(3 marks)

(b) Find the tension in the cable during the lift.

(2 marks)

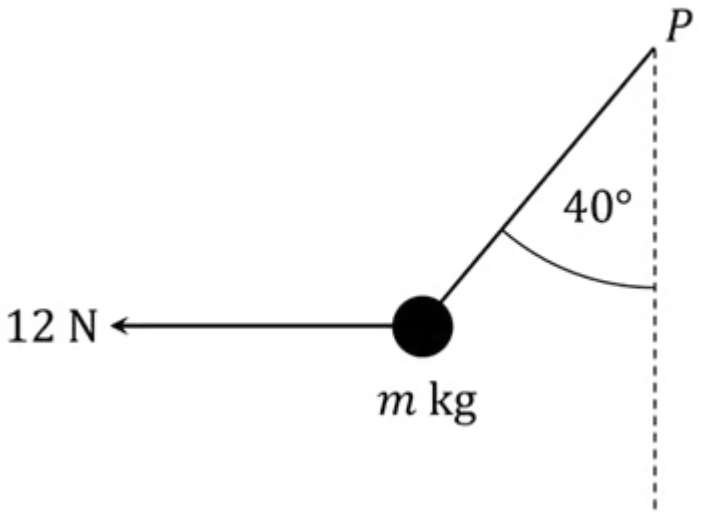
4 A smooth bead B with a mass of m grams has been threaded onto a light inextensible string. The ends of the string are fixed to two points A and C, where A is vertically above C. The bead is held in equilibrium by a horizontal force of 3 N, with sections AB and BC of the string making angles of $35°$ and $55°$ respectively with the vertical as shown in the diagram below:



Find the value of m.

(6 marks)

5 A particle of mass m kg is suspended by a light inextensible string, with the other end of the string attached to a fixed point P. With the string at an angle of $40°$ to the vertical, equilibrium is maintained by a horizontal force of 12 N which acts on the particle as shown in the diagram below:



Find

(i) the tension in the string
(ii) the value of m.

(5 marks)

6 (a) A bullet train has a maximum acceleration of $0.72\ \text{m s}^{-2}$.

One such train leaves a station at time $t = 0$ seconds and its displacement, s m, from the station is modelled using the equation

$$s = \frac{3}{200}t^3 \qquad 0 \leq t \leq 8$$

Show that it takes 8 seconds for the bullet train to reach its maximum acceleration.

(4 marks)

(b) After reaching its maximum acceleration the bullet train continues to accelerate at that rate until its velocity reaches its maximum of $75\ \text{m s}^{-1}$.

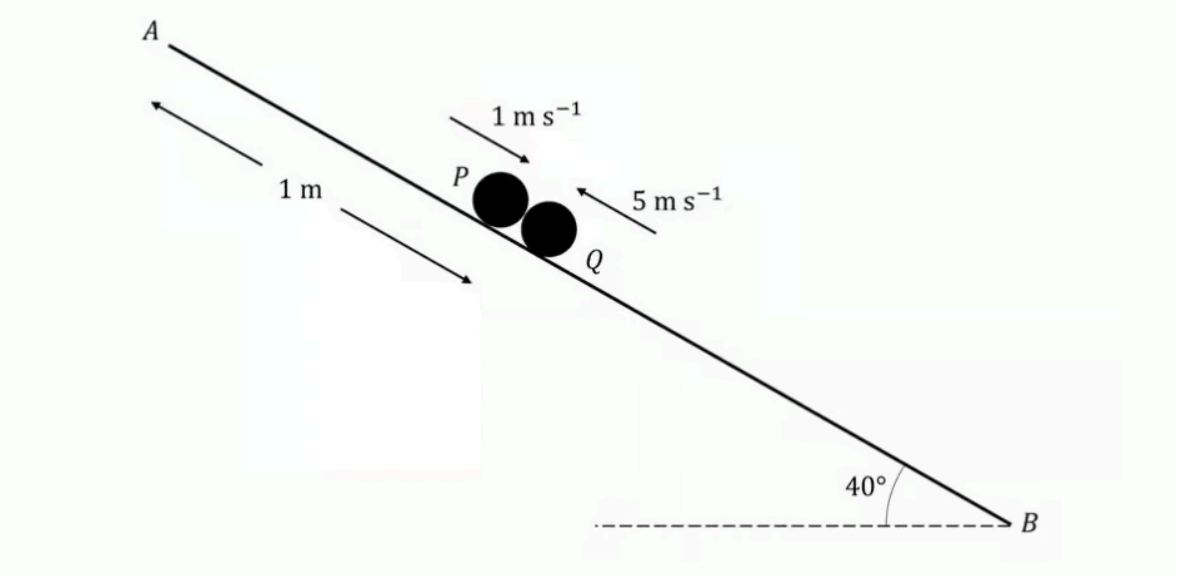
How long does it take for this increase in velocity to happen?

(3 marks)

(c) Once reaching its maximum velocity, the bullet train continues at this velocity for 10 minutes. Find the displacement of the train from the station at this time, giving your answer in kilometres to 3 significant figures.

(3 marks)

7 In this question, take $g = 10\,\text{m s}^{-2}$.



AB is a line of greatest slope, of length 4 m, on a smooth plane inclined at 40° to the horizontal. Particle P of mass 0.4 kg is projected down the slope from the point A and particle Q of mass 0.33 kg is projected up the slope from the point B. When P has speed 1 m s^{-1} and Q is moving up the slope with speed 5 m s^{-1}, the particles collide directly at a point 1 m down the slope from A, as shown in the diagram above. Immediately after the collision, the direction of motion of Q is reversed and it has speed 1 m s^{-1}.

Show that P reaches the top of the slope, A, in the subsequent motion.

(7 marks)

8 The engine of a car with mass 800 kg has a maximum power output of 45 kW. The car is travelling on a straight horizontal road and is experiencing a resistance to motion that is proportional to the car's speed. Find the maximum possible acceleration of the car at the instant when it is travelling at a speed of 25 m s^{-1} given that the car's maximum speed when on the straight horizontal road is 36 m s^{-1}.

(7 marks)