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SCIENCE

10

2020 EDITION

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Dr. S.A. **RAJKUMAR** MBBS., MS(EM)

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SCIENCE

10th Standard

First Edition : 2019

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PREFACE

Don Science Companion for the X Std. students is entirely based on the new syllabus and latest Question Paper pattern.

In this book, all the text book questions are answered. Additional questions are given as per the blue print of new syllabus. In Section B, all types of questions are dealt in detail. Also for every chapter an unit test question paper is given.

Along with this book a free practice book to all important questions is issued. And a Q book with Govt. Model question papers in all chapters is given free.

It is our robust optimism that our companion would provide an impetus to the students growth potential and serve as an useful guidance to the teachers.

All the best in all your endeavours.

S.A. Suresh Kumar, MCA., MBA.,
for Don Publications (P) Ltd.

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X Std. State Board Syllabus
Based on New Question Paper Pattern
Design of the Question Paper & Time Management

MODEL QUESTION PAPER

Time : 15 mins + 3 hours **Marks: 75**

Section	Question Number	Question Type	No. of Questions	Question to write	Total Marks	Writing Time (Average)	Revision Time
I.	1 - 12	Choose the correct answer	12	12	12	12 x 2 = 24	6
II.	13 - 22	2 Mark Questions (Question No.22 is compulsory)	10	7	14	7 x 5 = 35	6
III.	23 - 32	4 Mark Questions (Question No.32 is compulsory)	10	7	28	7 x 6 = 42	6
IV.	33 - 35	7 Mark Questions (Either or Type)	6	3	21	3 x 16 = 48	13
		Total	38	29	75	149	31

NOTE

- Science paper is for 75 marks only. Remaining 25 marks is for internal assessment and practicals.
- Around 40 % questions will be from inside book (created questions.)
- Students should write the answers in either BLUE or BLACK colour pen only (Do not use both the colours - even for highlighting or underlining or heading).

UNIT

1

Laws of Motion

POINTS TO REMEMBER

Mechanics	: The branch of physics that deals with the effect of force on bodies.
Statics	: It deals with the bodies which are at rest under the action of forces.
Force	: It is an external effort in the form of push or pull.
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.
Linear momentum	: The product of mass and velocity
Like parallel forces	: Two are more forces of equal or unequal magnitude acting along the same direction parallel to each other;
Unlike parallel forces	: Two are more equal forces or unequal forces act along opposite directions parallel to each other.
Resultant forces	: When several forces act simultaneously on the same body ,then the combined effect of multiple forces can be represented by a single force termed resultant force.
Moment of the force	: The rotating or turning effect of a force about a fixed point or fixed axis is called moment of the force.
Torque	: Moment of the force is otherwise called as Torque.
Couple	: Two equal and unlike parallel forces applied simultaneously at two distinct points constitute a couple.
Moment of a couple	: Rotating effect of a couple is known as moment of a couple.
1 newton	: The amount of force required for a body of mass 1 kg produces an acceleration of 1m s^{-2}.
Impulsive force	: A large force acting for a very short interval of time.
Mass	: Mass is the quantity of matter contained in a body.
Inertial mass	: If mass is defined in association with force and inertia ,it is termed as "inertial mass".
Gravitational mass	: When the mass of the body is defined in association with the gravitational field ,it is termed as gravitational mass.
Weight	: Weight is the gravitational force exerted on it due to the earth's gravity alone
Apparent weight	: It is the weight of the body acquired due to the action of gravity and other external forces acting on the body.
Weightlessness	: Whenever a body or a person falls freely under the action of Earth's gravitational force alone, it appears to have zero weight. This state is referred to as weightlessness.

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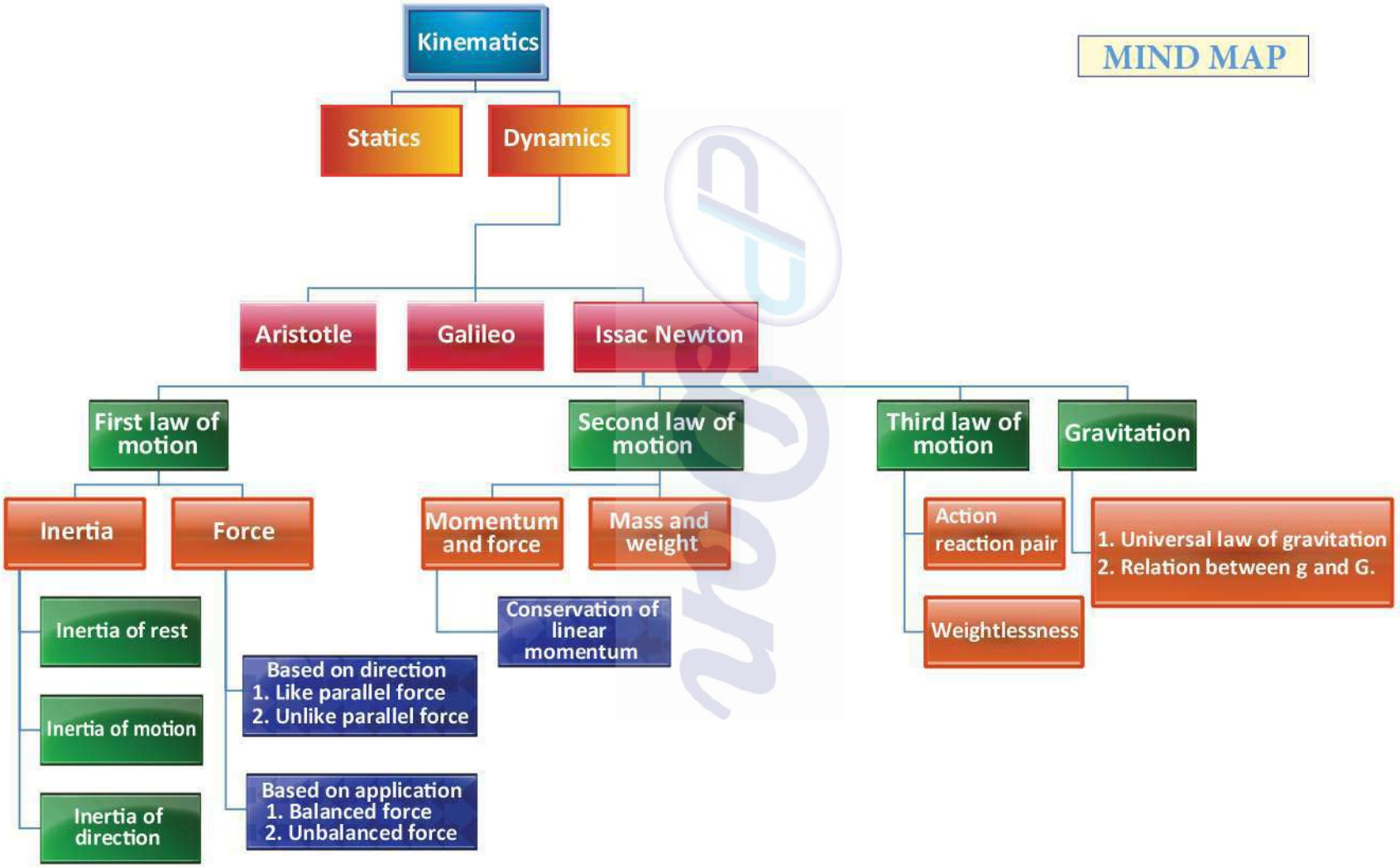
MIND MAP



