National Testing Agency [NTA]
National Eligibility cum Entrance Test

[NEET - 2024]

PHYSICS

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NEET/AIPMT Physics

Class- XI

Class -XII

NEET Exam Pattern & Syllabus

As per the NEET exam pattern, the questions in the medical entrance examination will be divided into two sections: Section A and B. Section A will contain 35 questions while Section B will have 15 questions. Of these 15 questions in Section B, candidates will have to answer 10 questions.

NTA will conduct the NEET exam in pen and paper-based mode for a 3 hours 20 minutes duration, where candidates must answer Multiple Choice Questions (MCQs) from Physics, Chemistry, and Biology subjects as per the given NEET syllabus. Aspirants seeking more information regarding the NEET exam pattern can check the article below to know the level of the exam, types, and the number of questions, marking schemes, and all other relevant information.

Factors in Exam Pattern	Details
Mode of NEET Question Paper	Pen and Paper-based. Candidates will be given an OMR sheet to mark the answers with a black or blue ballpoint pen
Duration of the NEET exam	3 hours and 20 minutes
Language/Medium	English, Hindi, Assamese, Bengali, Gujarati, Marathi, Tamil, Telugu, Oriya, Malayalam, Kannada, Punjabi and Urdu
Question Type	Multiple Choice Questions (MCQs)
Total Number of Questions	A total of 200 questions will be asked out of which candidates will have to answer 180 questions
Total marks in NEET	720 Marks
NEET Marking Scheme	4 marks will be awarded for each correct answer & 1 mark will be deducted for each wrong attempt

■ NEET Exam Sections and Total Marks

Subjects	Sections	Number of Questions	Section-wise Marks
Physics	Section A	35	140
	Section B	15	40
Chemistry	Section A	35	140
	Section B	15	40
Botany	Section A	35	140
	Section B	15	40
Zoology	Section A	35	140
	Section B	15	40
Total Marks			**720**

PHYSICS

■ Physical World and Measurement

- Physics: Scope and excitement; nature of physical laws; Physics, technology and society.
- Need for measurement: Units of measurement; systems of units; SI units, fundamental and derived units. Length, mass and time measurements; accuracy and precision of measuring instruments; errors in measurement; significant figures.
- Dimensions of physical quantities, dimensional analysis and its applications.

■ Kinematics

- Frame of reference, Motion in a straight line; Position-time graph, speed and velocity. Uniform and non-uniform motion, average speed and instantaneous velocity. Uniformly accelerated motion, velocity-time and position-time graphs, for uniformly accelerated motion (graphical treatment).
- Elementary concepts of differentiation and integration for describing motion. Scalar and vector quantities: Position and displacement vectors, general vectors, general vectors and notation, equality of vectors, multiplication of vectors by a real number; addition and subtraction of vectors. Relative velocity.
- Unit vectors. Resolution of a vector in a plane-rectangular components.
- Scalar and Vector products of Vectors. Motion in a plane. Cases of uniform velocity and uniform acceleration- projectile motion. Uniform circular motion.

■ Laws of Motion

- Intuitive concept of force. Inertia, Newton's first law of motion; momentum and Newton's second law of motion; impulse; 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, lubrication.
- Dynamics of uniform circular motion. Centripetal force, examples of circular motion (vehicle on level circular road, vehicle on banked road).

■ Work, Energy and Power

- Work done by a constant force and variable force; kinetic energy, work-energy theorem, power.
- Notion of potential energy, potential energy of a spring, conservative forces; conservation of

mechanical energy (kinetic and potential energies); nonconservative forces; motion in a vertical circle, elastic and inelastic collisions in one and two dimensions.

■ Motion of System of Particles and Rigid Body

- Centre of mass of a two-particle system, momentum conservation and centre of mass motion. Centre of mass of a rigid body; centre of mass of uniform rod.
- Moment of a force,-torque, angular momentum, conservation of angular momentum with some examples.
- Equilibrium of rigid bodies, rigid body rotation and equation of rotational motion, comparison of linear and rotational motions; moment of inertia, radius of gyration. Values of M.I. for simple geometrical objects (no derivation). Statement of parallel and perpendicular axes theorems and their applications.

■ Gravitation

- Kepler's laws of planetary motion. The universal law of gravitation. Acceleration due to gravity and its variation with altitude and depth.
- Gravitational potential energy; gravitational potential. Escape velocity, orbital velocity of a satellite. Geostationary satellites.

■ Properties of Bulk Matter

- Elastic behavior, Stress-strain relationship. Hooke's law, Young's modulus, bulk modulus, shear, modulus of rigidity, poisson's ratio; elastic energy.
- Viscosity, Stokes' law, terminal velocity, Reynold's number, streamline and turbulent flow. Critical velocity, Bernoulli's theorem and its applications.
- Surface energy and surface tension, angle of contact, excess of pressure, application of surface tension ideas to drops, bubbles and capillary rise.
- Heat, temperature, thermal expansion; thermal expansion of solids, liquids, and gases. Anomalous expansion. Specific heat capacity: Cp, Cv-calorimetry; change of state – latent heat.
- Heat transfer- conduction and thermal conductivity, convection and radiation. Qualitative ideas of Black Body Radiation, Wein's displacement law, and Green House effect.
- Newton's law of cooling and Stefan's law.

■ Thermodynamics

- Thermal equilibrium and definition of temperature (zeroth law of Thermodynamics). Heat, work and internal energy. First law of thermodynamics. Isothermal and adiabatic processes.
- Second law of the thermodynamics: Reversible and irreversible processes. Heat engines and refrigerators.

■ Behaviour of Perfect Gas and Kinetic Theory

- Equation of state of a perfect gas, work done on compressing a gas.
- Kinetic theory of gases: Assumptions, concept of pressure. Kinetic energy and temperature; degrees of freedom, law of equipartition of energy (statement only) and application to specific heat capacities of gases; concept of mean free path.

■ Oscillations and Waves

- Periodic motion-period, frequency, displacement as a function of time. Periodic functions. Simple harmonic motion(SHM) and its equation; phase; oscillations of a spring-restoring force and force constant; energy in SHM –Kinetic and potential energies; simple pendulum-derivation of expression for its time period; free, forced and damped oscillations (qualitative ideas only), resonance.
- Wave motion. Longitudinal and transverse waves, speed of wave motion. Displacement relation for a progressive wave. Principle of superposition of waves, reflection of waves, standing waves in strings and organ pipes, fundamental mode and harmonics. Beats. Doppler effect.

■ Electrostatics

- Electric charges and their conservation. Coulomb's law-force 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, statement of Gauss's theorem and its applications to find field due to infinitely long straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell (field inside and outside)
- Electric potential, potential difference, electric potential due to a point charge, a dipole and system of charges: equipotential surfaces, electrical potential energy of a system of two point charges and of electric diploes in an electrostatic field.
- Conductors and insulators, free charges and bound charges inside a conductor. Dielectrics and electric polarization, capacitors and capacitance, combination of capacitors in series and in parallel, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, energy stored in a capacitor, Van de Graff generator.

■ Current Electricity

- Electric current, flow of electric charges in a metallic conductor, drift velocity and mobility, and their relation with electric current; Ohm's law, electrical resistance, V-I characteristics (liner and non-linear), electrical energy and power, electrical resistivity and conductivity.
- Carbon resistors, colour code for carbon resistors; series and parallel combinations of resistors; temperature dependence of resistance.

- Internal resistance of a cell, potential difference and emf of a cell, combination of cells in series and in parallel.
- Kirchhoff's laws and simple applications. Wheatstone bridge, metre bridge.
- Potentiometer-principle and applications to measure potential difference, and for comparing emf of two cells; measurement of internal resistance of a cell.

■ Magnetic Effects of Current and Magnetism

- Concept of magnetic field, Oersted's experiment. Biot-Savart law and its application to current carrying circular loop.
- Ampere's law and its applications to infinitely long straight wire, straight and toroidal solenoids. Force on a moving charge in uniform magnetic and electric fields. Cyclotron.
- Force on a current-carrying conductor in a uniform magnetic field. Force between two parallel current-carrying conductors-definition of ampere. Torque experienced by a current loop in a magnetic field; moving coil galvanometer-its current sensitivity and conversion to ammeter and voltmeter.
- Current loop as a magnetic dipole and its magnetic dipole moment. Magnetic dipole moment of a revolving electron. Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis. Torque on a magnetic dipole (bar magnet) in a uniform magnetic field; bar magnet as an equivalent solenoid, magnetic field lines; Earth's magnetic field and magnetic elements.
- Para-, dia-and ferro-magnetic substances, with examples.
- Electromagnetic and factors affecting their strengths. Permanent magnets.

■ 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; reactance and impedance; LC oscillations (qualitative treatment only), LCR series circuit, resonance; power in AC circuits, wattles current.
- AC generator and transformer.

■ Electromagnetic Waves

- Need for displacement current.
- Electromagnetic waves and their characteristics (qualitative ideas only). Transverse nature of electromagnetic waves.
- Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, x-rays, gamma rays) including elementary facts about their uses.

■ Optics

- Reflection of light, spherical mirrors, mirror formula. Refraction of light, total internal reflection and its applications optical fibres, refraction at spherical surfaces, lenses, thin lens formula, lens-maker's formula. Magnification, power of a lens, combination of thin lenses in contact combination of a lens and a mirror. Refraction and dispersion of light through a prism.
- Scattering of light- blue colour of the sky and reddish appearance of the sun at sunrise and sunset.
- Optical instruments: Human eye, image formation and accommodation, correction of eye defects (myopia and hypermetropia) using lenses.
- Microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers.
- Wave optics: Wavefront and Huygens' principle, reflection and refraction of plane wave at a plane surface using wavefronts.
- Proof of laws of reflection and refraction using Huygens' principle.
- Interference, Young's double hole experiment and expression for fringe width, coherent sources and sustained interference of light.
- Diffraction due to a single slit, width of central maximum.
- Resolving power of microscopes and astronomical telescopes. Polarisation, plane polarized light; Brewster's law, uses of plane polarized light and Polaroids.

■ Dual Nature of Matter and Radiation

- Photoelectric effect, Hertz and Lenard's observations; Einstein's photoelectric equation-particle nature of light.
- Matter waves- wave nature of particles, de Broglie relation. Davisson-Germer experiment (experimental details should be omitted; only conclusion should be explained).

■ Atoms and Nuclei

- Alpha- particle scattering experiments; Rutherford's model of atom; Bohr model, energy levels, hydrogen spectrum. Composition and size of nucleus, atomic masses, isotopes, isobars; isotones.
- Radioactivity- alpha, beta and gamma particles/ rays and their properties decay law. Mass-energy relation, mass defect; binding energy per nucleon and its variation with mass number, nuclear fission and fusion.

■ Electronic Devices

- Energy bands in solids (qualitative ideas only), conductors, insulators and semiconductors; semiconductor diode- I-V characteristics in forward and reverse bias, diode as a rectifier; I-V characteristics of LED, photodiode, solar cell, and Zener diode; Zener diode as a voltage regulator. Junction transistor, transistor action, characteristics of a transistor; transistor as an amplifier (common emitter configuration) and oscillator. Logic gates (OR, AND, NOT, NAND and NOR). Transistor as a switch .

NEET (UG) /AIPMT AND AIIMS EXAMINATION PAPER ANALYSIS CHART

S. No.	Examination Question Paper	Exam Date/ year	No. of Question
1.	RE-NEET - Manipur	06.06.2023	50
2.	NEET (UG)	07.05.2023	50
3.	RE-NEET	04.09.2022	50
4.	NEET (UG)	17.07.2022	50
5.	NEET (UG)	12.09.2021	50
6.	NEET (UG)	14.10.2020 Phase 2	45
7.	NEET (UG)	13.09.2020	45
8.	NEET (UG) (Odisha)	20.05.2019	45
9.	NEET (UG)	05.05.2019	45
10.	NEET (UG)	06.05.2018	45
11.	NEET (UG)	07.05.2017	45
12.	NEET (UG)	24.07.2016 Phase 2	45
13.	NEET (UG)	01.05.2016	45
14.	AIPMT	25.07.2015 Re-Exam	45
15.	AIPMT	03.05.2015	45
16.	AIPMT	06.05.2014	45
17.	NEET (UG)	05.05.2013	45
18.	NEET (UG) (Karnataka)	18.05.2013	45
19.	AIPMT	2012 Mains	30
20.	AIPMT	2012	50
21.	AIPMT	2011 Mains	30
22.	AIPMT	2011	50
23.	AIPMT	2010 Mains	30
24.	AIPMT	2010	50
25.	AIPMT	2009	50
26.	AIPMT	2008	50
27.	AIPMT	2007	50
28.	AIPMT	2006	50
29.	AIPMT	2005	50
30.	AIPMT	2004	50
31.	AIPMT	2003	50
32.	AIPMT	2002	50
33.	AIPMT	2001	50
34.	AIPMT	2000	50
35.	AIPMT	1999	50
36.	AIPMT	1998	50
37.	AIPMT	1997	50
38.	AIPMT	1996	50
39.	AIPMT	1995	50
40.	AIPMT	1994	50
41.	AIPMT	1993	50
42.	AIPMT	1992	50
43.	AIPMT	1991	50
44.	AIPMT	1990	50
45.	AIPMT	1989	50
46.	AIPMT	1988	50
47.	AIPMT	1987	50
48.	NCERT EXEMPLAR	Class - XI	127
49.	NCERT EXEMPLAR	Class - XII	96
		Total	2448

Note- After the analysis of the above question papers, a total of 2448 (Repeated questions + similar nature questions) questions related to Physics have been placed below the name of the original questions, so that the examinees can understand the nature of repetition of questions.

Topic wise Trend Analysis of NEET/AIPMT Previous Question Papers

PHYSICS

S. No.	Topic	NEET 2013	AIPMT 2014	AIPMT 2015	AIPMT 2015 (Re)	NEET 2016 Phase-I	NEET 2016 Phase-II	NEET 2017	NEET 2018	NEET 2019	NEET 2019 Odisha	NEET 2020	NEET 2020 Phase-II	NEET 2021	NEET 2022	Re NEET 2022	NEET 2023	Re NEET 2023 Manipur
1	Modern Physics	5	6	5	4	4	4	4	4	3	4	7	5	5	5	5	4	5
2	Thermal Physics (Thermal Expansion, Calorimetry, Heat Transfer, KTG& Thermodynamics)	6	5	6	5	6	5	5	5	4	4	5	5	2	3	3	5	2
3	Current Electricity and Effect of Current	3	4	3	3	2	2	2	4	3	2	5	4	4	4	4	3	4
4	Semiconductor and Digital Electronics	3	2	2	2	3	3	3	3	2	2	3	4	3	3	3	3	3
5	Magnetic Effect of Current and Magnetism	3	2	2	2	3	3	3	2	3	3	2	1	4	3	4	3	4
6	Ray Optics and Optical Instruments	2	2	2	2	3	3	2	3	4	2	1	4	3	3	2	3	5
7	Rotational Motion	2	2	3	2	2	3	3	4	2	1	1	1	2	1	1	2	2
8	Electrostatics	2	2	1	1	1	1	2	1	3	2	3	3	4	3	2	2	3
9	Gravitation	2	2	1	2	2	2	2	2	2	3	1	1	2	1	1	2	2
10	Kinematics	2	2	2	2	2	1	2	1	2	3	1	1	3	3	2	4	2
11	Wave Motion and Doppler's Effect	3	3	1	2	3	2	2	2	0	1	1	1	0	1	1	2	1

12	**Properties of matter and Fluid Mechanics**	2	2	2	3	1	2	2	2	3	3	2	2	1	3	2	3	2
13	**Wave Optics (Nature of Light, Interference, Diffraction & Polarization)**	2	2	2	2	2	2	3	2	1	2	3	1	1	1	2	2	0
14	**Alternating Current**	1	0	1	1	2	3	0	1	0	2	2	1	2	2	3	1	4
15	**Laws of Motion and Friction**	2	3	2	1	0	0	1	2	1	2	1	1	1	0	3	3	1
16	**Electromagnetic Induction**	1	2	1	1	1	1	2	1	2	1	0	2	2	2	1	1	0
17	**Collisions and Centre of Mass**	1	1	2	3	0	3	0	1	1	2	1	1	0	2	1	1	2
18	**Oscillations (SHM, Damped and Forced Oscillations & Resonance)**	0	1	2	1	0	1	2	1	3	1	1	1	2	1	2	1	1
19	**Until, Dimension & Measurements**	1	1	1	1	0	1	1	1	1	1	3	1	3	4	2	1	2
20	**Circular Motion**	0	0	0	1	4	1	1	1	3	1	0	1	0	1	0	0	1
21	**Work, Energy & Power**	1	0	3	1	1	1	1	0	1	1	0	0	2	1	1	2	1
22	**EM Waves**	1	0	0	1	1	0	1	1	1	1	1	2	2	2	2	1	0
23	**Capacitors**	0	1	1	1	1	1	1	1	0	1	1	1	2	1	2	1	2
24	**Basic Mathematics & Vectors.**	0	0	0	1	1	0	0	0	0	0	0	1	0	0	1	0	1
Total		**45**	**45**	**45**	**45**	**45**	**45**	**45**	**45**	**45**	**45**	**45**	**45**	**50**	**50**	**50**	**50**	**50**

