Challenger

SAMPLE CONTENT

NEET-UG & JEE (Main)
PHYSICS Vol - I

As per latest syllabus issued by NMC

1500+ MCQs with Hints

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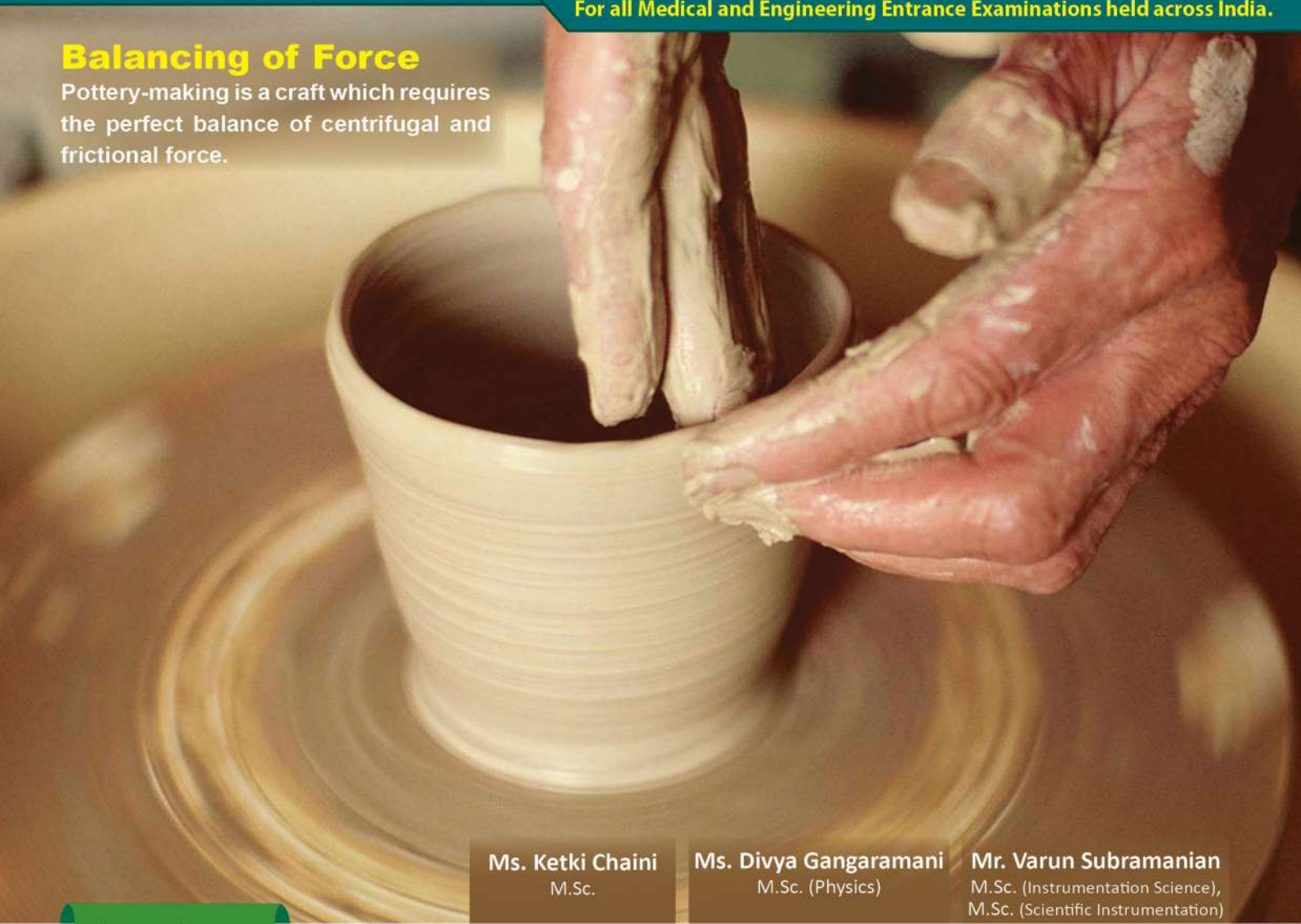

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Physics Vol. I

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Salient Features

- Concise theory for every topic
- Eclectic coverage of MCQs under each sub-topic
- Exhaustive coverage of questions including selective questions from previous years' NEET (UG) and JEE (Main) examinations updated upto year 2024:
  - **1700+** MCQs
  - **90+** Numerical Value type (NVT)
  - Solutions to the questions are provided for better understanding
- Inclusion of '**Problems To Ponder**' to engage students in scientific enquiry.
- Includes **Smart Keys:** Multiple study techniques to enhance understanding and problem solving:
  - ***Time Saver*** - ***Smart tip*** - ***Caution***
  - ***Learning Pointers*** - ***Think out of the box*** - ***Mind Over Matter***
- Includes Question Paper and Answer Keys (Solution through Q.R. code) of:
  - JEE (Main) 2024 31st Jan (Shift - I) - NEET (UG) 2024
- Q.R. codes provide:
  - Video links for boosting conceptual retention
  - Solutions of JEE (Main) 2024 31st Jan (Shift - I) and NEET (UG) 2024 question paper

Printed at: **India Printing Works,** Mumbai

P.O. No. 13418

TEID: 3743

PREFACE

'Challenger Physics Vol - I' is a compact guidebook, extremely handy for preparation of various competitive exams like NEET, JEE (Main). This edition provides an unmatched comprehensive amalgamation of theory with MCQs. The chapters are aligned with the latest syllabus for **NEET (UG) and JEE (Main) 2024** examinations. Although the alignment runs parallel to NCERT curriculum, the structure of the chapters prioritizes knowledge building of the students. The book provides the students with scientifically accurate context, several study techniques and skills required to excel in these examinations.

In this book the Theoretical Concepts are presented in the form of pointers, tables, charts and diagrams that form a vital part of preparation of any competitive examination.

Multiple Choice Questions have been specially created and compiled with the following objective in mind – to help students solve complex problems which require strenuous effort and understanding of multiple-concepts. The assortment of MCQs is a beautiful blend of questions based on higher order thinking, theory, and multiple concepts.

MCQs in each chapter are segregated into following sections.

- **Concept Building Problems** section is designed to boost prerequisite understanding of concepts.
- **Practice Problems** section contains questions crafted for thorough revision .
- **Numerical Value Type** section caters to newly added NVT questions in JEE (Main).
- **Problems to Ponder** section offers questions of diverse pattern created to instil the attitude of concentrating on the problems and to understand the application of various concepts in Physics.

All the features of this book pave the path of a student to excel in examination. The features are designed keeping the following elements in mind: Time management, easy memorization or revision and non-conventional yet simple methods for MCQ solving.

To keep students updated, the book covers selective solved questions of **JEE (Main) 2024 27th Jan (Shift - I)**. Question Papers along with Answers and Solutions (through Q.R. code) of **JEE (Main) 2024 31st Jan (Shift -I) and NEET (UG) 2024** have been provided to offer students glimpse of the complexity of questions asked in entrance examinations. These papers have been split unit-wise to let the students know which of the units were more relevant as per latest Question papers.

We hope the book benefits the learner as we have envisioned.

A book affects eternity; one can never tell where its influence stops.

