1. Law of motion.

1. **Inertia** :- The inherent property of a body to resist any change in its state of rest or the state of uniform motion, unless it is influenced upon by an external unbalanced force, is known as Inertia.

Types of Inertia :- (i) Inertia of rest (ii) Inertia of motion (iii) Inertia of direction.

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2. **Like parallel forces** :- Two (or) more forces of equal or unequal magnitude acting along the same direction, parallel to each other called like parallel forces.

Unlike parallel forces :- Two (or) more equal forces (or) unequal forces act along opposite direction parallel to each other, then they are called unlike parallel force

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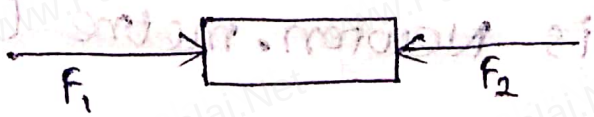
3). Parallel unequal forces are acting in opposite directions.

$F_{net} = F_1 - F_2 \quad (F_1 > F_2)$

$F_{net} = F_2 - F_1 \quad (F_2 > F_1)$

F_{net} is directed along the greater force.



4) Difference between mass and weight :-

Mass	weight.
(i) Fundamental quantity	Derived quantity
(ii) Its unit is kg	Its unit is Newton
(iii) Remains the same	varies from place to place.
(iv) It is measured Physical balance	It is measured spring balance.
(v) The amount of matter contained in a body	It is the gravitational pull acting on the body.

5) Moment of a couple :- The Product of any one forces and the perpandicular distance between the line of action of two forces.

(ii) The turning effect of a couple is measured by the magnitude of its moment.

moment of a couple } = Force x Perpandicular distance between the line of action of forces.

$$M = F \times S.$$

The unit is Newton. metre (N.m).

6) Principle of moments :- when a number of like or unlike parallel forces act on a rigid body and the body is in equilibrium, then the algebraic sum of the moments in the clockwise direction is equal to the algebraic sum of the moments in the anticlockwise direction.

moment in clockwise direction = moment in anti clockwise direction.

$F_1 \times d_1 = F_2 \times d_2$

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7) Newton Second Law :- The force acting on a body is directly proportional to the rate of change of momentum of the body and the change in momentum takes place in the direction of the force.

(OR)

The Rate of Change of momentum of an object is directly proportional to the applied unbalanced force in the direction of force.

8) Why a spanner have a long handle is preferred to tighten screws in heavy vechicles?

A spanner has a long handle because the turning effect of force depends upon the perpandicular distance of the point from the line of action of the force.

Turning effect of force = Force x Perpandicular distance,

9) while catching a cricket ball the fielder lowers his hands backwards. why?

If he stops his hands soon after catching the ball, the ball comes to rest very quickly. It means that the momentum of the ball is brought to rest very quickly. So the average force acting on the body will be very large. Due to this large average force, the hands will get hurt. To avoid getting hurt, the player brings the ball to rest slowly.

10) How does an astronaut float in a space shuttle?

(i) Astronauts are not floating but falling freely around the earth due to their huge orbital velocity. since spacestation and astronauts have equal accelaration they are under free fall condition.

(ii) Both the astronauts and the spacestation are in the state of weightlessness.

Book Inside 2 marks :-

11) Resultant force :- when several forces acts simultaneously on the same body then the combined effect of the multiple forces can be represented by a single force, which is termed as 'Resultant force'

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12) Balanced force :- Resultant force of all the forces acting on a body is equal to zero, then the body equilibrium. Such forces balanced force.

Unbalanced force :- The resultant force is not equal to zero, then it causes the motion of the body due to unbalanced force.

13) Moment of force :- The rotating (or) turning effect of a force about a fixed point (or) fixed axis is called moment of force.

14) Torque :- The product of the force and perpandicular distance between the fixed point or the fixed axis and the line of action of the force.

$$\tau = F \times d.$$

Torque is a vector quantity. It's acting along the direction, perpandicular to the plane containing the line of action of force and the distance. It's SI unit Nm.

15) Couple :- Two equal and unlike parellel forces applied simultaneously at two distinct points consist a couple.

(ii) The line of action of the two forces does not coincide.

(iii) It does not produce any translatory motion since the resultant is zero.

Example: (i) Turning a tap,

(ii) winding (or) unwinding screw.

(iii) Spinning of a top.

