Force and Laws of Motion

Case Study Based Questions

Case Study 1

If the resultant of all the forces acting on a body is zero, the forces are called balanced forces. A body under the action of balanced forces does not change its position of rest (or of uniform motion) and it appears as if no force is acting on it. They can, however, change the shape of the body.

On the other hand, if the resultant of all the forces acting on a body is not zero, the forces are called unbalanced forces. When unbalanced forces act on a body, they produce a change in its state of rest or of uniform motion.

Read the given passage carefully and give the answer of the following questions:

Q1. Mark the incorrect option:

a. Balanced forces cannot set any stationary body into motion.

b. Balanced forces cannot change the speed of a moving body.

c. Balanced forces can change the shape and size of a body.

d. None of the above

Q2. Which is correct for unbalanced forces?

a. When unbalanced forces act on an object at rest, the object will move.

b. Unbalanced forces are necessary to cause a non-moving object to start moving.

c. Unbalanced forces produces change in motion (acceleration).

d. All of the above

Q3. If the force acting on an object are balanced, then the object:

a. must be at rest

b. must be moving

c. must not be accelerating

d. must lose energy

Get More Learning Materials Here : CLICK HERE www.studentbro.in

Q4. A batsman hits a sweep short in the game of cricket. What is the nature of force experienced by the ball during the impact?

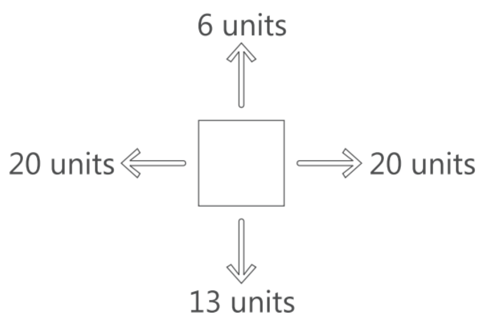
a. Balanced force

b. Unbalanced force

c. Both balanced and unbalanced forces

d. Neither balanced nor unbalanced forces

Q5. Find net force on the object shown in the figure and answer if the forces are balanced or unbalanced.



a. $(F_{net}) = 0$; Balanced forces

b. $(F_{net}) \neq 0$; Balanced forces

c. $(F_{net}) = 0$; Unbalanced forces

d. $(F_{net}) \neq 0$; Unbalanced forces

Solutions

1. (d) None of the above

2. (d) All of the above

3. (c) must not be accelerating

4. (b) Unbalanced force

During impact, the direction of the ball and speed changes. Thus, an unbalanced force is applied on the ball.

5. (d) $(F_{net}) \neq 0$; Unbalanced forces

According to given figure,

Net horizontal force = 20 – 20 = 0 unit

Get More Learning Materials Here : CLICK HERE www.studentbro.in

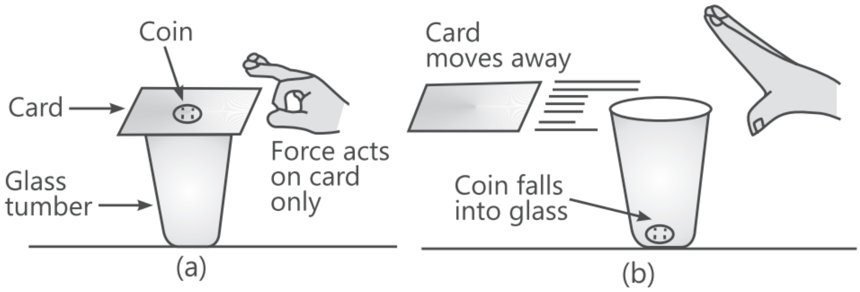
Net vertical force = 13 - 6 = 7 units

So, net force = 7 units (downward)

Hence, $F_{net} \neq 0$, i.e., forces are unbalanced.

Case Study 2

Varshney Sir was demonstrating an experiment in his class with the setup as shown in the figure below.



A five-rupee coin is set on a stiff card covering an empty glass tumbler standing on a table. He then flicks the card hard with his fingers.

Read the given passage carefully and give the answer of the following questions:

Q1. Give reason for the above observation.

a. The coin possesses inertia of rest, it resists the change and hence falls in the glass.

b. The coin possesses inertia of motion, it resists the change and hence falls in the glass.

c. The coin possesses inertia of rest, it accepts the change and hence falls in the glass.

d. The coin possesses inertia of motion, it accepts the change and hence falls in the glass.

Q2. Name the law involved in this case.

a. Newton's second law of motion

b. Newton's first law of motion

c. Newton's third law of motion

d. Law of conservation of energy

Get More Learning Materials Here : CLICK HERE www.studentbro.in

Q3. If the above coin is replaced by a heavy ten rupee coin, what will be your observation? Give reason.

a. Heavy coin will possess more inertia and lesser force is required to perform the activity.

b. Heavy coin will possess less inertia and more force is required to perform the activity.

c. Heavy coin will possess more inertia and more force is required to perform the activity.

d. Heavy coin will possess less inertia and lesser force is required to perform the activity.