Formulae	
Linear Momentum	$P = mv$
Parallel forces are acting in the same direction	$F_{net} = F_1 + F_2$
Parallel unequal forces are acting in the opposite direction	$F_{net} = F_1 - F_2$ (if $F_1 > F_2$) $F_{net} = F_2 - F_1$ (if $F_2 > F_1$)
Torque	$\tau = F \times d$
Principle of moments	$F_1 \times d_1 = F_2 \times d_2$
Moment of couple	$M = F \times S$
Force	$F = m \times a$
Impulse	$J = \Delta P$ (or) $F \times t$
Law of conservation of linear momentum	$m_1v_1 + m_2v_2 = m_1u_1 + m_2u_2$
Newton's Universal law of gravitation	$F = \frac{GMm}{R^2}$ $[G = 6.674 \times 10^{-11}\ Nm^2kg^{-2}]$
Acceleration due to gravity	$g = \frac{GM}{R^2}$
Weight	$W = mg$
Mass of the Earth	$M = \frac{gR^2}{G}$
Acceleration	$a = \frac{v-u}{t}$
Apparent weight i. When lift is moving upwards	$R = m(g + a)$ Where (R→ apparent weight of the person)
ii. When lift moving downards	$R = m(g - a)$ a → acceleration m → mass of the person
iii. When lift is at rest	$R = mg$, g → acceleration due to gravity
iv. when lift is falling down	$R = 0$

Textbook Evaluation

I. Choose the most suitable answer from the given four alternatives and write the option code and corresponding answer:

1. Inertia of a body depends on

a) weight of the object
b) acceleration due to gravity of the planet
c) mass of the object
d) Both a & b

2. Impulse is equal to ✶✶

a) rate of change of momentum
b) rate of force and time
c) change of momentum
d) rate of change of mass

3. Newton's III law is applicable

a) for a body at rest
b) for a body in motion
c) both a & b
d) only for bodies with equal masses

4. Plotting a graph for momentum on the X-axis and time on Y-axis. Slope of momentum-time graph gives ✶✶

a) Impulsive force
b) Acceleration
c) Force
d) Rate of force

5. In which of the following sport is the turning of effect of force used

a) swimming
b) tennis
c) cycling
d) hockey

6. The unit of 'g' is m s^{-2}. It can be also expressed as

a) cm s^{-1}
b) N kg^{-1}
c) N m^2kg^{-1}
d) cm^2s^{-2}

7. One kilogram force equals to ✶

a) 9.8 dyne
b) 9.8×10^4 N
c) 98×10^4 dyne
d) 980 dyne

8. The mass of a body is measured on planet Earth as M kg. When it is taken to a planet of radius half that of the Earth then its value will be _____ kg.

a) 4 M
b) 2M
c) M/4
d) M

9. If the Earth shrinks to 50% of its real radius and its mass remains the same, the weight of a body on the Earth will be ✶✶

a) decrease by 50%
b) increase by 50%
c) decrease by 25%
d) increase by 300%

10. To project the rockets which of the following principle(s) is /(are) required?

a) Newton's third law of motion
b) Newton's law of gravitation
c) law of conservation of linear momentum
d) both a and c

Ans:

1)	c)	Mass of the object	6)	b)	Nkg^{-1}
2)	c)	Change of momentum	7)	c)	98×10^4 dyne
3)	c)	both a & b	8)	d)	M
4)	c)	force	9)	d)	increases by 300%
5)	c)	cycling	10)	d)	both a and c

II. Fill in the blanks:

1. To produce a displacement _____ is required
2. Passengers lean forward when a sudden brake is applied in a moving vehicle. This can be explained by _____ ★★
3. By convention, the clockwise moments are taken as _____ and the anticlockwise moments are taken as_____
4. _____ is used to change the speed of a car.
5. A man of mass 100 kg has a weight of _____ at the surface of the Earth. ★★

Ans:

1.	Force	4.	A gear
2.	inertia of motion	5.	980 N
3.	negative, positive		

III. State whether the following statements are true or false. Correct the statement if it is false:

1. **The linear momentum of a system of particles is always conserved.** **False**
   The linear momentum of a system of particle is conserved only if no external force acts on the system.
2. **Apparent weight of a person is always equal to his actual weight.** ★★ **False**
   Apparent weight of a person may be the same, greater or lesser than his actual weight.
3. **Weight of a body is greater at the equator and less at the polar region.** **False**
   Weight of a body is greater at the poles and less at the equatorial region.
4. **Turning a nut with a spanner having a short handle is so easy than one with a long handle.** **False**
   Turning a nut with a spanner having a long handle is so easy than one with a short handle.
5. **There is no gravity in the orbiting space station around the Earth. So the astronauts feel weightlessness.** ★★ **False**
   Since spacestation and astronauts have equal acceleration, they are under free fall condition. So, the astronaut feels weightlessness.

