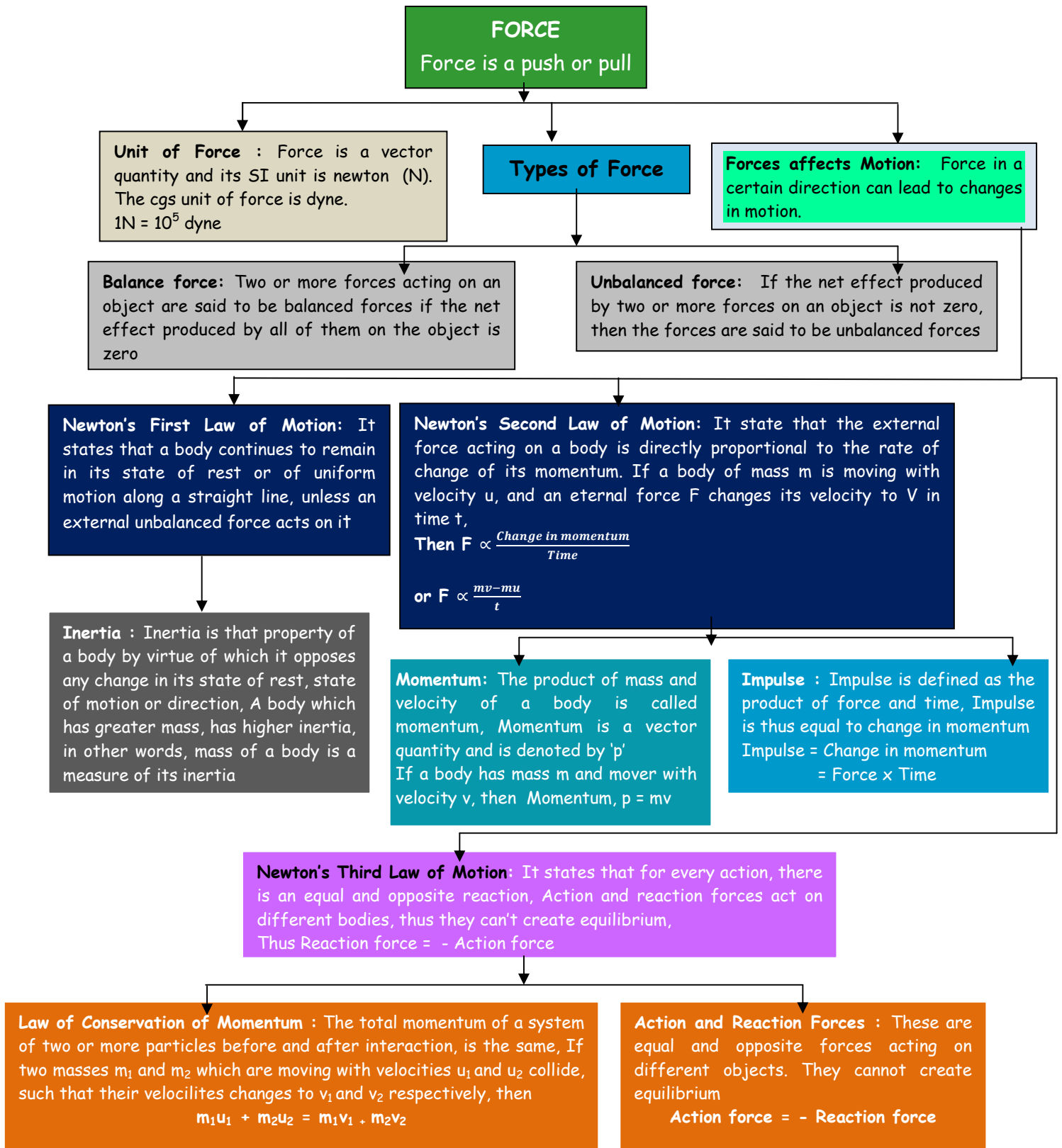


## Grade IX

### Lesson : 9 FORCE AND LAWS OF MOTION

#### CHAPTER AT A GLANCE



## NCERT BASED ACTIVITIES

### Activity / Project 1

- Objective** : To demonstrate the inertia of rest of a coin.
- Materials Required** : A 5 or 10 rupee coin, a light weight piece of cardboard, a glass tumbler,
- Method** :  
1. Place the cardboard on the glass tumbler and keep the arrangement on a plane surface  
2. Put the coin at the centre of the cardboard.  
3. Gently flick the cardboard away,  
4. Observe what happens to the coin
- Observation** : The card is flicked away but the coin does not fly off. It falls into the glass.
- Conclusion** : The coin possesses inertia of rest. As the cardboard is flicked, it tends to remain in its state of rest and falls into the glass.
- Discussion** : It is necessary that for such experiment, a light weighted cardboard is used. If a heavier cardboard is used, it will require a greater force to be moved. Such force might be sufficient to even overcome the inertia of the coin.