Q4. Complete the statement of the first law of motion:

A body at rest stays at .... and a body in motion stays in .... unless an .... is applied.

a. motion; rest; external force

b. rest; motion; external force

c. rest; motion; internal force

d. None of the above

Q5. Observe the diagram carefully. A car braked suddenly near a cliff. Explain the motion of the driver.

a. The driver is pushed backwards.

b. Due to inertia of motion, driver was thrown forward as he continues to be in motion in the forward direction.

c. Due to inertia of rest, the road is left behind and the driver reaches forward.

d. Due to inertia of motion, the driver moved in the backward direction.

Get More Learning Materials Here : CLICK HERE www.studentbro.in

Solutions

1. (a) The coin possesses inertia of rest; it resists the change and hence falls in the glass.

2. (b) Newton's first law of motion

3. (c) Heavy coin will possess more inertia and more force is required to perform the activity.

4. (b) rest; motion; external force

5. (b) Due to inertia of motion, driver was thrown forward as he continues to be in motion in the forward direction.

Case Study 3

Newton's second law of motion gives us a relationship between 'force' and 'acceleration'. The acceleration produced in a body is directly proportional to the force acting on it and inversely proportional to the mass of the body. Therefore, if the mass of a body is doubled, its acceleration will be halved. And if the mass is halved, then acceleration will get doubled (provided the force remains the same).

Read the given passage carefully and give the answer of the following questions:

Q1. Newton's second law of motion tells us that:

a. all forces in the universe occur in equal but oppositely directed pairs.

b. an object will remain at rest or in uniform motion in a straight line unless acted upon by an external force.

c. the rate of change of linear momentum is equal to force acting on the body.

d. None of the above

Q2. The incorrect statement about Newton's second law of motion is that:

a. it provides a measure of inertia

b. it provides a measure of force

c. it relates force and acceleration

d. it relates momentum and force

Get More Learning Materials Here : CLICK HERE www.studentbro.in

Q3. Which of the following situations involves the Newton's second law of motion?

a. A force can stop a lighter vehicle as well as a heavier vehicle which are moving

b. A force can accelerate a lighter vehicle more easily than a heavier vehicle which are moving

c. A force exerted by a lighter vehicle on collision with a heavier vehicle results in both the vehicles coming to a standstill

d. A force exerted by the escaping air from a balloon in the downward direction makes the balloon to go upwards

Q4. During athletics meet, a high jumping athlete is provided either a cushion or a heap of sand on the group to fall upon. Which law is used to explain it?

a. Law of inertia

b. Newton's first law of motion

c. Newton's second law of motion

d. Newton's third law of motion

Q5. Two bodies have masses in the ratio 3 : 4. When a force is applied on the first body, it moves with an acceleration of 6m s^{-2}. How much acceleration will the same force produce in the other body?

a. 1.5 m s^{-2}

c. 45 m s^{-2}

b. 3 m s^{-2}

d. 4.5 m s^{-2}

Solutions

1. (c) the rate of change of linear momentum is equal to force acting on the body.

2. (a) it provides a measure of inertia

3. (b) A force can accelerate a lighter vehicle more easily than a heavier vehicle which are moving

4. (c) Newton's second law of motion

Get More Learning Materials Here : CLICK HERE www.studentbro.in

5. (d) 4.5 ms^{-2}

Let the masses of the bodies be 3x and 4x respectively.

Given acceleration = 6 m s^{-2}

We know that, F = m x a

∴ F= 3x x 6 = 18x

As we are applying same force for the second body,

∴ 18x = 4x x a

⇒ a = 18/4 = 4.5 m/s^2.

Hence, acceleration is 4.5 m/s^2 or 4.5 ms^{-2}.

Case Study 4

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. The force exerted by the first body on the second body is known as 'action' and the force exerted by the second body on the first body is known as 'reaction'.

Read the given passage carefully and give the answer of the following questions:

Q1. 'The action and reaction are equal in magnitude. Is this statement true and which law is related with it?

a. Yes, Newton's second law

b. Yes, Newton's third law

c. No, Newton's third law

d. Yes, Newton's first law

Q2. Newton's third law of motion can be used to explain:

a. why the passengers in a bus tend to fall backward when its starts suddenly

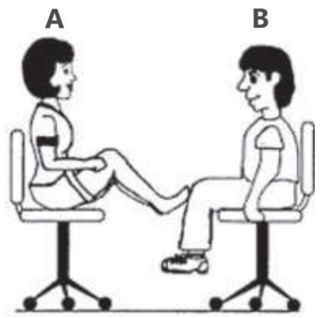
b. swimming of a man

c. walking

d. Both b. and c.

