Force & Laws of Motion

Assess Yourself

Q. 1. A bird hits the windscreen of a fast moving car and falls on the bonnet. Which of the two, bird or car, suffer a grater change in momentum?

Answer: The momentum is given by, p = m×v, that is product of mass and velocity. As we know that mass of both the objects will be constant and what will change is velocity, so car due to heavier mass and hence more inertia of motion will remain in motion and will experience little reduction in speed whereas bird has negligible mass as compared to car, so it will experience more drastic change in its velocity and in momentum.

Q. 2. A bowler runs a long distance before bowling from the bowling line. Why?

Answer: A bowler runs because it wants to give speed to the bowling ball and hence momentum , so that the bowler just leaves the ball when he reaches the line and the ball keeps on moving due to the momentum provided by running of bowler.

Q. 3. A piece of paper can be jerked out from under a book quickly without moving the book. Why?

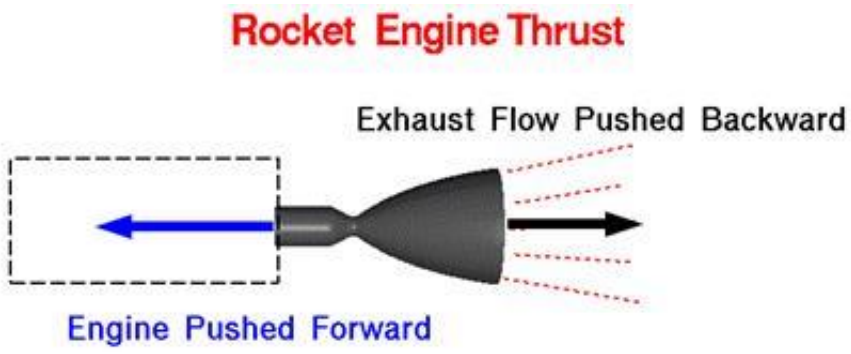
Answer: Due to the inertia of rest of the book and impulsive force applied by us we are able to jerk the paper out from under the book without moving the book.

Q. 4. Why is your foot hurt more when you kick a stone than when you hit a football?

Answer: When we kick a football due to its light weight it moves and gives less recoil to us due to law of conservation momentum and when we kick a heavy stone it gives us more recoil to conserve momentum and has more inertia of rest, so we get hurt by kicking a stone.

Q. 5. State Newton's third law of motion.

Answer: Statement of Newton's third law of motion is "To every action there is always an equal and opposite reaction."

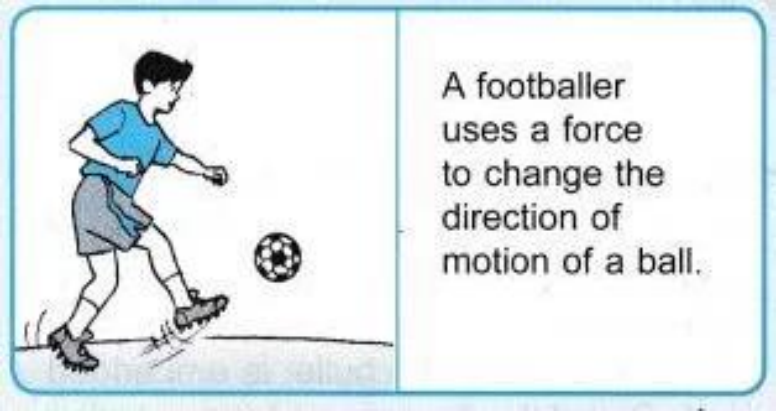


For every action, there is an equal and opposite re-action.

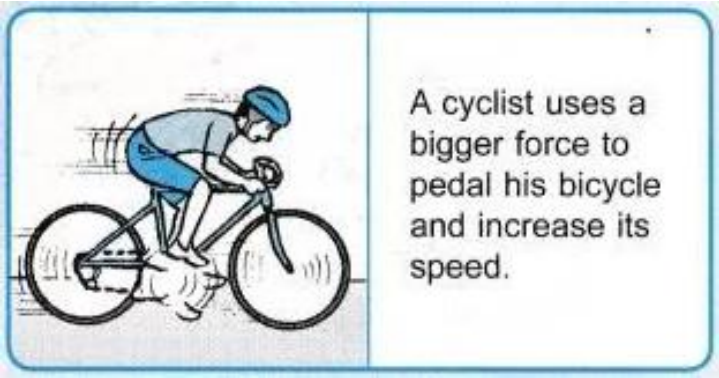
Q. 6. Define force. List any two effects of force.

Answer: Force is generally described as a push or a pull but it is also told as a product of mass and acceleration or rate of change in momentum.

1. Force can change the direction of motion of the object.



2. Force can change the speed of moving of object.



Q. 7. Give reason: sparks produced in a grinding stone move tangentially.

Answer: Grinding stone is like a wheel and at every point of the wheel at the periphery, the direction of linear velocity is tangential due to the inertia of motion, so that is why the sparks go tangential.