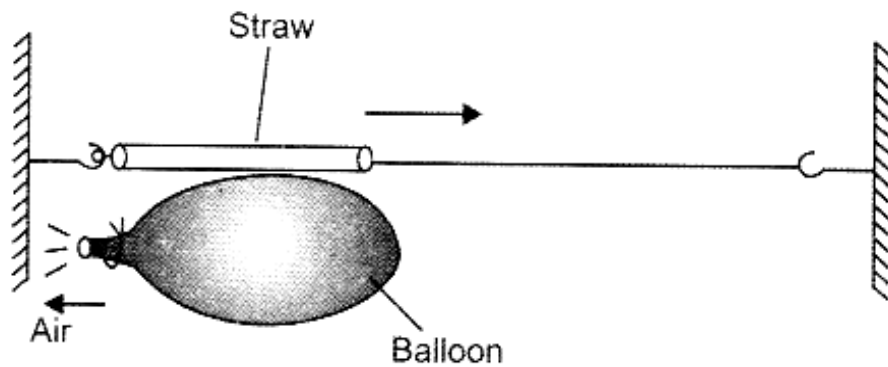
### Activity / Project 2

- Aim** : To study Newton's third law of motion.
- Materials Required** : A rubber balloon, thread, straw, adhesive tape, pump, hook in a wall/clamp etc.,
- Procedure** :  
1. Inflate a big rubber balloon and tie its neck using a thread.  
2. Using adhesive tape, fix the balloon with a straw.  
3. Pass a long inextensible thread through the straw and tie it between two hooks as shown in the figure.

4. Remove the thread tied at the neck of the balloon so that air escapes out of the balloon.

**Observation** : The balloon moves in forward direction as air escapes out.

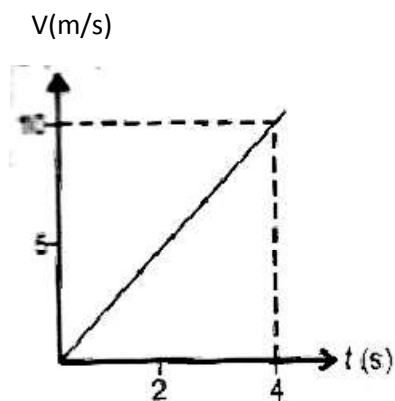
**Conclusion** : As air escapes out of the balloon, it exerts a reaction force in opposite direction. This pushes the balloon and it moves in forward direction.



## Objective Type Questions

### I. Multiple choice questions

- Impulse is the other name of
  - inertia
  - momentum
  - force
  - change in momentum
- Bags at the top of a school van are tied using a string to avoid the effect of
  - inertia
  - momentum
  - force
  - acceleration
- While catching a stone thrown by your friend you pull the hands back to
  - avoid getting hurt
  - increase the time to slow down
  - decrease the time to slow down
  - avoid the breaking of the stone
- A plate, a ball and a child all have the same mass. The one having more inertia is the
  - plate
  - ball
  - child
  - All have equal inertia
- The  $v-t$  graph of a body of 5 kg moving with the help of a force is shown. Then the force is shown. Then the force involved is



- 20 N
- 125N
- 12.5N
- 2.0N

$$a = \text{slope of graph} = \frac{10-0}{4-0} = 2.5 \text{ m/s}^2$$

$$F = ma = 5 \times 2.5 = 12.5 \text{ N}$$

6. Two equal masses  $m$  each moving in the opposite direction with the same speed  $v$  collide and stick to each other. The velocity of the combined mass is.
- a)  $v$                       b)  $2v$                       c)  $\frac{v}{2}$                       d) zero
7. When no external force acts on an object, the physical quantity that remains conserved is.
- a) velocity                      b) momentum                      c) acceleration                      d) force
8. The incorrect option regarding action-reaction pair is
- a) they are equal and opposite  
b) they act on two different bodies  
c) they act only between bodies in contact  
d) their sum on/ by a body is zero
9. According to second law of Newton, force is the cause and the outcome is
- a) acceleration                      b) velocity                      c) momentum                      d) time
10. If force, change in momentum and time are given by  $F$ ,  $p$  and  $t$  respectively, then they are related by .
- a)  $F=pt$                       b)  $F = \frac{p}{t}$                       c)  $Ft^2 = p$                       d)  $p= F^2t$
11. The one which has the least inertia among the following
- a) 1 kg stone                      b) 2 kg ball  
c) a train compartment                      d) a cup of tea
12. The minimum number of unequal forces that can make zero resultant is
- a) two                      b) three                      c) four                      d) ten
13. One can move a body with constant speed on a rough surface with frictional force  $F$  by applying a force of .
- a)  $F$                       b)  $2F$                       c)  $\frac{F}{2}$                       d) ten
14. A mass  $M$  breaks into two pieces in the ratio 1: 3 while at rest. If the heavier has a speed of  $v$ , the speed of the lighter is.
- a)  $v$                       b)  $2v$                       c)  $3v$                       d)  $4v$

