National Medical Commission
All India Medical Entrance Examination

NEET
PHYSICS
Objective
Chapterwise Solved Papers
Based on NMC Reduced & Updated Syllabus

Chief Editor
A.K. Mahajan

Compiled and Edited by
Subject Expert Group

Computer Graphics by
Balkrishna, Charan Singh

Editorial Office
12, Church Lane Prayagraj-211002
Mob. : 9415650134
Email : yctap12@gmail.com
website : www.yctbooks.com / www.yctfastbook.com

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CONTENT

NEET Updated (Reduced) Syllabus as per National Medical Commission (Undergraduate Medical Education Board)

UNIT 1. PHYSICS AND MEASUREMENT:

Units of measurements, System of Units and S I Units, Fundamental and derived units, Significant figures, Errors in measurements, Dimensions of physical quantities, Dimensional analysis and its applications.

UNIT 2. KINEMATICS:

The frame of reference, Motion in a straight line, Uniform and non-uniform motion, Average speed and instantaneous velocity, Velocity-time and Position-time graph, Relations for uniformly accelerated motion, Scalars and Vectors (Addition, subtraction and products), Unit Vector and Resolution of a Vector Relative Velocity, Motion in a plane, Projectile Motion

UNIT 3. LAWS OF MOTION:

Forces, Newton's First law of motion(inertia), Newton's Second Law of motion & Impulses, Newton's Third Law of motion, Law of conservation of linear momentum and its applications, Equilibrium of concurrent forces., Static and Kinetic friction, Laws of friction, Rolling friction, Centripetal force and its applications. Vehicle on level circular road, Vehicle on a banked road

UNIT 4. WORK, ENERGY, AND POWER:

Work done by a constant force and a variable force, Kinetic and potential energies, Power, Work-energy theorem, The potential energy of spring conservation of mechanical energy, Dynamics of uniform circular motion (Motion in a vertical circle), Elastic and inelastic collision in one and two dimensions.

UNIT 5. ROTATIONAL MOTION:

Centre of mass of a two-particle system & of a rigid body, Basic concepts of rotational motion, Moment of a force: Torque, Conservation of angular momentum and its applications, The moment of inertia and radius of gyration & their applications., Equilibrium of rigid bodies, Rigid body rotation and equations of rotational motion.

UNIT 6. GRAVITATION:

The universal law of gravitation, Acceleration due to gravity and its variation with altitude and depth, Kepler's law of planetary motion, Gravitational potential energy, Orbital velocity, Escape velocity, Time period and energy of satellite

UNIT 7. PROPERTIES OF SOLIDS AND LIQUIDS:

Elastic behaviour, Stress-strain relationship & Hooke's Law , Young's modulus, Bulk modulus & Modulus of rigidity , Pressure due to a fluid column, Pascal's law and its applications, Effect of gravity on fluid pressure, Viscosity. Stokes' law & Terminal velocity, Streamline flow, turbulent flow and Critical velocity, Bernoulli's principle and its applications, Surface energy, surface tension & its applications (drops, Bubbles, and capillary rise), Excess of pressure across a curved surface, Heat temperature thermal expansion, specific heat, calorimetry, change of state latent heat, Heat transfer-Conduction, Convection and Radiation

UNIT 8. THERMODYNAMICS:

Thermal equilibrium, Zeroth law and Concept of temperature

Heat, work and internal energy

First law of thermodynamics

Isothermal and adiabatic processes

Second law of thermodynamics: Reversible and irreversible processes

UNIT 9. KINETIC THEORY OF GASES:

Equation of state of a perfect gas, Work done on compressing a gas, Kinetic theory of gases-assumptions The concept of pressure, Kinetic interpretation of temperature, RMS speed of gas molecules, Law of equipartition of energy and applications to specific heat capacities of gases, Mean free path.

UNIT 10. OSCILLATIONS AND WAVES:

Oscillation and periodic motion- time period, Frequency, Displacement as a function of time, Periodic functions, Simple harmonic motion and its equation, energy in S.H.M.-Kinetic and potential energies, Phase: oscillations of a spring – restoring force and force constant, Simple pendulum-derivation of expression for its time period, Wave motion, Longitudinal and transverse waves, Speed of travelling wave Displacement relation for a progressive wave, Principle of superposition of waves and Reflection of waves, Standing waves in strings and organ pipes, Fundamental modes and harmonics (Beats).

UNIT 11. ELECTROSTATICS:

Conservation of charge, Coulomb's law forces between two point charges, Forces between multiple charges, Superposition principle and continuous charge distribution, Electric field: Electric field due to a point charge, Electric field lines, Electric dipole, Electric field due to a dipole, Torque on a dipole in a uniform electric field, Electric flux, Gauss's law and its applications (straight wire, infinite plane sheet, thin spherical shell), Electric potential and its calculation for a point charge, Potential difference, Equipotential surfaces, Conductors and insulators, Capacitors and capacitances.

UNIT 12. CURRENT ELECTRICITY:

Electric current, Drift velocity, Mobility and their relation with electric current, Ohm's law, Electrical resistance,V-I characteristics of Ohmic and non-ohmic conductors, Electrical energy and power, Electrical resistivity and conductivity, Series and parallel combinations of resistors, Temperature dependence of resistance, Internal resistance, Potential difference and emf of a cell, and combination of cells, Kirchhoff's laws and their applications, Wheatstone bridge, Metre Bridge.

UNIT 13. MAGNETIC EFFECTS OF CURRENT AND MAGNETISM:

Biot- Savart law , Ampere's law , Force on a moving charge and current-carrying conductor in a uniform magnetic field , Torque experienced by a current loop in a uniform magnetic field(Moving coil galvanometer and , Its sensitivity) and conversion to ammeter and voltmeter, Current loop as a magnetic dipole and its magnetic dipole moment, Bar magnet, Magnetic field due to a magnetic dipole (bar magnet), Torque on a magnetic dipole, Para-dia-and ferromagnetic substances with examples, Effect of temperature on magnetic properties.

UNIT 14. ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENTS:

Electromagnetic induction, Faraday's law, Induced emf and current: Lenz's Law, Eddy currents, Self and mutual inductance, Alternating currents, Peak and RMS value of alternating current/voltage, LCR series circuit: Reactance and Impedance, Resonance: power in AC circuits, wattless current, AC generator and transformer.

UNIT 15. ELECTROMAGNETIC WAVES:

Displacement current, Electromagnetic waves and their characteristics, Transverse nature of electromagnetic waves, Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, X-rays, Gamma rays), Applications of e.m. waves.

UNIT 16. OPTICS:

Reflection of light: Spherical mirrors, Mirror formula, Refraction of light at plane and spherical surfaces & through a prism, Thin lens formula, lens maker formula & Combination of thin lenses in contact, Total internal reflection and its applications, Magnification & Power of a Lens, Microscope and Astronomical Telescope (reflecting and refracting) and their magnifying powers, Wave optics: Wavefront and Huygens' principle, Interference and diffraction of light, Polarization, Plane-polarized light, Brewster's law, Uses of plane-polarized light and Polaroid.

UNIT 17.DUAL NATURE OF MATTER AND RADIATION:

Dual nature of radiation, Photoelectric effect, Hertz and Lenard's observations, Particle nature of light
De Broglie relation.

UNIT 18.ATOMS AND NUCLEI:

Rutherford's model of atom, Bohr model, Energy levels, hydrogen spectrum, Composition and size of nucleus, Atomic masses, Mass-energy relation, Mass defect; binding energy per nucleon and its variation with mass number, Nuclear fission and fusion.

UNIT 19. ELECTRONIC DEVICES:

Semiconductors, Semiconductor diode: I-V characteristics in forward and reverse bias, Diode as a rectifier; I-V characteristics of LED, The photodiode & Solar cell, Zener diode: Zener diode as a voltage regulator, Logic gates (OR, AND, NOT, NAND and NOR).

UNIT 20. EXPERIMENTAL SKILLS:

Familiarity with the basic approach and observation of the experiments and activities:

1. Vernier calipers-its use to measure the internal and external diameter and depth of a vessel 2. Screw gauge-its use to determine thickness/diameter of thin sheet/wire, 3. Simple Pendulum-dissipation of energy by plotting a graph between the square of amplitude and time, 4. Metre Scale- the mass of a given object by the principal of moments, 5. Young's modulus of elasticity of the material of a metallic wire

6. Surf ace tension of water by capillary rise and effect of detergents, 7. Co-efficient of Viscosity of a given viscous liquid by measuring terminal velocity of a given spherical body, 8. Speed of sound in air at room temperature using a resonance tube, 9. Specific heat capacity of a given (i) solid and (ii) liquid by method of mixtures, 10. The resistivity of the material of a given wire using a meter bridge, 11. The resistance of a given wire using Ohm's law, 12. Resistance and figure of merit of a galvanometer by half deflection method, 13. The focal length of:

(i) Convex mirror

(ii) Concave mirror, and

(iii) Convex lens, using the parallax method

14. The plot of the angle of deviation vs angle of incidence for a triangular prism

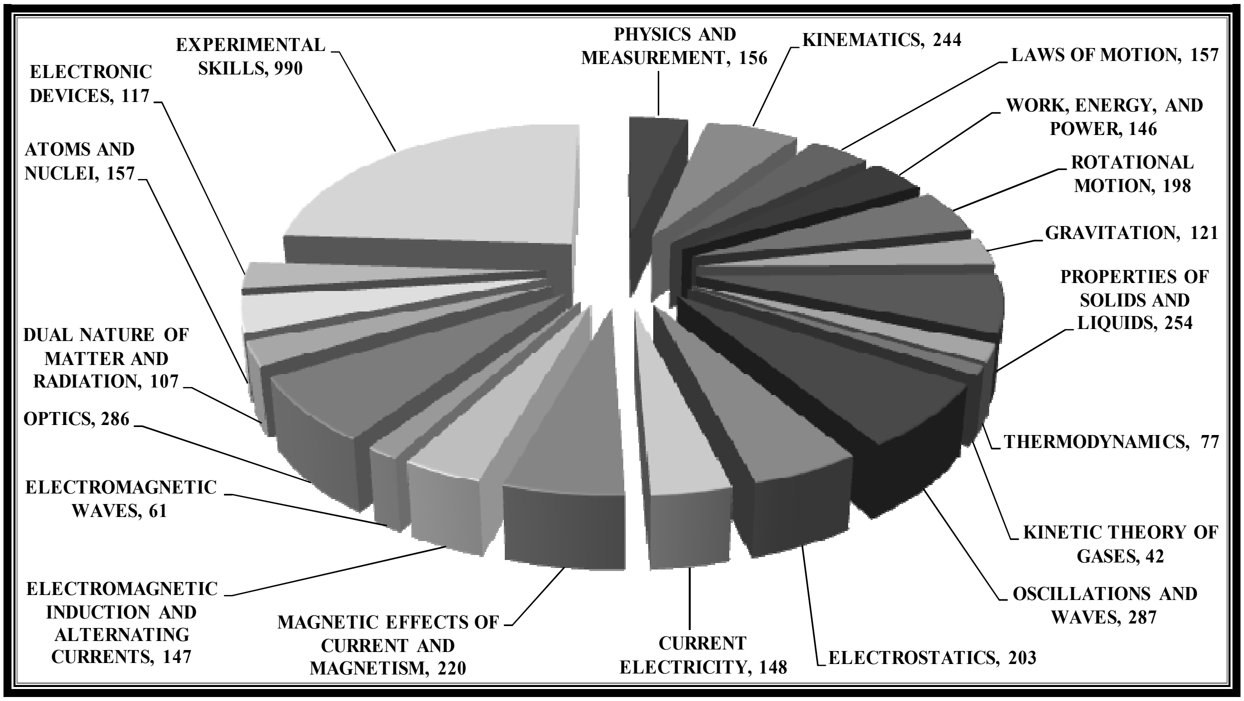
All India Medical Entrance Exam Physics Previous Years Exam Papers Analysis Chart

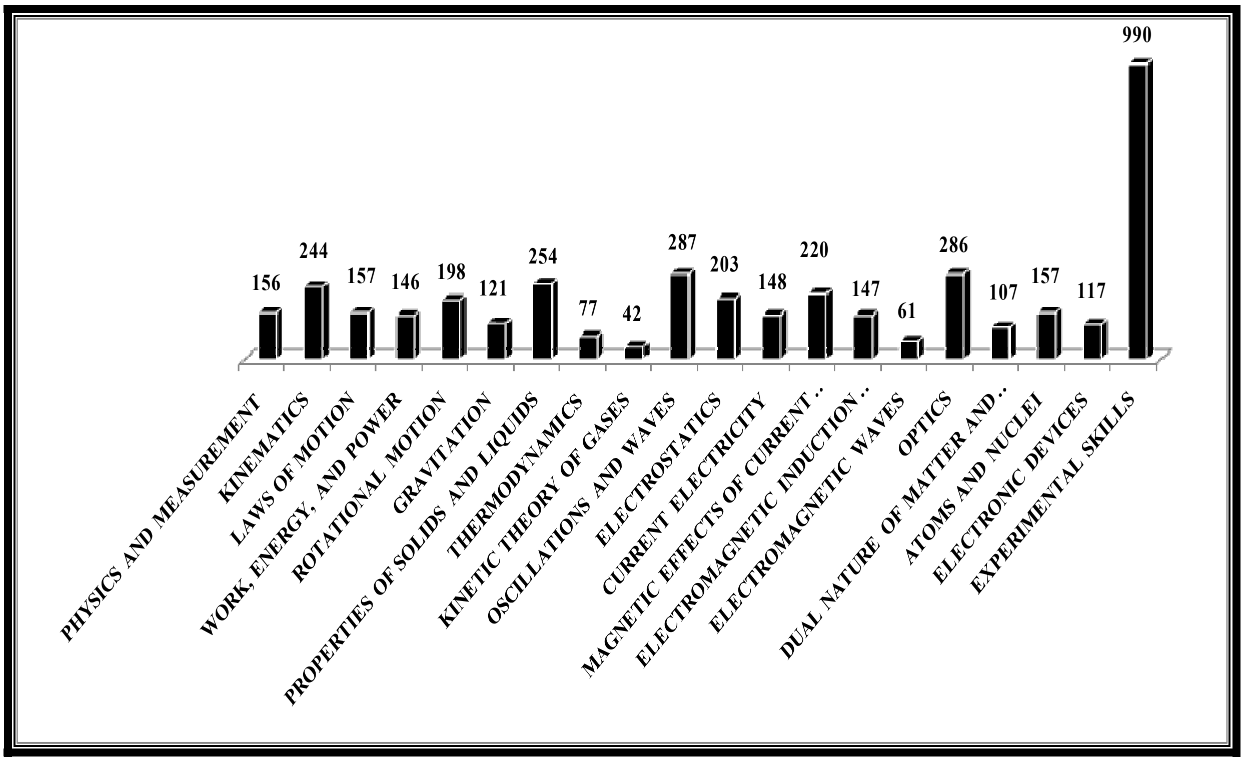
S. No	Exam	Proposed Year	Question Paper	Total Question
All India Pre Medical Test/National Eligibility Cum Entrance Test (AIPMT/NEET)				
1.	RE-NEET - Manipur	06.06.2023		50
2.	NEET (UG)	07.05.2023		50
3.	NEET	17.07.2022		50
4.	NEET	12.09.2021		50
5.	NEET	13.09.2020		50
6.	NEET	05.06.2019		50
7.	NEET	06.05.2018		50
8.	NEET	07.05.2017		50
9.	NEET	01.05.2016	Phase-I	50
10.	NEET	24.06.2016	Phase-II	50
11.	NEET/AIPMT	25.07.2015		50
12.	NEET	04.05.2014		50
13.	NEET	05.05.2013		50
14.	AIPMT	2012		50
15.	AIPMT	2011		50
16.	AIPMT	2010		50
17.	AIPMT	2009		50
18.	AIPMT	2008		50
19.	AIPMT	2007		50
20.	AIPMT	2006		50
21.	AIPMT	2005		50
22.	AIPMT	2004		50
23.	AIPMT	2003		50
24.	AIPMT	2002		50
25.	AIPMT	2001		50
26.	AIPMT	2000		50
27.	AIPMT	1999, 98, 97, 96, 95, 94, 93, 92, 91, 90, 89, 88		600
All India Institute of Medical Sciences (AIIMS)				
28.	AIIMS	26.05.2019	Shift-I	60
29.	AIIMS	26.05.2019	Shift-II	60
30.	AIIMS	25.05.2019	Shift-I	60
31.	AIIMS	25.05.2019	Shift-II	60
32.	AIIMS	2018		60
33.	AIIMS	2017		60
34.	AIIMS	2016		60
35.	AIIMS	2015		60
36.	AIIMS	2014		60
37.	AIIMS	2013		60
38.	AIIMS	2012		60
39.	AIIMS	2011		60
40.	AIIMS	2010		60
41.	AIIMS	2009		60
42.	AIIMS	2008		60
43.	AIIMS	2007		60
44.	AIIMS	2006		60
45.	AIIMS	2005		60
46.	AIIMS	2004		60
47.	AIIMS	2003		60
48.	AIIMS	2002		60
49.	AIIMS	2001		60
50.	AIIMS	2000		60
51.	AIIMS	1999, 98, 97, 96, 94		300

Andhra Pradesh Engineering, Agriculture and Medical Common Entrance Test (AP EAMCET)				
52.	AP EAMCET Medical	2013		50
53.	AP EAMCET Medical	2012		50
54.	AP EAMCET Medical	2010		40
55.	AP EAMCET Medical	2009		40
56.	AP EAMCET Medical	2008		40
57.	AP EAMCET Medical	2007		40
58.	AP EAMCET Medical	2006		40
59.	AP EAMCET Medical	2004		40
60.	AP EAMCET Medical	2003		50
61.	AP EAMCET Medical	2002		40
62.	AP EAMCET Medical	2001		40
63.	AP EAMCET Medical	1999		40
64.	AP EAMCET Medical	1998		50
65.	AP EAMCET Medical	1997		50
Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER)				
66.	JIPMER	2019		60
67.	JIPMER	2018		60
68.	JIPMER	2017		60
69.	JIPMER	2016		60
70.	JIPMER	2015		60
71.	JIPMER	2014		60
72.	JIPMER	2013		60
73.	JIPMER	2012		60
74.	JIPMER	2011		60
75.	JIPMER	2010		60
76.	JIPMER	2009		60
77.	JIPMER	2008		60
78.	JIPMER	2007		60
79.	JIPMER	2006		60
80.	JIPMER	2005		60
81.	JIPMER	2004		60
Uttar Pradesh Combined Pre Medical Test (UPCPMT)				
82.	UPCPMT	2014		50
83.	UPCPMT	2013		50
84.	UPCPMT	2012		50
85.	UPCPMT	2011		50
86.	UPCPMT	2010		50
87.	UPCPMT	2009		50
88.	UPCPMT	2008		50
89.	UPCPMT	2007		50
90.	UPCPMT	2006		50
91.	UPCPMT	2005		50
92.	UPCPMT	2004		50
93.	UPCPMT	2003		50
94.	UPCPMT	2002		50
95.	UPCPMT	2001		50
			Total	**5850**

Note : After detailed analysis of above mentioned papers of **NEET** and Other Medical Entrance Examination Related to **Physics** 5850 have been presented Chapterwise. Questions of repeated and similar nature have included so that the technique of asking question can benefit the competitors.

Trend Analysis of All Medical Entrance Exam Physics Questions through Pie Chart & Bar Graph





01.

Physics and Measurement

1.1 Units of measurements, System of Units and S I Units, Fundamental and derived units,

1. The S. I. unit of thermal conductivity is

(a) $J\ S\ m^{-1}\ K^{-1}$ (b) $W^{-1}\ m^{-1}\ K^{-1}$
(c) $W\ m^{-1}\ K^{-1}$ (d) $W\ m^{-2}\ K^{-1}$

NEET (National) 2019

Ans. (c) : The unit of thermal conductivity $(k) = \frac{QL}{A\Delta T}$

Unit of $k = \frac{M}{M^2 \times K} \times \text{watt}$

$k = Wm^{-1}K^{-1}$

2. "Parsec" is the unit of:

(a) time (b) distance
(c) frequency (d) angular acceleration

AIIMS-2005

Ans. (b) : Parsec is an astronomical unit of length equal to the distance at which a baseline of one astronomical unit subtends an angle of one second of arc.

1 Parsec = 3.08×10^{16} m
= 3.26 light year

3. If e is the charge, V the potential difference, T the temperature, then the units of $\frac{eV}{T}$ are the same as that of

(a) Planck's constant
(b) Stefan's constant
(c) Boltzmann's constant
(d) Gravitational constant

AIIMS-2016

Ans. (c) :

$\because \frac{eV}{T} = \frac{\text{Work done(W)}}{T}$

$= \frac{PV}{T} \qquad \left(\because PV = \frac{RT}{N}\right)$

$= \frac{R}{N} = K = \text{Boltzmann constant}$

4. Unit of electrical conductivity is

(a) ohm (b) siemen
(c) m/mho (d) mho/m

UP CPMT-2010

Ans. (d) : Resistivity and conductivity are interrelated Conductivity is the inverse of resistivity. According to this is easy to express one in terms of the other.

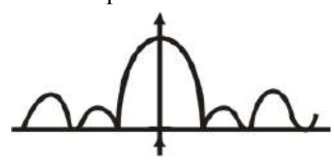
$\sigma = \frac{1}{\rho}$ unit mho/m or siemen/m

5. SI unit of intensity of wave is

(a) $J\ m^{-2}s^{-1}$ (b) $J\ m^{-1}s^{-2}$
(c) $W\ m^{-2}$ (d) $J\ m^{-2}$

UP CPMT-2012

Ans. (a,c) : The intensity of waves is defined as the power delivered per Unit area.



center of pattern

Intensity of wave = $\frac{\text{energy}}{\text{Area} \times \text{Time}}$

$= \frac{J}{m^2 \times S} = Wm^{-2}$

$\therefore$ The S.I Unit of intensity of wave is Wm^{-2}.

6. The unit of permittivity of free space, ε_0 is

(a) coulomb/newton-metre
(b) newton-metre^2/coulomb^2
(c) coulomb^2/newton-metre^2
(d) coulomb^2/(newton-metre)^2

AIPMT 2004

Ans. (c) : Coulomb law state that.

$F = \frac{1}{4\pi\varepsilon_0} . \frac{q_1.q_2}{r^2}$

$\varepsilon_0 = \frac{q_1.q_2}{4\pi F.r^2}$

When, unit of F =N
Unit of r = m
Unit of q = Coulomb (c)

$\varepsilon_0 = \frac{\text{Coulomb} \times \text{Coulomb}}{\text{newton} - (\text{metre})^2}$

$\varepsilon_0 = \frac{C.C}{N.m^2} = \text{Coulomb}^2 / \text{newton} - \text{metre}^2$

7. The unit of specific resistance is

(a) ohm/m^2 (b) ohm/m^3
(c) ohm m (d) ohm/m

UPCPMT-1975

Ans. (c) : We know that,

$$R = \rho \frac{l}{A}$$

ρ = specific resistance

$$\rho = \frac{RA}{l}$$

$$\rho = \frac{\text{ohm - m}^2}{\text{m}}$$

Unit of ρ = ohm − m

8. What is the SI unit of Stefan- Boltzmann′s constant σ ?

(a) $W\,m^{-2}\,K^{-4}$ (b) $W\,m^2\,K^4$

(c) $W\,K^{-4}$ (d) $erg\,s^{-2}\,K^{-4}$

AIPMT-2002,

Ans.(a): According to stefan's law, energy per unit time

$(E/t) = \sigma A T^4$

$$\sigma = \frac{E/t}{AT^4}$$

$$\sigma = \frac{W}{m^2K^4}$$

$= Wm^{-2}K^{-4}$

The SI unit of Stefan's constant = $W.m^{-2}.K^{-4}$ and CGS unit is = $Erg.cm^2$

9. Unit of Magnetic Flux is:

(a) Tesla (b) Gauss

(c) Weber (d) Weber/m^2

AIIMS-26.05.2019(E) Shift-2

Ans. (c) : The SI unit of magnetic flux is weber (Wb). Weber is commonly expressed in a multitude of other units.

$$Wb = \frac{kg.m^2}{s^2.A} = V.s = H.A = T.m^2 = \frac{J}{A} = 10^8 mx$$

where,

Wb = Weber s = second

T = Tesla H = Henry

V = volt A = Ampere

J = joule Mx = Maxwell

10. The correct unit of thermal conductivity is

(a) $Jm^{-2}\,sec^{-1}(°C)^{-1}$ (b) $Jm^{-1}\,sec^{-1}(°C)^{-2}$

(c) J-sec (d) $Jm^{-1}\,sec^{-1}(°C)^{-1}$

AIIMS-27.05.2018(E)

Ans. (d): The thermal conductivity of a material is a measure of its ability to conduct heat.