16) One Newton :- The amount of force required for a body of mass 1 kg produces acceleration of $1\ ms^{-2}$ is called one Newton. $1N = 1\ kg\ ms^{-2}$.

17) One Dyne :- The amount of force required for a body of mass 1 g produces acceleration of $1\ cms^{-2}$ is called one Dyne.

$1\ Dyne = 1\ g\ cms^{-2}$; $1N = 10^5 dyne$.

18) Impulse Force :- A large force acting for a very short interval of time is called as Impulsive force.

$J = F \times t$

Newton IInd Law, $F = \Delta P / t \Rightarrow \Delta P = F \times t$

$J = \Delta P$; $\Delta P = F \times t$.

Impulse is also equal to the magnitude of change in momentum. Unit is $kg\ ms^{-1}$ (or) Ns.

19) Relation between g and G

$F = \frac{GMm}{R^2} \rightarrow (i)$

$F = ma = mg$

$mg = \frac{GMm}{R^2}$

$$\boxed{g = \frac{GM}{R^2}}$$

20) Linear Momentum :- The product of mass and velocity of a moving body gives the magnitude of Linear momentum. It acts in the direction of the velocity of the object.

$P = mass \times velocity \Rightarrow P = m \times V$.

5 mark

1. Types of Inertia :-

Inertia of rest :- The resistance of a body to change its state of rest. is called

Example :- when you vigorously shake the branches of a tree, some of the leaves and fruits are detached and they fall down.

Inertia of motion :- The resistance of a a body to change its state of motion

Example :- An athlete runs some distance before jumping. Because, this will help him jump longer and higher.

Inertia of direction :- The resistance of a body to change its direction of motion.

Example :- When you make a sharp turn while driving a car, you tend to lean sideways.

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2) Newton Laws :-

I^St Law :- Every body continues to be in its state of rest (or) the state of uniform motion along a straight line unless it is acted upon by some external force.

II^nd Law :- The force acting on a body is directly proportional to the rate of change of linear momentum of the body and the change in momentum takes place in the direction of the force.

III^rd Law :- For every action, there is an equal and opposite reaction. They always act on two different bodies.

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3) Newton second law of mathematical relation :-

Let, 'm' be the mass of a moving body, moving along a straight line with an initial speed 'u'. After a time interval of 't', the velocity of the body changes to 'v' due to the impact of an unbalanced external force F.

Initial momentum of the body $P_i = mu$

Final momentum of the body $P_f = mv$

Change in momentum $\Delta P = P_f - P_i = mv - mu$

Second Law of motion, F $\propto$ rate of change of momentum

F $\propto$ change in momentum / time. $F \propto \frac{mv-mu}{t}$

$F = k \frac{mv-mu}{t} \Rightarrow F = \frac{km(v-u)}{t}$

$k = 1$; $F = \frac{m(v-u)}{t}$; k = proportionality constant

$a = \frac{(v-u)}{t}$ $\boxed{F = ma}$ v-u = change in velocity.

No external force is required to maintain the motion of a body moving with uniform velocity. When the net force acting on a body is not equal to zero, definitely velocity of the body will change

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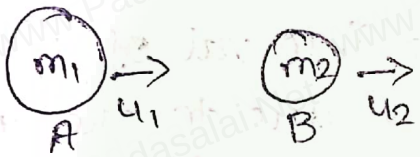
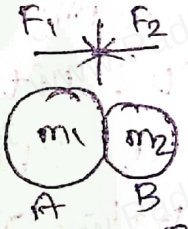
4) Linear conservation of momentum :-

The absence of external unbalanced force, the total linear momentum of a system of objects remains unchanged

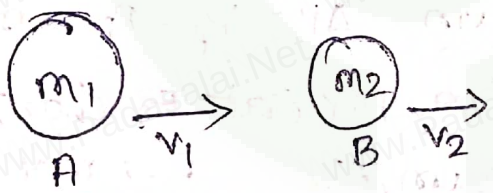
Proof :- Consider two object A and B of masses m_1 and m_2 travelling the same direction along a straight line at different velocities u_1 and u_2. There are no other external unbalanced forces acting on them. ($u_1 > u_2$).



Before collision
(a)



During collision
(b)



After collision
(c)

A Force acting on B

F_1 = mass of B × acceleration on B.