1. Units and Measurements

1.1 Units

1. The unit of thermal conductivity is:
ऊष्मा चालकता का मात्रक है :

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

NEET (UG)-05.05.2019

Ans. (c) : Thermal conductivity is the amount of heat that flows per unit time through a unit area with a temperature gradient of one Kelvin per unit length.

$$\frac{Q}{t} = kA\left(\frac{\Delta T}{\ell}\right)$$

Where k = thermal conductivity

$$k = \frac{Q\cdot\ell}{\Delta T\cdot At} = \frac{\text{Joule.m}}{\text{K.m}^2\text{.s}}$$

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

2. The density of a material in CGS system of units is 4 g/cm^3. In a system of units in which unit of length is 10 cm and unit of mass is 100g, the value of density of material will be/मात्रकों की CGS पद्धति में किसी पदार्थ का घनत्व 4 g/cm^3 है। मात्रकों की एक पद्धति जिसमें लम्बाई की इकाई 10 cm तथा द्रव्यमान की इकाई 100g है, तो पदार्थ के घनत्व का मान होगा-

(a) 0.04 (b) 0.4 (c) 40 (d) 400

AIPMT (Mains)-2011

Ans. (c) : The density of material in CGS system, d = 4g/cm^3
In other system of units-
1 unit of mass =100g

$$1g = \frac{1}{100}\text{ unit of mass}$$

1 unit of length = 10 cm

$$1\text{ cm} = \frac{1}{10}\text{ unit of length}$$

$$\text{So, density} = \frac{4g}{cm^3}$$

$$= \frac{4\left(\frac{1}{100}\right)}{\left(\frac{1}{10}\right)^3}$$

$$= \frac{4}{100}\times\frac{1000}{1} = 40 \text{ units}$$

3. The unit of permittivity of free space ε_0 is :-
मुक्त आकाश के लिए परवैद्युतांक ε_0 का मात्रक होगा:-

(a) Newton metre^2/ Coulomb^2/न्यूटन-मीटर^2/कूलॉम^2
(b) Coulomb^2 /Newton metre^2/कूलॉम^2/न्यूटन-मीटर^2
(c) Coulomb^2/ (Newton metre)^2 /कूलॉम^2/(न्यूटन-मीटर)^2
(d) Coulomb/Newton metre/कूलॉम/न्यूटन-मीटर

AIPMT-2004

Ans. (b) : By coulomb's law the electrostatic force

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

$$\varepsilon_0 = \frac{1}{4\pi}\times\frac{q_1q_2}{Fr^2}$$

Substituting the unit for q,r and F,

$$\varepsilon_0 = \frac{\text{Coulomb}\times\text{Coulomb}}{\text{Newton}\times(\text{Metre})^2}$$

$$\boxed{\varepsilon_0 = \frac{(\text{Coulomb})^2}{\text{Newton}\times(\text{Metre})^2}}$$

4. Tesla is the unit of
टेस्ला मात्रक है-

(a) electric field/विद्युत क्षेत्र
(b) magnetic field/चुम्बकीय क्षेत्र
(c) electric flux/विद्युत फ्लक्स
(d) magnetic flux/चुम्बकीय फ्लक्स

AIPMT-1997, 1998

Ans. (b) : The international system of unit of field intensity for magnetic field is Tesla (T). One Tesla (1T) is defined as the field intensity generating one Newton (N) of force per ampere (A) of the current per meter of conductor.

$$B = 1\ N\ A^{-1}\ m^{-1} = 1 \text{ Tesla.}$$

- The unit of electric field is V/m.
- The unit electric flux is V-m.
- The unit of magnetic flux Weber.

1.2 Measurements

5. A screw gauge gives the following readings when used to measure the diameter of a wire-
एक स्क्रूगेज जब एक तार के व्यास को मापने के लिए प्रयुक्त किया जाता है, तो निम्नलिखित पाठयांक देता है :

Main scale reading : 0 mm
मुख्य पैमाने का पाठयांक = 0 **मिलीमीटर**

Circular scale reading : 52 divisions
वृत्तीय पैमाने का पाठयांक = 52 **खाने**

Given that 1 mm on main scale corresponds to 100 divisions on the circular scale. The diameter of the wire from the above data is
दिया गया है कि मुख्य पैमाना पर 1 मिलीमीटर, वृत्तीय पैमाना के 100 खानों के संगत होता है। उपर्युक्त दिए गये प्रेक्षणों से तार का व्यास है :

(a) 0.052 cm (b) 0.52 cm
(c) 0.026 cm (d) 0.26 cm

NEET (UG)-12.09.2021

Ans. (a) : Here, Pitch of screw gauge = P = 1mm
No. of circular divisions, n = 100

Thus, least count (LC) = P/n = $\frac{1}{100}$ = 0.01mm
= 0.001cm

Diameter of wire = MSR+(CSR×LC)
Where, MSR = Main scale reading, CSR = Circular scale reading.
= 0 + (52×0.001 cm) = 0.052 cm

6. The angle of 1' (minute of arc) in radian is nearly equal to/1 (चाप के कोण) के कोण का रेडियन्स में मान होता है लगभग

(a) 1.75×10^{-2} rad (b) 2.91×10^{-4} rad
(c) 4.85×10^{-4} rad (d) 4.80×10^{-6} rad

NEET (UG)-14.10.2020, Phase-II

Ans. (b) : 1 minute = $\left(\frac{1}{60}\right)^{\circ} = \frac{1}{60} \times \frac{\pi}{180}$ radian

$\boxed{1\text{min} = 2.91 \times 10^{-4} \text{ radian}}$

7. A screw gauge has least count of 0.01 mm and there are 50 divisions in its circular scale.
The pitch of the screw gauge is :
किसी स्क्रू गेज़ का अल्पतमांक 0.01 mm है तथा इसके वृत्तीय पैमाने पर 50 भाग हैं।
इस स्क्रू गेज़ का चूड़ी अन्तराल (पिच) है:

(a) 0.25 mm (b) 0.5 mm
(c) 1.0 mm (d) 0.01 mm

NEET (UG)-13.09.2020

Ans. (b) : Screw gauge: A gauge is an instrument that is used to find the diameter of the wire or thin sheet.
Given that : L.C of screw gauge = 0.01 mm
no. of divisions of circular Scale = 50

$$\text{L.C.} = \frac{\text{Pitch}}{\text{No.of division on circular scale}}$$

$$0.01\text{mm} = \frac{\text{Pitch}}{50}$$

Pitch = 0.5mm

8. The main scale of a vernier callipers has n divisions/cm. n divisions of the vernier scale coincide with (n – 1) divisions of main scale. The least count of the vernier callipers is,
किसी वर्नीयर कैलीपर्स के मुख्य पैमाने पर n भाग प्रति सेन्टीमीटर हैं। वर्नीयर पैमाने के n भाग मुख्य पैमाने के (n – 1) भागों के संपाती है। वर्नीयर कैलीपर्स का अल्पतमांक है–

(a) $\frac{1}{n(n+1)}$cm (b) $\frac{1}{(n+1)(n-1)}$cm

(c) $\frac{1}{n}$cm (d) $\frac{1}{n^2}$cm

NEET (UG)-20.05.2019, (Odisha)

Ans. (d) : n main scale divisions (MSD) = 1 cm

$$1 \text{ MSD} = \frac{1}{n}\text{cm}$$

n vernier scale division VSD = (n – l) MSD

$$1 \text{ VSD} = \left(\frac{n-1}{n}\right)\text{MSD}$$

$$1 \text{ VSD} = \left(\frac{n-1}{n}\right) \times \frac{1}{n}\text{cm}$$

$$1 \text{ VSD} = \frac{n-1}{n^2}\text{cm}$$

Least Count (L.C.) = 1MSD – 1VSD

$$= \frac{1}{n} - \frac{n-1}{n^2}$$

$$= \frac{n-(n-1)}{n^2}$$

$$= \frac{n-n+1}{n^2}$$

$$\boxed{\text{L.C.} = \frac{1}{n^2}\text{cm}}$$

9. A student measured the diameter of a small steel ball using a screw gauge of least count 0.001 cm. The main scale reading is 5 mm and zero of circular scale division coincides with 25 divisions above the reference level. If screw gauge has a zero error of –0.004 cm, the correct diameter of the ball is
किसी छात्र ने इस्पात की लघु गेंद के व्यास की माप 0.001cm अल्पतमांक वाले स्क्रू गेज द्वारा की । मुख्य पैमाने की माप 5mm और वृत्तीय पैमाने का शून्य संदर्भ लेवल से 25 भाग ऊपर है। यदि स्क्रू गेज में शून्यांक त्रुटि -0.004 cm है, तो गेंद का सही व्यास होगा

(a) 0.521 cm (b) 0.525 cm
(c) 0.529 cm (d) 0.053 cm

NEET (UG)-06.05.2018

Ans. (c): The least count of screw gauge is 0.001 cm
The main scale reading of the screw gauge is,
MSR = 5 mm = 0.5 cm
Circular scale reading CSR = n × least count
Where, n = number of divisions coinciding = 25
Zero error in the screw gauge = –0.004cm
Observed reading of the screw gauge
= MSR + CSR = MSR + n × least count
= 0.5 + 25 × 0.001 = 0.5 + 0.025 = 0.525cm
Actual reading = reading of screw gauge – zero error
= 0.525 – (–0.004)
= 0.525 + 0.004
= 0.529 cm

1.3 Accuracy, Precision of Instruments and Errors in Measurement

10. 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:
एक धात्विक तार का द्रव्यमान (0.4 ± 0.002) g, त्रिज्या (0.3 ± 0.001) mm तथा लंबाई (5 ± 0.02) cm है। घनत्व के मापन में अधिकतम संभव त्रुटि लगभग होगी :
(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 –
$$\rho = \frac{m}{\pi r^2 L}$$
$$\frac{\Delta\rho}{\rho}\times 100 = \frac{\Delta m}{m}\times 100 + 2\frac{\Delta r}{r}\times 100 + \frac{\Delta L}{L}\times 100$$
$$= \frac{0.002}{0.4}\times 100 + 2\times\frac{0.001}{0.3}\times 100 + \frac{0.02}{5}\times 100$$
$$= \frac{2}{4}+\frac{2}{3}+\frac{2}{5}$$
$$= \frac{30+40+24}{60}$$
$$= \frac{94}{60}$$
$$\boxed{\frac{\Delta\rho}{\rho}\times 100 = 1.56\% = 1.6\%}$$

11. The errors in the measurement which arise due to unpredictable fluctuations in temperature and voltage supply are :
ताप तथा वोल्टेज स्त्रोत में अप्रत्याशी उतार चढ़ाव के कारण मापन में त्रुटियाँ हैं :
(a) Random errors/ यादृच्छिक त्रुटियाँ
(b) Instrumental errors/ यंत्रगत त्रुटियाँ
(c) Personal errors/ व्यक्तिगत त्रुटियाँ
(d) Least count errors / अल्पतमांक त्रुटियाँ
NEET (UG)-07.05.2023

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

12. The percentage error in the measurement of g is: (Given that $g = \frac{4\pi^2 L}{T^2}$, L = (10 ± 0.1) cm, T = (100 ± 1) s)
g के मापन में हुई प्रतिशत त्रुटि है: (दिया है $g = \frac{4\pi^2 L}{T^2}$, L = (10 ± 0.1) cm, T = (100 ± 1) s)
(a) 2% (b) 5%
(c) 3% (d) 7%
NEET (UG) Re-Exam-04.09.2022

Ans. (c) : The percentage error in the measurement of g is –
$$g = \frac{4\pi^2 L}{T^2}$$
Since errors are always added then,
$$\frac{\Delta g}{g}\times 100 = \frac{\Delta L}{L}\times 100 + 2\frac{\Delta T}{T}\times 100$$
$$= \left(\frac{0.1}{10}\times 100\right) + 2\left[\frac{1}{100}\times 100\right]$$
$$\frac{\Delta g}{g}\times 100 = 1 + 2 = 3\%$$

13. Time intervals measured by a clock give the following readings :
किसी घड़ी द्वारा मापे गए समय अंतरालों के पाठयांक नीचे दिये गए हैं।
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?
इन प्रेक्षणों की आपेक्षिक प्रतिशत त्रुटि क्या है?
(a) 1.6% (b) 2%
(c) 4% (d) 16%
NEET (UG)-14.10.2020, Phase-II

Ans. (a): Arithmetic mean of given value is taken as true value.

$$t_{mean} = \frac{t_1 + t_2 + t_3 + t_4 + t_5}{5}$$

$$t_{mean} = \frac{1.25 + 1.24 + 1.27 + 1.21 + 1.28}{5}$$

$$t_{mean} = 1.25 \text{ sec}$$

$$\Delta t_{mean} = \frac{|\Delta t_1| + |\Delta t_2| + |\Delta t_3| + |\Delta t_4| + |\Delta t_5|}{5}$$

$$= \frac{|1.25-1.25| + |1.24-1.25| + |1.27-1.25| + |1.21-1.25| + |1.28-1.25|}{5}$$

$$= \frac{0 + 0.01 + 0.02 + 0.04 + 0.03}{5} = \frac{0.1}{5}$$

$$\% \text{ error} = \frac{\Delta t_{mean}}{t_{mean}} = \frac{0.1 \times 100}{5 \times 1.25}$$

$$\boxed{\% \text{ error} = 1.6\%}$$

14. In an experiment, the percentage of error occurred in the measurement of physical quantities A, B, C and D are 1%, 2%, 3% and 4% respectively. Then the maximum percentage of error in the measurement X, where $X = \frac{A^2B^{1/2}}{C^{1/3}D^3}$, will be

किसी प्रयोग में भौतिक राशियों A, B, C और D की माप में होने वाली त्रुटि की प्रतिशतता क्रमशः 1%, 2%, 3% और 4% है। तब X की माप, जबकि $X = \frac{A^2B^{1/2}}{C^{1/3}D^3}$, है, में अधिकतम प्रतिशत त्रुटि होगी-

(a) 16% (b) –10%

(c) 10% (d) $\left(\frac{3}{13}\right)\%$

NEET (UG)-05.05.2019

Ans. (a) Given $X = \frac{A^2B^{1/2}}{C^{1/3}D^3}$

The percentage error in X is given by

$$\frac{\Delta X}{X} \times 100 = 2\left(\frac{\Delta A}{A}\right) \times 100 + \frac{1}{2}\left(\frac{\Delta B}{B}\right) \times 100 + \frac{1}{3}\left(\frac{\Delta C}{C}\right) \times 100 + 3\left(\frac{\Delta D}{D}\right) \times 100 \quad \ldots(i)$$

Here, $\frac{\Delta A}{A} \times 100 = 1\%$

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

$\frac{\Delta C}{C} \times 100 = 3\%$

$\frac{\Delta D}{D} \times 100 = 4\%$

Substituting these values in equation (i) we get

$$\frac{\Delta X}{X} \times 100 = 2(1\%) + \frac{1}{2}(2\%) + \frac{1}{3}(3\%) + 3(4\%)$$

$$= 2\% + 1\% + 1\% + 12\% = 16\%$$

15. In an experiment four quantities a, b, c and d are measured with percentage error 1%, 2%, 3% and 4% respectively. Quantity P is calculated as follows

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

% error in P is :-

किसी प्रयोग में चार राशियों a, b, c तथा d के मापन (नापने) में क्रमशः 1%, 2%, 3% तथा 4% की त्रुटि होती है। एक राशि P का मान निम्नलिखित रूप से परिकलित किया जाता है $P = \frac{a^3b^2}{cd}$ तो P के मापन में (%) त्रुटि होगी -

