

Science

Simple point based Answers for all Questions as per
Govt. Exam Key Pattern. Slow-learner's answers
also included.

Salient Features

- ◆ Complete solutions to Textbook Exercises.
- ◆ Answers as per **Govt. Exam key pattern.**
- ◆ ※ Symbol is used for **Important Questions.**
- ◆ Answers for **Slow Learning Students.**
- ◆ Model Question Papers **1 to 6 (PTA)** : Questions are incorporated in the appropriate sections.
- ◆ Govt. Model Question Paper - 2019 (**GMQP-'19**); Board Exam Question (**BEQ**); Quarterly Exam-2019, 2023 & 2024 (**QY-'19, '23 & '24**); Half Yearly Exam - 2023 & 2024 (**HY-'23 & '24**); Supplementary Exam September-2020, 2021; August-2022; July-2023, 2024 & 2025 (**Sep-2020, '21, Aug.-'22, July-'23, '24 & '25**); First Revision Test-2022, 2024 & Second Revision Test-2022 (**FRT-'22, '24 & SRT-'22**) and Public Exam May-2022; April-2023, 2024 & 2025 (**May-'22, April-'23, '24 & '25**) questions are incorporated in the appropriate sections.
- ◆ Additional 1, 2, 4 and 7 Marks Questions with Answers.
- ◆ Unit Test are given for all Units.
- ◆ Sura's Model Question Papers given (2 Nos.)
- ◆ Public Examination - March 2026 Question Paper is given with answers.

For bulk School orders **Lesson Plan & Notes of Lesson** Free for Teachers only.

Slow
Learner's
Answers given



SURA PUBLICATIONS

Chennai



For Orders Contact :

**80562 94222 / 81242 01000 / 81243 01000 /
96001 75757 / 98409 26027**

© Reserved with Publishers

Code No : LP10-S-03

All rights reserved @ SURA Publications

No part of this book may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, digitally, electronically, mechanically, photocopying, recorded or otherwise, without the written permission of the publishers. Strict action will be taken.

Authors :

Mr. K. Aadhishankar, M.Sc., M.Ed. PGT-Chemistry, Dharmapuri

Ms. A. Christina Joseph, M.Sc., M.Ed. PGT-Physics, Chennai

Mr. M. Zakir Ali, M.Sc., M.Phil., PGT-Botany, Vellore

Ms. D. Geetha, M.Sc., M.Phil., PGT-Zoology, Chennai

Reviewed by :

Dr. B. Parthasarathy, M.Sc., M.Phil., Ph.D.

Head of the Department, Chennai

Head Office

Sura Publications

1620, 'J' Block, 16th Main Road,
Anna Nagar, Chennai - 600 040.

Phones : 044-4862 9977, 044-4862 7755

e-mail : orders@surabooks.com

website : www.surabooks.com

For Orders Contact



80562 94222

81242 01000

81243 01000

96001 75757

98409 26027

Preface

Every great advance in science has issued from a new audacity of imagination.

- John Dewey

Sura's X Science Guide has been prepared as per the Latest New textbook.

The subject matter given is simple, lucid, and self-explanatory, which helps students score good marks on the Public Exam.

This guide has been framed based on the new 100 marks, a theory based pattern for 75 marks. This guide will be helpful for both high achievers and slow learners.

Sura's X Science Guide is an excellent support for the weak, a boon to the average and a helping hand to the intelligent students.

We wish all the students good luck for their board examinations.

- Publisher

All the Best

CONTENTS

	Unit	Title	Page No.
Physics	1.	Laws of Motion	1 - 26
	2.	Optics	27 - 47
	3.	Thermal Physics	48 - 64
	4.	Electricity	65 - 90
	5.	Acoustics	91 - 111
	6.	Nuclear Physics	112 - 134
Chemistry	7.	Atoms and Molecules	135 - 153
	8.	Periodic Classification of Elements	154 - 173
	9.	Solutions	174 - 190
	10.	Types of Chemical Reactions	191 - 209
	11.	Carbon and its Compounds	210 - 228
Biology	12.	Plant Anatomy and Plant Physiology	229 - 245
	13.	Structural Organisation of Animals	246 - 258
	14.	Transportation in Plants and Circulation in Animals	259 - 278
	15.	Nervous System	279 - 294
	16.	Plant and Animal Hormones	295 - 312
	17.	Reproduction in Plants and Animals	313 - 330
	18.	Genetics	331 - 347
	19.	Origin and Evolution of Life	348 - 360
	20.	Breeding and Biotechnology	361 - 376
	21.	Health and Diseases	377 - 391
	22.	Environmental Management	392 - 408
Computer	23.	Visual Communication	409 - 414
Sura's Model Question Papers given (2 Nos.)			415 - 420
Public Examination - March 2026 Question Paper is given with answers.			421 - 428

Syllabus

MONTH	PHYSICS	CHEMISTRY	BIOLOGY	PRACTICAL	TOTAL UNITS
June	1	7	12, 13	1, 4, 8	4
July	2	8	14, 15	2, 5, 12	4
I MID TERM TEST (8 UNITS)					
August	3	9	16, 17	6, 9, 10, 13	4
September	4	0	18	3	2
QUARTERLY EXAM (14 UNITS)					
October	5	10	19, 20	7, 11, 14	4
November	6	11	21, 22	0	4
II MID TERM TEST (8 UNITS)					
December	0	0	23	0	
HALF YEARLY EXAM (FULL PORTION)					
January	FIRST REVISION TEST				
February	SECOND REVISION TEST				
March	THIRD REVISION TEST				

PHYSICS

UNIT - 1 : LAWS OF MOTION

Important Formulae		
1.	Linear Momentum	$p = mv$
2.	Parallel forces are acting in the same direction	$F_{\text{net}} = F_1 + F_2$
3.	Parallel unequal forces are acting in the opposite direction	$F_{\text{net}} = F_1 - F_2$ (if $F_1 > F_2$) $F_{\text{net}} = F_2 - F_1$ (if $F_2 > F_1$)
4.	Torque	$\tau = F \times d$
5.	Principle of moments	$F_1 \times d_1 = F_2 \times d_2$
6.	Moment of a Couple	$M = F \times S$
7.	Force	$F = m \times a$
8.	Impulse	$J = \Delta P$
9.	Law of conservation of linear momentum	$m_1 v_1 + m_2 v_2 = m_1 u_1 + m_2 u_2$
10.	Newton's Universal law of gravitation	$F = \frac{GMm}{R^2}$ $[G = 6.674 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}]$
11.	Acceleration due to gravity	$g = \frac{GM}{R^2}$
12.	Weight	$W = mg$
13.	Mass of the Earth	$M = \frac{gR^2}{G}$
14.	Acceleration	$a = \frac{v - u}{t}$

TEXTBOOK EVALUATION

I. Choose the correct answer

1. **Inertia of a body depends on** ✖ [April-'24]
 (a) weight of the object (b) acceleration due to gravity of the planet
 (c) mass of the object (d) Both a & b **Ans. (c) mass of the object**

2. **Impulse is equals to** ✖ ✖ [PTA-1; QY-'24]
 (a) rate of change of momentum (b) rate of force and time
 (c) change of momentum (d) rate of change of mass
Ans. (c) change of momentum

3. **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 **Ans. (c) both a & b**