15. On a 3 kg mass, 5 newton of force acts for 0.1 second. The impulse imparted to the mass is ( in kg m/s. )
- a) 1.5                      b) 1.0                      c) 0.5                      d) 0.16
16. The two states of motion treated alike by the Newton's first law, among A,B,C and D are
- A: Rest                                      B: Unifrom motion  
C: uniformly accelerated              D : Non- uniformly accelerated
- a) A,D                      b) A,B                      c) A,C                      d) B,C
17. Water drops sticking to the wheel come out along the tangential line due to
- a) inertia                      b) momentum                      c) force                      d) acceleration
18. When a 12 N force acts on 3kg mass for a second, the change in velocity is ( in m/s)
- a) 36                      b) 4                      c) 2                      d) 18
19. A ball of mass  $m$  hitting the ground with a velocity  $u$ , bounces back with a velocity  $v$  in a small time interval 't' the force exerted on the ground is
- a)  $m\left(\frac{v-u}{t}\right)$                       b)  $\frac{mv}{t}$                       c)  $\frac{mu}{t}$                       d)  $m\left(\frac{v+u}{t}\right)$
20. Which of the following does not happen? As an automobile accelerates suddenly.
- a) a toy monkey hung from the roof moves back  
b) a standing person gets pushed back  
c) a bag at the roof gets displaced backward  
d) a person in the seat is pushed in front.
21. A passenger in a moving train tosses a coin which falls behind him. It means that motion of the train is.
- a) accelerated                      b) uniform                      c) retarded                      d) along circular tracks
22. An object of mass 2 kg is sliding with a constant velocity of  $4 \text{ ms}^{-1}$  on a friction less horizontal table. The force required to keep the object moving with the same velocity is.
- a) 32 N                      b) 0 N                      c) 2N                      d) 8N
23. Rocket works on the principle of conservation
- a) mass                      b) energy                      c) momentum                      d) velocity

24. A water tanker filled up to  $\frac{2}{3}$  rd of its height is moving with a uniform speed. On sudden application of the brake the water in the tank would

- a) move backwards    b) move forwards  
c) be unaffected    d) rise upwards

1. d	2. a	3. b	4. d	5. a	6. d	7. b	8. d
9. a	10. b	11. d	12. a	13. a	14. c	15. c	16. b
17. a	18. b	19. d	20. d	21. a	22. b	23. c	24. b

---

**I. Match the following**

Column I	Column II
1. Passengers fall forward as bus stops	A. Inertia of direction
2. Passengers fall backward as bus starts	B. Inertia of rest
3. Passengers fall sideways as bus turns	C. Balanced force
4. Applied force equals	D. Unbalanced force
5. Applied force is greater than force	E. Inertia of motion

1. E	2. B	3. A	4. C	5. D
------	------	------	------	------

**Fill in the blanks**

26. Newton's \_\_\_\_\_ law is called the real law of motion.
27. The S.I. unit of momentum is \_\_\_\_\_ or \_\_\_\_\_.
28. Forces acting on a body are \_\_\_\_\_ if there is no acceleration produced in the body.
29. Action and reaction forces act on \_\_\_\_\_ bodies
30. When a body moves with uniform velocity the net force acting on it is \_\_\_\_\_.
31. Friction acts in \_\_\_\_\_ direction to that of motion of the body \_\_\_\_\_ is doubled, its acceleration becomes.

26. second	27. kg m/s, N-s	28. Balanced	29. Different
30. zero	31. Opposite, mass		

**True or False**

32. For a given amount of applied force, when mass of the body is doubled, its acceleration becomes half.
33. Action and reaction forces act on the same body
34. Impulse of a body is equal to rate of momentum change
35. When a body moves in uniform motion unbalanced force acts on it.
36. Recoil velocity of lighter gun is more than that of heavier gun

32. True	33. False	34. False	35. False	36. True
----------	-----------	-----------	-----------	----------



**Direction (Q38 to 39) :** In the following questions the Assertion and Reason have been put forward. Read the statements carefully and choose the correct alternative from the following.

- a) Both the Assertion and the Reason are correct and the reason is the correct explanation of the Assertion.
- b) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion.
- c) Assertion is true but the Reason is false.
- d) The statement of the Assertion is false but the Reason is true.

**37. Assertion :** An oscillating pendulum stops on its own in air as well as in vacuum

**Reason :** Force act on an oscillating pendulum in air as well as in vacuum

- c) Assertion is true but the Reason is false.

**38. Assertion :** The recoil velocity of a gun is much less than that of the bullet.

**Reason :** Less force due to the bullet is exerted on the gun that exerted by gun on the bullet

- c) Assertion is true but the Reason is false.

**39. Assertion :** A bicycle has to be pedalled again and again to keep it moving with uniform velocity.

**Reason :** Force is applied on the bicycle to balance the force of friction exerted by the ground on bicycle.

- a) Both the Assertion and the Reason are correct and the reason is the correct explanation of the Assertion.

**40. What is meant by force?**

The push or pull exerted upon an object by an agent to cause a change in its state of rest or of motion is known as force.

**41. Mention any two kinds of changes that can be brought about in a body by force.**

- i. changes in position
- ii. Change in direction of motion

**42. Apart from changing the magnitude of velocity of an object or changing the direction of motion of an object or changing, what other changes can force bring on an object?**

Force can change the shape of the object.

**43. What do you mean by balanced force?**

Two or more forces acting upon a body are said to be balanced if they cancel each others effect so that the net force is zero

**44. State the name and type of force which is responsible for the formation of tides in the sea.**

Gravitational pull of the moon

**45. Name the force responsible for the revolution of moon around the earth.**

Gravitational force

**46. Name the force which is responsible for change in position or state of an object**

Unbalanced force

**47. Define inertia**

Inertia is the property of a body virtue of its position or state which it resists any change in its state of rest or of uniform motion in a direction.

**48. State the law of inertia.**

It states that " a body will continue to remain in its state of rest or of uniform motion along a straight line unless an external unbalanced force acts on it".

**49. Two trucks, one loaded and the other empty are moving with same velocity on straight road. Which of them requires a greater force to stop in same time and why?.**

Heavier truck, i.e. the loaded truck has a greater momentum. Thus greater force is required to stop it.