Sparks fly in straight line tangentially from the edge of a rotating grinding wheel

Q. 8. A ball moving on a surface stops after travelling some distance. Does it violate the first law of motion? Explain.

Answer: The first law states that when a body in motion stays in motion and a body at rest stays at rest until an external force is applied. But in the case of rolling of the ball, the ball stops after some time because frictional force is acting on the ball every time which keeps on reducing its speed.

Q. 9. A bullet of mass 10 g is fired horizontally with a velocity of 150 ms^{-1} from a pistol of mass 2 kg. Find the recoil of the pistol.

Answer: Given:

Mas of bullet = 10g

Velocity of bullet = 150ms^{-1}

Mass of pistol = 2 kg

Due to the law of conservation of momentum the momentum of the bullet is equal to the recoil of the gun. So the sum of the momentum of both the objects is equal to zero.

$M_bV_b = –M_gV_g$, Now,

$$V_g = -\frac{M_b V_b}{M_g} = -\frac{0.01 \times 150}{2} = 0.75\ ms^{-1}.$$

Q. 10. A body at rest opposes the force which tries to move it. Name this property and give two examples to illustrate it.

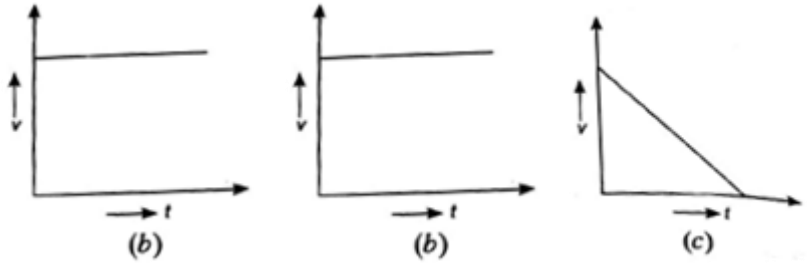
Answer: This is an inherent property called inertia of rest which is directly proportional to the mass of the object.

Examples: –

1. When we beat carpet dust particles comes out.

2. When you shake the branch of tree fruits or leaves comes out.

Q. 11. Observe the following v-t graphs and explain the type of force acting in the cases given:



Answer: Slope in the velocity versus time graph is acceleration and hence it is due to application of force.

a) The slope is constant, so the force is constant and is acting in the direction of motion.

b) The force acting on the object is zero because there is no velocity change.

c) The slope is constant, so the force is constant and is acting opposite to the direction of motion.

Q. 12. Give reasons for the following:

(a) A ball thrown upwards in a running train returns back to the hands.

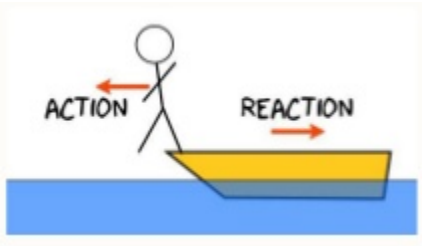
(b) When a person moves out of a boat, it moves backward.

Answer: Reasons:–

a) This is due to the inertia of motion which is that the body in motion likes to stay in motion and resist and change in its state.

b) This is due to the Newtons third law of motion.

As the man is trying to push himself forward, he is simultaneously pushing the boat back.



Q. 13. (a) Write an activity to demonstrate balanced and unbalanced forces.

(b) State whether the forces are balanced or unbalanced in each case:

(i) Suitcase dropped from a height.

(ii) A bicycle moving with constant velocity on a straight road.

(iii) The rope does not move in a tug of war on applying force at both ends.

Answer: (a)

a) Choose a heavy object like a table or a box, which you can move only by pushing hard.

b) Try to push it all by yourself. Can you move it?