4. **Plotting a graph for momentum on the Y-axis and time on X-axis. Slope of momentum-time graph gives**
 (a) Impulsive force (b) Acceleration
 (c) Force (d) Rate of force **Ans. (c) Force**

5. **In which of the following sport the turning of effect of force used?** ✖ [BEQ; QY-'19]
 (a) swimming (b) tennis (c) cycling (d) hockey **Ans. (c) cycling**

6. **The unit of 'g' is ms^{-2} . It can be also expressed as** [PTA-1; QY-'23; HY-'24]
 (a) cms^{-1} (b) Nkg^{-1} (c) $\text{Nm}^2\text{kg}^{-1}$ (d) cm^2s^{-2} **Ans. (b) Nkg^{-1}**

7. **One kilogram force equals to** ✖ [April-'25]
 (a) 9.8 dyne (b) $9.8 \times 10^4 \text{ N}$ (c) $98 \times 10^4 \text{ dyne}$ (d) 980 dyne
Ans. (c) $98 \times 10^4 \text{ dyne}$

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) 2 M (c) M/4 (d) M **Ans. (d) M**

9. **If the Earth shrinks to 50% of its real radius its mass remaining the same, the weight of a body on the Earth will** [HY-'23]
 (a) decrease by 50% (b) increase by 50%
 (c) decrease by 25% (d) increase by 300% **Ans. (d) increase by 300%**

Hint :

$$g = \frac{GM}{R^2} \Rightarrow R_1 = 50\% R = \frac{50}{100} \times R = \frac{1}{2} R ; g_1 = \frac{GM}{R^2} = \frac{GM}{\left(\frac{R}{2}\right)^2} = \frac{GM}{\frac{R^2}{4}} = \frac{4GM}{R^2} = 4g$$

$$g_1 = 4 \times g ; W = F = mg ; W_1 = F_1 = m_1 g_1$$

$$\begin{aligned} \text{Increase in weight percentage} &= \frac{W_1 - W}{W} \times 100 \Rightarrow \frac{mg_1 - mg}{mg} \times 100 = \frac{4mg - mg}{mg} \\ &= 3 \times 100 = 300\% \end{aligned}$$

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

[BEQ; GMQP-'19; Sep-'21; FRT & Aug.-'22; July-'23, '24 & '25]

- (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. (d) both a and c

II. Fill in the Blanks	Answers
1. To produce a displacement ____ is required. [BEQ; FRT-'22]	force/unbalanced force
2. Passengers lean forward when sudden brake is applied in a moving vehicle. This can be explained by ____.	inertia of motion
3. By convention, the clockwise moments are taken as ____ and the anticlockwise moments are taken as ____.	negative, positive
4. ____ is used to change the speed of car.	Gear
5. A man of mass 100 kg has a weight of ____ at the surface of the Earth. ※ [BEQ]	980 N
Hint: Weight of the man at the surface : Weight = $m \times g = 100 \times 9.8 = 980\text{N}$.	

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

- The linear momentum of a system of particles is always conserved.
Ans. **False** - In the absence of external force, the linear momentum of a system of particles is always conserved.
- Apparent weight of a person is always equal to his actual weight
Ans. **False** - Apparent weight of a person is **not equal** to his actual weight.
- Weight of a body is greater at the equator and less at the polar region. ※ [BEQ]
Ans. **False** - Weight of a body is **less** at the equator and **greater** at the polar region.
- Turning a nut with a spanner having a short handle is so easy than one with a long handle.
Ans. **False** - Turning a nut with a spanner having a **long handle** is so easy than one with a **short handle**.
- There is no gravity in the orbiting space station around the Earth. So the astronauts feel weightlessness.
Ans. **False** - When a space station and astronauts have **equal acceleration**, they are under **free fall condition**, so both the astronaut and the space station are in the state of weightlessness.

IV. Match the Following

[PTA-1]

Column I	Column II	Answers
a. Newton's I law	Propulsion of a rocket	Stable equilibrium of a body
b. Newton's II law	Stable equilibrium of a body	Law of force
c. Newton's III law	Law of force	Flying nature of bird
d. Law of conservation of linear momentum	Flying nature of bird	Propulsion of a rocket

V. Assertion and 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, 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.

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, but 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

[Hint : 'g' depends on the geometric radius of the Earth.]

VI. Answer Briefly

1. **Define inertia. Give its classification.** [Aug.-'22; April-'23]

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

2. **Classify the types of force based on their application.** ※ [BEQ; FRT & Aug.-'22]

➤ Based on the direction and application, forces can be classified into,

(i) Like parallel forces. (ii) 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.**

➤ $F_1 = 5 \text{ N}, F_2 = 15 \text{ N}$

$$\begin{aligned} \text{Resultant force } F_{\text{net}} &= F_2 - F_1 \text{ (if } F_2 > F_1) \\ &= 15 - 5 = 10 \text{ N} \end{aligned}$$

The direction of resultant force act along the direction of force 15 N.

4. Differentiate mass and weight.

✖ [May-'22]

	Mass	Weight
(i)	It is the quantity of matter contained in the body.	It is the gravitational force exerted on a body due to gravity.
(ii)	It is a scalar quantity .	It is a vector quantity .
(iii)	SI unit is kilogram (kg) .	SI unit is Newton (N) .
(iv)	Does not vary from place to place.	Varies from place to place.

5. Define moment of a couple.

[July-'24]

- Rotating effect of a couple is known as moment of a couple.
- 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. $M = F \times S$

6. State the principle of moments.

[QY-'19 & '23; April-'25]

- 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 anticlockwise direction.

$$F_1 \times d_1 = F_2 \times d_2$$

7. State Newton's second law.

✖ [GMQP-'19; May-'22; HY-'24]

- According to **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**".
- $F = m \times a$ (**Force = mass $\times$ acceleration**).

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

- A spanner with a long handle gives **high torque** with **less force**. $\tau = F \times d$
- So, tightening screws in heavy vehicles is **easy** with a long handle spanner.

9. While catching a cricket ball the fielder lowers his hands backwards. Why? [FRT-'24]

- When the fielder pulls back his hands, he experiences a **smaller force** for a **longer interval** of time. This leads to **less damage** to his hands.

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

[July-'24]

- Astronauts are not floating but falling freely around the Earth due to their **huge orbital velocity**.
- Since the space station and astronauts have equal acceleration, they are under a **free fall condition**. Hence, astronauts are in the state of weightlessness and seem to be floating.

VII. Solve the given 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. ※

Given : m_1 (Smaller body) = 3 kg; m_2 (bigger body) = 4 kg a_2 (bigger body) = 12 ms^{-2} To find : a_1 (smaller body) = ?	Solution : According to Newton's third law of motion, $F_1 = -F_2$; $m_1 \times a_1 = -m_2 \times a_2$ $3a_1 = -4 \times 12 \Rightarrow a_1 = \frac{-4 \times 12}{3} \Rightarrow a_1 = \frac{-48}{3}$ $a_1 = -16$; $a_1 = 16 \text{ ms}^{-2}$
---	--

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 : $m = 1 \text{ kg}$; $u = 10 \text{ ms}^{-1}$; $v = -10 \text{ ms}^{-1}$ To find : Δp (Change in linear momentum) = ?	Solution : Change in momentum (Δp) = $mv - mu$ $\Delta p = (1)(-10) - (1)(10) = -10 - 10$ $\Delta p = -20 \text{ kg ms}^{-1}$
--	--

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?