IV. Match the following

1.

Column I		Column II	
1) Newton's I law	-	a) propulsion of a rocket	(b)
2) Newton's II law	-	b) Stable equilibrium of a body	(c)
3) Newton's III law	-	c) Law of force	(d)
4) Law of conservation of linear momentum	-	d) Flying nature of bird	(a)

V. Assertion & Reasoning

Mark the correct choice as

a) If both the assertion and the reason are true and the reason is the correct explanation of assertion.

b) If both the assertion and the reason are true, the reason is not the correct explanation of the assertion.

c) Assertion is true, but the reason is false.

d) Assertion is false, but the reason is true.

1. **Assertion:** The sum of the clockwise moments is equal to the sum of the anticlockwise moments.
   Reason: The principle of conservation of momentum is valid if the external force on the system is zero.

Ans : b) If both the assertion and the reason are true, the reason is not the correct explanation of the assertion.

2. **Assertion:** The value of 'g' decreases as height and depth increases from the surface of the Earth.
   Reason: 'g' depends on the mass of the object and the Earth.

Ans : c) Assertion is true, but the reason is false.

VI. Answer briefly.

1. Define inertia. Give its classification. ★★

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 :

- Inertia of rest
- Inertia of motion
- Inertia of direction

2. Classify the types of force based on their application.

Based on the direction in which the force acts, they can be classified as

- Like Parallel forces
- Unlike Parallel forces.

3. If a 5 N and a 15 N forces are acting opposite to one another. Find the resultant force and the direction of action of the resultant force. ★

Let, $F_1 = 5$ N

$F_2 = 15$ N

$F_{net} = F_2 - F_1$ $[\because F_2 > F_1]$

$= 15 - 5 = 10$ N

F_{net} i.e, the resultant force acts along the direction of the greater force 15 N.

4. Differentiate mass and weight. ★★

Mass	Weight
Fundamental quantity	Derived quantity
It is the amount of **matter** containing in a body	It is the **gravitational pull** acting on the body
Its unit is **kilogram**	Its unit is **newton**
Remains the **same**	**Varies** from place to place.
It is a **scalar** quantity	It is a **vector** quantity

5. Define moment of a couple. ★★

- The **rotating effect** of a couple is known as moment of a couple
- **Eg:** Turning a tap, winding or unwinding a screw.
- Moment of a couple = Force × perpendicular distance between the line of action of force.
- $\boxed{M = F \times S}$

6. State the 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 clock wise direction is equal to the algebraic sum of the moments in the anti-clockwise direction.
- Moment in clockwise direction = Moment in anticlockwise direction.
- $\boxed{F_1 \times d_1 = F_2 \times d_2}$

7. State Newton's second 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".
- Force = mass × acceleration
- $\boxed{F = ma}$

8. Why a spanner with a long handle is preferred to tighten screws in heavy vehicles?

- A spanner has a long handle to produce a larger moment of force by a small force applied normally at the end of its handle.
- **Moment of force** = $\boxed{\vec{F} \times \vec{d}}$

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 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?

- Since space station and astronauts have equal acceleration, they are under **free fall condition.**
- Both the astronauts and the space station are in the state of weightlessness.
- They are not actually floating but falling freely around the earth due to the **huge orbital velocity.**

VII. Solve the given problems: (Numerical Problems)

1. Two bodies have a mass ratio of 3:4 The force applied on the bigger mass produces an acceleration of 12 ms^{-2}.What could be the acceleration of the other body, if the same force acts on it.

Formula used:
Newton's second law
$F = ma$

Given $m_1 : m_2 = 3 : 4$

$a_2 = 12\ m\ s^{-2}$

$a_1 = ?$

Using Newton's second law

$F = ma$

$F = m_1 a_1 = 3a_1$

$F = m_2 a_2 = 4 \times 12 = 48\ N$

$3a_1 = 48$

$a_1 = 48 / 3 = 16\ m\ s^{-2}$

$\mathbf{a_1 = 16\ ms^{-2}}$

The acceleration produced on the other body is **16 m s^{-2}**

2. A ball of mass 1 kg moving with a speed of 10 ms^{-1} rebounds after a perfect elastic collision with the floor. Calculate the change in linear momentum of the ball. ✱

Given $m = 1\ kg$, $v = 10\ m\ s^{-1}$

When a ball bounces back with the same speed, the momentum changes from mv to – mv. So the change in momentum is –2 mv.

$\Delta P = -2mv = -2 \times 1 \times 10$

$\mathbf{\Delta P = -20\ kg\ m\ s^{-1}}$

3. A mechanic unscrew a nut by applying a force of 140 N with a spanner of length 40 cm. What should be the length of the spanner if a force of 40 N is applied to unscrew the same nut?

Formula used:
Moment of force
$= F_1\ d_1$

Given $F_1 = 140\ N$

$d_1 = 40\ cm = 40 \times 10^{-2}\ m$

$F_2 = 40\ N$

$d_2 = ?$

The moment of force on the nut

$= F_1\ d_1 = 140 \times 40 \times 10^{-2}$

$= 56\ Nm$

The same moment of force is required to unscrew the nut so,

$56 = F_2\ d_2$

$56 = 40 \times d_2$

$d_2 = \frac{56}{40} = 1.4\ m$

$\mathbf{d_2 = 1.4\ m}$

The spanner with the longer handle requires very less force to unscrew the same nut.

