2. Force and Laws of Motion

Very Short Answer Type Questions-Pg-55

1. Question

What name is given to the product of mass and velocity of a body?

Answer

The quantity of motion of a moving body, measured as a product of its mass and velocity is called as momentum. It is also defined as the impetus gained by a moving object.

2. Question

Name the physical quantity which is considered to be a measure of the quantity of motion of a body.

Answer

Momentum is considered to be a measure of the quantity of motion of a body. It is the product of the mass and velocity of an object, quantified in kilogram-meters per second. It is dimensionally equivalent to impulse, the product of force and time, quantified in Newton - seconds.

3. Question

What is the SI unit of momentum?

Answer

The SI unit of momentum is kilogram meter per second and it is symbolized as kg m/s

4. Question

State whether momentum is scalar or vector.

Answer

Momentum is a vector quantity. For a particle with mass, the momentum equals mass times velocity, and velocity is a vector quantity while mass is a scalar quantity. A scalar multiplied by a vector is a vector.

5. Question

What is the total momentum of the bullet and the gun before firing?

Answer

When we fire a bullet from a gun, its veleocity is zero before firing, hence momentum is also zero.

6. Question

Name the physical quantity whose unit is kg m/s.

Answer

Momentum is defined to be ‘mass x velocity’, so it is a vector, in the same direction as the velocity.

Mass is measured in kilograms, kg, and velocity is measured in metres per second, m/s. These are the standard SI units of these quantities. Hence, the SI unit of momentum is kg m/s.

1. Question

What will be the momentum of a body of mass ‘m’ which is moving with the velocity?

Answer

Mass of the object = m

Let, the Velocity of the object be 'v'

Since, Momentum = Mass ×Velocity

Hence, Momentum = mv

8. Question

What is the usual name of the forces which cannot produce motion in a body but only change its shape?

Answer

Balanced Forces cannot produce motion, but can change the shape of the body.

9. Question

Name the unbalanced force which slows down a moving bicycle when we stop pedaling it.

Answer

.It is frictional force which slows down the bicycle and gradually stops the cycle when we stop pedaling it.

10. Question

State whether the following statement is true of false.

Unbalanced forces acting on a body change its shape.

Answer

False: Balanced forces acting on a body change its shape.

11. Question

When a ball is dropped from a height, its speed increases gradually. Name the force which causes this change its speed.

Answer

When a ball is thrown towards the ground from the height h then, acceleration due to gravity acts on the body in the same direction of the motion of the body.

Hence acceleration of the body increases.

12. Question

Name the property of bodies (or objects) to resist a change in their state of rest or of motion.

Answer

The intrinsic property of material body which resists a change in its state of rest or of uniform motion along a straight line is called inertia. Inertia is a natural tendency of the body.

13. Question

What is the other name of Newton’s first law of motion?

Answer

Newton's first law of motion is also called as the law of inertia. An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

14. Question

The mass of object A is 6 kg whereas that of another object B is 34 kg. Which of the two objects, A or B, has more inertia?

Answer

Since, mass is directly proportional to inertia. Hence, Ball B, which is heavier than Ball A and thus having a greater mass, will also have a greater inertia.

15. Question

Name the scientist who gave the laws of motion.

Answer

Sir Issac Newton gave laws of motion which constitute three physical laws that, together, laid the foundation for classical mechanics.

16. Question

State whether force is a scalar or a vector quantity.

Answer

Force is defined as the product of mass and acceleration. We know, that mass is a scalar quantity while acceleration is a vector quantity whose direction and magnitude both can be specified. The product of a scalar and vector always yield a vector quantity. Hence, force is a vector quantity.

17. Question

With which physical quantity should the speed of a running bull the multiplied so as to obtain its momentum?

Answer

Since momentum is equal to the product of mass and velocity. Hence, mass of bull should be multiplied to its speed in order to find its Momentum.

18. Question

Fill in the following blanks with suitable words:

(a) …… is a measure of the inertia of a body.

(b) When a running car stops suddenly, the passengers are jerked ……..

(c) When a stationary car starts suddenly, the passengers are jerked ……

(d) Newton's first law of motion is also called Galileo's law of ……..

(e) If there were no unbalanced force of …… and no ……..resistance, a moving bicycle would go on moving forever.

Answer

(a) Mass

(b) Forward

(c) Backward

(d) Inertia

(e) Friction; Air

Short Answer Type Questions-Pg-55

19. Question

Explain why, it is easier to stop a tennis ball than a cricket ball moving with the same speed.

Answer

We know that

Momentum, p = mv

As from question, balls have same speed.

p α m

Since cricket ball has more mass than the tennis ball.

So, cricket ball has more momentum than the tennis ball.

That is why it is easier to stop a tennis ball than a cricket ball moving with the same speed.

20. Question

Explain the meaning of the following equation:

P = m × v

Where symbol have their usual meaning

Answer

.P = mv, shows the method to calculate the momentum of an object. Where, p represents momentum

m, mass of object and v, velocity of the object.

It shows that the momentum of an object is the product of its mass and velocity.

21. Question

Explain how, a karate player can break a pile of tiles with a single blow of his hand.

Answer

In doing so, the entire momentum of the hand is reduced to zero in very short interval of time. As a result, very large force is delivered to the pile of tiles which breaks it in a single blow.

22. Question

Calculate the momentum of a toy car of mass 200 g moving with a speed of 5 m/s.

Answer

Given: Mass of car, m =200gVelocity of car, v =5 m/s

Now, 1 kg = 1000 g

Thus, mass of car, m = 0.2kg

Momentum of the car, p= mass × velocity

= 0.2kg × 5 m/s

= 1 kg-m/s

23. Question

What is the change in momentum of a car weighing 1500 kg when its speed increases from 36 km/h to 72 km/h uniformly?

Answer

The formula of change in momentum= mv - mu,

Where m = mass i.e. 1500kg,

v = final velocity i.e. 72 km/hr,

u = initial velocity i.e. 36 km/hr.

We will change the v and u to m/s

i.e. 72 X 5/18=20 m/s and 36 X 5/18=10 m/s.