Thermal conductivity (K) = $\frac{QL}{A.\Delta T}$

Where,

Q = Heat transfer through the material

L = Length

A = Area

ΔT = Temperature difference

So,

The unit of thermal conductivity = $\frac{Js^{-1} \times m}{m^2 \times °C}$

$= Js^{-1}m^{-1}°C^{-1}$

11. The unit of viscosity in the CGS system is poise (P) and that in SI Poiseuille (PI). Which of the following statement is correct?

(a) 1 P = 1PI (b) 1P = 10PI

(c) 10P =1PI (d) Non of these

UP CPMT-2013

Ans. (c) : 1P = 1 gm $cm^{-1}\,S^{-1}$

∴ 1 PI = 10 g $cm^{-1}\,S^{-1}$

1PI = 10 P

1.2 Significant figures,

12. The diameter of a spherical bob, when measured with vernier calipers yielded the following values :3.33 cm, 3.32 cm, 3.34cm, 3.33cm, and 3.32 cm.
The mean diameter to appropriate significant figures is:

(a) 3.33cm (b) 3.32cm

(c) 3.328 (d) 3.3cm

RE-NEET (UG)-06.06.2023 (Manipur)

Ans. (a) :

Mean diameter = $\frac{3.33 + 3.32 + 3.34 + 3.33 + 3.32}{5}$

= 3.328 cm

Mean diameter = 3.33 cm

(by taking appropriate significant figure)

13. The number of significant figures in the quantity 5.6200 J is

(a) 3 (b) 5

(c) 2 (d) 4

AP EAMCET-11.07.2022, Shift-II

Ans. (b) : As we know zeroes only after a non-zero digit, after the decimal, and zeroes between any two non-zero digits are significant.
Therefore, the answer is 5.

14. What is the number of significant figures in $(3.20 + 4.80)\times10^5$

(a) 2 (b) 3

(c) 4 (d) 5

AP EAMCET-07.09.2021, Shift-I

Ans. (b) :3.20 has '3' significant figures 4. 80 has '3' significant figures. Therefore, there is 3 significant Figure's because 10^5 has no singeficant figures.

15. Taking into account of the significant figures, what is the value of 9.99 m − 0.0099 m?

(a) 9.98 m (b) 9.980 m

(c) 9.9 m (d) 9.9801 m

[NEET (Sep.) 2020]

Ans. (a) :

$$\begin{array}{r} 9.9900 \\ -\ 0.0099 \\ \hline 9.9801 \end{array}$$

Since least number of significant figure persent in given numbers in 2, hence,

$$9.99\text{m} - 0.0099\text{m} = 9.98\text{m}$$

16. **Assertion (A) :** The number 0.00764 has three significant figures.

Reason (R) : If the number is less than 1, the zeros on the right of the decimal point but to the left of the first non-zero digit are not significant.

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(c) (A) is true but (R) is false.
(d) (A) is false but (R) is true.

AP EAMCET (23.04.2019) Shift-I

Ans. (a) : For Assertion (A):-
No. of significant figure in 0.00764
= (7, 6, 4)
There are 3 significant figure in above number
For reason (R):-
Let a number is

$$0.\boxed{00}\,\text{abc}\boxed{00} \rightarrow \text{significant (Right zeros)}$$
$$\downarrow$$
$$\text{Non} - \text{significant (Left zeros)}$$

17. **Assertion: Number of significant figures in 0.005 is one and that in 0.500 is three**

Reason: This is because zeros are not significant.

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

AIIMS-25.05.2019(E) Shift-2

Ans. (c) : No. of significant in 0.005
= (digit 5)
= only 1 significant figure
No. of significant in 0.500
= (5, 0, 0)
= 3 significant figure
So, Zeroes placed to the left of the number are never significant, but zeroes places to right of the number are significant.
Hence, assertion is true but reason is false.

18. **Two intervals of time are measured as Δt_1= (2.00 ± 0.02) s and Δt_2= (4.00 ± 0.02)s. The value of with $\sqrt{(\Delta t_1)(\Delta t_2)}$ with correct significant figures and error is**

(a) (2.828 ± 0.01)s (b) (2.83 ± 0.02)s
(c) (2.828 ± 0.0075)s (d) (2.83 ± 0.0075)s

AP EAMCET (21.04.2019) Shift-I

Ans. (b) : Given,
$\Delta t_1 = (2.00 \pm 0.02)$ second Δt_1 = 2.00 second,
$\Delta te_1 = \pm 0.02$ second
$\Delta t_2 = (4.00 \pm 0.02)$ second Δt_2 = 4.00 second,
$\Delta te_2 = \pm 0.02$ second

$$\because T = \sqrt{\Delta t_1 \times \Delta t_2}$$
$$T = \sqrt{2.00 \times 4.00} = 2.8284$$
$$T = 2.838$$
$$\frac{\Delta T_e}{\Delta T} = \frac{1}{2}\left(\frac{\Delta te_1}{\Delta t_1} + \frac{\Delta te_2}{\Delta t_2}\right) = \pm\frac{1}{2}\left[\frac{0.02}{2.00} + \frac{0.02}{4.00}\right]$$
$$= \pm\frac{1}{2}[0.01 + 0.005]$$
$$\frac{\Delta T_e}{2.83} = \pm\frac{1}{2}(0.015)$$
$$\Delta T_e = 0.0212258 = 0.02$$
$$T = (2.83 \pm 0.02)\text{second}$$

19. **The length, breadth and thickness of a block are given by *l* = 12 cm, b = 6 cm and t = 2.45cm. The volume of the block according to the idea of significant figures should be**

(a) $1 \times 10^2 \text{cm}^3$ (b) $2 \times 10^2 \text{ cm}^3$
(c) $1.763 \times 10^2 \text{cm}^3$ (d) None of the above

JIPMER-2005
UPCPMT-2004

Ans. (b) : Given that,
l = 12 cm
b = 6 cm
t = 2.45 cm
Using the relation for volume
V = l × b × t
V = 12 × 6 × 2.45
V = 176.4
V = $1.764 \times 10^2 \text{ cm}^3$
The minimum number of significant figures is one in thickness, hence the volume will contain only one significant figure.
Therefore,
V = $2 \times 10^2 \text{ cm}^3$

20. **In a system of units, the units of mass, length and time are 1 quintal, 1 km and 1h respectively. In this system 1 N force will be equal to**

(a) 1 unit (b) 129.6 unit
(c) 125.7 unit (d) 10^3 unit

UP CPMT-2002

Ans. (b) : 1 kg = 10^{-2} quintal

$1\text{ m} = 10^{-3}\text{ km}$

$1\text{ s} = \frac{1}{3600}\text{ hour}$

$$1\text{ N} = \frac{\text{kg}\times\text{m}}{\text{s}^2} = \frac{10^{-2}\times10^{-3}}{\left(\frac{1}{3600}\right)^2}$$

$1\text{ N} = 10^{-5}\times3600\times3600$

1 N = 129.6 unit

Hence, unit in quintal, kilometer and hour is 129.6 unit.

21. Assertion: The number of significant figures depends on the least count of measuring instrument.
Reason: Significant figures define the accuracy of measuring instrument.
(a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

AIIMS-2016

Ans. (b) : Significant figure refers to the accuracy of measurement and accuracy of measurement also depend upon the least count of measuring instrument.

22. The length and breadth of a metal sheet are 3.124 m and 3.002 m respectively. The area of this sheet upto four correct significant figure is:
(a) 9.378 m^2 (b) 9.37 m^2
(c) 9.378248 m^2 (d) 9.3782 m^2

AIIMS-2001

Ans. (a) : Given, Length = 3.124 m
Breadth = 3.002 m
Area = L × B
$= 3.124\times3.002 = 9.378\text{ m}^2$

23. The number of significant figures in quantity 0.00005041 J is
(a) 9 (b) 4
(c) 3 (d) 10

AP EAMCET-07.07.2022, Shift-I

Ans. (b) : $0.00005041 = 5041\times10^{-8}$
Significant digit = 5041
Only 4 significant figures

24. If N_A, N_B and N_C are the number of significant figures in A = 0.001204 m, B = 43120000 m and C = 1.200 m respectively then
(a) $N_A = N_B = N_C$ (b) $N_A > N_B > N_C$
(c) $N_A < N_B < N_C$ (d) $N_A > N_B < N_C$

AP EAMCET-04.07.2022, Shift-I

Ans. (a) :
0.001204 contains 4 significant figure i.e. $N_A = 4$
43120000 contains 4 significant figure i.e. $N_B = 4$
1200 contains 4 significant figure i.e. $N_C = 4$
Hence, $N_A = N_B = N_C$

1.3 Errors in measurements

25. The errors in the measurement which arise due to unpredictable fluctuations in temperature and voltage supply are :
(a) Random errors
(b) Instrumental errors
(c) Personal errors
(d) Least count errors

NEET (UG)-07.05.2023

Ans. (a) : The error in the measurement which arise due to unpredictable fluctuations in the temperature in temperature and voltage supply are random error.

26. A metal wire has mass (0.4 ± 0.002)g, radius (0.3 ± 0.001) mm and length (5 ± 0.02) cm. The maximum possible percentage error in the measurement of density will nearly be:
(a) 1.4% (b) 1.2%
(c) 1.3% (d) 1.6%

NEET (UG)-07.05.2023

Ans. (d) : Given that : m = (0.4 ± 0.002) g
r = (0.3 ± 0.001) mm
l = (5 ± 0.02)cm

The volume of the wire is given by –
$V = \pi r^2 L$

The density of the wire is –

$$\rho = \frac{m}{\pi r^2 L}$$

$$\frac{\Delta\rho}{\rho}\times100 = \frac{\Delta m}{m}\times100 + 2\frac{\Delta r}{r}\times100 + \frac{\Delta L}{L}\times100$$

$$= \frac{0.002}{0.4}\times100 + 2\times\frac{0.001}{0.3}\times100 + \frac{0.02}{5}\times100$$

$$= \frac{2}{4}+\frac{2}{3}+\frac{2}{5}$$

$$= \frac{30+40+24}{60}$$

$$= \frac{94}{60}$$

$$\frac{\Delta\rho}{\rho}\times100 = 1.56\% = 1.6\%$$

27. What is the fractional error in g calculated from $T = 2\pi\sqrt{\ell/g}$? Given fraction errors in T and l are ± x and ± y respectively?
(a) x + y (b) x – y
(c) 2x + y (d) 2x – y

AIIMS-2012

Ans. (c) : $T = 2\pi\sqrt{\frac{l}{g}}$

Squaring both side

$$T^2 = \left(2\pi\sqrt{\frac{l}{g}}\right)^2$$

$$g = \frac{4\pi^2 l}{T^2}$$

$$g \propto \frac{l}{T^2}$$

taking log and differentiating

log g = log l – 2 log T

$$\frac{\Delta g}{g} = \frac{\Delta l}{l} - 2\frac{\Delta T}{T}$$

for maximum error is +ve sign

% Error, $\frac{\Delta g}{g} = \frac{\Delta l}{l} + \frac{2\Delta T}{T}$

$$\frac{\Delta g}{g} = y + 2x$$

28. The least count of a stop watch is 0.2 second. The time of 20 oscillations of a pendulum is measured to be 25 second. The percentage error in the measurement of time will be

(a) 8% (b) 1.8%

(c) 0.8% (d) 0.1%

AIIMS-2015

Ans. (c) : Given,

Least count of stop watch = [ΔT] = 0.2 sec

No. of Oscillation (n) = 20

Time taken = 25 sec

∴ Time Period of oscillation (T) = $\frac{25}{20}$

= 1.25 sec

% error = $\frac{\Delta T}{T \times n} \times 100 = \frac{0.2}{1.25 \times 20} \times 100$

= 0.8%

29. The heat generated in a circuit is given by Q = I^2 Rt, where I is current, R is resistance and t is time. If the percentage errors in measuring I, R and t is 2%, 1% and 1% respectively, then the maximum error in measuring heat will be

(a) 2% (b) 3%

(c) 4% (d) 6%

AIIMS-26.05.2018(M)

BITSAT-2020

Ans. (d) : Generated heat, $Q = I^2Rt$

taking log and differentiating

log Q = 2 log I + log R + log t

$$\frac{\Delta Q}{Q} = 2\frac{\Delta I}{I} + \frac{\Delta R}{R} + \frac{\Delta t}{t}$$

$$\frac{\Delta Q}{Q} \times 100 = \frac{2\Delta I}{I} \times 100 + \frac{\Delta R}{R} \times 100 + \frac{\Delta t}{t} \times 100$$

$$= 2 \times 2\% + 1\% + 1\% = 6\%$$

30. Assertion: The error in the measurement of radius of the sphere is 0.3%. The permissible error in its surface area is 0.6%

Reason: The permissible error is calculated by the formula $\frac{\Delta A}{A} = \frac{4\Delta r}{r}$

(a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

(c) If the Assertion is correct but Reason is incorrect.

(d) If both the Assertion and Reason are incorrect.

(e) If the Assertion is incorrect but the Reason is correct.

AIIMS-2008

Ans. (c) : We know that,

Area of sphere, A = $4\pi r^2$

taking log and differentiating

$$\frac{\Delta A}{A} = \frac{2\Delta r}{r}$$

$$\frac{\Delta A}{A} \times 100 = 2 \times 0.3\% = 0.6\%$$

The permissible error is not calculated by

$$\frac{\Delta A}{A} = \frac{4\Delta r}{r}$$

So, Reason is not correct.

31. Assertion: When percentage errors in the measurement of mass and velocity are 1% and 2% respectively, the percentage error in K.E. is 5%.

Reason: $\frac{\Delta E}{E} = \frac{\Delta m}{m} + \frac{2\Delta v}{v}$

(a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.

(c) If Assertion is correct but Reason is incorrect.

(d) If both the Assertion and Reason are incorrect.

AIIMS-2010

Ans. (a) : We know that,

Kinetic Energy, K.E $= \frac{1}{2}mv^2$

taking log and Differentiating of Both side

$$\frac{\triangle E}{E} = \frac{\triangle m}{m} + \frac{2\triangle v}{v}$$

$$\frac{\Delta E}{E} \times 100 = \frac{\Delta m}{m} \times 100 + 2\frac{\Delta V}{V} \times 100$$

$= 1\% + 2 \times 2\% = 5\%$

32. If the error in the measurement of momentum of a particle is (+100%), then the error in the measurement of kinetic energy is

(a) 25% (b) 200%
(c) 300% (d) 400%

UP CPMT-2014

Ans. (c) : We know that

Momentum (p) = mv

Kinetic energy (KE) = $\frac{1}{2}mv^2$

Then,

$$KE = \frac{p^2}{2m}$$

Given, $p_i = p$

$$p_f = p + \frac{p \times 100}{100} = 2p$$

Error,

$$\frac{KE_f - KE_i}{KE_i} \times 100 = \frac{p_f^2 - p_i^2}{p_i^2} \times 100$$

$$\text{Error} = \frac{(2p)^2 - p^2}{p^2} \times 100$$

= 3×100

=300%

33. A public park, in the form of a square, has an area of (100 ± 0.2)m². The side of park is

(a) (10 ± 0.01)m (b) (10 ± 0.1)m
(c) (10.0 ± 0. 1)m (d) (10.0 ± 0.2)m

UP CPMT-2014

Ans. (a) : Area = (100± 0.2)m²

So,

$100 = l^2$

10 m = l (length)

Now,

$$\frac{\Delta A}{A} = \frac{2\Delta l}{l}$$

$$\frac{0.2}{100} = 2 \times \frac{\Delta l}{10}$$

Δl = 0.01 m

So, length = (10± 0.01)m

34. The length of a pendulum is measured as 1.01 m and time for 30 oscillations is measured as one minute 3 s. Error length is 0.01 m and error in time is 3 s. The percentage error in the measurement of acceleration due to gravity is

(a) 1 (b) 5
(c) 10 (d) 15

AP EAMCET -2012

Ans. (c) : Given data,

T = 1 min 3 sec

= 60 + 3

= 63 sec

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$T^2 = 4\pi^2 \frac{l}{g} \Rightarrow g = \frac{4\pi^2 l}{T^2}$$

Error analysis,

$$\frac{\Delta g}{g} = \frac{\Delta l}{l} + 2\frac{\Delta T}{T}$$

$$\frac{\Delta g}{g} = \frac{0.01}{1.01} + 2 \times \frac{3}{63}$$

$$\frac{\Delta g}{g} = 0.0099 + 0.095$$

$$\frac{\Delta g}{g} \times 100 = [0.0099 + 0.095] \times 100$$

$= 0.1042 \times 100$

$= 10.4\% \approx 10\%$

35. The density of a cube is measured by measuring its mass and length of its sides. If the maximum error in the measurement of mass and length are 4% and 3% respectively, the maximum error in the measurement of density will be

(a) 7% (b) 9%
(c) 12% (d) 13%

[AIPMT 1996]

Ans. (d) : Given that,

% error in mass = 4%

% error in length = 3%

∵ Density D = $\frac{\text{mass}}{\text{volume}} = \frac{m}{L^3}$

∴ $$\frac{\Delta D}{D} \times 100 = \left(\frac{\Delta m}{m} \times 100\right) + 3\left(\frac{\Delta L}{L} \times 100\right)$$

= 1 × 4% + 3 × 3%

= 4% + 9%

max. error in measurement of density = 13%

36. The percentage errors in the measurement of mass and speed are 2% and 3% respectively. The error in kinetic energy obtained by measuring mass and speed, will be

(a) 12% (b) 10%
(c) 8% (d) 2%

[AIPMT 1995]

Ans. (c) : Given that,

% error in mass (m) = 2%

% error in speed (v) = 3%

$\because$ K.E. = $\frac{1}{2}mv^2$

taking log of both side

logE = 10g m + 2 log v

Differentiating of both side

$$\frac{\Delta E}{E} = \frac{\Delta M}{M} + \frac{\Delta V}{V}$$

$$= \left(\frac{\Delta m}{m}\times 100\right) + 2\left(\frac{\Delta v}{v}\times 100\right)$$

= 1×2% + 2 × 3%

= 2% + 6%

= 8%

37. In an experiment four quantities a, b, c and d are measured with percentage error 1%, 2%. 3% and 4% respectively. A quantity 'P' is calculated as $P = \frac{a^3b^2}{cd}$. Then the percentage error in 'P' is

(a) 14% (b) 10%

(c) 7% (d) 4%

AP EAMCET-28.04.2017, Shift-II

NEET- 2013

Ans. (a) : Given that,

Percentage change in, $a\left(\frac{\Delta a}{a}\times 100\right)$ =1%

Percentage change in, $b\left(\frac{\Delta b}{b}\times 100\right)$ = 2%

Percentage change in, $c\left(\frac{\Delta c}{c}\times 100\right)$ = 3%

Percentage change in, $d\left(\frac{\Delta d}{d}\times 100\right)$ = 4%

and $P = \frac{a^3b^2}{cd}$

Percentage change in P = ?

$$\frac{\Delta P}{P}\times 100 = 3\left(\frac{\Delta a}{a}\times 100\right) + 2\left(\frac{\Delta b}{b}\times 100\right) + \left(\frac{\Delta c}{c}\times 100\right) + \left(\frac{\Delta d}{d}\times 100\right)$$

= 3 × 1% + 2 × 2% + 1 × 3% + 1 × 4%

= 3% + 4% + 3% + 4%

$$\frac{\Delta P}{P}\times 100 = 14\%$$

Percentage change in P = 14%

38. In an experiment of simple pendulum, the errors in the measurement of length of the pendulum (L) and time period (T) are 3% and 2% respectively. The maximum percentage error in the value of $\frac{L}{T^2}$ is

(a) 5% (b) 7%

(c) 8% (d) 1%

AP EAMCET-2001

Ans. (b) : Given that,

Error in the measurement of length, $\frac{\Delta L}{L} = 3\%$

Error in the measurement of time, $\frac{\Delta T}{T} = 2\%$

Let $\frac{L}{T^2} = x$

So, the fractional error in the measurement of x

$$\frac{\Delta x}{x}\times 100 = \frac{\Delta L}{L}\times 100 + \frac{2\Delta T}{T}\times 100$$

= 3 + 2 (2) = 3 + 4 = 7%

Hence, the maximum percentage error in the value of $\frac{L}{T^2}$ is 7%.

39. A clock with an iron pendulum keeps correct time at 15^0C. If room temperature rises to 20^0C, the error in seconds per day will be : (coefficient of linear expansion of iron is $00.000012/^0C$)

(a) 2.5 s (b) 2.6 s

(c) 2.4 s (d) 2.2 s

AP EAMCET(Medical)-1997

Ans. (b) : Given that,

t_1 = 15°C

t_2 = 20°C

$\alpha = 00.000012/^0C = 12 \times 10^{-6}/°C$

Loss or gain time per day

$$= \frac{1}{2}\times \alpha\Delta T \times 24 \times 60 \times 60$$

$$= \frac{1}{2}\times 12 \times 10^{-6} \times 5 \times 24 \times 60 \times 60$$

= 2.592

$\simeq$ 2.6 sec

40. Dimensional formula of a physical quantity X is $[M^{-1}L^3T^{-2}]$ the errors is measuring the quantities M,L and T respectively are 2%,3% and 4%, The maximum percentage of error that occurs in measuring the quantity X is:

(a) 9 (b) 10

(c) 14 (d) 19

AP EAMCET(Medical)-2002

Ans. (d) : Given that,

$X = [M^{-1}L^3T^{-2}]$

$$\frac{\Delta X}{X}\times 100 = \frac{\Delta M}{M}\times 100 + 3\frac{\Delta L}{L}\times 100 + 2\frac{\Delta T}{T}\times 100$$

= 2% + 3 × 3% + 2 × 4%

= 2% + 9% + 8%

= 19%

The maximum percentage of error occur in measuring is 19%.

41. While measuring acceleration due to gravity by a simple pendulum, a student makes a positive error of 2% in the length of the pendulum and a positive error of 1% in the value of time period, this actual percentage error in the measurement of the value of g will be

(a) 5% (b) 4%
(c) 3% (d) 0%

AP EMCET(Medical)-2011

Ans. (d) : Given that

$$\frac{\Delta l}{l} \times 100 = +2\%$$

$$\frac{\Delta T}{T} \times 100 = +1\%$$

$$g = \frac{4\pi^2 l}{T^2}$$

$$\frac{\Delta g}{g}\times 100 = \frac{\Delta l}{l}\times 100 + (-2)\frac{\Delta T}{T}\times 100$$

$$\frac{\Delta g}{g}\times 100 = 2\% + (-2)\times(1)\%$$

$$\frac{\Delta g}{g}\times 100 = 2\% - 2\%$$

$$\frac{\Delta g}{g}\times 100 = 0\%$$

42. If the absolute errors in two physical quantities A and B are a and b respectively, then the absolute error in the value of A – B is

(a) a – b (b) b – a
(c) a = b (d) a + b

AP EAMCET(Medical)-2014

Ans. (d) : Absolute error in the given value,

$X = A - B$
$\Delta A = a$
$\Delta B = b$
$\Delta X = \Delta A + \Delta B$
$\Delta X = a + b$

Where a and b are absolute errors in the quantity A and B respectively.