4. The ratio of masses of two planets is 2:3 and the ratio of their radii is 4:7. Find the ratio of their accelerations due to gravity. ★

Given, the ratio of masses of two planets $M_1 : M_2$ is 2 : 3

The ratio of their radii $R_1 : R_2$ is 4 : 7

$g_1 : g_2 = ?$

Formula used:

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

$$g = \frac{GM}{R^2} ; \quad g_1 = \frac{GM_1}{R_1^2} ; \quad g_2 = \frac{GM_2}{R_2^2}$$

$$\frac{g_1}{g_2} = \frac{\frac{GM_1}{R_1^2}}{\frac{GM_2}{R_2^2}} ; \quad \frac{g_1}{g_2} = \frac{M_1}{R_1^2} \times \frac{R_2^2}{M_2} = \frac{2 \times 7 \times 7}{4 \times 4 \times 3} = \frac{49}{24}$$

So $\mathbf{g_1 : g_2 = 49 : 24}$

VIII. Answer in detail.

1. What are the types of inertia? Give an example for each type.

Definition:

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:

- Inertia of rest
- Inertia of motion
- Inertia of direction

I. Inertia of rest:

The resistance of a body to **change** its **state of rest** is called inertia of rest.

Example: When you vigorously shake the branches of a tree some of the leaves and fruits are detached and they fall down. (Inertia of rest)

II. Inertia of motion:

The resistance of a body to **change its state of motion** is called inertia of motion.

Example: An athlete runs some distance before jumping. Because, this will help him jump longer and higher. (Inertia of motion).

III. Inertia of direction:

The resistance of a body to **change its direction of motion** is called inertia of direction.

Example: When we make a sharp turn while driving a car we tend to lean sideways due to inertia of direction

2. State Newton's laws of motion. ★★★

Newton's first law

Everybody continues to be in the state of rest or the state of uniform motion along a straight line unless it is acted upon by some external force.

Newton's 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.

Newton's third law

For every action there is an equal and opposite reaction. They always act on two different bodies.

3. Deduce the equation of a force using Newton's second law of motion. ★★

- "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".
- 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 $\Delta p = P_f - P_i$

$= mv - mu$

By Newton's second law of motion,

Force, $F \propto$ rate of change of momentum

$F \propto$ change in momentum / time

$$F \propto \frac{mv-mu}{t}$$

$$F = \frac{km(v-u)}{t}$$

Here, k is the proportionality constant.

k = 1 in all systems of units. Hence,

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

Since, acceleration = change in velocity/ time, a = (v – u) / t. Hence, we have

$$\boxed{F = m \times a}$$

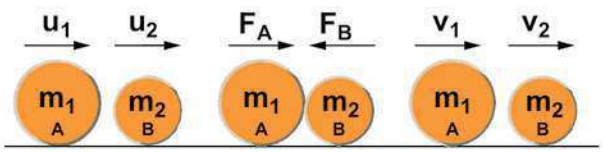
Force = mass × acceleration

4. State and prove the law of conservation of linear momentum. ★★

There is no change in the linear momentum of a system of bodies as long as no net external force acts on them.

Proof:

- Let us prove the law of conservation of linear momentum with the following illustration:



Conservation of linear momentum

- Let two bodies A and B having masses $\mathbf{m_1}$ and $\mathbf{m_2}$ move with initial velocity $\mathbf{u_1}$ and $\mathbf{u_2}$ in a straight line.
- Let the velocity of the **first body** be **higher** than that of the second body. i.e., $\mathbf{u_1 > u_2}$.
- During an interval of time t second, they tend to have a collision.
- After the impact, both of them move along the same straight line with a velocity v_1 and v_2 respectively.

Force on body B due to A, $\mathbf{F_B = m_2 (v_2 - u_2) / t}$

Force on body A due to B, $\mathbf{F_A = m_1 (v_1 - u_1) / t}$

By Newton's III law of motion,

Action force = Reaction force

$F_A = -F_B$

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

$$\mathbf{m_1v_1 + m_2v_2 = m_1u_1 + m_2u_2}$$

The above equation confirms **in the absence of an external force, the algebraic sum of the momentum after collision is numerically equal to the algebraic sum of the momentum before collision.**

Hence the law of conservation of linear momentum is proved.

5. Describe rocket propulsion. ★★

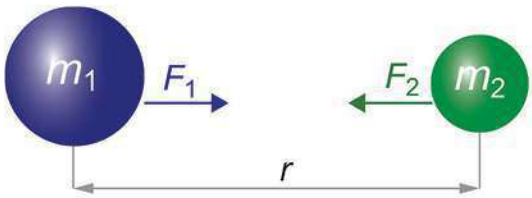
- Propulsion of rockets is based on the **law of conservation of linear momentum** as well as **Newton's III law** of motion.
- Rockets are filled with a fuel (either liquid or solid) in the propellant tank
- When the rocket is fired, this **fuel** is burnt and a **hot gas is ejected** with a high speed from the nozzle of the rocket, producing a huge momentum.
- To balance this momentum, an **equal and opposite reaction** force is produced in the **combustion chamber,** which makes the rocket project forward.
- 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.
- The mass of the rocket **decreases with altitude**, which results in the gradual **increase in velocity** of the rocket.
- At one stage, it reaches a velocity, which is sufficient to just escape from the gravitational pull of the Earth. This velocity is called **escape velocity.**

6. State the universal law of gravitation and derive its mathematical expression.

This law states that every particle of matter in this universe attracts every other particle with a force. This force is directly proportional to the product of their masses and inversely proportional to the square of the distance between the centers of these masses. The direction of the force acts along the line joining the masses.

Derivation:

- Force between the masses is always attractive and it does not depend on the medium where they are placed.



Gravitational force between two masses

- Let, $\mathbf{m_1}$ and $\mathbf{m_2}$ be the masses of two bodies A and B placed r metre apart in space

  Force $F \propto m_1 \times m_2$

  $F \propto 1/r^2$

- On combining the above two expressions

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

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

Where G is the universal gravitational constant.

- Its value in SI unit is 6.674×10^{-11} N m^2 kg^{-2}.