Hence, change in Momentum= mv - mu

= 1500X20 - 1500X10

=1500[20 - 10]

= 1500 X 10

= 15000 kg m/s

24. Question

A body of mass 25 kg has a momentum of 125 kg. m/s. Calculate the velocity of the body.

Answer

Given: mass of the body, m =25 kg

Let the velocity of the body be v m/s

Momentum of the body, p =125 kg. M/sNow, p = m×v

125 = 25(v)

v = 5 m/s

Hence, the velocity of the body is **5 m/s**

25. Question

Calculate the momentum of the following:

(a) an elephant of mass 2000 kg moving at 5 m/s

(b) a bullet of mass 0.02 kg moving at 400 m/s

Answer

As we know,

Momentum, p = mv

Where, m is the mass of the body

V is the velocity of the body,

(a) m = 2000 kg

v = 5 m/s

p = (2000) × (5)

= 10000 kg m/s

(b) m = 0.2 kg

v = 400 m/s

p = (0.2) × (400)

= 80 kg m/s

26. Question

Which of the two, balanced forces or unbalanced forces, can change the shape of an object? Give an example to illustrate your answer.

Answer

Balanced forces can change the shape of the object.

Example: Squeeze a rubber ball between the palms of your hands. What do you observe? The shape of the rubber ball changes. The force applied on the ball is equal and opposite, so, the resultant of this force does not move the object, this is balanced force.

27. Question

Describe the term ‘inertia’ with respect to motion.

Answer

Inertia can easily be described as the reluctance or resistance of a body to change its state of motion i.e. if a body is at rest, it will continue to remain at rest if an external force is not applied to change its state of rest whereas if a body is in motion, it will continue to remain in motion if an external force is not applied to change its state of motion.

28. Question

State Newton’s first law of motion. Give two examples to illustrate Newton’s first law of motion.

Answer

Newton's first law of motion, also referred to as the law of inertia states that an object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

For example,

(i) When a bus suddenly starts, the passengers sitting or standing in the bus tend to fall backward. This is due to inertia of rest and can be explained as follows: when the bus suddenly starts, the lower part of the body of the passenger which is in contact with the bus moves along with the bus while the upper part of the body tends to retain its state of rest due to inertia. As a result, the passenger falls backward.

(ii)A rider on a running horse is thrown forward when the horse stops suddenly due to inertia of motion.

29. Question

On what factor does the inertia of a body depend? Which has more inertia, a cricket ball or a rubber ball of the same size?

Answer

Inertia of a body depends on its mass. A cricket ball has more mass than a rubber ball, hence it has more inertia.

30. Question

Why do the passengers in a bus tend to fall backward when it starts suddenly?

Answer

When a bus suddenly starts, the passengers sitting or standing in the bus tend to fall backward. This is due to inertia of rest and can be explained as follows: when the bus suddenly starts, the lower part of the body of the passenger which is in contact with the bus moves along with the bus while the upper part of the body tends to retain its state of rest due to inertia. As a result, the passenger falls backward.

31. Question

Explain why, a person travelling in a bus falls forward when the bus stops suddenly.

Answer

When moving bus suddenly stops, the passengers sitting or standing in the bus are thrown forward. This is due to inertia of motion and can be explained as follows: when the moving bus suddenly stops, the lower part of the body of the passenger contact with the bus suddenly comes to rest while the upper part of the body tends to retain its state of motion due to inertia. As a result, the passenger is thrown forward.

32. Question

Give reason for the following:

When a hanging carpet is beaten with a stick, the dust particles start coming out of it.

Answer

When a blanket is given a sudden jerk, the dust particles in it fall off due to inertia at rest. Dust particles were at rest on the carpet. However when you beat the carpet, you are forcing the dust to move along with the carpet. Due to the dust having inertia, it doesn't move, or rather, it resists motion. This is why dust comes out of a carpet when it is beaten with a stick.

33. Question

When a tree is shaken, its fruits and leaves fall down. Why?

Answer

When a branch of a tree is vigorously shaken the fruits and seeds in It fall down due to inertia of rest. The tree was at rest (at first), when the tree is shaken the branches of the tree gains motion but the fruits and leaves tends to be in rest due to inertia of rest and hence they fall down.

34. Question

Explain why, it is dangerous to jump out of a moving bus.

Answer

The man jumping out from a moving bus possesses the inertia of motion. As the man lands on the ground, feet come to rest immediately while the upper part of body continue to move due to inertia of motion and hence the person may fall forward. Hence, it is dangerous to jump out of a moving bus.

35. Question

What is the momentum in kg. m/s of a 10 kg car travelling at

(a) 5 m/s (b) 20 cm/s, and (c) 36 km/h?

Answer

As we know,

Momentum, $p = m \times v$

Where, m is the mass of the body

v is the velocity of the body,

Here, m = 10 kg

(a) v = 5 m/s

p = (10) × (5)

= 50 kg m/s

(b) v = 20 cm/s = 0.2 m/s

p = (10) × (0.2)

= 2 kg m/s

(c) v = 36 km/h = 10 m/s

p= (10) × (10)

= 100 kg m/s

Long Answer Type Questions-Pg-56

36 A. Question

Define momentum of a body, on what factors does the momentum of a body depend?

Answer

Momentum is defined as amount of motion a body contains. Mathematically it is defined as the product of mass and velocity. So the factors on which momentum of a body depends are its mass and velocity.

36 B. Question

Calculate the change in momentum of a body weighing 5 kg when its velocity decreases from 20 m/s to 0.20 m/s.

Answer

The formula of change in momentum= mv - mu,

Where m=mass i.e. 5kg

v=final velocity i.e. 0.2 m/s

u=initial velocity i.e. 20m/s

Hence, change in Momentum= mv - mu

= 5 (0.2 - 20)

= 5(-19.8)

= -99 kg m/s

99 kg m/s decreases

37 A. Question

| Define the term ‘force.’

Answer

A push or pull is a force. Or in other words we can say that force is the capacity to do work or cause any physical change.

