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SUB : Science
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CHAPTER 9

Force and Laws of Motion

ONE MARK QUESTIONS

1. Define force.

Ans :

It is a push or pull on an object that produces acceleration in the body on which it acts.

2. What is balanced force?

Ans :

When forces acting on a body from the opposite direction do not change the state of rest or of motion of an object, such forces are called balanced forces.

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3. What is frictional force?

Ans :

The force that always opposes the motion of object is called force of friction.

4. What is inertia?

Ans :

The natural tendency of an object to resist a change in their state of rest or of uniform motion is called inertia.

5. State Newton's first law of motion.

Ans :

An object remains in a state of rest or of uniform motion in a straight line unless acted upon by an external unbalanced force.

6. State Newton's second law of motion.

Ans :

The rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of the force.

7. What is momentum?

Ans :

The momentum of an object is the product of its mass and velocity and has the same direction as that of the velocity. The SI unit is kg m/s. ($p = mv$)

8. State Newton's third law of motion.

Ans :

To every action, there is an equal and opposite reaction and they act on two different bodies.

9. Which will have more inertia a body of mass 10 kg or a body of mass 20 kg?

Ans :

A body of mass 20 kg will have more inertia, as inertia is measure of mass.

10. Name the factor on which the inertia of the body depends.

Ans :

Inertia of a body depends upon the mass of the body.

11. Name two factors which determine the momentum of a body.

Ans :

Two factors on which momentum of a body depend is mass and velocity. Momentum is directly proportional to the mass and velocity of the body.

12. What decides the rate of change of momentum of an object?

Ans :

The rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of force.

13. Why do athletes run some distance before jumping?

Ans :

Athlete has the inertia of motion and thus continues to move past the line.

14. How is inertia measured quantitatively?

Ans :

Quantitatively the inertia of an object is measured by its mass.

15. The fruits fall off the branches when a strong wind blows. Give reason.

Ans :

Fruits tend to continue in the state of rest on account of inertia while branches suddenly come into motion.

16. Name the physical quantity which is determined by the rate of change of linear momentum.

Ans :

Force.

17. Why action and reaction do not cancel each other?

Ans :

Action and reaction act simultaneous but on different objects. Hence, they do not cancel each other.

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

Ans :

When a man jumps out of a boat to the bank of the river, he supplies a force in the forward direction. Due to the reaction of this, the boat moves backwards.

19. Explain our walking in terms of Newton's third law of motion.

Ans :

When we walk on ground, our foot pushes the ground backward and in return the ground pushes our foot forward. The forward reaction exerted by the ground on our foot makes us walk forward.

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20. There are three solid balls, made up of aluminium, steel and wood of the same shape and volume. Which of them would have highest inertia? Why?

Ans :

Steel ball because the density of steel is maximum. For the same shape and volume, steel ball will have maximum mass.

21. It is easier to push an empty box than to push the box full of books. Give reason.

Ans :

This is because the empty box has less inertia of rest than the box full of books.

22. No force is required to move an object with a constant velocity. Why?

Ans :

For an object moving with a constant velocity, a = 0, so F = ma = 0

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

Ans :

The time of impact of vehicles is very small at high speed. So, they exert very large forces on each other. Hence, road accidents at high speeds are highly fatal.

24. Is force a scalar quantity or a vector quantity?

Ans :

Force is a vector quantity. It has both magnitude and direction.

25. Define SI unit of force.

or

What is one Newton force?

Ans :

A Newton is that force which act on a body of mass of 1 kg to produce an acceleration of 1 ms^{-2} in it.

26. Two similar trucks are moving with the same velocity on a road. One of them is loaded while the other one is empty. Which of the two will require a larger force to stop it?

Ans :

The loaded truck will require a larger force to stop because it has greater momentum.

27. Name the scientist who introduced the property of momentum.

Ans :

Newton.

28. What is the direction of momentum?

Ans :

The direction of momentum is the same as that of velocity.

29. Which type of force does not change the state of rest or of motion of an object?

Ans :

Balanced force.

30. If a ball is thrown up in a moving train, it comes back to the person's hands. Why?

Ans :

This is because no horizontal force acts on it. It moves with the same horizontal speed.

31. Which type of force brings an object in motion?

Ans :

Unbalanced force.