43. Assertion: In the measurement of physical quantities direct and indirect methods are used.
Reason: The accuracy and precision of measuring instruments along with errors in measurements should be taken into account, while expressing the result.

(a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

AIIMS-2017

Ans. (a) : Both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

44. R = 65± 1Ω L, *l* = 5 ± 0.1 mm and d = 10 ± 0.5 mm. Find error I calculation of resistivity.

(a) 21% (b) 13%
(c) 16% (d) 41%

JIPMER-2018

Ans. (b) : Given that,

R = 65 ± 1 Ω, l = 5 ±0.1 mm, d = 10 ± 0.5

Since we know that

$$R = \rho\frac{l}{A}$$

$$\rho = \frac{RA}{l}$$

$$\rho = R\frac{\pi d^2}{4l}$$

So, error in resistivity, $\frac{\Delta\rho}{\rho} = \frac{\Delta R}{R} \pm \frac{2\Delta d}{d} \pm \frac{\Delta l}{l}$

$$\frac{\Delta\rho}{\rho} = \frac{1}{65} + \frac{2\times(0.5)}{10} + \frac{(0.1)}{5}$$

$$\frac{\Delta\rho}{\rho} = 0.015 + 0.1 + 0.02$$

$$\frac{\Delta\rho}{\rho} = 0.015 + 0.1 + 0.02$$

$$\frac{\Delta\rho}{\rho} = 0.135$$

$$\frac{\Delta\rho}{\rho}\times 100\% = 0.135\times 100$$

$$\boxed{\frac{\Delta\rho}{\rho}\times 100\% = 13.5\%}$$

45. The velocity of projection of a body is increased by 2%. Other factors remaining unchanged, what will be the percentage change in the maximum height attained?

(a) 1% (b) 2%
(c) 4% (d) 8%

AIIMS-25.05.2019(E) Shift-2

Ans. (c) : Height of projection

$$H = \frac{u^2\sin^2\theta}{2g} \Rightarrow H \propto u^2, \left(\frac{\sin^2\theta}{2g}\right) = \text{constant}$$

taking log and differentiating

log H = 2 log 4

$$\frac{\Delta H}{H} = 2\frac{\Delta u}{u}$$

$$\frac{\Delta H}{H} = 2\frac{\Delta u}{u} \Rightarrow \frac{\Delta H}{H}\times 100 = 2\frac{\Delta u}{u}\times 100$$

$$= 2(2\%) = 4\%$$

46. If 1% and 2% are the errors in the measurement of mass and density of a cube respectively, then the error in the measurement of length is

(a) 1% (b) 3%
(c) 2% (d) 4%

AP EAMCET (22.04.2019) Shift-I

Ans. (a) : Volume of cube, $V = a^3$
Where, a = side of cube

Density of cube is given as $\rho = \frac{m}{V}$

$$\because V = a^3$$
$$\therefore \rho = \frac{m}{a^3}$$
$$a^3 = \frac{m}{\rho}$$
$$a = \left(\frac{m}{\rho}\right)^{1/3}$$

So, percentage error in measurement of length of a cube is given as–

$$\left(\frac{\Delta a}{a}\times 100\right)\% = \frac{1}{3}\left[\left(\frac{\Delta m}{m}\times 100\right)\% + \left(\frac{\Delta\rho}{\rho}\times 100\right)\%\right]$$

$$\because \left(\frac{\Delta m}{m}\times 100\right)\% = 1\%, \quad \left(\frac{\Delta \rho}{\rho}\times 100\right)\% = 2\%$$

$$\therefore \left(\frac{\Delta a}{a}\times 100\right)\% = \frac{1}{3}[1\% + 2\%]$$
$$\left(\frac{\Delta a}{a}\times 100\right)\% = \frac{1}{3}\times 3\% = 1\%$$
$$\boxed{\left(\frac{\Delta a}{a}\times 100\right)\% = 1\%}$$

47. The sides of a rectangular plate are (9.0 ± 0.3) cm and (3.0 ± 0.1) cm. The area of the plate with error limits is

(a) $(27.0 \pm 0.1)\text{cm}^2$ (b) $(27.0 \pm 0.3)\text{cm}^2$
(c) $(27.0 \pm 1.8)\text{cm}^2$ (d) $(27.0 \pm 0.2)\text{cm}^2$

AP EAMCET-24.04.2019, Shift-II

Ans. (c) : Given that,
Length (l) = (9.0 ± 0.3)
Breadth (d) = (3.0 ± 0.1)
Area (A) = l × b = 9 × 3 = 27 cm^2
Percentage error of Area

$$\frac{\Delta A}{A} = \frac{\Delta l}{l} + \frac{\Delta b}{b}$$
$$\frac{\Delta A}{A} = \left(\frac{0.3}{9.0} + \frac{0.1}{3.0}\right) = \frac{1.8}{27.0}$$
$$\Delta A = \frac{1.8}{27.0}\times A$$
$$\Delta A = \frac{1.8}{27.0}\times A$$
$$\Delta A = \frac{1.8}{27.0}\times 27.0$$
$$\Delta A = 1.8$$

So, Area = (27.0 ± 1.8)cm^2

48. To estimate g from $g = 4\pi^2 \frac{L}{T^2}$, error in measurement of L is ±2% and error in measurement of T is ±3%. The error in estimated g will be

(a) ±8% (b) ±5%
(c) ±3% (d) ±6%

AP EAMCET (18.09.2020) Shift-II

Ans. (a) : Given, $g = \frac{4\pi^2 L}{T^2}$
The percentage error in measurement of 'g' is given as–

$$\left(\frac{\Delta g}{g}\times 100\right)\% = \left(\frac{\Delta L}{L}\times 100\right)\% + 2\times\left(\frac{\Delta T}{T}\times 100\right)\%$$

$$\because \left(\frac{\Delta L}{L}\times 100\right)\% = \pm 2\%, \quad \left(\frac{\Delta T}{T}\times 100\right)\% = \pm 3\%$$

$$\therefore \left(\frac{\Delta g}{g}\times 100\right)\% = \pm 2\% + 2\times(\pm 3\%)$$
$$\left(\frac{\Delta g}{g}\times 100\right)\% = 2\% + 6\%$$
$$\boxed{\left(\frac{\Delta g}{g}\times 100\right)\% = \pm 8\%}$$

49. Time intervals measured by a clock give the following readings 1.25 s, 1.24 s, 1.27 s, 1.21 s and 1.28 s. What is the percentage relative error of the observations?

(a) 2% (b) 4%
(c) 16% (d) 1.6%

[NEET (Oct.) 2020]

Ans. (d) : Error = Reading value – mean value

$$\text{Mean value} = \frac{\text{Sum of observation}}{\text{No. of observation}}$$
$$= \frac{1.25+1.24+1.27+1.21+1.28}{5}$$
$$= \frac{6.25}{5}$$
$$= 1.25 \text{ sec}$$

Error in each reading, $E_1 = 1.25 - 1.25 = 0$

$E_2 = 1.24 - 1.25 = -0.01$

$E_3 = 1.27 - 1.25 = 0.02$

$E_4 = 1.21 - 1.25 = -0.04$

$E_5 = 1.28 - 1.25 = 0.03$

Relative error = $\frac{\text{Sum of absolute error}}{\text{Mean value} \times 5}$

$= \frac{|E_1|+|E_2|+|E_3|+|E_4|+|E_5|}{1.25\times5}\times100\%$

$= \frac{0+0.01+0.02+0.04+0.03}{1.25\times5}\times100\%$

$= \frac{0.1}{1.25\times5}\times100\%$

$= 1.6\%$

50. When two resistors of resistances $R_1 = (200 \pm 2)$ Ω and $R_2 = (400 \pm 4)$ Ω are connected in series, the equivalent resistance of the combination is ______

(a) (800 ± 7) Ω (b) (600 ± 2) Ω
(c) (600 ± 6) Ω (d) (200 ± 2) Ω

AP EAMCET-25.08.2021, Shift-I

Ans. (c) : Given that,
Resistances $R_1 = (200\pm2)\Omega$, $R_2=(400\pm4)\Omega$
When two resistances connected in series then equivalent resistance is-
$R = R_1 + R_2$
$\therefore R = (200 \pm 2) + (400 \pm 4)$
$R = (600 \pm 6)\Omega$

51. Zero error belongs to the category of:

(a) Constant errors (b) Instrumental errors
(c) Personal errors (d) Random errors

AP EAMCET-24.08.2021, Shift-II

Ans. (b) : Instrumental errors:- It is the errors due to imperfect design or calibration of the measuring instrument. Zero error is the instrumental error.
• **Random error:–** Measurements lack precision, but cluster around accurate value.

52. A physical quantity P is related to four observables a,b,c, and d as $P = \frac{\sqrt{ab}.d^{\alpha}}{\sqrt{c}}$ (α is constant). The percentage errors in a,b,c and d are 0.5% in each. If the percentage error in P is 2%, then α is–

(a) $\frac{5}{2}$ (b) $\frac{2}{5}$
(c) $\frac{3}{4}$ (d) $\frac{3}{2}$

AP EAMCET-07.07.2022, Shift-II

Ans. (a) : Given,

$$P = \frac{\sqrt{ab}\, d^{\alpha}}{\sqrt{c}}$$

$$\frac{\Delta P}{P}\times100 = \left(\frac{1}{2}\frac{\Delta a}{a}+\frac{1}{2}\frac{\Delta b}{b}+\alpha\frac{\Delta d}{d}+\frac{1}{2}\frac{\Delta c}{c}\right)\times100$$

$$\frac{\Delta P}{P}\times100 = \frac{1}{2}\times0.5+\frac{1}{2}\times0.5+\alpha\times0.5+\frac{1}{2}\times0.5$$

$$2 = \frac{1}{4}+\frac{1}{4}+\frac{\alpha}{2}+\frac{1}{4}$$

$$2 = \frac{3}{4}+\frac{\alpha}{2}$$

$$\therefore \alpha = \frac{5}{2}$$

53. The pressure on a square plate is measured by measuring the force on the plate and the length of the sides of the plate. If the maximum errors in the measurement of force and length are respectively 4% and 2 %, then the maximum error in the measurement of pressure is

(a) 1 % (b) 2 %
(c) 6 % (d) 8 %

AIIMS-2017

Ans. (d) : We know that, $P = \frac{F}{A} = \frac{F}{l^2}$

So maximum error in Pressure (P),

$$\left|\frac{\Delta P}{P}\right|_{max} = \frac{\Delta F}{F}+\frac{2\Delta l}{l}$$

$$\left(\frac{\Delta P}{P}\times100\right)_{max} = \frac{\Delta F}{F}\times100+2\left(\frac{\Delta l}{l}\times100\right)$$

$$= 4\% + 2\times2\%$$

$$\left(\frac{\Delta P}{P}\times100\right)_{max} = 8\%$$

54. A certain body weighs 22.42 g and has a measured volume of 4.7 cc. The possible error in the measurement of mass and volume are 0.01 g and 0.1 cc. Then, maximum error in the density will be

(a) 22% (b) 2%
(c) 0.2% (d) 0.02%

[NEET 2021]
AP EMCET(Medical)-2010
[AIPMT 1991]

Ans. (b) : Given that,
Weight of body (m) = 22.42 g
Volume of body (v) = 4.7 cc
Error in mass (Δm) = 0.01 g
Error in volume (Δv) = 0.1 cc

% error in mass = $\frac{\Delta m}{m}\times 100 = \frac{0.01}{22.42}\times 100$

$= \frac{1}{2242}\times 100$

% error in volume = $\frac{\Delta v}{v}\times 100$

$= \frac{0.1}{4.7}\times 100 = \frac{1}{47}\times 100$

$\because$ Density $D = \frac{\text{mass(m)}}{\text{volume(v)}}$

%error in density = %error in mass + %error in volume

$= \frac{1}{2242}\times 100 + \frac{1}{47}\times 100 = 2.17\%$

Maximum error in density $\simeq 2\%$

55. If the error in the measurement of radius of a sphere is 2%, then the error in the determination of volume of the sphere will be

(a) 4% (b) 6%
(c) 8% (d) 2%

AP EAMCET-25.09.2020, Shift-II
[AIPMT 2008]

Ans. (b) : Given that,

% error in radius = 2%

$\frac{\Delta r}{r}\times 100 = 2\%$

$\because$ volume of sphere $= \frac{4}{3}\pi r^3$

log of both side log v = 3 logr

Differentiating both side

$\frac{dV}{V} = 3\frac{dr}{r}$

$\frac{\Delta v}{v}\times 100 = 3\left(\frac{\Delta r}{r}\times 100\right)$

$= 3 \times 2\%$

$\frac{\Delta v}{v}\times 100 = 6\%$

$\frac{\Delta v}{v} = 6\%$

% error in volume = 6%

1.4 Dimensions of physical quantities,

56. The mechanical quantity, which has dimensions of reciprocal of mass (M^{-1}) is

(a) Torque
(b) Gravitational constant
(c) Angular momentum
(d) Coefficient of thermal conductivity

RE-NEET (UG)-06.06.2023 (Manipur)

Ans. (b) : Dimension of torque = $[M^1L^2T^{-2}]$
dimension of Gravitational constant = $[M^{-1}L^3T^{-2}]$
dimension of angular momentum = $[ML^2T^{-1}]$
dimension of coefficient of thermal conductivity
$= [MLT^{-3}\theta^{-1}]$
From above it is clear that the gravitational constant is mechanical quantity which has dimensions of reciprocal of mass (M^{-1}).

57. The physical quantity which has dimensional formula as that of $\frac{\text{Energy}}{\text{Mass}\times\text{Length}}$ is :

(a) force (b) power
(c) pressure (d) acceleration

AP EAMCET(Medical)-2000

Ans. (d) :
$\frac{\text{Energy}}{\text{mass}\times\text{length}} = \text{Acceleration}$
and the dimension of Acceleration is
$\frac{[ML^2T^{-2}]}{[M][L]} = [LT^{-2}]$

58. The correct order in which the dimension of 'Length' increases in the following physical quantities is?

(A) Permittivity (B) Resistance
(C) Magnetic permeability (D) Stress

(a) (A), (B), (C), (D) (b) (D), (C), (B), (A)
(c) (A), (D), (C), (B) (d) (C), (B), (D), (A)

AP EAMCET(Medical)-2004

Ans. (c) : (A) Electrical Permittivity,
$(\varepsilon_0) = [M^{-1}L^{-3}T^4A^2] = -3$
(B) Resistance (R) $=[M^1L^2T^{-3}A^{-2}] \Rightarrow 2$
(C) Magnetic permeability (μ) $=[M^1L^1T^{-2}A^{-2}] \Rightarrow 1$
(D) stress (σ) $= [M^1L^{-1}T^{-2}] \Rightarrow -1$
$\therefore$ The correct order is the (A, D, C, B) dimension of 'length' increase in the following physical quantities.

59. What is the dimensions of impedance?

(a) $[ML^2T^{-3}I^{-2}]$ (b) $[M^{-1}L^{-2}T^3I^2]$
(c) $[ML^3T^{-3}I^{-2}]$ (d) $[M^{-1}L^{-3}T^3I^2]$

AIIMS-2007

Ans. (a) : Impedance (Z) $= \frac{\text{Voltage (V)}}{\text{Current (I)}}$

Dimension of $[Z] = \frac{[V]}{[I]} = \frac{[M^1L^2T^{-3}A^{-1}]}{[M^0L^0T^0A^1]}$

$= [M^1L^2T^{-3}A^{-2}]$

$= [ML^2T^{-3}I^{-2}]$ ($\because$ A = I)

60. Which of the following physical quantities do not have same dimensions?

(a) pressure and stress
(b) tension and surface tension
(c) strain and angle
(d) energy and work

AIIMS-2007, 2001

Ans. (b) : Tension is a force experienced within a body to resist another force applied externally.
Dimension of tension = Dimension of force
$= [MLT^{-2}]$

Surface tension is the force per unit length perpendicular to line drawn in the surface of the liquid.
Dimension of surface tension,

$$= \frac{\text{Force}}{\text{Length}} = \frac{[MLT^{-2}]}{[L]} = [MT^{-2}]$$

Dimension of surface tension = $[MT^{-2}]$

61. Which of the following pair of quantities do not have the same dimensions:
(a) Potential gradient, electric field
(b) Torque, kinetic energy
(c) Light year, time period
(d) Impedance, reactance

AIIMS-2011

Ans. (c) : Light year is unit of distance.
So, dimension of light year = [L]
• Time taken for one complete oscillation to occur is called time period.
So, Dimension of time period = [T]

62. The dimensional formula of Farad is
(a) $[M^{-1}L^{-2}TQ]$ (b) $[M^{-1}L^{-2}T^2Q^2]$
(c) $[M^{-1}L^{-2}TQ^2]$ (d) $[M^{-1}L^{-2}T^2Q]$

AIIMS-2012

Ans. (b) : Dimension of Farad

$$\therefore \quad C = \frac{Q}{V}$$

As we know,

$$W = Q.V \quad \Rightarrow V = \frac{W}{Q}$$

$$C = \frac{Q^2}{W} \quad [\because Q = CV]$$

And $W = F.d$

Thus, $C = \frac{Q^2}{F.d}$

$$\text{Dimension of } C = \frac{[\text{Dimension of Q}]^2}{\text{Dimension of F} \times \text{dimension of d}}$$

$$= \frac{[Q^2]}{[M^1L^1T^{-2}].[L^1]}$$

$$= [M^{-1}L^{-2}T^2Q^2]$$

63. Assertion: The dimensional formula for relative velocity is same as that of the change in velocity.
Reason: Relative velocity of P w.r.t. Q is the ratio of velocity of P and that of Q.
(a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

AIIMS-2002

Ans. (c) : The relative velocity is defined as the velocity of an object with respect to another object or observer. It is vector subtraction of two velocities.
Relative velocity of P w.r.t Q

$$V_r = V_P - V_Q$$

So, the dimensional formula of relative velocity is same as that of the change in velocity.

64. Assertion: Specific gravity of a fluid is a dimensionless quantity.
Reason: It is the ratio of density of fluid to the density of water.
(a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

AIIMS-2005

Ans. (a) : Specific gravity of fluid,

$$(G) = \frac{\text{Density of fluid}}{\text{Density of water at } 4°C}$$

It is clear that the specific gravity of fluid is dimensionless quantity.

65. The magnetic moment has dimensions of
(a) [LA] (b) $[L^2 A]$
(c) $[LT^{-1} A]$ (d) $[L^2 T^{-1}A]$

JCECE-2007
AIIMS-2006

Ans. (b) : Magnetic moment of a current carrying coil is defined as the product of current in the coil with the area of coil in vector form. That is,

$$\vec{M} = I\vec{A}$$

Thus, dimensions of M = $[A][L]^2$
$= [L^2 A]$

66. Dimensions of relative density is
(a) $[ML^{-2}]$ (b) $[ML^{-3}]$
(c) Dimensionless (d) $[M^2L^{-6}]$

UP CPMT-2003

Ans. (c) : Relative density = $\frac{\text{Density of substance}}{\text{Density of water}}$

$$= \frac{[ML^{-3}]}{[ML^{-3}]}$$

Since, both have the same dimensions, thus their ratio is dimensionless.

67. The dimensional formula for emf, e in MKS system will be

(a) $[ML^2T^{-2}Q^{-1}]$ (b) $[ML^2T^{-1}]$
(c) $[ML^{-2}Q^{-1}]$ (d) $[MLT^{-2}Q^{-2}]$

UP CPMT-2002

Ans. (a) : Dimensional formula of emf electro magnetic force -

$$EMF = \frac{W}{q} \text{ or } \frac{[ML^2T^{-2}]}{[Q]} = [ML^2T^{-2}Q^{-1}]$$

or $$EMF = \frac{[ML^2T^{-2}]}{[AT]}$$

$$EMF = [ML^2T^{-3}A^{-1}]$$

68. $[ML^3T^{-3}A^{-2}]$ is the dimensional formula of

(a) resistance (b) resistivity
(c) conductance (d) conductivity

UP CPMT-2012

Ans. (b) : The formula of resistivity is given by

$$\rho = \frac{AR}{l}$$

• Here, ρ is the resistivity of the wire A is Area of cross section- of wire R is the resistance of the wire.
l is the length of the wire.
The dimension of Resistivity ρ = $[ML^3T^{-3}A^{-2}]$
The dimension of Resistance R = $[ML^2T^{-3}A^{-2}]$
The dimension of Conductance C = $[M^{-1}L^{-2}T^3A^2]$
The dimension of Conductivity = $[M^{-1}L^{-2}T^3A^1]$

69. When light is refracted from a surface, which of its following physical parameters does not change?

(a) Velocity (b) Amplitude
(c) Frequency (d) Wavelength

WB JEE 2015

Ans. (c) : Frequency of the light depends upon the source so it does not change in case of reflection or refraction or polarization.