37 B. Question

State the various effects of force.

Answer

The Effects of Forces are - force acting on an object may cause the object to change shape, to start moving, to stop moving, to accelerate or decelerate.

When two objects interact with each other they exert a force on each other, the forces are equal in size but opposite in direction.

38. Question

Give one example each where:

(a) A force moves a stationary body.

(b) A force stops a moving body.

(c) A force changes the speed of a moving body.

(d) A force changes the direction of a moving body.

(e) A force changes the shape (and size) of a body.

Answer

The required examples of forces are:

(a) While pushing a table, a stationary object is moved through force.

(b) When brakes are applied in order to stop the bicycle.

(c) While hitting a moving football changes its direction, here the force changes the direction of a moving object.

(d) When we push a slowly moving bicycle its speed increases gradually.

(e) Applying force on a rubber ball changes its shape. Here a force tends to change the shape of an object.

39 A. Question

What do you understand by the terms “balanced forces” and “unbalanced forces”? Explain with examples.

Answer

Forces that are equal in size but opposite in direction are called balanced forces. Balanced forces do not cause a change in motion. When balanced forces act on an object at rest, the object will not move. For example- If you push against a wall, the wall pushes back with an equal but opposite force. Neither you nor the wall will move.

Forces that cause a change in the motion of an object are unbalanced forces. Unbalanced forces are not equal and opposite. For example- Suppose that one of the teams in tug of war pulls harder than the other team. The forces would no longer be equal. One team would be able to pull the other team in the direction of the larger force.

39 B. Question

What type of forces – balanced or unbalanced - act on a rubber ball when we press it between our hands? What effect is produced in the ball?

Answer

When we press the rubber ball between our hands an equal and opposite force acts and only the shape of the ball is changed, hence we can conclude that the balanced forces acts on it. As an effect of force the shape of the ball changes, it gets a little compressed.

40 A. Question

What happens to the passengers travelling in a bus when the bus taken a sharp turn? Give reasons for your answer.

Answer

When the bus takes a sharp turn the passengers travelling in a bus tends to fall due to the Inertia of direction. While the bus is moving the passengers exist the Inertia of motion in the direction the bus is moving but when it takes sharp turn the body of the passengers opposes the change, hence they tends to fall.

40 B. Question

Why are road accidents at high speeds very much worse than road accidents at low speeds?

Answer

This is because of the momentum. When a car or a vehicle moves in a slow speed its momentum is less due to which the damage due to the accident is less but when a car or vehicle moves at a high speed then damage due to accident is very large so it is advised to drive cars at slow speeds to be in control and prevent damage and if the damage occurs then the damage will be less.

Multiple Choice Questions (MCQs)-Pg-56

41. Question

When a toothpaste tube is squeezed, its shape changes. The force responsible for this is an example of:

A. Balanced forces

B. Centripetal forces

C. Unbalanced forces

D. Centrifugal forces

Answer

Since, balanced forces are forces that produce no change in motion but can change its shape.

42. Question

The inertia of an object tends to cause an object:

A. To increase its speed

B. To decrease its speed

C. To resist a change in its state of motion

D. To decelerate due to friction

Answer

Since, Inertia is the resistance of any physical object to any change in its state of motion; this includes changes to its speed, direction, or state of rest.

43. Question

When we talk of force acting on a body, it usually means:

A. Electrical force

B. Balanced force

C. Unbalanced force

D. Nuclear force

Answer

Since, Forces that cause a change in the motion of an object are unbalanced forces.

44. Question

A passenger in a moving train tosses a coin which falls behind him. This shows that the motion of train is:

A. Accelerated B. Uniform

C. Retarded D. along circular track

Answer

Since, when the coin is tossed the train accelerates forward whereas coin due to inertia tends to move with the same velocity when tossed.

45. Question

‘When a hanging carpet is beaten with stick, the dust particles start coming out of it’. This phenomenon can be best explained by making use of:

A. Newton’s third law of motion

B. Newton’s law of gravitation

C. Newton’s first law of motion

D. Newton’s second law of motion

Answer

Since, due to inertia of rest the dust particles come out of the carpet when beaten with stick.

46. Question

A water tanker filled up to two-thirds of its tank with water is running with a uniform speed. When the brakes are suddenly applied, the water in its tank would:

A. Move backward

B. Move forward

C. Rise upwards

D. Remain unaffected

Answer

This happens due to the Inertia of motion that water exist at that moment.

47. Question

If we release a magnet held in out hand, it falls to the ground. The force which makes the magnet fall down is an example of:

A. Balanced force

B. Unbalanced force

C. Magnetic force

D. Muscular force

Answer

Since, unbalanced forces are the forces that cause a change in the motion of an object.

48. Question

The inertia of a moving object depends on:

A. Momentum of the object

B. Speed of the object

C. Mass of the object

D. Shape of the object

Answer

Since, The heavier the body more the Inertia it exists.

49. Question

When a rubber balloon held between the hands is pressed, its shape changes. This happens because:

A. Balanced forces act on the balloon

B. Unbalanced forces act on the balloon

C. Frictional forces act on the balloon

D. Gravitational forces act on the balloon

Answer

As the balanced forces cause the change in shape of an object without bringing a change to its motion.

50. Question

Which of the following effect cannot be produced by unbalanced force acting on a body?

A. Change in speed of the body

B. Change in shape of the body

C. Change in direction of motion of the body

D. Change in state of rest of the body

Answer

Since, only the balanced forces can cause the change in shape of the body.

Questions Based on High Order Thinking Skills (HOTS)-Pg-57

51. Question

A plastic ball and a clay ball of equal masses, travelling in the same direction with equal speeds, strike against a vertical wall. From which ball does the wall receive a greater amount of momentum?

Answer

The amount of momentum that an object has depends on two physical quantities: the mass and the velocity of the moving object in the frame of reference.

We know,

$p = m \times v$

where p is the momentum, m is the mass and v is the velocity.

Since, in the above case both the mass and velocity of clay ball and plastic ball are same and they are travelling in the same frame of reference their momentum will be equal.