THREE MARKS QUESTIONS

32. Why all cars are provided with seat belts?

Ans :

Sudden movement of the vehicle results in the sudden change in the state of motion of the vehicle when our feet are in contact with it. But the rest of our body opposes this change due to its inertia and tends to remain where it was. Seat belts are provided to protect the passengers from falling backward or forward during such situation.

33. Why we tend to get thrown to one side when a motorcar makes a sharp turn at a high speed?

Ans :

We tend to get thrown to one side when a motorcar makes a sharp turn at a high speed due to law of inertia. When we are sitting in moving car on a straight road, we tend to continue in our straight-line motion. But when an unbalanced force is applied on car to change the direction of motion, we slip to one

side of the seat due to the inertia of our body.

34. Why do fielders pull their hand gradually with the moving ball while holding a catch?

Ans :

While catching a fast moving cricket ball, a fielder on the ground pulls his hands backwards with the moving ball. This is done so that the fielder increases the time during which the high velocity of the moving ball decreases to zero. Thus, the acceleration of the ball is decreased and therefore, the impact of catching the fast moving ball is reduced.

35. Why are athletes made to fall either on a cushioned bed or on a sand bed in a high jump athletic event?

Ans :

In a high jump athletic event, athletes are made to fall either on a cushioned bed or on a sand bed so as to increase the time of the athlete's fall to stop after making the jump. This decreases the rate of change of momentum and hence the force.

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36. Why are roads on mountains inclined inwards at turns?

Ans :

A vehicle moving on mountains is in the inertia of motion. At a sudden turn there is a tendency of vehicle to fall off the road due to sudden change in the line of motion hence the roads are inclined inwards so that the vehicle does not fall down the mountain.

37. Why do athletes have a special posture with their right foot resting on a solid supporter for athletic races?

Ans :

Athletes have to run the heats and they rest their foot on a solid supports before start so that during the start of the race the athlete pushes the support with lot of force and this support gives him equal and opposite push to start the race.

38. How are safety belts helpful in preventing any accidents?

or

Why do you think it is necessary to fasten your seat belts while travelling in your vehicle?

Ans :

While travelling in a moving car, our body remains in the state of rest with respect to the seat. But when driver applies sudden breaks in the car, our body tends to continue in the same state of motion because of its inertia. Therefore, this sudden break may cause injury to us by impact or collision. Hence, safety belt exerts a force on our body to make the forward motion slower.

39. Why you get hurt by hitting a stone while when you kick a football it flies away?

Ans :

This is because stone is heavier than football and heavier objects offer larger inertia. When we kick a football its mass is less and inertia is also less so force applied by our kick acts on it and hence it shows larger displacement but in case of stone, it has more mass and offers larger inertia. When we kick (action) the stone it exerts an equal and opposite force (reaction) and hence it hurts the foot.

40. If a person jumps from a height on a concrete surface he gets hurt. Explain.

Ans :

When a person jumps from a height he is in state of inertia of motion. When he suddenly touches the ground he comes to rest in a very short time and hence the force exerted by the hard concrete surface on his body is very high, and the person gets hurt.

41. What is the relation between Newton's three laws of motion?

Ans :

(i) Newton's first law explains about the unbalanced force required to bring change in the position of the body.
(ii) Second law explains about the amount of force required to produce a given acceleration.
(iii) While Newton's third law explains how these forces acting on a body are interrelated.

42. Give any three examples in daily life which are based on Newton's third law of motion.

Ans :

Three examples based on Newton's third law are :
Swimming : We push the water backward to move forward.
(i) Action - water is pushed behind
(ii) Reaction - water pushes the swimmer ahead
Firing gun : A bullet fired from a gun and the gun recoils.
(i) Action - gun exerts force on the bullet
(ii) Reaction - bullet exerts an equal and opposite force on the gun
Launching of rocket :
(i) Action - hot gases from the rocket are released
(ii) Reaction - the gases exert upward push to the rocket

43. Why does a ball rebound after striking against a floor?

Ans :

When a ball strikes against a floor, it exerts a force on the floor. According to Newton's third law of motion, the floor exerts an equal and opposite force on the ball. Due to this reaction, the ball rebounds.

44. How do we swim?

Ans :

While swimming, a swimmer pushes the water backward with his hands. The reaction offered by the water to the swimmer pushes him forward.

45. Which concept is behind the phenomenon- "A

boatman pushes the river bank with a bamboo pole to take his boat into the river".

