CHAPTER 2 FORCE AND LAWS OF MOTION

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Solution 2:
The product of mass and velocity of a body is called momentum.

Solution 2:
Momentum is the measure of quantity of motion of a body

Solution 3:
The SI unit of momentum is kilogram meters per second(kg.m/s)

Solution 4:
Momentum is a vector quantity and is dirceted along the direction of velocity.

Solution 5:
The total momentum of the bullet and the gun before firing would be zero because velocities of both of them will be zero.

Solution 6:
Momentum has its SI unit as kilogram meters per second(kg.m/s)

Solution 7:
Momentum of a body of mass 'm' and velocity 'v' will be
p = m x v

Solution 8:
Balanced forces cannot produce motion in a body but can its shape.

Solution 9:
Frictional force slows down a moving bicycle when we stop pedaling it.

Solution 10:
The given statement is false.

Solution 11:
Force of gravity causes this change in speed.

Solution 12:
Inertia is the property of bodies to resist a change in their state of rest or motion

Solution 13:
Newton's first law of motion is also known as Galileo's law of inertia.

Solution 14:
Object B has more inertia. Since mass is a measure of inertia of a body and object B has greater mass, so it will have greater inertia.

Solution 15:
Isaac Newton gave the laws of motion.

Solution 16:
Force is a vector quantity.

Solution 17:
The speed of the running bull should be multiplied with its mass to get its momentum.

Solution 18:
a) Mass
b) forward
c) backward
d) inertia
e) friction; air

Solution 19:
Since the speed of tennis ball and cricket ball is same, the momentum of cricket ball will be higher due to its mass being greater than mass of tennis ball. So, less force is required to stop a tennis ball than to stop a cricket ball.

Solution 20:
p = m x v
This equation signifies that momentum of a body is the product of its mass and its velocity.
Here, p is momentum of the body
m is the mass of the body
v is the velocity of the body.

Solution 21:
A karate player can break a pile of tiles with a single blow because he strikes the pile with his hand very fast. In doing so, the large momentum of his hand is reduced to zero in a very short time. This exerts a large force on the pile of tiles which is sufficient to break them apart.

Solution 22:
Mass of the toy car,
m = 200 g = 0.2 kg
Speed, v = 5 m/s
Momentum, p = m x v
= 0.2 x 5 = 1 kg.m/s

Solution 23:
Mass of car = 1500 kg
Velocity v_1 = 36 km/hr = 10 m/s
Momentum p_1 = 1500 x 10 = 15000 kg.m/s
Velocity v_2 = 72 km/hr = 20 m/s
Momentum p_2 = 1500 x 20 = 30000 kg.m/s
Change in momentum = p_2-p_1= 30000 – 15000 = 15000 kg.m/s

Solution 24:
Mass of the body, m = 25 kg
Momentum p = 125 kg.m/s
p = m x v
Mass of the body, m = 25 kg
Momentum p = 125 kg.m/s
p = m x v

$$v = \frac{P}{m} = \frac{125}{25} = 5 \text{ m/s}$$

Velocity of the body is 5 m/s

Solution 25:
a) Mass of elephant = 2000kg
Velocity = 5 m/s
Momentum = 2000 x 5 = 10000 kg.m/s

b) Mass of bullet = 0.02 kg
Velocity = 400 m/s
Momentum = 0.02 x 400 = 8 kg.m/s

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Solution 26:
Balanced forces can change the shape of the object. For example, when a balloon is pressed between hands, then balanced forces (equal and opposite forces) act on the balloon due to which the shape of the balloon changes.

Solution 27:
Inertia of motion is the property of a body due to which it resists a change in its state of uniform motion. For eg., if there is no air resistance and no friction to oppose the motion of a moving bicycle, it will go on moving forever.

Solution 28:
Newton's first law of motion states that a body at rest will remain at rest, and a body in motion will continue in motion in a straight line with a uniform speed unless it is compelled by an external force to change its state of rest or of uniform motion. For example, a book lying on a table remains on the table unless we lift it with the force of our hands. And, on a frictionless surface, a moving car continues to be in the state of motion until brakes are applied on it.