**50. Out of the four physical quantities associated with the motion of an object viz force, velocity, acceleration and momentum, which one remains constant for all bodies large or small. Undergoing a free fall?**

During free fall, the body accelerates. Thus velocity and momentum increase at every point of motion.

Acceleration remains constant. Thus force also remains constant ( as  $F=ma$  )

**51. Three blocks of same size and shape are made of steel, wood and rubber. Which of them has the highest inertia and why?**

Steel has the greatest density and hence the highest mass out of the three. Since mass is a measure of inertia, it means it will have the highest inertia.

**52. Why is Newton's first law of motion also called law of inertia because?**

Newton's first law of motion is also called law of inertia because inertia also opposes any change in state of rest or motion of the body.

53. What should be the value of  $F$  in the following



If forces are balanced then  $F = F_1 + F_2$

54. Place a water-filled tumbler on a tray. Hold the tray and turn around as fast as you can. Why does the water spill?

Water possesses inertia of rest. As the tray is moved, water tends to remain in its state of rest and spills around.

55. When does a spring exert force upon objects attached to its ends?

The spring exerts force upon objects when it is in a compressed state (pushing the objects) and when it is in a stretched state (pulling the objects).

56. A runner presses the ground with his feet before he starts his run. Identify action and reaction in this situation.

The force applied by the runner on the ground is the action force, and the reaction force of the ground acts on the runner and pushes him forward.

57. Why is a groove provided in a saucer for placing tea cups?

The groove prevents the cups from toppling over in case of sudden jerks.

58. Do all bodies have the same inertia? If not, name the factor which determines inertia of a body.

No, all bodies don't have the same inertia. Inertia is measured with the help of mass of the body. For example, it is easier to carry an empty carton than a loaded carton.

59. What did Galileo observe by placing two inclined planes facing each other and rolling down a marble ball from the top end of one of them?

The marble ball rose to the same height on the second inclined plane.

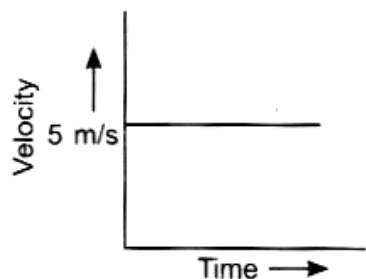
60. How is the frictional force in Galileo's experiment on an inclined reduced plane minimised?

The frictional force can be minimised by using a smooth marble and a smooth plane and providing a lubricant on top of the inclined planes.

61. Name the physical quantity on which the inertia of a body depends

Mass of the body

62. Velocity-time graph of a moving particle of mass 1 kg is shown in figure.



Is any force acting on the body? Justify your answer.

No, because the particle is moving with constant velocity which means no net unbalanced force acts upon it.

63. While riding on the bicycle, if we stop pedalling, why does the bicycle begin to slow down?

If we stop pedalling the applied force becomes less than the friction between bicycle wheels and the road. Thus the bicycle begins to slow down.

64. An athlete always runs some distance before taking a jump, Why?

By running the athlete acquires inertia of motion. This helps him to take a longer jump.

A longer jump .

65. A body of mass 9kg is lying on a surface of table. Calculate the net force acting on it.

Net force acting on the body is zero as it is at rest.

66. A heavy jug is kept on a newspaper. You can jerk the newspaper under the jug without disturbing it. How?

Jug has a large inertia of rest due to its mass so it does not move if the newspaper is jerked out suddenly.

67. Define momentum. State its SI unit.

Momentum is defined as the product of mass and velocity of a body. Its SI unit is kg m/s.

**68. State Newton's second law of motion**

It states that "the force exerted upon an object is directly proportional to the rate of change of its momentum"

**69. Define one newton force**

Force exerted by an object is 1 newton if it produces an acceleration of  $1 \text{ m/s}^2$  in a unit mass.

**70. You are applying force on the pan of single pan weighing balance and the pointer points to 100g. What is the force in newton applied by you.**

$$1 \text{ gram force} = (9.8 \times 10^{-3}) \text{ N} = 0.0098 \text{ N}$$

**71. Is momentum vector quantity? If yes, what determines its direction?**

Momentum is a vector quantity Its direction is the same as that of velocity of the body.

**72. A ball of mass 500 g is thrown upwards with a velocity of  $15 \text{ ms}^{-1}$ . Calculate its momentum at the highest point.**

At the highest point, the ball comes to a momentary rest. Since velocity is zero, momentum is also zero.

**73. A force of 20N changes the position of a body. If mass of the body is 2 kg, find the acceleration produced in the body.**

$$\text{Acceleration} = \frac{\text{Force}}{\text{Mass}} = \frac{20 \text{ N}}{2 \text{ kg}} = 10 \text{ ms}^{-2}$$

**74. Define impulse**

Impulse is the force acting for a short time Mathematically, Impulse = force x time = change in momentum

**75. Relate impulse with Newton's second law of motion. Define impulse.**

$$\text{Force (F)} \propto \frac{\text{Change in momentum}}{\text{Time (t)}}$$

$$\text{=or } \Delta p = F \times t = \text{impulse}$$

**76. How is kilogram weight related to SI unit of force? 1 kilogram weight = 9.8 newton**

$$1 \text{ kilogram weight} = 9.8 \text{ newton}$$

**77. Athletes in pole jump even fall on cushioned surface and not on floor. Why?**

When athlete falls on cushioned surface, the change in momentum takes place over a long duration of time. This reduces the force acting duration of time. This reduces the force acting on the body of athletes and they are not hurt.