(a) 4% (b) 14%

(c) 10% (d) 7%

NEET (UG)-05.05.2013

Ans. (b) : Percentage error in a, $\frac{\Delta a}{a} \times 100 = 1\%$

Percentage error in b, $\frac{\Delta b}{b} \times 100 = 2\%$

Percentage error in c , $\frac{\Delta c}{c} \times 100 = 3\%$

Percentage error in d , $\frac{\Delta d}{d} \times 100 = 4\%$

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

Percentage error in P

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

$$= 3 \times 1 + 2 \times 2 + 3 + 4$$

$$= 3 + 4 + 3 + 4$$

$$= 14\%$$

16. A student measures the distance traversed in free fall of a body, initially at rest, in a given time. He uses this data to estimate g, the acceleration due to gravity. If the maximum percentage errors in measurement of the distance and the time are e_1 and e_2 respectively, the percentage error in the estimation of g is

एक वस्तु प्रारम्भ में विराम अवस्था में है। एक विद्यार्थी इस वस्तु के मुक्त पतन में, किसी दिये गये समय में तय की गई दूरी नापता है और इसका उपयोग गुरुत्वीय त्वरण g का मान ज्ञात करने में करता है। यदि दूरी तथा समय की मापों में अधिकतम प्रतिशत त्रुटि क्रमशः e_1 तथा e_2 हो तो, g का मान ज्ञात करने में प्रतिशत त्रुटि होगी –

(a) $e_2 - e_1$ (b) $e_1 + 2e_2$
(c) $e_1 + e_2$ (d) $e_1 - 2e_2$

AIPMT (Mains)-2010

Ans. (b) : From second equation of motion-

$$S = ut + \frac{1}{2}at^2$$

Where S = h and a = g
g is acceleration due to gravity.
Now initial velocity is zero (u = 0)

then $h = \frac{1}{2}gt^2$

$$\boxed{g = \frac{2h}{t^2}} \qquad ...(i)$$

By taking natural logarithm on both sides in the above equation (i) we get.

$$\ell n(g) = \ell n\left(\frac{2h}{t^2}\right)$$

Using property, $\log \frac{a}{b} = \log a - \log b$

$$\ell n(g) = \ell n(2h) - 2\ell n(t)$$

Differentiating

$$\frac{\Delta g}{g} = \left|\frac{\Delta h}{h}\right| + \left|-2 \times \frac{\Delta t}{t}\right|$$

For maximum Permissible error

$$\left(\frac{\Delta g}{g} \times 100\right)_{max} = \left(\frac{\Delta h}{h} \times 100\right) + 2 \times \left(\frac{\Delta t}{t} \times 100\right)$$

According to problem,

$$\frac{\Delta h}{h} \times 100 = e_1 \text{ and } \frac{\Delta t}{t} \times 100 = e_2$$

Therefore,

$$\boxed{\frac{\Delta g}{g} \times 100 = e_1 + 2e_2}$$

17. 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 –
यदि किसी गोले के त्रिज्या मापन में 2 % की त्रुटि हुई हो, तो गोले के आयतन के परिकलन में त्रुटि होगी :-

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

AIPMT-2008

Ans. (d) : Given: Error in measurement in radius of sphere = 2%

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

Volume of sphere $V = \frac{4}{3}\pi r^3$

Percentage error in volume

$$\frac{\Delta V}{V} \times 100 = 3 \times \frac{\Delta r}{r} \times 100$$

% error in volume = 3 × % error in radius
= 3 × 2
= 6 %

18. The error in measurement of radius of a sphere is 0.1% then error in its volume is
किसी गोले के त्रिज्या मापन में 0.1 % की त्रुटि हुई हो, तो गोले के आयतन के परिकलन में त्रुटि होगा

(a) 0.3% (b) 0.4%
(c) 0.5% (d) 0.6%

AIPMT-1999

Ans. (a) : We know that,

Volume of sphere, $V = \frac{4}{3}\pi r^3$

Then error in its volume–

$$\frac{\Delta v}{V} = 3\frac{\Delta r}{r}$$

= 3 × 0.1 = 0.3%

Method II

We Known

Volume of Sphere, $V = \frac{4}{3}\pi R^3$

Differentiate the Expression of volume w.r.t radius,

$$\frac{dV}{dR} = \frac{4}{3}\pi.3R^2$$

$$dV = \frac{4}{3}\pi R^3.3\frac{dR}{R}$$

[Multiply by R in $\frac{N}{D}$ $\therefore$ V= $\frac{4}{3}\pi R^3$]

$$\frac{dV}{V} = \frac{3dR}{R}$$

$$\Rightarrow \quad \frac{dV}{V} \times 100 = 3\left(\frac{dR}{R} \times 100\right)$$

% Error in measurement of volume
= 3×0.1%
= 0.3%

19. 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 lengths are 3% and 2% respectively, the maximum error in the measurement of density would be/ एक घन का घनत्व इसके द्रव्यमान तथा भुजा से मापा जाता है। यदि द्रव्यमान तथा भुजा मापने में अधिकतम त्रुटि क्रमशः 3% तथा 2% हो, तो घनत्व में अधिकतम त्रुटि होगी

(a) 12% (b) 14%
(c) 7% (d) 9%

PMT-1996

Ans. (d): Given that,

Maximum error in the mass, $\left(\frac{\Delta m}{m}\right) = 3\%$

and in the length , $\left(\frac{\Delta L}{L}\right) = 2\%$

We know that,

$$\text{Density of cube} = \frac{\text{mass}(m)}{\text{volume}(V)}$$

$$\rho = \frac{m}{L^3} \quad \because \text{volume } (V) = L^3$$

Taking log on both sides above,

$\Rightarrow \quad \ln \rho = \ln m - 3 \ln L$

Differentiating the above equation,

$$\left|\frac{\Delta\rho}{\rho}\right| = \left|\frac{\Delta m}{m}\right| + \left|-3\frac{\Delta L}{L}\right|$$

$$\frac{\Delta\rho}{\rho}\times 100 = \frac{\Delta m}{m}\times 100 + 3\frac{\Delta L}{L}\times 100$$

$= 3 + 3\ (2)$

$= 3 + 6$

Maximum error in the measurement of density,

$\left(\frac{\Delta\rho}{\rho}\right) = 9\%$

20. Percentage errors in the measurement of mass and speed are 2% and 3% respectively. The error in the estimate of kinetic energy obtained by measuring mass and speed will be

द्रव्यमान तथा वेग को मापने में प्रतिशत त्रुटि क्रमशः 2% तथा 3% है। गतिज ऊर्जा को मापने में प्रतिशत त्रुटि होगी:

(a) 8% (b) 2%

(c) 12% (d) 10%

AIPMT-1995

Ans. (a) : Given that,

$$\text{Percentage errors in mass } \frac{(\Delta m)}{m} = 2\%$$

$$\text{and in speed, } \frac{\Delta v}{v} = 3\%$$

We know that, kinetic energy (KE) = $\frac{1}{2}mv^2$

Error is estimated in kinetic energy as

So, $\frac{\Delta k.E}{k.E}\times 100 = \frac{\Delta m}{m}\times 100 + 2\frac{\Delta v}{v}\times 100$ [taking log and differentiating the kinetic energy's equation]

$= 2\% + 2\ (3\%)$

$= 8\%$

21. A certain body weights 22.42 g and has a measured volume of 4.7cc. 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

एक पिण्ड का द्रव्यमान 22.42 ग्राम तथा आयतन 4.7 घन सेमी है। इसके द्रव्यमान के मापन में 0.01 ग्राम तथा घन के मापन में 0.1 घन सेमी की त्रुटि है, तो घनत्व में अधिकतम त्रुटि होगी:

(a) 22% (b) 2%

(c) 0.2% (d) 0.02%

AIPMT-1991

Ans. (b) : Given that,

mass of body (m) = 22.42 g

volume of body (V) = 4.7 cc

Possible error measurement in mass of body (Δm) = 0.0lg

and error in volume of body (ΔV) = 0.1 cc

We know that,

$$\text{Density } (\rho) = \frac{\text{mass}(m)}{\text{volume}(V)}$$

for maximum error,

$$\frac{\Delta\rho}{\rho} = \left(\frac{\Delta m}{m}\right) + \left(\frac{\Delta v}{v}\right)$$

$$= \left(\frac{0.01}{22.42}\right) + \left(\frac{0.1}{4.7}\right)$$

$$= \left(\frac{1}{2242}\right) + \left(\frac{1}{47}\right)$$

$= 0.0217$

So the maximum error in the density will be

$= 2.17\% \ \because 2\%$

1.4 Significant Figures

22. 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:

एक गोलाकार बॉब का व्यास, जब वर्नियर कैलीपर्स से मापा जाता है, तो निम्नलिखित मान प्राप्त होते है: 3.33 सेमी, 3.32 सेमी, 3.34 सेमी, .3.33 सेमी और 3.32 सेमी।

उपयुक्त सार्थक अंकों में औसत व्यास है:

(a) 3.33cm/3.33 सेमी (b) 3.32cm/3.32 सेमी

(c) 3.328/3.328 सेमी (d) 3.3cm/3.3 सेमी

RE NEET Manipur (UG)- 06.06.2023

Ans. (a) :

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

$= 3.328$ cm

Mean diameter = 3.33 cm

(by taking appropriate significant figure)

23. The area of a rectangular field (in m^2) of length 55.3 m and breadth 25 m after rounding off the value for correct significant digits is
55.3 m लम्बाई एवं 25 m चौड़ाई वाले आयताकार क्षेत्र के क्षेत्रफल (m^2 में) का मान, निकटतम पूर्णांक बनाने के बाद सही सार्थक अंक के लिए है:

(a) 14×10^2 (b) 138×10^1
(c) 1382 (d) 1382.5

NEET (UG)-17.07.2022

Ans. (a) : Given
Length = 55.3 m
Breadth = 25 m
We know that
Area = Length × Breadth
$= 55.3\times25$
$= 1382.5$
$= 14\times10^2$
Resultant should have 2 significant figure.

24. Taking into account of the significant figures, what is the value of 9.99 m – 0.0099 m?
सार्थक अंकों को महत्त्व देते हुए 9.99 m – 0.0099 m का मान क्या है?

(a) 9.98 m (b) 9.980 m
(c) 9.9 m (d) 9.9801 m

NEET (UG)-13.09.2020

Ans. (a) : Let X = 9.99 m -0.0099m = 9.9801 m
But our answer, should have same no. of significant figure as least accurate number.
So, X = 9.98m

1.5 Dimensional Analysis and its Applications

25. The mechanical quantity, which has dimensions of reciprocal of mass (M^{-1}) is
वह यांत्रिक राशि, जिसकी विमाएं द्रव्यमान के व्युत्क्रम (M^{-1}) होती है-

(a) Torque/ बल आघूर्ण
(b) Gravitational constant/गुरूत्वाकर्षण स्थिरांक
(c) Angular momentum/कोणीय गति
(d) Coefficient of thermal conductivity/ऊष्मीय चालकता का गुणांक

RE NEET Manipur (UG)- 06.06.2023

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}).

26. Match List-I with List-II
सूची-I का सूची-II के साथ मिलान करें:

	List-I/सूची-I		List-II/सूची-II
(A)	Gravitational constant (G)/गुरुत्वीय स्थिरांक (G)	(i)	$[L^2T^{-2}]$
(B)	Gravitational potential energy/गुरुत्वीय स्थितिज ऊर्जा	(ii)	$[M^{-1}L^3T^{-2}]$
(C)	Gravitational potential/गुरुत्वीय विभव	(iii)	$[LT^{-2}]$
(D)	Gravitational intensity/गुरुत्वीय तीव्रता	(iv)	$[ML^2T^{-2}]$

Choose the correct answer from the options given below
नीचे दिए गए विकल्पों में से सही उत्तर चुनें:

(a) (A) - (iv), (B) - (ii), (C) - (i), (D) - (iii)
(b) (A) - (ii), (B) - (i), (C) - (iv), (D) - (iii)
(c) (A) - (ii), (B) - (iv), (C) - (i), (D) - (iii)
(d) (A) - (ii), (B) - (iv), (C) - (iii), (D) - (i)

NEET (UG)-17.07.2022

Ans. (c) : Option (a) Gravitational constant (G),

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

$$G = \frac{Fr^2}{m_1m_2} = \frac{\left[MLT^{-2}\right]\left[L^2\right]}{\left[M^2\right]}$$

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

Option (b) Gravitational potential energy,

$$U = \frac{1}{2}mgh = \left[M^1L^2T^{-2}\right]$$

Option (c) Gravitational potential,

$$= \frac{\text{Work}}{\text{Mass}} = \frac{\left[ML^2T^{-2}\right]}{\left[M\right]} = \left[L^2T^{-2}\right]$$

Option (d) Gravitational intensity, $I = \frac{\text{Force}}{\text{mass}}$

$$= \left[L^1T^{-2}\right]$$

27. The physical quantity that has the same dimensional formula as pressure is:/भौतिक राशि जिसका, दाब के समान ही विमीय सूत्र है, वह है;

(a) Force/बल
(b) Momentum/संवेग
(c) Young's modulus of elasticity
प्रत्यास्थता का यंग गुणांक
(d) Coefficient of viscosity/श्यानता गुणांक

NEET (UG) Re-Exam-04.09.2022

Ans. (c):

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

$$\text{Young' modulus (Y)} = \frac{\text{Stress}}{\text{Strain}}$$

$$Y = \frac{\frac{F}{A}}{\frac{\Delta L}{L}} = \frac{\left[MLT^{-2}\right]}{\left[L^2\right]} = \left[ML^{-1}T^{-2}\right]$$

Hence, the young's modulus of elasticity has the same dimensional formula as pressure.

28. Plane angle and solid angle have
समतलीय कोण एवं घन कोण में होता है:

(a) Both units and dimensions/मात्रक एवं विमा दोनों
(b) Units but no dimensions/मात्रक पर कोई विमा नहीं
(c) Dimensions but no units
विमा लेकिन कोई मात्रक नहीं
(d) No units and no dimensions
ना कोई मात्रक ना कोई विमा

NEET (UG)-17.07.2022

Ans. (b) : Plane angle $= \frac{\text{arc}}{\text{radius}}$, has radian as unit but No - dimensions. Solid angle $= \frac{\text{area}}{r^2}$, has streradian as unit but No - dimensions.

29. The dimensions $[MLT^{-2}A^{-2}]$ belong to the
विमाएं $[MLT^{-2}A^{-2}]$ सम्बन्धित हैं:

(a) Electric permitivity/वैद्युत विद्युतशीलता
(b) Magnetic flux/चुम्बकीय फ्लक्स
(c) Self inductance/स्व-प्रेरकत्व
(d) Magnetic permeability/चुम्बकीय पारगम्यता

NEET (UG)-17.07.2022

Ans. (d) : Solve by option
(a) dimension of electric permitivity is $M^{-1}L^{-3}T^4I^2$

option (b) Magnetic flux

$$\phi = B.A = \frac{F}{il}A$$

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

$$= \left[ML^2T^{-2}I^{-1}\right]$$

option (c) self inductance

$$L = \frac{Q}{\ell}$$

$$= \left[ML^2T^{-2}I^{-2}\right]$$

option (d) Magnetic permeability

$$L = \frac{\mu_o N^2 A}{\ell}$$

$$\mu_o = \frac{L\ell}{N^2 A}$$

$$\mu_o = \frac{\left[ML^2T^{-2}I^{-2}\right]\left[L\right]}{L^2}$$

$$\mu_o = \left[MLT^{-2}I^{-2}\right] \text{or} \left[MLT^{-2}A^{-2}\right]$$

So option (d) is the correct answer.