Publisher

Edition: Sixth

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

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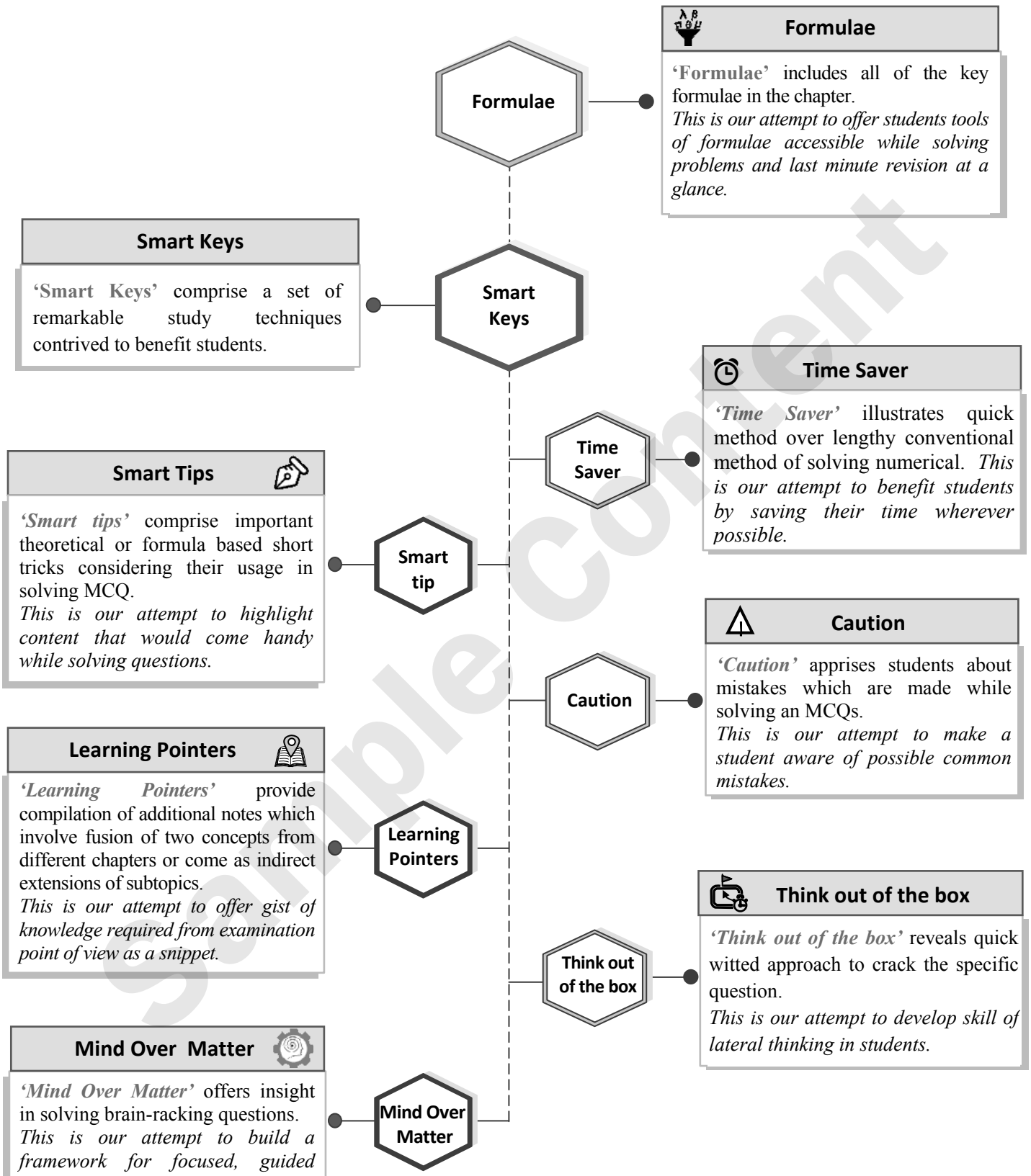
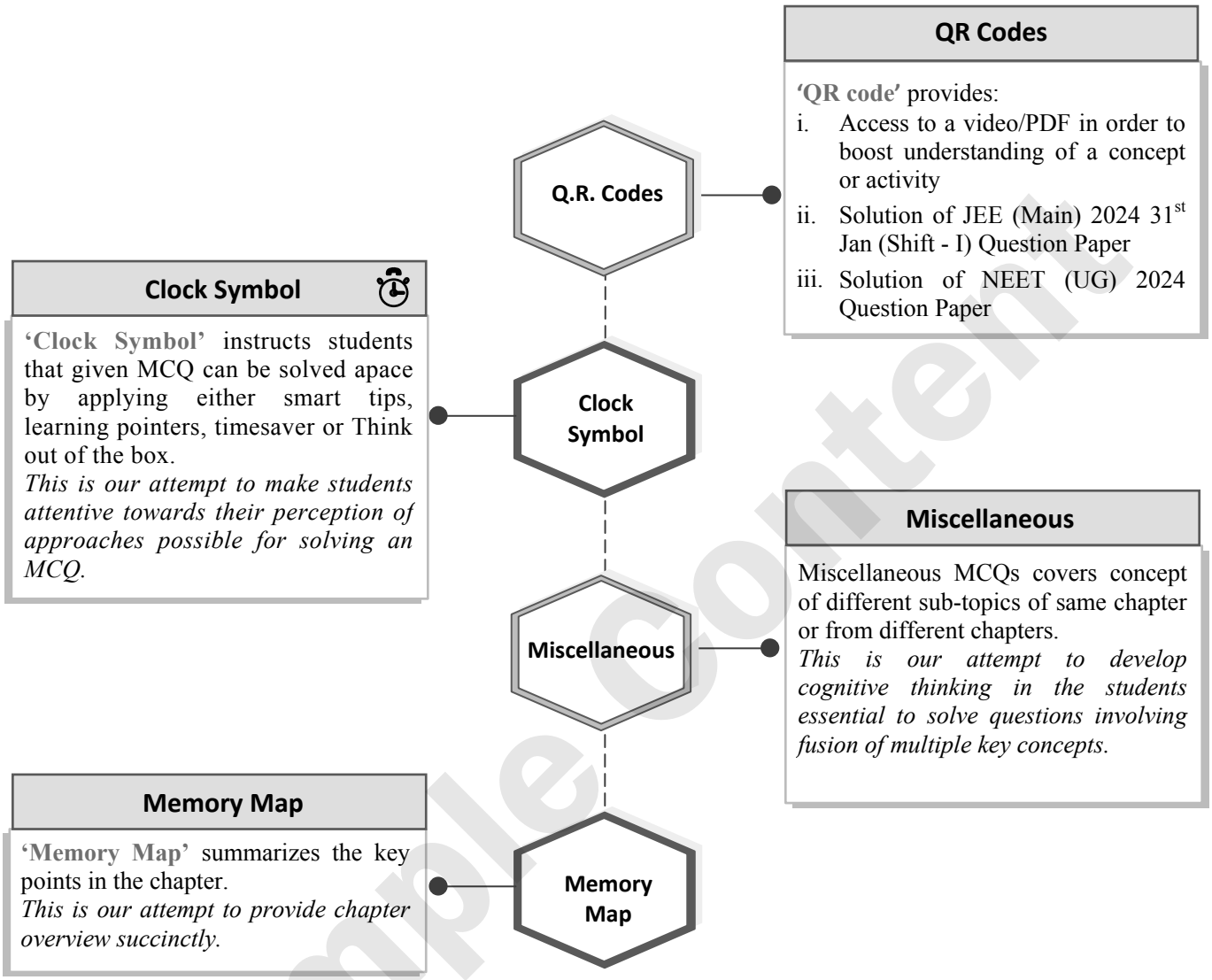
KEY FEATURES



To be continued…

KEY FEATURES



QR Codes

'QR code' provides:

i. Access to a video/PDF in order to boost understanding of a concept or activity

ii. Solution of JEE (Main) 2024 31st Jan (Shift - I) Question Paper

iii. Solution of NEET (UG) 2024 Question Paper

Clock Symbol

'Clock Symbol' instructs students that given MCQ can be solved apace by applying either smart tips, learning pointers, timesaver or Think out of the box.

This is our attempt to make students attentive towards their perception of approaches possible for solving an MCQ.

Miscellaneous

Miscellaneous MCQs covers concept of different sub-topics of same chapter or from different chapters.

This is our attempt to develop cognitive thinking in the students essential to solve questions involving fusion of multiple key concepts.

Memory Map

'Memory Map' summarizes the key points in the chapter.

This is our attempt to provide chapter overview succinctly.

Frequently Asked Questions

- **Why Challenger Series?**

  Gradually, every year the nature of competitive entrance exams is inching towards conceptual understanding of topics. Moreover, it is time to bid adieu to the stereotypical approach of solving a problem using a single conventional method.

  To be able to successfully crack the NEET examination, it is imperative to develop skills such as data interpretation, appropriate time management, knowing various methods to solve a problem, etc. With Challenger Series, we are sure, you'd develop all the aforementioned skills and take a more holistic approach towards problem solving. The way you'd tackle advanced level MCQs with the help of solutions, Smart tips, Time Savers and Think out of the box section would give you the necessary practice that would be a game changer in your preparation for the competitive entrance examinations.