70. Match the List I with List II.

	List-I		List-II
A.	Boltzmann constant	I.	$[ML^0T^0]$
B.	Coefficient of viscosity	II.	$[ML^{-1}T^{-1}]$
C.	Water equivalent	III.	$[MLT^{-3}K^{-1}]$
D.	Coefficient of thermal conductivity	IV.	$[ML^2T^{-2}K^{-1}]$

The correct match in the following is

(a) A–III; B– I; C–II; D–IV
(b) A–III; B– II; C–I; D–IV
(c) A–IV; B– II; C–I; D–III
(d) A–IV; B– I; C–II; D–III

AP EAMCET -2016

Ans. (c) :
• Baltzman constant = $[ML^2T^{-2}K^{-1}]$
• Coefficient of viscosity = $\frac{MLT^{-2}}{[L^2 \times T^{-1}]} = [ML^{-1}T^{-1}]$
• Water equivalent = [ML°T°]
• Coefficient of thermal conductivity = $[MLT^{-3}K^{-1}]$

71. Plane angle and solid angle have

(a) No units and no dimensions
(b) Both units and dimensions
(c) Unit but no dimensions
(d) Dimensions but no units

NEET 17.07.2022

Ans. (c) : Unit but no dimensions

Plane angle	Radian
Solid angle	Steradian

72. The dimensions $[MLT^{-2}A^{-2}]$ belong to the

(a) Magnetic permeability
(b) Electric permittivity
(c) Magnetic flux
(d) Self inductance

NEET 17.07.2022

Ans. (a) :

List–I	List–II
(a) Magnetic Permeability	$[M^1LT^{-2}A^{-2}]$
(b) Electric Permeability	$[M^{-1}L^{-3}T^4A^2]$
(c) Magnetic flux	$[M^1L^2T^{-2}A^{-1}]$
(d) Self Inductance	$[ML^2T^{-2}A^{-2}]$

73. Match the following

A. Angular momentum 1. $[M^{-1}L^2T^{-2}]$
B. Torque 2. $[M^1T^{-2}]$
C. Gravitational constant 3. $[M^1L^2T^{-2}]$
D. Tension 4. $[M^1L^2T^{-1}]$

(a) C –2, D –1 (b) A –4, B –3
(c) A –3, C –2 (d) B –2, A –1

JIPMER-2014

Ans. (b) : Dimensional formula of angular momentum
angular momentum = mvr
= kg (m/s)m
= $[M][LT^{-1}]$ [L]
= $[ML^2T^{-1}]$
Dimensional formula of Torque
Torque τ = F.r = ma.r

$= kg\ (m/s^2)m$
$= [M]\ [LT^{-2}]\ [L] = [ML^2T^{-2}]$

Dimensonal formula of Gravitiational constant -

Gravitational constant $(G) = \frac{F.r^2}{M_e.m}$

$= \frac{[MLT^{-2}][L^2]}{[M][M]} = [M^{-1}L^3T^{-2}]$

Dimensional formula of Tension -

Tension force = Gravity force = mg
$= kg.\ (m/s^2)$
$= [M]\ [LT^{-2}] = [MLT^{-2}]$

74. The Physical quantity having the dimensions $[M^{-1}\ L^{-3}\ T^3\ A^2]$ is

(a) Resistance (b) Resistivity
(c) Electrical conductivity (d) Electromotive force

JIPMER-2011

Ans. (c) : We know that,

Resistivity $\rho = \frac{RA}{l}$

$\rho = \frac{[ML^2T^{-3}A^{-2}][L^2]}{[L]}$

$\rho = \frac{[M]}{L^{-3}[AT][T]} = [ML^3A^{-2}\ T^{-3}]$

So, Electrical conductivity $\sigma = \frac{1}{\rho}$

$\rho = [ML^3A^{-2}T^{-3}]$

$\sigma = \frac{1}{\rho} \Rightarrow \sigma = [M^{-1}L^{-3}A^2T^3]$

75. Match list-I with List-II

	List-I		List-II
(a)	Gravitational constant	(i)	$[L^2T^{-2}]$
(b)	Gravitational potential energy	(ii)	$[M^{-1}L^3T^{-2}]$
(c)	Gravitational potential	(iii)	$[LT^{-1}]$
(d)	Gravitational intensity	(iv)	$[ML^2T^{-2}]$

Choose the correct answer from the options given below

(a) (a)-(ii), (b)-(iv), (c)-(iii), (d)-(i)
(b) (a)-(iv), (b)-(ii), (c)-(i), (d)-(iii)
(c) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)
(d) (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)

NEET 17.07.2022

Ans. (d) : (a) – (ii) , (b) – (iv), (c) – (i), (d) – (iii)

List-I		List-II	
A.	Gravitational constant	(ii)	$[M^{-1}L^3T^{-2}]$
B.	Gravitational Potential Energy	(iv)	$[ML^2T^{-2}]$
C.	Gravitational Potential	(i)	$[L^2T^{-2}]$
D.	Gravitational Intensity	(iii)	$[LT^{-1}]$

76. The dimensions of $(\mu_0\ \varepsilon_0)^{-1/2}$ are

(a) $[L^{1/2}T^{-1/2}]$ (b) $[L^{-1}T]$
(c) $[LT^{-1}]$ (d) $[L^{1/2}T^{1/2}]$

[AIPMT 2012]

Ans. (c) : We know that,

Velocity of electromagnetic wave (c) = $\frac{1}{\sqrt{\mu_0\varepsilon_0}}$

Then, $(\mu_0\varepsilon_0)^{-1/2}$ have same dimension of velocity is $[LT^{-1}]$

77. The dimensions of $\frac{1}{2}\varepsilon_0E^2$, where ε_0 is permittivity of free space and E is electric field, are

(a) $[ML^2T^{-2}]$ (b) $[ML^{-1}T^{-2}]$
(c) $[ML^2T^{-1}]$ (d) $[MLT^{-1}]$

[AIPMT 2010]
AIIMS-2014

Ans. (b) : The given equation is $\frac{1}{2}\varepsilon_0E^2$

Where,
ε_0 = permittivity
E = Electric field

$\because$ Dimension of $\varepsilon_0 = [M^{-1}L^{-3}T^4A^2]$

and

Dimension of electric field E = $\frac{F}{q}$

$E = \frac{[MLT^{-2}]}{[AT]}$

$E = [MLT^{-3}A^{-1}]$

$\therefore$ Dimension of $\frac{1}{2}\varepsilon_0E^2 = [M^{-1}L^{-3}T^4A^2]\ [MLT^{-3}A^{-1}]^2$

$\frac{1}{2}\varepsilon_0E^2 = [M^{-1}L^{-3}T^4A^2]\ [M^2L^2T^{-6}A^{-2}]$

$\frac{1}{2}\varepsilon_0E^2 = [ML^{-1}T^{-2}]$

78. Which two of the following five physical parameters have the same dimensions?

(i) Energy density
(ii) Refractive index
(iii) Dielectric constant
(iv) Young's modulus
(v) Magnetic field

(a) (ii) and (iv) (b) (iii) and (v)
(c) (i) and (iv) (d) (i) and (v)

[AIPMT 2008]

Ans. (c) :

	Physical parameter		Dimensions
(i)	Energy density	-	$[ML^{-1}T^{-2}]$
(ii)	Refractive index	-	$[M^0L^0T^0]$
(iii)	Dielectric constant	-	$[M^0L^0T^0]$
(iv)	Young's modulus	-	$[ML^{-1}T^{-2}]$
(v)	Magnetic field	-	$[MA^{-1}T^{-2}]$

Hence, Energy density and Young's modulus has the same dimension.

79. The ratio of the dimensions of Planck's constant and that of the moment of inertia is the dimension of
(a) frequency
(b) velocity
(c) angular momentum
(d) time

SRM JEE-2010
[AIPMT 2005]

Ans. (a) : Dimension of Planck's constant,

$$h = \frac{E}{\nu} = \frac{[ML^2T^{-2}]}{[M^0L^0T^{-1}]} = [ML^2T^{-1}]$$

Dimension of moment of Inertia = mass × (Radius of gyration)^2

$$= [M^1L^0T^0] \times [M^0L^1T^0]^2 = [ML^2]$$

The ratio of the dimensions,

$$= \frac{[ML^2T^{-1}]}{[ML^2]}$$

$$= [T^{-1}]$$

T^{-1} is the dimension of frequency.

80. A pair of physical quantities having same dimensional formula is
(a) force and torque
(b) work and energy
(c) force and impulse
(d) linear momentum and angular momentum

[AIPMT 2000]

Ans. (b) : A pair of physical quantities having same dimensional formula is –
work and energy.
The dimension of work = Fd cos θ

$$= [MLT^{-2}][L]$$
$$= [ML^2T^{-2}]$$

The dimension of energy $E = m.c^2$

$$E = [M][L^1T^{-1}]^2$$
$$E = [ML^2T^{-2}]$$

81. The force F on a sphere of radius r moving in a medium with velocity v is given by F = 6πηrv. The dimensions of η are
(a) $[ML^{-3}]$ (b) $[MLT^{-2}]$
(c) $[ML^{-1}]$ (d) $[ML^{-1}T^{-1}]$

[AIPMT 1997]

Ans. (d) : Given,

$$F = 6\pi\eta rv$$
$$\eta = \frac{F}{6\pi rv}$$

The dimension of F = $[MLT^{-2}]$
The dimension of r = [L]
The dimension of v = $[LT^{-1}]$

$$\therefore \quad \eta = \frac{[MLT^{-2}]}{[L][LT^{-1}]}$$
$$\eta = [ML^{-1}T^{-1}]$$

82. Which of the following will have the dimensions of time?
(a) [LC] (b) $\left[\frac{R}{L}\right]$
(c) $\left[\frac{L}{R}\right]$ (d) $\left[\frac{C}{L}\right]$

[AIPMT 1996]

Ans. (c) : [RC] = [T] Time constant of R – C circuit.

$\left[\frac{L}{R}\right] = [T]$ Time constant of R – L circuit

Hence, option (c) is correct.

83. The dimensional formula of torque is
(a) $[ML^2T^{-2}]$ (b) $[MLT^{-2}]$
(c) $[ML^{-1}T^{-2}]$ (d) $[ML^{-2}T^{-2}]$

UPCPMT-2014
[AIPMS 2011]
[AIPMT 1989]

Ans. (a) : Torque
τ= F.r
Where F = torque
r = distance of force form the center
Dimensions of r and F are [r] = [L] and [F] = $[MLT^{-2}]$
$[\tau] = [MLT^{-2}] [L]$
$[\tau] = [ML^2T^{-2}]$

84. Which of the following is a dimensional constant ?
(a) Relative density
(b) Poisson's ratio
(c) Refractive index
(d) Gravitational constant

[AIPMT 1995]

Ans. (d) : Gravitational constant is a dimensional constant.

$$\because \quad F = G.\frac{m_1m_2}{r^2}$$

$$\because \quad G = \frac{Fr^2}{m_1m_2}$$

The dimension of (F) = $[MLT^{-2}]$
The dimension of (r^2)= $[L^2]$
The dimension of $m_1m_2 = [M^2]$

The dimension of G = $\frac{[MLT^{-2}].[L^2]}{[M^2]}$

$= [M^{-1}L^3T^{-2}]$

85. Of the following quantities, which one has dimensions different from the remaining three?

(a) Energy per unit volume
(b) Force per unit area
(c) Product of voltage and charge per unit volume
(d) Angular momentum

[AIPMT 1989]

Ans. (d) : Energy per unit volume

$\frac{[ML^2T^{-2}]}{[L^3]} = [ML^{-1}T^{-2}]$

Force per unit Area = $\frac{F}{A}$

$= \frac{[MLT^{-2}]}{[L^2]}$

$= [ML^{-1}T^{-2}]$

Product of voltage and charge per unit volume

$= \frac{vit}{V}$

$= \frac{P \times t}{V} = \frac{[ML^2T^{-3}][T]}{[L^3]}$

$= [ML^{-1}T^{-2}]$

Dimension of angular momentum

= (r) (P)

= (r) (mv)

= [L] [M] $[LT^{-1}]$

$= [ML^2T^{-1}]$

So, concluding we can say that angular momentum has different units.

86. Dimension of force is

(a) $[M^2L^1T^{-1}]$
(b) $[M^1L^1T^{-2}]$
(c) $[M^2L^{-1}T^{-2}]$
(d) $[M^1L^1T^{-1}]$

JIPMER-2018

Ans. (b) : Dimension of force

Force = mass × acceleration

Unit = [Kg] $\left[\frac{meter}{sec^2}\right]$

Dimension of force = $[M^1L^1T^{-2}]$

87. Some physical constants are given in List 1 and their dimensional formulae are given in List 2. Match the correct pairs in the lists:

List 1	List 2
(A) Planck's constant	(1) $[ML^{-1}T^{-2}]$
(B) gravitational constant	(2) $[ML^{-1}T^{-2}]$
(C) bulk modulus	(3) $[ML^2T^{-1}]$
(D) coefficient of viscosity	(4) $[M^{-1}L^3T^{-2}]$

(a) (1) D, (2) C, (3) B, (4) A
(b) (1) B, (2) A, (3) C, (4) D
(c) (1) C, (2) B, (3) A, (4) D
(d) (1) C, (2) D, (3) A, (4) B

AP EAMCET(Medical)-2006

Ans. (d) :

$h = \frac{E}{\nu} = \frac{[ML^2T^{-2}]}{[T^{-1}]}$

$h = [ML^2T^{-1}]$

• Gravitational constant (G)

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

$G = \frac{gR^2}{M}$

$G = \frac{[LT^{-2}][L^2]}{[M]}$

$G = [M^{-1}L^3T^{-2}]$

• Bulk modulus (K)= $K = -V\frac{dP}{dV}$

Where, P = Pressure
V = Volume
P = F/A

$K = \frac{F/A}{\left\{\frac{\Delta V}{V}\right\}}$

$K = \frac{F}{A} = \frac{[MLT^{-2}]}{[L^2]}$

$K = [M^1L^{-1}T^{-2}]$

• Coefficient of viscosity (η) = $\frac{F}{A.\left\{\frac{dv}{dx}\right\}}$

$(\eta) = \frac{[MLT^{-2}]}{[L^2][T^{-1}]}$

$= [ML^{-1}T^{-1}]$

88. If force (F), work (W) and velocity (v) are taken as fundamental quantities, then the dimensional formula of time (T) is:

(a) [WFv]
(b) $[WFv^{-1}]$
(c) $[W^{-1}F^{-1}v]$
(d) $[WF^{-1}v^{-1}]$

AP EAMCET(Medical)-2007

Ans. (d) : Force = F
Work = W
Velocity = v
Let the distance be 'd' and the time be t Distance can be expressed as d = v ×t

Work done by an object is given by.
$W = F \times d$
$= F \times v \times t$
$t = \frac{W}{Fv}$
$t = \left[W^1 F^{-1} v^{-1}\right]$
Hence, the dimensional formula of the time will be $[WF^{-1}v^{-1}]$

89. If energy (E), force (F) and linear momentum (P) are fundamental quantities, then match the following and give the correct answer.

(A) Physical quantity	**(B) Dimensional formula**
(a) Mass	(d) $[E^0 F^{-1} P^1]$
(b) Length	(e) $[E^{-1} F^0 P^2]$
(c) Time	(f) $[E^1 F^{-1} P^0]$

(a) a-d, b-e, c-f (b) a-f, b-e, c-d
(c) a-e, b-f, c-d (d) a-e, b-d, c-f

AP EAMCET(Medical)-2015

Ans. (c) :

(A) Physics quantity	**(B) Dimensional formula**
(A) Mass	(E) $E^{-1} F^0 p^2$
(B) Length	(F) $E^1 F^{-1} p^0$
(C) Time	(D) $E^0 F^{-1} p^1$

90. The dimensional formula of coefficient of kinematic viscosity is:
(a) $[M^0L^{-1}T^{-1}]$ (b) $[M^0L^2T^{-1}]$
(c) $[ML^2T^{-1}]$ (d) $[ML^{-1}T^{-1}]$

AP EAMCET(Medical)-2002

Ans. (b) : The dimensional formula of kinematic viscosty is $[M^0L^2T^{-1}]$.

91. The dimensional formula of magnetic induction is:
(a) $[MT^{-1}A^{-1}]$ (b) $[MT^{-2}A^{-1}]$
(c) $[MTA^{-2}]$ (d) $[MTA^{-2}]$

AP EAMCET(Medical)-2000

Ans. (b) : The dimensional formula of magnetic induction is $[MT^{-2}A^{-1}]$.

92. What is the dimension of Luminous flux?
(a) $[cd^1]$ (b) $[cd^1T^{-1}]$
(c) $[cd^1L^{-2}]$ (d) $[cd^1L^1T^{-1}]$

AIIMS-26.05.2019(M) Shift-1

Ans. (a) : The unit of luminous intensity is Candela and denoted as cd.
So, the unit of luminous flux = [cd]

93. P, Q, R and S denote energy, mass, angular momentum and gravitational constant respectively, the quantity $\left[\frac{Q^5S^2}{PR^2}\right]$ has the dimensions of
(a) Mass (b) Length
(c) Time (d) Angle

AP EAMCET (Medical)-24.04.2019, Shift-I

Ans. (d) : Given,
Let quantity is x
So, $x = \left[\frac{Q^5S^2}{PR^2}\right]$ ....(i)
Where, P → energy
Q → mass
R → angular momentum
S → Gravitational constant
Dimension of ,
Energy $[P] = [ML^2T^{-2}]$
Mass $[Q] = [M]$
Angular momentum $[R] = [ML^2T^{-1}]$
Gravitational constant $[S] = [M^{-1}L^3T^{-2}]$
Substituting dimension of each quantity in equation (1)
$$[x] = \frac{[M]^5[M^{-1}L^3T^{-2}]^2}{[ML^2T^{-2}][ML^2T^{-1}]^2}$$
$$= \frac{M^3L^6T^{-4}}{M^3L^6T^{-4}} = \left[M^0L^0T^0\right]$$
Angle is dimension less quantity
So, dimension formula of angle = $[M^0L^0T^0]$

94. If E and G respectively denote energy and gravitational constant. Then $\frac{E}{G}$ has the dimensions of
(a) $[M^2] [L^{-1}] [T^0]$
(b) $[M] [L^{-1}] [T^{-1}]$
(c) $[M] [L^0] [T^0]$
(d) $[M^2] [L^{-2}] [T^{-1}]$

[NEET 2021]

Ans. (a)
Energy (E) = $\frac{1}{2}mv^2$
Dimension of E = $[ML^2T^{-2}]$
and gravitational constant (G) = $\frac{Fr^2}{m_1m_2}$
$$G = \frac{[MLT^{-2}][L^2]}{[M^2]}$$
$$G = \left[M^{-1}L^3T^{-2}\right]$$
Now,
Dimension of $\frac{E}{G} = \frac{[ML^2T^{-2}]}{[M^{-1}L^3T^{-2}]}$
$$\frac{E}{G} = \left[M^2L^{-1}T^0\right]$$

95. The dimensions of Boltzmann constant are

(a) $\left[ML^2T^{-2}\theta^{-1}\right]$ (b) $\left[ML^2T^{-2}\theta\right]$

(c) $\left[M^2LT^{-2}\theta^{-1}\right]$ (d) $\left[ML^0T^{-2}\theta^{-1}\right]$

AP EAMCET-08.07.2022, Shift-I
AIIMS-26.05.2019(E) Shift-2

Ans. (a) : Dimensional formula of Boltzmann constant

$$(K_b) = \frac{\text{Dimensional formula of energy}}{\text{Dimensional formula of temperature}}$$

$$= \frac{[ML^2T^{-2}]}{[\theta]}$$

$$= [ML^2T^{-2}\theta^{-1}]$$

96. The dimension of angular momentum is

(a) $[M^0L^1T^{-1}]$ (b) $[M^1L^2T^{-2}]$

(c) $[M^1L^2T^{-1}]$ (d) $[M^2L^1T^{-2}]$

UPCPMT-1999, 1989, 1986, 1982, 1973
AIPMT-1988
AIPMT-1992, 1988

Ans. (c) : We know

Angular momentum (L) = mvr.

where = m = mass (kg)

V = velocity (m/s)

r = radius (m)

$L = [M][LT^{-1}][L]$

$L = [M^1L^2T^{-1}]$

97. The correct dimensional formula for impulse is given by

(a) $[ML^2T^{-2}]$ (b) $[MLT^{-1}]$

(c) $[ML^2T^{-1}]$ (d) $[MLT^{-2}]$

AIPMT-1991
UPCPMT-1978
AP EAMCET-1981

Ans. (b) : Impulse (I) = Force × time

$[M^1L^1T^{-2}] \times [T]$

$[I] = [M^1L^1T^{-1}]$

98. Dimensional formula of Stefan's constant is

(a) $[MT^{-3}K^{-4}]$ (b) $[ML^0T^{-2}K^{-4}]$

(c) $[ML^2T^{-2}]$ (d) $[MT^{-2}L^0]$

(e) $[MT^{-4}L^0]$

AIPMT-2002

Ans. (a) : Stefan's constant $(\sigma) = \dfrac{E}{AtT^4}$

$$[\sigma] = \frac{[ML^2T^{-2}]}{[L^2][K^4][T]}$$

$$[\sigma] = \frac{[ML^0T^{-3}]}{[K]^4}$$

Dimension of $(\sigma) = [ML^0T^{-3}K^{-4}]$

99. The dimensions of self inductance *L* are

(a) $[ML^2T^{-2}A^{-2}]$ (b) $[ML^2T^{-1}A^{-2}]$

(c) $[ML^2T^{-1}A^{-1}]$ (d) $[ML^{-2}T^{-2}A^{-2}]$

AIPMT-1992, 1989

Ans. (a) : We know that,

$$E = L\frac{di}{dt}$$

where is 'i' is the current of circuit and L is the self inductance.

$$L = \frac{|E|}{\frac{di}{dt}} = \frac{[ML^2T^{-3}A^{-1}]}{[AT^{-1}]}$$

$[L] = [ML^2T^{-2}A^{-2}]$

100. The dimensions of universal gravitational constant are–

(a) $[M^{-2}L^{-3}T^{-2}]$ (b) $[M^{-2}L^2T^{-1}]$

(c) $[M^{-1}L^3T^{-2}]$ (d) $[ML^2T^{-2}]$

AP EAMCET-23.09.2020, Shift-II
JIPMER-2004
AIIMS-2000
UPCPMT-1996, DPMT-1984
AIPMT-2004, 1992

Ans. (c) : Gravitational force acting between two body is–

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

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

Where, G = Universal gravitational constant

F = Gravitational force

m_1 = mass of first body

m_2 = mass of second body

r = Distance between two body.

∴ Unit of Universal gravitational constant–

$$\Rightarrow \text{ Unit of } G = \frac{\text{Newton. m}^2}{\text{kg . kg}} = \frac{N.m^2}{(Kg)^2}$$

$$\Rightarrow \text{ Dimension of G = Dimension of } \frac{N.m^2}{(Kg)^2}$$

$$\Rightarrow \text{ Dimension of } G = \frac{\left[MLT^{-2}\right]\left[L^2\right]}{\left[M^2\right]}$$

$$\Rightarrow \text{ Dimension of } G = \left[M^{-1}L^3T^{-2}\right]$$

101. Planck's constant has the dimensions of

(a) linear momentum (b) angular momentum

(c) energy (d) power

AP EAMCET-06.09.2021, Shift-I
AIPMT-2001

Ans. (b) : We know that, E = hν

Where, E = Energy, h = Planck's constant,

ν = Frequency

Dimension of Plank's constant

$$h = \frac{E}{\nu}$$

$$h = \frac{[ML^2T^{-2}]}{[M^0L^0T^{-1}]}$$

$$h = [ML^2T^{-1}]$$

Dimension of Angular momentum

= MVr

= $[M][LT^{-1}]\ [L]$

= $[ML^2T^{-1}]$

Hence, option (b) is correct.

102. Dimensions of Planck's constant is :

(a) $[ML^2T^{-1}]$ (b) $[MLT^{-2}]$

(c) $[ML^{-2}T]$ (d) $[ML^{-1}T^2]$

AIIMS-1997,

UPCPMT-1999

Ans. (a) : Formula, E = hν

$$\text{Planck's Constant } (h) = \frac{\text{Energy in each Photon}}{\text{Frequency of radiation}}$$

$$= \frac{E}{\nu} = \frac{[ML^2T^{-2}]}{[T^{-1}]}$$

$$= [ML^2T^{-1}]$$

103. The dimension of magnetic flux is

(a) $[MLT^{-1}A^{-1}]$ (b) $[ML^{-1}TA^{-2}]$

(c) $[ML^{-2}T^2A^{-2}]$ (d) $[ML^2T^{-2}A^{-1}]$

AP EAMCET (Medical)-2003

AIPMT-1999, 89, AIIMS-1998

Ans. (d) : Magnetic flux (ϕ_B) = B × A × cosθ

Where, B = Magnetic Field

A = Surface Area

θ = Angle between the magnetic field and normal to the surface.

Therefore, dim. (ϕ_B) = $[M^1T^{-2}A^{-1}][M^0L^2T^0]$

$$\phi_B = [M^1L^2T^{-2}A^{-1}]$$

Since, θ is a dimensionless quantity.

104. Dimensions of $1/\mu_0\varepsilon_0$, where symbols have their usual meaning, are

(a) $[L^{-1}T]$ (b) $[L^2T^2]$

(c) $[L^2T^{-2}]$ (d) $[LT^{-1}]$

AFMC-1986, AIIMS-1993

AIPMT-1992, UPCPMT-1997, 1992

Ans. (c) : We know,

$$c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$$

$$c^2 = \frac{1}{\mu_0\varepsilon_0}$$

Then, dimensional formula of $\frac{1}{\mu_0\varepsilon_0}$ is given as –

$$\frac{1}{\mu_0\varepsilon_0} = c^2 = [LT^{-1}]^2 = [L^2T^{-2}]$$

105. Dimensional formula for ε_0 is

(a) $[M^{-1}L^{-2}A^2T^2]$ (b) $[ML^2A^{-2}T^4]$

(c) $[M^{-1}L^{-3}A^2T^4]$ (d) $[ML^3A^{-2}T^4]$

AP EAMCET (17.09.2020) Shift-II

AIIMS-2004

Ans. (c) : From Coulomb's law,

$$F = \frac{1}{4\pi\varepsilon_0}\cdot\frac{q_1q_2}{r^2}$$

$$\therefore \quad \varepsilon_0 = \frac{1}{4\pi F}\cdot\frac{q_1q_2}{r^2}$$

$$\therefore \text{ Dimensions of } \varepsilon_0 = \frac{1}{[MLT^{-2}]}\times\frac{[AT]^2}{[L^2]}$$

$$= [M^{-1}L^{-3}A^2T^4]$$

106. The dimension of light year

(a) $[LT^{-1}]$ (b) [T]

(c) $[ML^2T^{-2}]$ (d) [L]

UPCPMT-1991

Ans. (d) : Light year is a distance that light can travel in one year since its unit is in meter.