30. If E and G respectively denote Energy and Gravitational constant, then $\frac{E}{G}$ has the dimension of-
यदि E तथा G क्रमशः ऊर्जा तथा गुरुत्वाकर्षण नियतांक को प्रदर्शित करते हैं, तो $\frac{E}{G}$ की विमा होती है :

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

NEET (UG)-12.09.2021

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

$$[G] = \frac{F \times r^2}{m_1 m_2} = \left[\frac{MLT^{-2}L^2}{M^2}\right] = M^{-1}L^3T^{-2}$$

$$\therefore \left[\frac{E}{G}\right] = \frac{ML^2T^{-2}}{M^{-1}L^3T^{-2}} = [M^2L^{-1}T^0]$$

31. If Force [F], Acceleration [A] and Time [T] are chosen as the fundamental physical quantities. Find the dimensions of energy.
यदि बल [F], त्वरण [A] तथा समय [T] को मुख्य भौतिक राशियाँ मान लिया जाए, तो ऊर्जा की विमा ज्ञात कीजिए।

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

NEET (UG)-12.09.2021

Ans. (c) : Energy $= F^\alpha A^\beta T^\gamma$

$M^1L^2T^{-2} = (MLT^{-2})^\alpha (LT^{-2})^\beta (T)^\gamma$

$M^1L^2T^{-2} = M^\alpha L^{\alpha+\beta} T^{-2\alpha-2\beta+\gamma}$

Equating the power constants of M, L and T on LHS & RHS

$\alpha = 1$

$\alpha+\beta = 2 \Rightarrow \beta = 1$

$-2\alpha-2\beta+\gamma = -2 \quad \Rightarrow \gamma = 2$

$\therefore$ Energy $= F^1A^1T^2$

32. Dimensions of stress are :
प्रतिबल की विमाएँ हैं:

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

NEET (UG)-13.09.2020

Ans. (c) : $\text{Stress} = \frac{\text{Force}}{\text{Area}}$

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

Stress $= \left[ML^{-1}T^{-2}\right]$

33. A physical quantity of the dimensions of length that can be formed out of c, G and $\frac{e^2}{4\pi\varepsilon_0}$ is [c is velocity of light, G is universal constant of gravitation and e is charge] /c, G तथा $\frac{e^2}{4\pi\varepsilon_0}$ से बनने वाली एक भौतिक राशि की विमायें वही हैं जो लम्बाई की है। (जहाँ c - प्रकाश का वेग, G - सार्वत्रिक गुरुत्वीय स्थिरांक तथा e आवेश है) यह भौतिक राशि होगी:

(a) $\frac{1}{c^2}\left[G\frac{e^2}{4\pi\varepsilon_0}\right]^{\frac{1}{2}}$ (b) $c^2\left[G\frac{e^2}{4\pi\varepsilon_0}\right]^{\frac{1}{2}}$

(c) $\frac{1}{c^2}\left[\frac{e^2}{G4\pi\varepsilon_0}\right]^{\frac{1}{2}}$ (d) $\frac{1}{c}G\frac{e^2}{4\pi\varepsilon_0}$

NEET (UG)-07.05.2017

Ans. (a) : Given, C, G, $\frac{e^2}{4\pi\varepsilon_0}$

So, $[L] = [C]^x [G]^y \left[\frac{e^2}{4\pi\varepsilon_0}\right]^z$

$$[L] = \left[LT^{-1}\right]^x \left[M^{-1}L^3T^{-2}\right]^y \left[ML^3T^{-2}\right]^z$$
$$= L^{x+3y+3z} M^{-y+z} T^{-x-2y-2z}$$

On comparing we get

$x + 3y + 3z = 1$

$-y + z = 0$

$-x - 2y - 2z = 0$

On solving we get

$$x = -2, \quad y = \frac{1}{2}, \quad z = \frac{1}{2}$$

Thus $L = [C]^{-2}[G]^{1/2}\left[\frac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$

$$\boxed{L = \frac{1}{C^2}\left[\frac{Ge^2}{4\pi\varepsilon_0}\right]^{1/2}}$$

34. Planck's constant (h), speed of light in vacuum (c) and Newton's gravitational constant (G) are three fundamental constants. Which of the following combinations of these has the dimension of length?/यदि प्लांक स्थिरांक (h) निर्वात में प्रकाश का वेग (c) तथा न्यूटन का गुरूत्वीय स्थिरांक (G) तीन मौलिक स्थिरांक हों, तो निम्नलिखित में से किसकी विमा वही होगी जो लम्बाई की होती है ?

(a) $\frac{\sqrt{hG}}{c^{3/2}}$ (b) $\frac{\sqrt{hG}}{c^{5/2}}$

(c) $\sqrt{\frac{hc}{G}}$ (d) $\sqrt{\frac{Gc}{h^{3/2}}}$

NEET (UG)-24.07.2016, PHASE-II

Ans. (a) :

• Dimension of planck's constant h-

$h = \lambda \times mv$

$$[h] = \left[L \times M \times \frac{L}{T}\right] = \left[\frac{ML^2}{T}\right] \text{---- (i)}$$

• Dimension of gravitational constant G-

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

$$[G] = \frac{\left[MLT^{-2}\right] \times \left[L^2\right]}{\left[M^2\right]} = \left[\frac{L^3}{MT^2}\right] \text{---- (ii)}$$

• Dimension of Velocity c-

$$[c] = \left[\frac{L}{T}\right] \quad \text{------ (iii)}$$

$$[hG] = \left[\frac{ML^2}{T}\right]\left[\frac{L^3}{MT^2}\right]$$

$$[hG] = \left[L^2\right] \times \left[\frac{L^3}{T^3}\right]$$

$$[hG] = \left[L^2\right] \times \left[C^3\right]$$

$$\text{i.e } \left[L^2\right] = \frac{[hG]}{\left[C^3\right]}$$

$$\boxed{L = \sqrt{\frac{hG}{C^3}}} \Rightarrow \boxed{L = \frac{\sqrt{hG}}{C^{3/2}}}$$

Hence, option (a) is correct.

35. If energy (E), velocity (V) and time (T) are chosen as the fundamental quantities, the dimensional formula of surface tension will be: यदि ऊर्जा (E), वेग(V) तथा समय (T) को मूल राशियाँ माना जाय तो, पृष्ठतनाव की विमा होगा:

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

(c) $[E^{-2}V^{-1}T^{-3}]$ (d) $[EV^{-2}T^{-1}]$

AIPMT-03.05.2015

Ans. (b) : From the question

$S = E^a V^b T^c$ ..... (1)

$$\left[MT^{-2}\right] = \left[ML^2T^{-2}\right]^a \left[LT^{-1}\right]^b [T]^c$$

$$\left[ML^0T^{-2}\right] = \left[M^a L^{2a+b} T^{-2a-b+c}\right]$$

Comparing powers on both sides, we get

$\Rightarrow a = 1$

$\Rightarrow 2a + b = 0 \Rightarrow 2 \times 1 + b = 0 \Rightarrow b = -2$

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

$\Rightarrow c = -2$

On putting these values in eqn (1), we get

$[S] = \left[EV^{-2}T^{-2}\right]$

36. If force (F), velocity (V) and time (T) are taken as fundamental units, then the dimensions of mass are.
यदि बल(F), वेग(V) तथा समय(T) को मूल मात्रक मान लिया जाय तो, द्रव्यमान की विमायें होंगी:-

(a) $[F\ VT^{-1}]$ (b) $[F\ VT^{-2}]$
(c) $[F\ V^{-1}\ T^{-1}]$ (d) $[F\ V^{-1}T]$

AIPMT-06.05.2014

Ans. (d) :
We know that the dimension of force (F) = $[MLT^{-2}]$ and velocity V = $[LT^{-1}]$

$$\therefore\ M = \frac{F}{LT^{-2}}$$

$$M = \frac{F}{LT^{-1}T^{-1}} = \frac{F}{VT^{-1}} = [FV^{-1}T]$$

37. The pair of quantities having same dimensions is

(a) Young's modulus and Energy
(b) Impulse and Surface Tension
(c) Angular momentum and Work
(d) Work and Torque

NEET (UG)-18.05.2013, Karnataka

Ans. (d) : Dimensions formula

$$\text{Young's modulus} = \frac{F}{A} = \frac{MLT^{-2}}{L^2} = \left[ML^{-1}T^{-2}\right]$$

$$\text{Energy} = mc^2 = [M]\left[L^2T^{-2}\right] = \left[ML^2T^{-2}\right]$$

$$\text{Impulse} = \text{F.t.} = \left[MLT^{-2}\right][T] = \left[MLT^{-1}\right]$$

$$\text{Surface Tension} = \frac{F}{L} = \frac{\left[MLT^{-2}\right]}{[L]} = \left[ML^0T^{-2}\right]$$

Angular momentum

$$= \vec{r} \times \vec{p} = [L]\left[MLT^{-1}\right] = \left[ML^2T^{-1}\right]$$

$$\text{Work} = \text{F.d.} = \left[MLT^{-2}\right][L] = \left[ML^2T^{-2}\right]$$

$$\text{Torque} = F_1\text{d.} = \left[MLT^{-2}\right][L] = \left[ML^2T^{-2}\right]$$

Option (d) is correct. Work and Torque have same dimensions.

38. The dimensions of $(\mu_0\varepsilon_0)^{-1/2}$ are
$(\mu_0\varepsilon_0)^{-1/2}$ की विमा होती है।

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

AIPMT (Mains)-2012
AIPMT (Screening)-2011

Ans. (a) : Speed of light is given by

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

where, μ_0 = permeability of free space
ε_0 = permittivity of free space
Dimension of $\mu_0 = [MLT^{-2}A^{-2}]$
$\varepsilon_0 = [M^{-1}L^{-3}T^4A^2]$

$$c^2 = \frac{1}{\left[MLT^{-2}A^{-2}\right]\left[M^{-1}L^{-3}T^4A^2\right]}$$

$$c^2 = \frac{1}{\left[L^{-2}T^2\right]}$$

$c^2 = [L^2T^{-2}]$
$c = [LT^{-1}]$
where, c = speed of light
unit of c = meter/second

$$c = \frac{L}{T}$$

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

39. The dimension of $\frac{1}{2}\epsilon_0 E^2$ where ϵ_0 is permittivity of free space and E is electric field.
$\frac{1}{2}\epsilon_0 E^2$, की विमा, जहाँ ϵ_0 निर्वात की विद्युतशीलता व E विद्युत क्षेत्र है, होगी –

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

AIPMT (Screening)-2010

Ans. (b) : We know that $F = \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r^2}$

$$\epsilon_0 = \frac{1}{4\pi F}\frac{q_1q_2}{r^2}$$

Dimensional formula will be-

$$\epsilon_0 = \frac{[AT][AT]}{\left[MLT^{-2}\right][L^2]}$$

Dimensions of $\epsilon_0 = [M^{-1}L^{-3}T^4A^2]$

we know electric field $E = \frac{F}{q} = \frac{\left[MLT^{-2}\right]}{[AT]}$

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

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

40. If the dimensions of a physical quantity are given by $[M^aL^bT^c]$, then the physical quantity will be:/यदि किसी भौतिक राशि की विमाएं $[M^aL^bT^c]$ से सूचित की गई हों, तो यहः

(a) Force if /बल होगा यदि a = 0, b = –1, c = –2
(b) Pressure if /बल होगा यदि a = 1, b = –1, c = –2
(c) Velocity if /बल होगा यदि a = 1, b = 0, c = –1
(d) Acceleration if /बल होगा यदि a = 1, b = 1, c = –2

AIMPT-2009

Ans. (b): Given $\Rightarrow M^a L^b T^c$

Force = ma = $kg\frac{m}{s^2} = MLT^{-2} \Rightarrow a = 1, b = 1, c = -2$

Pressure = $\frac{F}{A} = \frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2} \Rightarrow a = 1, b = -1,$ $c = -2$ (satisfied the option)

Velocity = $\frac{\text{Displacement}}{\text{time}} = \frac{s}{t} = \frac{m}{sec} = LT^{-1} \Rightarrow a = 0,$ $b = 1, c = -1$

Acceleration = $\frac{\text{velocity}}{\text{time}} = \frac{LT^{-1}}{T} = M^0L^1T^{-2} \Rightarrow a = 0,$ $b = 1, c = -2$

41. Which two of the following five physical parameters have the same dimensions ?
निम्न पाँच भौतिक राशियों में से कौन सी दो एक जैसी विमायें रखती है?

(a) Energy density/ऊर्जा घनत्व

(b) Refractive index/ अपवर्तनांक

(c) Dielectric constant/ डाइइलैक्ट्रिक स्थिरांक

(d) Young's modulus/ यंग का गुणांक

(e) Magnetic field/चुम्बकीय क्षेत्र

(a) (a) and (d)/ (a) और (d)

(b) (a) and (e)/ (a) और (e)

(c) (b) and (d)/ (b) और (d)

(d) (c) and (e)/ (c) और (e)

AIPMT-2008

Ans. (a) : Energy density = $\frac{\text{Energy}}{\text{volume}}$

$= \frac{\text{dimension of energy}}{\text{dimension of volume}} = \frac{[ML^2T^{-2}]}{[L^3]} = [ML^{-1}T^{-2}]$

Young modulus = $\frac{\text{stress}}{\text{strain}} = \frac{[ML^{-1}T^{-2}]}{\text{No dimension}} = [ML^{-1}T^{-2}]$

Magnetic field B = $\frac{\text{Force}}{\text{charge} \times \text{velocity}} = \frac{[MLT^{-2}]}{[AT][LT^{-1}]} = [MT^{-2}A^{-1}]$

Refractive index $\mu = \frac{\text{speed of light in medium 1}}{\text{speed of light in medium 2}}$

So, refractive index has no units, no dimensions.

Dielectric constant = $\frac{\text{Permittivity of the object}}{\text{Permittivity of free space.}}$

So, dielectric constant is ratio of two same quantity therefore, it has no unit, no dimensions.

42. 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:
द्रव्यमान (mass) की विमा M, लम्बाई (length) की विमा L, समय (time) की विमा T और धारा की विमा I मानते हुए किसी वैद्युत परिपथ में प्रतिरोध की विमाएँ होंगी:-

(a) $ML^2T^{-3}I^{-2}$ (b) $ML^2T^{-3}I^{-1}$

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

AIPMT-2007

Ans. (a) : We know voltage $V = IR$

so resistance $R = \frac{V}{I}$

where $V = \frac{\text{Work done}}{\text{Charge}} = \frac{w}{q}$

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

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

$\therefore \text{Resistance } [R] = \frac{[ML^2T^{-3}I^{-1}]}{[I]}$

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

43. The velocity v of a particle at time t is given by $v = at + \frac{b}{t+c}$, where a, b and c are constants. The dimensions of a, b and c respectively:-
समय t पर एक कण का वेग v समीकरण $v = at + \frac{b}{t+c}$ द्वारा दिया जाता है जहाँ a, b तथा c नियतांक हैं। a, b तथा c की विमाएँ क्रमानुसार होंगी-

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

$\because$ Velocity (v) = $\frac{\text{Displacement}}{\text{Time}}$

$\therefore$ Dimension of velocity 'v' = $[M^0LT^{-1}]$

Now,

Dimension of velocity = Dimension of at

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

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

Again, Dimension of v = Dimension of $\frac{b}{t+c}$

$[LT^{-1}] = \frac{b}{t+c}$ ...(i)

$\because$ 'c' is added to 't', therefore dimension of c & t will be same.