Ans :

When the boatman pushes the river bank with a bamboo pole, the river bank offers an equal and opposite reaction. This reaction helps the boat to move into the river.

46. Why does a fireman struggle to hold a hose-pipe?

Ans :

A fireman has to make a great effort to hold a hose-pipe to throw a stream of water on fire to extinguish it. This is because the stream of water rushing through the hose-pipe in the forward direction with a large speed exerts a large force on the hose-pipe in the backward direction.

47. Why is the movement of a rocket in the upward direction?

Ans :

(i) The movement of a rocket in the upward direction can also be explained with the help of the law of conservation of momentum.

(ii) The momentum of a rocket before it is fired is zero. When the rocket is fired, gases are produced in the combustion chamber of the rocket due to the burning of fuel. These gases come out of the rear of the rocket with high speed. The direction of the Momentum of the gases coming out of the rocket is in the downward direction. To conserve the momentum of the system (rocket gases), the rocket moves upward with a momentum equal to the momentum of the gases. The rocket continues to move upward as long as the gases are ejected out of the rocket.

48. What happens when a quick jerk is given to a smooth thick cardboard placed on a tumbler with a small coin placed on the cardboard? The coin will fall in the tumbler. Why?

Ans :

The coin was initially at rest. When the cardboard moves because of the jerk, the coin tends to remain at rest due to inertia of rest. When the cardboard leaves contact with the coin, the coin falls in the tumbler on account of gravity.

49. Explain why- An inflated balloon lying on the surface of a floor moves forward when pierced with a pin.

Ans :

The momentum of the inflated balloon is zero before it is pierced with a pin. Air comes out with a speed in the backward direction from balloon after it is pierced with a pin. The balloon moves in the forward direction to conserve the momentum.

50. How can force change the state of motion of the objects?

Ans :

Force can bring objects into motion by pushing hitting and pulling them.

51. State Newton's three laws of motion.

Ans :

Sir Isssac Newton further studied the idea of Galileo's on force and motion and presented three laws of motion. These laws are as follows :

(i) **First Law :** A body remains in resting position unless it is not introduced with an unbalanced external force.

(ii) **Second Law :** The rate of change of momentum of a body is directly proportional to the applied unbalanced force and change takes place in the direction of the force.

(iii) **Third law :** Action and reaction are equal and opposite and they act on different bodies.

52. State the law of conservation of momentum.

Ans :

(i) Momentum of two bodies before collision is equal to the momentum after collision.

(ii) In an isolated system, the total momentum remains conserved.

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53. Why is it dangerous to jump out from a moving bus?

Ans :

While moving in a bus our body is in motion. On jumping out of a moving bus our feet touches the ground and come to rest. While the upper part of our body fall in motion and moves forward due to inertia of motion and hence we can fall in forward direction. Thus, to avoid this we need to run forward in the direction of bus.

54. Give difference between balanced and unbalanced forces.

Ans :

	Balanced Force	Unbalanced Force
1.	Forces acting on a body from the opposite directions are same.	Forces acting on a body from two opposite directions are not same.
2.	It does not change the state of rest or motion of an object.	It does change the state of rest or motion of an object.

55. Use law of conservation to explain why a gun recoils.

Ans :

Gun and bullet both are at rest before firing. Hence, their initial velocities are zero. So, the initial momentum of the gun and the bullet is zero before fire. When a bullet is fired from the gun, it moves forward with a large velocity. The bullet imparts an equal and

opposite momentum to the gun due to which the gun recoils backwards. Thus, the final momentum of the system is zero.

56. Why do the passengers fall backward when a bus accelerates from rest?

Ans :

The passengers fall backward when a bus accelerates from rest due to their inertia. The passengers tend to remain in their state of rest even when the bus starts moving.

57. Write the effect of force.

or

What change will be in a body by force?

Ans :

Force can produce three effects :
(a) It can change the magnitude of velocity of an object (i.e. to make the object move faster or slower).
(b) It can change the direction of motion of an object.
(c) It can change the shape and size of an object.

58. What do you understand by the gravitational unit of force?

Ans :

A gravitational unit of force is defined as that force which produces an acceleration equal to the acceleration due to gravity in a body of one unit mass. Gram-weight and kilogram-weight are the gravitational unit of force.

59. Mention the factors on which the force of friction depends?

Ans :

(a) The force of friction is directly proportional to the weight of the body sliding over the surface.
(b) The force of friction depends on the surfaces in contact.