- **What is the intention behind the launch of Challenger Series?**

  The sole objective behind the introduction of Challenger Series is to severely test the student's preparedness to take competitive entrance examinations. With an eclectic range of critical and advanced level MCQs, we intend to test a student's MCQ solving skills within a stipulated time period.

- **What do I gain out of Challenger Series?**

  After using Challenger Series, students would be able to:

  a. assimilate the given data and apply relevant concepts with utmost ease.
  b. tackle MCQs of different pattern such as match the columns, diagram based questions, Statement based questions, multiple concepts and assertion-reason efficiently.
  c. garner the much needed confidence to appear for competitive exams.
  d. easy and time saving methods to tackle tricky questions will help ensure that time consuming questions do not occupy more time than you can allot per question.

- ***Can the Questions presented in Problems to Ponder section be a part of the NEET Examination?***

  No, the questions would not appear as it is in the NEET Examination. However, there are fair chances that these questions could be covered in parts or with a novel question construction.

Best of luck to all the aspirants!

CONTENTS

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To see complete chapter buy **Target Notes** or **Target E-Notes**

20. In the relation $J = \frac{\alpha}{\beta} e^{-\frac{\alpha x}{t}}$, J is impulse, x is the distance, and t is the time. The dimensional formula of $(1/\beta)$ will be same as
(A) Energy (B) Force
(C) Surface tension (D) Power

21. If $\int \frac{dx}{\sqrt{8ax - x^2}} = a^n \sin^{-1}\left(\frac{x - 4a}{4a}\right)$, where 'x' and 'a' represent distance, then the value of 'n' using dimensional analysis is
(A) −1 (B) 1 (C) 0 (D) 2

Practice Problems

Unit of measurement and system of units

1. The physical quantity denoted by $\frac{\text{mass} \times \text{pressure}}{\text{density}}$ is
(A) force
(B) work
(C) momentum
(D) angular momentum

2. The unit of magnetic induction is newton/ampere-metre. Its other equivalent unit is
(A) Vm^{-1} (B) Vm^2
(C) $\frac{\text{volt} - \text{second}}{\text{m}}$ (D) $\frac{\text{volt} - \text{second}}{\text{m}^2}$

3. dyne/cm^2 is NOT a unit of
(A) Pressure
(B) Strain
(C) Stress
(D) Young's modulus

4. In which of the following the SI units are same as practical units?
(A) Thermodynamic temperature
(B) Electric potential
(C) Wavelength
(D) All of the above

5. **Statement I:** Fundamental units mass, length and time are used in our 3-dimensional world.
Statement II: We will need less number of units if world has lesser dimensions.
(A) Both statements (I) and (II) are true.
(B) Statement (I) is an assertion with Statement (II) as its reason.
(C) Statement (II) is an assertion with Statement (I) as its reason.
(D) Statement (I) is true and Statement (II) is false.

Least count of measuring instruments

1. A vernier callipers has 1 mm marks on the main scale. It has 20 equal divisions on the vernier scale which match with 18 main scale divisions. For this vernier callipers, the least count is
(A) 0.02 m (B) 0.05 mm
(C) 0.1 mm (D) 0.2 mm

2. The main scale of a vernier callipers marked upto 10 cm is equally divided into 100 equal parts. Its vernier scale of 10 divisions coincides with 9 mm on the main scale. The least count of the instrument is
(A) 0.02 cm (B) 0.002 cm
(C) 0.01 cm (D) 0.001 cm

3. A spherometer has 50 equal divisions marked along the peripheri of its disc and five full rotations of the disc advances on the main scale by 0.160 cm. The least count of the system is
(A) 6.4×10^{-4} cm (B) 64×10^{-3} cm
(C) 6.4×10^{-2} cm (D) 64×10^{-4} cm

4. A student measured the length of a rod and wrote it as 4.40 cm. Which of the following instrument did he use to measure it?
(A) A meter scale
(B) A vernier calliper where the 10 divisions in vernier scale matches with 9 division in main scale and main scale has 10 divisions in 1 cm
(C) A screw guage having 50 divisions in the circular scale and pitch as 1 mm
(D) A screw gauge having 100 divisions in the circular scale and pitch as 1 mm

Errors in measurement

1. The physical quantity $P = A^{\alpha}B + C$ has maximum relative error $\frac{\Delta P}{P} = \frac{\Delta B}{B}$ then
i. A and C have to be constants.
ii. A can be any physical quantity with $\alpha = 0$ and C is constant.
(A) Only (i) is correct.
(B) Only (ii) is correct.
(C) (i) and (ii) both are correct.
(D) neither (i) nor (ii) is correct.

2. An instrument having five display screen, where first two and last two show the final value of the quantity and middle screen displays the mean value. If 1st and 5th screen both display a value of 35 ^{o}C; 2nd and 3rd screen displays 20 ^{o}C and 75 ^{o}C respectively then, what value will be displayed by 4th screen?
(A) 150 ^{o}C (B) 210 ^{o}C
(C) 285 ^{o}C (D) 20 ^{o}C

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SCALAR PRODUCT (DOT PRODUCT) AND VECTOR PRODUCT (CROSS PRODUCT) OF VECTORS

1. **Assertion:** Angle between $(\hat{i}+\hat{k})$ and $\hat{i}$ is $\frac{\pi}{4}$.

Reason: $(\hat{i}+\hat{k})$ is equally inclined both to X and Z axes.

(A) Assertion is True, Reason is True; Reason is a correct explanation for Assertion.
(B) Assertion is True, Reason is True; Reason is not a correct explanation for Assertion.
(C) Assertion is True, Reason is False.
(D) Assertion is False, Reason is True.

2. The vector sum of two velocities is perpendicular to their vector differences. In this case, the velocities

(A) are equal to each other in magnitude.
(B) are not equal to each other in magnitude.
(C) are at an angle of 90° with each other.
(D) are equal to each other in direction.

Mind over Matter

The key to crack this question lies in comprehending that, perpendicular vectors satisfy the orthogonality condition.

3. If a vector $2\hat{i} + 3\hat{j} + 6\hat{k}$ is perpendicular to the vector $-6\hat{i} + 8\hat{j} + \alpha\hat{k}$, then the value of α is

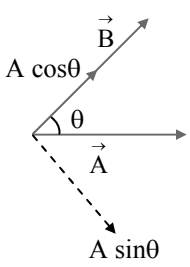
(A) $\frac{1}{2}$ (B) $\frac{-1}{2}$
(C) 1 (D) –2

4. Given $\vec{A} = 5\hat{i} + 3\hat{j}$ and $\vec{B} = \hat{i} - \hat{j}$. The magnitude of component of vector $\vec{A}$ along $\vec{B}$ is

(A) $\frac{1}{\sqrt{2}}$ unit (B) 2 unit
(C) $\sqrt{2}$ unit (D) $\frac{1}{2}$ unit

Mind over Matter

The key to crack this question lies in comprehending that, the component of $\vec{A}$ along $\vec{B}$ will be A cosθ if θ is the angle between $\vec{A}$ and $\vec{B}$.



5. If vectors $\vec{A} = \cos\omega t\,\hat{i} + \sin\omega t\,\hat{j}$ and $\vec{B} = \cos\frac{\omega t}{2}\,\hat{i} + \sin\frac{\omega t}{2}\,\hat{j}$ are functions of time, then the value of t at which they are orthogonal to each other is **[AIPMT Re-Test 2015]**

(A) $t = 0$ (B) $t = \frac{\pi}{4\omega}$
(C) $t = \frac{\pi}{2\omega}$ (D) $t = \frac{\pi}{\omega}$

6. In a triangle ABC, the sides AB and AC are represented by the vectors $3\hat{i} + \hat{j} + \hat{k}$ and $\hat{i} + 2\hat{j} + \hat{k}$ respectively. Calculate the angle ∠ABC.

(A) $\cos^{-1}\left(\sqrt{\frac{5}{11}}\right)$
(B) $\cos^{-1}\left(\sqrt{\frac{6}{11}}\right)$
(C) $90° - \cos^{-1}\left(\sqrt{\frac{5}{11}}\right)$
(D) $180° - \cos^{-1}\left(\sqrt{\frac{5}{11}}\right)$

7. A vector $\vec{A}$ points vertically downward and $\vec{B}$ points towards east. The vector product $\vec{A} \times \vec{B}$ is

(A) zero.
(B) along north.
(C) along south.
(D) vertically upward.