$[c] = [T]$

Now, from (i)

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

$$[b] = [L]$$

44. The ratio of the dimension of Planck's constant and that of the moment of inertia is the dimension of :
प्लांक नियतांक और जड़त्व के आघूर्ण की विमाओं का अनुपात समतुल्य होगा इनमें से किस की विमाओं का :-

(a) Velocity/वेग
(b) Angular momentum/कोणीय संवेग
(c) Time/समय
(d) Frequency/आवृत्ति

AIPMT-2005

Ans. (d) : We know that $E = h\nu$
Where, h = Planck's constant

Planck's constant, $h = \frac{E}{\nu}$

$$\text{dimension of } h = \frac{\left[ML^2T^{-2}\right]}{\left[T\right]^{-1}} = \left[ML^2T^{-1}\right] ----(i)$$

Moment of inertia, $I = mr^2$
dimension of $I = [ML^2]$ -------- (ii)
On dividing equation (i) by equation (ii) , we get

$$\frac{h}{I} = \frac{\left[ML^2T^{-1}\right]}{\left[ML^2\right]}$$

$$\frac{h}{I} = \frac{T^{-1}}{1}$$

$$\text{i.e. } \frac{h}{I} = T^{-1} = \frac{1}{T} = \text{dimension of frequency}$$

45. The dimension of Planck constant equals to that of :
प्लांक नियतांक की विमा किसके समान है-

(a) Energy/ ऊर्जा
(b) Momentum/ संवेग
(c) Angular momentum/ कोणीय संवेग
(d) Power/शक्ति

AIPMT-2001

Ans. (c) : Planck's constant : It is a physical constant that is quantum of electromagnetic action. It relates the energy carried by a photon to its frequency by $E = h\nu$

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

E = Energy, ν = frequency & h = planck's constant
Dimensional formula of energy (E) = $[ML^2\,T^{-2}]$
Dimensional formula of frequency (ν) = $[T^{-1}]$

$$h = \frac{ML^2\,T^{-2}}{T^{-1}}$$

$\therefore h = ML^2\,T^{-1}$

$\therefore$ Dimensional formula of planck's constant h is $[ML^2\,T^{-1}]$

Angular Momentum
It is the rotational equivalent of linear momentum
$\therefore L = I \times \omega$
$\therefore L = r \times p$ $\quad [\because P = m.v]$
L = angular momentum
ω = angular velocity
I = moment of Inertia
r = distance
P = linear momentum
Dimensional formula for L= [L] $[MLT^{-1}]$
$L = [ML^2T^{-1}]$

Physical Quantity	Dimensional formula
Energy	$[ML^2\,T^{-2}]$
Momentum	$[M^1L^1T^{-1}]$
Power	$[ML^2\,T^{-3}]$

46. Which pair have not equal dimensions :
निम्न में से कौनसा युग्म असमान विमा रखता है –

(a) Energy and torque/ऊर्जा व बल आघूर्ण
(b) Force and impulse/बल व आवेग
(c) Angular momentum and Planck's constant
कोणीय संवेग तथा प्लांक स्थिरांक
(d) Elastic modulus and pressure
प्रत्यास्थता गुणांक तथा दाब

AIPMT-2000

Ans. (b) :
For option A:
Energy = kg m^2s^2 = $[ML^2\,T^{-2}]$
Torque = kg m^2s^2 = $[ML^2\,T^{-2}]$
For option B:
Force = kg × m/s^2 = $[MLT^{-2}]$
Impulse = kg m/s = $[MLT^{-1}]$
For option C:
Angular momentum = kg m^2/s = $[ML^2\,T^{-1}]$
Planck's constant = kg m^2/s = $[ML^2T^{-1}]$
For option D:
Elastic modulus = N/m^2 = $[ML^{-1}T^{-2}]$
Pressure = N/m^2 = $[ML^{-1}T^{-2}]$

47. The dimensions of universal gravitational constant are
सार्वत्रिक गुरुत्वाकर्षण नियतांक की विमाएँ हैं:

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

AIPMT-2004,1992

Ans. (a): Universal gravitational constant- It can be defined as the constant relating the force exerted on the objects to the mass and distance between the objects. The gravitational constant is equal to the numerical value of the attracting force when two unit masses are separated by a unit distance.

• The value of the universal gravitational constant (G) is 6.673×10^{-11} N m^2/kg^2.

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

$$F = m\times a$$

$$= \frac{kg - m}{sec^2}$$

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

Now, $G = \frac{[MLT^{-2}][L^2]}{[M][M]}$

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

• So, the dimension of the gravitational constant is $[M^{-1}\,L^3\,T^{-2}]$.

48. The dimensions of impulse are equal to that of आवेग की विमाएँ निम्न में से किसकी विमाओं के समान है?

(a) pressure/दाब

(b) linear momentum/रैखिक संवेग

(c) force/बल

(d) angular momentum/कोणीय संवेग

AIPMT-1996

Ans. (b) : Impulse- It is used to describe the effect of force acting over time to change the momentum of on object. It is represented by symbol 'J' and its unit is Newton second or kg m/sec.

$$J = F.\Delta t$$

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

Dimension of time $(\Delta t) = [T]$

$$J = F\times\Delta t$$

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

$$J = [MLT^{-1}]$$

Momentum = m × v

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

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

• So, impulse is equal to the change in linear momentum of the body.

49. Which of the following dimensions will be the same as that of time?/निम्न में से किसकी विमा समय की विमा के समान है?

(a) $\frac{L}{R}$ (b) $\frac{C}{L}$

(c) LC (d) $\frac{R}{L}$

AIPMT-1996

Ans. (a): We know that, dimensions of time is [T].

So, we check the option,

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

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

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

(a) $\frac{L}{R} = \frac{ML^2T^{-2}A^{-2}}{ML^2T^{-3}A^{-2}} = [T]$

(b) $\frac{C}{L} = \frac{M^{-1}L^{-2}T^4A^2}{ML^2T^{-2}A^{-2}} = [M^{-2}L^{-4}T^6A^4]$

(c) $LC = [ML^2T^{-2}A^{-2}]\ [M^{-1}L^{-2}T^4A^2]$

$$= [T^2]$$

(d) $\frac{R}{L} = \frac{ML^2T^{-3}A^{-2}}{ML^2T^{-2}A^{-2}} = [T^{-1}] = \left[\frac{1}{T}\right]$

So, from the given option (a) has same dimension as that of time.

50. The dimensions of RC is/RC की विमाएँ है:

(a) square of time/समय का वर्ग

(b) square of inverse time/समय के वर्ग का व्युत्क्रम

(c) time/समय

(d) inverse time/व्युत्क्रम समय

AIPMT -1995

Ans. (c) : Dimensions of RC =

We know that, R is Resistance and its dimension is $[ML^2T^{-3}I^{-2}]$ and C is capacitance and its dimension is $[M^{-1}L^{-2}T^4I^2]$

So, dimensions of RC = $[ML^2T^{-3}I^{-2}][M^{-1}L^{-2}T^4I^2]$

$$= [T]$$

[T] is dimension of time.

So, dimension of RC is time.

51. Which of the following has the dimensions of pressure?/दाब का विमीय सूत्र होगा-

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

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

AIPMT -1994, 1990

Ans. (b) : Pressure- It is the amount of force applied perpendicular to the surface of an object per unit area.

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

52. Of the following quantities, which one has dimensions different from the remaining three? निम्न चार में से किस राशि का विमीय सूत्र अन्य तीनों से भिन्न है?

(a) Energy per unit volume/ऊर्जा प्रति एकांक आयतन

(b) Force per unit area/बल प्रति एकांक क्षेत्रफल

(c) Product of voltage and charge per unit volume/वोल्टेज और आवेश का गुणनफल प्रति एकांक आयतन

(d) Angular momentum/कोणीय संवेग

AIPMT -1989

Ans. (d): From the given options,

(a) Energy per unit volume $= \frac{\text{Energy}}{\text{Volume}} = \frac{[ML^2T^{-2}]}{[L^3]}$

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

(b) Force per unit area

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

(c) Product of voltage and charge per unit volume

$= \frac{\text{Voltage} \times \text{charge}}{\text{Volume}}$

$= \frac{\text{Work}}{\text{volume}}$

$\because$ voltage × charge = work

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

(d) Angular momentum- The property of any rotating object given by moment of inertia times angular velocity. It is denoted by 'L'

$L = I\omega = r \times P$

Where, I = inertia

ω = angular velocity

r = radius

P = linear momentum = mv

L = mvr

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

where, m = mass and v = velocity

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

So, from the given options angular momentum has the dimensions different from the remaining three.

53. The dimensional formula of permeability of free space μ_0 is

चुम्बकशीलता μ_0 का विमीय सूत्र है:

(a) $[MLT^{-2}A^{-2}]$

(b) $[M^0L^1T]$

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

(d) none of these/इनमें से कोई नहीं

AIPMT-1991

Ans. (a) : Permeability- The property of the material which supports the formation of magnetic flux when passed through a magnetic field is known as permeability.

• The permeability of the material is defined as the ratio of flux density to the field strength of a material. It is denoted by 'μ_0' which is equal to the $4\pi \times 10^{-7}$ Henry/meter. It is also measured in Newtons per Ampere square (N/A^2).

$\mu_0 = \frac{\text{Newton}}{\text{Ampere}^2}$

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

54. According to Newton, the viscous force acting between liquid layers of area A and velocity gradient $\Delta V/\Delta Z$ is given by $F = \eta A\frac{\Delta V}{\Delta Z}$, where η is constant called coefficient of viscosity. The dimensional formula of η is

न्यूटन के अनुसार दो परतों के बीच लगने वाला श्यान बल $F = \eta A \frac{\Delta V}{\Delta Z}$ से दिया जाता है, जहाँ A = क्षेत्रफल तथा $\Delta V/\Delta Z$ वेग-प्रवणता है। श्यानता गुणांक η की विमा होगी:

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

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

AIPMT -1990

Ans. (d) : Given that, $F = \eta A\frac{\Delta V}{\Delta Z}$

where, F = Viscous force = $[MLT^{-2}]$

A = Area = $[L^2]$

and $\frac{\Delta V}{\Delta Z}$ = velocity gradient = $\frac{[LT^{-1}]}{[L]}$

So, η (coefficient of viscosity) = $\frac{F}{A}\frac{\Delta Z}{\Delta V}$

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

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

55. Dimensional formula of self inductance is

स्वप्रेरण गुणांक का विमीय सूत्र है:

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

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

AIPMT -1989

Ans. (c) : Self inductance- It is a form of electromagnetic inductance. It can be defined as the property of current carrying coil that resists or opposes the change of the current flowing through it.

$\text{emf}(\varepsilon) = L \cdot \frac{di}{dt}$

Where L = coefficient of self inductance.

$L = \varepsilon\frac{dt}{di}$ .....(i)

$\because$ Voltage/ emf $(\varepsilon) = \frac{\text{work}}{\text{charge}}$ (W) (Q)

eq^n (i) $\Rightarrow L = \frac{W}{Q} \cdot \frac{dt}{di}$ and charge = current × time

$= \frac{[ML^2T^{-2}]}{[AT]} \cdot \frac{[T]}{[A]}$

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

56. The dimensional formula of torque is
आघूर्ण का विमीय सूत्र है:

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

AIPMT - 1989

Ans. (a) : Torque- It refers to the twisting force that causes motion. It is the measure of the force that can cause an object to rotate about an axis.

Torque (τ) = Force × distance

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

$$= \left[ML^2T^{-2}\right]$$

57. If C and R denote capacitance and resistance, the dimensional formula of CR is
यदि C धारिता तथा R प्रतिरोध को प्रदर्शित करते हों तो CR का विमीय सूत्र होगा:

(a) $[M^0L^0T^1]$
(b) $[M^0L^0T^0]$
(c) $[M^0L^0T^{-1}]$
(d) not expressible in terms of MLT/MLT के पदों में व्यक्त नहीं किया जा सकता है।

AIPMT -1988

Ans. (a) :

$$CR = \frac{Q}{V} \times R$$

$$= \frac{It}{V} \times R$$

$$= \frac{It}{V} \times \frac{V}{I} = t = [T] = \left[M^0L^0T^1\right]$$

58. The dimensional formula of angular momentum is
कोणीय संवेग का विमीय सूत्र है

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

AIPMT -1988

Ans. (d) : Angular momentum- The angular momentum of a rigid object is defined as the product of the moment of inertia and the angular velocity. It is analogous to linear momentum.

Angular momentum (L) = I × ω

Where, I = moment of Inertia

ω = angular velocity

L = mvr

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

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

59. An equation is given here $\left(P + \frac{a}{V^2}\right) = b\frac{\theta}{V}$ where P = Pressure, V = Volume and θ = Absolute temperature. If a and b are constants, the dimensions of a will be
दी गयी समीकरण $\left(P + \frac{a}{V^2}\right) = b\frac{\theta}{V}$, में P = दाब, V = आयतन, θ = परमताप तथा a, b नियतांक हैं, तो a का विमीय सूत्र होगा:

(a) $[ML^{-5}T^{-1}]$
(b) $[ML^5T^1]$
(c) $[ML^5T^{-2}]$
(d) $[M^{-1}L^5T^2]$.

AIPMT- 1996

Ans. (c) : Given that,

$$\left(P + \frac{a}{v^2}\right) = b\frac{\theta}{v}$$

Where, V is volume $[L^3]$

P is pressure $[ML^{-1}T^{-2}]$

and θ is absolute temperature [K]

According to the principle of Homogeneity dimensions of each of the terms of a dimensional equation on both sides should be the same.

So, $P = \frac{a}{V^2} = \frac{b\theta}{V}$

$a = P.V^2$

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

$= [ML^5T^{-2}]$

60. Which of the following is a dimensional constant ?
निम्न में से कौन-सा विमीय नियतांक है?

(a) Relative density/आपेक्षिक घनत्व
(b) Gravitational constant/गुरुत्वाकर्षण नियतांक
(c) Refractive index/अपवर्तनांक
(d) Poisson's ratio/पायसन अनुपात

AIPMT- 1995

Ans. (b) : Dimensional constant- The physical quantities which have dimensions and have a fixed value are called dimensional constant. For example Gravitational constant (G), Planck constant (h), and electrostatic force etc.

Gravitational constant (G)- It is the proportionality constant used in Newton's law of universal gravitation. The value of 'G' is equal to 6.67×10^{-11} Nm^2/kg^2.

Relative density- It is defined as the density of a substance divided by the density of water. Therefore relative density is dimensionless.

Refractive index- It is defined as the relative speed at which light moves through a material with respect to its speed in vacuum. It is also a dimensionless quantity.

Poisson's ratio- It is defined as the ratio of the transverse contraction of a material to the Longitudinal extension strain in the direction of stretching force.

μ (Poisson's ratio) = $\frac{\text{Lateral strain}}{\text{Linear strain}}$.

61. 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 a distance *x* from the axis of the tube. The dimensions of η are

तारपीन तेल एक ट्यूब के द्वारा बहता है जिसकी लम्बाई *l* तथा त्रिज्या r है। ट्यूब के दोनों सिरो के बीच का अतंर P है तथा श्यानता गुणांक है $\eta = \frac{P(r^2 - x^2)}{4vl}$ जहाँ ट्यूब के अक्ष से *x* दूरी पर तेल के वेग v है। η की विमायें हैं:

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

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

AIPMT- 1993

Ans. (d) : Given that,

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

Where, P = pressure difference and its dimensions is $[ML^{-1}T^{-2}]$

r = radius and its dimension is [L]

x = distance and its dimension is [L]

v = velocity and its dimension is $[LT^{-1}]$

l = length and its dimension is [L]

Dimensions of η (viscosity of oil)

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

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

62. The time dependence of a physical quantity P is given by $p = p_0 \exp(-at^2)$, where a is a constant and t is the time. The constant a has dimension

एक समीकरण में P का समय के साथ संबंध इस प्रकार है $P = P_0 \exp(-at^2)$ जहाँ a एक नियतांक है, तो a की विमा होगी:

(a) is dimensionless /कोई विमा नहीं

(b) has dimensions $[T^{-2}] / T^{-2}$ की विमा

(c) has dimensions $[T^2]/T^2$ की विमा

(d) has dimensions of P/P की विमा

AIPMT-1993

Ans. (b) : Given that,

$$P = p_0 \exp(-at^2)$$

Where, a is constant

t is time

P and P_0 have the same dimensions. We know that the power of exponential should be dimensionless.

Therefore, the dimension of 'at^2' should be dimensionless. Now, the multiplication of the respective dimensions is one.