Given : $F_1 = 140 \text{ N}$; $L_1 = 40 \text{ cm} = 40 \times 10^{-2} \text{ m}$ $F_2 = 40 \text{ N}$ To find : $L_2 = ?$	Solution : Length of the spanner : $F_1 L_1 = F_2 L_2$ $L_2 = \frac{F_1 L_1}{F_2}$ $L_2 = \frac{140 \times 40 \times 10^{-2}}{40} = 140 \times 10^{-2} \text{ m}$ $L_2 = 1.4 \text{ m}$
---	---

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. ※ [BEQ]

Given : $m_1 : m_2 = 2 : 3$ $R_1 : R_2 = 4 : 7$ To find : Ratio of $g = ?$	Solution : $g_1 = \frac{GM_1}{R_1^2}$; $g_2 = \frac{GM_2}{R_2^2}$ $g_1 : g_2 = \frac{GM_1}{R_1^2} \div \frac{GM_2}{R_2^2}$ $g_1 : g_2 = \frac{M_1}{R_1^2} \times \frac{R_2^2}{M_2} = \frac{2 \times (7)^2}{3 \times (4)^2} = \frac{2 \times 49}{3 \times 16} = \frac{98}{48} = \frac{49}{24}$ $\therefore g_1 : g_2 = 49 : 24.$
---	---

VIII. Answer in Detail

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

[BEQ; PTA-3; [FRT & Aug.-'22; April-'24]

➤ **Inertia of rest :**

- ♦ The resistance of a body to **change its state of rest** is called inertia of rest.
- ♦ **Eg:** 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 body to **change its state of motion** is called inertia of motion.
- ♦ **Eg:** 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** is called inertia of direction.
- ♦ **Eg:** When you make a sharp turn while driving a car, you tend to lean sideways.

2. State Newton's laws of motion.

✖ [Sep-'21; FRT & Aug.-'22; QY-'23]

- **First 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**.
- **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. $F = ma$
- **Third law :** For every action, there is an **equal and opposite reaction**. They always act on two different bodies. $F_B = -F_A$

3. Deduce the equation of a force using Newton's second law of motion. [PTA-5; April-'23]

- "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."
- **Derivation :**

Mass of moving body = m ; Initial speed = u ; Final speed = v ; Interval of time = t Initial momentum of the body $P_i = mu$; Final momentum of the body $P_f = mv$ Change in momentum $\Delta p = P_f - P_i \Rightarrow \Delta p = mv - mu$ By Newton's second law of motion, $F \propto \frac{\text{Change in momentum}}{\text{Time}}$

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

Here, k is the proportionality constant. $k = 1$ in all systems of units.

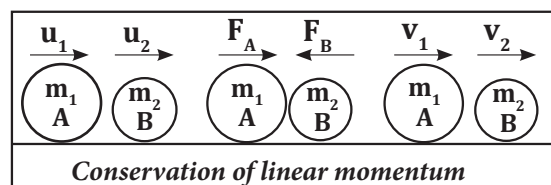
$$\text{Hence, } F = \frac{m(v-u)}{t}; F = \frac{mv - mu}{t} \Rightarrow \text{Since acceleration } a = \frac{(v-u)}{t}.$$

Hence, we have $F = m \times a$ **Force = mass $\times$ acceleration**

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

✂ [GMQP-'19; FRT & HY -'24; April-'25]

- **Law :** "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 two bodies A and B having masses m_1 and m_2 move with initial velocity u_1 and u_2 in a straight line.
- Let the velocity of the **first body** be **higher** than that of the second body. i.e., $u_1 > u_2$.
- During an **interval of time** t second, they tend to have a collision.
- So final velocity will be v_1 and v_2 respectively.

$$\text{Force on body B due to A, } F_A = m_2 \frac{(v_2 - u_2)}{t}$$

$$\text{Force on body A due to B, } F_B = m_1 \frac{(v_1 - u_1)}{t}$$

By Newton's Third law of motion,

Action force = Reaction force

$$F_B = -F_A$$

$$m_1 \frac{(v_1 - u_1)}{t} = -m_2 \frac{(v_2 - u_2)}{t} \Rightarrow m_1 v_1 - m_1 u_1 = -m_2 v_2 + m_2 u_2$$

$$\boxed{m_1 v_1 + m_2 v_2 = m_1 u_1 + m_2 u_2} \quad \text{----- (1)}$$

The above equation (1) confirms **in the absence of an external force, the algebraic sum of the momentum after collision is numerically equal to sum of the momentum before collision**. Hence, the law of conservation of linear momentum is proved.

5. Describe Rocket Propulsion.

✂ [BEQ; PTA-4; Sep-2020; Aug.-'22]

- 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** 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.
- To balance this momentum, an **equal and opposite reaction force** is produced in the combustion chamber, which makes the rocket project forward.

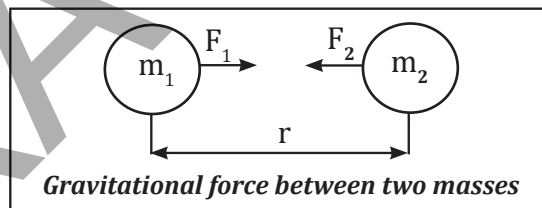
- In motion, the **mass** of the rocket gradually **decreases**, until the fuel is completely burnt out.
- The **mass** of the rocket **decreases with altitude**, which results in the gradual increase in velocity of the rocket.
- At one stage, it reaches a velocity, which is sufficient to just escape 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.

- **Universal law of gravitation :** [QY-'19; July-'23 & '25]
 - ◆ 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.
- ◆ Let m_1 and m_2 be the masses of two bodies A and B placed at r metre apart in space.



$$\text{Force } F \propto m_1 \times m_2 \quad \dots (1)$$

$$F \propto 1/r^2 \quad \dots (2)$$

On combining the above two expressions,

$$F \propto \frac{m_1 \times m_2}{r^2} \Rightarrow F = \frac{Gm_1 \times m_2}{r^2} \quad (\text{or}) \quad \frac{Gm_1 m_2}{r^2}$$

Where G is the universal gravitational constant.

Its value in SI unit is $6.674 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$.

7. Give the applications of universal law of gravitation.

[July-'24 & '25]

- **Dimensions of the heavenly bodies** can be measured using **gravitation law**. i.e. Mass of earth, radius of the earth, acceleration due to gravity etc., can be calculated accurately.
- Helps in discovering **new stars** and **planets**.
- One of the irregularities in the motion of stars is called "**Wobble**" lead to the disturbance in the motion of planet nearby.
- Helps to explain **germination of roots** due to the property of **geotropism**.
- Helps to predict the **path of the astronomical bodies**.

IX. HOT Questions

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 15N. Calculate the force exerted on the 2 kg mass.