60. What are the disadvantages of friction?

or

Why friction is considered wasteful?

Ans :

Friction is considered wasteful because :
(1) Friction leads to a loss of energy. Therefore, it reduces the efficiency of machines.
(2) Friction cause wear and tear of machine's parts.

61. Why are tyres corrugated and made rough?

Ans :

Tyres are corrugated and made rough to increase friction.
(1) This provides better grip on the road.
(2) It also prevents the vehicles from slipping.

62. What does first law of motion indicates when an unbalanced external force acts on an object?

Ans :

First law of motion indicates that when an unbalanced external force acts on an object, its velocity changes, i.e. the object gets acceleration.

63. What happens to the velocity of an object when the force acting on the object are balanced?

Ans :

An object can move with uniform velocity only when the forces (pushing force and friction force) acting on the object are balanced.

64. What is resultant force?

Ans :

The resultant force of several forces acting simultaneously on a body is that single force which produces the same effect on a body as all these forces produce together.

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65. Name the various types of forces.

Ans :

Various types of forces are :
(i) Muscular force,
(ii) Tension,
(iii) Gravitational,
(iv) Reaction,
(v) Frictional forces,
(vi) Electrical forces,
(vii) Magnetic forces.

66. What are the changes possible on an object at rest if we apply on it?
(a) A balanced force?
(b) An unbalanced force?

Ans :

(a) Object may changes its shape or size.
(b) Objects changes its speed, velocity or accelerates.

67. How is force represented graphically?

Ans :

Force is a vector quantity. So, force is represented by a line with an arrow head.
(i) The head of arrow represents the direction of the force.
(ii) The length of the line is proportional to the magnitude of the force.
(iii) This is done by choosing a convenient scale.
(iv) For example : A force of 10 N can be represented by a line with an arrow head.
(v) The length of the line depends upon the scale chosen.

So, if a scale of 1 cm = 2 N is chosen, the force of 10 N is represented by a line of 5 cm in length.

68. When we hold a bag full of books in our hand steady at some height above the ground, what kind of forces are acting on it?

Ans :

The bag full of books is steady. This means its position

is fixed. So, it must be under balanced forces. The forces acting on it are :
(i) Weight (or the gravitational pull) downwards,
(ii) Upward force applied by the person holding the bag.

69. What happens when you shake a wet piece of cloth? Explain your observation.

Ans :

When a wet piece of cloth is shaken, small droplets of water fall down. This is because in the beginning both water and the piece of cloth were at rest. When the cloth is moved, the water in it tends to remain in the state of rest due to inertia of rest. As a result, the droplets of water fall down and the clothes dry quickly.

70. Give 3 examples in daily life which shows inertia.

Ans :

Three examples of inertia in daily life are :
(i) When we are travelling in a vehicle and sudden brakes are applied we tend to fall forward.
(ii) When we shake the branch of a tree vigorously, leaves fall down.
(iii) If we want to remove the dust from carpet we beat the carpet so that dust fall down.

71. Why is it necessary to bend knees while jumping from greater height?

Ans :

(i) Our feet come to rest at once during the jump.
(ii) Due to the less time a large force acts on the feet.
(iii) If we bend out knees, the time of impact increases. Hence, less force acts on the feet.

72. Why is it difficult to achieve a zero unbalanced force in practical situations? In practice what happens to a rolling marble? How can we reduce the effect of friction on a marble?

Ans :

(i) It is difficult to achieve a zero unbalanced force because of the presence of the frictional force acting opposite to the direction of motion.
(ii) In practice, the rolling marble stops after travelling some distance.
(iii) The effect of frictional force may be reduced by using a smoother marble and a smoother plane and providing a lubricant.

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FIVE MARKS QUESTIONS

73. State all 3 Newton's law of motion.

Ans :

Newton's I law of motion : An object remains in a state of rest or of uniform motion in a straight line unless acted upon by an external unbalanced force.
Newton's II law of motion : The rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of the force.
Newton's III law of motion : To every action, there is an equal and opposite reaction and they act on two different bodies.

74. Explain inertia and momentum.

Ans :

Inertia : The natural tendency of an object to resist a change in their state of rest or of uniform motion is called inertia. For example : A book lying on a table will remain there until an external force is applied on it to remove or displace it from that position.
Momentum : Momentum of body is the quantity of motion possessed by the body. It is equal to the product of the mass and velocity of the body and is denoted by p. $p = mv$
Momentum is a vector quantity and its direction is same as the direction of velocity of the object. Its SI unit is kilogram metre per second (kg ms^{-1}).