Thus, the wall will receive equal momentum from both plastic and clay ball.

52. Question

A moving bicycle comes to rest after sometimes if we stop pedaling it. But Newton’s first law of motion says that a moving body should continue to move forever, unless some external force acts on it. How do you explain the bicycle case?

Answer

There is an external force of friction between the tyres and the road and in the axles of the bicycle acting which resists the motion and hence tends to stop the cycle.

53. Question

A man throws a ball weighing 500 g vertically upwards with a speed of 10 m/s.

(i) What will be its initial momentum?

(ii) What would be its momentum at the highest point of its flight?

Answer

(i) The momentum, p = mv.

The values of mass and velocity are given as

Mass, m =500g = 0.5 kg

Initial velocity, u = 10 m / s

Initial Momentum = mu

= 0.5 ×10 = 5 kg m/s

(ii) At the highest point, the velocity of the ball will be zero. So, its momentum is zero.

54. Question

A car is moving on a level road. If the driver turns off the engine of the car, the car's speed decreases gradually and ultimately it comes to a stop. A student says that two forces act on the car which brings it to a stop. What could these forces be? Which of these two forces contributes more to slow down and stop the car?

Answer

These forces would be the air friction and the friction between the tires and the road which would tend to bring the car at rest. Frictional force would contribute more in stopping the car.

55. Question

There are two types of forces X and Y. The forces belonging to type X can produce motion in a stationary object but cannot change the shape of the object. On the other hand, forces belonging to type Y cannot produce motion in a stationary object but can change the shape of the object. What is the general name of the forces such as (a) X, and (b) Y?

Answer

(a) Unbalanced forces as these forces are not opposite in direction and equal in size always cause a change in motion.

(b) Balanced forces as balanced forces can cause an object to stay at rest or at constant velocity but don't change the motion of the object rather may change the shape.

Very Short Answer Type Questions-Pg-74

1. Question

Which physical quantity corresponds to the rate of change of momentum?

Answer

Force is the rate of change of momentum. The SI unit of force is the Newton and it's symbol is 'N'.

2. Question

State the relation between the momentum of a body and the force acting on it.

Answer

Consider a body of mass m, initial velocity of magnitude u, a force F acts on the body to a final velocity of magnitude v. We have from Newton's second law F= m(v-u)/t or F = (mv-mu)/t. mu is the initial momentum of the body and mv is the final momentum of the body.

Force = rate of change of momentum.

F = DP/Dt or Dp = F x Dt

The FDt is called the impulse of the force F.

The change in momentum can be calculated by the area under the graph of force against time.

F = D (mv)/Dt

= m/Dt x Dv.

3. Question

What is the unit of force?

Answer

The SI unit of force is the Newton and it's symbol is 'N'.

4. Question

Define one Newton force.

Answer

The force which when applied on a body of mass of 1 kg provides the acceleration of 1 m/s^2 is known as 1 Newton force.

1 Newton force = 1 kg m/s^2

5. Question

What is the relationship between force and acceleration?

Answer

Newton's second law of motion describes the relationship between force and acceleration.

The force is defined as the rate of change of momentum of a body

OR in mathematical terms,

F= dP/dt

where P is momentum that is equal to m*v, where m is mass of the body and v is its velocity.

Putting this value, we get

F= d (mv)/dt

If the mass of the body is constant not variable then m is constant and can be taken out

F= m (dv/dt)

Now rate of change of velocity with respect to time is acceleration, a

So, F = ma

6. Question

If the mass of a body and the force acting on it are both doubled, what happens to the acceleration?

Answer

The acceleration would remain the same. It can be explained as-

We know, F=ma a=F/m

When both Force and Mass are doubled it means

A = 2F/2m

= F/m

Hence, acceleration remains constant.

7. Question

Name the physical quantity whose unit is ‘Newton’.

Answer

'Newton' is the unit of force which can be defined as the rate of change in Momentum.

8. Question

Which physical principle is involved in the working of a jet airplane?

Answer

Simply by Newton's third law I.e. conservation of momentum. The jet engine exerts force rearwards by throwing high velocity jet of air and as a reaction the plane moves forward.

9. Question

Name the principle on which a rocket works.

Answer

It relates with the principle of Newton's 3rd law of motion stated as "for every action there is a equal and opposite reaction". When the force on with holds the rocket then, the rocket pushes itself through the ground and hence, this is the principle on which a rocket works and flies into space.

10. Question

Is the following statement true or false :

A rocket can propel itself in a vacuum.

Answer

True: Rockets and engines in space behave according to Isaac Newton's third law of motion: Every action produces an equal and opposite reaction. When a rocket shoots fuel out one end, this propels the rocket forward — no air is required.

11. Question

What is the force which produces an acceleration of 1 m/s^2 in a body of mass 1 kg?

Answer

Newton produces an acceleration of 1 m/s^2 in a body of mass 1 kg.

1 Newton force = 1 kg m/s^2

12. Question

Find the acceleration produced by a force of 5 N acting on a mass of 10 kg.

Answer

Force, F= 5N

Mass, m=10 kg

Let, the acceleration be 'a'

We know,

F =ma

a= F/m

=5/10

= 0.5 m/s^2

13. Question

A girl weighing 25 kg stands on the floor. She exerts a downward force of 250 N on the floor. What force does the floor exert on her?

Answer

250N (Due to the 3rd law of motion)

14. Question

Name the physical quantity which makes it easier to accelerate a small car than a large car.

Answer

Mass of the car would make it easier to accelerate a small car than a large car. Since, mass is inversely proportional to acceleration. Hence, lesser the mass more the acceleration it would have.

15. Question

Fill in the following blanks with suitable words:

(a) To every action, there is an ……. and ……..reaction.

(b) Momentum is a ……..quantity. Its unit is …….

(c) Newton's second law of motion can be written as Force = mass × …… or Force = …….. or change of ……

(d) Forces in a Newton's third law pair have equal …… but act in opposite ……

(e) In collisions and explosions, the total …… remains constant, provided that no external …… acts.