Given : Mass of block 1, m_1 = 8 kg Mass of block 2, m_2 = 2 kg Total mass, m = $m_1 + m_2$ m = $8 + 2 = 10$ kg Force, F_1 = 15 N To find : Force exerted on 2 kg, $F_2 = ?$	Solution : $F_2 = \frac{m_2 F_1}{m_1 + m_2} = \frac{2 \times 15}{8 + 2} = \frac{30}{10}$ $= 3 \text{ N}$ Force exerted on the 2 kg mass = 3 N $F_2 = 3 \text{ N}$
---	--

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 = 2:1) ※

Given : Kinetic energy of the truck = Kinetic energy of the bike. To find : Ratio of the momenta, i.e., $m_t v_t : m_b v_b$	
Solution $\frac{1}{2} m_t v_t^2 = \frac{1}{2} m_b v_b^2 \quad \dots\dots (1)$ Also, $m_t = 4m_b \quad \dots\dots (2)$ Substituting (1) in (2) $\frac{1}{2} (4) m_b v_t^2 = \frac{1}{2} m_b v_b^2$	$\Rightarrow 4v_t^2 = v_b^2$ $\Rightarrow v_t^2 = \frac{1}{4} v_b^2$ $\Rightarrow v_t = \frac{1}{2} v_b \quad \dots\dots (3)$ $\therefore \frac{p_{\text{truck}}}{p_{\text{bike}}} = \frac{m_t v_t}{m_b v_b} = 4 \times \frac{1}{2}$ $p_t : p_b = \frac{2}{1} = 2 : 1$

3. "Wearing helmet and fastening the seat belt is highly recommended for safe journey" Justify your answer using Newton's laws of motion. [QY-'24]

- Wearing a helmet and seat belt helps reduce injury.
- When the vehicle is moving with a high speed, our body tends to be in movement due to inertia of motion in the forward direction.
- So, when there is a sudden collision, serious injuries can happen.
- However, wearing a helmet or a seat belt exerts a force on our body to slow down the forward motion.

PTA & Government Questions and Answers

I. One Mark Questions

- F be the force between the two bodies placed at a certain distance. If the distance between them is doubled, then the gravitational force F will be _____.** [PTA-5]
(a) $2F$ (b) $F/2$ (c) $F/4$ (d) $4F$
- The force required to produce an acceleration of 1 cm s^{-2} on a body of mass 1 g is ____.** [PTA-6]
(a) 1 N (b) 10 (c) 102 dyne (d) 1 dyne
- Force has :** [FRT-'22]
(a) Magnitude only (b) Direction only
(c) Both direction and magnitude (d) None of the above
- Unit of force in SI system is ____.** [FRT-'22] Ans. Newton

II. 2 Marks Questions

- Use the analogy to fill the blank.** [PTA-4]
(a) Opening a door: Moment of force, Opening a water tap: _____. Ans. Moment of a couple
(b) pushing a bus by a group of people: Like parallel forces, Tug of war _____.
Ans. Unlike parallel force

- A lift is moving downwards with an acceleration of 1.8 ms^{-2} . What is apparent weight realised by a man of mass 50 kg ?** [PTA-1]

Given :

$$\begin{aligned}\text{acceleration} &= 1.8 \text{ ms}^{-2} \\ \text{mass} &= 50 \text{ kg} \\ g &= 9.8 \text{ ms}^{-2}\end{aligned}$$

To find : Apparent weight, $R = ?$ **Solution :****Formula :**

$$\begin{aligned}R &= m(g - a) \\ R &= 50(9.8 - 1.8) \\ &= 50 \times 8 = 400 \\ R &= 400 \text{ N}\end{aligned}$$

- Understand the assertion statement and the reason given and choose the correct choice.**

Assertion : When a person swims he pushes the water using the hands backwards and the water pushes the person in the forward direction. [PTA-3]

Reason : For every action there is an equal and opposite reaction.

- Both the assertion and the reason are true and the reason is the correct explanation of the assertion.
- Both the assertion and the reason are true but the reason is not the correct explanation of the assertion.
- Assertion is true but the reason is false.
- Both the assertion and the reason are false.

Ans: (a) Both the assertion and the reason are true and the reason is the correct explanation of the assertion.

- Calculate the velocity of a moving body of mass 5 kg whose linear momentum is 2 kg ms^{-1} .** [GMQP-'19]

$$\text{Linear momentum} = \text{mass} \times \text{velocity}$$

$$\text{Velocity} = \frac{\text{linear momentum}}{\text{mass}} = \frac{2}{5} = 0.4 \text{ ms}^{-1}.$$

5. Write short notes on gears.

[Sep-2020]

- 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**.

III. 4 Marks Questions

1. Why the apples weigh more at poles than at equator?

[PTA-3]

- Apples weigh more at poles than at equator due to the difference in **acceleration** due to **gravity**.
- The value of g is **maximum** at the polar region and **minimum at the equatorial** region.
- So the apples weigh more at poles than at equator.

2. A force of 5 N applied on a body produces an acceleration 5 cm s^{-2} . Calculate the mass of the body.

[PTA-5]

Given :

$$\begin{aligned}\text{Force} &= 5 \text{ N} \\ \text{Acceleration} &= 5 \text{ cm s}^{-2} \\ &= 0.05 \text{ ms}^{-2}\end{aligned}$$

To find : Mass of the body = ?Solution :

$$\begin{aligned}F &= ma \\ 5 &= m(0.05) \\ m &= \frac{5}{0.05} = 100 \text{ kg}\end{aligned}$$

3. At what height from the centre of the earth surface, the acceleration due to gravity will be $1/4^{\text{th}}$ of its value on the surface of the earth.

[PTA-6]

Given :

$$\begin{aligned}\text{Height from the centre of the Earth,} & R' = R + h \\ \text{The acceleration due to gravity at that height,} & g' = g/4;\end{aligned}$$

To find : $h = ?$ Solution :

$$\begin{aligned}g &= GM/R^2; \quad g' = GM/R'^2 \\ \frac{g}{g'} &= \left(\frac{R'}{R}\right)^2 = \left(\frac{R+h}{R}\right)^2 = \left(1+\frac{h}{R}\right)^2 \\ 4 &= \left(1+\frac{h}{R}\right)^2\end{aligned}$$

$$2 = 1 + \frac{h}{R} \quad (\text{or}) \quad h = R$$

$$R' = 2R.$$

From the centre of the Earth, the object is placed at twice the radius of the earth.

4. Match the following :

[FRT-'22]

List - I		List - II	Answers
(1)	Newton's I law	(a) Passengers leaning sideways.	(b) Stable equilibrium of a body.
(2)	Newton's II law	(b) Stable equilibrium of a body.	(c) Law of force.
(3)	Newton's III law	(c) Law of force.	(e) Flying nature of a bird.
(4)	Inertia of direction	(e) Flying nature of a bird.	(a) Passengers leaning sideways.
		(d) Falling of an object from upward to Earth.	

IV. 7 Marks Questions

1. i) Shock absorbers are used in luxury buses. Why? [PTA-2]
 ii) A weight of a man is 686 N on the surface of the earth. Calculate the weight of the same person on moon. ('g' value of a moon is 1.625 ms^{-2})
 iii) Name the law of motion used in flying of birds. Give another example for the same law.

Ans. i) Shock absorbers are used in luxury buses to **reduce impulse** on jerks while moving on uneven roads.

Given	Solution
Weight of a mass on earth = 686 N. $9.8 \text{ N} = 1 \text{ kg in mass}$ $\therefore 686 \text{ N} = \frac{686}{9.8} = 70 \text{ kg}$ 'g' value of a moon is 1.625 ms^{-2}	Weight = mass (m) $\times$ acceleration due to gravity (g) $m = 70 \text{ kg} ; g = 1.625 \text{ ms}^{-2}$ $W = mg$ $W = 70 \times 1.625 = 113.75 \text{ N}$

iii) **Newton's Third Law of Motion :**

Another Example : When a person swims, he pushes the water using his hands **backwards** (action), and the water pushes the swimmer in the **forward direction** (reaction).