7. Give the applications of universal law of gravitation. ★

- **Dimensions of the heavenly bodies** can be measured using the law of gravitation. Mass of the Earth, radius of the Earth, acceleration due to gravity, etc. can be calculated with a higher accuracy.
- Helps in **discovering new stars** and **planets**.
- One of the irregularities in the motion of stars is called **'Wobble'** that leads 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.
- Helps to explain **germination of roots** due to the property of geotropism which is the property of a root responding to the gravity.
- Helps to predict the **path of the astronomical bodies**.

IX. Higher Order Thinking Skills (HOTS)

1. Two blocks of masses 8 kg and 2 kg respectively lie on a smooth horizontal surface in contact with one other. They are pushed by a horizontally applied force of 15 N. Calculate the force exerted on the 2 kg mass.

Consider both the masses as a unit system as they will move with common acceleration,

$\vec{F_1} = M\vec{a}$, Let $m_1 = 8$ kg, $m_2 = 2$ kg, $\vec{F_1} = 15$ N

$\vec{F_1} = (m_1 m_2)\vec{a}$

$15 = (8 + 2)\vec{a}$

$15 = 10\,a$

$a = 15 / 10 = 1.5$ ms^{-2}

Formula used:

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

Let F_2 be the force exerted on 2 kg mass then

$$\vec{F_2} = m\vec{a}$$

$$\vec{F_2} = 2 \times 1.5 = 3 \text{ N}$$

So, the force exerted on 2 kg mass is 3 N.

2. A heavy truck and bike are moving with the same kinetic energy. If the mass of the truck is four times that of the bike, then calculate the ratio of their momenta. (Ratio of momenta = 1:2

The kinetic energy of the truck = $\frac{1}{2} m_1 v_1^2$

The kinetic energy of the bike = $\frac{1}{2} m_2 v_2^2$

Formula used:
Kinetic energy
$= \frac{1}{2}mv^2$

Given that both are equal

$$\frac{1}{2} m_1 v_1^2 = \frac{1}{2} m_2 v_2^2 = k$$

$$v_1 = \sqrt{\frac{2k}{m_1}}, \quad v_2 = \sqrt{\frac{2k}{m_2}}$$

∴ momentum of the two bodies are given by,

$$P_1 = \sqrt{2m_1 k}, \quad P_2 = \sqrt{2m_2 k}$$

Given that $m_1 = 4m_2$; $\frac{P_1}{P_2} = \frac{\sqrt{2(4)(m_2)k}}{\sqrt{2m_2 k}} = \frac{\sqrt{4}}{\sqrt{1}}$

Ratio of momenta = 2 : 1

3. "Wearing helmet and fastening the seat belt is highly recommended for safe journey" Justify your answer using Newton's laws of motion.

- The second law tells us that applying a force on an object produces an acceleration proportional to the object's mass.
- When **you're wearing your seat belt**, it supplies the force to decelerate you in the event of a crash so that you don't hit the wind shield.
- According to **Newton's first law** an object in motion continues in motion with the same speed and in same direction, unless acted upon by a force.
- If the motor cycle were to abruptly stop, then the rider in motion would continue in motion.
- The rider would likely be propelled from the motor cycle, the rider becomes a projectile.
- If the person is not wearing the helmet, the injury would be severe.
- Thus wearing helmet and fastening the seat belt is highly recommended for safe journey.

Additional Questions

I. Choose the most suitable answer from the given four alternatives and write the option code and corresponding answer:

1. When a force is applied on bodies, they resist any change in their state. This property is called
   a) momentum b) inertia
   c) torque d) impulse

2. Force is vector quantity that has
   a) magnitude only b) direction only
   c) both magnitude and direction d) None of these

3. Which of the Newton's laws give the definition of force as well as inertia?
   a) Newton's I law b) Newton's II law
   c) Newton's III law d) zeroth law of Thermodynamics

4. Drawing water from a well is an example of
   a) balanced forces b) unbalanced forces
   c) parallel forces d) axial forces

5. Moment of force is also termed as
   a) torque b) inertia c) impulse d) None

6. Which of the following is an example for moment of couple? ✱
   a) turning a tap b) winding a screw
   c) spinning of a top d) All the above

7. Newton's second law is also called as ✱
   a) law of force b) law of inertia
   c) law of impulse d) law of conservation of momentum

8. Which of the following statements are true about Newton's second law of motion?
   a) Force is directly proportional to the rate of change of momentum
   b) This law helps to measure the amount of force
   c) Force is required to produce the acceleration of a body
   d) All the above statements are true.

9. 1 kg f is equal to
   a) 980 N b) 98 N c) 9.8 N d) 9.8 dyne

10. Impulse is product of
   a) force and time b) mass and velocity
   c) mass and acceleration d) force and velocity

11. Force between the masses is
   a) Always attractive b) Always repulsive
   c) either attractive or repulsive d) cannot be predicted

12. Force between the masses
   a) depends on the medium where they are placed
   b) does not depend on the medium
   c) may or may not depend on the medium
   d) None of the above

13. SI unit of G is
    a) Nm^2kg^{-2} b) Nm^2kg^2 c) $Nm^{-2}kg^2$ d) $Nm^{-2}kg^{-2}$
14. When we move to a higher altitude from the surface of the earth, the value of 'g'
    a) increases b) reduces c) becomes zero d) becomes infinity
15. When we move deep below the surface of the earth, the value of 'g'
    a) increases b) reduces c) becomes zero d) becomes infinity
16. Direction of weight is
    a) always towards the centre of the earth
    b) always away from the centre of the earth
    c) cannot be predicted
    d) either towards or away from the centre of the earth
17. A person whose mass is 60 kg on the surface of earth would weigh ★
    a) 97.5 N b) 60 N c) 588 N d) 65 N
18. Apparent weight is the
    a) actual weight of the body
    b) weight of the body acquired by gravity
    c) weight of the body due to other external forces acting on the body
    d) both b and c

Ans:

1)	b)	inertia	10)	a)	force and time
2)	c)	both magnitude and direction	11)	a)	Always attractive
3)	a)	Newton's I law	12)	b)	does not depend on the medium
4)	b)	unbalanced forces	13)	a)	$Nm^2 kg^{-2}$
5)	a)	Torque	14)	b)	reduces
6)	d)	All the above	15)	b)	reduces
7)	a)	law of force	16)	a)	always towards the centre of the earth
8)	d)	All the above statements are true	17)	c)	588 N
9)	c)	9.8 N	18)	d)	both (b) and (c)

II. Fill in the blanks:

1. _____ measures the impact of force on a body
2. Unit of momentum in C.G.S system is _____
3. A force which is equal to the resultant force in magnitude but opposite in direction is called as _____ ★
4. Moment of force is also called as _____
5. Newton's second law of motion is also called as _____ ★
6. _____ is required to produce the acceleration of a body
7. Impulse is also equal to the magnitude of _____
8. Propulsion of rockets is based on the _____ and _____

9. The value of g is maximum in _____ region and minimum at the _____ region

10. Value of g is _____ at the centre of the earth

11. The weight of a body is more at the _____ than at the _____ region

12. Ability of a body to maintain its state of rest or motion is called _____ ★

Ans:

1.	linear momentum	7.	change in momentum
2.	g cm s^{-1}	8.	law of conservation of momentum and Newton's third law of motion
3.	Equilibrant	9.	polar region, equatorial
4.	Torque	10.	zero
5.	law of force	11.	poles, equatorial
6.	Force	12.	inertia

III. State whether the following statements are true or false. Correct the statement if it is false:

1. Kinematics deals with the motion of bodies considering the cause of motion

False

Kinetics deals with the motion of bodies considering the cause of motion

2. In presence of air when two different mass bodies are dropped from a height, the heavier body falls faster than the lighter one. **True**

3. The impact of force is more if the velocity and the mass of the body is less. ★

False

The impact of force is more if the velocity and the mass of the body is more.

4. Newton's second law gives the definition of force as well as inertia. ★ **False**

Newton's first law gives the definition of fore as well as inertia.

5. Change in momentum can be achieved when a large force acting for a longer period of time **False**

Change in momentum can be achieved when a large fore acting for a short period of time.

6. Force between the masses is always attractive and it does not depend on the medium where they are placed. **True**

IV. Match the following

	Column I		Column II	
1)	Linear momentum	-	a) $F = ma$	(d)
2)	Force	-	b) $M = F \times s$	(a)
3)	Moment of couple	-	c) $J = F \times t$	(b)
4)	Impulse	-	d) $P = mV$	(c)

2. **Column I** **Column II**

1) Force	-	a) Nm	(c)
2) Torque	-	b) kg ms^{-1}	(a)
3) Impulse	-	c) Newton	(d)
4) Momentum	-	d) Ns	(b)

3. **Column I** **Column II** ✶

1) Like parallel forces	-	a) Action of a lever	(b)
2) Unlike parallel forces	-	b) A kick on the moving soccer ball.	(c)
3) Balanced forces	-	c) Tug of war	(d)
4) Unbalanced forces	-	d) A book lying on a table	(a)

V. Assertion & Reasoning

Mark the correct choice as

a) If both the assertion and the reason are true and the reason is the correct explanation of assertion.

b) If both the assertion and the reason are true, the reason is not the correct explanation of the assertion.

c) Assertion is true, but the reason is false.

d) Assertion is false, but the reason is true.

1. **Assertion:** When you make a sharp turn while driving a car you tend to lean sideways.
   Reason: It is due to inertia of direction

Ans : a) If both the assertion and the reason are true and the reason is the correct explanation of assertion.

2. **Assertion:** In balanced forces the resultant force of all the forces acting as a body is equal to zero.
   Reason: The body will be in equilibrium. ✶

Ans : a) If both the assertion and the reason are true and the reason is the correct explanation of assertion.

3. **Assertion:** In C.G.S system unit of force is dyne
   Reason: A large force acting for a very short interval of time is called impulsive force.

Ans : b) If both the assertion and the reason are true, the reason is not the correct explanation of the assertion.

VI. Answer briefly.

1. What do you mean by inertia of rest? Give example.

- The resistance of a body to **change** its **state of rest** is called inertia of rest.
- When you vigorously shake the branches of a tree, some of the leaves and fruits are detached and they fall down.

2. What is inertia of motion? Give example.

- The resistance of a body to **change its state of motion** is called inertia of motion.
- An athlete runs some distance before jumping, because this will help him jump longer and higher.

3. What do you mean by inertia of direction? Give example.

- The resistance of a body to **change its direction of motion** is called inertia of direction.
- When we make a sharp turn while driving a car we tend to lean sideways due to inertia of direction.

4. Define Linear momentum. Give its SI unit.

- The **product of mass and velocity** of a moving body gives the magnitude of linear momentum.
- Linear momentum is a **vector** quantity
- Its unit is **kg m s^{-1}**

5. What are like parallel forces?

Two or more forces of equal or unequal magnitude **acting along the same direction**, parallel to each other are called like parallel forces.

6. What are unlike parallel forces?

If two or more equal forces or unequal forces **act along opposite directions** parallel to each other, then they are called unlike parallel forces.

7. What is a resultant force?

When several forces act 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'.

8. What are balanced forces?

If the **resultant force** of all the forces acting **on a body is equal to zero,** then the body will be in equilibrium. Such forces are called balanced forces.

9. What causes unbalanced forces?

If the **resultant force is not equal to zero,** then it causes the motion of the body due to unbalanced forces.

10. What is Equilibrant?

A system can be brought to equilibrium by applying another force which is equal to the resultant force in magnitude but opposite in direction. Such force is called 'Equilibrant'.