75. Define force. What are different types forces?

Ans :

Force : It is a push or pull on an object that produces acceleration in the body on which it acts. The S.I. unit of force is Newton.
Types of forces :
Balanced force : When the forces acting on a body from the opposite direction do not change the state of rest or of motion of an object, such forces are called balanced forces.
Unbalanced force : When two opposite forces acting on a body move a body in the direction of the greater force or change the state of rest, such forces are called as unbalanced forces.
Frictional force : Force of friction is the force that always opposes the motion of object.

76. What is inertia? Explain different types of inertia.

Ans :

Inertia : The natural tendency of an object to resist change in their state of rest or of motion is called inertia. The mass of an object is a measure of its inertia. Its S.I. unit is kg.
Types of inertia :
Inertia of rest : The object remain in rest unless acted upon by an external unbalanced force.
Inertia of motion : The object in the state of uniform motion will continue to remain in motion with same speed and direction unless external force is not applied on it.

77. Give example to show the effects of force.

Ans :

(i) Place a ball in the ground. Kick it with your foot. The ball starts moving. The ball moves because of the force applied to it.
(ii) If ball is coming towards you, you can kick it in any direction. The direction of motion of the ball changes because of the force applied to it.
(iii) Place a rubber on the ground. Press it with your

foot. It is found that the ball is no longer round but takes the shape of an egg, i.e. it is oblong. The shape of the ball has changed because of the force applied on the ball.

78. Name three non-SI units of force. Define them.

Ans :

Some commonly used non-SI units force are :

Dyne : The dyne is the CGS unit of force. One dyne is the force which produces an acceleration of 1 cm/s^2 in a body mass 1 g, i.e.,

$$\text{dyne} = 1 \text{ G} * 1 \text{ cm/s}^2$$

Gram-weight : It is the gravitational unit of force in CGS system. This is denoted as g-wt.

One gram weight is the force which produces an acceleration of 981 cm/s^2 in a body of mass 1 g. Thus,

$$\text{g-wt} = 1 \text{ g} * \text{acceleration due to gravity (g)}$$

Or, $1 \text{ g-wt} = 1 \text{ g} * 981 \text{ cm/s}^2 = 981 \text{ dynes}$

$[\because 1 \text{ g} * 1 \text{ cm/s}^2 = 1 \text{ dynes}]$

Kilogram-weight : It is the gravitational unit of force in SI system. This unit is denoted as kg-wt and it is the force which produces an acceleration of 9.81 m/s^2 in a body of mass 1 kg. Thus,

$$1 \text{ kg-wt} = 1 \text{ kg} * 9.81 \text{ m/s}^2$$

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79. (a) What is friction?
(b) What are the advantages of friction?

or

Why is friction necessary?

Ans :

(a) The force which opposes the motion of one body over the surface of another is called friction or the force of friction.
(b) Friction is very desirable and an important force in our daily life.

Some advantages of friction are :

(i) The nails and screws hold the wooden boards together due to friction.
(ii) It is due to the friction between the ground/road and the soles of our shoes that we are able to walk.
(iii) The friction between the road and the surface of the tyres permits safe driving.
(iv) We are able to write on paper because of the friction between the pen/pencil and the paper. That is why, it is very difficult to write on a glazed/waxed paper.
(v) The application of brakes to stop a cycle, scooter or car, etc., is possible due to friction between the brake-lining and the rim of the wheel.

80. (i) What are the causes of friction?
(ii) How can friction between any two surfaces can be reduced?

or

Describe some method for reducing friction.

Ans :

The friction rises due to the following factors :

1. Due to the force of attraction between the molecules of the two surfaces in contact. This is called the force of adhesion.
2. Due to the interlocking of the surface irregularities.
3. Thus, friction is due to the roughness of the two surfaces in contact.
4. The friction between two surfaces can be reduced by following methods :

(i) By polishing surfaces : Rough surfaces can be made smooth by polishing. Therefore, polishing reduces friction.
(ii) By applying oil or grease on the surfaces : Oil/grease forms a thin layer between the two surfaces and reduces friction.