ADDITIONAL QUESTIONS

I. Choose the Correct Answer

- Physics that deals with the effect of force on bodies is _____.
 (a) Kinematics (b) Dynamics (c) Statics (d) **Mechanics**
- Study of moving bodies under the action of forces _____.
 (a) Statics (b) Kinematics (c) **Dynamics** (d) Mechanics
- The SI unit of force is _____.
 (a) energy (b) joule (c) **newton** (d) dyne
- The law that gives a qualitative definition of force is _____.
 (a) **Newton's I law** (b) Newton's II law (c) Newton's III law (d) Law of gravitation
- The rotating or turning effect of a force is _____.
 (a) momentum (b) **torque** (c) couple (d) none
- An example for a vector quantity is _____.
 (a) speed (b) distance (c) **momentum** (d) length
- Impulse is equal to _____.
 (a) ma (b) **Ft** (c) mv (d) $\frac{v-u}{t}$
- _____ stated that the natural state of all Earthly bodies is at rest.
 (a) **Aristotle** (b) Galileo (c) Newton (d) Pluto direction
- The magnitude of the weight is expressed in the units of _____.
 (a) displacement (b) mass (kg) (c) **force (Newton)** (d) none

10. A lift of mass 1000 kg which is moving with an acceleration of 1 ms^{-2} in upward direction, then the tension developed in string which is connected to lift is ____.

(a) 10,000 N (b) 10,800 N (c) 9800 N (d) 11000 N

Hint: $R > W$; $F = R - W$ $\therefore R = mg + ma$

$$R = m(g + a) \Rightarrow 1000 (9.8 + 1) = 10,800 \text{ N}$$

11. Newton's law of ____ helps in discovering new stars and planets.

(a) inertia (b) gravitation (c) motion (d) linear momentum

12. The motion of falling bodies towards Earth is due to ____.

(a) gravitational rotation (b) weightless mass
(c) acceleration due to gravity (d) gravitational force

II. Fill in the Blanks	Answers
1. ____ deals with the motion of bodies without considering the cause of motion.	Kinematics
2. If the body behaves contrary to their own natural state is called ____.	violent motion
3. The two different mass bodies dropped, the ____ falls faster.	heavier
4. Bodies of different size, shape and mass fall from a height in ____ reach the ground at the same time.	vacuum
5. A body changes its state, then it is said to be in ____.	motion
6. A sharp turn while driving a car, tend to lean sideways is due to ____.	inertia of direction
7. The acceleration in a body is due to ____.	unbalanced force
8. When an object undergoes acceleration ____.	a force always acts on it
9. In balanced force, the resultant force is equal to ____.	zero
10. Torque is a ____ quantity.	vector
11. Unit of torque is ____.	Nm
12. Two equal and unlike parallel force is called ____.	couple
13. ____ helps to change the speed of the rotation.	Gears
14. The momentum of massive object at rest is ____.	zero
15. When a person falls freely under the action of gravity has ____.	zero weight
16. The apparent weight of an object ____ in an elevator while accelerating upward.	increases
17. Mass is the measure of ____.	matter
18. Weight is the measure of force of ____ on an object.	gravity
19. The unit of weight is ____.	newton
20. The unit of mass is ____.	kilogram
21. The weight of a 1 kg mass object on Earth is ____.	9.8 N
22. Mass is associated with gravitational force is ____.	gravitational mass
23. ____ force keeps the satellite in its orbit.	Centripetal
24. ____ is divided into kinematics and kinetics.	Dynamics
25. ____ is also called as force independent.	Natural motion

26. _____ is also called as force dependent.	Violent motion
27. _____ measures the impact of force on a body.	Linear momentum
28. Linear momentum acts in the direction of _____.	velocity
29. The unit of momentum in SI system is _____.	kg m s⁻¹
30. The unit of momentum in C.G.S system is _____.	g cm s⁻¹
31. Force is an external effort in the form of _____ or _____.	push, pull
32. _____ has both magnitude and direction.	Force
33. _____ force is equal to the vector sum of all the forces.	Resultant
34. If the resultant force acting on a body is zero, then the body will be in _____.	equilibrium
35. The C.G.S unit of couple is _____.	dyne cm
36. At equilibrium, the algebraic sum of the moments of all individual forces about any point is equal to _____.	zero
37. Newton's second Law helps us to measure the _____.	amount of force
38. The acceleration produced along the _____ is called centripetal acceleration.	radius
39. Impulse is equal to magnitude of change in _____.	momentum
40. A cricketer pulls his hands back while catching a ball to lower the _____ on his hands.	impulse
41. The gravitational unit of force in SI system is _____.	kg f
42. 1 g f = _____ dyne.	980
43. The _____ of a body does not change as long as no external force acts on it.	linear momentum
44. Impulse is represented by _____.	J
45. _____ is based on the law of conservation of linear momentum.	Propulsion of rockets
46. The mass of a rocket decreases with _____.	altitude
47. As the mass of a rocket decreases with altitude, its _____ increases.	velocity
48. Force between the _____ is always attractive.	mass
49. _____ does not depend on the medium in which it is placed.	Force of an object
50. The acceleration of a falling object is due to the Earth's _____ force.	gravitational
51. The reaction force R exerted by lift's surface is known as _____.	apparent weight
52. _____ 'R' of the person that arise, depending on the motion of the lift.	Apparent weight
53. When lift is at rest, the apparent weight is _____ to actual weight.	equal
54. The condition for lift falling down freely is _____.	apparent weight is zero
55. The effect takes place while falling freely in roller coaster is _____.	weightlessness
56. The SI unit of gravity is _____.	m s⁻²
57. Mass of the Earth is _____ kg.	5.972 × 10²⁴
58. The value of 'g' of maximum in the _____ region.	polar

59. The value of 'g' is minimum in the _____ region.	equatorial
60. The value of 'g' decreases with _____.	altitude
61. _____ are said to be in a state of weightlessness.	Space stations
62. Gears in vehicles, see saw and steering wheel are the application of _____.	torque
63. _____ law is also called as law of force.	Newton's Second Law
64. In circulation motion, the acceleration produced along the radius is called as _____.	centripetal acceleration
65. Dimensions of _____ can be measured using gravitation law.	heavenly bodies
66. One of the _____ in the motion of stars is called Wobble.	irregularities
67. The product of _____ and _____ is called impulse.	force, time
68. _____ is the weight of the body acquired due to the action of gravity and other external forces.	Apparent weight
69. Galileo stated that, the _____ of all Earthly bodies is at rest.	natural state
70. When two different bodies of different mass are dropped from a height, the heavier body falls _____ than the light one.	faster
71. At natural state, all earthly bodies are in a state of rest or in _____.	uniform motion
72. When dropped from a height in vacuum, bodies of different size, shape and mass reach the ground at the _____.	same time
73. A Tug of war is an example of a _____.	unlike parallel force
74. When a body is in _____, it experiences balanced force.	equilibrium
75. When the resultant force of a body is _____, then the body experiences unbalanced force.	not equal to zero
76. Drawing water from a well is an example of _____.	unbalanced force
77. The turning effect of applied force is _____ when the distance between the fixed edge and the point of application is more.	more
78. The axis of a fixed edge about which the door is rotated is called _____.	axis of rotation
79. When the net force acting on a body is not equal to zero than its _____ changes.	velocity
80. The force which produces centripetal acceleration is called _____.	centripetal force
81. The amount of force required to produce an acceleration of 1 m s^{-2} in a body of mass 1 kg called _____.	unit force
82. Flying motion of birds in the air is an example of Newton's _____ Law of motion.	third
83. The apparent weight of a person moving upward in a lift will be _____.	greater
84. A body needs a _____ to move, or bring to rest or change its velocity.	push or pull
85. In vacuum, two objects with a mass 1 kg and 2 kg are dropped from same height and they reach the ground at _____.	same time