Get More Learning Materials Here : CLICK HERE www.studentbro.in

Q3. Student A and student B sit in identical office chairs facing each other, as shown in figure. Student A is heavier than student B. Student A suddenly pushes with his feet. Which of the following occurs?



a. Neither student applies a force on each other

b. A exerts a force that is applied to B, but A experiences no force

c. Each student applies a force to the other, but A exerts the larger force

d. The students exerts the same amount of force on each other

Q4. According to Newton's third law, action is always equal and opposite to the reaction. A horse can pull a cart because it applies a:

a. force on cart

b. force on ground

c. Both a. and b.

d. None of the above

Q5. When a fireman directs a powerful stream of water on a fire from a hose pipe, the hose pipe tends to go backward. This is an example of Newton's:

a. law of gravitation

b. first law of motion

c. second law of motion

d. third law of motion

Solutions

1. (b) Yes, Newton's third law

2. (d) Both b. and c.

Get More Learning Materials Here : CLICK HERE www.studentbro.in

3. (d) The students exerts the same amount of force on each other

4. (c) Both a. and b.

5. (d) third law of motion

Case Study 5

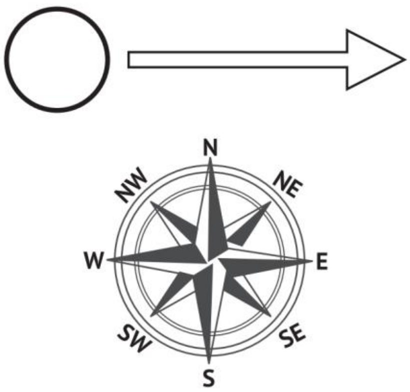
Momentum is a vector quantity that is the product of the mass and velocity of an object or particle. Momentum is measured in the standard unit of kilogram-metre per second. The direction of momentum is same as the direction of velocity. Every moving body possesses momentum. Since momentum depends on the mass and velocity of a body, so a body will have a large momentum (a) if its mass is large, or (b) if its velocity (speed) is large, or (c) if both mass and velocity (speed) are large.

Read the given passage carefully and give the answer of the following questions:

Q1. Define momentum. State its SI unit.

Q2. Is momentum a scalar or a vector quantity?

Q3. A ball is moving in the direction as shown. What will be the direction of momentum?



Q4. A hockey ball of mass 200 g travelling at 10 m s^{-1} is struck by a hockey stick so as to return it along its original path with a velocity of 5 m s^{-1}. Calculate the change of momentum which occurred in the motion of the hockey ball by the force applied by the hockey stick.

Q5. Represent the following graphically:

(i) Momentum versus velocity when mass is fixed.

(ii) Momentum versus mass when velocity is fixed.

Get More Learning Materials Here : CLICK HERE www.studentbro.in

Solutions

1. Momentum is defined as the product of mass and velocity of an object. Its SI unit is kg-m/s.

2. Momentum is a vector quantity.

3. Direction of momentum is same as the direction of velocity. Hence, the direction of momentum of ball in the given case is East.

4. Given, mass of the hockey ball,

m = 200 g = 0.2 kg

Initial velocity of ball, u = 10 ms^{-1}

Final velocity of ball, v = -5 m s^{-1}

Initial momentum of the ball = mu

= 0.2 kg x 10 m s^{-1}

= 2 kg-m s^{-1}

Final momentum of the ball = mv

= 0.2 kg x (-5 m s^{-1})

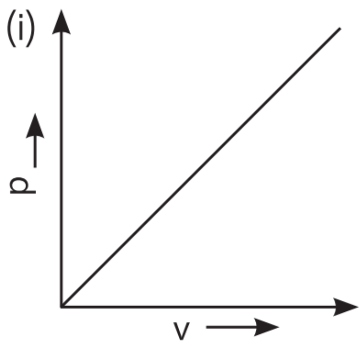
= -1 kg-m s^{-1}

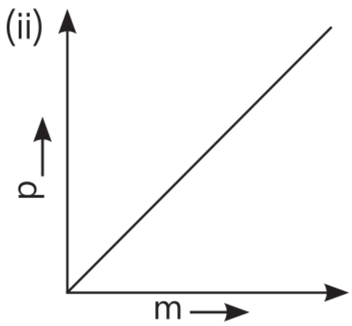
Therefore, the change in momentum = mv – mu

= −1 kg-m s^{-1} −2 kg-m s^{-1}

= - 3 kg-m s^{-1}

5.





Get More Learning Materials Here : CLICK HERE www.studentbro.in