11. What is moment of force? (or) Define torque. Give its SI unit. ✶✶

- The rotating or turning effect of a force about a fixed point or fixed axis is called moment of the force about that point or torque (τ)
- It is measured by the product of the force and the perpendicular distance is between the fixed point or the fixed axis and the line of action of the force.
- $\boxed{\tau = F \times d}$
- Its SI unit is **Nm**.

12. What is a couple? ✶

Two equal and unlike parallel forces applied simultaneously at two distinct points constitute a couple.

13. State the principle of moments.

At equilibrium, the algebraic sum of the moments of all the individual forces about any point is equal to zero.

14. Define the CGS unit of force.

The CGS unit of force is dyne. One dyne is the amount of force required for a **body of mass 1 gram** produces an **acceleration of 1 cms^{-2}.**

15. Define unit force.

The amount of force required to produce an **acceleration of 1 ms^{-2} in a body of mass 1 kg** is called unit force.

16. What is an impulsive force?

A large force acting for a very short interval of time is called an Impulsive force.

17. What is impulse? ✶

- Impulse is the product of force and time.
- Impulse = Force × Time
- $\boxed{J = F \times t}$

18. How can change in momentum be achieved?

- A large force acting for a short period of time.
- a smaller force acting for a longer period of time produce the change in momentum.

19. State principle of conservation of linear momentum.

There is **no change in the linear momentum** of a system of bodies as long as no net external force acts on them.

20. What is acceleration due to gravity? ✶

The acceleration of a body due to **Earth's gravitational force** is called as acceleration due to gravity.

21. Define weight. Give its unit.

Weight of a body is defined as the **gravitational force exerted** on it due to the **Earth's gravity** alone.

22. What do you mean by apparent weight?

Apparent weight is the weight of the body acquired due to the **action of gravity** and other external forces acting on the body.

23. What is the meaning of weightlessness?

Whenever a body or a person falls freely under the **action of Earth's gravitational force** alone, it appears to have **zero weight**. This weight is referred to as "weightlessness".

VII. Solve the given problems: (Numerical Problems)

1. A cricket ball of mass 0.20 kg is moving with a velocity of 1.2 ms^{-1}. Find the impulse on the ball and average force applied by the player if he is able to stop the ball in 0.1s. ★★

Impulse = change in momentum = m × v

$= 0.20 \times 1.2 = 0.24 \text{ kg ms}^{-1}$

Impulse $= F \times t$

$$F = \frac{0.24}{0.10} = 2.4 \text{ N}$$

F = 2.4 N

2.4 N force is required to stop the ball.

Formula used:

Impulse = F × t

2. A vehicle accelerate at the rate of 10 ms^{-2} after applying a force equal to 50, 000 N. Find the mass of the vehicle.

Given : F = 50, 000 N; $a = 10 \text{ ms}^{-2}$

$$m = \frac{F}{a} = \frac{50,000}{10} = 5000 \text{ kg}$$

m = 5000 kg

Formula used:

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

3. The moment of force of 5 N about a point P is 2 Nm. Calculate the distance of point of application of the force from the point P. ★

Given, moment of force = 2 Nm

F = 5 N

Moment of force = Force × distance

$2 = 5 \times r$

$$r = \frac{2}{5} = 0.4 \text{ m}$$

r = 0.4 m

Formula used:

Moment of force = F×r

4. Calculate the force of gravity between the earth (m = 5.98×10^{24} kg) and a 70 kg person, if the person is standing at sea level, a distance of 6.38×10^6 m from earth's centre. ★

Given , $m_1 = 5.98 \times 10^{24}$ kg $\quad m_2 = 70$ kg

$r = 6.38 \times 10^6$ m

$$F = \frac{Gm_1m_2}{r^2} = \frac{6.67 \times 10^{-11} \times 5.98 \times 10^{24} \times 70}{\left(6.38 \times 10^6\right)^2}$$

F = 686 N.

Formula used:

$$F = \frac{m_1m_2}{r^2}$$

5. An object of mass 1 kg travels at a constant 10 m/s speed. Calculate the linear momentum of the object.

Formula used:

$P = mv$

$m = 1$ kg

$v = 10\ ms^{-1}$

Linear momentum $p = mv$

$= 1 \times 10 = 10$ kg m s^{-1}

$p = 10$ kg m s^{-1}

VIII. Answer in detail.

1. Give a detailed account on Galileo's concepts about force, motion and inertia of bodies.

Galileo proposed the following concepts about force, motion and inertia of bodies:

- The natural state of all earthly bodies is either the state of rest or the state of uniform motion.
- A body in motion will continue to be in the same state of motion as long as no external force is applied.
- When a force is applied on bodies, they resist any change in their state. This property of bodies is called 'inertia'.
- When dropped from a height in vacuum, bodies of different size, shape and mass fall at the same rate and reach the ground at the same time.

2. Write any three applications of torque.

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.

Seasaw

- Most of you have played on the seasaw. Since there is a difference in the weight of the persons 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.

Steering Wheel

A small steering wheel enables you to turn a car easily by **transferring a torque to the wheels** with less effort.

3. Write a detailed note on moment of the force.

- The rotating or **turning effect of a force** about a fixed point or fixed axis is called moment of the force about that point or **torque (τ).**
- It is measured by the product of the force (F) and the perpendicular distance (d) 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 is acting along the direction, perpendicular to the plane containing the line of action of force and the distance.
- Its SI unit is N m.

Couple:

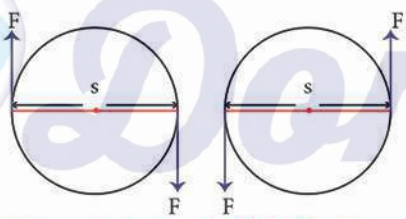
- Two equal and unlike parallel forces applied simultaneously at two distinct points constitute a couple.
- The line of action of the two forces does not coincide
- It does not produce any translatory motion since the resultant is zero.
- But, a couple results in of the rotation of the body.
- Rotating effect of a couple is known as **moment of a couple**.

Examples: Turning a tap, winding or unwinding a screw, spinning of a top, etc.