Answer

(a) equal; opposite (As per Newton's third law)

(b) Vector; kg m/s (As momentum is the product of mass and velocity and velocity is a vector quantity)

(c) Acceleration; rate; momentum

(d) Magnitude; directions (Conservation of momentum)

(e) Momentum; force; (Explained in conservation of momentum)

Short Answer Type Questions-Pg-74

16. Question

Explain the meaning of the following equation:

$F = m \times a$

Where symbols have their usual meaning.

Answer

F is the net force applied,

m is the mass of the body,

And a is the body's acceleration. Thus, the net force applied to a body produces a proportional acceleration. This states that the rate of change of momentum of a body, is directly proportional to the force applied and this change in momentum takes place in the direction of the applied force.

17. Question

To take the boat away from the bank of a river, the boatman pushes the bank with an oar. Why?

Answer

Pushing of the river bank is an action, the river thus pushes back the boat in the forward direction as a reaction in accordance with the Newton's third law of motion which states that every action has a equal and opposite reaction.

18. Question

Why does a gunman get a jerk on firing a bullet?

Answer

This is because when the bullet is fired from the gun, it moves forwards and exerts a force on the gun; an equal amount of force is exerted on the bullet by the gun. This is because according to third law of motion, when a force is applied on a body, the body exerts an equal and opposite force on another body.

19. Question

If action is always equal to reaction, explain why a cart pulled by a horse can be moved.

Answer

When horse is moving forward it applies a backward effort towards the ground, meaning that when the horse push the ground backwards from his feet then the ground also exerts a forward push on the horse. That is why the horse moves and so the cart along with it.

20. Question

Explain how a rocket works.

Answer

Rockets are great examples of how forces make things move. ... This can be explained by the force what's often called "action and reaction" (another name for Newton's third law of motion). During the launching of rocket the hot exhaust gas firing down act as the action force creating an equal and opposite force as the reaction that speeds the rocket up.

21. Question

Do action and reaction act on the same body or different bodies? How are they related in magnitude and direction? Are they simultaneous or not?

Answer

Action and reaction always acts on two different bodies.

For example: A boatman jumps out of the boat and then boat goes backwards. Here jumping of boatman is action and backward motion of boat is reaction.

They are equal in magnitude and opposite in direction. And yes they are simultaneous.

22. Question

If a man jumps out from a boat, the boat moves backwards. Why?

Answer

This can be explained by Newton's Third law: The mutual forces of action and reaction between two bodies are equal, opposite and collinear.

Jumping off the boat is the action, and as a result the boat moves backward is the reaction. This is the reason why boat moves backward when the man jumps out of the boat.

23. Question

Why is it difficult to walk on a slippery road?

Answer

You push backward with your feet. Newton's third law: the ground pushes you forward. But that interaction is friction. Reduce friction and it doesn't matter how strong your legs are, the surface is incapable of pushing you accordingly. The coefficient of static friction is very low so it is easy to slide your foot rather than push. Accordingly, the ground doesn't push back.

24. Question

Explain why, a runner presses the ground with his feet before he starts his run.

Answer

According to Newton's third law of motion to every action there is an equal and opposite reaction. When runners push the ground the ground also push the runner with an equal and opposite force which he utilizes to run fast. Runners push the ground so he can gain more reaction force from ground. The harder the runner pushes the ground, the more force he can gain to move forward.

25. Question

A 60 g bullet fired from a 5 kg gun leaves with a speed of 500 m/s. Find the speed (velocity) with which the gun recoils (jerks backwards).

Answer

Mass of bullet, m1 = 0.06 kg,

Speed of bullet, v1 = 500m/s

Mass of gun, m2 = 5kg,

Velocity of recoil of gun, v2 = ?

By using the law of conservation of momentum,

$0.06 \times 500 = 5 \times v2$

v2 = 0.06*500/5

= 6m/s

Hence, the gun recoils with the velocity of 6m/s.

26. Question

A 10 g bullet travelling at 200 m/s strikes and remains embedded in a 2 kg target which is originally at rest but free to move. At what speed does the target move off?

Answer

Mass of bullet, m = 10 g

= 0.01 kg

Speed of bullet, v = 200 m/s

Mass of target, M = 2 kg

Combine speed after hitting target = V

Before collision, momentum of the system is = mv = 2

After collision, the bullet and target move together. Their combined mass is (m+M) = 2.01 kg

So, the momentum of the system after collision is = 2.01V

Applying conservation of momentum,

Momentum of the system before collision = momentum of the system after collision

2 = 2.01 V

V = 0.99 m/s

This is the combined velocity of the target and bullet after the collision.

27. Question

A body of mass 2 kg is at rest. What should be the magnitude of force which will make the body move with a speed of 30 m/s at the end of 1 s?

Answer

Given:

Mass of Body, m = 2 kg

Initial velocity, u = 0 m/s

Final velocity, v = 30 m/s

Time, t = 1 s

We know,

F = mafrom, First equation of motion $v = u + a \times t$ We get,

$a = \frac{v - u}{t}$ a=30 m/sec^2

F = m × a = 2 × 30 =60 N

28. Question

A body of mass 5 kg is moving with a velocity of 10 m/s. A force is applied to it so that in 25 seconds, it attains a velocity of 35 m/s. Calculate the value of the force applied.

Answer

According to the question we have:-Mass of body, m = 5kg

Initial velocity, u=10m/s

Final velocity, v=35m/s

Time taken, t=25s

We know that,

$v = u + at$

Putting the values we get,

$\Rightarrow$ 35m/sec = 10 m/sec + a×25 sec

$\Rightarrow$ (35 - 10) m/sec = a×25 sec

$\Rightarrow$ 25 m/sec = a×25 sec

$\Rightarrow a = 1 m/sec^2$

Now, using Newton's Second law of motion, we get,

F= ma

$F = 5kg \times 1m/sec^2$

$F = 5kg\text{-}m/sec^2$

F = 5 Newton

29. Question

A car of mass 2400 kg moving with a velocity of 20 m s^{-1} is stopped in 10 seconds on applying brakes. Calculate the retardation and the retarding force.

