AS · CIE · Maths

50 mins 7 questions

Practice Paper 4 (Mechanics)

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Total Marks /50

1 (a) Two objects A and B have masses 0.6 kg and 1.4 kg respectively. They are moving towards each other in opposite directions in a straight line on a smooth horizontal plane. The objects collide directly and coalesce to form an object C. Immediately before the collision, A is moving with speed 8 m s^{-1} and B is moving with speed 6 m s^{-1}.

By modelling the objects as particles, find the speed and direction of motion of C after the collision.

(3 marks)

(b) At the instance that object C is moving with speed $u\ m\ s^{-1}$, the magnitude of its momentum is 13 N s.

Find the value of u.

(1 mark)

2 (a) A bus of mass 2400 kg moves forwards on a straight horizontal road, and it travels with its maximum speed of 30 m s^{-1}. There is a constant resistive force of 2000 N acting on the bus.

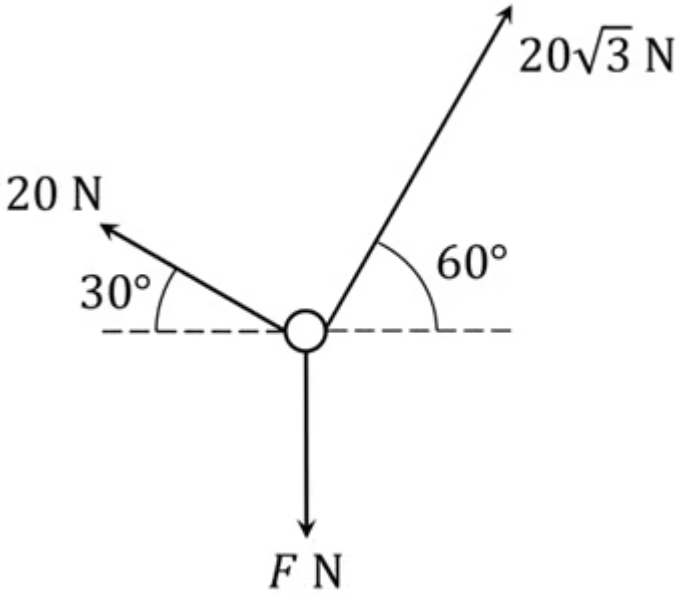
Find the maximum power that the engine of the bus can produce.

(5 marks)

(b) Find the maximum acceleration of the bus at the instant when it is travelling at a speed of 10 m s^{-1}.

(3 marks)

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



Show that the resultant force on the particle in the horizontal direction is zero.

(3 marks)

(b) Given that the particle is in equilibrium, find the exact value of F.

(3 marks)

4 (a) The acceleration, $a \text{ m s}^{-2}$, of a particle moving in a straight line at time t seconds is given by $a = 4t - 7$ for $0 \leq t \leq 6$. Initially the velocity of the particle is 3 m s^{-1}.

Find the time(s) when the particle is instantaneously at rest.

(4 marks)

(b) Find the exact total distance travelled by the particle in the first 6 seconds of motion.

Show your method clearly.

(5 marks)

5 (a) A child has connected two toy wagons together with a light horizontal rod and is pushing them along a horizontal level track. Each wagon has a mass of $11.2\ \text{kg}$, and the resistance to motion of each wagon is modelled as a constant force of P N.

The child pushes on the rearmost wagon with a constant horizontal force of $16.6\ \text{N}$ and the wagons experience a forward acceleration of $0.25\ \text{m s}^{-1}$.

Find:

the value of the constant P

(3 marks)

(b) the thrust in the connecting rod.

(2 marks)

6 (a) A box of mass 4 kg slides down the line of greatest slope on a ramp inclined at $\alpha°$ to the horizontal with constant acceleration 2 m s^{-2}. Two markers on the ramp are set 7 metres apart and the box slides past the second marker exactly 2 seconds after sliding past the first.

Show that the box passes the first marker with speed 1.5 m s^{-1} and find the speed of the box as it passes the second marker.

(2 marks)

(b) The work done against friction on the box as it slides between the two markers is 84 J. Find,

i) the magnitude of the frictional force,

ii) the value of the angle, α,

iii) the work done against gravity during this period of time.

(5 marks)

7 (a) A particle of mass m kg is projected up a rough plane which is inclined at an angle of $\theta°$ to the horizontal. It is projected up the line of greatest slope with an initial velocity of u metres per second, and it comes to instantaneous rest in t_1 seconds after moving a distance of s metres up the slope. The coefficient of friction between the particle and the slope is μ.

Show that:

(i) $$t_1 = \frac{u}{g(\sin\theta + \mu\cos\theta)}$$

(ii) $$s = \frac{u^2}{2g(\sin\theta + \mu\cos\theta)}$$

(7 marks)

(b) After coming to instantaneous rest, the particle begins to slide back down the slope, and after t_2 seconds it has returned to its starting point.

Find an expression for t_2 in terms of u, g, μ and θ.

(4 marks)