FORCE AND LAWS OF MOTION

NCERT / CBSE TEXTBOOK EXERCISE QUESTIONS SOLVED

Q.1: An object experiences a net zero external unbalanced force. Is it possible for the object to be travelling with the non-zero velocity? If yes, state the conditions that must be placed on the magnitude and direction of the velocity. If no, provide a reason.

Ans:

Yes, an object may travel with a non-zero velocity even when the net external force on it is zero. A rain drop falls down with a constant velocity. The weight of the drop is balanced by the up thrust and the velocity of air. The net force on the drop is zero.

Q.2: *When a carpet is beaten with a stick, dust comes out. Explain, why?*

Ans:

When a carpet is beaten with a stick it comes into motion at once. But the dust particles continue to be at rest due to inertia and get detached from the carpet.

Q.3: *Why is it advised to tie any luggage kept on the roof of a bus with a rope?*

Ans:

Due to sudden jerks or due to the bus taking sharp turns on the road, the luggage may fall down from the roof because of its tendency to continue to be either at rest or in motion in the same direction (inertia of motion).

To avoid this, it advised to tie the luggage kept on the roof of a bus with a rope.

Q.5: A truck starts from rest and rolls down a hill with constant acceleration. It travels a distance of 400 m in 20 sec. Find its acceleration. Also find the force acting on it if its mass is 7 metric tones.

Ans:

Here, u = 0, s = 400 m, t = 20 s
We know, $s = ut + \frac{1}{2} at^2$
Or, $400 = 0 + \frac{1}{2} a (20)^2$
Or, $a = 2\ ms^{-2}$
Now, m = 7 MT
= 7000 kg,
a = $2\ ms^{-2}$

Or, F = ma
= 7000 x 2
= 14000 N **Ans.**

Q.6: A stone of 1 kg is thrown with a velocity of 20 ms^{-1} across the frozen surface of a lake and comes to rest after travelling a distance of 50 m. What is the force of friction between the stone and the ice?

Ans:

Here, m = 1 kg, u = 20 ms^{-1} v = 0, s = 50 m
Since, $v_2 - u_2 = 2as$,
Or, $0 - 20^2 = 2a \times 50$,
Or, $a = -4\ ms^{-2}$
Force of friction, F = ma = – 4N *Ans*.

Q.7: An 8000 kg engine pulls a train of 5 wagons, each of 2000 kg along a horizontal track. If the engine exerts a force of 40000 N and the track offers a friction force of 5000 N, then calculate:

(a) The net accelerating force;
(b) The acceleration of the train; and
(c) The force of wagon 1 on wagon 2.

Ans:

Total mass, m = mass of engine + mass of wagons
Or, m = 8000 + 5 x 2000
= 18000 kg.

(a) The net accelerating force,
F = Engine force - Frictional force
Or, F = 40000 - 5000
= 35000 N

(b) The acceleration of the train,
a = F ÷ m
= 35000 ÷ 18000
= 1.94 ms^{-2}.

(c) The force of wagon 1 on wagon 2
= The net accelerating force - (mass of wagon x acceleration)
= 35000 - (2000 x 1.94)
= 31111.2 N *Ans*.

Q.10: Using a horizontal force of 200 N, we intend to move a wooden cabinet across a floor at constant velocity. What is the force of friction that will be exerted on the cabinet?

Ans:

The cabinet will move with constant velocity only when the net force on it is zero. Therefore, force of friction on the cabinet = 200 N, in a direction opposite to the direction of motion of the cabinet.

Q.11: Two objects each of mass 1.5 kg are moving in the same straight line but in opposite directions. The velocity of each object is 2.5 ms^{-1} before the collision during which they stick together. What will be the velocity of the combined object after collision?

Ans:

Here, $m_1 = m_2 = 1.5$ kg,
$u_1 = 2.5\ ms^{-1}$
$u_2 = -2.5\ ms^{-1}$
Let v be the velocity of the combined object after collision.
By the law of conservation of momentum,

Total momentum after collision = Total momentum before collision,
Or, $(m_1 + m_2)\ v = m_1u_1 + m_2u_2$
Or, $(1.5 + 1.5)\ v = 1.5 \times 2.5 + 1.5 \times (-2.5)$
[negative sign as moving in opposite direction]
Or, v = 0 ms^{-1} *Ans*.

Q.12:

According to the third law of motion when we push on an object, the object pushes back on us with an equal and opposite force. If the object is a massive truck parked along the roadside, it will probably not move. A student justifies this by answering that the two opposite and equal forces cancel each other. Comment on this logic and explain why the truck does not move.

Ans: The logic is that Action and Reaction always act on different bodies, so they can not cancel each other. When we push a massive truck, the force of friction between its tyres and the road is very large and so the truck does not move.

Q.13:

A hockey ball of mass 200 gm travelling at 10 ms^{-1} is struck by a hockey stick so as to return it along its original path with a velocity at 5 ms^{-1}.

Calculate the change of momentum occurred in the motion of the hockey ball by the force applied by the hockey stick.

Ans:

Change in momentum = m (v - u)
= 0.2 (–5 - 10)
= –3 kg ms^{-1}.

(The negative sign indicates a change in direction of hockey ball after it is struck by hockey stick. Magnitude of change in momentum = 3 kg ms^{-1}).

Q.16:

An Object of mass 100 kg is accelerated uniformly from a velocity of 5 ms^{-1} to 8 ms^{-1} in 6 sec. Calculate the initial and final momentum of the object. Also find the magnitude of the force exerted on the object.

Ans:

Here,

m = 100 kg,
u = 5 ms^{-1},
v = 8 ms^{-1},
t = 6 sec.

Initial momentum, p_1 = mu = 500 kg ms^{-1}
Final momentum, p_2 = mv = 800 kg ms^{-1}

The magnitude of the force exerted on the object,

F = $(p_2 - p_1) \div t$
= (800 - 500) ÷ 6
= 50 N *Ans*.