

E. Problems

1. A constant retarding force of 50 N is applied to a body of mass 20 kg moving initially with a speed of 15 ms^{-1} . How long does the body take to stop? [NCERT]
[Ans: 6 s]
2. A train of mass 200 tons moving at a speed of 36 kmph switches off the engine and comes to rest in $1/2 \text{ km}$. Find the resistance offered. [Ans: 20 kN]
3. A car weighing 2 tons moving at the rate of 54 kmph is brought to rest in 30 s. Find the resistance offered. [Ans: 1000 N]
4. A bullet of mass 0.01 kg moving at a speed 100 ms^{-1} strikes a wooden plank of thickness 0.1 m and emerges with a velocity 25 ms^{-1} . Find the resistance offered by the plank assuming it to be uniform. [Ans: 468.75 N]
5. A bullet of mass 0.06 kg moving with a speed of 500 ms^{-1} is brought to rest in 0.01 s. Find the impulse and the average force of the blow. [Ans: 30 Ns; 3000 N]
6. A jet of water is projected against a wall so as to strike it normally. If the velocity of the jet is 20 ms^{-1} and 50 kg of water strikes the wall every second, what force will be exerted against the wall (a) when water does not rebound (b) when it rebounds with a velocity 2.5 ms^{-1} ? [Ans: 1000 N; 1125 N]
7. Bullets are fired by a machine gun into a target at the rate of 500 per minute. If each bullet weighs 0.01 kg and the bullets reach the target with a velocity 600 ms^{-1} , calculate the thrust exerted on the target. [Ans: 50 N]
8. A machine gun fires 210 bullets per minute each weighing 0.02 kg with a speed of 500 ms^{-1} . Find the force of reaction on the support. [Ans: 35 N]
9. A shot weighing 1 kg is fired from a gun weighing 5 ton with a velocity 1000 ms^{-1} . Find the velocity of recoil. Also calculate the force required to stop the gun in a distance of 0.25 m. [Ans: 0.2 ms^{-1} ; 400 N]
10. Masses 0.3 kg and 0.26 kg are hung at the ends of a light string passing over a smooth pulley. After the system is in motion for 4 s from start the string snaps. How much higher the smaller mass will rise? ($g = 9.8 \text{ ms}^{-2}$) [Ans: 0.4 m]
11. Two billiard balls each of mass 0.05 kg moving in opposite directions with a speed of 6 ms^{-1} each collide and rebound with the same speed. What is the impulse imparted to each ball due to the other? [NCERT]
[Ans: 0.6 kgms^{-1}]
12. A trolley of mass 2 kg is pulled along a table by a string attached to a mass of 0.025 kg hanging down over a pulley. The trolley is observed to move 2.16 m in 6 seconds, starting from rest. Find the value of g . [Ans: 9.72 ms^{-2}]

13. A hammer weighing 3 kg moving with a velocity 10 ms^{-1} strikes horizontally against the head of a spike and drives it into a block of wood. If the hammer comes to rest in 0.025 seconds, find (1) impulse and (2) average driving force on the spike. (Neglect mass of the spike).

[Ans: 30 Ns; 1200 N]

14. A bullet of mass 0.04 kg moving with a speed of 90 ms^{-1} enters a heavy wooden block and is stopped after a distance of 60 cm. What is the average resistive force exerted by the block on the bullet?

[NCERT]

[Ans: 270 N]

15. A block of mass 25 kg is raised by a 50 kg man in two different ways as shown in the figure. What is the action on the floor by the man in the two cases?

[NCERT]

Hint: Case (a) $R = Mg + F$. (b) $R = Mg - F$.