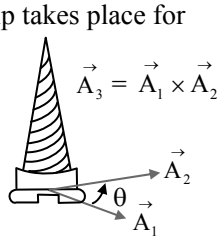
Mind over Matter

The key to crack this question lies in comprehending that, the direction of any vector $\vec{A} = \vec{B} \times \vec{C}$ is always perpendicular to the plane containing vectors $\vec{B}$ and $\vec{C}$.

8. According to right handed screw rule, when a right handed screw is placed with its axis perpendicular to plane containing two vectors $\vec{A}_1$ and $\vec{A}_2$, is rotated from $\vec{A}_1$ to $\vec{A}_2$ through angle θ, then the sense of advancement of tip of the screw is in direction of $\vec{A}_3$.

The advancement of the tip takes place for

(A) $0 < \theta \le 90°$
(B) $0 \le \theta \le 90°$
(C) $0 < \theta \le 360°$
(D) $0 \le \theta \le 360°$



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MEMORY MAP

Scan the adjacent QR code in *Quill - The Padhai App* for chapter revision and relevant additional information

LAWS OF MOTION

Force

1. It is a push/pull which either changes/tends to change the state of rest/uniform motion of a body.
2. $\vec{F} = m\vec{a}$
3. Types of forces: i. Contact ii. Non-contact

Newton's Laws of motion

1. **Inertia:** It is the inherent property of objects by virtue of which they do not change their state of rest or motion unless acted upon by an external force.
   - i. Inertia of Motion
   - ii. Inertia of Rest
   - iii. Inertia of Direction
2. **First Law:** A body continues to be in its state of rest or of uniform motion along a straight line, unless it is acted upon by some external force to change the state.
3. **Second Law:**
   - i. Linear Momentum: $\vec{p} = m\vec{v}$
   - ii. Statement: The rate of change of linear momentum of a body is directly proportional to the applied external force on it and this change in momentum takes place in the direction of the force.

   $\vec{F} \propto \frac{d\vec{p}}{dt} \Rightarrow \vec{F} = m\vec{a}$ (Constant mass)
4. **Third Law:** To every action there's an equal and opposite reaction.
5. **Apparent Weight of a body in a lift:**

Condition		Apparent Weight
Lift is at rest or moving with uniform velocity	a = 0	W = mg
Lift is accelerating upwards	a < g or a > g	W = m(g + a)
	a = g	W = 2mg
Lift is accelerating downwards	a < g	W = m(g – a)
	a = g	W = 0
	a > g	W = –ve

Impulse

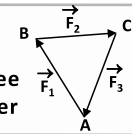
1. Impulse is the product of average force and time of impact. $\vec{I} = \vec{F}.t$
. Impulse is equal to the area under F-t curve. $I = \int F_{av}\Delta t$

Conservation of Linear Momentum

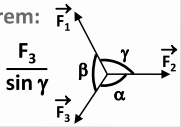
1. If no external force acts on a isolated system of constant mass, the total momentum of the system remains constant with time.
2. Recoil of Gun: $\vec{v}_G = \frac{-m_B}{m_G}\vec{v}_B$
3. Rocket Propulsion: $F = -u\frac{dm}{dt} - mg$ (Thrust on the rocket)

Equilibrium of Concurrent Forces

1. If all the forces working on a body are acting on the same point, then they are said to be concurrent.
2. The necessary condition for the equilibrium of a body under the action of concurrent forces is that the vector sum of all the forces acting on the body must be zero.
3. Three concurrent forces will be in equilibrium, if they are represented completely by three sides of a triangle taken in order

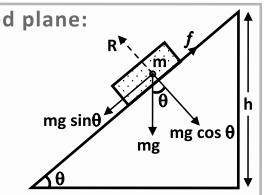


4. Lami's Theorem: $\frac{F_1}{\sin\alpha} = \frac{F_2}{\sin\beta} = \frac{F_3}{\sin\gamma}$



Friction

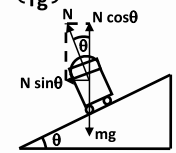
1. **Static Friction:** The force of friction that comes into play between the surfaces of two bodies before the body actually starts moving is called static friction.
   (Limiting value) $F_s = \mu_s N$
2. **Kinetic Friction:** The force of friction that comes into play between the two surfaces, when one surface is in steady motion relative to the other surface is called kinetic friction.
   (Limiting value) $F_k = \mu_k N$
3. Angle of friction $(\theta) = \tan^{-1}\mu \Rightarrow \mu = \tan\theta$
4. **Laws of Friction:** Limiting friction is,
   - i. Directly proportional to Normal Reaction.
   - ii. Directed opposite to motion.
   - iii. Depends upon material, surfaces in contact and their state of roughness/smoothness.
   - iv. Independent of the shape or the area of the surfaces in contact as long as the normal reaction remains the same.
5. **Inclined plane:**
   - i.



   - ii. Angle of repose $(\alpha) = \tan^{-1}\mu$

Vehicle on curved unbaked road and banked road

1. **Curved unbanked road:** For safe driving of vehicle on curved unbanked road, $v < \sqrt{rg}$
2. **Motion of a vehicle on banked road:** i. Angle of banking $(\theta) = \tan^{-1}\left(\frac{v^2}{rg}\right)$
   - ii. Maximum speed with which a vehicle can move along a curved banked road is $v_{max} = \sqrt{rg\tan\theta}$
   - ii. If friction is present between road and tyres of vehicle, then maximum safe speed is $v_{max} = \sqrt{\frac{rg(\mu + \tan\theta)}{1 - \mu\tan\theta}}$



7. **Bending of a cyclist on a curved road:**
   - i. Cyclist should bend through an angle, $\theta = \tan^{-1}\left(\frac{v^2}{rg}\right)$
   - ii. It follows that the angle through which cyclist should bend will be greater, if
     - a. The radius of the curve is small i.e. the curve is sharper.
     - b. The velocity of the cyclist is large.

6 Work, Energy and Power

- Work
- Energy
- Work-Energy theorem
- Conservative and Non-conservative forces
- Power
- Collisions

WORK

➢ **Work done by a constant force:**

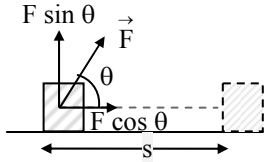
The work done by a force on a body is measured as the product of the force and the displacement produced in the direction of the force.

Unit: joule in (SI) and erg in (CGS) **Dimensions:** $[M^1L^2T^{-2}]$ **Type:** scalar

i. Work done by the applied force $\vec{F}$ on block of mass 'm' when displaced through 's' in the direction of applied force is given by,

$W = \vec{F} \cdot \vec{s} = Fs\cos\theta$

where, θ = Angle made by $\vec{F}$ with horizontal



ii. The work done is zero, when $\theta = 90°$ i.e. when displacement and direction of application of force are perpendicular to each other.

iii. The work done is maximum, when $\theta = 0°$ i.e., displacement due to the application of force and the direction of force is same.

iv. If a number of forces $\vec{F}_1$, $\vec{F}_2$, $\vec{F}_3$ ….. $\vec{F}_n$ are acting on a body and it shifts from position vector $\vec{r}_1$ to $\vec{r}_2$, then work done is given by, $W = \left(\vec{F}_1 + \vec{F}_2 + \vec{F}_3 ..... + \vec{F}_n\right)\left(\vec{r}_2 - \vec{r}_1\right)$

➢ **Nature of work done:**

i. **Positive work:** Work done is said to be positive if the applied force has a component in the direction of the displacement.
Example: When a body falls freely under gravitational pull, the work done by gravity is positive.

ii. **Negative work:** Work done by a force is said to be negative if the applied force has a component in the opposite direction to that of the displacement.
Example: When a body is dragged on a rough inclined plane, the work done by the frictional force is negative.

iii. **Zero work:** Work done by a force is zero, if the body is displaced in the perpendicular direction to the direction of force or magnitude of displacement or force is zero.
Example: When a coolie travels on a platform with load on his head, work done by the force of gravity is zero. This is because the force of gravity acting downwards is perpendicular to the displacement.