- Moment of a couple is measured by the product of any one of the forces and the perpendicular distance between the line of action of two forces.
- The turning effect of a couple is measured by the magnitude of its moment.
- Moment of a couple = Force × perpendicular distance between the line of action of forces

$$\boxed{M = F \times S}$$

- The unit of moment of a couple is newton metre (N m) in SI system and dyne cm in CGS system.
- By convention, the direction of moment of a force or couple is taken as positive if the body is rotated in the anti-clockwise direction and negative if it is rotate in the clockwise direction.

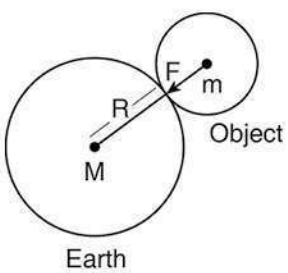


Clockwise moment *Anticlockwise moment*

4. Deduce the relation between g and G. ★★

- When a body is at rest on the surface of the Earth, it is acted upon by the gravitational force of the Earth.
- Let us compute the magnitude of this force in two ways.
- Let, M be the mass of the Earth and m be the mass of the body.
- The entire mass of the Earth is assumed to be concentrated at its centre.
- The radius of the Earth is R = 6378 km (= 6400 km approximately).
- By Newton's law of gravitation, the force acting on the body is given by

$$F = \frac{GMm}{R^2} \quad \text{.....(1)}$$



Relation between g and G

- Here, the radius of the body considered is negligible when compared with the Earth's radius.
- Now, the same force can be obtained from Newton's second law of motion.
- According to this law, the force acting on the body is given by the product of its mass and acceleration (called as weight).
- Here, acceleration of the body is under the action of gravity hence a = g

F = m a = m g

F = weight = mg ..... (2)

Comparing equation (1) and (2) we get,

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

Acceleration due to gravity

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

IX. Higher Order Thinking Skills (HOTS)

1. Suppose that two objects attract each other with a gravitational force of 16 N. If the distance between the two objects is doubled, what is the new force of attraction between the two objects?

If the distance is increased by a factor of 2, then force will be decreased by a factor of 4. Then the new force is

$$\frac{16N}{4} = 4$$

$$F_1 = \frac{Gm_1m_2}{d_1^2} = 16N$$

$$F_2 = \frac{Gm_1m_2}{d_2^2} = ?$$

$$d_2 = 2d_1$$

$$\frac{F_2}{F_1} = \frac{d_1^2}{d_2^2} = \frac{d_1^2}{4d_1^2} = \frac{1}{4}$$

$$F_2 = \frac{1}{4} \times 16N = 4N$$

$$\mathbf{F_2 = 4N}$$

Formula used:

$$F = \frac{Gm_1m_2}{d_1^2}$$

2. A small ball of mass 0.2 kg is thrown horizontally with a constant speed of 10 m/s. The ball hits the wall and reflected with the same speed. What is the change in linear momentum of the ball?

The change in momentum = $mv_f - mv_i = m(v_f - v_i)$

$= 0.2(-10 - 10) = -(0.2)(+20)$

$= -4\ kgms^{-1}$

magnitude of change in momentum is **4 kgms^{-1}**

Formula used:

$mv_f - mv_i$

3. A boy of 50 kg mass is running with a velocity of 2 m/s. He jumps over a stationary cart of 2 kg while running. Find the velocity of cart after jumping of boy.

Given $m_1 = 50$ kg

initial velocity of the boy ; $v_1 = 2$ m/s

$m_2 = 2$ kg

initial velocity of the cart $u_2 = 0$

Final velocity of cart $v_2 = ?$

Formula used:

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

Since the boy jumped over the car, the final velocity of boy will be equal to that of the cart.

$v_1 = v_2$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$= 50 \times 2 + 2 \times 0 = 50 \times v_1 + 2 \times v_2$

$= 100 = 50\ v_2 + 2\ v_2\ (v_1 = v_2)$

$= 100 = 52\ v_2$

$$v_2 = \frac{100}{52} = 1.92\ ms^{-1}$$

$$\mathbf{v_2 = 1.92\ ms^{-1}}$$

Time : 1 hr Marks : 30

Unit Test - 1
Laws of Motion

Time : 1 hr Marks : 30

I. Choose the most suitable answer and write the code with the corresponding answer. 5× 1 = 5

1. Impulse is equals to
   a) rate of change of momentum b) rate of force and time
   c) change of momentum d) rate of change of mass
2. Newton's III law is applicable
   a) for a body is at rest b) for a body in motion
   c) both a & b d) only for bodies with equal masses
3. Plotting a graph for momentum on the X-axis and time on Y-axis. Slope of momentum-time graph gives
   a) Impulsive force b) Acceleration c) Force d) Rate of force
4. A person whose mass is 60 kg on the surface of earth would weigh
   a) 97.5 N b) 60 N c) 588 N d) 65 N
5. **Assertion: The sum of the clockwise moments is equal to the sum of the anticlockwise moments.**
   Reason: The principle of conservation of momentum is valid if the external force on the system is zero.
   a) If both the assertion and the reason are true and the reason is the correct explanation of assertion.
   b) If both the assertion and the reason are true, but the reason is not the correct explanation of the assertion.
   c) Assertion is true, but the reason is false.
   d) Assertion is false, but the reason is true.

II. Answer the following questions in one or two lines. 5 × 2 = 10

1. If a 5 N and a 15 N forces are acting opposite to one another. Find the resultant force and the direction of action of the resultant force.
2. Define moment of a couple.
3. Why a spanner with a long handle is preferred to tighten screws in heavy vehicles?
4. Give an example for inertia of direction.
5. State the principle of moments.

III. Answer the following questions in brief: 2 × 4 = 8

1. Deduce the equation of a force using Newton's second law of motion.
2. Write any three applications of torque.

IV. Answer the following questions in detail: 1 × 7 = 7

1. i) Deduce the relation between g and G.
   ii) Classify the types of force based on their direction.