NUMERICAL QUESTIONS

81. When a force of 40 N is applied on a body it moves with an acceleration of 5 ms^2. Calculate the mass of the body.

Ans :

Let m be the mass of the body.
Given : F = 40 N, a = 5 ms^2
From the relation F = m a, we have

$$40 = m \times 5$$

$$m = \frac{40}{5} = 8 \text{ kg}$$

82. An object undergoes an acceleration of 8 ms^{-2} starting from rest. Find the distance travelled in 1 second.

Ans :

Given,

$$\text{Acceleration, } a = 8 \text{ ms}^{-2}$$

$$\text{Initial velocity, } u = 0$$

$$\text{Time interval, } t = 1 \text{ s}$$

$$\text{Distance travelled, } s = ?$$

Using the equation of motion, $s = ut + \frac{1}{2}at^2$, one gets

$$s = 0 \times 1 + \tfrac{1}{2} \times 8 \times 1^2 = 4 \text{ m}$$

The object travels a distance of 4 m.

83. It is required to increase the velocity of a scooter of mass 80 kg from 5 to 25 ms^{-2} in 2 seconds. Calculate the force required.

Ans :

Given : $m = 80$ kg,

$u = 5 \text{ ms}^{-2}$

$v = 25 \text{ ms}^{-2}$

and $t = 2$ s

Now acceleration a = change in velocity time

$$= \frac{v - u}{t}$$

$$= \frac{25 - 5}{2} = 10 \text{ ms}^{-2}$$

Force = mass × acceleration of F

$$= ma$$

Therefore, $F = 80 \times 10 = 800$ N

84. Calculate the force required to impact to a car, a velocity of 30 ms^{-1} in 10 seconds. The mass of the car is 1,500 kg.

Ans :

Here u = 0 ms^{-1}; v = 30 ms^{-1}; t = 10 s; a = ?

Using $v = u + at$, we have

$30 = 0 + a\ (10)$

$a = 3\ ms^{-2}$

Now $F = ma = 1{,}500 \times 3$

or $F = 4{,}500$ N

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85. A cricket ball of mass 70 g moving with a velocity of 0.5 ms^{-1} is stopped by player in 0.5 s. What is the force applied by player to stop the ball?

Ans :

Here $m = 70\ g = 0.070\ kg$;

$u = 0.5\ ms^{-1}$; $v = 0$; $t = 0.5$ s

$F = m\frac{v-u}{t}$

or $F = 0.07\frac{0-0.50}{0.5}$

or $F = -0.07$ newton

The negative sign indicates that the force exerted by the player is opposite to the direction of motion of the ball.

86. What will be acceleration of a body of mass 5 kg if a force of 200 N is applied to it?

Ans :

Here m = 5 kg; F = 200 N

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

$a = \frac{F}{m} = \frac{200}{5} = 40\ ms^{-2}$

$a = 40\ ms^{-2}$

87. A bullet of mass 10 g is fired from a rifle. The bullet takes 0.003 s to move through its barrel and leaves with a velocity of 300 ms^{-1}. What is the force exerted on the bullet by the rifle?

Ans :

Here $m = 10\ g = 0.010\ kg$; $u = 0$; $v = 300\ ms^{-1}$

$t = 0.003$ s, F = ?

$F = m\frac{v-u}{t}$

$F = 0.010\frac{300-0}{0.003}$

or $F = 1{,}000$ N

88. What force would be needed to produce an acceleration of 1 ms^{-2} on a ball of mass 1 kg?

Ans :

Here m = 1 kg; $a = 1\ ms^{-2}$; F = ?

Now $F = ma$

$= 1 \times 1$

or $F = 1$ Newton

89. What is the acceleration produced by a force of 5 N exerted on an object of mass 10 kg?

Ans :

Here F = 5 N; m = 10 kg; a = ?

Now $F = ma$ or $a = = \frac{F}{m}$

$a = 0.5\ ms^{-2}$

90. How long should a force of 100 N act on a body of 20 kg so that it acquires a velocity of 100 ms^{-1}?

Ans :

Here $v - u = 100\ ms^{-1}$, m = 20 kg; F = 100 N; t = ?

We know $F = ma = m\frac{v-u}{t}$

or $t = m\frac{v-u}{F}$

$= 20\frac{100}{100} = 20$ s

91. A 1,000 kg vehicle moving with a speed of 20 ms^{-1} is brought to rest in a distance of 50 m, (i) Find the acceleration; (ii) Calculate the unbalanced force acting on the vehicle; (iii) The actual force applied by the brakes may be slightly less than that calculated. Why? Give reason.