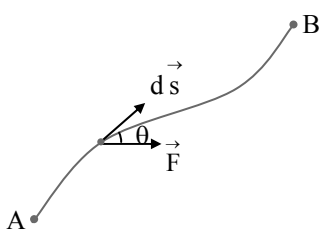
➢ **Work done by a variable force:**

i. **Mathematical treatment:**

a. When the magnitude and direction of a force varies with position, the work done by such a force for an infinitesimal displacement is given by, $dW = \vec{F} \cdot d\vec{s}$

b. The total work done in going from A to B is given by,

$W = \int_A^B \vec{F} \cdot d\vec{s} = \int_A^B F\, ds \cos\theta$



c. In terms of rectangular components, $\vec{F} = F_x\hat{i} + F_y\hat{j} + F_z\hat{k}$, $d\vec{s} = dx\,\hat{i} + dy\,\hat{j} + dz\,\hat{k}$

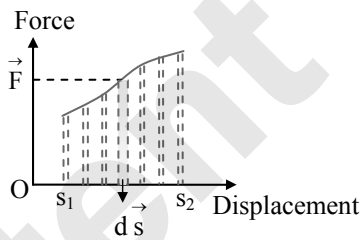
$\therefore \quad W = \int_A^B \left(F_x\hat{i} + F_y\hat{j} + F_z\hat{k}\right) \cdot (dx\,\hat{i} + dy\,\hat{j} + dz\,\hat{k})$

$\therefore \quad W = \int_{xA}^{xB} F_x dx + \int_{yA}^{yB} F_y dy + \int_{zA}^{zB} F_z dz$

ii. Graphical method:

Let a body having initial position s_1 be acted upon by a variable force (whose magnitude is changing continuously) and consequently the body acquires its final position s_2.

Let $\vec{F}$ be the average value of variable force within the interval $d\vec{s}$. The work done will be the area of the shaded strip of width ds. The work done on the body in displacing it from position s_1 to s_2 will be equal to the sum of areas of all such strips.



$dW = \vec{F} \cdot d\vec{s}$

$\therefore \quad W = \int_{s_1}^{s_2} dW = \int_{s_1}^{s_2} \vec{F} \cdot d\vec{s}$

$\therefore \quad W = \int_{s_1}^{s_2} (\text{Area of strip of width } ds)$

$\therefore$ W = Area under curve between s_1 and s_2

$\therefore$ Area under force-displacement curve with proper algebraic sign represents work done by the force.

ENERGY

➢ **Energy:**

The energy of a body is defined as its capacity of doing work. It is measured as the total quantity of work done.

Unit: joule in (SI) and erg in (CGS) **Dimensions:** $[M^1L^2T^{-2}]$ **Type:** Scalar

i. There are different forms of energy such as mechanical energy, chemical energy, electrical energy, nuclear energy, light energy, heat energy, magnetic energy etc.

ii. Mechanical energy is of two types: kinetic energy and potential energy.

➢ **Kinetic energy:**

Energy possessed by a body by virtue of its motion is called kinetic energy.

i. Kinetic energy of a body of mass 'm' moving with velocity 'v', is given by, $K.E = \frac{1}{2}mv^2$

ii. K.E is always positive.

iii. K.E depends upon frame of reference.

Example: The K.E. of a person of mass 'm' sitting in a train moving with velocity 'v' is zero in the frame of reference of train but it is $\frac{1}{2}mv^2$ in the frame of reference of the earth.

iv. When a body moves in the direction of the force with increasing velocity, its K.E increases.

v. When a body moves in the opposite direction of the force with decreasing velocity, its K.E. decreases.

vi. **Relation between K.E and momentum:**

$$K.E = \frac{1}{2}mv^2 = \frac{1}{2}\left[\frac{p}{v}\right]v^2 = \frac{1}{2}pv = \frac{p^2}{2m}$$

$\therefore \quad p = \sqrt{2m\,K.E.} = \frac{2K.E}{v}$

Smart tip - 1

When the momentum of a body increases by a factor n, then its kinetic energy is increased by factor n^2.

Time saver - 3

When a particle of mass m is taken from the Earth's surface to a height h = nR, then the change in P.E. can be calculated as,

$$\Delta U = mgR\left(\frac{n}{n+1}\right)$$

Example:

A body of mass m rises to a height h = R/5 from the surface of the Earth. If g is acceleration due to gravity on the Earth's surface, then the increase in potential energy is (R = radius of Earth)

(A) mgh (B) $\frac{4}{5}$ mgh (C) $\frac{5}{6}$ mgh (D) mgR

Conventional Method:

Increase in the P.E. is given by,

$\Delta U = U_B - U_A$

$$U_B = -\frac{GMm}{R+h} = -\left(\frac{GMm}{R+R/5}\right) = -\frac{5GMm}{6R}$$

$$U_A = -\frac{GMm}{R}$$

$$\therefore \quad \Delta U = -\frac{5GMm}{6R} + \frac{GMm}{R}$$

$$= \frac{GMm}{R}\left(1-\frac{5}{6}\right)$$

$$\Delta U = \frac{GMm}{6R}$$

$$\therefore \quad \Delta U = \frac{mgR^2}{6R} \quad \ldots.(\because GM = gR^2)$$

$$\therefore \quad \Delta U = \frac{mgR}{6}$$

$$\therefore \quad \Delta U = \frac{5}{6}\text{ mgh} \quad \ldots.(\because R = 5h)$$

Ans: (C)

Quick method:

Here, $h = \frac{R}{5}$

$$\therefore \quad n = \frac{1}{5}$$

$$\therefore \quad \Delta U = mgR\left(\frac{\frac{1}{5}}{\frac{1}{5}+1}\right)$$

$$= mgR\left(\frac{1}{6}\right)$$

But R = 5h

$$\therefore \quad \Delta U = \frac{mg}{6} \times 5h = \frac{5}{6}\text{ mgh}$$

Ans: (C)

ESCAPE VELOCITY

The minimum velocity with which a body must be projected up so as to enable it to just overcome the gravitational pull is known as escape velocity.

i. The work done to displace a body from the surface of earth to infinity (r = ∞) is

$$W = -\int_R^\infty \left(-\frac{GMm}{x^2}\right) dx$$

$$= -GMm\left(\frac{1}{\infty} - \frac{1}{R}\right)$$

$$\therefore \quad W = \frac{GMm}{R}$$

This work required to project the body so as to escape the gravitational pull is performed on the body by providing an equal amount of kinetic energy to it at the surface of the earth.

ii. If v_e is the required escape velocity, then

$$v_e = \sqrt{\frac{2GM}{R}}$$

i. Mathematically, for unit volume of liquid flowing through a pipe, $P + \rho gh + \frac{1}{2}\rho v^2 = \text{constant}$.

ii. Bernoulli's theorem for unit mass of liquid flowing through a pipe can also be written as,

$$\frac{P}{\rho} + gh + \frac{1}{2}v^2 = \text{constant}.$$

$$\frac{P}{\rho g} + h + \frac{v^2}{2g} = \text{constant}$$

….(Dividing above equation by g)

CAUTION

Bernoulli's theorem is strictly valid for ideal (non-viscous and incompressible) fluid.

Here, $\frac{P}{\rho g}$ is called pressure head, h is called gravitational head and $\frac{v^2}{2g}$ is called velocity head. From this equation, Bernoulli's theorem can be stated as:

In streamline flow of an ideal liquid, the sum of pressure head, gravitational head and velocity head of every cross-section of the liquid is constant.

➢ **Equation of continuity:**

i. For a non-viscous liquid in streamline flow passing through a tube of varying cross-section,

$av = \text{constant}$ or $a \propto \frac{1}{v}$

where, a = area of cross-section of tube,
v = velocity of flow

This expression is called equation of continuity.

CAUTION

Equation of continuity is strictly valid for a non-viscous fluid in streamline flow.

ii. Velocity of flow of liquid is independent of the nature of liquid.

iii. Velocity of flow of non-viscous liquid increases with decrease in cross-sectional area of the tube.

➢ **Poiseuille's formula:**

Rate of flow of liquid through a horizontal capillary tube i.e., volume of the liquid flowing per second is V and it is given by,

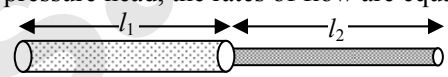
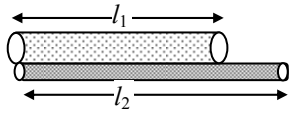
$$V = \frac{\pi P r^4}{8\eta l} = \frac{P}{R}$$ ….(Poiseuille's equation)

where, $\frac{\pi}{8}$ is proportionality constant; P is pressure difference; r is radius of tube; l is length of tube; η is coefficient of viscosity and R is called as liquid resistance.