$at^2 = 1$

$[a]\,[T^2] = 1$

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

63. P represents radiation pressure, c represents speed of light and S represents radiation energy striking per unit area per sec. The non zero integers *x*, y, z such that $P^xS^yc^z$ is dimensionless are

P = दाब, c = प्रकाश वेग, S = प्रति एकांक क्षेत्र प्रति सेकण्ड विकिरण ऊर्जा है, तो $P^x\,S^y\,c^z$ की कोई विमा नहीं होगी, यदि

(a) $x = 1, y =, z = 1$

(b) $x = -1, y = 1, z = 1$

(c) $x = -1, y = 1, z = -1$

(d) $x = 1, y = 1, z = -1$

AIPMT-1992

Ans. (c) : Given that,

$P^x\,S^y\,c^z$ is dimensionless

Where, P is radiation pressure and its dimensions is $[ML^{-1}T^{-2}]$

C is speed of light and its dimensions is $[LT^{-1}]$

S is radiation energy per unit area and per sec.

$$\text{So, } S = \frac{\text{energy/area}}{\text{second}} = \frac{[ML^2T^{-2}]/[L^2]}{[T]} = [MT^{-3}]$$

As per question,

$[M^\circ L^\circ T^\circ] = [ML^{-1}T^{-2}]^x\,[LT^{-1}]^z\,[MT^{-3}]^y$

Comparing power,

For [M], $0 = x + y$ ....(i)

For [L], $0 = -x + z$ ....(ii)

For [T], $0 = -2x - 3y - z$ ....(iii)

Solving equation (i), (ii) and (iii)

we get, $x = -1$

$y = 1$

$z = -1$

64. The frequency of vibration f of a mass m suspended from a spring of spring constant k is given by a relation $f = am^xk^y$, where a is a dimensionless constant. The values of *x* and y are

किसी स्प्रिंग से बँधे द्रव्यमान m की आवृत्ति f है, जो $f = am^x\,k^y$ से सम्बन्धित है, जहाँ a की कोई विमा नहीं है। तब x व y के मान होंगें:

(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 that,

$$\text{frequency } (f) = am^x k^y$$

Where, a is constant so its dimensions is $[M^oL^oT^o]$

m is mass, so its dimensions is [M]

k is spring constant, so its dimensions is $\left[MT^{-2}\right]$

Dimension of frequency is $[T^{-1}]$

So, putting the value of dimensions in above equations

$$[M^oL^oT^{-1}] = \left[M\right]^x \left[MT^{-2}\right]^y$$

Comparing power of the respective physical quantities,

for [M], $x + y = 0$ ....(1)

for [T] $-2y = -1$

$$\Rightarrow \quad y = \frac{1}{2}$$

$$\text{and } x = \frac{-1}{2}$$

65. If $x = at + bt^2$, where x is the distance travelled by the body in kilometers while t is the time in seconds, then the units of b is
यदि $x = at + bt^2$ में x चली गई दूरी (किमी में) तथा t समय (सेकण्ड में) हो, तो b का मात्रक है:

(a) km/s/किमी/सेकण्ड
(b) km s/ किमी-सेकण्ड
(c) km/s^2/किमी-सेकण्ड^2
(d) km s^2/किमी/सेकण्ड^2

AIPMT-1989

Ans. (c) : Given that,

$$x = at + bt^2$$

Where, x is distance in kilometers (km)

t is time in second (s)

According to the principle of homogeneity,

Dimension of x = Dimension of at = Dimension of bt^2

for units of b,

$(km) = b\ (sec)^2$

$b = km/sec^2$

1.6 NCERT Exemplar Problems

66. The number of significant figures in 0.06900 is
0.06900 में सार्थक अंकों की संख्या है–

(a) 5 (b) 4
(c) 2 (d) 3

Ans. (b) : "The significant figures of a given number are those significant or important digits which convey the meaning according to its accuracy."

Given data : 0.06900

Since, we know that. all the zeros that are on the right side of the last non-zero digit, after the decimal point are significant thus, number of significant figures in 0.06900 is 4

67. The sum of the numbers 436.32, 227.2 and 0.301 in appropriate significant figures is
436.32, 227.2 एवं 0.301 संख्याओं का योग उपर्युक्त सार्थक अंकों में है–

(a) 663.821 (b) 664
(c) 663.8 (d) 663.82

Ans. (c) : Given numbers : 436.32. 227.2 and 0.301

Sum of these numbers = 663.821

$\because$ The number after 8 is 2 (which is less than 5), then we have to exclude all the numbers present on the right side for rounding off digit.

Thus, appropriate significant figures is = 663.8

68. The mass and volume of a body are 4.237 g and 2.5 cm^3, respectively. The density of the material of the body in correct significant figures is
एक पिंड का द्रव्यमान और आयतन क्रमशः 4.237g एवं 2.5cm^3 है। इस पिंड के पदार्थ के घनत्व का सही सार्थक अंकों में मान है–

(a) 16948 g cm^{-3}
(b) 1.69 g cm^{-3}
(c) 1.7 g cm^{-3}
(d) 1.695 g cm^{-3}

Ans. (c) : Given, Mass (m) = 4.237g

Volume (V) = 2.5 cm^3

$$\text{Then density } (\rho) = \frac{\text{mass}}{\text{volume}}$$

$$\rho = \frac{4.237g}{2.5cm^3}$$

$$\rho = 1.6948 \text{ g } cm^{-3}$$

As per rules, the result of division will have two significant figures.

$$\text{Density } (\rho) = 1.7 gcm^{-3}$$

69. The numbers 2.745 and 2.735 on rounding off to 3 significant figures will give
यदि 2.745 एवं 2.735 संख्याओं को 3 सार्थक अंकों तक पूर्णांकित कर व्यक्त किया जाए तो प्राप्त संख्याएँ होंगी–

(a) 2.75 and 2.74 (b) 2.74 and 2.73
(c) 2.75 and 2.73 (d) 2.74 and 2.74

Ans. (d) : We have to round off 2.745 to 3 significant figures. Here the digit to be dropped is 5 then the previous digit is left unchanged if it is even. Hence, on rounding of 2.745 it would be 2.74.

• Next 2.735 where the digit to be dropped is 5 then the preceding digit is raised by one if it is add.

Hence, on rounding off 2.735 to 3 significant figure, it would be 2.74.

70. The length and breadth of a rectangular sheet are 16.2 cm and 10.1 cm, respectively. The area of the sheet in appropriate significant figures and error is

एक आयताकार शीट की लंबाई एवं चौड़ाई 16.2 cm और 10.1 cm है। उपयुक्त सार्थक अंकों में और उपयुक्त त्रुटि के उल्लेख के साथ शीट का क्षेत्रफल होगा–

(a) $164 \pm 3\ cm^2$ (b) $163.62 \pm 2.6\ cm^2$

(c) $163.6\ cm^2$ (d) $163.62 \pm 3\ cm^2$

Ans. (a) : Step 1 : Find the area of rectangular sheet
Formula used : $A = l \times b$
Given : Length of sheet (l) = 16.2 cm
Breadth of sheet (b) = 10.1 cm
Then, Area (A) = $l \times b$
$A = 16.2 \times 10.1$
$A = 163.62\ cm^2$
Step 2 : Find the error in area of rectangular sheet.
Error in product of quantities:
Suppose $x = a \times b$
Let Δa = absolute error in measurement of a.
Δb = absolute error in measurement of b,
Δx = absolute error in x.
The maximum fractional error in x is $\frac{\Delta x}{x} = \pm\left(\frac{\Delta a}{a} + \frac{\Delta b}{b}\right)$
According to the question,
Length (l) = (16.2 ± 0.1)cm
Breadth (b) = (10.1 ± 0.1)cm.
Area (A) = $163.62\ cm^2$
As per rule, area will have only three significant figures and error will have only one significant figure.
Thus, $A = 164\ cm^2$.
If ΔA is error in the area, the relative error is $\frac{\Delta A}{A}$
Therefore, $\frac{\Delta A}{A} = \frac{\Delta l}{l} + \frac{\Delta b}{b}$

$$\frac{\Delta A}{A} = \frac{0.1cm}{16.2cm} + \frac{0.1cm}{10.1cm}$$

$$\frac{\Delta A}{A} = \frac{1.01 + 1.62}{16.2 \times 10.1} = \frac{2.63}{163.62}$$

$$\Delta A = A \times \frac{2.63}{163.62}$$

$$\Rightarrow \Delta A = 163.62 \times \frac{2.63}{163.62} = 2.63 cm^2$$

$\Rightarrow \Delta A = 3\ cm^2$ (by rounding off to one significant figure)
Hence, Area of rectangular sheet in significant figure & error is given by : $A = (164 \pm 3)\ cm^2$

71. Which of the following pairs of physical quantities does not have same dimensional formula?
भौतिक राशियों के निम्नलिखित जोड़ों में से किस जोड़े का विमीय सूत्र समान नहीं है?–

(a) Work and torque./कार्य और बल-आघूर्ण
(b) Angular momentum and Planck's constant./कोणीय संवेग और प्लॉक नियतांक
(c) Tension and surface tension./तनाव और पृष्ठ तनाव
(d) Impulse and linear momentum./आवेग और रेखीय संवेग

Ans. (c) : $\therefore$ Tension, F = ma
Dimensional formula for tension,
$= [M^1][L^1T^{-2}] = [M^1L^1T^{-2}]$
Surface tension, $T = \frac{F}{L}$
Dimensional formula for surface tension,

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

Hence, Tension and surface Tension does not have same dimensional formula.

72. Measure of two quantities along with the precision of respective measuring instrument is $A = 2.5\ m\ s^{-1} \pm 0.5\ m\ s^{-1}$, $B = 0.10\ s \pm 0.01\ s$ The value of AB will be
दो राशियों की माप, उनको मापने में प्रयुक्त हुए माप यंत्रों की परिशुद्धता के साथ व्यक्त करते हुए हैं–
A B का मान होगा

(a) (0.25 ± 0.08) m
(b) (0.25 ± 0.5) m
(c) (0.25 ± 0.05) m
(d) (0.25 ± 0.135) m

Ans. (a) : Step 1 : Calculate the value of AB.
Given A = $2.5\ m/s \pm 0.5\ m/s$
B = $0.10s \pm 0.01\ s$.
$\Rightarrow$ AB = (2.5) (0.10)
AB = 0.25 m.
Step 2 : Find the error in the value AB.
Formula used : $\frac{\Delta AB}{AB} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$
Given, $\Delta A = 0.5\ m/s$
$\Delta B = 0.01\ s$

$$\frac{\Delta AB}{AB} = \frac{0.5}{2.5} + \frac{0.01}{0.1} = \frac{0.075}{0.25}$$

$$\Delta AB = \frac{0.75}{0.25} \times AB$$

$$\Delta AB = \frac{0.75}{0.25} \times 0.25$$

$\Delta AB = 0.075$
Rounding of two significant figures.
$\Delta AB = 0.08m$.
$AB = (0.25 \pm 0.08)m$

73. We measure two quantities as A = 1.0 m ± 0.2 m, B = 2.0 m ± 0.2 m. We should report correct value for $\sqrt{AB}$ as
दो राशियों को माप कर आप उनका मान A = 1.0 m ± 0.2 m, B = 2.0 m ± 0.2 m प्राप्त करते हैं। $\sqrt{AB}$ का सही मान होगा–

(a) 1.4 m ± 0.4 m
(b) 1.41 m ± 0.15 m
(c) 1.4 m ± 0.3 m
(d) 1.4 m ± 0.2 m

Ans. (d) : Calculate the value of $\sqrt{AB}$:
Given, A = 1.0m ± 0.2m
& B = 2.0 ± 0.2m.
So, $\sqrt{AB} = \sqrt{(1.0)(2.0)}$
$\sqrt{AB} = 1.414m.$
Now, Error in the value AB :
Formula used : $\frac{\Delta\sqrt{AB}}{\sqrt{AB}} = \frac{1}{2}\frac{\Delta A}{A} + \frac{1}{2}\frac{\Delta B}{B}$
Given, $\Delta A = 0.2m$ & $\Delta B = 0.2m$
Then, $\frac{\Delta\sqrt{AB}}{1.4} = \frac{1(0.2)}{2(1)} + \frac{1(0.2)}{2(2)}$
$\Delta\sqrt{AB} = 0.21$
Rounding of one significant figure,
$\Delta\sqrt{AB} = 0.2m$
Hence, $\sqrt{AB} = 1.4m \pm 0.2m.$

74. Which of the following measurement is most precise?
निम्नलिखित में कौन-सा मान सर्वाधिक परिशुद्ध है?

(a) 5.00 mm (b) 5.00 cm
(c) 5.00 m (d) 5.00 km

Ans. (a) : ∵ Smallest the unit more precise is the measurement.
So, 5.00 mm is smallest unit of measurement of length so the precision will be more.
Hence, (a) is correct answer.

75. The mean length of an object is 5 cm. Which of the following measurements is most accurate?
किसी पिंड की औसत लंबाई 5 cm है। निम्नलिखित में कौन-सा माप सर्वाधिक यथार्थ है?

(a) 4.9 cm (b) 4.805 cm
(c) 5.25 cm (d) 5.4 cm

Ans. (a) : We know that accuracy is the closeness of the measured value with the true value.
More close value of measurement with the true value more is the accuracy of the measurement
So, $\Delta L = 5 - 4.9 = 0.1$ cm
$\Delta L = 5 - 4.805 = 0.195$ cm
$\Delta L = 5.25 - 5 = 0.25$ cm
$\Delta L = 5.4 - 5 = 0.4$ cm
We can see that 4.9 cm is more close to 5 cm.
Hence more accurate.

76. Young's modulus of steel is 1.9×10^{11} N m^{-2}. When they expressed in CGS units of dynes cm^{-2}. It will be equal to
($1 N = 10^5$ dyne, $1 m^2 = 10^4 cm^2$)
स्टील का यंग प्रत्यास्था गुणांक 1.9×10^{11} N m^{-2} है। यदि इसे CGS मात्रकों, डाइन प्रति सेंटीमीटर में व्यक्त किया जाए तो इसका मान होगा–

(a) 1.9×10^{10} (b) 1.9×10^{11}
(c) 1.9×10^{12} (d) 1.9×10^{13}

Ans. (c) : Given, young's modulus (y)= 1.9×10^{11} N/m^2
As we know that, 1 N = 10^5 dyne
1 metre = 10^2 cm
So, converting the value to CGS we get.
$y = \frac{1.9 \times 10^{11} \times 10^5}{(10^2)^2 cm^2} = 1.9 \times 10^{11+5-4}$
$\Rightarrow y = 1.9 \times 10^{12}$ dyne/cm^2

77. If momentum (P), area (A) and time (T) are taken to be fundamental quantities, then energy has the dimensional formula
यदि संवेग (P), क्षेत्रफल (A) एवं समय (T) को मूल राशियाँ मान लें तो ऊर्जा का विमीय सूत्र होगा–

(a) $[p^1 A^{-1} t^{-1}]$ (b) $[p^2 A^1 t^1]$
(c) $[p^1 A^{-1/2} t^1]$ (d) $[p^1 A^{1/2} t^{-1}]$

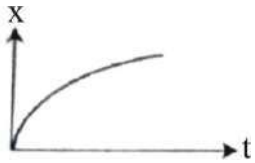
Ans. (d) : Let, energy $E = K P^a A^b T^c$ ... (i)
Where, K is dimensionless constant of proportionality.
P = momentum
A = Area
T = time.
On equating dimension both side in eq^n(1) we get
$[ML^2T^{-2}] = [MLT^{-1}]^a [M^0L^2T^0]^b [M^0L^0T]^c$
$= [M^a L^{a+2b} T^{-a+c}]$
Appling the principle of homogeneity of dimensions. We get,
$a = 1$ ... (ii)
$a + 2b = 2$ ... (iii)
$-a + c = -2$ ... (iv)
On solving equations, (ii), (iii) and (iv).
We get, $a = 1, b = \frac{1}{2}, \quad c = -1$
∴ Dimensional formula of energy $[E] = [P^1 A^{1/2} T^{-1}]$
$[E] = [p^1 A^{1/2} t^{-1}]$

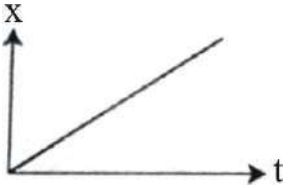
2. Motion in Straight Line

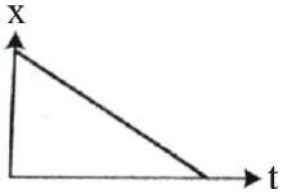
2.1 Position, Path Length and Displacement

1. The position-time (x – t) graph for positive acceleration is:
धनात्मक त्वरण के लिए स्थिति-समय (x – t) ग्राफ है:

(a) 

(b) 

(c) 

(d) 

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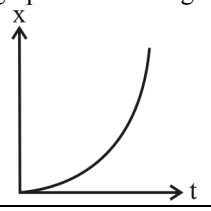
Ans. (a) : For +ve acceleration,

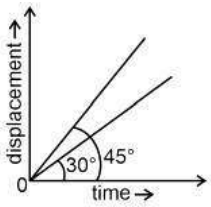
$\frac{dv}{dt} > 0$. So, velocity is increasing

Acceleration is given by second derivative of displacement hence the variation of acceleration on x-t graph will be parabolic.

Also, slope of x-t graph is increasing.