Solution 29:
Inertia of a body depends on its mass. A cricket ball has more inertia than a rubber ball of the same size because it has more mass than the rubber ball.

Solution 30:
When a bus starts suddenly, its passengers tend to fall backwards because due to their inertia, the passengers tend to remain in a state of rest even when the bus starts moving.

Solution 31:
When a bus stops suddenly, its passengers tend to fall forward because due to their inertia, the passengers tend to remain in a state of motion even though the bus has come to rest.

Solution 32:
When a hanging carpet is beaten with a stick, the carpet moves to and fro with the force of the stick while the dust particles remain in their state of rest on account of their inertia and thus dust particles separate out from the carpet.

Solution 33:
When a tree is shaken, the tree moves to and fro while the fruits and leaves remain in their state of rest on account of their inertia and thus fruits and leaves separate from the tree and fall from the tree.

Solution 34:
It is dangerous to jump out of a moving bus because the jumping man, who is moving with the high speed of the bus would tend to remain in state of motion due to inertia even on falling to the ground and get hurt due to resistance offered by the ground.

Solution 35:
Mass of car, m = 10 kg
Momentum = m x v
a) Velocity, v = 5 m/s Momentum = 10 x 5 = 50 kg.m/s

b) Velocity, v = 20 cm/s = 0.2 m/s Momentum = 10 x 0.2 = 2 kg.m/s

c) Velocity, v = 36km/hr = 10 m/s Momentum = 10 x 10 = 100 kg.m/s

Solution 36:
a) Momentum is the physical quantity which is the measure of the quantity of motion of a moving body. It depends on mass and velocity of the body.

b) Mass of body = 5 kg
Velocity v_1 = 20 m/s
Momentum p_1 = 20 x 5 = 100 kg.m/s
Velocity v_2 = 0.2 m/s
Momentum p_2 = 5 x 0.2 = 1 kg.m/s
Change in momentum = $p_2 - p_1$ = 1-100 = -99 kg.m/s (Negative sign shows that momentum decreases)

Solution 37:
a) Force is an influence which tends to set a stationary body in motion or stop a moving body; or which tends to change the speed and direction of a moving body; or which tends to change the shape and size of a body.

b) Various effects of force are
i) A force can move a stationary body.
ii) A force can stop a moving body.
iii) A force can change the speed of a moving body.
iv) A force can change the direction of a moving body.
v) A force can change the shape and size of a body.

Solution 38:
a) Kicking a stationary football.
b) Applying brakes to a moving bicycle.
c) Pressing an accelerator to speed up a moving car.
d) A moving cricket ball hit by a bat.
e) Flattening of dough by a rolling pin to make chapatis.

Solution 39:
a) If the resultant of all the forces acting on a body is zero, the forces are called

balanced forces. These forces do not change the state of rest or of uniform motion of a body but can change the shape of the body. For example, when a balloon is pressed between hands, then balanced forces (equal and opposite forces) act on the balloon due to which the shape of the balloon changes.
If the resultant of all the forces acting on a body is not zero, the forces are called unbalanced forces. These forces change the state of rest or of uniform motion of a body. For eg., if we push a toy car lying on the ground, it starts moving due to the unbalanced force exerted by our hands.

b) When we press a rubber ball between our hands, balanced forces acts on it and hence its shape changes.

Solution 40:
a) When a bus takes a sharp turn, the passengers tend to fall sideways because of their inertia or their tendency to continue moving in a straight line.
b) Road accidents at high speeds are much worse than road accidents at low speeds because the momentum of vehicles at high speeds is very high and causes a lot of damage to the vehicles and injuries to the passengers during collision.

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Solution 51:
The wall will receive equal momentum from both the balls because both balls have equal mass and velocity.