CAUTION

Poiseuille's equation is strictly valid for steady flow of liquid passing through horizontal capillary tube.

Special cases:

Series combination of capillary tubes:	Parallel combination of capillary tubes:
When two capillary tubes are connected in series under the same pressure head, the rates of flow are equal.  a. When two tubes of length l_1, l_2 and radii r_1, r_2 are connected in series across a pressure difference P, then $P = P_1 + P_2$ Where, P_1 and P_2 are the pressure difference across the first and second tube respectively. b. The volume of liquid flowing through both the tubes i.e., rate of flow of liquid is same. $\therefore$ $V = V_1 = V_2$ i.e., $V = \frac{\pi P_1 r_1^4}{8\eta l_1} = \frac{\pi P_2 r_2^4}{8\eta l_2}$ ….(2)	When two capillary tubes are connected parallel under the same pressure head, the rates of flow are added.  a. When two tubes of length l_1, l_1 and radii r_1 and r_2 are connected in parallel across pressure difference P then, $P = P_1 = P_2$ b. The net volume of liquid flowing through tubes is sum of volumes of liquid flowing through each tube. $\therefore$ $V = V_1 + V_2 = \frac{P\pi r_1^4}{8\eta l_1} + \frac{P\pi r_2^4}{8\eta l_2} = P\left[\frac{\pi r_1^4}{8\eta l_1} + \frac{\pi r_2^4}{8\eta l_2}\right]$

5. Assume that a drop of liquid evaporates by decrease in its surface energy so that its temperature remains unchanged. What should be the minimum radius of the drop for this to be possible? The surface tension is T, density of liquid is ρ and L is its latent heat of vaporization. **[JEE (Main) 2013]**

(A) ρL/T (B) $\sqrt{T/\rho L}$

(C) T/ρL (D) 2 T/ρL

6. Under isothermal conditions, two soap bubbles of radii a and b coalesce to form a single bubble of radius c. If the external pressure is P, then surface tension of the bubbles is

(A) $\frac{P\left(c^3-a^3+b^3\right)}{4\left(a^2+b^2-c^2\right)}$ (B) $\frac{P\left(c^3-a^3-b^3\right)}{4\left(a^2+b^2-c^2\right)}$

(C) $\frac{P\left(c^2+a^2-b^2\right)}{4\left(a^3+b^3-c^3\right)}$ (D) $\frac{P\left(a^3+b^3-c^3\right)}{4\left(a^2+b^2-c^2\right)}$

Numerical Value Type Questions

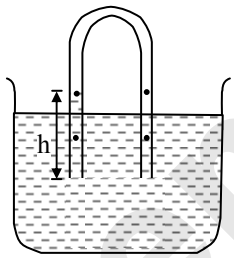
1. There is a soap bubble of radius 2.4×10^{-4} m in air cylinder which is originally at the pressure of 10^5 N/m^2. The air in the cylinder is now compressed isothermally until the radius of the bubble is halved. The pressure of air in the cylinder now becomes $n \times 10^5$ N/m^2. The surface tension of soap film is 0.08 Nm^{-1}. Find the integer value of n.

2. A glass capillary sealed at the upper end is of length 10 cm and internal radius 1×10^{-5} m. The tube is immersed vertically into a liquid of surface tension 5×10^{-2} N/m. If the approximate length (in m) the capillary has to be immersed so that the liquid level inside and outside the capillary becomes the same is 8×10^{-n} m. Calculate the value of n.
(1 atm = 1.01×10^5 N/m^2)

3. A metal wire of density ρ floats on water surface horizontally. For it not to sink in water maximum possible radius of wire should be $\frac{T^n}{\sqrt{\pi\rho g}}$ where, T is surface tension of water. Find n^{-1}.

4. A long capillary tube of radius 0.2 mm is placed vertically inside a beaker of water of surface tension 0.07 N/m. Water due to zero angle of contact rises upto height of 7.05 cm in tube. Now if tube is pushed into water so that only 5 cm of its length is above the surface, find new angle of contact in degrees between water and glass surface. (Take $\sqrt{2}$ = 1.41)

5. A glass U-tube is such that the diameter of one limb is 4.0 mm and that of the other is 6.00 mm. The tube is inverted vertically with the open ends below the surface of the water in a beaker. What is the difference between the heights (in mm) to which water rises in the two limbs? The surface tension of water is 0.07 Nm^{-1}. Assume that the angle of contact between water and glass is 0°.



Problems To Ponder

1. Explain splitting of the nib of ink pen on the basis of capillary action.

2. Suggest few methods with explanation to separate two pieces of paper joined by glue.

3. Derive an expression for capillary rise of liquid between two parallel plates when the plates are dipped into a liquid of density ρ with separation distance 'd' between them.

4. Swelling of wood and wooden furniture in monsoon is common. How does sealing or specific polishing of wood help wood to resist moisture?

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To see complete chapter buy **Target Notes** or **Target E-Notes**

Formulae

1. Heat energy: $Q = mc\Delta\theta$

2. Specific heats:

i. Specific heat at constant pressure:

a. Principle specific heat: $c_P = \frac{(\Delta Q)_P}{m\Delta T}$

b. Molar specific heat:

$$C_P = Mc_P = \frac{M(\Delta Q)_P}{m\Delta T} = \frac{1}{n}\frac{(\Delta Q)_P}{\Delta T}$$

ii. Specific heat at constant volume:

a. Principle specific heat: $c_V = \frac{(\Delta Q)_V}{m\Delta T}$

b. Molar specific heat:

$$C_V = Mc_V = \frac{M(\Delta Q)_V}{m\Delta T} = \frac{1}{n}\frac{(\Delta Q)_V}{\Delta T}$$

3. Relation between specific heats:

i. $C_P - C_V = R$

ii. $c_P - c_V = \frac{R}{M}$

iii. $\gamma = \frac{C_P}{C_V} = \frac{c_P}{c_V}$

4. Work done by a gas in changing volume at constant pressure:

$$W = \int_{V_1}^{V_2} PdV = P(V_2 - V_1)$$

5. Work done during an isothermal change for 1 mole of a gas:

i. $W_{iso} = RT \log_e\left(\frac{V_2}{V_1}\right) = 2.303 \times RT \log\left(\frac{V_2}{V_1}\right)$

ii. $W_{iso} = RT \log_e\left(\frac{P_1}{P_2}\right) = 2.303 \times RT \log\left(\frac{P_1}{P_2}\right)$

6. Work done in an adiabatic process:

$$W_{adi} = \frac{R(T_2 - T_1)}{1-\gamma} = \frac{R(T_1 - T_2)}{\gamma - 1}$$

7. Molar specific heat in polytropic process:

$$C = \frac{R}{1-N} + C_V$$

8. First law of thermodynamics:

$\Delta Q = \Delta U + \Delta W$

9. Increase in internal energy:

i. Melting process, $\Delta U = mL$

ii. Boiling process, $\Delta U = mL - P(V_{vap} - V_{liq})$

Learning Pointers

1. If a massless piston is attached to a spring of force constant k and the external pressure is P_0, then due to the expansion of gas, the total work done by the gas in moving the piston through a distance x is

$$W = P_0V + \frac{1}{2}kx^2 \quad \ldots \left(\because W = \int_0^x F\,dx \text{ and } F = P_0A + kx\right)$$

Further if a mass m is kept on the piston, then

$$W = P_0V + \frac{1}{2}kx^2 + mgx$$

2. Temperature of a body is measure of average internal energy which is basically disordered kinetic energy of the atoms or molecules. It is not related with external or ordered kinetic energy that arises due to coordinated motion of body parts around the centre of mass of the body. This explains a bullet fired from a gun is not at higher temperature due to its high speed.

Concept Building Problems

Thermal equilibrium and Zeroth law of thermodynamics

1. When a gas is in thermal equilibrium, its molecules have
(A) zero energy.
(B) the same energy.
(C) a certain constant energy.
(D) different energies which remain constant.

2. The zeroth law of thermodynamics leads to the concept of
(A) work done. (B) heat.
(C) internal energy. (D) none of the above.