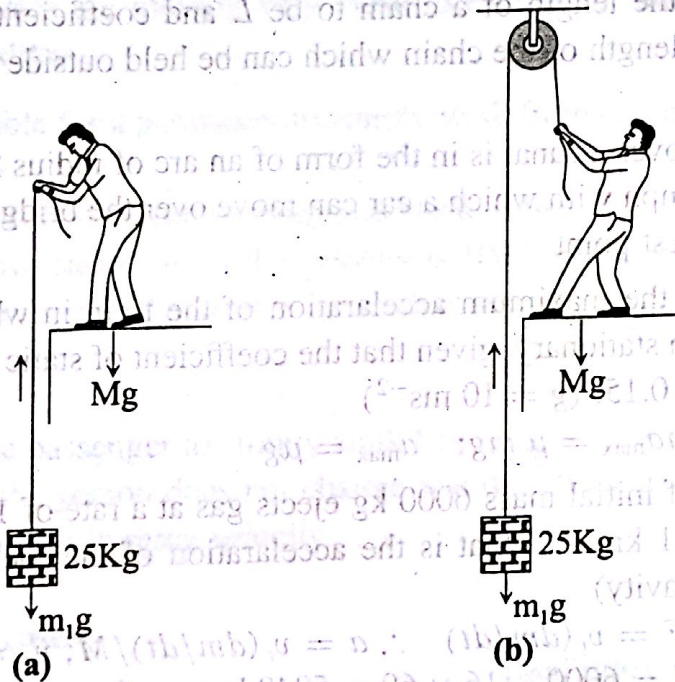


Fig. 46

16. A body of mass 1 kg is initially at rest. It explodes into three fragments of masses in the ratio 1 : 1 : 3. Two pieces of equal masses fly off perpendicular to each other with a speed of 30 ms^{-1} each. What is the velocity of the heavier mass?

[Ans: 735 N, 245 N]

17. Calculate the force required to pull a train of mass 200 tons up an incline of 5° at a uniform speed of 72 km/h. Coefficient of friction = 0.02.

[Ans: 14.14 ms^{-1}]

[Ans: $2.099 \times 10^5 \text{ N}$]

18. Find the distance travelled by a body before coming to rest if it was moving with a velocity 36 km/h. Coefficient of kinetic friction = 0.2.

[Ans: 25.51 m]

19. A block of mass 4 kg is placed on a wooden plank of length 1.5 m which is lying on the ground. The plank is lifted from one end so that it becomes inclined. It is noted that when the vertical height of the top end of the plank is 0.5 m the box begins to slide. Find the coefficient of friction between the box and the plank.

[Ans: 0.35]

20. A neutron having a mass 1.67×10^{-27} kg and moving at 10^8 ms^{-1} collides with a deuteron of mass 3.34×10^{-27} kg at rest and stick together. Calculate the speed of the combination.

[Ans: 3.3×10^7 ms^{-1}]

21. A body of mass 20 kg travelling with a velocity 4 ms^{-1} strikes on another body of mass 10 kg coming in the opposite direction with a velocity 6 ms^{-1} . After collision the velocity of the first is reduced to 0.5 ms^{-1} . Determine the velocity of the second body.

[Ans: 1 ms^{-1}]

22. On a planet X a stone falls 48 m in 4 seconds. (a) What is the value of g on the planet? (b) What is the weight of a 10 kg mass on the planet X?

[Ans: 6 ms^{-2} ; 60 N]

23. Assuming the length of a chain to be L and coefficient of friction μ , calculate the maximum length of the chain which can be held outside a table without sliding?

[Ans: $\mu L / (\mu + 1)$]

24. A railway over a canal is in the form of an arc of radius 20 m. What is the maximum speed in kmph with which a car can move over the bridge without leaving the ground at the highest point

[Ans: 50.4 km/h]

25. Determine the maximum acceleration of the train in which a box lying on its floor will remain stationary, given that the coefficient of static friction between the box and the floor is 0.15. ($g = 10$ ms^{-2})

[NCERT]

Hint: $ma_{\max} = \mu mg$; $a_{\max} = \mu g$

[Ans: 1.5 ms^{-2}]

26. A rocket of initial mass 6000 kg ejects gas at a rate of 16 kg/s with constant relative speed of 11 km/s. What is the acceleration of the rocket a minute after the blast? (Neglect gravity)

[NCERT]

Hint: $F = v_r(dm/dt)$ $\therefore a = v_r(dm/dt)/M$; $v_r = 11 \times 10^3$ m/s; $(dm/dt) = 16$ kg/s; $M = 6000 - 16 \times 60 = 5040$ kg; $a = ?$

[34.9 m/s^2]

27. The driver of a three-wheeler moving with a speed of 36 km/h sees a child standing in the middle of the road and brings his vehicle to rest in 4.0 s just in time to save the child. What is the average retarding force of the vehicle? (The mass of the vehicle is 400 kg and the mass of the driver is 65 kg)

[NCERT]

Hint: $a = (v - u)/t = (0 - 10)/4 = -2.5$ m/s^2 ;

$F = ma = 465 \times -2.5 = ?$

[Ans: 1162.5 N]