86. _____ stops or tries to stop a moving body.	Force
87. Parallel forces are acting in the _____.	same direction
88. _____ forces are act along opposite directions.	Parallel or unequal
89. If the resultant force is not equal to zero, then it causes the motion of the body due to _____.	unbalanced force
90. Force on a weight balance is an example for _____.	balanced force
91. _____ law always act on two different bodies only.	Newton's Third
92. The algebraic sum of momentum after collision is numerically equal to algebraic sum of momentum before the collision in the absence of _____.	external force
93. Every particle of matter in this universe _____ every other particles with a force.	attracts
94. The value of 'g' _____ at all points on the surface of Earth.	not same
95. The radius of Earth is _____.	6378 km

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

- In the recoiling of a gun on firing, both the linear momentum and kinetic energy are conserved.
Ans. False - Only linear momentum is conserved. The total kinetic energy of the system is **not conserved** (it increases).
- The relation between absolute units of force on MKS and C.G.S system is $1 \text{ N} = 10^5 \text{ dyne}$. **Ans : True**
- Newton's first law defines force and inertia. **Ans : True**
- The unit of force and impulse is same.
Ans. False - The unit of force is newton and the unit of impulse is Ns.
- Forces of action and reaction never cancel each other as they are acting at different bodies. **Ans : True**
- Two bodies of different masses are allowed to fall freely from the same height, then both the bodies reach the Earth together.
Ans. False - If air resistance for each body is same, both will reach the Earth together.
- The geometric radius of the Earth is maximum in the equatorial region and minimum in the polar region. **Ans : True**

IV. Match the Following

I.	Column I	Column II	Answers
(a)	Statics	Force acting on moving bodies.	Force acting on rest bodies.
(b)	Dynamics	Cause of motion.	Force acting on moving bodies.
(c)	Kinematics	Not considering the cause of motion.	Not considering the cause of motion.
(d)	Kinetics	Force acting on rest bodies.	Cause of motion.

II.	Column I	Column II	Answers
(a)	Moment of force	1 gram force	Torque
(b)	Two equal & unlike force	Torque	Couple
(c)	Principle of moments	Couple	$F_1 \times d_1 = F_2 \times d_2$
(d)	980 dyne	$F_1 \times d_1 = F_2 \times d_2$	1 gram force

III.	Quantity	Unit	Answers
(a)	Acceleration due to gravity	$\text{N m}^2\text{kg}^{-2}$	ms^{-2}
(b)	Inertial mass	N	kg
(c)	Universal gravitational constant	ms^{-2}	$\text{Nm}^2\text{kg}^{-2}$
(d)	Weight	kg	N

IV.	Quantity	Unit	Answers
(a)	Impulse	$5.972 \times 10^{24} \text{ kg}$	Ns
(b)	Mass of Earth	Nm	$5.972 \times 10^{24} \text{ kg}$
(c)	Linear momentum	Ns	$p=mv$
(d)	Torque	$p=mv$	Nm

V. Assertion and Reason

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

1. **Assertion** : The net force acting on a body is zero.

Reason : The body is moving uniformly along a straight line.

Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion

2. **Assertion** : Action and reaction forces balance each other.

Reason : Both forces act always on two different bodies.

Ans. (c) Assertion is true but reason is false

3. **Assertion** : The ratio of inertial mass to gravitational mass is equal to one.

Reason : The inertial mass & gravitational mass of a body are equivalent.

Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion

[Hint : Both are scalar & measured in same unit.]

4. **Assertion** : Like forces equal in magnitude simultaneously acts on a body leads translatory or rotatory motion.

Reason : Act in the same direction of action of force leads translatory ; acting tangent to the body leads rotatory.

Ans. (a) Both assertion and reason are true and reason is the correct explanation of assertion

5. **Assertion** : Gravitational force exerted on a body is weight.

Reason : Acceleration due to gravity for Earth is 9.8 ms^{-2} .

Ans. (b) Both assertion and reason are true but reason is not the correct explanation of assertion

VI. Use the Analogy to fill in the blank

- Unit of force in CGS is 1 dyne = 1 g cm s⁻² :: Unit of force in SI is 1 N = ____ **Ans. 10⁵ dyne**
- Natural motion : Force independent :: Violent motion : ____ **Ans. Force dependent**
- Opening a pen cap : ____ :: Opening the door : moment of force **Ans. Moment of couple**
- Statics : rest :: Dynamics : ____ **Ans. motion**
- Law of inertia : Newton's 1 law :: Law of force : ____ **Ans. Newton's II law**

VII. Very Short Answers

- When a ball of 0.5 kg mass moving with a speed of 20 ms⁻¹ rebounds after striking normally a perfectly elastic wall. Find the change in momentum.**
 - Change in linear momentum = $m(v - u)$

$$\begin{aligned}\Delta P &= -mv - mv = -2mv \\ &= 2 \times 0.5 \times 20 = 20 \times 1 \\ &= 20 \text{ kg ms}^{-1}\end{aligned}$$
- What is meant by natural motion?**
 - According to Aristotle, A moving body naturally comes to rest without any external influence of the force. Such motions are termed as "**natural motion**".
- 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 as 'Equilibrant'.
- What is Torque? (or) moment of 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). $\tau = F \times d$
- Define 1 newton (N).**
 - The amount of force required for a body of mass 1 kg produces an acceleration of **1 m s⁻²; 1 N = 1 kg m s⁻².**
- Define impulse.**
 - A large force acting for a very short interval of time is called as '**Impulsive force**'. When a force F acts on a body for a period of time t , then the product of force and time is known as '**impulse**'. It is represented by ' J '.

VIII. Short Answers

- What is Mechanics? Explain its branches.**
 - Mechanics** : Branch of physics that deals with the effect of force on bodies.
 - Branches** : It is divided into two branches, namely, statics and dynamics.
 - Statics** : It deals with the bodies which are at rest under the action of forces.
 - Dynamics** : It is the study of moving bodies under the action of forces. Dynamics is further divided as follows:
 - Kinematics** : It deals with the motion of bodies without considering the cause of motion.
 - Kinetics** : It deals with the motion of bodies considering the cause of motion.
- What is 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**.
 - It is equal to vector sum of all the forces.
- Define 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.
 - Linear momentum = mass $\times$ velocity

$p = mv$

4. Distinguish between balanced and unbalanced force.

No.	Balanced Force	Unbalanced force
i)	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 .	If the resultant force is not equal to zero, then it causes the motion of the body due to unbalanced forces .
ii)	Eg : Force applied with a crow bar.	Eg : Action of a lever.