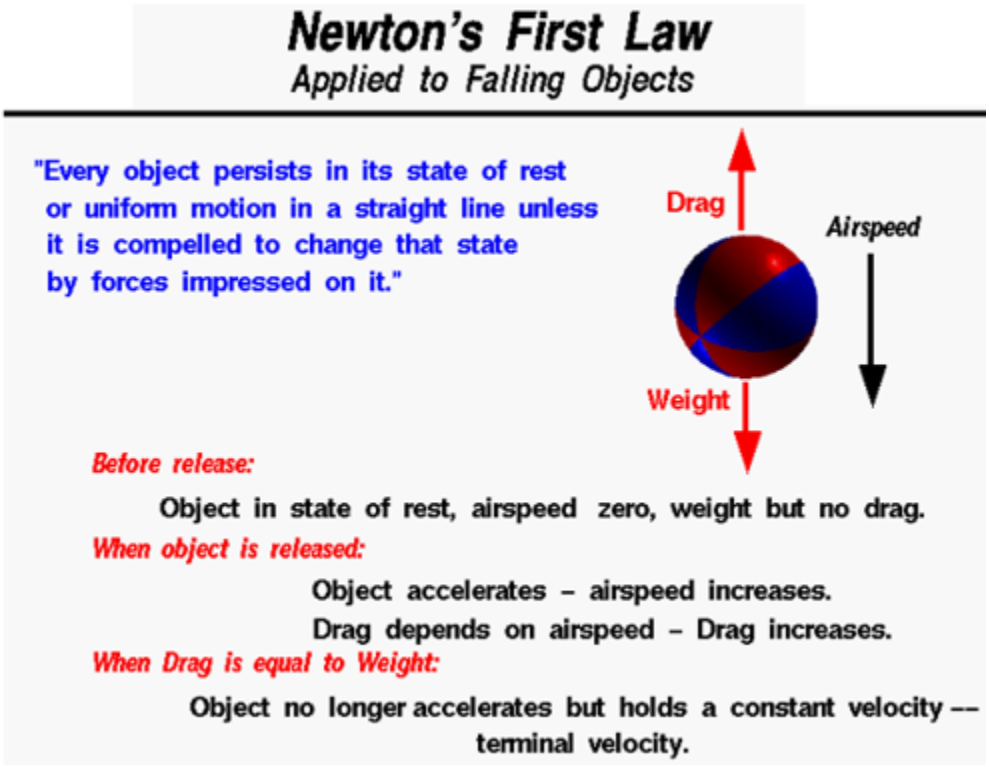
c) Now ask one of your friends to help you in pushing it in the same direction.

d) Is it easier to move it now? Can you explain why? Next, push the same object, but ask your friend to push it from the opposite side.

e) Does the object move? If it does, note the direction in which it moves. Can you guess which one of you is applying a larger force?

(b) i. The forces acting on the suitcase are unbalanced.

The air friction, weight & the airspeed are acting on the ball. Example, the figure is given below:



ii. Balanced forces.

iii. There are balanced forces.

Q. 14. State and prove the law of conservation of linear momentum.

Answer: According to the law of conservation of momentum

When two or more bodies act upon each other their total momentum remains constant provided no external forces are acting

•So, Momentum is never created or destroyed.

•When this law is applied for a collision between two bodies, the total momentum of the colliding bodies before the collision is equal to the total momentum after the collision.

•We can apply this law for a collision between two vehicles. This law is applicable for all types of collisions.

•Consider two particles say A and B of mass m1 and m2 collide with each other and forces acting on these particles are only the ones they exert on each other.

•Let u_1 and v_1 be the initial and final velocities of particle A and similarly, u_2 and $v_2$for particle B. Let the two particles be in contact for a time t.

So, Change in momentum of A=m_1 (v_1-u_1) Change in the momentum of B=m_2 (v_2-u_2)

•During the collision, let A impart an average force equal to FBA on B and let B exert an average F_{AB}on A. We know that from third law of motion F_{BA} = F_{AB} eq. (4)

$$F_{BA} = m_2 \times a_2 = \frac{m_2(v_2 - u_2)}{t}$$

$$F_{AB} = m_1 \times a_1 = \frac{m_1(v_1 - u_1)}{t}$$

Putting above two in equation 4 we get

$$\frac{m_2(v_2 - u_2)}{t} = -\frac{m_1(v_1 - u_1)}{t}$$

Canceling t on both sides and rearranging the equation we getm_1u_1+m_2u_2 = m_1v_1+m_2v_2 eq.(5)

Now, m_1u_1+m_2u_2 represents the total momentum of particles A and B before collision and m_1v_1+m_2v_2 represents the total momentum of particles after the collision. This means that

Total momentum before collision=total momentum after the collision

•Equation 5 which m_1u_1+m_2u_2 = m_1v_1+m_2v_2, is known as the law of conservation of momentum.

Q. 15. Sonam was reading about balanced and unbalanced forces. She read that the gravitational force of sun and moon also acts on us. She wondered why we don't fly towards these bodies. Her teacher, however, listened to her patiently and stored her doubts.

(a) What values of Sonam do you observe?
(b) Throw light on characteristic values of her teacher.
(c) Distinguish between balanced and unbalanced forces.
(d) What explanation would you give towards Sonam's questions?
(e) Good reading habits lead to constructive learning. Comment.

Answer: (a) We observe that sonam is very curious in understanding natural phenomenons about the gravitational forces between sun and moon

(b) The characterstic value of her teacher is as below:

- Expert communication skills
- Superior listening skills
- Deep knowledge and passion for their subject matter
- The ability to build caring relationships with students
- Friendliness and approachability
- Excellent preparation and organization skills
- Strong work ethic
- Community-building skills
- High expectations for all

(c) Balanced forces are those in which $F_{net} = 0$ N, whereas Unbalanced forces are those in which $F_{net} \neq 0$ N.

(d) Gravitational force is a weak force and it depends upon distance and earth is closer to us than sun or moon, so pulling of the earth is more effective than the other two.

(e) Good reading habits led to constructive learning. The good heading habits like reading newspaper, science journal led a constructive learning of the new technology and ideas in his dictionary which led him to question existing theory which led to constructive learning.