Heat, internal energy and work

1. A thermos-flask contains coffee. When the flask is stirred rapidly, then, considering the coffee as a system, the value of its internal energy will
(A) be increased.
(B) be reduced.
(C) first decrease and then increase.
(D) remain constant.

2. One mole of an ideal monoatomic gas is heated at a constant pressure from 0 °C to 110 °C. Then the change in the internal energy of the gas is (Given: R = 8.32 $Jmol^{-1}K^{-1}$)
(A) 0.83×10^3 J (B) 4.6×10^3 J
(C) 1.15×10^3 J (D) 1.37×10^3 J

where, $k_B = \frac{R}{N_A}$ = Boltzmann constant = 1.38×10^{-23} J/K, N_A = Avogadro's number,

$r = \frac{R}{M}$ = specific gas constant.

- **Van der Waal's gas equation:** The real gas does not obey gas equation, but obeys van der Waal's gas equation which is:

For one mole: $\left(P + \frac{a}{V^2}\right)(V-b) = RT$

For n moles: $\left(P + \frac{n^2a}{V^2}\right)(V-nb) = nRT$

Students can scan the adjacent QR code in *Quill - The Padhai App* to get information about **van der Waal's equation** with the aid of a linked video.

Where, a and b are Van der Waal's gas constants for one mole of a real gas. Here, 'a' represents the strength of the intermolecular forces while 'b' represents the size of the gas particle.

➢ **Universal gas constant:** *The constant 'R' in the equation of state is called universal gas constant. It denotes the work done by a gas per unit mole per kelvin.*

Formula: $R = \frac{PV}{nT}$ **Unit:** J/mol K (SI) and erg/mol K (CGS) **Dimensions:** $[M^1L^2T^{-2}K^{-1}mol^{-1}]$

- **Values of gas constant in different units:**

In SI units:

At S.T.P., P = 1 atm = 1.013×10^5 N/m^2, V = 22.414 dm^3 = 22.414×10^{-3} m^3, n = 1 mole, T = 273 K

$R = \frac{PV}{nT} = \frac{1.013 \times 10^5 \times 22.414 \times 10^{-3}}{1 \times 273} =$ **8.314 J/mol K**

In CGS unit	In Calories	In litre-atmosphere
$R = 8.314 \times 10^7$ erg/mol K	$R \approx 2$ cal/mol K	R = 0.08210 litre atm/mol K

➢ **Gas laws:**

Law	Boyle's law	Charles' law	Gay Lussac's law
Quantity kept constant	Temperature (T)	Pressure (P)	Volume (V)
Relation between the variable quantities	$V \propto \frac{1}{P}$	$V \propto T$	$P \propto T$
Equation	PV = constant	$\frac{V}{T}$ = constant	$\frac{P}{T}$ = constant
Relation with density	$\frac{P}{\rho}$ = constant	ρT = constant	As V is constant, density (ρ) also remains constant

- **Avogadro's law and number:**

Equal volumes of all the gases under similar conditions of temperature and pressure contain equal number of molecules.

For any gas at S.T.P., 1 mole = M gram = 22.4 litre = **6.023×10^{23} molecules.** This number is called **Avogadro's number (N_A).**

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6. **(A)**

$\vec{r} = \vec{x}+\vec{y}+\vec{z} = -2\hat{i} - \hat{j} + 3\hat{i} + 2\hat{j} - \hat{k} = \hat{i} + \hat{j} - \hat{k}$

$\hat{r} = \dfrac{\vec{r}}{|\vec{r}|} = \dfrac{\hat{i}+\hat{j}-\hat{k}}{\sqrt{1^2+1^2+(-1)^2}} = \dfrac{\hat{i}+\hat{j}-\hat{k}}{\sqrt{3}}$

Think out of the box - Q. 6

Considering magnitude of all the given options, $|x| = |y| = |z| = 1$

Thus, the term $\left|\vec{r}\right|$ in $\hat{r} = \dfrac{\vec{r}}{\left|\vec{r}\right|}$ must be $\sqrt{1^2+1^2+1^2} = \sqrt{3}$

Hence, only option (A) is correct.

7. **(B)**

For any number of consecutive vectors, if the initial point of the first vector coincides with the final point of last vector, then the resultant is zero.

8. **(B)**

Here, $\vec{B} + \vec{C} = \left(\hat{i} - 3\hat{j} + 5\hat{k}\right) + \left(2\hat{i} + \hat{j} - 4\hat{k}\right)$

$= 3\hat{i} - 2\hat{j} + \hat{k} = \vec{A}$

As, $\vec{A} = 3\hat{i} - 2\hat{j} + \hat{k}$,

$\left|\vec{A}\right| = \sqrt{9+4+1} = \sqrt{14}$ ....(i)

Similarly,

$\left|\vec{B}\right| = \sqrt{1+9+25} = \sqrt{35}$ ....(ii)

$\left|\vec{C}\right| = \sqrt{4+1+16} = \sqrt{21}$ ....(iii)

From equations (i), (ii) and (iii), we get,
$B^2 = A^2 + C^2$

9. **(D)**

$\overline{AB} + \overline{AC} + \overline{AD} + \overline{AE} + \overline{AF}$

$= \overline{AB} + \left(\overline{AD} - \overline{DC}\right) + \overline{AD} + \left(\overline{AD} + \overline{DE}\right) + \overline{AF}$

$= 3\ \overline{AD} + \left(\overline{AB} + \overline{DE}\right) + \left(\overline{AF} - \overline{DC}\right)$

$= 3\ \overline{AD} \quad \left[\because \overline{AB} = -\overline{DE}, \text{ and } \overline{DC} = \overline{AF}\right]$

$= 3 \times \left(2\overline{AO}\right) = 6\overline{AO}$

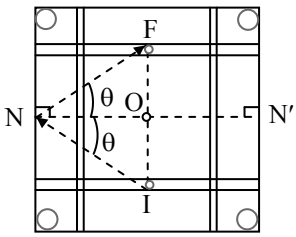
10. **(D)**

$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$

$= (-3+2+1)\hat{i} + (-4+4)\hat{j} + (5-5)\hat{k}$

$= 0\hat{i} + 0\hat{j} + 0\hat{k}$

11. **(C)**



Co-ordinates of initial point I are (25, 8).
Similarly, for final point F co-ordinates are, (25, 42).
As laws of reflection are obeyed with respect to X-axis, striker must hit at point N or N′ to reach point F.
Hence, along side B,
co-ordinates of point N are (0, 25).
i.e., position vector of striker at N = $\left(25\hat{j}\right)$cm

Think out of the box - Q. 11

According to laws of reflection, the striker should hit the middle of side B, i.e., at 25 $\hat{j}$.

12. **(C)**

$\theta = 120° - 30° = 90°$

$\therefore \quad |R| = \sqrt{9^2+12^2+2\times9\times12\cos90°} = 15$ unit

13. **(D)**

Resultant of two vectors $\vec{A}$ and $\vec{B}$ can be given by, $\vec{R} = \vec{A} + \vec{B}$

$\therefore \quad \left|\vec{R}\right| = \left|\vec{A}+\vec{B}\right| = \sqrt{A^2+B^2+2AB\cos\theta}$

If $\theta = 0$, then $\left|\vec{R}\right| = A + B = \left|\vec{A}\right| + \left|\vec{B}\right|$

14. **(C)**

$R = \sqrt{A^2+B^2+2AB\cos\theta}$

Here, $A = B = F$

$\therefore \quad R = \sqrt{2F^2+2F^2\cos\theta}$

$= \sqrt{2F^2(1+\cos\theta)}$

$= 2F\cos\dfrac{\theta}{2}$ $\quad \left[\because (1+\cos\theta) = 2\cos^2\dfrac{\theta}{2}\right]$

$= 2\times10\cos\dfrac{\theta}{2} = 20\cos\dfrac{\theta}{2}$

15. **(C)**

$A = 3$ N, $B = 2$ N

$R = \sqrt{A^2+B^2+2AB\cos\theta}$

$R = \sqrt{9+4+12\cos\theta}$ ....(i)

Now, $A = 3$ N, $B = 4$ N then,

$R = \sqrt{9+16+24\cos\theta}$ ....(ii)

From equations (i) and (ii) we get, $\cos\theta = -1$

$\therefore \quad \theta = \pi^c$

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To see complete chapter buy **Target Notes** or **Target E-Notes**

NEET (UG) 2024
QUESTION PAPER & ANSWER KEY

[Note: The following questions belong to chapters of Challenger Physics Volume - I]

Section A

Units and Measurements

1. The quantities which have the same dimensions as those of solid angle are:
   (A) strain and arc
   (B) angular speed and stress
   (C) strain and angle
   (D) stress and angle

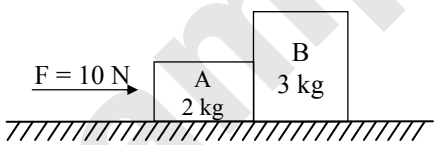
Motion in a Plane

2. A bob is whirled in a horizontal plane by means of a string with an initial speed of ω rpm. The tension in the string is T. If speed becomes 2ω while keeping the same radius, the tension in the string becomes:
   (A) $\frac{T}{4}$ (B) $\sqrt{2}$ T (C) T (D) 4T

3. A particle moving with uniform speed in a circular path maintains:
   (A) constant velocity but varying acceleration.
   (B) varying velocity and varying acceleration.
   (C) constant velocity.
   (D) constant acceleration.