**78. Acceleration is a vector while force is a scalar quantity. "True/ False"? correct the statement in case your reply is "false".**

False because both force and acceleration are vector quantities.

**79. State Newton's third law of motion**

Newton's third law states that for every action, there is an equal and opposite reaction.

**80. How are action - reaction forces related in magnitude and direction?**

They have the same magnitudes but different directions

**81. Do all action and reaction forces produce acceleration of equal magnitudes in both objects? Why/ why not?**

No, though action and reaction are equal in magnitude, they may not produce acceleration of equal magnitudes because each force acts on different objects which have different mass.

**82. A balloon is inflated and released. Why does it fly forward as air escapes out of it?**

Air pushed out of the balloon exerts an equal reaction force on the balloon and it moves forward.

**83. A wooden block is slid over a surface. A students puts weight on the block. What happens to the reading of spring balance?**

The reading increases as the value of normal reaction increases.

**84. If action is always equal and opposite to reaction, why don't the two cancel each other?**

Action and reaction forces act on different bodies. Thus they cannot cancel each other.

**85. What would be the final momentum if two bodies of mass m each and moving with velocities each in opposite direction collide?**

Total initial momentum  $mu + = mu + m(-u) = zero$

Thus, final momentum = zero

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

$$m = 5\text{kg}$$

$$\text{Velocity } u = 20 \text{ ms}^{-1}, v = 0.20\text{ms}^{-1}$$

$$\text{Momentum changes} = m (v - u) = 5(0.20 - 20)$$

$$= - 99\text{kg ms}^{-1}$$

87. A car of mass 800kg is travelling with a velocity of 20 m/s. when brakes are applied, it stops after travelling a distance of 8 metres. Find retardation and retarding force?

$$m = 800\text{kg}, u = \frac{20\text{m}}{\text{s}}, v = 0, s = 8\text{m}$$

$$a = \frac{v^2 - u^2}{2s} = \frac{0 - (20)^2}{2 \times 8} = \frac{-400}{16}$$

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

$$F = ma = - 800 \times 25 = -20000 \text{ N}$$

88. Define SI unit of force. A force of 2N acting on a body changes its velocity uniformly from 2 m/s to 5 m/s in 10s. Calculate the mass of the body.

SI unit of force is newton (N) Force applied by a body is equal to 1 N if it accelerates a unit mass by 1 m/s in its direction.

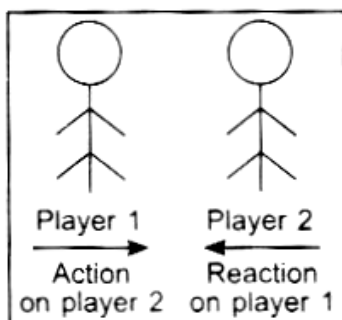
$$\text{Given : } F = 2\text{N}, t = 10\text{s}, u = 2\text{ms}^{-1}$$

$$v = 5\text{ms}^{-1}$$

$$\text{Since, } F = ma \Rightarrow F = m \left( \frac{v-u}{t} \right)$$

$$\text{Or } m = \frac{Ft}{v-u} = \frac{2 \times 10}{5-2} = 6.67\text{kg}$$

89. If one object exerts an action force on another, the other object instantaneously exerts an equal and opposite force on the first, illustrate with an example.



Action and reaction forces are equal and opposite, and act on different objects. For example, if in the game of football, two players collide with each other, they both get hurt because each player applied an equal and opposite force to each other.

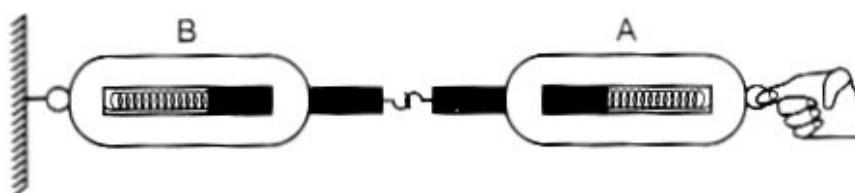
90. A stone released from the top of a tower of height 19.6m. Calculate its final velocity just before touching the ground.

$$\text{Given } u = 0, s = 19.6\text{m}, g = 9.8\text{ms}^{-2}$$

$$v^2 = u^2 + 2as = 0 + 2 \times 9.8 \times 19.6$$

$$v = \sqrt{(19.6)^2} = 19.6\text{ms}^{-1}$$

Short Answer Questions



91. Look at the diagram above and answer the following questions.

- (a). when a force is applied through the free end of the spring balance A, the reading on the spring balance A is 15g wt. What will be the reading of spring balance B?
- (b). Write reasons for your answer.
- (c). Name the force which balance A exerts on balance B and the force of balance B on Balance A.

- (a). 15g wt
- (b). Every action has equal and opposite reaction.
- (c). Action force and reaction force.



92. A stone released from the top of a tower of height 19.6m. Calculate its final velocity just before touching the ground.

(Take  $g = 9.8 \text{ m/s}^2$ )

Initial velocity,  $u = 0$

Height of fall,  $h = 19.6\text{m}$

$$G = 9.8 \text{ m/s}^2$$

Final velocity,  $v = \sqrt{u^2 + 2gh}$

$$= \sqrt{0 + 2 \times 9.8 \times 19.6}$$

$$= 19.6\text{m/s}$$

93. Explain the following briefly:

(a). A cricket ball causes much severe injury than a tennis ball on hitting a spectator.