Solution 52:
In this case, the bicycle has been compelled to change its state of motion by the external force of air resistance and friction. If there were no air resistance and no friction to oppose the motion of the bicycle, then according to the first law of motion, the bicycle would go on moving forever.

Solution 53:
Mass of ball = 500 g = 0.5 kg
Initial velocity = 10 m/s
1. Initial momentum = 0.5 x 10 = 5 kg.m/s
2. Velocity at the highest point = 0 m/s

Momentum at the highest point = 0.5 x 0 = 0 kg.m/s

Solution 54:
The two forces acting on the car are force of friction and air resistance. Force of friction contributes more to slow down and stop the car.

Solution 55:
a) X are unbalanced force.
b) Y are balanced forces.

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Solution 1:
Force corresponds to the rate of change of momentum.

Solution 2:
The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts.

Solution 3:
The SI unit of force is newton(N)

Solution 4:
A newton force is defined as that force which when acting on a body of mass of 1 kg produces an acceleration of $1 m/s^2$ in it.

Solution 5:
Force acting on a body is directly proportional to the acceleration produced in the body.

Force acting on a body is directly proportional to the acceleration produced in the body.

$F \propto a$

Solution 6:
Acceleration remains same since

$$a = \frac{F}{m}$$

Now if force is doubled i.e. 2F and mass is doubled i.e. 2m

Then acceleration $a = \frac{2F}{2m} = \frac{F}{m}$

Acceleration remains same since
Now if force is doubled i.e. 2F and mass is doubled i.e. 2m
Then acceleration

Solution 7:
Newton is the SI unit of force.

Solution 8:
Jet airplanes work on the principle of conservation of momentum.

Solution 9:
Rockets work on the principle of conservation of momentum.

Solution 10:
True, because rocket does not require air for obtaining uplift or for burning its fuel.

Solution 11:
Mass, m = 1 kg
Acceleration, a = $1 m/s^2$
Force F = m x a = 1 x 1= 1N

Solution 12:
Force F =5 N
Mass m = 10 kg

Force F =5 N
Mass m = 10 kg
Acceleration $a = \frac{F}{m} = \frac{5}{10} = 0.5\ m/s^2$

Solution 13:
The force exerted by the floor on her = the downward force exerted by the girl =250 N
This is due to Newton's third law of motion which states that to every action there is an equal and opposite reaction.

$a = \frac{F}{m}$

Solution 14:
Less mass of the small car makes it easier to accelerate a small car than a large car because acceleration is inversely
proportional to mass of the car

Solution 15:
a) Equal; opposite
b) Vector; kg.m/s
c) Acceleration; rate; momentum
d) Magnitude; directions
e) Momentum; force

Solution 16:
Force is directly proportional to the product of 'mass' of the body and the 'acceleration' produced in the body by the action of force.
F = m x a
where F is the force applied on the body
m is the mass of the body
a is the acceleration produced in the body

Solution 17:
To take boat away from the bank of a river, the boatman pushes the bank with the oar. The bank exerts an equal and opposite force on the boat which makes the boat move forward away from the bank.

Solution 18:
Gunman gets a jerk on firing a bullet because when a bullet is fired from a gun, the force sending the bullet forward is equal to the force sending the gun backwards but due to high mass of the gun, it moves only a little distance backwards giving a jerk to the gunman.

Solution 19:
To make the cart move, the horse bends forward and pushes the ground with its feet. When the forward reaction to the backward push of the horse on the ground is greater than the opposing frictional forces of the wheels, the cart moves.

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Solution 20:
A rockets works on the principle of action and reaction. In a rocket, the hot gases produced by the rapid burning of fuel rush out of a jet at the bottom of the rocket at a very high speed. The equal and opposite reaction force of the downward going gases pushes the rocket upward with a great speed.

Solution 21:
Action and reaction act on two different bodies. Action and reaction are equal in magnitude but they act in opposite directions and there is simultaneous action and reaction.

