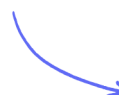


Practice Paper 4 (Mechanics)

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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 $u\text{ m s}^{-1}$, 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.

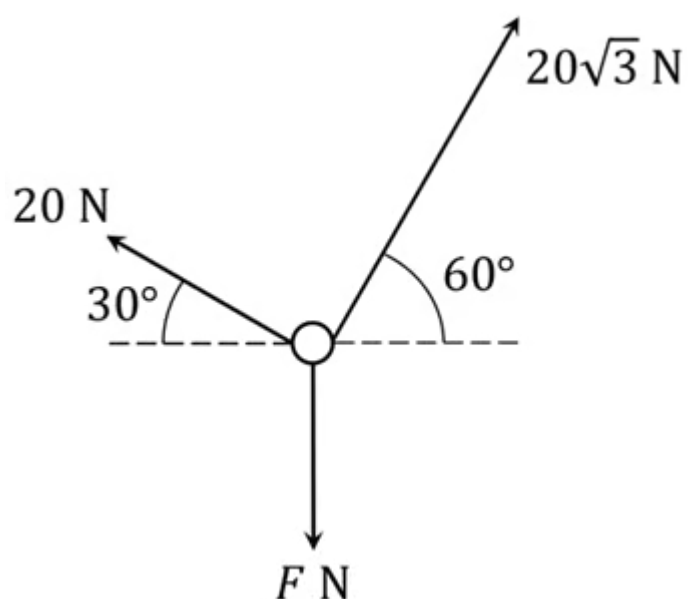
Find the maximum power that the engine of the bus can produce.

(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 kg , and the resistance to motion of each wagon is modelled as a constant force of $P \text{ N}$.

The child pushes on the rearmost wagon with a constant horizontal force of 16.6 N and the wagons experience a forward acceleration of 0.25 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 α° 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 θ° 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:

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

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

(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)