Answer

Mass, m = 2400 kg

Initial velocity, u = 20 m/s

Time, t = 10 s

Final velocity, v = 0 m/s

We know that,

a = v-u/t

=-20/10

$=-2 m/s^2$

Now,

Force, F = ma

=2400 (-2)

= 4800 N

30. Question

For how long should a force of 100 N act on a body of 20 kg so that it acquired a velocity of 100 m/s?

Answer

Force F = m (v-u)/t .....equation 1

u is initial velocity = 0

v is final velocity = 100m/s

F = 100N

m = 20kg

Putting these values in equation 1 we can find time t

100 = 20(100-0)/t

t = 20 seconds

31. Question

How long will it take a force of 10 N to stop a mass of 2.5 kg which is moving at 20 m/s?

Answer

Force applied (F) = -10 N (since the force is acting in the opposite direction of motion or opposing the motion)

Mass of body (m) = 2.5kg

Initial velocity of body (u) = 20m/s

Final velocity of body (v) = 0m/s

According to Newton's second law of motion

F = ma

-10 = 2.5×a

-10/2.5 = v-u/t (since a = v-u/t)

-4t = 0 - 20

t = -20/-4

t = 5 sec

32. Question

The velocity of a body of mass 10 kg increases from 4 m/s to 8 m/s when a force acts on it for 2 s.

(a) What is the momentum before the forces acts?

(b) What is the momentum after the force acts?

(c) What is the gain in momentum per second?

(d) What is the value of the force?

Answer

Mass of the body, m = 10 kg

Initial velocity, u = 4 m/s

Final velocity, v = 8 m/s

Time, t = 2s

(a) Initial Momentum, p1 = mu

= 10 × 4 = 40 kg m/s

(b) Final Momentum, p2 = mv

= 10× 8= 80 kg m/s

(c) Gain in momentum for 2s = p2 – p1 = 40kg m/s

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

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

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

33. Question

A gun of mass 3 kg fires a bullet of mass 30 g. The bullet takes 0.003 s to move through the barrel of the gun and acquires a velocity of 100 m/s Calculate:

(i) The velocity with which the gun recoils.

(ii) The force exerted on gunman due to recoil of the gun

Answer

(i) For gun,

M_1 =3 kg(Given)

V_1 =?

For bullet,

M_2 = 30 g = 0.03kg (As 1kg=1000g)

V_2 = 100m/s

By law of conservation of momentum

$M_1 \times V_1 = M_2 \times V_2$

$3 \times V_1 = 0.03 \times 100$

$V_1 = 0.03 \times 100 / 3$ **V_1 = 1m/s**

Hence, the velocity of recoil of gun is 1m/s

(ii) Acceleration of bullet, a = v-u/t

$100-0/0.003 = 33333.33 m/s^2$

We know that:-Force, F = ma

$= 0.03 \times 33333.33$

= **1000 N**

34. Question

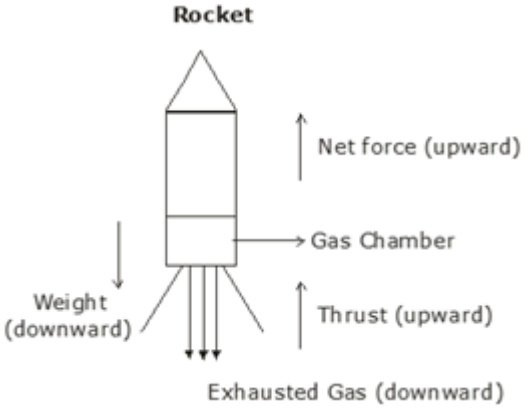
Draw a diagram to show how a rocket engine provides a force to move the rocket upwards. Label the diagram appropriately.

Answer

Rocket works on the principle of Newton's third law of motion.

Every action there is equal and opposite reaction.

When exhausted gas moves downward, they provide equal amount of force on the rocket in upward direction, therefore rocket gets the thrust in upward direction.



35. Question

Name the laws involved in the following situations:

(a) The sum of products of masses and velocities of two moving bodies before abd after their collision remains the same.

(b) A body of mass 5 kg can be accelerated more easily by a force than another body of mass 50 kg under similar conditions

(c) When person A standing on roller skates pushes another person B (also standing on roller skates) and makes him move to the right side, then the person A himself gets moved to the left side by an equal distance.

(d) If there were no friction and no air resistance, then a moving bicycle would go on moving forever.

Answer

(a) The name of the corresponding law is law of conservation of momentum. It can be derived from Newton's laws of motion.

(b) The name of corresponding law is Newton's second law of motion which proves that the acceleration of the body is inversely proportional to its mass.

(c) In this Newton's third law of motion is involved which says that every action has a equal and opposite reaction.

(d) This involves Newton's first law of motion or the law of inertia which states that n object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

Long Answer Type Questions-Pg-75

36 A. Question

State and explain Newton’s second law of motion.

Answer

The second law states that the rate of change of momentum of a body is directly proportional to the force applied and this change in momentum takes place in the direction of the applied force.

Acceleration is produced when a force acts on a mass. The greater the mass (of the object being accelerated) the greater the amount of force needed (to accelerate the object).

36 B. Question

A 1000 kg vehicle moving with a speed of 20 m/s is brought to rest in a distance of 50 metres:

(i) Find the acceleration.

(ii) Calculate the unbalanced force acting on the vehicles.

Answer

Vehicle Mass = 1000 kg

Initial Velocity (that is speed) let it be u = 20 ms-1

Final Velocity let it be v= 0ms-1

Distance travelled = 50 m

Let the acceleration be "a"

From equation = v2 = u2 + 2as

Putting all value

0= 20 + 2*a*50

0= 400+ 100a

0- 400= 100a (Side changing)

-400 = 100a

-400/ 100 = a (Side changing)

-4= a

a = -4 m/s^2

This shows that the acceleration is in opposite direction that means it is retardation.

Retardation = 4m/s^2

37 A. Question

Explain why, a cricket player moves his hands backwards while catching a fast cricket ball.