5. What is Gravitational unit of force?

- In the SI system of units, gravitational unit of force is kilogram force, represented by kg f. In the CGS system its unit is gram force, represented by g f.

$$+ 1 \text{ kgf} = 1 \text{ kg} \times 9.8 \text{ m s}^{-2} = 9.8 \text{ N};$$

$$+ 1 \text{ gf} = 1 \text{ g} \times 980 \text{ cm s}^{-2} = 980 \text{ dyne}$$

6. What is meant by Weightlessness?

- When the person in a lift moves down with an acceleration (a) equal to the acceleration due to gravity (g), i.e., when **a = g**, this motion is called as '**free fall**'.
- Here, the apparent weight ($R = m(g - g) = 0$) of the person is **zero**.

7. Classify the following things into like parallel and unlike parallel forces (Dragging water from well, force applied to crow bar, weight balance, turning pen cap).

- Dragging water from well - Unlike parallel forces
- Force applied to crow bar - Unlike parallel forces
- Weight balance - Like parallel forces
- Turning pen cap - Unlike parallel forces

IX. Numerical Problems

1. A 20g bullet moving at 300 m/s stops after penetrating 2 cm of bone. Calculate the average force exerted by the bullet.

Given :

$$\text{Mass of the bullet, } m = 20 \times 10^{-3} \text{ kg}$$

$$\text{Initial velocity, } u = 300 \text{ m/s}$$

$$\text{Final velocity, } v = 0$$

$$\begin{aligned} \text{Distance, } s &= 2 \text{ cm} \\ &= 2 \times 10^{-2} \text{ m} \end{aligned}$$

To find :

Force exerted by the bullet, $f = ?$

Solution :

Using equations of motion,

$$v^2 = u^2 + 2as$$

$$0 = (300)^2 + 2(a) \times 2 \times 10^{-2}$$

$$a = -\frac{(300)^2}{4 \times 10^{-2}} = -\frac{9 \times 10^4}{4 \times 10^{-2}}$$

$$a = -2.25 \times 10^6 \text{ m/s}^2$$

$$a = 2.25 \times 10^6 \text{ m/s}^2$$

$$\text{Average force, } F = ma$$

$$= 20 \times 10^{-3} \times 2.25 \times 10^6$$

$$F = 45 \times 10^3$$

$$= 4.5 \times 10^4 \text{ N}$$

2. A bullet of mass 50 g moving with a speed of 300 ms^{-1} is brought to rest in 1s. Find the impulse and the force.

Given : Mass of the bullet, $m = 50 \times 10^{-3} \text{ kg}$ Initial speed of the bullet, $u = 300 \text{ m/s}$ Final speed, $v = 0$ Time, $t = 1 \text{ s}$ To find : (i) Impulse (of a force), $J = ?$ (ii) Force, $F = ?$	Solution : (i) Impulse, $J = \text{Change in momentum}$ $= m(v - u)$ $= 50 \times 10^{-3} [0 - 300]$ $= -15 \text{ Ns}$ (ii) Impulse $= F \times t$ $-15 = F \times 1 \text{ s}$ $F = \frac{-15}{1} = -15 \text{ N}$
--	--

3. A force of 200 dyne acts on a body of mass 10 g for 5 s. What will be the velocity of the body if it starts from rest? Express in SI unit.

Given : Force, $F = 200 \text{ dyne}$ Mass $m = 10 \text{ g}$ $t = 5 \text{ s}$	Solution : Acceleration, $a = \frac{F}{m} \Rightarrow a = \frac{200}{10} = 20 \text{ cm/s}^2$ Velocity $v = at \Rightarrow v = 20 \times 5 = 100 \text{ cm/s}$ In SI unit $v = 100 \times 10^{-2} \text{ ms}^{-1} \text{ (or) } 1 \text{ ms}^{-1}$ $v = 1 \text{ ms}^{-1}$
---	--

4. Calculate the mass of a body weighing 100 dyne. $g = 10 \text{ m/s}^2$

Given : Weight, $W = 100 \text{ dyne}$ Acceleration due to gravity, $g = 10 \text{ m/s}^2$ $g = 1000 \text{ cm/s}^2$ To find : Mass of the body, $m = ?$	Solution : $W = mg; m = \frac{W}{g}$ $m = \frac{100 \text{ dyne}}{1000 \text{ cm/s}^2} = \frac{1}{10} \text{ g}$ Mass, $m = 0.1 \text{ g}$
---	--

5. A force of 10 kg weight acting on an object of mass for 2 s gives to it a velocity of 10 ms^{-1} . What is the mass of an object in kg? [$g = 9.8 \text{ ms}^{-1}$]

Given : Force, $F = 10 \text{ kg wt} = 10 \times 9.8 = 98 \text{ N}$ Time, $t = 2 \text{ s}$; Velocity, $v = 10 \text{ ms}^{-1}$ To find : Mass $m = ?$ $F = ma; a = \frac{v}{t}$	Solution : $a = \frac{10}{2} = 5 \text{ ms}^{-2}$ $\therefore m = \frac{F}{a} = \frac{98}{5} = 19.6 \text{ kg}$ $m = 19.6 \text{ kg}$
---	---

6. The masses of two planets are in the ratio 1 : 2 their radii are in the ratio 1 : 2. Find the ratio of the acceleration due to gravity on the planets.

Given : Ratio of mass of two planets = $M_1 : M_2 = 1 : 2$ Ratio of radius of the planets = $R_1 : R_2 = 1 : 2$ To find : Acceleration due two planets = $g_1 : g_2 = ?$ $g = \frac{GM}{R^2}$ gravitational Constituent $G = 6.674 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$	Solution : $g_1 = \frac{GM_1}{R_1^2}$ $g_2 = \frac{G(2M_1)}{(2R_1)^2}$ $\frac{g_1}{g_2} = \frac{GM_1}{R_1^2} \times \frac{4R_1^2}{G.2M_1} = \frac{2}{1}$ $g_1 : g_2 = 2 : 1$
--	--

7. Force of 50 N acts perpendicular on a body, which is fixed at a point O. The distance of point of action of force from O is 5 cm. Find the moment of force.

Given : Force, $F = 50 \text{ N}$; Distance, $d = 5 \text{ cm}$ To find : moment of force = $F \times d$	Solution : Moment of force, = $50 \times 5 \times 10^{-2}$ = 250×10^{-2} = 2.5 Nm
---	--

X. Long Answers

1. What are the concepts prepared by Galileo?

- The natural state of all earthly bodies is either the **state of rest** or the **state of uniform motion**.
- An body in motion will continue to be in the same state of motion as long as no external force is applied.
- When 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. Give the application 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.
- **Seesaw :** 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 maneuver a car easily by transferring a torque to the wheels with less effort.

3. Derive the Relation between g and G .

- Let, M be the mass of the Earth and m be the mass of the object.
- The entire mass of the Earth is assumed to be concentrated at its centre. The radius of the Earth is $R = 6378 \text{ km}$ ($= 6400 \text{ km}$ approximately).

- By Newton's law of gravitation, the force acting on the object is given by

$$F = G M m / R^2 \quad \dots (1)$$

- According to Newton second law, the force acting on the body is given by the product of its mass and acceleration. Here, acceleration of the body is under the action of gravity hence $a = g$.

$$F = ma = mg$$

$$F = \text{weight} = mg \quad \dots (2)$$

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

$$mg = G M m / R^2$$

$$\text{Acceleration due to gravity } g = \frac{GM}{R^2}.$$

XI. Higher Order Thinking (HOTS)

1. Why is the recoil of a heavy gun on firing not so strong as of a light gun using the same cartridges?

- Recoil velocity of a gun $\propto \frac{1}{m}$. So light rifle recoils with large velocity than the heavy rifle.