Solution 22:
When a man jumps out from a boat, the boat moves backwards due to the fact that to step out of the boat, the man presses the boat with his foot in the backward direction. The push of the man on the boat is action. The boat exerts an equal force on the man in the forward direction and since the boat is not fixed and is floating, it moves backwards due to the action force exerted by the man.

Solution 23:
It becomes very difficult to walk on a slippery road because of the fact that on a slippery road, the friction is much less, and we cannot exert a backward action force on slippery ground which would produce a forward reaction force on us.

Solution 24:
To start his run, a runner bends forward and pushes the ground with his feet in the backward direction. In turn ground exerts a reaction force on the runner in the forward direction which makes him run.

Solution 25:
Mass of bullet, m_1 = 60g = 0.06 kg
Velocity of bullet v_1 = 500 m/s
Mass of gun m_2 = 5 kg
Recoil velocity v_2
According to the law of conservation of momentum
$m_1 \times v_1 = m_2 \times v_2$
$0.06 \times 500 = 5 \times v_2$

Mass of bullet, m_1 = 60g = 0.06 kg
Velocity of bullet v_1 = 500 m/s
Mass of gun m_2 = 5 kg
Recoil velocity v_2
According to the law of conservation of momentum
$m_1 \times v_1 = m_2 \times v_2$
$0.06 \times 500 = 5 \times v_2$

$$v_2 = \frac{0.06 \times 500}{5} = 6 \text{ m/s}$$

Solution 26:
Mass of bullet, m_1 = 10g = 0.01 kg
Velocity of bullet v_1 = 200 m/s
Mass of block with the bullet as bullet gets embedded in it, m_2 = 2+0.01 = 2.01 kg
Recoil velocity v_2

According to the law of conservation of momentum $m_1 \times v_1 = m_2 \times v_2$
$0.01 \times 200 = 2.01 \times v_2$

Mass of bullet, $m_1 = 10g = 0.01$ kg
Velocity of bullet $v_1 = 200$ m/s
Mass of block with the bullet as bullet gets embedded in it, $m_2 = 2+0.01 = 2.01$ kg
Recoil velocity v_2
According to the law of conservation of momentum
$m_1 \times v_1 = m_2 \times v_2$
$0.01 \times 200 = 2.01 \times v_2$

$$v_2 = \frac{0.01 \times 200}{2.01} = 0.99 \text{ m/s}$$

Solution 27:
Mass of the body = 2kg
Initial velocity u = 0
Final velocity v = 30 m/s
Time t = 1 s

Mass of the body = 2kg
Initial velocity u = 0
Final velocity v = 30 m/s
Time t = 1 s

$$\text{Acceleration } a = \frac{v-u}{t} = \frac{30-0}{1} = 30 \text{ m/s}^2$$

Force = m x a = 2 x 30 = 60 N

Solution 28:
Mass of the body = 5 kg
Initial velocity u = 10 m/s
Final velocity v = 35 m/s
Time t = 25 s

Mass of the body = 5 kg
Initial velocity u = 10 m/s
Final velocity v = 35 m/s
Time t = 25 s

$$\text{Acceleration } a = \frac{v-u}{t} = \frac{35-10}{25} = 1 \text{ m/s}^2$$

Force = m x a = 5 x 1 = 5 N

Solution 29:
Mass of the car = 2400 kg
Initial velocity u = 20 m/s
Final velocity v = 0 m/s

Time t = 10 s

Mass of the car = 2400 kg
Initial velocity u = 20 m/s
Final velocity v = 0 m/s
Time t = 10 s

Retardation $a = \frac{v-u}{t} = \frac{0-20}{10} = -2\ m/s^2$

Force = m x a = 2400 x -2 = - 4800 N

Solution 30:
Mass of the body = 20 kg
Initial velocity u = 0 m/s
Final velocity v = 100 m/s
Force F = 100 N

Mass of the body = 20 kg
Initial velocity u = 0 m/s
Final velocity v = 100 m/s
Force F = 100 N