2. The displacement-time graphs of two moving particles make angles of 30° and 45° with the *x*-axis as shown in the figure. The ratio of their respective velocity is
दो गतिमान कणों का विस्थापन-समय अभिरेख चित्र में प्रदर्शित x-अक्ष से 30° एवं 45° का कोण बनाता हैं। उनके क्रमशः वेगों का अनुपात होगा:

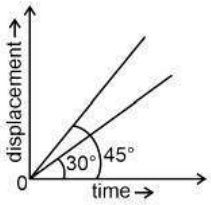


(a) $1:\sqrt{3}$ (b) $\sqrt{3}:1$

(c) 1 : 1 (d) 1 : 2

NEET (UG)-17.07.2022

Ans. (a) :



Let displacement be s and time be t and y-intercept is zero

$\therefore$ s = ut + 0

s = ut, where u is velocity as per law of motion

Also u is slope of the graph s vs t

$\therefore$ u = tanθ

$u_1 = \tan 30^\circ \Rightarrow u_1 = \frac{1}{\sqrt{3}}$

$u_2 = \tan 45^\circ \Rightarrow u_2 = 1$

$\therefore u_1 : u_2 = \frac{1}{\sqrt{3}} : 1$

$\boxed{u_1 : u_2 = 1:\sqrt{3}}$

3. The X and Y coordinates of the particle at any time are x= 5t -2t^2 and y = 10t respectively, where x and y are in meters and t in seconds. The acceleration of the particle at t = 2 s is/यदि किसी समय पर, किसी कण के x तथा y निर्देशांक, क्रमशः x = 5t – 2t^2 तथा y = 10t हैं। (जहाँ x तथा y मीटर में और t सेकंड में हैं।) तो, t = 2s पर उस कण का त्वरण होगा:

(a) 0 (b) 5 m/s^2

(c) –4m/s^2 (d) –8 m/s^2

NEET (UG)-07.05.2017

Ans. (c): Given

$x = 5t - 2t^2$

$y = 10t$

Velocity along x-axis,

$$V_x = \frac{dx}{dt}$$

$V_x = (5 - 4t)$ m/s

Acceleration along x-axis

$$a_x = \frac{dv}{dt}$$

$$= \frac{d}{dt}(5 - 4t)$$

$a_x = -4 m/s^2$

Velocity along y-axis,

$$V_y = \frac{dy}{dt} = \frac{d(10t)}{dt}$$

$V_y = 10$ m/s

Acceleration $a_y = \frac{dy}{dt}$

$$a_y = \frac{d(10)}{dt}$$

$= 0 m/s^2$

The acceleration of the particle at t = 2s is $-4 m/s^2$.

4. A particle staring from the origin (0, 0) moves in a straight line in the (x, y) plane. Its coordinates at a later time are $(\sqrt{3}, 3)$. The path of the particle makes with the x-axis an angle of:-

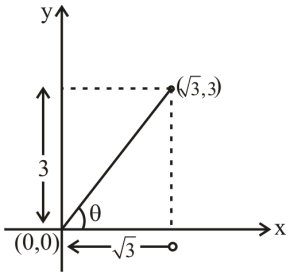
एक कण मूल बिन्दु (0, 0) से आरम्भ करके (x, y) तल में एक सीधी रेखा पर चलता है। कुछ समय पश्चात के क्षण पर इसके निर्देशांक $(\sqrt{3}, 3)$ होते हैं। इस कण के चलन पथ का x-अक्ष के साथ कोण होगा:-

(a) 0º (b) 30º

(c) 45º (d) 60º

AIPMT-2007

Ans. (d) :



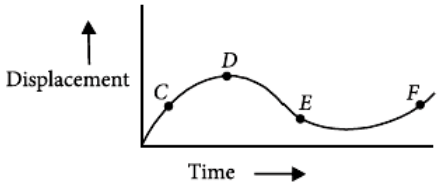
$$\tan\theta = \frac{3}{\sqrt{3}} = \frac{3 \times \sqrt{3}}{3} = \sqrt{3}$$

$\Rightarrow \tan\theta = \sqrt{3}$

$\Rightarrow \theta = 60^\circ$

5. The displacement-time graph of a moving particle is shown below. The instantaneous velocity of the particle is negative at the point

चित्र में विस्थापन-समय ग्राफ दिखाया गया है। कण का तात्क्षणिक वेग किस बिन्दु पर ऋणात्मक होगा?



(a) E (b) F

(c) C (d) D

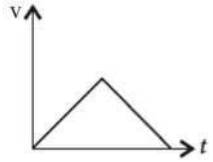
AIPMT-(1994)

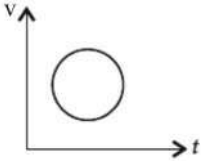
Ans. (a) : The slope of the tangent at any point on the displacement-time graph gives instantaneous velocity at any point/instant.

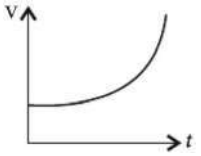
- The only part of the graph with negative slope is point E. So, the instantaneous velocity of the particle is negative at the point E.

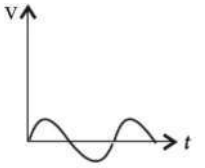
6. Which of the following curve does not represent motion in one dimension?

दिए गए ग्राफ में, कौन-सा ग्राफ एकविमीय गति प्रदर्शित नहीं करता है?

(a) 

(b) 

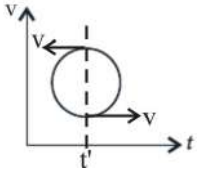
(c) 

(d) 

AIPMT-(1992)

Ans. (b) : An object or a body is said to be in motion if its position continuously changes with time.

- When the position of an object changes linearly, it is called the motion in one dimension. The object cannot have two displacement at the same time.
- In the given option (b), curve shows the body has two different velocities at a given time. Therefore, this curve does not represent the motion in one dimension.



2.2 Average Velocity and Average Speed

7. A vehicle travels half the distance with speed θ and the remaining distance with speed 2θ. Its average speed is :

एक वाहन आधी दूरी चाल θ से तथा शेष दूरी चाल 2θ से गति करता है। इसकी औसत चाल है :

(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) :

$$\text{Average speed} = \frac{\text{total distance travelled}}{\text{total time taken}}$$

$$= \frac{L}{\frac{\frac{L}{2}}{\theta} + \frac{\frac{L}{2}}{2\theta}}$$

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

$$= \frac{4}{3}\theta$$

$$\boxed{\text{Average speed} = \frac{4}{3}\theta}$$

8. A person travelling in a straight line moves with a constant velocity v_1 for certain distance 'x' and with a constant velocity v_2 for next equal distance. The average velocity v is given by the relation

कोई व्यक्ति किसी सरल रेखा में गमन करते समय कोई निश्चित दूरी x नियत वेग v_1 से तय करता है तथा नियत वेग v_2 से इतनी ही दूरी तय करता है। औसत वेग v के लिए संबंध है–

(a) $v = \sqrt{v_1 v_2}$ (b) $\frac{1}{v} = \frac{1}{v_1} + \frac{1}{v_2}$

(c) $\frac{2}{v} = \frac{1}{v_1} + \frac{1}{v_2}$ (d) $\frac{v}{2} = \frac{v_1 + v_2}{2}$

NEET (UG)-20.05.2019, (Odisha)

Ans. (c) : Total distance travelled = 2x

Distance travelled during each phase = x

Time taken during first phase $= \frac{x}{v_1}$

Time taken during second phase $= \frac{x}{v_2}$

Total time taken

$$t = \frac{x}{v_1} + \frac{x}{v_2}$$

$$= x\left(\frac{1}{v_1} + \frac{1}{v_2}\right)$$

$$\text{Average velocity} = \frac{\text{Total distance}}{\text{Total time taken}}$$

$$v = \frac{2x}{x\left(\frac{1}{v_1} + \frac{1}{v_2}\right)}$$

$$v = \frac{2}{\left(\frac{1}{v_1} + \frac{1}{v_2}\right)}$$

$$\boxed{\frac{1}{v_1} + \frac{1}{v_2} = \frac{2}{v}}$$

9. A toy car with charge q moves on a frictionless horizontal plane surface under the influence of a uniform electric field $\vec{E}$. Due to the force $q\vec{E}$, its velocity increases from 0 to 6 m/s in one second duration. At that instant the direction of the field is reversed. The car continues to move for two more seconds under the influence of this field. The average velocity and the average speed of the toy car between 0 to 3 seconds are respectively

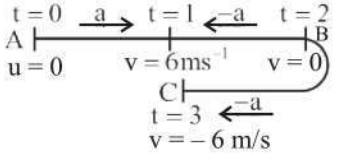
कोई खिलौना कार जिस पर आवेश q है किसी एकसमान विद्युत-क्षेत्र $\vec{E}$ के प्रभाव में किसी घर्षणहीन समतल क्षैतिज पृष्ठ पर गतिमान है। एक सेकण्ड के अन्तराल में बल $q\vec{E}$ के कारण इसका वेग 0 से 6 m/s हो जाता है। उसी क्षण विद्युत-क्षेत्र की दिशा उत्क्रमित कर दी जाती है। इस क्षेत्र के प्रभाव में कार और दो सेकण्ड तक गति करती रहती है। 0 से 3 सेकण्ड के बीच खिलौना कार के औसत वेग और औसत चाल क्रमशः हैं

(a) 2 m/s, 4 m/s (b) 1 m/s, 3 m/s

(c) 1.5 m/s, 3 m/s (d) 1 m/s, 3.5 m/s

NEET (UG)-06.05.2018

Ans. (b) :



Acceleration, $a = \frac{v-u}{t} = \frac{6-0}{1} = 6\,m/s^{-2}$

For t = 0 to t = 1s,

Displacement, $S_1 = ut + \frac{1}{2}at^2$

$\Rightarrow S_1 = \frac{1}{2}\times 6(1)^2 = 3m \quad ...(i)$

Similarly,

For t = 1s to t = 2s,

Displacement, $S_2 = 6.1 - \frac{1}{2}\times 6(1)^2 = 3m \quad ...(ii)$

For t = 2s to t = 3s,

Displacement, $S_3 = 0 - \frac{1}{2}\times 6(1)^2 = -3m \quad ...(iii)$

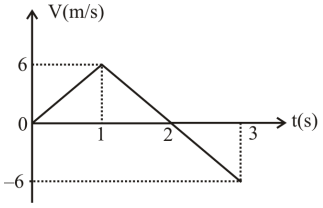
Total displacement, $S = S_1 + S_2 + S_3 = 3m$

Average velocity $= \frac{3}{3} = 1m/s$

Total distance travelled =9m

Average speed $= \frac{9}{3} = 3m/s$

Alternate Solution :-



0 s< t < 1 s velocity increases from 0 to 6 m/s.

1 s< t < 2 s velocity becomes 0 m/s from 6 m/s.

2 s < t < 3 s velocity goes to – 6 m/s from 0 m/s.

The total displacement is the area of velocity time graph considering sign,

$$= \frac{1}{2}\times(2-0)\times 6 - \frac{1}{2}\times(3-2)\times 6 = 6 - 3 = 3m$$

Total time = 3s

Average velocity = $\frac{3}{3} = 1$ m/s

The total distance is the area of velocity time graph without considering sign.

$$= \frac{1}{2}\times(2-0)\times 6 + \frac{1}{2}\times(3-2)\times 6 = 6 + 3 = 9m$$

Average speed = $\frac{9}{3} = 3$ m/s

10. Preeti reached the metro station and found that the escalator was not working. She walked up the stationary escalator in time t_1. On other days, if she remains stationary on the moving escalator, then the escalator takes her up in time t_2. The time taken by her to walk up on the moving escalator will be/एक दिन मैट्रो स्टेशन पर एस्कलेटर (चलती सीढ़ी) के न चलने पर प्रीति, उसकी सीढ़ियों पर पैदल ऊपर चढ़ती है। इसमें उसे t_1 समय लगता है। अन्य दिनों में जब एस्कलेटर चल रहा होता है तब वह उस पर खड़ी रह कर t_2 समय में ऊपर पहुँच जाती है तो, उसके द्वारा चलते हुए एस्कलेटरपर चलकर ऊपर चढ़ने में लिया गया समय होगा:

(a) $\frac{t_1 + t_2}{2}$ (b) $\frac{t_1 t_2}{t_1 - t_2}$

(c) $\frac{t_1 t_2}{t_1 + t_2}$ (d) $t_1 - t_2$

NEET (UG)-07.05.2017

Ans. (c) : Velocity of girl w.r.t. to elevator $= \frac{d}{t_1} = V_{ge}$

Velocity of elevator w.r.t. to ground $V_{eG} = \frac{d}{t_2}$

Then velocity of girl w.r.t. ground

$$\vec{V}_{gG} = \vec{V}_{ge} + \vec{V}_{eG}$$

i.e. $V_{gG} = V_{ge} + V_{eG}$

Let t be the time to cover d distance with both girl and escalator moving

$$\frac{d}{t} = \frac{d}{t_1} + \frac{d}{t_2}$$

$$\frac{1}{t} = \frac{1}{t_1} + \frac{1}{t_2}$$

$$t = \frac{t_1 t_2}{t_1 + t_2}$$

11. A particle is moving such that its position co-ordinate (x, y) are
(2m, 3m) at time t =0
(6m, 7m) at time t = 2 s and
(13m, 14m) at time t = 5s.
Average velocity vector ($\vec{V}_{av}$) from t = 0 to t= 5 s is:-
एक कण इस प्रकार गति करता है कि, इसके स्थिति निर्देशांक (x, y) निम्न प्रकार है
(2m, 3m) समय t = 0 पर
(6m, 7m) समय t = 2 s पर
(13m, 14m) समय t = 5s पर
तो t = 0 से t = 5s तक, औसत वेग सदिश ($\vec{V}_{av}$) होगा:-

(a) $\frac{1}{5}(13\hat{i} + 14\hat{j})$ (b) $\frac{7}{3}(\hat{i} + \hat{j})$

(c) $2(\hat{i} + \hat{j})$ (d) $\frac{11}{5}(\hat{i} + \hat{j})$

AIPMT-06.05.2014

Ans. (d) : At time t = 0, the position vector of the particle is $\vec{r}_1 = 2\hat{i} + 3\hat{j}$

At time t = 5s, the position vector of the particle is $\vec{r}_2 = 13\hat{i} + 14\hat{j}$

Displacement from $\vec{r}_1$ to $\vec{r}_2$ is $\Delta\vec{r} = \vec{r}_2 - \vec{r}_1$

$$= \left(13\hat{i} + 14\hat{j}\right) - \left(2\hat{i} + 3\hat{j}\right)$$

$= 11\hat{i} + 11\hat{j}$

$\therefore$ Average velocity,

$$\vec{v}_{av} = \frac{\Delta\vec{r}}{\Delta t} = \frac{11\hat{i} + 11\hat{j}}{5-0} = \frac{11}{5}\left(\hat{i} + \hat{j}\right)$$

12. A particle covers half of its total distance with speed v_1 and the rest half distance with speed v_2. Its average speed during the complete journey is/एक कण अपनी कुल दूरी की आधी v_1 चाल से तथा शेष आधी v_2 चाल से तय करता है। पूरी यात्रा के दौरान उसकी औसत चाल है :

(a) $\frac{v_1 + v_2}{2}$ (b) $\frac{v_1 v_2}{v_1 + v_2}$

(c) $\frac{2v_1 v_2}{v_1 + v_2}$ (d) $\frac{v_1^2 v_2^2}{v_1^2 + v_2^2}$

AIPMT (Mains)-2011

Ans. (c) : If the half distance (x) covered with the speed v_1 in t_1 time.

So, using formula of speed is-

$$v_1 = \frac{x}{t_1}$$

$$t_1 = \frac{x}{v_1}$$

And another half distance (x), covered with speed v_2 in time t_2.

So, $$v_2 = \frac{x}{t_2}$$

$$t_2 = \frac{x}{v_2}$$

$\because$ $$\text{Average velocity} = \frac{\text{Total distance}}{\text{Total time}}$$

total distance = x + x = 2x

total time = $t_1 + t_2$

$$= \frac{x}{v_1} + \frac{x}{v_2}$$

$\therefore$ $$\text{Average seepd} = \frac{x + x}{t_1 + t_2} = \frac{2x}{\frac{x}{v_1} + \frac{x}{v_2}}$$

$$\text{Average seepd} = \frac{2v_1 v_2}{v_1 + v_2}$$

13. A body is moving with velocity 30 m/s towards east. After 10 seconds its velocity becomes 40 m/s towards north. The average acceleration of the body is :
एक वस्तु 30 m/s वेग से पूर्व की ओर गति कर रही है। 10 सैकेण्ड के पश्चात् इसका वेग उत्तर की ओर 40 m/s हो जाता है, तो वस्तु का औसत त्वरण है :

(a) 5 m/s^2 (b) 1 m/s^2

(c) 7 m/s^2 (d) $\sqrt{7}$ m/s^2

AIPMT (Screening)-2011

Ans. (a) : Given – Initial velocity u = $30\,\hat{i}$ (East)

Final velocity v = $40\,\hat{j}$ (North)

Change in velocity $\Delta v = 40\,\hat{j} - 30\,\hat{i}$

Magnitude $|\Delta v| = \sqrt{30^2 + 40^2} = 50 \text{m/s}$

Average acceleration = $\frac{\text{change inve locity}}{\text{Time taken}}$

Average acceleration (a) = $\frac{|\Delta v|}{\Delta t} = \frac{50}{10} = 5 \text{ m/s}^2$.