∴ Dimension of light year is [L]

107. The dimensional formula for Young's modulus is

OR

The dimensional formula of modulus of rigidity is

OR

The dimensional formula of pressure is

OR

The dimensional formula for volume elasticity is

OR

The dimensional formula of modulus of elasticity is

OR

Dimension of Bulk modulus is

OR

What is the dimension of stress?

(a) $ML^{-1}T^{-2}$ (b) M^0LT^{-2}

(c) MLT^{-2} (d) ML^2T^{-2}

NEET (Sep.) 2020

JIPMER-2005,

UP CPMT-2004, 1991

AP EAMCET (Med.)-1995

AIPMT-1990, IIT-1982

Ans. (a) : Young's modulus = $\frac{\text{stress}}{\text{strain}}$

$$\text{Stress} = \frac{\text{Force}}{\text{Area}} = \frac{[MLT^{-2}]}{[L^2]} = [ML^{-1}T^{-2}]$$

$$\text{Strain} = \frac{\Delta l}{l} \Rightarrow \frac{[L]}{[L]} = [M^0L^0T^0]$$

$$\text{Dimension of Young's modulus} = \frac{[ML^{-1}T^{-2}]}{[M^0L^0T^0]}$$

Dimensional formula of Young's modulus = $[ML^{-1}T^{-2}]$

108. If M, L, T, and I stand for mass, length, time and electric current respectively, the dimensional formula for capacitance is

(a) $[M^{-1}L^{2}T^{-4}I^{2}]$ (b) $[M^{-1}L^{-2}T^{4}I^{2}]$
(c) $[ML^{2}T^{4}I^{2}]$ (d) $[ML^{2}T^{-4}I^{-2}]$

AIIMS-25.05.2019 (E)-Shift-II
AP EAMCET(Medical)-1997

Ans. (b) : Capacitance = $\frac{\text{charge}}{\text{voltage}}$

Capacitance = charge × voltage^{-1} …….. (i)
Dim. of charge = [IT]
Voltage = Electric field × displacement
Electric field = force × charge^{-1}
$= [M L T^{-2}] \times [IT]^{-1}$
Dim. (Electric field) = $[ML^{1}T^{-3}I^{-1}]$
Now, dimension of voltage = $[MLI^{-1}T^{-3}]$ [L]
$= [M L^2 I^{-1} T^{-3}]$
Put in the equation (i),
Dim. (Capacitance) = $[IT] \times [M L^2 I^{-1} T^{-3}]^{-1}$
$= [M^{-1} L^{-2} T^{4} I^{2}]$

109. Dimensions of resistance in an electrical circuit, in terms of dimension of mass M, of length L, of time T and of current I, would be

(a) $[ML^{2}T^{-3}I^{-1}]$ (b) $[ML^{2}T^{-2}]$
(c) $[ML^{2}T^{-1}I^{-1}]$ (d) $[ML^{2}T^{-3}I^{-2}]$

JIPMER-2009,
AIIMS-2005, UPCPMT-2008, [AIPMT 2007]

Ans. (d) : From the relation of ohm's law-
V = IR
Where – V = Voltage
I = current of the circuit
R = Resistance of the wire
or

$$R = \frac{V}{I} \qquad \left(\because \ V = \frac{W}{q}\right)$$

$$\therefore \quad R = \frac{W}{q.I} \qquad (\because \ q = I.t)$$

or

$$R = \frac{W}{I.t.I} = \frac{[ML^{2}T^{-2}]}{[IT][I]}$$

or

$R = [ML^{2}T^{-3}I^{-2}]$

110. The dimensional formula for latent heat is

(a) $[MLT^{-2}]$ (b) $[ML^{2}T^{-2}]$
(c) $[M^{0}L^{2}T^{-2}]$ (d) $[MIT^{-1}]$

UPCPMT-1986, 1978

Ans. (c) : Formula of latent heat given by $L = \frac{Q}{m}$

Where, L= latent heat
Q= amount of heat
M = mass of substance
Dimension of heat or work = force × displacement
$= [M L T^{-2}] [L]$
$= [M L^{2} T^{-2}]$
Dimension of mass = [M]

$$\text{Dimension of Latent heat } L = \frac{\text{dim.of Q}}{\text{dim.of m}}$$

$= [M L^{2}T^{-2}]. [M]^{-1}$
$= [M^{0}L^{2}T^{-2}]$

111. If C and R denote capacitance and resistance respectively, then the dimensional formula of CR is

(a) $[M^{0}L^{0}T]$
(b) $[M^{0}L^{0}T^{0}]$
(c) $[M^{0}L^{0}T^{-1}]$
(d) Not expressible in terms of [MLT]

[AIPMT-1995, 1992, 1988]
UPCPMT-2005, 1985, 1981

Ans. (a) :

$$\text{Capacitance } (C) = \frac{q}{v} = \frac{q}{\frac{w}{q}} = \frac{q^2}{w} = \frac{(it)^2}{F.d}$$

Where q = charge
C = Capacitance
v = voltage

$$= \frac{(it)^2}{Fx} = \frac{[AT]^2}{[ML^2T^{-2}]}$$

$$= [M^{-1}L^{-2}T^{4}A^{2}]$$

$$\text{and } R = \frac{V}{i} = \frac{w}{qi} = \frac{F.d}{i^2.t} = \frac{[MLT^{-2}][L]}{[A]^2[T]}$$

$[ML^{2}T^{-3}A^{-2}]$

Dimensional formula of CR

$= [M^{-1}L^{-2}T^{4}A^{2}][ML^{2}T^{-3}A^{-2}]$

$= [M^{0}L^{0}T^{1}]$

112. The dimensional formula for permeability of free space, μ_0 is

(a) $[MLT^{-2}A^{-2}]$ (b) $[ML–1T^{-2}A^{2}]$
(c) $[ML^{-1}T^{-2}A^{2}]$ (d) $[MLT^{-2}A^{-1}]$

UPCPMT-2007, AIIMS-2003
AIPMT-1993, 1991

Ans. (a) : The dimensional formula for permeability of free space,

$$\mu_0 = \frac{2\pi \times \text{force} \times \text{distance}}{\text{current} \times \text{current} \times \text{length}}$$

Dimension of force = $[MLT^{-2}]$
Dimension of current = [A]
Dimension of length and distance = [L]

$$\therefore \mu_0 = \frac{[MLT^{-2}][L]}{[A][A][L]}$$

$$\mu_0 = [MLT^{-2}A^{-2}]$$

113. $[ML^{-1}T^{-1}]$ stand for dimension of
(a) work
(b) torque
(c) linear momentum
(d) coefficient of viscosity

AIIMS-2010, UP CPMT-2001

Ans. (d) :
(i) Dimension of work
W = f.d
$W = [MLT^{-2}] [L] = [ML^2T^{-2}]$
(ii) Dimension of torque
T = f × r
$= [MLT^{-2}] [L]$
$T = [ML^2T^{-2}]$
(iii) Linear momentum
P = m.v.
$= [M] [LT^{-1}] = [MLT^{-1}]$
(iv) Dimension of coefficient of viscosity
$F = 6\pi\eta rv$

$$\eta = \frac{F}{6\pi r.v}$$

$$= \frac{[MLT^{-2}]}{[L][LT^{-1}]} = [ML^{-1}T^{-1}]$$

114. Percentage of Se in peroxidase anhydrous enzyme is 0.5% by weight (at wt. = 78.4) then minimum molecules weight of peroxidase anhydrous enzyme is
(a) 1.568×10^4
(b) 1.568×10^3
(c) 15.68
(d) 2.136×10^4

NEET-2001

Ans. (a) : Since, 0.5g Se = 100 gm peroxidase anhydrous enzyme

$$78.4\text{g Se} = \frac{100 \times 78.4}{0.5} = 1.568 \times 10^4$$

Minimum molecular mass of peroxidase anhydrous enzyme means molecule atleast contains one selenium atom.

115. The empirical formula of a compound is CH_2O. Its molecular weight is 180. The molecular formula of compounds is:
(a) $C_2H_4O_2$
(b) $C_3H_6O_3$
(c) $C_6H_{12}O_6$
(d) $C_5H_{10}O_5$

AIIMS-1999

Ans. (c): Given,
Molecular formula weight = 180
Empirical formula weight of CH_2O is = 12+2+16=30
We know that,

$$n = \frac{\text{Molecular formula weight}}{\text{Emperical formula weight}} = \frac{180}{30} = 6$$

Molecular formula = $6 \times CH_2O$
$= C_6H_{12}O_6$
Therefore, Molecular formula of compound is $C_6H_{12}O_6$

116. 60g of an organic compound on analysis is found to have, C=24 g, H=4 g and O=32g. The empirical formula of compound is:
(a) CH_2O
(b) C_2H_4O
(c) C_2H_2O
(d) $C_2H_2O_2$

AIIMS-1998

Ans. (a): Given, Organic compound = 60g
Mass of C = 24 g, mass of H = 4g , mass of O=32g
The ratio of number of gram atoms
C : H : O

$$\frac{24}{12} : \frac{4}{1} : \frac{32}{16}$$

2 : 4 : 2
The Empirical formula is = $C_2H_4O_2 = CH_2O$

117. The percentage of oxygen in NaOH is
(a) 16%
(b) 4%
(c) 40%
(d) 8%

AIIMS-1996

Ans. (c): Given that,
Molar mass of sodium atom = 23
Molar mass of oxygen atom = 16
Molar mass of hydrogen atom = 1
Total molar mass of NaOH = 40

$$\%\text{ composition of oxygen } = \frac{\text{Mass of oxygen}}{\text{Mass of NaOH}} \times 100$$

$$= \frac{16}{40} \times 100$$

= 40 %

118. Which of the following fertilizers has the highest nitrogen percentage?
(a) Ammonium sulphate
(b) Calcium cyanamide
(c) Urea
(d) Ammonium nitrate

NEET-1993

Ans. (c):
(a) Mass of N in $(NH_4)_2SO_4$ = 28 g
Mass of $(NH_4)_2SO_4$ = 132 g

$$\%\text{ of N in } (NH_4)_2SO_4 = \frac{28}{132} \times 100 = 21.2\%$$

(b) Mass of N in $CaCN_2$ = 28 g.
Mass of $CaCN_2$ = 80 g

$$\%\text{ of N} = \frac{28}{80} \times 100 = 35\%$$

(c) Mass of N in NH_2 $CONH_2$ = 28 g

Mass of NH_2CONH_2 = 60 g

$$\% \text{ of N} = \frac{28}{60}\times 100 = 46.6\%$$

(d) Mass of N in NH_4NO_3 = 28 g

Mass of NH_4NO_3 = 80g

$$\% \text{ of N} = \frac{28}{80}\times 100 = 35\%$$

1.5 Dimensional analysis, and its applications.

119. If L, C and R denote the inductance, capacitance and resistance respectively, the dimensional formula for C^2LR is

(a) $[ML^{-2}T^{-1}I^0]$ (b) $[M^0L^0T^3I^0]$

(c) $[M^{-1}L^{-2}T^6I^2]$ (d) $[M^0L^0T^2I^0]$

Manipal UGET-2014

UP CPMT-2014

Ans. (b) : We know that,

Dimension of Inductance (L) = $[ML^2T^{-2}I^{-2}]$

Dimension of Capacitance [C] = $[M^{-1}L^{-2}T^4I^2]$

Dimension of Resistance (R) = $[ML^2T^{-3}I^{-2}]$

So,

The dimension formula of C^2LR is

$C^2LR = [M^{-1}L^{-2}T^4I^2]^2\ [ML^2T^{-2}I^{-2}]\ [ML^2T^{-3}I^{-2}]$

$= [M^{-2}L^{-4}T^8I^4]\ [M^2L^4T^{-5}I^{-4}]$

$= [M^0L^0T^3I^0]$

120. If $P = \frac{RT}{V-b}e^{-\alpha V/RT}$, then dimensional formula of α is

(a) P (b) R

(c) T (d) V

UP CPMT-2010

Ans. (a) : Given $P = e^{-\frac{\alpha V}{RT}}\frac{RT}{V-b}$

$\frac{\alpha V}{RT}$ should be dimensionless

$$[\alpha] = \frac{[RT]}{[V]} \text{ ____(i)}$$

We know that $PV = nRT$

$$[P] = \frac{[nRT]}{[V]} \text{ ___(ii)}$$

From equation (i) and (ii)

$$\alpha = P$$

121. If E = energy , G = gravitational constant, I = impulse and M = mass, then dimensions of $\frac{GIM^2}{E^2}$

(a) time (b) mass

(c) length (d) force

UP CPMT-2006

Ans. (a) : The dimensional formula of given equation is : -

$$\frac{GIM^2}{E^2} = \frac{[M^{-1}L^3T^{-2}][MLT^{-1}][M]^2}{[ML^2T^{-2}]^2}$$

$$= \frac{[M^2L^4T^{-3}]}{[M^2L^4T^{-4}]}$$

$$= [M^0L^0T^1]$$

So, it is clear that dimensions of $\frac{GIM^2}{E^2}$ are same as that of the time.

122. In the relation $p = \frac{\alpha}{\beta}e^{-\alpha z/k\theta}$ p is pressure, Z is distance, k is Boltzmann constant and θ is the temperature. The dimensional formula of β will be

(a) $[ML^2T]$ (b) $[M^0L^2T^0]$

(c) $[ML^0T^{-1}]$ (d) $[M^0L^2T^{-1}]$

UP CPMT-2011

Ans. (b) : $p = \frac{\alpha}{\beta}e^{-\frac{\alpha z}{k\theta}}$

As we know that exponential term is dimensionless,

Dimension of α, $[\alpha] = \frac{[k][\theta]}{[z]}$

Where, k = Boltzmann constant

θ = Temperature

z = Distance

$$\alpha = \frac{[ML^2T^{-2}K^{-1}]\times[K]}{[L]}$$

$$\alpha = [MLT^{-2}]$$

$$[p] = \frac{[\alpha]}{[\beta]} \quad (\text{from equation})$$

$$\beta = \frac{[\alpha]}{[P]} = \frac{[MLT^{-2}]}{[ML^{-1}T^{-2}]} = [L^2] \text{ or}$$

$$\beta = [M^0L^2T^0]$$

123. Number of particles is given by

$n = -D\frac{n_2 - n_1}{x_2 - x_1}$ crossing a unit area perpendicular to X-axis in unit time, where n_1 and n_2 are number of particles per unit volume. Find dimensions of D called as diffusion constant

(a) $[M^0LT^{-2}]$ (b) $[M^0L^2T^{-4}]$

(c) $[M^0LT^{-3}]$ (d) $[M^0L^2T^{-1}]$

UP CPMT-2014

Ans. (d) : Given

Number of particles (n) = $-D\frac{n_2 - n_1}{x_2 - x_1}$

$n_1 = n_2$ = number of particles per unit volume = $[L^{-3}]$

So,

$$n = \frac{\text{Number of particles}}{A \times t} = \frac{[M^0L^0T^0]}{[L^2][T]} = [L^{-2}T^{-1}]$$

Now, from formula

$$[D] = \frac{[n][x_2 - x_1]}{[n_1 - n_2]} = \frac{[L^{-2}T^{-1}][L]}{[L^{-3}]} = [L^2T^{-1}]$$

124. An object is moving through the liquid the viscous damping force acting on it' is proportional to the velocity. then dimensional formula of constant of proportionality is

(a) $[ML^{-1}T^{-1}]$ (b) $[MLT^{-1}]$

(c) $[ML^0LT^{-1}]$ (d) $[ML^0T^{-1}]$

UP CPMT-2009

Ans. (d) :

$F \propto V$

$F = LV$

$$L = \frac{F}{V} = \frac{[MLT^{-2}]}{[LT^{-1}]}$$

$= [ML^{\circ}T^{-1}]$

125. If E, M, J and G respectively denote energy, mass, angular momentum and universal gravitational constant, the quantity, which has the same dimensions as the dimensions of $\frac{EJ^2}{M^5G^2}$

(a) Time (b) Angle

(c) Mass (d) Length

AP EAMCET -2013

Ans. (b) : E = Energy = $[ML^2T^{-2}]$

M = Mass = [M]

J = Angular momentum $[M^1L^2T^{-1}]$

G = Universal gravitational constant $[M^{-1}L^3T^{-2}]$

$$\frac{EJ^2}{M^5G^2} = \frac{[ML^2T^{-2}][M^1L^2T^{-1}]^2}{[M]^5[M^{-1}L^3T^{-2}]^2}$$

$$= \frac{[ML^2T^{-2}][M^2L^4T^{-2}]}{[M^5][M^{-2}L^6T^{-4}]}$$

$$= [M^0L^0T^0]$$

$[M^0L^0T^0]$ is dimension of angle.

126. The dimensional formula of $\frac{1}{2}\mu_0H^2$ (μ_0 = magnetic field intensity) is

(a) $[MLT^{-1}]$ (b) $[ML^2T^{-2}]$

(c) $[ML^{-1}T^{-2}]$ (d) $[ML^2T^{-1}]$

AP EAMCET -2011

Ans. (c) : $\frac{1}{2}\mu_0H^2$ is energy density of a magnetic field

Hence, its dimension is same as that of energy density.

$$\frac{1}{2}\mu_0H^2 = \frac{[ML^2T^{-2}]}{[L^3]}$$

$= [ML^{-1}T^{-2}]$

127. If velocity [v], time [T] and force [F] are choosen as the base quantities, the dimensions of the mass will be

(a) $[FT^{-1}v^{-1}]$ (b) $[FTv^{-1}]$

(c) $[FT^2v]$ (d) $[FvT^{-1}]$

[AIPMT 2014]

Ans. (b) : Let,

mass (m) $\propto F^a v^b T^c$ … (i)

$$m \propto [MLT^{-2}]^a [LT^{-1}]^b [T]^c$$

$$[M^1L^0T^0] \propto [M^aL^{a+b}T^{-2a-b+c}]$$

On comparing both side, we get

a = 1

$a + b = 0 \Rightarrow 1 + b = 0 \Rightarrow b = -1$

$-2a - b + c = 0 \Rightarrow -2 \times 1 - (-1) + c = 0, c = 1$

On putting value of a, b & c in equation (i), we get

Dimension of m = $[F]^1 [v]^{-1} [T] = [F v^{-1} T]$

128. The potential energy of a particle varies with distance x from a fixed origin as $v = \left(\frac{A\sqrt{x}}{x+B}\right)$; where, A and B are constants. The dimensions of AB are

(a) $[ML^{5/2}T^{-2}]$ (b) $[ML^2T^{-2}]$

(c) $[M^{3/2}L^{3/2}T^{-2}]$ (d) $[ML^{7/2}T^{-2}]$

JIPMER-2010

Ans. (d) : Given , $v = \frac{A\sqrt{x}}{x+B}$ ....(i)

Dimensions of v = dimensions of potential energy

= $[ML^2T^{-2}]$

From equation (i)

Dimensions of B = dimensions of x = $[M^0LT^0]$

∴ Dimensions of A

$$= \frac{\text{dimensions of } v \times \text{dimensions of } (x+B)}{\text{dimensions of } \sqrt{x}}$$

$$= \frac{[ML^2T^{-2}][M^0LT^0]}{[M^0L^{1/2}T^0]} = [ML^{5/2}T^{-2}]$$

Hence, dimensions of AB

$= [ML^{5/2}T^{-2}][M^0LT^0] = [ML^{7/2}T^{-2}]$

129. If energy (E), velocity (v) and time (T) are chosen as the fundamental quantities, the dimensional formula of surface tension will be

(a) $[Ev^{-2}T^{-1}]$ (b) $[Ev^{-1}T^{-2}]$
(c) $[Ev^{-2}T^{-2}]$ (d) $[E^{-2}v^{-1}T^{-3}]$

[AIPMT 2015]
AP EAMCET(Medical)-2009

Ans. (c) : We know that,

Surface Tension $[T] = \frac{\text{Force}}{\text{Length}}$

$$[T] = \frac{\text{Mass} \times \text{Acceleration}}{\text{Length}} \text{ …….. (i)}$$

and Energy (E) $= \frac{1}{2}mv^2$

$$m = \frac{E}{v^2} \times 2$$

$[M] = [Ev^{-2}]$

Now, in equation (i)

$$[T] = \frac{[Ev^{-2}][LT^{-2}]}{[L]}$$

$$[T] = [Ev^{-2}T^{-2}]$$

130. If dimensions of critical velocity V_c of a liquid flowing through a tube are expressed as $[\eta^x \rho^y r^z]$ r , where η, ρ and r are the coefficient of viscosity of liquid, density of liquid and radius of the tube respectively, then the values of x, y and z are given by

(a) 1, –1, –1 (b) –1, –1, 1
(c) –1, –1, –1 (d) 1, 1, 1

[AIPMT 2015]

Ans. (a) : We know that,

$$[V_c] = [M^0LT^{-1}]$$

$$\eta = \frac{F \times r}{A \times v}$$

$$[\eta] = \frac{[MLT^{-2}] \times [L]}{[L^2] \times [LT^{-1}]}$$

$$[\eta] = [ML^{-1}T^{-1}]$$

$$\rho = \frac{\text{Mass}[M]}{\text{Volume}[L^{-3}]}$$

$$[\rho] = [ML^{-3}]$$

$$[r] = [L]$$

We have given that the critical velocity is given as,

$$V_c = [\eta^x \rho^y r^z]$$

$$[M^0LT^{-1}] = [ML^{-1}T^{-1}]^x [ML^{-3}]^y [L]^z$$

$$[M^0LT^{-1}] = [M^{x+y}L^{-x-3y+z}T^{-x}]$$

Now, comparing the power of M, L and T on the both sides, we get

For M, $M^0 = M^{x+y}$

$x = -y$

For T, $T^{-1} = T^{-x}$

$-1 = -x$

$x = 1, y = -1$

For L, $L^1 = L^{-x-3y+z}$

$1 = -1 + 3 + z$

$z = -1$

So,

$x = 1$, $y = -1, -1$

131. If the dimensions of a physical quantity are given by $[M^a L^b T^c]$, then the physical quantity will be

(a) pressure if a = 1,b = −1,c = −2
(b) velocity if a =1, b =0, c = −1
(c) acceleration if a =1, b =1, c = −2
(d) force if a =0, b = −1, c = −2

[AIPMT 2009]

Ans. (a) : We know that-

$$P = \frac{F}{A}$$

Where, P = Pressure
F = Force
A = Area

$\therefore \quad P = \frac{[MLT^{-2}]}{[L^2]} \quad (\because \; F = [MLT^{-2}])$

or $\quad P = [ML^{-1}T^{-2}]$

The value of a, b and c are 1, –1 and –2 respectively.