Acceleration $a = \frac{F}{m} = \frac{100}{20} = 5\ m/s^2$

Time $t = \frac{v-u}{a} = \frac{100-0}{5} = 20\ s$

Solution 31:
Mass of the body = 2.5 kg
Initial velocity u = 20 m/s
Final velocity v = 0 m/s
Force F = 10 N

Mass of the body = 2.5 kg
Initial velocity u = 20 m/s
Final velocity v = 0 m/s
Force F = 10 N

Acceleration $a = \frac{F}{m} = \frac{10}{2.5} = 4\ m/s^2$

Since $v < u$, so acceleration will have a negative sign $a = -4\ m/s^2$

Time $t = \frac{v-u}{a} = \frac{0-20}{-4} = 5\ s$

Solution 32:
Mass of the body = 10 kg
Initial velocity u = 4 m/s

Final velocity v = 8 m/s
Time t = 2 s
a) Momentum before force acts p_1= m x u = 10 x 4 = 40 kg.m/s

b) Momentum after force acts p_2 = m x v = 10 x 8 = 80 kg.m/s

c) Gain in momentum for 2 s = p_2-p_1 =40 kg.m/s

Mass of the body = 10 kg
Initial velocity u = 4 m/s
Final velocity v = 8 m/s
Time t = 2 s
a) Momentum before force acts p_1= m x u = 10 x 4 = 40 kg.m/s
b) Momentum after force acts p_2 = m x v = 10 x 8 = 80 kg.m/s
c) Gain in momentum for 2 s = p_2-p_1 =40 kg.m/s

Gain in momentum per second = $\frac{40}{2}$ = 20 kg.m/s

d) Acceleration a = $\frac{v-u}{t} = \frac{8-4}{2} = 2\ m/s^2$

Force = m x a = 10 x 2 =20 N

Solution 33:

Mass of the gun m_1 = 3 kg
Mass of bullet m_2 = 30 g = 0.03 kg
Velocity of bullet v_2 =100 m/s
i) According to the law of conservation of momentum
m_1 x v_1 = m_2 x v_2
3 x v_1= 0.03 x 100

Mass of the gun m_1 = 3 kg
Mass of bullet m_2 = 30 g = 0.03 kg
Velocity of bullet v_2 =100 m/s
i) According to the law of conservation of momentum
m_1 x v_1 = m_2 x v_2
3 x v_1= 0.03 x 100

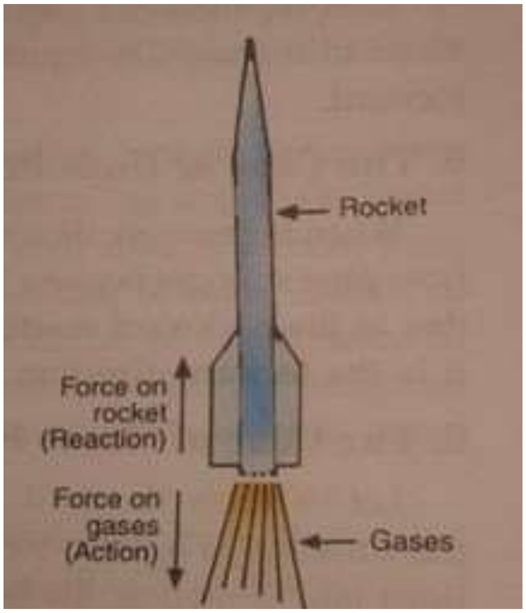
Recoil velocity $v_1 = \frac{100 \times 0.03}{3}$ = 1 m/s

ii) Initial velocity of the gun u = 0 m/s
Final velocity of the gun v = 1 m/s
Time t = 0.003 s

Acceleration a = $\frac{v-u}{t} = \frac{1-0}{0.003} = \frac{1000}{3}\ m/s^2$

Force = m x a =3 x $\frac{1000}{3}$ = 1000 N

Solution 34:



Solution 35:

a) Law of conservation of momentum
b) Newton's second law of motion
c) Newton's third law of motion
d) Newton's first law of motion

Solution 36:

(a) According to Newton's second law of motion: The rate of change of momentum of a body is directly proportional to the applied force, and takes place in the direction in which the force acts.
Consider a body of mass m having initial velocity u. the initial momentum of this body will be mu. Suppose a force F acts on this body for time t causing the final velocity to be v. The final momentum of the body will be mv. Now the change in momentum is mv � mu and the time taken for this change is t. So according to

Newton's second law of motion,

(a) According to Newton's second law of motion: The rate of change of momentum of a body is directly proportional to the applied force, and takes place in the direction in which the force acts.
Consider a body of mass m having initial velocity u. the initial momentum of this body will be mu. Suppose a force F acts on this body for time t causing the final velocity to be v. The final momentum of the body will be mv. Now the change in momentum is mv � mu and the time taken for this change is t. So according to Newton's second law of motion,

$$F \propto \frac{mv-mu}{t}$$

$$\propto \frac{m(v-u)}{t}$$

But $\frac{(v-u)}{t}$ represents change in velocity with time i.e. acceleration 'a'. So by replacing $\frac{(v-u)}{t}$ with a in the above relation, we get

$$F \propto m \times a$$

Thus, the force acting on a body is directly proportional to the product of mass and acceleration produced in the body by the action of the force.
Thus, Newton's second law gives the relationship between force and acceleration.

(b) Mass of the vehicle, m = 1000kg
Initial velocity u = 20 m/s
Final velocity v = 0 m/s
Distance covered before stopping, s = 50 m
Using third equation of motion
$v^2 - u^2 = 2as$
$0^2 - 20^2 = 2 \times a \times 50$
Acceleration, $a = \frac{-400}{2 \times 50} = -4\ m/s^2$

Unbalanced Force = m x a = 1000 x -4 = -4000 N

Solution 37:

a) A player moves his hands backwards while catching a fast ball because a fast moving ball has a large momentum and in stopping this ball, its momentum has to be reduced to zero. Now, when a cricket player moves back his hands on catching the fast ball, then the time taken to reduce the momentum of the ball is increased. So, the rate of change of momentum of ball is decreased and hence a small force is exerted on the hands of the player and the hands of the player do not get hurt.

b) Mass of ball = 150 g = 0.15 kg
Initial velocity u = 30 m/s
Final velocity v = 0 m/s
Time t = 0.05 s

a) A player moves his hands backwards while catching a fast ball because a fast moving ball has a large momentum and in stopping this ball, its momentum has to be reduced to zero. Now, when a cricket player moves back his hands on catching the fast ball, then the time taken to reduce the momentum of the ball is increased. So, the rate of change of momentum of ball is decreased and hence a small force is exerted on the hands of the player and the hands of the player do not get hurt.
b) Mass of ball = 150 g = 0.15 kg
Initial velocity u = 30 m/s
Final velocity v = 0 m/s
Time t = 0.05 s

Acceleration $a = \frac{(v-u)}{t} = \frac{0-30}{0.05} = -6000\ m/s^2$

Force = m x a = 0.15 x 6000 = 90 N

Solution 38:

a) According to Newton's third law of motion: Whenever one body exerts a force on another body, the second body exerts an equal and opposite force on the first body. In other words, to every action, there is an equal and opposite reaction.
Two examples to illustrate this law-
When a man jumps out from a boat, the boat moves backwards. This is due to the fact that to step out of the boat, the man presses the boat with his foot in the backward direction. The push of the man on the boat is action. The boat exerts an equal force in the forward direction and since the boat is not fixed and is floating, it moves backwards due to the action force exerted by the man.
Gunman gets a jerk on firing a bullet from his gun. This is because when a bullet is fired from a gun, the force sending the bullet forward is equal to the force sending the gun backwards but due to high mass of the gun, it moves only a little distance backwards giving a jerk to the gunman.
b) When a fireman directs a powerful stream of water on a fire, the hose pipe tends to go backward due to the reaction force of the water rushing through it in the forward direction at a great speed.