Answer

A cricketer moves his hand backwards because by doing this he increases the time due to which the rate of change of momentum decreases. That means that the ball comes to rest gently and does not hurt the fielder. But, if does not move his hand backwards, then the ball would come to rest in a fraction of a second with a high rate of change of momentum. The ball will exert a lot of force on the hands of the fielder which will hurt him.

37 B. Question

A 150 g ball, travelling at 30 m/s, strikes the palm of a player's hand and is stopped in 0.05 second. Find the force exerted by the ball on the hand.

Answer

Mass of ball = 150g = 0.15kg

Initial velocity, u = 30 m/s

Final velocity, v = 0m/s (as player stops the ball)

Time, t = 0.05s (as player stops ball in 0.05s)

Force, F = m x a

F = m x v-u/t

F = 0.15 x 0-30/0.05

F = 3 x -30

F = -90 N

38 A. Question

State Newton's third law of motion and give two examples to illustrate the law.

Answer

The third law states that all forces between two objects exist in equal magnitude and opposite direction: if one object A exerts a force FA on a second object B, then B simultaneously exerts a force FB on A, and the two forces are equal in magnitude and opposite in direction: FA = −FB

38 B. Question

Explain why, when a fireman directs a powerful stream of water on a fire from a hose pipe, the hose pipe tends to get backward.

Answer

The water from the house pipe rushes out with great speed in forward direction (action of house pipe on water).Then due to Newton's 3rd law of motion the house pipe moves in backward direction as a reaction.

39 A. Question

State the law of conservation of momentum.

Answer

The law of conservation of momentum states that for any two objects colliding in an isolated system, the total momentum before and after the collision is equal. This is because the momentum lost by one object is equal to the momentum gained by the other.

39 B. Question

Discuss the conservation of momentum in each of the following cases:

(i) A rocket taking off from ground.

(ii) Flying of a jet airplane.

Answer

(i) Before launch, the total momentum of a rocket and its fuel is zero. During launch, the downward momentum of the expanding exhaust gases just equals in magnitude the upward momentum of the rising rocket, so that the total momentum of the system remains constant—in this case, at zero value. In a collision of two particles, the sum of the two momentum before collision is equal to their sum after collision.

(ii) In airplane, the turbine works the compressor and drives the gas through tail piece of engine at larger speed. This results in forward momentum and jet moves forward. The forward momentum is equal to backward momentum of gases. The rates of burning and ejection of gases in the fuel burning chamber is adjusted to get desired increase momentum in the forward direction.

40 A. Question

If a balloon filled with air and its mouth unties, is released with its mouth in the downward direction, it moves upwards. Why?

Answer

It moves in the upwards direction because according to Newton's third law of motion EVERY ACTION HAS IT'S OPPOSITE AND EQUAL REACTION and therefore when the air starts coming out from the mouth of the balloon(ACTION) in the downward direction, as a reaction the balloon moves upward .

40 B. Question

An unloaded truck weighing 2000 kg has a maximum acceleration of 0.5 m/s2. What is the maximum acceleration when it is carrying a load of 2000 kg?

Answer

For unloaded truck,

Mass, m = 2000 kg

$a = 0.5\ m/s^2$

Now, using F = ma

F = 2000 x 0.5

= 1000 N

For loaded truck,

m = 2000 + 2000 = 4000 kg

F = 1000 N (remains unchanged)

Again,

F = ma

a = F/m

= 1000/4000

$= 0.25\ m/s^2$

Multiple Choice Questions (MCQs)-Pg-76

41. Question

The rocket work on the principle of conservation of:

A. Mass B. Energy

C. Momentum D. Velocity

Answer

When exhausted gas moves downward, they provide equal amount of force on the rocket in upward direction, therefore rocket gets the thrust in upward direction.

42. Question

An object of mass 2 kg is sliding with a constant velocity of 4 m/s on a frictionless horizontal table. The force required to keep this object moving with the same velocity is:

A. 32 N B. 0 N

C. 2 N D. 8 N

Answer

As according to the law of inertia the object will keep moving with the same velocity if no external force is applied.

43. Question

The physical quantity which makes it easier to accelerate a small car than a large is measures in the unit of:

A. m/s B. kg

C. kg m/s D. kg m/s^2

Answer

As it's the unit of mass.

44. Question

According to the third law of motion, action and reaction:

A. Always act on the same body but in opposite directions

B. Always act on different bodies in opposite directions

C. Have same magnitudes and directions

D. Act on either body at normal to each other

Answer

That is the reason why Momentum remains conserved.

45. Question

The unit of measuring momentum of a moving body is:

A. $m\ s^{-1}$ B. $kg\ m\ s^{-1}$

C. $kg\ m\ s^{-2}$ D. $Nm^2\ kg^{-2}$

Answer

Since, Momentum is the product of mass and velocity.

46. Question

A boy of mass 50 kg standing on ground exerts a force of 500 N on the ground. The force exerted by the ground on the boy will be:

A. 50 N B. 25000 N

C. 10 N D. 500 N

Answer

As per 3rd law of motion which states that every action has equal and opposite reaction.

47. Question

A Honda City car, A Maruti Alto car, A Tata Nano car and a Mahindra Scorpio car, all are running at the same speed of 50 m/s under identical conditions. If al these cars are hit from behind with the same force and they continue to move forward, the maximum acceleration will be produced in: Mass of the different vehicles: Honda City – 1150Kg, Maruti Alto-720Kg, Tata Nano-600Kg,Mahindra Scorpio-2510Kg

A. Honda City B. Maruti Alto

C. Tata Nano D. Mahindra Scorpio

Answer

Since the speed of all the vehicles are same, hence the accelaration will depend on the the mass of the object.

Since, Accelaration is inversely proportional to the mass of the object.

Hence, the maximum accelaration will be of Tata Nano.

48. Question

The acceleration produced by a force of 5 N acting on a mass of 20 kg in m/s2 is:

A. 4 B. 100

C. 0.25 D. 2.5

Answer

As per Newton's 2nd law of motion where F = ma

49. Question

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 is 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

Answer

As the second law states that the rate of change of momentum of a body, is directly proportional to the force applied and this change in momentum takes place in the direction of the applied force.