$F_1 = \frac{m_2 (v_2 - u_2)}{t}$ → (i)

B Force acting on A

F_2 = mass of A × acceleration on A

$F_2 = \frac{m_1 (v_1 - u_1)}{t}$ → (2)

According to Newton III rd law $F_1 = -F_2$

eqn (i) and (ii),

$m_2 (v_2 - u_2) = -m_1 (v_1 - u_1)$

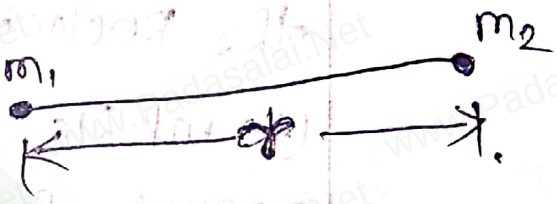
$m_2 v_2 - m_2 u_2 = -m_1 v_1 - m_1 u_1$

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

Before collision = After collision.

6). Newton's Law of Gravitation (or) Universal Law of Gravitation.

Every object in the universe attracts every other object with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.



$F \propto m_1 m_2 \rightarrow (i)$

$F \propto 1/r^2 \rightarrow (ii)$

Comparing (i) and (ii)

$F \propto \frac{m_1 m_2}{r^2}$

$F = \frac{G m_1 m_2}{r^2}$

$G = \frac{F \cdot d^2}{m_1 m_2}$

G - Gravitational Constant.

The value of $G = 6.674 \times 10^{-11} \, Nm^2 kg^{-2}$

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5) Rocket Propulsion :-

(i) Based on the Law of conservation of linear momentum and Newton's III Law of motion.

(ii) Rockets are filled with a fuel in the propellant tank.

(iii) When the rocket is fired, this fuel is burnt and hot gas is ejected with a high speed from the nozzle of the rocket, producing a huge momentum.

(iv) To balance this momentum an equal and opposite reaction force is produced in the combustion chamber which make the Rocket ~~to~~ project forward.

(v) While in motion, the mass of the rocket gradually decreases, until the fuel is completely burnt out. since, there is no net external force acting on it, the linear momentum of the system is conserved.

(vi) The mass of the rocket decreases with altitude which results in the gradual increase in velocity of the rocket

(vii) At one stage, it reaches a velocity, which is sufficient to just escape from the gravitational pull of the Earth.

(7) Application of Newton's Law of Gravitation:

(i) Dimensions of the heavenly bodies can be measured using the Gravitation Law. Mass of Earth, Radius of Earth, acceleration due to gravity etc. can be calculated with a higher accuracy.

(ii) Helps in discovering new stars and planets.

(iii) One of the irregularities in the motion of stars is called 'wobble'. Lead to the disturbance in the motion of a planet nearby. In this condition the mass of the star can be calculated using the Law of Gravitation.

(iv) Helps to predict the path of the astronomical bodies.

(v) Helps to explain germination of roots is due to the property of geotropism which is the property of a root responding to the gravity.

8 Application of Torque :-

1. Gears :- A gear is a circular wheel with teeth around its rim. It helps to change the speed of rotation of a wheel by changing the torque and helps to transmit power.

2. Seasaw :- Most of you have played on the seasaw. Since there is a difference in the weight of the person sitting on it, the heavier person lifts the lighter person. When the heavier person comes closer to the pivot point (fulcrum) the distance of the line of action of the force decreases It causes less amount of torque to act on it. This enables the lighter person to lift the heavier person.

3. Steering wheel :- A small steering wheel enables you to manoeuvre a car easily by transferring a torque to the wheels with less effort.

Table 1.2 Apparent weight of a person in a moving lift

Case 1: Lift is moving **upward** with an acceleration 'a'	Case 2: Lift is moving **downward** with an acceleration 'a'	Case 3: Lift is at **rest.**	Case 4: Lift is **falling down freely**
$R - W = F_{net} = ma$ $R = W + ma$ $R = mg + ma$ $\mathbf{R = m(g+a)}$	$W - R = F_{net} = ma$ $R = W - ma$ $R = mg - ma$ $\mathbf{R = m(g-a)}$	Here, the acceleration is zero $a = 0$ $R = W$ $\mathbf{R = mg}$	Here, the acceleration is equal to g $a = g$ $\mathbf{R = m(g-g)}$
$R > W$	$R < W$	$R = W$	$R = 0$
Apparent weight is **greater** than the actual weight.	Apparent weight is **lesser** than the actual weight.	Apparent weight is **equal** to the actual weight.	Apparent weight is equal to **zero.**

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