2. If a body moves with uniform velocity, what is the net force acting on a body?

- If a body moves with uniform velocity, the acceleration of body is zero.

$\therefore$ Net force acting on the body is zero.

$$F = ma [a = 0]$$



Slow Learner's Material - Textbook Evaluation (As per Exam Key Pattern)

VI. Answer Briefly

1. Define inertia. Give its classification.

[Aug.-'22; April-'23]

- The inherent property of a body to **resist any change** in its **state of rest** or motion is called 'inertia'.

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

4. Differentiate mass and weight.

✖ [May-'22]

	Mass	Weight
i)	Quantity of matter.	Gravitational force.
ii)	Scalar quantity.	Vector quantity.
iii)	Unit is kilogram.	Unit is Newton.

5. Define moment of a couple.

[July-'24]

- Rotating effect of a couple is known as **moment of a couple**. $M = F \times S$

- Its SI unit is Nm.

6. State the principle of moments.

[QY-'19 & '23; April-'25]

- The **algebraic sum of the moments** in the **clockwise direction** is equal to the algebraic sum of the moments in the **anticlockwise direction**.
- $F_1 \times d_1 = F_2 \times d_2$

VIII. Answer in Detail**1. What are the types of inertia? Give an example for each type.**

[BEQ; PTA-3; [FRT & Aug.-'22; April-'24]

- **Inertia of rest** : To resist a body to change its **state of rest**. (E.g): Falling down of ripe fruits.
- **Inertia of motion** : To resist a body to change its **state of motion**. (E.g): An athlete runs some distance before jumping.
- **Inertia of direction** : To resist a body to **change its direction**. (E.g): When you make sharp turn while driving a car.

2. State Newton's laws of motion.

✂ [Sep-'21; FRT & Aug.-'22; QY-'23]

- **First law** : Every body continues to be in its state of rest or **state of uniform motion** along a straight line unless it is acted upon by some **external force**.
- **Second law** : The force acting on a body is **directly proportional** to the **rate of change** of linear momentum. $F = ma$
- **Third law** : For every action, there is an **equal and opposite reaction**. $F_B = -F_A$

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

[PTA-5; April-'23]

- The force is directly proportional to **rate of change of momentum**.

$$F \propto \frac{\text{Change in momentum}}{\text{Time}} \Rightarrow F \propto \frac{mv - mu}{t} \Rightarrow F = \frac{km(v - u)}{t}$$

$$K = 1; \frac{m(v - u)}{t} = a \Rightarrow F = m \times a \quad \boxed{\text{Force} = \text{mass} \times \text{acceleration}}$$

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

✂ [GMQP-'19; FRT & HY -'24; April-'25]

- **Law** : 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 two bodies A and B having masses m_1 and m_2 .
 - ◆ Initial velocity u_1 and u_2 and $u_1 > u_2$.
 - ◆ Final velocity will be v_1 and v_2 .

$$\text{Force on body B due to A, } F_A = m_2 \frac{(v_2 - u_2)}{t};$$

$$\text{Force on body A due to B, } F_B = m_1 \frac{(v_1 - u_1)}{t};$$

By Newton's Third law of motion, $F_B = -F_A$

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

Hence the law of conservation of linear momentum is proved.

Refer to the image Page. No. 8, Q. No. 4.

5. Describe Rocket Propulsion.

✂ [BEQ; PTA-4; Sep-2020; Aug.-'22]

- Rocket Propulsion is based on the **law of conservation** of linear momentum and **Newton's third law** of motion.
- Rockets are filled with a **fuel** in the propellant tank.
- When the **fuel is burnt** and a hot **gas is ejected**.
- This motion helps to propel the **rocket forward**.
- **Velocity increases** as **mass decreases**.

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

[QY-'19; July-'23 & '25]

- **Universal law :** Every particle attracts every other particle in the universe with force **directly proportional** to the product of the masses and **inversely proportional** to the **square of the distance** between them.
- **Derivation :** Let m_1 and m_2 be the masses of two bodies.

Force $F \propto m_1 \times m_2$ (1)

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

On combining the above two equations, $F \propto \frac{m_1 \times m_2}{r^2} \Rightarrow F = \frac{Gm_1 m_2}{r^2}$

Refer to the image Page. No. 9, Q. No. 6.

7. Give the applications of universal law of gravitation.

[July-'24 & '25]

- **Dimensions of the heavenly bodies** can be measured.
- To accurately calculate **Earth's mass, radius and gravity**.
- To discover the **new stars and planets**.
- To explain the **germination of roots** using geotropism.
- To predict the **path of the astronomical bodies**.



UNIT TEST**Time : 60 minutes****Marks : 25****PART - I****I. Choose the correct answer :****(4 × 1 = 4)****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. In which of the following sport the turning of effect of force used?

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

3. 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

4. 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.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion
(b) Both assertion and reason are true but reason is not the correct explanation of assertion
(c) Assertion is true but reason is false
(d) Both assertion and reason are false

PART-II**II. Answer the following:****(3 × 2 = 6)**

1. Define inertia.
2. 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
3. State Newton's second law.

PART-III**III. Answer the following:****(2 × 4 = 8)**

1. Differentiate mass and weight.
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.

PART-IV**IV. Answer the following:****(1 × 7 = 7)**

1. (i) Shock absorbers are used in luxury buses. Why?
(ii) A weight of a man is 686 N on the surface of the earth. Calculate the weight of the same person on moon. ('g' value of a moon is 1.625 ms^{-2})
(iii) Name the law of motion used in flying of birds. Give another example for the same law.



UNIT - 2 : OPTICS

Important Formulae		
1.	Velocity of light	$C = v\lambda$
2.	Snell's law	$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$
3.	Rayleigh's Scattering Law	$S \propto \frac{1}{\lambda^4}$
4.	Lens formula	$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$
5.	Magnification	$m = \frac{h'}{h} = \frac{v}{u}$
6.	Power of lens	$P = \frac{1}{f}$
7.	Lens maker's formula	$\frac{1}{f} = (\mu - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$
8.	The focal length of the required concave lens for myopia.	$f = \frac{xy}{x - y}$
9.	The focal length of the required convex lens for hypermetropia.	$f = \frac{dD}{d - D}$

TEXTBOOK EVALUATION

I. Choose the correct answer

- The refractive index of four substances A, B, C and D are 1.31, 1.43, 1.33, 2.4 respectively. The speed of light is maximum in
 (a) A (b) B (c) C (d) D Ans. (a) A
 ※ [FRT-'22]
- Where should an object be placed so that a real and inverted image of same size is obtained by a convex lens
 (a) f (b) 2f (c) infinity (d) between f and 2f Ans. (b) 2f
 [May-'22]
- A small bulb is placed at the principal focus of a convex lens. When the bulb is switched on, the lens will produce
 (a) a convergent beam of light (b) a divergent beam of light
 (c) a parallel beam of light (d) a coloured beam of light
 Ans. (c) a parallel beam of light
 [BEQ; PTA-3]