(b). An applied unbalanced force causes a change in momentum.

(c). A greater force is required to impart greater velocity to an object

(a). A cricket ball has a greater mass than a tennis ball. So, its momentum is higher than a Tennis ball moving at same velocity. Thus it causes a greater impact upon the person who is hit.

(b). Force is required to accelerate an object. This causes a change in its velocity which means a change in momentum of the object.

(c). Force produces an acceleration in an object on which it acts. If larger changes in velocity is required. Then more force needs to be applied.

94. (a). State the law of conservation of momentum.

(b). A body of mass 2kg, initially moving with a velocity of 10 m/s, collides with another body of mass 5kg at rest. After collision velocity of first body becomes 1 m/s. find the velocity of second body.

(a). The total momentum of a system remains constant when no external force acts on it

(b)  $m_1 = 2\text{kg}, u_1 = 10\text{m/s}, v_1 = 1 \text{ m/s}$

$$m_2 = 5\text{kg}, u_2 = 0, v_2 = ?$$

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

$$\Rightarrow 2 \times 10 + 0 = 2 \times 1 + 5 \times v_2$$

$$\Rightarrow v_2 = \frac{20 - 2}{5} = 3.6\text{m/s}$$

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

$$\text{Mass of boy} = m_1 = 50 \text{ kg}$$

$$\text{Mass of trolley} = m_2 = 20 \text{ kg}$$

$$\text{Initially velocity of boy} = u_1 = 5 \text{ ms}^{-1}$$

$$\text{Initially velocity of trolley} = u_2 = 1.5 \text{ ms}^{-1}$$

$$\text{Final velocity} = v$$

$$v = \frac{m_1 u_1 + m_2 u_2}{m_1 + m_2} = \frac{(50 \times 5) + (20 \times 1.5)}{50 + 20}$$

$$= 4 \text{ ms}^{-1}$$

96. A man weighing 60kg runs along the rails with a velocity of 18 km/h and jumps into a car of mass 1 quintal (100 kg) standing on the rails. Calculate the velocity with which car will start travelling along the rails.

$$m_1 = 60 \text{ kg}, u_1 = 18 \text{ km/h} = 5 \text{ m/s}, m_2 = 100 \text{ kg}, u_2 = 0$$

$$m_1 u_1 + m_2 u_2 = (m_1 + m_2) v$$

$$(60 \times 5) + 0 = (60 + 100) v$$

$$v = \frac{300}{160} = 1.87 \text{ m/s}$$

97. A force of 5 N gives a mass  $m_1$  an acceleration of  $10 \text{ m/s}^2$  and a mass  $m_2$  an acceleration of  $20 \text{ m/s}^2$ . What acceleration would it give if both the masses were tied together?

$$F = 5 \text{ N}$$

$$a_{m_1} = 10 \text{ m/s}^2 \Rightarrow m_1 = \frac{F}{a_{m_1}} = \frac{5}{10} = 0.5 \text{ kg}$$

$$a_{m_2} = 20 \text{ m/s}^2 \Rightarrow m_2 = \frac{F}{a_{m_2}} = \frac{5}{20} = 0.25 \text{ kg}$$

$$m_1 + m_2 = 0.5 + 0.25 = 0.75 \text{ kg}$$

$$a = \frac{F}{m_1 + m_2} = \frac{5}{0.75} = 6.67 \text{ m/s}^2.$$

98. Car A of mass 1500 kg travelling at 25 m/s collides with another car B of mass 1000kg travelling at 15 m/s in the same direction. After collision, the velocity of car A becomes 20 m/s Calculate the velocity of car B after collision.

$$\text{Masses } m_a = 1500 \text{ kg } m_b = 1000 \text{ kg}$$

$$\text{Velocities : } u_a = 25 \text{ ms}^{-1}, v_b = 0, u_b = 15 \text{ ms}^{-1}$$

$$v_a = 20 \text{ ms}^{-1}, v_b = 0$$

By conservation of momentum,

$$m_a u_a + m_b u_b = m_a v_a + m_b v_b$$

$$\Rightarrow (1500 \times 25) + (1000 \times 15)$$

$$= 1500 \times 20 + (1000 \times v_b)$$

$$= 22.5 \text{ ms}^{-1}$$

99. A bullet of mass 20g moving with a velocity of  $200 \text{ ms}^{-1}$  strikes and gets embedded into a stationary wooden block of mass 980g. Find the velocity with which the block moves.

$$\text{Mass of bullet } m_1 = 20 \text{ g} = 0.02 \text{ kg}$$

$$\text{velocity of bullet } u_1 = 200 \text{ ms}^{-1}$$

$$\text{Mass of blocks } m_2 = 980 \text{ g} = 0.98 \text{ kg}$$

$$\text{velocity of blocks } u_2 = 0$$

Total initial momentum of bullet and wooden block

$$p_1 = m_1 u_1 + m_2 u_2$$

$$= 0.02 \times 200 + 0 = 4 \text{ kgms}^{-1}$$

$$\therefore \text{ Total final momentum of bullet and wooden blocks } p_2 = (m + m_2)v = 4 \text{ kgms}^{-1}$$

$$\text{Velocity of block and bullet} = v = \frac{p^2}{m_1 + m_2}$$

$$= \frac{4}{0.02 + 0.98} = 4 \text{ ms}^{-1}$$

100. A bullet of mass 10g moving with velocity of 400m/s or a cricket ball of mass 400g thrown with the speed of 90km/h. Which one have a higher value of momentum?