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Solution 39:

a) According to the law of conservation of momentum: When two (or more) bodies act upon one another, their total momentum remains constant (or conserved) provided no external forces are acting. It means that when one body gains momentum, then some other body loses an equal amount of momentum i.e. momentum is neither created nor destroyed.

b)
a. Rocket taking off from the ground The chemicals inside the rocket burn and produce very high velocity blast of hot gases. These gases pass out through the tail nozzle of the rocket in the downward direction with tremendous speed and the rocket moves up to balance the momentum of the gases. The gases have a very high velocity ang hence a very large momentum. An equal momentum is imparted to the rocket in the opposite direction, so that it goes up with a high velocity.
b. Flying of jet aeroplane
In jet aeroplanes, a large volume of gases produced by the combustion of fuel is allowed to escape through a jet in backward direction. Due to high velocity, the backward rushing gases have a large momentum. They impart an equal and opposite momentum to the jet aeroplane due to which it moves forward with a great speed.

Solution 40:

a) If of a balloon filled with compressed air and its mouth untied is released with its mouth in the downward direction, the balloon moves in the upward direction because the air present in the balloon rushes out in the downward direction. The equal and opposite reaction of downward going air pushes the balloon upwards.

b) Mass of the unloaded truck, m_1= 2000 kg
Acceleration a_1 = 0.5 m/s^2
Mass of loaded truck, m_2 = 2000+ 2000 = 4000 kg
Acceleration a_2
$m_1 \times a_1 = m_2 \times a_2$

b) Mass of the unloaded truck, m_1= 2000 kg
Acceleration a_1 = 0.5 m/s^2
Mass of loaded truck, m_2 = 2000+ 2000 = 4000 kg
Acceleration a_2
$m_1 \times a_1 = m_2 \times a_2$

$$a_2 = \frac{2000 \times 0.5}{4000} = 0.25 \text{ m/s}^2$$

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Solution 51:

Car seat-belts are somewhat stretchable so as to increase the time taken by the passengers to fall forward. Due to this, the rate of change of momentum of passengers is reduced and hence less stopping force acts on them. So the passengers do not get hurt.

Solution 52:

The paratroopers roll on landing to increase the time taken to reduce the momentum of their body. Thus, the rate of change of momentum is reduced and hence less force is exerted on their legs and they do not get hurt.

Solution 53:

An aircraft needs air because air moving under the wings of aircraft is strong enough to hold it up and air is also required to burn the fuel in aircraft engines. Since there is no air on moon, an aircraft cannot fly on moon.

Solution 54:

It is possible for a small animal to fall from a considerable height without being injured because a small animal has small mass, so the momentum produced is less. When the small animal falls to the ground with less momentum, less opposing force of ground acts on it and hence no injury is caused to it

Solution 55:
Mass of the boy, m_1= 50 kg
Speed of boy, u_1 = 5 m/s
Mass of trolley m_2 = 20 kg
Speed of trolley u_2 =1.5 m/s
Combined mass of boy and trolley, m = 20+ 50 = 70 kg
Combined velocity v
Acc. to the law of conservation of momentum
$m_1u_1 + m_2u_2 = mv$
50 x 5 + 20 x 1.5 = 70 x v

Mass of the boy, m_1= 50 kg
Speed of boy, u_1 = 5 m/s
Mass of trolley m_2 = 20 kg
Speed of trolley u_2 =1.5 m/s
Combined mass of boy and trolley, m = 20+ 50 = 70 kg
Combined velocity v
Acc. to the law of conservation of momentum
$m_1u_1 + m_2u_2 = mv$
50 x 5 + 20 x 1.5 = 70 x v
$$v = \frac{250 + 30}{70} = 4 \text{ m/s}$$