Ans :

(i) Here $u = 20\ ms^{-1}$; $v = 0$; $s = 50$ m; a = ?

Using $v^2 - u^2 = 2as$, we have

$a = \frac{v^2-u^2}{2s}$

$= \frac{0-(20)^2}{2 \times 50}$

(ii) $F = ma = 1{,}000 \times (-4) = -4{,}000$ N

(iii) Due to force of friction, the actual force applied by brakes may be slightly less than calculated one.

92. Which would require greater force : accelerating a 10 g mass at 5 ms^{-2} or 20 g mass at 2 ms^{-2}?

Ans :

In first case $m_1 = 10\ g = kg = 0.010\ kg$;

Now $a_1 = 5\ ms^{-2}$; $F_1 = ?$

$F_1 = m_1a_1 = 0.010 \times 5$

$F_1 = 0.050$ Newton

In second case, $m_2 = 20\ g = 0.020\ kg$

$a_2 = 2\ ms^{-2}$; $F_2 = ?$

Now $F_2 = m_2a_2 = 0.020 \times 2$

or $F_2 = 0.04$ Newton

We find that $F_1 > F_2$, hence more force is required to accelerate 10 g at 5 ms^{-2} than accelerating 20 g at 2 ms^{-2}.

93. A truck starts from rest and rolls down a hill with constant acceleration. It travels a distance of 400 m in

20 s. Find its acceleration. Find the force acting on it if its mass is 7 metric ton.

Ans :

Here $u = 0$ ms^{-1} (Starting from rest);

$s = 400$ m; $t = 20$ s; $a = ?$

Using $s = ut + \frac{1}{2}at^2$,

We have $400 = 0 \times 20 + \frac{1}{2} \times a \times 20^2 = 200\ a$

$$a = \frac{400}{200}$$

or $a = 2$ ms^{-2}

Now mass $m = 7$ metric ton $= 7{,}000$ kg; $F = ?$

$F = ma = 7{,}000 \times 2$

or $F = 14{,}000$ N

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94. A force of 5 N gives a mass m_1, an acceleration of 8 ms^{-2} and a mass m_2, an acceleration of 24 ms^{-2}. What acceleration would it give if both the masses are tied together?

Ans :

Let us first find mass m_1 and m_2.

$F = m_1a_1$

$5 = m_1\ (8)$

or $m_1 = \frac{8}{5}$ kg

$F = m_2a_2$

$5 = m_2\ (24)$ or $m_2 = \frac{5}{24}$ kg

Total mass $M = (m_1 + m_2)$

or $M = \frac{5}{8} + \frac{5}{24} = \frac{15+5}{24}$

or $M = \frac{20}{24}$kg

Let A be the acceleration produced in mass M.

$F = m \times a$

or $5 = \frac{20}{24}a$

or $a = \frac{5 \times 24}{20} = \frac{120}{20} = 6$ms^{-2}

Hence, the acceleration of the combination is 6 ms 2.

95. A car of mass 1,000 kg moving with a velocity of 40 km h^{-1} collides with a tree and comes to stop in 5 s. What will be the force exerted by car on the tree?

Ans :

Here, $m = 1{,}000$ kg

$u = 40$ kmh$^{-1} = \frac{100}{9}$ ms^{-1}

$v = 0$; $t = 5$ s

$F = ma$

$a = \frac{v-u}{t}$

So, $F = m\left[\frac{v-u}{t}\right]$

or $F = \frac{-20000}{9}$

or $F = -2{,}222$ N

96. A bullet of mass 100 g is fired from a gun of mass 20 kg with a velocity of 100 ms^{l}. Calculate the velocity of recoil of the gun.

Ans :

Mass of bullet, $m = 100$ g $- 1000$ kg

Velocity of bullet, $u = 100$ ms^{-1}

Mass of gun, $M = 20$ kg

Let recoil velocity of gun $= V$

Step 1. Before firing, the system (gun + bullet) is at rest, therefore, initial momentum of the system = 0

Final momentum of the system

= momentum of bullet + momentum of gun

$= mu + MV = \frac{1}{10} \times 100 + 20\ V$

$V = 10 + 20\ V$

Step 2. Apply law of conservation of momentum

Final momentum = Initial momentum

i.e. $10 + 20\ V = 0$

$20\ V = 10$

or $V = -0.5$ ms^{-1}

Negative sign shows that the direction of recoil velocity of the gun is opposite to the direction of the velocity of the bullet.