Bullet : Mass  $m_b = 10g = 0.01kg$

Velocity  $v_b = 400m/s$

Momentum  $p_b = m_b v_b = 0.01 \times 400$

$= 4kg \text{ ms}^{-1}$

Ball : Mass  $m_B = 400g = 0.4kg$

Velocity  $v_B = 90km/h = \frac{5}{18} \times 90m/s$

Momentum  $p_B = m_B v_B = 0.4 \times 25$

$= 10kg \text{ ms}^{-1}$

Thus cricket ball has higher momentum.

---

### Long Answer Questions

101. Name and define the various types of inertia. Illustrate each of them with suitable example. [Or]

Define inertia and list its types. Give two examples to describe each type. On what factor inertia depends?

The property of body by virtue of which it tends to remain in its state of rest or motion is called inertia.

Inertia of rest - The body tends to resist any change in its state of rest, e.g. a boy sitting in car at rest, falls backwards when the car starts moving.

Inertia of motion - The body resists any change in its state of motion, e.g. a body falls forward when a car suddenly stops.

Inertia of direction - The body resists any change in its direction of motion. E.g. when a car takes a steep turn, the persons fall outwards.

Factors on which inertia depends - Mass of the body.

102. (a) Define "Inertia".

(b) A shopkeeper shows three toys to a child made up of aluminium, steel and wood of ( same shape and volume. Which one of them would have highest inertia? Why?

c) Describe in brief an activity to illustrate the property of inertia of rest.

(a). The property of a body due to which it opposes a change in its state of rest or motion is inertia.

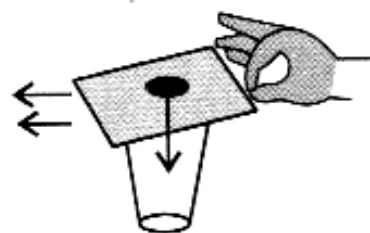
(b) Aluminium, as it has the greatest mass.

(c) Aim: to demonstrate inertia of rest of a coin.

Materials required: A 5 or 10 rupee coin, a light weight piece of cardboard, a glass tumbler.

**METHOD:**

- (i) Place the cardboard on the glass tumbler and keep the arrangement on a plane surface.
- (ii) Put the coin at the centre of the cardboard.
- (iii) Gently flick the cardboard away.
- (iv) Observe what happens to the coin.



**Conclusion:** The coin possesses inertia of rest. As the card is flicked. It flies off but coin tends to be in a state of rest and falls into the glass.

103.i) Name the property of bodies to resist a change in their velocity,

(ii) what is the relationship between force and acceleration?

(iii) What name is given to the product of mass and velocity of a body?.

(iv) Which physical quantity corresponds to the rate of change of momentum?

(v) Name the principle on which a rocket works.

- (i) Inertia
- (ii)  $F=ma$
- (iii) Momentum
- (iv) Force
- (v) Newton's third of motion

104. (i) Define momentum, State its SI unit

(ii) An object of mass 50kg is accelerated uniformly from a velocity of 4m/s to 8m/s in 8s. Calculate the initial and final momentum of the object. Also find the magnitude of the force exerted on the object.

The product of mass and velocity of a body is called momentum

SI unit:  $\text{Kg ms}^{-1}$

Mass,  $m=50\text{kg}$ , velocities,  $u=4\text{ms}^{-1}$  and  $v = 8\text{ms}^{-1}$ , time  $t = 8\text{s}$ .

$$\begin{aligned}\text{Initial momentum, } p_1 &= mu = 50 \times 4 \\ &= 200\text{kgm/s}\end{aligned}$$

$$\begin{aligned}\text{Final momentum, } p_2 &= mv = 50 \times 8 \\ &= 400\text{kg ms}^{-1}\end{aligned}$$

$$\begin{aligned}\text{Force} &= \frac{\text{Momentum Change} = p_2 - p_1}{\text{Time } t} \\ &= \frac{400 - 200}{8} = \frac{200}{8} = 25 \text{ N}\end{aligned}$$

105.(a) State Newton's second law of motion and show that the first law of motion can be mathematically stated from the mathematical expression for the second law of motion.

b) A stone dropped from a window reaches the ground in 0.5seconds (given  $g = 10 \text{ m/S}^2$ )

i) Calculate the speed just before it hits the ground.

ii) What is the average speed at  $t=0.5\text{s}$ ?

iii) Calculate the height of window from the ground.

a) Force acting on a body is directly proportional to rate of change of its momentum

$$F = ma$$

In uniform velocity,  $F=0$  (as  $a = 0$ )

When body is at rest,  $F=0$  (as  $a = 0$ )

This derives first law of motion.

b)  $u=0$ ,  $t=0.5 \text{ s}$ ,  $g = 10 \text{ m/S}^2$

$$\text{i) } v = u + gt = 0 + 10 \times 0.5 = 5 \text{ m/s}$$

$$\text{ii) } v_{mg} = \frac{u+v}{2} = \frac{0+5}{2} = \frac{5}{2} = 2.5 \text{ m/s.}$$