$\because \quad V = \frac{S}{t}$

Where, v = velocity
s = displacement
t = time

$\therefore \quad V = \frac{[L]}{[T]}$

$v = [M^0LT^{-1}]$

Here, a = 0, b = 1 and c = –1

$\because \quad a = \frac{v}{t}$

Where a = acceleration
v = velocity
t = time

$\therefore \quad a = \frac{[LT^{-1}]}{[T]}$

or

$a = [M^0LT^{-2}]$

Here, a = 0, b =1 and c = –2

$\because \quad F = ma$

Where,
F = force
m = Mass
a = Acceleration

$\therefore \quad F = [M]\,[LT^{-2}]$

or $\quad F = [MLT^{-2}]$

Here, a = 1, b = 1 and c = –2

132. **The velocity υ of a particle at time t is given by $\upsilon = at + \frac{b}{t+C}$, where a, b and c are constants. The dimensions of a b, and c are respectively**

(a) $[LT^{-2}]$,[L] and [T] (b) $[L^2]$,[T] and $[LT^2]$
(c) $[LT^2]$,[LT] and [L] (d) [L],[LT] and $[T^2]$

[AIPMT 2006]

Ans. (a) : Given,

$$v = at + \frac{b}{t+c}$$

The dimension of v = The dimension of a.t = the dimension of $\frac{b}{t+c}$

Then,

The dimension of v = dimension of a.t

$[LT^{-1}]$ = a.t

$$a = \frac{[LT^{-1}]}{[T]}$$

The dimension of a = $[LT^{-2}]$

The dimension of b = [V] [T]

= $[LT^{-1}]$ [T]

= [L]

The dimension of c = [T]

Hence, option (a) is correct.

133. **According to Newton, the viscous force acting between liquid layers of area A and velocity gradient $\frac{\Delta v}{\Delta z}$ is given by $F = -\eta A\frac{dv}{dz}$, where η is constant called coefficient of viscosity. The dimensional formula of η is**

(a) $[ML^{-2}T^{-2}]$ (b) $[M^0L^0T^0]$
(c) $[ML^2T^{-2}]$ (d) $[ML^{-1}T^{-1}]$

[AIPMT 1990]

Ans. (d) : Given,

$$F = -\eta A\frac{dv}{dz}$$

where η is coefficient of viscosity

The dimensions of F = $[MLT^{-2}]$

The dimensions of A = $[L^2]$

The dimensions of dz = [L]

The dimensions of dv = $[LT^{-1}]$

$\therefore$ The dimensions of η

$$= \frac{[MLT^{-2}][L]}{[L^2][LT^{-1}]} = \frac{[ML^2T^{-2}]}{[L^3][T^{-1}]}$$

$\eta = [ML^{-1}T^{-1}]$

134. **Turpentine oil is flowing through a tube of length l and radius r. The pressure difference between the two ends of the tube is p. The viscosity of oil is given by $\eta = \frac{p(r^2 - x^2)}{4vl}$ where, v is the velocity of oil at distance x from the axis of the tube. The dimensions of η are**

(a) $[M^0L^0T^0]$ (b) $[MLT^{-1}]$
(c) $[ML^2T^{-2}]$ (d) $[ML^{-1}T^{-1}]$

[AIPMT 1993]

Ans. (d) : Given,

$$\eta = \frac{P(r^2 - x^2)}{4vl}$$

Where,

P = Pressure difference
r = radius
l = length
v = velocity
x = distance

The dimension of P = $[ML^{-1}T^{-2}]$

The dimension of $(r^2 - x^2)$ = $[L^2]$

The dimension of velocity = $[LT^{-1}]$

The dimension of distance = [L]

$$[\eta] = \frac{[P][r^2 - x^2]}{[v][L]} \Rightarrow [\eta] = \frac{[ML^{-1}T^{-2}][L^2]}{[LT^{-1}][L]}$$

$$[\eta] = \frac{[ML^1T^{-2}]}{[L^2T^{-1}]} = [ML^{-1}T^{-1}]$$

135. **The velocity of light 'c', the constant of gravitation 'G' and Planck's constant 'h' be chosen as fundamental units, the dimensions of mass in terms of c, G and h is**

(a) $[h^{1/2}c^{-3/2}G^{1/2}]$ (b) $[h^{1/2}c^{1/2}G^{-1/2}]$
(c) $[h^{1/2}c^{-5/2}G^{1/2}]$ (d) $[h^{1/2}c^{-1/2}G^{1/2}]$

AP EAMCET -2014

Ans. (b) : We know that, dimensional formula of

Speed of light [c] = $[LT^{-1}]$

Gravitational constant [G] = $[M^{-1}L^3T^{-2}]$

Planck's constant [h] = $[ML^2T^{-1}]$

Let formula of mass in term of c, G and h be

$M = c^x G^y h^z$

$[M] = [LT^{-1}]^x [M^{-1}L^3T^{-2}]^y [ML^2T^{-1}]^z$

$[M] = [M^{-y+z} L^{x+3y+2z} T^{-x-2y-z}]$

where,

$-y + z = 1$, $x + 3y + 2z = 0$, $-x - 2y - z = 0$

On solving, we get

$$x=\frac{1}{2}, y=-\frac{1}{2}, z=\frac{1}{2}$$

So, dimension of [M] = $[h^{1/2} c^{1/2} G^{-1/2}]$

136. **If m is mass Q is charge and B is magnetic induction, then $\frac{m}{BQ}$ has the same dimensions as:**

(a) frequency (b) $\frac{1}{\text{frequency}}$
(c) velocity (d) acceleration

AP EAMCET(Medical)-1999

Ans. (b) : Magnetic induction (B) = $ML^0T^{-2}A^{-1}$
Charge (Q) = TA
Mass (m) = M

Hence,

$$\frac{m}{BQ} = \frac{[M]}{[ML^0T^{-2}A^{-1}][TA]}$$

$$\frac{m}{BQ} = \frac{1}{[L^0T^{-1}A^0]}$$

$$\frac{m}{BQ} = [T]$$

$$\text{Time} = \frac{1}{\text{frequency}}$$

137. The dimensional formula of the product of two physical quantities P and Q is $[ML^2T^{-2}]$. The dimensional formula of $\frac{P}{Q}$ is $[MT^{-2}]$ P and Q respectively are:

(a) force, velocity
(b) momentum, displacement
(c) force, displacement
(d) work, velocity

AP EAMCET(Medical)-2001

Ans. (c) : Given, PQ = $[ML^2T^{-2}]$

$$\frac{P}{Q} = [MT^{-2}]$$

$$PQ \times \frac{P}{Q} = ML^2T^{-2} \times MT^{-2}$$

$$P^2 = M^2L^2T^{-4}$$

$$P = MLT^{-2} = \text{Force}$$

Now,

$$\frac{PQ}{\left(\frac{P}{Q}\right)} = \frac{PQ}{P} \times Q = \frac{ML^2T^{-2}}{MT^{-2}}$$

$$Q^2 = L^2$$

$$Q = L \quad = \text{Displacement}$$

138. According to Bernoulli's theorem $\frac{P}{d} + \frac{V^2}{2} + gh = \text{constant}$. The dimensional formula of the constant is: (P = pressure, d = density, h = height, V = velocity and g = acceleration due to gravity)

(a) $[M^0L^0T^0]$ (b) $[M^0LT^0]$
(c) $[M^0L^2T^{-2}]$ (d) $[M^0L^2T^{-4}]$

AP EAMCET(Medical)-2005

Ans. (c) : Bernoulli's theorem $\frac{P}{d} + \frac{V^2}{2}$ + gh = constant

Dimensional formula of the constant is same as dimensional formula of $\frac{P}{d}, \frac{V^2}{2}$, gh.

So, dimensional formula of gh = $[LT^{-2}][L]$
$= [L^2T^{-2}]$
$= [M^0L^2T^{-2}]$

139. The van der Waal's equation for n moles of a real gas is

$$\left(p + \frac{a}{V^2}\right)(V - b) = nRT$$

Where p is pressure, V is volume, T is absolute temperature, R is molar gas constant a, b and c are van der Waal's constants. The dimensional formula for ab is

(a) $[ML^8L^{-2}]$ (b) $[ML^6L^{-2}]$
(c) $[ML^4L^{-2}]$ (d) $[ML^2L^{-2}]$

AP EAMCET(Medical)-2012

Ans. (a) : P must be same as $\frac{a}{V^2}$

Hence, $\frac{[a]}{L^6} = [ML^{-1}T^{-2}]$

$$[a] = [ML^5T^{-2}]$$

The dimension of b must be same as that of V

Hence, $[b] = L^3$

$$[ab] = [ML^8T^{-2}]$$

140. In the equation $\left(\frac{1}{p\beta}\right) = \frac{y}{K_BT}$, where p is the pressure, y is the distance, K_B is Boltzmann constant and T is the temperature Dimensions of β are

(a) $[M^{-1}L^1T^2]$ (b) $[M^0L^2T^0]$
(c) $[M^1L^{-1}T^{-2}]$ (d) $[M^0L^0T^0]$

AP EAMCET(Medical)-2013

Ans. (b) : From the equation $= \frac{1}{p.\beta} = \frac{y}{K_BT}$

$$\beta = \frac{K_BT}{p.y} = \frac{[ML^2T^{-3}][T]}{[ML^{-1}T^{-2}][L]}$$

$$= \frac{[ML^2T^{-2}]}{[ML^0T^{-2}]} = [M^0L^2T^0]$$

Hence, the dimension of β is $[L^2]$

141. Which of the following physical quantities represent the dimensions of $\frac{b}{a}$ in the relation $P = \frac{x^2 - b}{at}$, where P is power, x is distance and t is time

(a) Power (b) Surface tension
(c) Torsional constant (d) Force

AP EAMCET(Medical)-2016

Ans. (c) : Given,

$$P = \frac{x^2 - b}{at}$$

The dimension of b = The dimension of x^2

$\therefore \quad [b] = [L^2]$------------(1)

Also,

$[P] = [M^1L^2T^{-3}]$

$[t] = [T^1]$

$[a] = \frac{[b]}{[P][t]} = \frac{[L^2]}{[ML^2T^{-3}][T]}$

$[a] = [M^{-1}T^2]$---------------(2)

$\therefore \quad \frac{[b]}{[a]} = \frac{[L^2]}{[M^{-1}T^2]} = [ML^2T^{-2}]$---------(3)

Torsional constant $k = \frac{\tau}{\theta}$

$\therefore \quad [k] = [\tau]$

$[k] = [ML^2T^{-2}]$-------------(4)

From 3 and 4,

$\frac{[b]}{[a]} = k$

142. The velocity of water waves (v) may depend on their wavelength λ, the density of water ρ and the acceleration due to gravity g. The method of dimensions gives the relation between these quantities is

(a) v
(b) $v^2 \propto g\lambda$
(c) $v^2 \propto g\lambda^2$
(d) $v^2 \propto g^{-1}\lambda^2$

AIIMS-26.05.2018(E)

Ans. (b) : Let, $v \propto \lambda^a\rho^b g^c$

The dimensional formula for all quantities we get,

$[LT^{-1}] \propto [L]^a[ML^{-3}]^b[LT^{-2}]^c$

$[M^0L^1T^{-1}] \propto [M^b L^{a-3b+c} T^{-2c}]$

Comparing power of M,L and T

b = 0, $\quad a - 3b + c = 1, \quad$ and $\quad -2c = -1$

$a - 3 \times 0 + \frac{1}{2} = 1 \qquad c = \frac{1}{2}$

$a = 1 - \frac{1}{2} = \frac{1}{2}$

$a = \frac{1}{2}$

$\therefore \quad v \propto \lambda^{1/2}\rho^0 g^{1/2}$

$v = \sqrt{\lambda g}$

So, $\quad v^2 \propto \lambda g$

143. The speed of light (c), gravitation constant (G), and Plank's constant (h) are taken as the fundamental units in a system. The dimension of time in this new system should be:

(a) $\left[G^{1/2} h^{1/2} c^{-5/2}\right]$
(b) $\left[G^{-1/2} h^{1/2} c^{1/2}\right]$
(c) $\left[G^{1/2} h^{1/2} c^{-3/2}\right]$
(d) $\left[G^{1/2} h^{1/2} c^{1/2}\right]$

AIIMS-2008

Ans. (a) : dimension

$[C] = LT^{-1}$

$[G] = M^{-1}L^3T^{-2}$

$[h] = M^1L^2T^{-1}$

Let $\quad t \propto c^x\, G^y h^z$

$T = (LT^{-1})^x (M^{-1}L^3T^{-2})^y (ML^2T^{-1})^z$

$= [M]^{-y+z}\,[L]^{x+3y+2z}\,[T]^{-x-2y-z}$

By equating

$-y + z = 0$ ___(i)

$x + 3y + 2z = 0$ ___(ii)

$-x - 2y - z = 1$ ___(iii)

By Solving eq^n (i), (ii) & (iii)

We get, $x = \frac{-5}{2},\ y = \frac{1}{2},\ z = \frac{1}{2}$

$[t] = [C^{-5/2}G^{1/2}h^{1/2}]$

144. If the force is given by F = at + bt² with t as time. The dimensions of a and b are

(a) $[MLT^{-4}]$ and $[MLT^{-2}]$
(b) $[MLT^{-3}]$ and $[MLT^{-4}]$
(c) $[ML^2T^{-3}]$ and $[ML^2T^{-2}]$
(d) $[ML^2T^{-3}]$ and $[ML^3T^{-4}]$

JIPMER-2013, 2005,
AP EAMCET -2010, BCECE-2003

Ans. (b) : Given, $F = at + bt^2$

Dimension of F = Dimension of at

$[MLT^{-2}] = a[T]$

$a = \frac{[MLT^{-2}]}{[T]}$

$a = [MLT^{-3}]$

Dimension of F = Dimension of bt^2

$F = bt^2$

$[MLT^{-2}] = b[T]^2$

$b = \frac{[MLT^{-2}]}{[T^2]}$

$b = [MLT^{-4}]$

145. The equation of state of some gases can be expressed as

$$\left(p + \frac{a}{V^2}\right)(V - b) = RT$$

where, p is the pressure, V the volume, T the absolute temperature and a and b are constants. The dimensional formula of a is

(a) $[ML^5T^{-2}]$
(b) $[M^{-1}L^5T^{-2}]$
(c) $[ML^{-1}T^{-2}]$
(d) $[ML^{-5}T^{-2}]$

UPCPMT-1997

Ans. (a) : According to the principle of dimensional homogeneity the dimensions of each the terms of a dimensional equation on both sides are the same.

So, dimension of p and $\frac{a}{V^2}$ will be same

$$p = \left[\frac{a}{V^2}\right]$$
$$a = [p]\left[V^2\right]$$
$$a = \left[ML^{-1}T^{-2}\right]\left[L^6\right]$$
$$a = \left[ML^5T^{-2}\right]$$

146. The frequency of vibration f of a mass m suspended from a spring of spring constant k is given by a relation of the type f = Cm^x k^y, where C is a dimensionless constant. The values of x and y are

(a) $x = \frac{1}{2}, y = \frac{1}{2}$ (b) $x = -\frac{1}{2}, y = -\frac{1}{2}$

(c) $x = \frac{1}{2}, y = -\frac{1}{2}$ (d) $x = -\frac{1}{2}, y = \frac{1}{2}$

[AIPMT 1990]

Ans. (d) : Given,

$f = Cm^x.K^y$

where, C = dimensionless constant

m = mass

K = spring constant

The dimension of frequency, f = $[T^{-1}]$

The dimension of mass, m = [M]

The dimension of spring constant, k = $[MT^{-2}]$

$F = Cm^x.K^y$

$[M^0L^0T^{-1}] = [M]^x [MT^{-2}]^y$

$[M^0L^0T^{-1}] = [M^{x+y}. T^{-2y}]$

x + y = 0 and –2y = –1

$x = -y$ and $y = \frac{1}{2}$

$\Rightarrow x = -\frac{1}{2}, y = \frac{1}{2}$

147. If p represents radiation pressure, c represents speed of light and S represents radiation energy striking unit area per sec. The non-zero integers x, y, z such that p^x S^y c^z is dimensionless are

(a) x = 1, y = 1, z = 1 (b) x = –1, y = 1, z = 1

(c) x = 1, y = –1, z = 1 (d) x = 1, y = 1, z = –1

[AIPMT 1992], UPCPMT-1992, 1981

Ans. (c) : Given,

P = radiation pressure

C = speed of light

S = radiation energy

x,y and z are non zero intezers.

$[P^x S^y C^z] = [M^0L^0T^0]$ …(i)

The dimension of P = $[ML^{-1}T^{-2}]$

The dimension of S = $[MT^{-3}]$

The dimension of C = $[LT^{-1}]$

Putting the dimension in equation (i)

$[ML^{-1}T^{-2}]^x [MT^{-3}]^y. [LT^{-1}]^z = [M^0L^0T^0]$

$[M^{x+y}.L^{-x+z}.T^{-2x-3y-z}] = [M^0L^0T^0]$

x + y = 0 …(ii)

z – x = 0 …(iii)

–2x – 3y – z = 0 …(iv)

From equation (iii)

x = z

From equation (ii)

∴ z = –y

By solving, we get,

x = 1, y = –1, z = 1

Hence, option (c) is correct.

148. If the capacitance of a nanocapacitor is measured in terms of a unit 'u' made by combining the electric charge 'e', Bohr radius 'a$_0$', Planck's constant 'h' and speed of light 'c' then

(a) $u = \frac{e^2h}{a_0}$ (b) $u = \frac{hc}{e^2a_0}$

(c) $u = \frac{e^2c}{ha_0}$ (d) $u = \frac{e^2a_0}{hc}$

AIIMS-2016

Ans. (d) : Let 'u' related with e, a_0, h and c as

$[u] = [e]^a [a_0]^b [h]^c [c]^d$ .....(i)

Using dimension formula,

$\left[M^{-1}L^{-2}T^4A^2\right] = \left[A^1T^1\right]^a [L]^b \left[ML^2T^{-1}\right]^c \left[LT^{-1}\right]^d$

$\left[M^{-1}L^{-2}T^4A^2\right] = \left[M^cL^{b+2c+d}T^{a-c-d}A^a\right]$

Comparing power

a = 2, c = –1,

a – c – d = 4

d = – 4 + 3 = –1

Putting the value of d,

b + 2c + d = –2

b = 1

Hence, a = 2, b = 1, c = –1, d = –1

Putting the value of a, b, c, d in equation (i)

$u = e^2 a_0^1 h^{-1}c^{-1}$

$\therefore \quad u = \frac{e^2a_0}{hc}$

149. The equation $\left(p + \frac{a}{V^2}\right)(V - b)$ = constant. The units of a is

(a) Dyne × cm^5 (b) Dyne × cm^4

(c) Dyne/cm^3 (d) Dyne/cm^2

UP CPMT-2014

Ans. (b) : Given that,

$$\left(P + \frac{a}{V^2}\right)(V - b) = \text{constant}$$

In the term $\left(P+\frac{a}{V^2}\right)$, the units of p and $\frac{a}{V^2}$ are the same

$\therefore$ $a = PV^2$ [here v is the volume]

$\therefore$ Unit of a = unit of P × unit of v^2

$\therefore$ Unit of a = $\frac{\text{dyne}}{\text{cm}^2}\times\left(\text{cm}^3\right)^2$

$= \frac{\text{dyne}}{\text{cm}^2}\times \text{cm}^6$

$= \text{dyne}\times\text{cm}^4$

Note:– Here we use CGS system. In SI system unit of a is $N\text{-}m^4$

150. If $x = at + bt^2$, where x is the distance travelled by the body in kilometer while t is the time in second, then the unit of b is

(a) km/s (b) km-s
(c) km/s^2 (d) $km\text{-}s^2$

[AIPMT 1989]

Ans. (c) : Given that,
$x = at + bt^2$ (where x is distance)
From principle of Homogeneity
$[x] = [at] = [bt^2]$
$[L] = b[T^2] \Rightarrow b = [LT^{-2}]$
So, Unit of b = km/s^2

151. 20.0 g of magnesium carbonate sample decomposes on heating to give carbon dioxide and 8.0 g magnesium oxide. What will be the percentage purity of magnesium carbonate in the sample?
(At. wt. of Mg = 24)

(a) 96 (b) 60
(c) 84 (d) 75 **NEET-2015**

Ans. (c) : $MgCO_3(s)\xrightarrow{\Delta}MgO(s)+CO_2(g)$

Molar mass of $MgCO_3$ = 24 +12 + 48 = 84g/mol
Molar mass of MgO = 24 + 16 = 40g/mol
$\therefore$ 84g of $MgCO_3$ ≡ 40g of MgO

And 20g of $MgCO_3 \equiv \frac{40}{84}\times 20 = 9.52$ g of MgO

But actual yield = 8g of MgO

$\therefore$ % purity = $\frac{8}{9.52}\times 100 = 84\%$

152. The reaction of calcium with water is represented by the equation:
$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$
What volume of H_2 at STP would be liberated when 8 g of calcium completely reacts with water?

(a) $0.2cm^3$ (b) $0.4cm^3$
(c) $2240cm^3$ (d) $4480cm^3$

AIIMS-2010

Ans. (d): $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$
40 gm of Ca on complete reaction with water liberates = 2 gm H_2

$\therefore$ 8 gm of Ca, on complete reaction with water will liberates = $\frac{2}{40}\times 8\,\text{gm}$ H_2 = 0.40 gm H_2

At STP, 2g of H_2 have the volume = 22.4 litre = 22400 cm^3

$\therefore$ 0.40 gm of H_2 having = $\frac{0.40}{2}\times 22400\,\text{cm}^3$

= 4480 cm^3 of H_2 at S.T.P.

153. What is the stoichiometric coefficient of Ca in the reaction?
$Ca + Al^{3+} \rightarrow Ca^{2+} + Al$

(a) 2 (b) 1
(c) 3 (d) 4 **UP CPMT-2007**

Ans. (c) : $Ca \rightarrow Ca^{2+} + 2e^-$ ……(i)
$Al^{3+} + 3e^- \rightarrow Al$ …...(ii)
Eq. (i) multiply by 3 and Eq. (ii) multiply by 2, and add Eqs. (i) and (ii)
$3Ca \rightarrow 3Ca^{2+} + 6e^-$
$2Al^{3+} + 6e^- \rightarrow 2Al$

$3Ca + 2Al^{3+} \rightarrow 3Ca^{2+} + 2Al$

Therefore, the stoichiometric coefficient of Ca in the given reaction is 3.

154. Value of x in potash alum, $K_2SO_4.Al_x(SO_4)_3\cdot 24H_2O$ is

(a) 4 (b) 1
(c) 2 (d) None of these

UP CPMT-2007

Ans. (c) : Potash alum is double salt.
Given Potash alum, $K_2SO_4\cdot Al_x(SO_4)_3\cdot 24H_2O$ ... (1)
But formula of potash alum is
$K_2SO_4\cdot Al_2(SO_4)_3\cdot 24H_2O$ ... (2)
After comparing both equations,
Value of x = 2

155. During electrolysis of water the volume of O_2 liberated is 2.24 dm^3. The volume of hydrogen liberated, under same conditions will be

(a) 2.24 dm^3 (b) 1.12 dm^3
(c) 4.48 dm^3 (d) 0.56 dm^3

AIIMS-2008

Ans. (c) : $\underset{2\,\text{Vol.}}{2H_2O}\xrightarrow{\text{Electrolysis}}\underset{2\,\text{Vol.}}{2H_2}+\underset{1\,\text{Vol.}}{O_2}$

The volume of hydrogen liberated is twice that of the volume of oxygen liberated. When 2.24 dm^3 of oxygen is liberated the volume of hydrogen liberated will be 2 × 2.24 dm^3 or 4.48 dm^3.

156. The weight of one molecule of a compound of molecular formula $C_{60}H_{122}$ is

(a) 1.2×10^{-20}g (b) 5.025×10^{-23}g
(c) 1.4×10^{-21}g (d) 6.023×10^{-20}g

AIIMS-2002

Ans. (c) : The molecular weight of $C_{60}H_{122}$ is 842g/mol
one mole of $C_{60}H_{122}$ weight 6.02 × 10^{23}g.
Weight of one molecule of $C_{60}H_{122}$ is

$\frac{842}{6.02\times10^{23}} = 1.4\times10^{-21}$g

02.