97. An iron sphere of mass 10 kg is dropped from a height of 80 cm. If the downward acceleration of the ball is 10 ms^{-2}, calculate the momentum transferred to the ground by the ball.

Ans :

Here, initial velocity of sphere, $u = 0$

Distance travelled, $s = 80$ cm $= 0.8$ m

Acceleration of sphere, $a = 10$ ms^{-2}

Step 1. Final velocity of sphere when it just reaches the ground can be calculated using

$v^2 - u^2 = 2as$

$u^2 - 0 = 2 \times 10$ ms$^{-2} \times 0.8$ m

$= 16$ m^{2}s^{-2}

or $v = \sqrt{16\ \text{m}^2\text{s}^{-2}} = 4$ ms^{-1}.

Momentum of the sphere just before it touches the ground = mv = 10 kg $\times$ 4 ms^{-1} = 40 kg ms^{-1}

Step 2. On reaching the ground, the iron sphere comes to rest, so its final momentum = 0

According to the law of conservation of momentum, Momentum transferred to the ground = momentum of the sphere just before it comes to rest = 40 kg ms^{-1}.

98. Calculate the force required to impart to a car a velocity of 30 m/s in 10 s. The mass of the car is 1500 kg.

Ans :

$u = 0$, $v = 30$ m/s, $t = 10$ s

$v = u + at$

$30 = 0 + a \times 10$

$a = 3$ ms^{-2}

Now $m = 1500$ kg, $a = 3$ ms^{-2}

Required Force $= F = ma$

$1500 \times 3 = 4500$ N

99. A boy of mass 60 kg running at 3 m/s jumps on to a trolley of mass 140 kg moving with a velocity of 1.5 m/s in the same direction. What is their common velocity?

Ans :

For boy, $m_1 = 60$ kg, $u_1 = 3$ ms^{-1}, $v_1 = v$

For trolley, $m_2 = 140$ kg, $u_2 = 1.5$ ms^{-1}, $v_2 = v$

By conservation of momentum,

$$m_1u_1 + m_2u_2 = (m_1 + m_2)\ v$$

$$60 \times 3 + 140 \times 1.5 = (60 + 140)\ v$$

$$v = \frac{180 + 210}{200} = \frac{390}{200}\ \text{ms}^{-1}$$

$$= 1.95\ \text{ms}^{-1}$$

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100. A bullet of mass 20 g moving with a speed of 500 ms^{-1} strikes a wooden block of mass 1 kg and gets embedded in it. Find the speed with which block moves along with the bullet.

Ans :

For bullet, $m_1 = 20$ g $= 0.2$ kg, $u_1 = 500$ ms^{-1}, $v_1 = v$

For block, $m_2 = 1$ kg, $u_2 = 0$ ms^{-1}, $v_2 = v$

By conservation of momentum,

$$m_1u_1 + m_2u_2 = (m_1 + m_2)\ v$$

$$v = \frac{m_1u_1 + m_2u_2}{m_1 + m_2}$$

$$= \frac{0.02 \times 500 + 1 \times 0}{0.02 + 1}$$

$$= \frac{10}{1.02} = \frac{1000}{102} = 9.8\ \text{ms}^{-1}$$

101. A force of 0.6 N acting on a body increases its velocity from 5 m/s to 6 m/s in 2 s. Calculate the mass of the body.

Ans :

$F = 0.6$ N, $u = 5$ ms^{-1}, $v = 6$ ms^{-1}, $t = 2$ s

Acceleration $a = \frac{v - u}{t} = \frac{6 - 5}{2}$

$$= \frac{1}{2}\ \text{ms}^{-2} = 0.05\ \text{ms}^{-2}$$

$$m = \frac{F}{a} = \frac{0.6}{0.5} = 1.2\ \text{kg}$$

102. Calculate the force needed to speed up a car with a rate of 5 ms^{-2}, if the mass of the car is 1000 kg.

Ans :

According to question :

Acceleration (a) $= 5$ m/s^2

and Mass.(m) $= 1000$ kg,

therefore, Force (F) $= ?$

We know that, $F = m \times a$

$= 1000$ kg $\times$ 5 m/s^2

$= 5000$ kg m/s^2

Therefore, required force

$= 5000$ kg m/s^2 or 5000 N

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