Laws of Motion

4. A horizontal force 10 N is applied to a block A as shown in figure. The mass of blocks A and B are 2 kg and 3 kg, respectively. The blocks slide over a frictionless surface. The force exerted by block A on block B is:



   (A) 6 N (B) 10 N (C) zero (D) 4 N

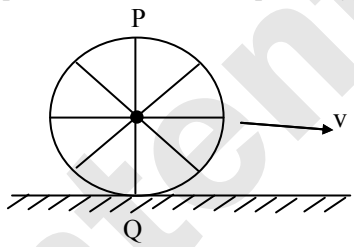
Work, Energy and Power

5. At any instant of time t, the displacement of any particle is given by 2t – 1 (SI unit) under the influence of force of 5 N. The value of instantaneous power is (in SI unit):
   (A) 7 (B) 6 (C) 10 (D) 5

6. Two bodies A and B of same mass undergo completely inelastic one dimensional collision. The body A moves with velocity v_1 while body B is at rest before collision. The velocity of the system after collision is v_2. The ratio $v_1 : v_2$ is:
   (A) 4 : 1 (B) 1 : 4
   (C) 1 : 2 (D) 2 : 1

System of Particles and Rotational Motion

7. A wheel of a bullock cart is rolling on a level road as shown in the figure below. If its linear speed is v in the direction shown, which one of the following options is correct (P and Q are any highest and lowest points on the wheel, respectively)?



   (A) Both the points P and Q move with equal speed
   (B) Point P has zero speed.
   (C) Point P moves slower than point Q.
   (D) Point P moves faster than point Q.

8. The moment of inertia of a thin rod about an axis passing through its mid point and perpendicular to the rod is 2400 g cm^2. The length of the 400 g rod is nearly:
   (A) 20.7 cm (B) 72.0 cm
   (C) 8.5 cm (D) 17.5 cm

Gravitation

9. The mass of a planet is $\frac{1}{10}$ th that of the earth and its diameter is half that of the earth. The acceleration due to gravity on that planet is :
   (A) 4.9 m s^{-2} (B) 3.92 m s^{-2}
   (C) 19.6 m s^{-2} (D) 9.8 m s^{-2}

Mechanical Properties of Solids

10. The maximum elongation of a steel wire of 1 m length if the elastic limit of steel and its Young's modulus, respectively, are 8×10^8 N m^{-2} and 2×10^{11} N m^{-2} is:
    (A) 40 mm (B) 8 mm
    (C) 4 mm (D) 0.4 mm

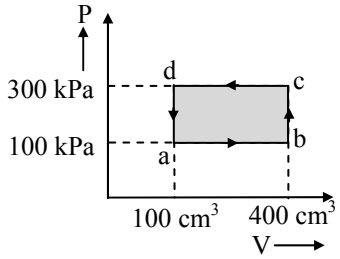
Mechanical Properties of Fluids: Surface Tension

11. A thin flat circular disc of radius 4.5 cm is placed gently over the surface of water. If surface tension of water is 0.07 Nm^{-1}, then the excess force required to take it away from the surface is:
    (A) 1.98 mN (B) 99 N
    (C) 19.8 mN (D) 198 N

Thermodynamics

12. A thermodynamic system is taken through the cycle abcda. The work done by the gas along the path bc is:

(A) –90 J
(B) –60 J
(C) zero
(D) 30 J



Oscillations

13. If $x = 5\sin\left(\pi t + \frac{\pi}{3}\right)$ m represents the motion of a particle executing simple harmonic motion, the amplitude and time period of motion, respectively, are:

(A) 5 cm, 1 s (B) 5 m, 1 s
(C) 5 cm, 2 s (D) 5 m, 2 s

Section B

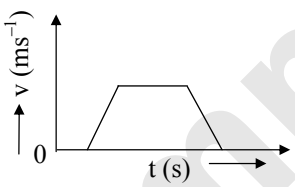
Units and Measurements

14. A force defined by $F = \alpha t^2 + \beta t$ acts on a particle at a given time t. The factor which is dimensionless, if α and β are constants, is:

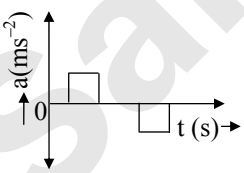
(A) αβt (B) $\frac{\alpha\beta}{t}$ (C) $\frac{\beta t}{\alpha}$ (D) $\frac{\alpha t}{\beta}$

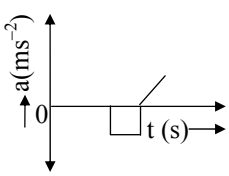
Motion in a Straight Line

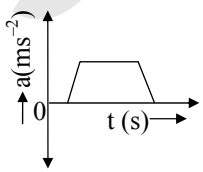
15. The velocity (v) - time (t) plot of the motion of a body is shown below:

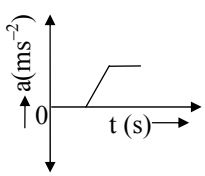


The acceleration (a) – time (t) graph that best suits this motion is:

(A) 

(B) 

(C) 

(D) 

Gravitation

16. The minimum energy required to launch a satellite of mass m from the surface of earth of mass M and radius R in a circular orbit at an altitude of 2R from the surface of the earth is:

(A) $\frac{GmM}{2R}$ (B) $\frac{GmM}{3R}$
(C) $\frac{5\,GmM}{6R}$ (D) $\frac{2\,GmM}{3R}$

Mechanical Properties of Solids

17. A metallic bar of Young's modulus, 0.5×10^{11} Nm^{-2} and coefficient of linear thermal expansion 10^{-5} $°C^{-1}$, length 1 m and area of cross-section 10^{-3} m^2 is heated from 0°C to 100°C without expansion or bending. The compressive force developed in it is:

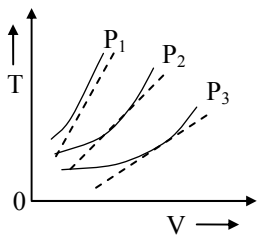
(A) 100×10^3 N (B) 2×10^3 N
(C) 5×10^3 N (D) 50×10^3 N

Thermodynamics

18. The following graph represents the T-V curves of an ideal gas (where T is the temperature and V the volume) at three pressures P_1, P_2 and P_3 compared with those of Charles' law represented as dotted lines.

Then the correct relation is:

(A) $P_2 > P_1 > P_3$
(B) $P_1 > P_2 > P_3$
(C) $P_3 > P_2 > P_1$
(D) $P_1 > P_3 > P_2$



Oscillations

19. If the mass of the bob in a simple pendulum is increased to thrice its original mass and its length is made half its original length, then the new time period of oscillation is $\frac{x}{2}$ times its original time period. Then the value of x is:

(A) $2\sqrt{3}$ (B) 4 (C) $\sqrt{3}$ (D) $\sqrt{2}$

Answer Key

1.	(C)	2.	(D)	3.	(B)	4.	(A)
5.	(C)	6.	(D)	7.	(D)	8.	(C)
9.	(B)	10.	(C)	11.	(C)	12.	(C)
13.	(D)	14.	(D)	15.	(A)	16.	(C)
17.	(D)	18.	(B)	19.	(D)		

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