50. Question

A fielder pulls his hands backwards after catching the cricket ball. This enables the fielder to:

A. Exert larger force on the ball

B. Reduce the force exerted by the ball

C. Increase the rate of change of momentum

D. Keep the ball in hands firmly

Answer

As it increases the time taken to bring the momentum to zero.

Questions Based on High Order Thinking Skills (HOTS)-Pg-77

51. Question

Why are car seat-belts designed to stretch somewhat in a collision?

Answer

When a car is moving with a high velocity, its momentum is also high and the people in the vehicle are also in the same momentum. We know that momentum is inversely proportional to time. So if the momentum is bought to 0 at a short time then force acting on a body is very large. So when a car meets with an accident, the person falling front with the presence of stretchable seat belt as these elastic seat belt reduce the momentum in more time to reduce the force.

52. Question

The troops (soldiers) equipped to be dropped by parachutes from an aircraft are called paratroopers. Why do paratroopers roll on loading?

Answer

When you hit the ground, the ground exerts a force up on you to stop you. The force which it exerts depends on how long the collision lasts. You have no control over your mass or the speed you hit the ground, but you can increase the time and reduce the rate of change in momentum and rolling is one such trick. Hence, we would get less hurt.

53. Question

Why would an aircrafts be unable to fly on the moon?

Answer

An aircraft needs air due to following reasons:

(i) Air moving under the wings of aircraft is strong enough to hold it up, and

(ii) Air burns the fuel in aircraft engines.

Since there is no air on moon, an aircraft cannot fly on the moon.

54. Question

Explain why it is possible for a small animal to fall from a considerable height without any injury being caused when it reaches the ground.

Answer

The amount of downward force on a falling object depends on its weight. The greater the mass, the greater the force will be, and, therefore, the greater the terminal velocity. It is important to understand, that

acceleration due to gravity is the same for all objects; it is the drag factor that causes the variations with weight and shape.

A large person will fall faster than a small person due to the greater weight of the large person in relation to the cross-sectional area as compared to the small person.For a very light person, the drag will eventually become equal to the weight of the person and therefore very small animals such as mice when dropped from large height will escape un hurt.

55. Question

A boy of mass 50 kg running at 5 m/s jumps on to a 20 kg trolley travelling in the same direction at 1.5 m/s. What is their common velocity?

Answer

Using conservation of momentum

MV + mv = (M + m) v'

Where:

M - Mass of the boy - 50kg

m - Mass of the trolley - 20kg

V- Velocity of the boy - 5m/s

v - Velocity of the trolley - 1.5m/s

v' - common velocity - x

(50+20) x = (50x5 +20x1.5)

x= 4m/s.

Hence, the common velocity is 4m/s.

56. Question

A girl of mass 50 kg jumps out of a rowing boat of mass 300 kg on the bank, with a horizontal velocity of 3 m/s. With what velocity does the boat begin to move backwards?

Answer

Mass of girl, m_1= 50kg

Mass of the boat, m_2= 300kg

Velocity of the girl, v_1= 3m/s

v_2=? we have to find it

We know,

According to Law of conservation of momentum,

= $m_1v_1 + m_2v_2$= 0 (As no initial velocity is applied)

$\Rightarrow 50 \times 3 + 300 \times v_2 = 0$

$v_2 = -150/300$

$= (-0.5 m/s)$

Since, the boat is moving in backward direction the velocity (v_2) will be 0.5m/s in the backward direction.

57. Question

A truck of mass 500 kg moving at 4 m/s collides with another truck of mass 1500 kg moving in the same direction at 2 m/s. What is their common velocity just after the collision if they move off together?

Answer

Let

m1=500,

m2=1500

u1=4m/s

u2=2m/s

v1=v2 (since after collision they stuck together)

According to law of conservation of momentum,

m1u1 + m2u2 = m1v1 + m2v2

500 x 4 + 1500 x 2 = (500 + 1500) v

5000 = 2000v

v = 5000/2000

v = 2.5m/s

58. Question

A ball X of mass 1 kg travelling at 2 m/s has a head-on collision with an identical ball Y at rest. X stops and Y moves off. Calculate the velocity of Y after the collision.

Answer

Mass of ball X, m1 = 1 kg

Mass of ball Y, m^2 = 1kg

According to conservation of momentum,

m1u1 + m2u2 = m1v1 + m2v2

1*2 + 1*0 = 1*0 + 1*v2

2 + 0 = 0 + v2

v2 = 2 m/s

59. Question

A heavy car A of mass 2000 kg travelling at 10 m/s has a head-on collision with a sports car B of mass 500 kg. If both cars stop dead on colliding, what was the velocity of car B?

Answer

Applying conservation of momentum,

P1 = P2

Mass of car A be 2000kg

Mass of car B be 500kg

Velocity of car A before impact = Va = 10m/s

Velocity of car B before impact = Vb=?

Velocity of car A after impact = 0

Velocity of Car B after impact = 0

2000 Va + 500Vb = 2000×0 + 500×0

2000 × 10 + 500Vb = 0

Vb = - 20000/500 = - 40m/s

Negative sign shows that direction of Va and Vb are opposite.

60. Question

A man wearing a bullet-proof vest stands still on roller skates. The total mass is 80 kg. A bullet of mass 20 grams is fired at 400 m/s. It is stopped by the vest and falls to the ground. What is then the velocity of the man?

Answer

m - Mass of bullet

= 0.02 kg

M - Mass of man

= 80 kg

u - Initial velocity of bullet

= 400 m/s

U - Initial velocity of man

= 0 m/s

v - Final velocity of bullet

= 0 m/s

V - Final velocity of man

Using conservation of momentum

Initial momentum = Final momentum

M * u + M * U = m * v + M * V

0.02 * 400 + 80 * 0 = 0.02 * 0 + 80 * V

8 = 80 * V

V = 0.1 m/s

Therefore, the man moves with a velocity of 0.1 m/s