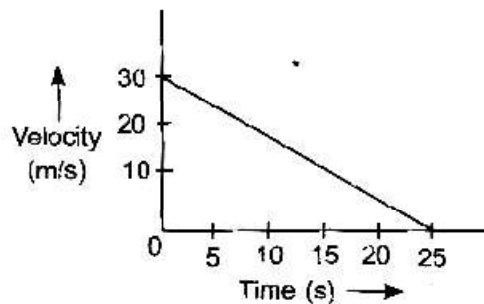
$$\text{iii) } h = ut + \frac{1}{2}gr^2$$

$$= 0 + \frac{1}{2} \times 10 \times (0 - 0.5)^2$$

$$= 1.25\text{m}$$

106. a) State the law that provides the formula for measuring force and the law which provides the definition of force.

b) Velocity -time graph of a 50 g marble rolling on floor is given below. Find



i) Time in which it stops

ii) Negative acceleration produced in it

iii) Positive force acting on the marble

a) A) Newton's second law of motion. It states that the amount of force acting on a body is directly proportional to the rate of change of its momentum. This defines force as the product of mass and acceleration produced in the body

b) i)  $t = 25\text{s}$

ii)  $a = \frac{0-30}{25} = -1.2\text{m/s}^2$  (from graph)

iv)  $F = ma = \left(\frac{50}{1000}\right) \text{kg} \times (-1.2) \text{ms}^{-2}$

-0.06 N

107 i) When a carpet is beaten with a stick dust come out of it. Explain.?

ii) Calculate the force required to impart a car with a velocity of 30 m/s in 10s starting.

i) When the carpets is beaten it particles and to remain at rest due to their inertia or rest. So they get detached from the carpet. As a result they fall down.

ii) Initial velocity,  $u = 0$

Final velocity,  $v = 30 \text{ms}^{-1}$

Time,  $t = 10\text{s}$

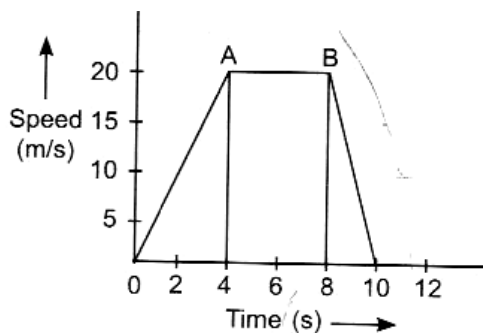
Mass of car,  $m = 15000\text{ kg}$

$$\text{Acceleration } a = \frac{v-u}{t} = \frac{30-0}{10} = 3\text{ ms}^{-2}$$

$$F = ma = 15000 \times 3$$

$$= 45000\text{N}$$

108. The speed-time graph of a car of 1000 kg mass is given. On the basis of this, answer the following question.:



- i. When is the maximum accelerating force acting on car?
- ii. What is the retarding force acting on the car?
- iii. For how long is no force acting on the car?
- iv. What is the velocity of the car after 4 seconds?
- v. Find the acceleration of the car during each of the first two intervals of four second each.

$$\text{i) } a = \frac{20}{4} = 5\text{ m/s}^2 \text{ from } t = 0\text{ s to } t = 4\text{ s}$$

Thus, force is maximum in this period

$$\text{ii) } a \text{ is negative from } t = 8\text{ s to } t = 10\text{ s}$$

$$a = \frac{0-20}{10-8} = -10\text{ m/s}^2$$

$$\text{iii) From } t = 4\text{ s to } t = 8\text{ s; no force acts as } a = 0$$

$$\text{iv) } v = 20\text{ m/s from } 4\text{ s to } 8\text{ s}$$



v) 'a' from 0-4 s =  $5 \text{ m/s}^2$

'a' from 4-8s =  $0 \text{ m/s}^2$

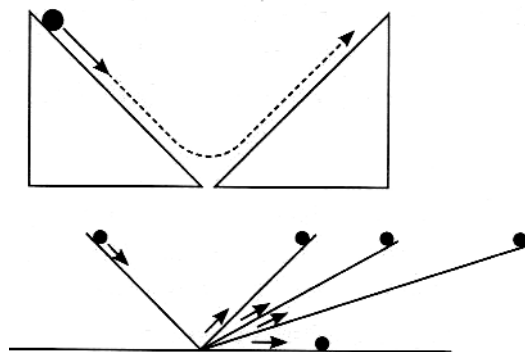
109. a) Describe Galileo's experiment to demonstrate motion of objects on an inclined plane.

b) Why does the speed of an object change with time?

a) Galileo, for the first time deduced that objects move with a constant speed when no force acts on them by studying the motion of objects on an inclined plane. He rolled down a marble down an inclined plane which accelerated as it moved down. Galileo claimed that when a marble is released from one inclined plane, it rolls down and climbs the opposite side up to the same height from which it was released. If the angle of inclination of the second plane was decreased gradually, then the marble travelled farther distances until it reached the same height.

Galileo hypothesised that if the second plane was made horizontal then it would continue to move along the same path forever trying to reach the same height. In such a case, the unbalanced force acting on it changes the motion of the marble, some external unbalanced force must act on it. In this case, the effect of friction on the marble is considered to be zero.

Galileo's hypothesis thus laid the foundation for the formulation of the first law of motion.



b) Speed of an object changes with time if an external unbalanced force acts upon it. This is because an unbalanced force is required to change the state of motion of an object. If no unbalanced force acts on the object, it remains at rest or continues to move along a straight line path with uniform velocity.