Kinematics

2.1 The frame of reference

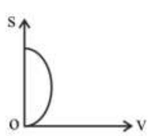
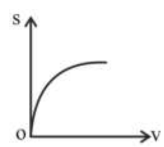
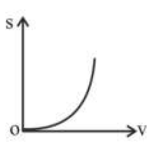
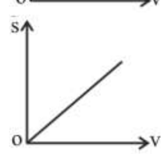
1. Assertion: The driver in a vehicle moving with a constant speed on a straight road is an inertial frame of reference.
Reason: A reference frame in which Newton's laws of motion are applicable is non-inertial.

(a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

AIIMS-2009

Ans. (c) : Here, assertion is correct but reason is wrong. A vehicle moving with constant velocity on a straight road is an inertial frame of reference. But, a reference frame in which Newton's laws of motion are applicable is known as inertial frame.
A reference frame in which Newton's laws of motion are not applicable is known as Non-inertial frame of reference. Example: Rotational frame of reference.

2. An object is moving with a uniform acceleration which is parallel to its instantaneous direction of motion. The displacement (s) - velocity (v) graph of this object is ______

(a)

(b)

(c)

(d)


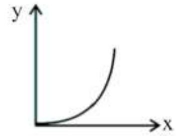
AIIMS-2003

Ans. (c) :
From Newton's third equation of motion,

$v^2 - u^2 = 2as$

$v^2 = 2as \quad [\because u = 0]$

We know,
Parabola equation, $x^2 = 2ay$

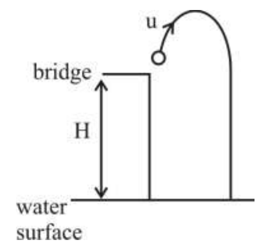
2.2 Motion in a straight line

3. A horizontal bridge is built across a river. A student standing on the bridge throws a small ball vertically upwards with a velocity 4 m s^{-1}. The ball strikes the water surface after 4s. The height of bridge above water surface is (Take g = 10 m s^{-2}) :

(a) 68 m (b) 56 m
(c) 60 m (d) 64 m

NEET (UG)-07.05.2023

Ans. (d) :



By equation of motion –

$$S = ut - \frac{1}{2}gt^2$$

$$-H = 4\times4 - \frac{1}{2}\times10\times(4)^2$$

$$-H = 16 - 80$$

$$-H = -64$$

H = 64 cm

4. A bullet from a gun is fired on a rectangular wooden block with velocity u. When bullet travels 24 cm through the block along its length horizontally, velocity of bullet becomes $\frac{u}{3}$, .Then it further penetrates into the block in the same direction before coming to rest exactly at the other end of the block. The total length of the block is :

(a) 30 cm (b) 27 cm
(c) 24 cm (d) 28 cm

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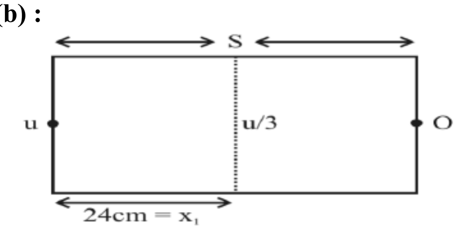
Ans. (b) :



By using eq^n of motion –

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

$$\left(\frac{u}{3}\right)^2 = u^2 - 2a \times 24$$

$$24 \times 2a = \frac{8u^2}{9} \quad ...(i)$$

Now, again using eq^n of motion –

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

$$0 = u^2 - 2as$$

$$u^2 = 2as \quad ...(ii)$$

On dividing eq^n (i) by eq^n (ii) we get

$$\frac{24 \times 2a}{2as} = \frac{8u^2}{9} \times \frac{1}{u^2}$$

$$\frac{24}{s} = \frac{8}{9}$$

$$\boxed{s = 27 \text{ cm}}$$

5. A particle of mass 100 g is thrown vertically upwards with a speed of 5 m/s. The work done by the force of gravity during the time the particle goes up is

(a) –0.5 J (b) –1.25 J
(c) 1.25J (d) 0.5J

JIPMER-2009, 2014

Ans. (b) : Given, m = 100 g, u = 5 m/sec
From third equation of motion,

$$v^2 = u^2 - 2gh$$

$$0 = 25 - 2 \times 10h$$

$$h = 1.25 \text{ m}$$

Work done by gravity (W_g) = – mgh
= – 0.1 × 10 × 1.25
= – 1.25 J

6. Velocity-time curve for a body projected vertically upwards is

(a) Parabola (b) Ellipse
(c) Hyperbola (d) Straight line

JIPMER-2011

Ans. (d) : Velocity–time curve for a body projected vertically upward is a straight line because the acceleration due to gravity is constant and opposite to the direction of initial velocity.
$v = u_0 - gt$, which is a straight line with slope negative.

7. When a bomb is released from an aeroplane. the path described by it as observed by the pilot is

(a) Straight line
(b) Projectile
(c) Depends on speed of aeroplane
(d) None

AP EAMCET (Medical)-05.10.2021, Shift-I

Ans. (a) : When a bomb is released from an aeroplane. the path described by it as observed by the pilot is straight line.

8. Assertion: A body can have acceleration even if its velocity is zero at a given instant of time.
Reason: A body is numerically at rest when it reverses its direction.

(a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct.

AIIMS-1998

Ans. (a): When body going vertically upward reaches at the highest point. Then, it is numerically at rest when it reverses its direction. At the highest point of motion, its velocity is zero but its acceleration is equal to acceleration due to gravity.

9. A man is at a height of 100 m. He sees a car which makes an angle of $\frac{\pi}{6}$ with man's position. If the car moves to a point where angle is $\frac{\pi}{3}$, what is the distance moved by it ?

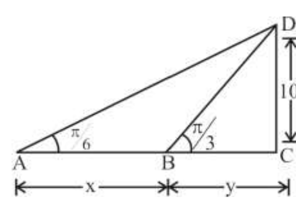
(a) $\left(\frac{100}{\sqrt{3}}\right)$m (b) $\left(200\sqrt{3}\right)$m
(c) $\left(\frac{200}{\sqrt{3}}\right)$m (d) $\left(\frac{150}{\sqrt{3}}\right)$m

UP CPMT-2003

Ans. (c) : A man is at a height of 100m. He sees a car which makes an angle of $\frac{\pi}{6}$ with man's position.

If the car moves to a point where angle is $\frac{\pi}{3}$

Let,



In ΔBCD

$$\tan\frac{\pi}{3} = \frac{DC}{BC}$$

$$\Rightarrow \quad \sqrt{3} = \frac{100}{y}$$

$$\Rightarrow \quad y = \frac{100}{\sqrt{3}}$$

Now,

In ΔACD

$$\tan\frac{\pi}{6} = \frac{DC}{AC}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{100}{AB + BC}$$

$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{100}{x + y}$$

$$\Rightarrow \quad x + y = 100\sqrt{3}$$

Put the value of y in above equation

$$x + \frac{100}{\sqrt{3}} = 100\sqrt{3}$$

$$x = 100\sqrt{3} - \frac{100}{\sqrt{3}}$$

$$x = \frac{100 \times 3 - 100}{\sqrt{3}}$$

$$x = \frac{300 - 100}{\sqrt{3}}$$

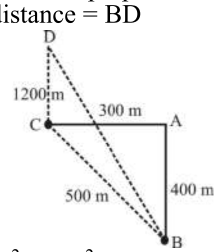
$$x = \frac{200}{\sqrt{3}} m$$

10. An aeroplane moves 400 m towards the north, 300 m towards west and then 1200 m vertically upwards, then its displacement from the initial position is

(a) 1600 m (b) 1800 m
(c) 1500 m (d) 1300 m

AIIMS-1998

Ans. (d) : Here, CD is perpendicular to the plane of paper. Required distance = BD



$CB^2 = BA^2 + AC^2$
$CB^2 = 400^2 + 300^2$
$CB = \sqrt{400^2 + 300^2} = 500 \, m$
$BD^2 = CB^2 + CD^2$
$BD^2 = 500^2 + 1200^2$
$BD = \sqrt{500^2 + 1200^2} = 1300 \, m$

11. The ratio of displacement to distance for a moving particle is

(a) Always less than one
(b) Always greater than one
(c) Always one
(d) One or less than one **JIPMER-2011**

Ans. (d) : Displacement is the shortest length between the start and end of a journey, while distance is the actual length of the path travelled.
Hence the distance will always be equal to or greater than the displacement.

$\therefore$ Distance $\geq$ Displacement

$$1 \geq \frac{\text{Displacement}}{\text{Distance}}$$

So, $\frac{\text{Displacement}}{\text{Distance}}$ is equal one or less than one

2.3 Uniform and non-uniform motion,

12. Which motion does not require force to maintain it?

(a) Uniform circular motion
(b) Elliptical motion
(c) Uniform straight line motion
(d) Projectile motion

UP CPMT-2007

Ans. (c) : Uniform straight line motion is a type of linear motion. It work according to Newton's first law of motion i.e. objects that do not experience any net force will continue to move in straight line with a constant velocity until they are subjected to a net force.

13. Assertion : A body may be accelerated even when it is moving uniformly.
Reason: When direction of motion of the body is changing, the body must have acceleration.

(a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect. **AIIMS-26.05.2018(M)**

Ans. (d) : The uniform motion of a body means that the body is moving with constant velocity, but if the direction of motion is changing (such as in uniform circular motion), its velocity changes and thus acceleration is produced in uniform motion.

14. Assertion: The equation of motion can be applied only if acceleration is along the direction of velocity and is constant.
Reason: If the acceleration of the body is constant then its motion is known as uniform motion.

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

AIIMS-26.05.2019(E) Shift-2

Ans. (d): Equation of motion can be applied if the acceleration is in opposite direction to that of velocity and uniform motion mean the acceleration is zero.
Hence, both assertion and reason are false.

15. Assertion (A) : An object can possess acceleration even at a time when it has a uniform speed.
Reason (R) : It is possible when the direction of motion keeps changing.

(a) Both A and R are true and R is a correct explanation for A
(b) Both A and R are true but R is not a correct explanation for A

(c) A is true. R is false
(d) A is false. R is true

AP EAMCET (Medical)-05.10.2021, Shift-I

Ans. (a) : Both A and R are true and R is correct explanation for A
We know that, An object can possess acceleration even at a time when it has uniform speed because, it is possible when the direction of motion keeps changing.
e.g. Uniform circular motion

16. An athlete completes one round of a circular track of radius R in 40 s. What will be his displacement at the end of 2 min 20 s ?

(a) 7R (b) 2R
(c) $2\pi R$ (d) $7\pi R$

AP EAMCET -2010

Ans. (b) : t = 2 min 20 sec = 140 sec
1 round of a circular track of radius R in 40 sec
3 round of a circular track of radius R in 120 s.
Then displacement zero.
t = 120 sec
$\Delta t = 140 - 120 = 20$ sec
Displacement = Diameter of circular track
$= 2 \times R = 2R$

17. A wheel of circumference C is at rest on the ground. When the wheel rolls forward through half a revolution, then the displacement of initial point of contact will be

(a) $C\sqrt{\frac{1}{\pi^2}+\frac{1}{4}}$ (b) $\frac{C}{2}$
(c) $\pi\sqrt{C^2+4}$ (d) $C\sqrt{\frac{1}{\pi}+\frac{1}{2}}$

AP EAMCET(Medical)-2016

Ans. (a) : Let horizontal distance = x
and vertical distance = y
Circumference of wheel = C

$\therefore \quad x = \frac{C}{2}$ and $Y = \frac{C}{\pi}$

$\therefore$ Total displacement, $d = \sqrt{x^2+y^2}$

$$d = \sqrt{\left(\frac{C}{2}\right)^2+\left(\frac{C}{\pi}\right)^2}$$

$$\therefore \quad d = C\sqrt{\frac{1}{4}+\frac{1}{\pi^2}} = C\sqrt{\frac{1}{\pi^2}+\frac{1}{4}}$$

2.4 Average speed and instantaneous velocity

18. A vehicle travels half the distance with speed θ and the remaining distance with speed 2θ. Its average speed is :

(a) $\frac{3\theta}{4}$ (b) $\frac{\theta}{3}$
(c) $\frac{2\theta}{3}$ (d) $\frac{4\theta}{3}$

NEET (UG)-07.05.2023

Ans. (d) :

$$\text{Average speed} = \frac{\text{total distance travelled}}{\text{total time taken}}$$

$$= \frac{L}{\frac{L/2}{\theta}+\frac{L/2}{2\theta}} = \frac{1}{\frac{1}{2\theta}+\frac{1}{4\theta}} = \frac{4}{3}\theta$$

$$\boxed{\text{Average speed} = \frac{4}{3}\theta}$$

19. A person walks along a straight road from his house to a market 2.5 km away with a speed of 5 km/h and instantly turns back and reaches his house with a speed of 7.5 km/h. The average speed of the person during the time interval 0 to 50 min is (in m/s)

(a) $4\frac{2}{3}$ (b) $\frac{5}{3}$
(c) $\frac{5}{6}$ (d) $\frac{1}{3}$

AP EAMCET -2014

Ans. (b) : Given,
Total time = 50 minutes = 50×60 = 3000 sec
Total distance = 2.5 + 2.5 = 5 km = 5000 m

$\therefore$ Average speed of the person $= \frac{\text{Total distance}}{\text{Total time}}$

$$V_{avg} = \frac{5000}{3000} = \frac{5}{3}$$

$$\boxed{V_{avg} = \frac{5}{3}}$$

So, average speed of the person during the time interval 0 to 50 is 5/3 m/s

20. A car travelling on a straight track moves with uniform velocity of ν_1 for same time and with uniform velocity ν_2 of next equal time. The average velocity is given by :

(a) $\sqrt{\nu_1\nu_2}$ (b) $\frac{\nu_1+\nu_2}{2}$
(c) $\left(\frac{1}{\nu_1}+\frac{1}{\nu_2}\right)$ (d) $\left(\frac{1}{\nu_1}+\frac{1}{\nu_2}\right)^{-1}$

AP EAMCET(Medical)-1998

Ans. (b) : Given that,
• Uniform velocity of A car = V_1
Time = t
• Then with velocity V_2 for time t the displacement in time 2t sec.

$d_1 + d_2 = d$
$d = v_1 t + v_2 t$ [$\because$ distance = velocity time]
$d = (v_1 + v_2)\, t$

So, Average velocity $= \frac{\text{total distance}}{\text{total time}}$

$$= \frac{(v_1+v_2)t}{2t} = \frac{v_1+v_2}{2}$$

21. **Assertion: Retardation is directly opposite to the velocity.**
Reason: Retardation is equal to the time rate of decrease of speed.
(a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.
(e) If the Assertion is incorrect but the Reason is correct. **AIIMS-2002**

Ans. (a): Acceleration is the time rate of increase of velocity but retardation is negative of acceleration.

$$\text{Retardation} = \frac{\text{Decrease velocity}}{\text{Time}}$$

Retardation is the rate of decrease of velocity with time and also retardation acts in the direction opposite to that of velocity.

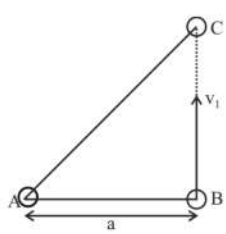
22. **Two boys are standing at the ends A and B of a ground, where AB = a. The boy at B starts running in a direction perpendicular to AB with velocity v_1. The boy at A starts running simultaneously with velocity v and catches the other boy is a time t, where t is**

(a) $\frac{a}{\sqrt{v^2+v_1^2}}$ (b) $\sqrt{\frac{a^2}{v^2-v_1^2}}$

(c) $\frac{a}{\left(v^2-v_1\right)}$ (d) $\frac{a}{\left(v+v_1\right)}$

JIPMER- 2007

Ans. (b) :



$BC = v_1 \times t$
$AC = v \times t$
$\therefore \quad AC^2 = AB^2 + BC^2$
$(vt)^2 = a^2 + (v_1 \times t)^2$
$v^2t^2 = a^2 + v_1^2 \times t^2$
$v^2t^2 - v_1^2t^2 = a^2$
$t^2(v^2 - v_1^2) = a^2$

$$t = \sqrt{\frac{a^2}{(v^2-v_1^2)}}$$

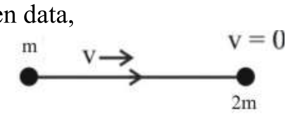
23. **A particle of mass m moving with velocity v collides with a stationary particle of mass 2m. The speed of the system, will be**

(a) 3v (b) $\frac{v}{2}$

(c) $\frac{v}{3}$ (d) 2v

JIPMER-2004

Ans. (c): Given data,



$m_1 = m \qquad u_1 = v$
$m_2 = 2m \qquad u_2 = 0$

Now,
Law of conversion of linear momentum

$m_1u_1 + m_2u_2 = (m_1 + m_2)V \qquad \ldots (i)$

Putting value in equation (i)

$m \times v + 2m \times 0 = (m + 2m)\, V$
$mv = (3m)V$

$$V = \frac{mv}{3m}$$

$$V = \frac{v}{3}$$

24. **A police jeep is chasing with velocity of 45 km/h. A thief in another jeep moving with velocity 153 km/h. Police fires a bullet with muzzle velocity of 180 m/s. The velocity it will strike the car the thief is**

(a) 150 m/s (b) 27 m/s
(c) 450 m/s (d) 250 m/s

JIPMER-2005

Ans. (a) : Given,
Velocity of police Jeep = 45 km/h

$$= 45 \times \frac{5}{18} = 12.5\,m/s$$

Velocity of thief Jeep = 153 km/h

$$= 153 \times \frac{5}{18} = 42.5\,m/s$$

Muzzle velocity = 180 m/s
Effective speed of the bullet = speed of bullet + speed of police Jeep

= (180 + 12.5)m/s
= 192.5 m/s

Speeds of thief's Jeep = 42.5 m/s
Velocity of bullet with respect to thief's car

= 192.5 – 42.5 = 150 m/s

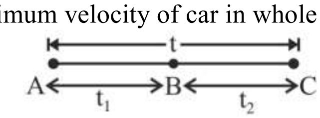
25. **A car starts from rest, moves with an acceleration a and then decelerates at a constant rate b for sometimes to come to rest. If the total time taken is t. The maximum velocity of car is given by:**

(a) $\frac{abt}{\left(a+b\right)}$ (b) $\frac{a^2t}{a+b}$

(c) $\frac{at}{\left(a+b\right)}$ (d) $\frac{b^2t}{a+b}$

JIPMER-2005

Ans. (a) : Let the car travels with accelerates 'a' for t_1 sec. and car decelerates with acceleration 'b' for t_2 second.
Let the maximum velocity of car in whole journey be v.



Since total time taken by the car in whole journey is t.

$\therefore \quad t_2 = (t - t_1)$

Using the Newton's 1st law of motion for A to B

$v = u + at$

$\because u = 0$, and $t = t_1$

$\therefore v = 0 + at$

$$t_1 = \frac{v}{a} \quad \ldots(i)$$

Again for B to C –

$v = u + at$

$\because v = 0$ at C,

$a = -b, t = t_2$

And $u = v$

$\therefore 0 = v - bt_2 \Rightarrow v = b(t - t_1) \quad \ldots(ii)$

From equation (i) and (ii)

$$v = b\left(t - \frac{v}{a}\right) \Rightarrow \frac{v}{b} = \left(t - \frac{v}{a}\right)$$

$$v\left(\frac{a+b}{ab}\right) = t$$

$$v = \frac{abt}{a+b}$$

26. A bus is moving with a speed of 10 ms^{-1} on a straight road. A scooterist wishes to overtake the bus in 100 s. If the bus is at a distance of 1 km from the scooterist, with what speed should the scooterist chase the bus?

(a) 20 ms^{-1} (b) 40 ms^{-1}
(c) 25 ms^{-1} (d) 10 ms^{-1}

[AIPMT 2009]

Ans. (a) : Given, distance = 1km = 1000m.

Velocity of bus, $v_B = 10 m/s$

Let us assume the velocity of scooter is v_s.

Distance covered by scooterist in 100s = Position of the bus at 100s

$= (1000 + x)$

Distance covered by scooterist in (100s)

$\Rightarrow x = 100 \times 10 = 1000m$

Velocity of the scooter:

$1000m + 1000m = 100 \times v_s$

$$v_s = \frac{2000}{100}$$

$v_s = 20$ m/s

27. A particle moves a distance x in time t according to the equation x = (t + 5)$^{-1}$. The acceleration of particle is proportional to

(a) (velocity)$^{3/2}$ (b) (distance)^2
(c) (distance)$^{-2}$ (d) (velocity)$^{2/3}$

[AIPMT 2010]

Ans. (a) : Given

Distance, $x = (t+5)^{-1} \quad \ldots(i)$

Differentiating equation (i) w.r.t 't' we get,

$$\frac{dx}{dt} = v = \frac{-1}{(t+5)^2} \quad \ldots(ii)$$

Again, differentiating equation (ii) w.r.t 't' we get,

$$\frac{d^2x}{dt^2} = (a) = \frac{2}{(t+5)^3} \quad \ldots(iii)$$

Comparing equation (ii) and (iii), we get

$a \propto v^{3/2}$

28. A car covers the first-half of the distance between two places at 40 km/h and other half at 60 km/h. The average speed of the car is

(a) 40 km/h (b) 48 km/h
(c) 50 km/h (d) 60 km/h

[AIPMT 1990]

Ans. (b) : Given,

Speed in first half, $v_1 = 40$ km/h

Speed in second half, $v_2 = 60$ km/h

$\because$ Car covers equal distance with different speeds.

$\therefore$ Average speed of car $(v_{av}) = \frac{2v_1 \times v_2}{v_1 + v_2}$

$$= \frac{2 \times 40 \times 60}{40 + 60}$$

$$= \frac{4800}{100}$$

$= 48$ km/h

29. A car moves a distance of 200 m. It covers the first-half of the distance at speed 40 km/h and the second-half of distance at speed v km/h. The average speed is 48 km/h. Find the value of v.