Solution 56:
Mass of the boat m_b = 300 kg
Velocity of boat v_b
Mass of girl m_g = 50 kg
Velocity of girl v_g = 3 m/s
Acc. to the law of conservation of momentum
$m_bv_b=m_gv_g$
300 x v_b = 50 x 3

Mass of the boat m_b = 300 kg
Velocity of boat v_b
Mass of girl m_g = 50 kg
Velocity of girl v_g = 3 m/s
Acc. to the law of conservation of momentum
$m_bv_b=m_gv_g$
300 x v_b = 50 x 3
$$v_b = \frac{50 \times 3}{300} = 0.5 \text{ m/s}$$

Solution 57:
Mass of first truck, m_1= 500 kg

Speed of first truck, u_1 = 4 m/s
Mass of second truck, m_2 = 1500 kg
Speed of second truck, u_2 =2 m/s
Combined mass of both trucks, m = 1500 + 500 = 2000 kg
Combined velocity v
Acc. to the law of conservation of momentum
$m_1u_1 + m_2u_2 = mv$
500 x 4 + 1500 x 2 = 2000 x v

Mass of first truck, m_1= 500 kg
Speed of first truck, u_1 = 4 m/s
Mass of second truck, m_2 = 1500 kg
Speed of second truck, u_2 =2 m/s
Combined mass of both trucks, m = 1500 + 500 = 2000 kg
Combined velocity v
Acc. to the law of conservation of momentum
$m_1u_1 + m_2u_2 = mv$
500 x 4 + 1500 x 2 = 2000 x v
$$v = \frac{2000 + 3000}{2000} = 2.5 \text{ m/s}$$

Solution 58:
Mass of the ball x, m_1= 1 kg
Speed of ball x, u_1 = 2 m/s
Mass of ball y, m_2 = 1 kg
Speed of ball y, u_2 =0 m/s (at rest)
Velocity of ball x after collision, v_1 = 0 m/s
Velocity of ball y after collision, v_2
Acc. to the law of conservation of momentum
$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
1 x 2 + 1 x 0 = 1 x 0 + 1 x v_2

Mass of the ball x, m_1= 1 kg
Speed of ball x, u_1 = 2 m/s
Mass of ball y, m_2 = 1 kg
Speed of ball y, u_2 =0 m/s (at rest)
Velocity of ball x after collision, v_1 = 0 m/s
Velocity of ball y after collision, v_2
Acc. to the law of conservation of momentum
$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
1 x 2 + 1 x 0 = 1 x 0 + 1 x v_2
$$v_2 = \frac{1x2}{1} = 2 \text{ m/s}$$

Solution 59:
Mass of car A, m_1= 2000 kg
Speed of car A, v_1 = 10 m/s
Mass of car B, m_2 = 500 kg
Speed of car B, v_2
Acc to law of conservation of momentum
$m_1v_1 = m_2v_2$
$2000 \times 10 = 500 \times v_2$

Mass of car A, m_1= 2000 kg
Speed of car A, v_1 = 10 m/s
Mass of car B, m_2 = 500 kg
Speed of car B, v_2
Acc to law of conservation of momentum
$m_1v_1 = m_2v_2$
$2000 \times 10 = 500 \times v_2$

$$v_2 = \frac{2000 \times 10}{500} = 40 \text{ m/s}$$

Solution 60:
Mass of the man, m_1= 80 kg
Speed of man, v_1
Mass of bullet m_2 = 20 g = 0.02 kg
Speed of bullet v_2= 400 m/s
Acc to law of conservation of momentum
$m_1v_1 = m_2v_2$
$80 \times v_1 = 0.02 \times 400$

Mass of the man, m_1= 80 kg
Speed of man, v_1
Mass of bullet m_2 = 20 g = 0.02 kg
Speed of bullet v_2 = 400 m/s
Acc to law of conservation of momentum
$m_1v_1 = m_2v_2$
$80 \times v_1 = 0.02 \times 400$

$$v_1 = \frac{400 \times 0.02}{80} = 0.1 \text{ m/s}$$