(a) 56 km/h (b) 60 km/h
(c) 50 km/h (d) 48 km/h

[AIPMT 1991]

Ans. (b) : Given data,

Distance = 200m

Speed in 1st half distance = 40 km/h

Average speed = 48km/h

$\therefore$ Average speed $= \frac{\text{Total distance}}{\text{Total time}}$

$$48 = \frac{200}{\frac{100}{40} + \frac{100}{v}}$$

$$\frac{1}{40} + \frac{1}{v} = \frac{1}{24}$$

$$v = \frac{120}{5-3} \Rightarrow v = \frac{120}{2}$$

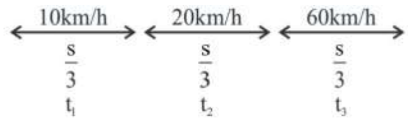
$v = 60$ km/h

30. A bus travelling the first one-third distance at a speed of 10 km/h, the next one-third at 20 km/h and the last one-third at 60 km/h. The average speed of the bus is

(a) 9 km/h (b) 16 km/h
(c) 18 km/h (d) 48 km/h

[AIPMT 1991]

Ans. (c) :



$$\text{Average speed} = \frac{\text{Total distance}}{\text{Total time}}$$

$$\text{Average speed} = \frac{s}{t_1 + t_2 + t_3}$$

$$= \frac{s}{\frac{\frac{s}{3}}{10} + \frac{\frac{s}{3}}{20} + \frac{\frac{s}{3}}{60}}$$

$$= \frac{s}{\frac{s}{3}\left[\frac{1}{10} + \frac{1}{20} + \frac{1}{60}\right]} = \frac{1}{\frac{1}{3}\left(\frac{1}{10} + \frac{1}{20} + \frac{1}{60}\right)}$$

$$= \frac{1}{\left(\frac{1}{30} \times \frac{10}{6}\right)} = 18 \text{ km/h}$$

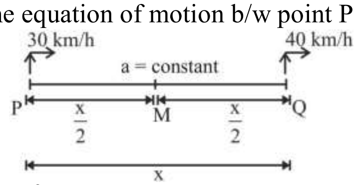
The average speed of the bus = 18 km/h

31. A car is moving along a straight road with a uniform acceleration. It passes through two points P and Q separated by a distance with velocity 30 km/h and 40 km/h respectively. The velocity of the car midway between P and Q is

(a) 33.3 km/h (b) $20\sqrt{2}$ km/h
(c) $25\sqrt{2}$ km/h (d) 0.35 km/h

[AIPMT 1988]

Ans. (c) :
By using the equation of motion b/w point P and M,



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

$\Rightarrow v^2 = (30)^2 + 2as$

$\Rightarrow v^2 - (30)^2 = 2as$

$\Rightarrow v^2 - 900 = 2a\frac{x}{2}$

$\Rightarrow v^2 - 900 = ax$

$a = \frac{v^2 - 900}{x}$ ……..(i)

Using equation of motion between point M and Q,

$(40)^2 = v^2 + 2a\frac{x}{2}$

$1600 = v^2 + ax$

$a = \frac{1600 - v^2}{x}$ ……..(ii)

From equation (i) and (ii)

$\frac{v^2 - 900}{x} = \frac{1600 - v^2}{x}$

$2v^2 = 2500$

$v^2 = \frac{2500}{2}$

$v = \sqrt{\frac{2500}{2}}$

$v = \frac{50}{\sqrt{2}}$

Multiplying by $\sqrt{2}$

$v = \frac{50 \times \sqrt{2}}{\sqrt{2} \times \sqrt{2}}$

$v = \frac{50\sqrt{2}}{2}$

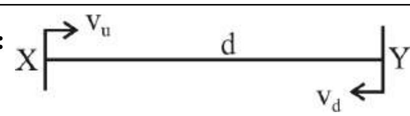
$v = 25\sqrt{2}$ km/h

32. A car moves from X to Y with a uniform speed v_u and returns to Y with a uniform speed v_d. The average speed for this round trip is

(a) $\frac{2v_d v_u}{v_d + v_u}$ (b) $\sqrt{v_u v_d}$
(c) $\frac{v_d v_u}{v_d + v_u}$ (d) $\frac{v_u + v_d}{2}$

UP CPMT-2008

Ans. (a) :



$\therefore t = \frac{\text{distance}}{\text{time}}$

Time taken by car from X to Y

$t_1 = \frac{d}{v_u}$

Time taken by car from Y to X

$t_2 = \frac{d}{v_d}$

$\text{Average speed} = \frac{\text{Total distance}}{\text{Total time}}$

$= \frac{d + d}{\frac{d}{v_u} + \frac{d}{v_d}} = \frac{2d}{d\left(\frac{1}{v_u} + \frac{1}{v_d}\right)}$

Average speed, $V_{avg} = \frac{2v_u v_d}{v_u + v_d}$

33. A block is kept on the floor of an elevator at rest. The elevator starts descending with an acceleration of 12 m/s². Find the displacement of the block during the first 0.2 s after the start. (Take, g = 10 m/s²)

(a) 30 cm (b) Zero
(c) 20 cm (d) 25 cm

JIPMER-2015

Ans. (c) : Given,
t = 0.2 sec
g = 10 m/sec²
u = 0

Given, elevator is descending with an acceleration of 12 m/s^2 (>g).
Hence, block will lose contact and freely fall.

$$s = ut + \frac{1}{2}gt^2$$

$$s = 0 \times 0.2 + \frac{1}{2}\times 10(0.2)^2$$

$$s = \frac{1}{2}\times 10\times\frac{2}{10}\times\frac{2}{10}$$

s = 0.2 m
s = 20 cm

2.5 Velocity-time and Position-time graph

34. The position of a particle is given by

$$\vec{r}(t) = 4t\hat{i} + 2t^2\hat{j} + 5\hat{k}$$

Where t is in seconds and r in meter. Find the magnitude and direction of velocity v(t), at t= 1s, with respect to x-axis.

(a) $3\sqrt{2}ms^{-1}, 30^\circ$ (b) $3\sqrt{2}\,ms^{-1}, 45^\circ$
(c) $4\sqrt{2}\,ms^{-1}, 45^\circ$ (d) $4\sqrt{2}\,ms^{-1}, 60^\circ$

RE-NEET (UG)-06.06.2023 (Manipur)

Ans. (c) : Given: $\vec{r}(t) = (4t\hat{i} + 2t^2\hat{j} + 5\hat{k})$

$$\frac{dr}{dt} = 4\hat{i} + 4t\hat{j}$$

$$\vec{V} = \frac{dr}{dt}\bigg|_{t=1} = 4\hat{i} + 4\hat{j}$$

$$|\vec{V}| = \sqrt{4^2 + 4^2} = \sqrt{32}$$

$$\boxed{|\vec{V}| = 4\sqrt{2}\text{ m/sec}}$$

$$\tan\phi = \frac{V_y}{V_x} = \frac{4}{4} = 1$$

$$\boxed{\phi = 45^\circ}$$

35. If the velocity of a particle is v = At +Bt², where A and B are constants, then the distance travelled by it between 1s and 2s is

(a) 3A + 7B (b) $\frac{3}{2}A + \frac{7}{3}B$
(c) $\frac{A}{2} + \frac{B}{3}$ (d) $\frac{3}{2}A + 4B3$

[NEET 2016]

Ans. (b) : Given, $v = At + Bt^2$

Velocity (v) = $\frac{ds}{dt}$

ds = vdt-------------(1)

Integrating equation (1)

$$s = \int_1^2 \left(At + Bt^2\right)dt$$

$$s = \left[\frac{At^2}{2} + \frac{Bt^3}{3}\right]_1^2$$

$$s = \frac{A}{2}(2^2 - 1^2) + \frac{B}{3}(2^3 - 1^3)$$

$$s = \frac{3A}{2} + \frac{7B}{3}$$

36. The position x of a particle varies with time t, as $x = at^2 - bt^3$. The acceleration of the particle will be zero at time t equals to

(a) zero (b) $\frac{a}{3b}$
(c) $\frac{2a}{3b}$ (d) $\frac{a}{b}$

AIPMT-1997

Ans. (b) : Given, $x = at^2 - bt^3$

Velocity (v) = $\frac{dx}{dt} = 2at - 3bt^2$

$$a = \frac{dv}{dt} = 2a - 6bt$$

According to question (a = 0)

0 = 2a – 6bt
6 bt = 2a

$$t = \frac{2a}{6b} \Rightarrow t = \frac{a}{3b}$$

37. The position x of a particle w.r.t. time t along x-axis is given by $x = 9t^2 - t^3$, where x is in metre and t in sec. What will be the position of this particle when it achieves maximum speed along the + x direction?

(a) 32 m (b) 54 m
(c) 81 m (d) 24 m

[AIPMT 2007]

Ans. (b) : Given,

$x = 9t^2 - t^3$------------(1)

speed (v) = $\frac{dx}{dt} = 18t - 3t^2$

Maximum velocity at $\frac{dv}{dt} = 0$,

$$\frac{dv}{dt} = 18 - 6t$$

The time will be-

0 = 18 – 6t
t = 3 sec

From equation (1)

$x = 9(3)^2 - (3)^3$
x = 81 – 27
x = 54 m

38. A particle moves along a straight line OX. At a time t (in second), the distance x (in metre) of the particle from O is given by $x = 40 + 12t - t^3$. How long would the particle travel before coming to rest?

(a) 24 m (b) 40 m
(c) 56 m (d) 16 m

[AIPMT 2006]
JIPMER - 2008

Ans. (c) : Given, $x = 40 + 12t - t^3$

Velocity $(v) = \frac{dx}{dt} = 0 + 12 - 3t^2$

At coming to rest (v = 0),

$0 = 12 - 3t^2$

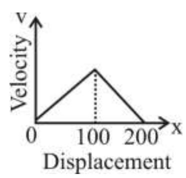
$t^2 = 4 \Rightarrow t = 2$ sec

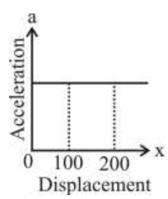
The distance travelled by particle before coming to rest

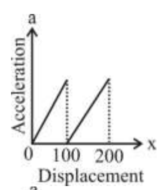
$x = 40 + 12(2) - (2)^3$

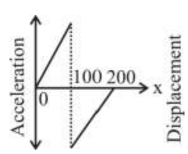
$x = 56$ m

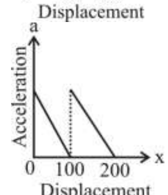
39. Velocity (v) versus displacement (x) plot of a body moving along a straight line is as shown in the graph. The corresponding plot of acceleration (a) as a function of displacement (x) is



(a)


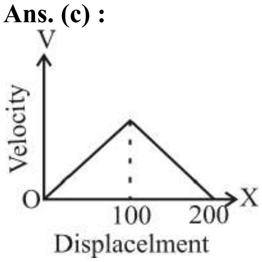
(b)


(c)


(d)


AP EAMCET -2014

Ans. (c) :



From the given graph,

equation of velocity, $V = Kx$ ……..(i)

$\therefore \quad \frac{dv}{dt} = K.v$ (from the equation (i))

$= K(Kx) = K^2x$

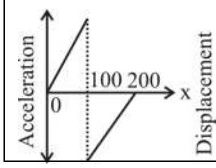
We know that, $a = \frac{dv}{dt} = k^2x$

$v = -Kx + v_0$

$\therefore \quad \frac{dv}{dt} = -Kv = -K(-Kx + v_0)$

$a = K^2x - Kv_0$ .....(i)

So, as per equation (ii) the shape of a–x graph is as,



40. The displacement x of a particle varies with time t as $x = ae^{-\alpha t} + be^{\beta t}$, where a, b, α and β are positive constants. The velocity of the particle will

(a) Decrease with time
(b) Be independent of α and β
(c) Drop to zero when α = β
(d) Increase with time

AIPMT-2005
JIPMER-2016

Ans. (d): Given,

$x = ae^{-\alpha t} + be^{\beta t}$ …….(i)

Differentiating eqn (i), with respect to time (t)

$\frac{dx}{dt} = -a\alpha e^{-\alpha t} + b\beta e^{\beta t}$

$v = -a\alpha e^{-\alpha t} + b\beta e^{\beta t}$

Differentiating again

$\frac{dv}{dt} = a\alpha^2 e^{-\alpha t} + b\beta^2 e^{\beta t} > 0$

Thus, velocity of the particle (v) will always increase with time.

41. The reaction time for a car driver is 0.9s. If the car travelling initially with 36 km/h is stopped by the driver after observing a signal by the deceleration of $5 m/s^2$, the total distance travelled by the car before coming to rest is:

(a) 19 m (b) 9 m
(c) 10 m (d) 28 m

AP EAMCET(Medical)-1997

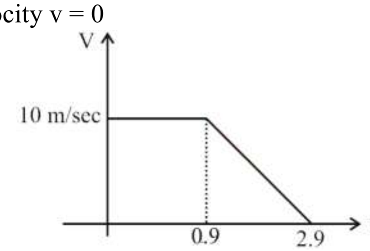
Ans. (a) : Given that

Initial velocity, u = 36 km/s

$u = 36 \times \frac{5}{18}$

= 10 m/sec

Final velocity v = 0



$v = u - at$

$0 = 10 - 5t$

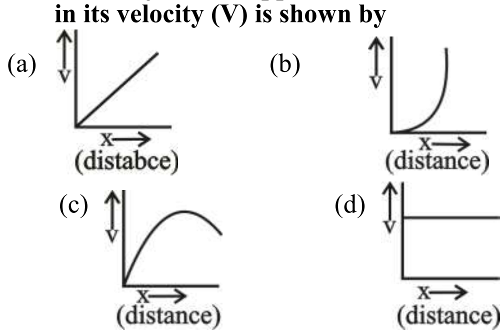
$t = \frac{10}{5}$

$t = 2$ sec

$S_1 = ut + \frac{1}{2}at^2$

$= 10\times2+\frac{1}{2}(-5)(2)^2$
$= 20 - 10$
$= 10$
Distance covered within reaction time, $S_1 = ut$
$= 10 \times 0.9$
$= 9$ m
So, total distance, $s = s_1 + s_2$
$= 10 + 9$
$= 19$ m

42. If an object is dropped from rest, then changes in its velocity (V) is shown by



AP EAMCET(Medical)-2011

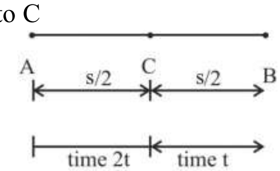
Ans. (c) : According question
$u = 0$
$\because v^2 = u^2 + 2gs$
$\therefore v^2 = 2gs$
This equation is like parabola equation.

43. A vehicle moving with a constant acceleration form A to B in a straight line AB, has velocities 'u' and 'v' at A and B respectively. C is the mid point of AB. If time taken to travel from A to C is twice the time taken to travel from C to B then the velocity of the vehicle 'v' at B is.

(a) 5u (b) 6u
(c) 7u (d) 8u

AP EAMCET(Medical)-2015

Ans. (c) : According to question can be drawn as for motion from A to C



$\frac{s}{2} = ut + \frac{1}{2}a\times(2t)^2 = 2ut + 2at^2$

Also for motion from C to B (let initial velocity be v)

$\frac{s}{2} = (u+2at)t + \frac{1}{2}at^2$ $(\therefore v_1 = u + 2at)$

$= ut + 2at^2 + \frac{1}{2}at^2$

Now,

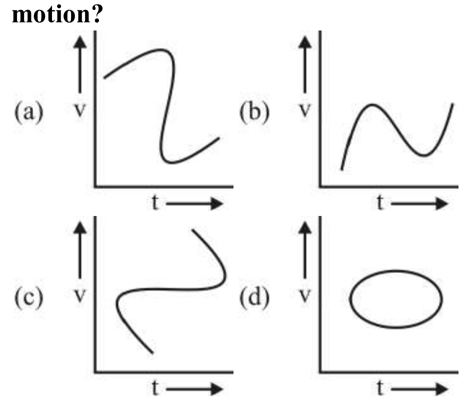
$2ut + 2at^2 = ut + 2at^2 + \frac{1}{2}at^2$

$ut = \frac{1}{2}at^2$

$\Rightarrow u = \frac{1}{2}at$

For over all motion
$v = u + 3at$
$= \frac{at}{2} + 3at$
$= \frac{7at}{2}$ $\left(\therefore u = \frac{at}{2}\right)$
$v = 7u$

44. Which of the following velocity-time graphs shown a realistic situation for a body in motion?



AIIMS-2004, 2007

Ans. (b) : Time cannot reverse itself if or it can only go forward. In graph (a) and (d) some portion of graph has show time changing in such a way or time is going from high volume to law volume which is not practical. In realistic situation, the body can't have more than one velocity at the same instant.

45. The coordinates of a moving particle at any time t are given by $x = a\,t^2$ and $y = b\,t^2$. The speed of the particle is

(a) $2t(a + b)$ (b) $2t\sqrt{(a^2+b^2)}$
(c) $2t\sqrt{(a^2-b^2)}$ (d) $\sqrt{(a^2+b^2)}$

AIIMS-2012

Ans. (b): Given, $x = at^2$ and $y = bt^2$

Velocity along x – axis $v_x = \frac{dx}{dt} = 2at$

Velocity along y – axis $v_y = \frac{dy}{dt} = 2bt$

Magnitude of velocity of the particle –

$v = \sqrt{(v_x)^2 + (v_y)^2} = 2t\sqrt{a^2+b^2}$

46. Assertion: Velocity-time graph for an object in uniform motion along a straight path is a straight line parallel to the time axis.

Reason: In uniform motion of an object velocity increases as the square of time elapsed.

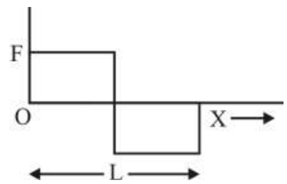
(a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

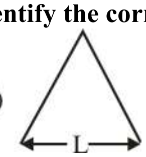
AIIMS-2015

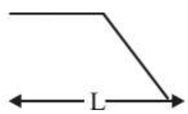
Ans. (c): In uniform motion, the object moves with uniform velocity. The magnitude of its velocity at different instant i.e at t = 0, t = 1 sec, t = 2 sec .... will always be constant in uniform motion along a straight path is a straight line parallel to time axis.

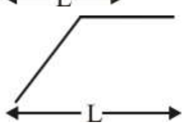
47. A person used force (F), shown in the figure to move a load with a constant velocity on a given surface.

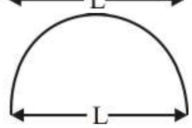


Identify the correct surface profile:

(a) 

(b) 

(c) 

(d) 

AIIMS-2006

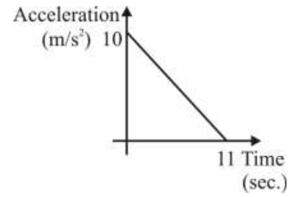
Ans. (a) : The figure shows that the force is constant during loading and unloading. In figure (b) and (c) there are regions of constant slope. Thus no force is required in loading through those regions. But the force always has a magnitude. In figure (d), the force needs to change at every point as the inclination of the surface change at every point.]
The correct surface is option (a) where a loading force of mg sinθ is required , and mg sinθ acts in opposite direction while unloading.

48. Assertion : The position-time graph of a uniform motion in one dimension of a body can have negative slope.
Reason: When the speed of body decreases with time, the position-time graph of the moving body has negative slope.
(a) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.
(c) If Assertion is correct but Reason is incorrect.
(d) If both the Assertion and Reason are incorrect.

AIIMS-27.05.2018(M)

Ans. (c) : The negative slope of position-time graph represent that the body is moving towards the negative direction and if the slope of the graph decreases with time. Then, it represents the decrease in speed i.e retardation in motion.

49. A body starts from rest at time t = 0, the acceleration time graph is shown in the figure. The maximum velocity attained by the body will be



(a) 110m/s (b) 55m/s
(c) 650m/s (d) 550m/s

AIIMS-2014

Ans. (b) : Area under the acceleration - time graph determines the change in velocity i.e.

$$a = \frac{dv}{dt}$$

$$dv = \int a dt$$

Area under the curve will gives us change in velocity

$v_i = 0, v_f = v_{max}$

Δv = area under the curve = $\frac{1}{2}\times 10 \times 11 = 55$

$\Delta v = v_f - v_i$

$v_f = 55$ m/s

$v_f = v_{max} = 55$ m/s

50. A particle moving along X-axis has acceleration f at time t given by $f = f_0\left(1 - \frac{t}{T}\right)$, where f_0 and T are constants. The particle at t = 0 has zero velocity. In the time interval between t = 0 and the instant when f = 0, the particle's velocity is

(a) $\frac{1}{2}f_0T^2$ (b) f_0T^2
(c) $\frac{1}{2}f_0T$ (d) f_0T

AIPMT-2007

Ans. (c) : Acceleration of the particle is given as –

$$f = f_0\left(1-\frac{t}{T}\right) \quad ...(i)$$

∴ Velocity of particle is given as,

$$v = \int f\ dt = \int f_0\left(1-\frac{t}{T}\right)dt = f_0\left(t-\frac{t^2}{2T}\right)+c \quad ...(ii)$$

Given that, at t = 0, v = 0
Hence, from Eq. (i), we get

$$0 = f_0(0-0)+c \Rightarrow c = 0$$

∴ From Eq. (ii), we have

$$v = f_0\left(t-\frac{t^2}{2T}\right) \quad ...(iii)$$

Suppose, acceleration of the particle becomes zero at time $t = t_1$.
Hence, from Eq. (i),

$$0 = f_0\left(1-\frac{t_1}{T}\right) \Rightarrow 1-\frac{t_1}{T} = 0 \Rightarrow t_1 = T$$

Hence, velocity of particle at $t = t_1 = T$,
from Eq. (iii),

$$v = f_0\left(t_1 - \frac{t_1^2}{2T}\right)$$

$$v = f_0\left(T - \frac{T^2}{2T}\right) = f_0\left(T - \frac{T}{2}\right) = \frac{1}{2}f_0T$$

51. The displacement x of a particle varies with time t as $x = ae^{-\alpha t} + be^{\beta t}$, where a, b, α and β are positive constants. The velocity of the particle will

(a) go on decreasing with time
(b) be independent of α and β
(c) drop to zero when $\alpha = \beta$
(d) go on increasing with time **JIPMER- 2007**

Ans. (d) : Given,

$$x = ae^{-\alpha t} + be^{\beta t}$$

Differentiating w.r.t. t, we get

$$\frac{dx}{dt} = ae^{-\alpha t}(-\alpha) + be^{\beta t}.\beta$$

$$v = -a\alpha e^{-\alpha t} + b\beta e^{\beta t}$$

From the above equation we can tell that velocity will increase with time since the negative component will decrease with an increase in time and the positive component will increase in the given equation.

52. The acceleration of a particle is increasing linearly with time t as bt. The particle starts from the origin with an initial velocity v_0. The distance travelled by the particle in time t will be

(a) $v_0t + \frac{1}{3}bt^2$ (b) $v_0t + \frac{1}{3}bt^3$

(c) $v_0t + \frac{1}{6}bt^3$ (d) $v_0t + \frac{1}{2}bt^2$

UP CPMT-2011

Ans. (c) : Given,
Acceleration a = bt
time = t

$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{change in time}}$$

$$a = \frac{dv}{dt}$$

$$\frac{dv}{dt} = a = bt$$

$$\Rightarrow \frac{dv}{dt} = bt$$

$$dv = bt\,dt$$

Now integrating this we will get

$$\int dv = \int bt\,dt$$

$$v = \frac{bt^2}{2} + C$$

At, $t = 0$, $v = v_0$, thus $v_0 = C$

$$\therefore \quad v = \frac{bt^2}{2} + v_0$$

$$\text{Now,} \quad v = \frac{\text{change is position}}{\text{change in time}} = \frac{ds}{dt}$$

$$\Rightarrow \frac{ds}{dt} = \frac{bt^2}{2} + v_0$$

$$\Rightarrow ds = \left(\frac{bt^2}{2} + v_0\right)dt$$

Integrating above we get,

$$s = \frac{bt^3}{6} + v_0t + C$$

At $t = 0$, $s = 0$, $C = 0$

i.e. $s = \frac{bt^3}{6} + v_0t$

or $s = v_0t + \frac{1}{6}bt^3$

53. Two cars P and Q start from a point at the same time in a straight line and their positions are represented by $X_P(t) = at + bt^2$ and $X_Q(t) = ft - t^2$. At what time do the cars have the same velocity?

(a) $\frac{a-f}{1+b}$ (b) $\frac{a-f}{2(b-1)}$

(c) $\frac{a-f}{2(1+b)}$ (d) $\frac{f-a}{2(1+b)}$

[NEET 2016]

Ans. (d) : Given: $X_P(t) = at + bt^2$ ...(i)
And $X_Q(t) = ft - t^2$ ….(ii)
Differentiating eqn (i) and (ii) w.r.t 't' we get,

$$v_P = \frac{d[X_P(t)]}{dt} = \frac{d(at+bt^2)}{dt} = a + 2bt \quad \text{...(iii)}$$

$$v_Q = \frac{d[X_Q(t)]}{dt} = \frac{d(ft-t^2)}{dt} = f - 2t \quad \text{…(iv)}$$

Let at time 't_0' the cars have same velocity

$$[v_P]_{t=t_0} = [v_Q]_{t=t_0}$$

$$\Rightarrow a + 2bt_0 = f - 2t_0$$

$$\Rightarrow t_0 = \frac{f-a}{2(1+b)}$$

54. The motion of a particle along a straight line is described by equation $x = 8 + 12t - t^3$ where, x is in metre and t in sec. The retardation of the particle when its velocity becomes zero, is

(a) 24 ms^{-2} (b) zero
(c) 6 ms^{-2} (d) 12 ms^{-2}

[AIPMT 2012]

Ans. (d) : Given,

$x = 8 + 12t - t^3$ $a = ?$ $v = 0$

Differentiation,

$$\frac{dx}{dt} = 0 + 12 - 3t^2$$