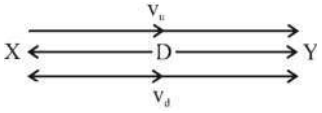
14. A car moves from X to Y with a uniform speed v_u and returns to Y with a uniform speed v_d. The average speed for this round trip is:-
एक मोटर गाड़ी X से Y तक अचर चाल v_u से चलती है और Y से X तक अचर चाल v_d से वापस आती हैं इस पूरी यात्रा के लिये गाड़ी की औसत चाल होगी:-

(a) $\frac{v_u + v_d}{2}$ (b) $\frac{2v_d v_u}{v_d + u_u}$

(c) $\sqrt{v_u v_d}$ (d) $\frac{v_d v_u}{v_d + v_u}$

AIPMT-2007

Ans. (b) :



Let distance between X and Y = D.

As Average speed $= \frac{\text{Total distance}}{\text{Total time}}$

$$= \frac{D + D}{\frac{D}{v_u} + \frac{D}{v_d}}$$

$$= \frac{2D}{D\left[\frac{v_d + v_u}{v_d v_u}\right]} = \frac{2v_d v_u}{v_d + v_u}$$

15. A particle starts from rest with constant acceleration. The ratio of space-average velocity to the time average velocity is
एक कण स्थिर अवस्था से नियत त्वरण से गति प्रारंभ करता है तब इसके समष्टि-औसत वेग का समय-औसत वेग के साथ अनुपात क्या होगा :

(a) $\frac{1}{2}$ (b) $\frac{3}{4}$

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

AIPMT-1999

Ans. (c): Space average velocity is $\frac{\int v dx}{\int dx}$ ...(i)

Time average velocity is $\frac{\int v dt}{\int dt}$ ...(ii)

Initially the particle is at rest so u = 0

$v = at$ ... (a)

$x = \frac{1}{2}at^2$ .... (b)

$dx = \frac{2at}{2}dt$ .... (c)

For space - average velocity put (a) and (c) in (i)

$$\frac{\int a^2t^2dt}{\int at\,dt} = \frac{\frac{at^3}{3}}{\frac{t^2}{2}} = \frac{2}{3}at \quad ...(d)$$

For time average velocity put equation (a) in (ii)

$$\frac{\int at\,dt}{\int dt} = \frac{at^2}{2t} = \frac{at}{2} \quad ...(e)$$

Taking ratio of (d) and (e)

$$\frac{\frac{2}{3}at}{\frac{at}{2}} = \frac{4}{3}$$

Hence the ratio of space average velocity to the time average velocity is 4 : 3

16. 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. The average speed is 48 km/h. The value of v is
एक कार 200 मी. की दूरी तय करती है। यात्रा का पहला आधा भाग वह 40 किमी/घण्टा वेग से तथा दूसरा आधा भाग v वेग से चलती है। यदि औसत वेग 48 किमी/घण्टा है, तो v का मान है:

(a) 56 km/h (b) 60 km/h
(c) 50 km/h (d) 48 km/h

AIPMT-(1991)

Ans. (b) : Given that,

Distance = 200 m

Speed of the car in the first half (v_1) = 40 km/hr.

Average speed of the car ($v_{avg.}$) = 48 km/hr

Speed of the car in the second half (v_2) is v

So, we know that,

$$v_{avg} = \frac{2v_1.v_2}{v_1 + v_2}$$

$$\Rightarrow \quad 48 = \frac{2 \times 40 \times v}{40 + v}$$

$$\Rightarrow \quad 48\,(40 + v) = 80\,v$$

$$32v = 48 \times 40$$

So, v = 60 km/hr.

17. A bus travelling the first one-third distance at a speed of 10 km/h, the next one-third at 20 km/h and at last one-third at 60 km/h. The average speed of the bus is
एक बस किसी दूरी का एक तिहाई 10 किमी/घण्टा वेग से, दूसरा तिहाई भाग 20 किमी/घण्टा वेग से तथा तीसरा तिहाई भाग 60 किमी/घण्टा वेग से चलती है। बस का औसत वेग होगा:

(a) 9 km/h (b) 16 km/h
(c) 18 km/h (d) 48 km/h

AIPMT-(1991)

Ans. (c) : Given that,

Bus travels first one-third of the total distance at speed = 10 km/hr.

Next one-third at the speed = 20 km/hr.

and the last one third at the speed = 60 km/hr.

Let us consider the total distance is 'D'.

We know that,

$$\text{Average speed} = \frac{\text{total distance}}{\text{total time taken}}$$

$$= \frac{D}{t_1 + t_2 + t_3}$$

Time taken at the speed of 10 km/hr,

$$(t_1) \quad = \frac{D/3}{10}$$

similarly, For 20 km/hr

$$t_2 = \frac{D/3}{20}$$

For 60 km/hr, $t_3 = \frac{D/3}{60}$

So, Average speed $= \frac{D}{\left(\frac{D/3}{10}\right)+\left(\frac{D/3}{20}\right)+\left(\frac{D/3}{60}\right)}$

$$= \frac{1}{\left(\frac{1}{30}\right)+\left(\frac{1}{60}\right)+\left(\frac{1}{180}\right)}$$

$$= \frac{1}{\left(\frac{6+3+1}{180}\right)}$$

$$= \frac{180}{10}$$

= 18 km/hr.

18. A car covers the first half of the distance between two places at 40 km/h and another half at 60 km/h. The average speed of the car is
कार द्वारा कुछ दूरी तय की जाती है। दूरी का आधा भाग वह 40 किमी/घण्टा से तथा शेष भाग 60 किमी/घंटा वेग से तय करती है। कार का औसत वेग है:

(a) 40 km/h (b) 48 km/h
(c) 50 km/h (d) 60 km/h

AIPMT-(1990)

Ans. (b): Given that,
First half of the distance at speed (v_1) = 40 km/hr.
And another half of the distance at speed (v_2) = 60 km/hr.
We know that, If distance is constant then,

$$\text{Average speed} = \frac{2v_1 \times v_2}{v_1 + v_2}$$

$$= \frac{2 \times 40 \times 60}{40 + 60}$$

$$= 48 \text{ km/hr.}$$

19. A train of 150 meter length is going towards north direction at a speed of 10 m/s. A parrot flies at the speed of 5 m/s towards south direction parallel to the railways track. The time taken by the parrot to cross the train is
एक ट्रेन की लम्बाई 150 मी. है। यह उत्तर दिशा में 10 मी./सेकंड के वेग से चलती है। एक तोता 5 मी./सेकंड से दक्षिण दिशा में रेलमार्ग के समान्तर उड़ता है। कितने समय में तोता ट्रेन को पार कर जाएगा?

(a) 12 s (b) 8 s
(c) 15 s (d) 10 s

AIPMT-(1988)

Ans. (d) : Given that,
length of train = 150 m
speed of train = 10 m/sec in north direction
speed of parrot = 5 m/sec in south direction
Both direction is opposite
So, relative velocity = 5 – (–10)
= 15 m/sec
time taken to cross the train is

$$= \frac{\text{length of train}}{\text{relative velocity}} = \frac{150}{15} = 10 \text{ sec}$$

2.3 Instantaneous Velocity and Instantaneous Speed

20. The position of a particle is given by
कण की स्थिति दी जाती है

$$\vec{r}(t) = 4t\hat{i} + 2t^2\hat{j} + 5\hat{k}$$

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.
जहाँ t सेकंड में और r मीटर में है। x-अक्ष के संबंध में t = 1s पर वेग v(t) का परिणाम और दिशा ज्ञात कीजिए।

(a) $3\sqrt{2}\text{ms}^{-1}, 30^\circ$ (b) $3\sqrt{2}\,\text{ms}^{-1}, 45^\circ$
(c) $4\sqrt{2}\,\text{ms}^{-1}, 45^\circ$ (d) $4\sqrt{2}\,\text{ms}^{-1}, 60^\circ$

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Ans. (c) : Given: $\vec{r}(t) = (4t\hat{i} + 2t^2\hat{j} + 5\hat{k})$

$$\frac{dr}{dt} = 4\hat{i} + 4t\hat{j}$$

$$\vec{V} = \left.\frac{dr}{dt}\right|_{t=1} = 4\hat{i} + 4\hat{j}$$

$$\left|\vec{V}\right| = \sqrt{4^2 + 4^2} = \sqrt{32}$$

$$\boxed{\left|\vec{V}\right| = 4\sqrt{2}\,\text{m/sec}}$$

$$\tan\phi = \frac{V_y}{V_x} = \frac{4}{4} = 1$$

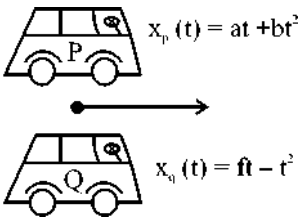
$$\boxed{\phi = 45^\circ}$$

21. 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?
P और Q एक ही समय पर किसी बिन्दु से सरल रेखा में चलना प्रारंभ करती है और उनकी स्थितियों को क्रमशः $x_P(t) = at + bt^2$ और $x_Q(t) = ft - t^2$ से निरूपित किया जाता है । किस समय पर इन दोनों कारों का वेग समान होगा ?

(a) $\frac{a-f}{1+b}$ (b) $\frac{a+f}{2(b-1)}$
(c) $\frac{a+f}{2(b+1)}$ (d) $\frac{f-a}{2(1+b)}$

NEET (UG)-24.07.2016, PHASE-II

Ans. (d) :



Position of car P,
$x_p(t) = at + bt^2$
Thus velocity of car P

$$V_p = \frac{d\left[X_p(t)\right]}{dt} = a + 2bt$$

Position of car Q
$x_Q(t) = ft - t^2$
Thus, velocity of car Q

$$v_Q = \frac{d\left[x_Q(t)\right]}{dt} = f - 2t$$

According to the question,

$$v_p\big|_{t=t_0} = v_Q\big|_{t=t_0}$$

Where, t_0 is time at which there velocity is same

$\therefore a + 2bt_0 = f - 2t_0$

$\Rightarrow \boxed{t_0 = \frac{f-a}{2(1+b)}}$

22. If the velocity of a particle is $v = At + Bt^2$, where A and B are constants, then the distance travelled by it between 1 s and 2s is
यदि किसी कण का वेग $v = At + Bt^2$ है यहाँ A तथा B स्थिरांक है, तो इस कण द्वारा 1 s और 2s के बीच चली गयी दूरी है

(a) $\frac{A}{2}+\frac{B}{2}$ (b) $\frac{3}{2}A + B$

(c) 3A+7B (d) $\frac{3}{2}A+\frac{7}{3}B$

NEET (UG)-01.05.2016

Ans. (d) : Given

$v = At + Bt^2$

We know $v = \frac{ds}{dt}$

$ds = vdt$

$\int ds = \int vdt$

Hence $\int_0^s ds = \int_{t=1s}^{t=2s} (At + Bt^2)dt$

$S = \left[\frac{At^2}{2} + \frac{Bt^3}{3}\right]_1^2$

$S = \frac{A}{2}(2^2 - 1^2) + \frac{B}{3}(2^3 - 1^3)$

$\boxed{S = \frac{3A}{2} + \frac{7B}{3}}$

23. A particle of unit mass undergoes one-dimensional motion such that its velocity varies according to /एकांक द्रव्यमान का कोई कण एकविमीय गति करता है और इसका वेग निम्नांकित समीकरण के अनुसार परिवर्तित होता है:

$v(x) = \beta x^{-2n}$

where β and n are constants and x is the position of the particle. The acceleration of the particle as a function of x, is given by :
जहाँ β तथा n स्थिरांक हैं तथा x कण की स्थिति है। तो, इस कण के त्वरण को, x के फलन के रूपमें निरूपित किया जा सकता है।

(a) $-2n\beta^2 x^{-4n-1}$ (b) $-2\beta^2 x^{-2n+1}$

(c) $-2n\beta^2 e^{-4n+1}$ (d) $-2n\beta^2 x^{-2n-1}$

AIPMT-03.05.2015

Ans. (a)

$v(x) = \beta x^{-2n}$

$\frac{dv}{dx} = -2n\beta x^{-2n-1}$

Acceleration of the particle is given by

$a = \frac{dv}{dt} = \frac{dv}{dx} \times \frac{dx}{dt} = \frac{dv}{dx} \times v$

Therefore, $a = v.\ \frac{dv}{dx}$

$a = \beta x^{-2n} \times (-2n\ \beta x^{-2n-1})$

$a = -2n\ \beta^2 x^{-4n-1}$

24. A car of mass m starts from rest and accelerates so that the instantaneous power delivered to the car has a constant magnitude P_0. The instantaneous velocity of this car is proportional to
m द्रव्यमान की एक कार विरामावस्था से प्रारम्भ होकर इस प्रकार त्वरित होती हे, कि कार को प्राप्त तात्क्षणिक शक्ति का स्थिर मान P_0 है। तो, इस कार का तात्क्षणिक वेग समानुपाती हो सकता है:-

(a) $t^{-1/2}$ (b) $t/\sqrt{m}$

(c) $t^2 P_0$ (d) $t^{1/2}$

AIPMT (Mains)-2012

Ans. (d) : Mass of car = 'm'

Instantaneous power delivered to the car has a constant magnitude P_o

$\because\ P_0 = Fv$

Also, $F = ma = m \times \frac{dv}{dt}$

$\Rightarrow \quad P_0 = mv\frac{dv}{dt}$

$\Rightarrow \quad P_0\, dt = mv\, dv$

Now, Integrating both side –

$\int_0^t P_0 dt = m\int_0^v vdv$

$\Rightarrow \quad P_0 t = \frac{mv^2}{2}$

$\Rightarrow \quad v = \left(\frac{2P_0 t}{m}\right)^{1/2}$

$\Rightarrow \quad \boxed{v \propto t^{1/2}}$

25. 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 second. The retardation of the particle when its velocity becomes zero is:/एक सरल रेखा के अनुदिश, किसी कण की गति को समीकरण $x = 8 + 12t - t^3$ द्वारा परिभाषित (प्रकट) किया जाता है। जहाँ x मीटर में तथा t सेकंड में है। वेग शून्य होने पर कण का मंदन है:–

(a) $6ms^{-2}$ (b) $12ms^{-2}$

(c) $24ms^{-2}$ (d) zero/शून्य

AIPMT (Screening)-2012

Ans. (b) : Equation of motion of a particle along a straight line is–

$x = 8 + 12t - t^3$

Now, Velocity, $v = \frac{dx}{dt} = 12 - 3t^2$ ——— (i)

also, acceleration $\boxed{a = \frac{dv}{dt} = -6t}$ ——— (ii)

Now, retardation of particle when its velocity becomes zero is,

→ Put v = 0 in equation (i)

$0 = 12 - 3t^2$

$t = 2$ sec

Now, Put $t = 2$ sec in equation (ii)

$a = -6 \times 2 = -12\ m/s^2$

$a = 12\ m/s^2$ (retardation)

26. A particle has initial velocity $(2\hat{i}+3\hat{j})$ and acceleration $(0.3\hat{i}+0.2\hat{j})$. The magnitude of velocity after 10 seconds will be:/किसी कण का प्रारंभिक वेग $(2\hat{i}+3\hat{j})$ तथा त्वरण $(0.3\hat{i}+0.2\hat{j})$ है। 10 सेकण्ड बाद कण के वेग का मान होगा:-

(a) 5 units (b) 9 units

(c) $9\sqrt{2}$ units (d) $5\sqrt{2}$ units

AIPMT (Screening)-2012

Ans. (d) : Given

Initial velocity $= 2\hat{i}+3\hat{j} = u_x\hat{i}+u_y\hat{j}$

Acceleration $= 0.3\hat{i}+0.2\hat{j} = a_x\hat{i}+a_y\hat{j}$

Velocity (v) after time 't' $= (u_x + a_x t)\hat{i} + (u_y + a_y t)\hat{j}$

Now, velocity after $t = 10$ sec

$u = [2+0.3(10)]\hat{i} + [3+0.2(10)]\hat{j}$

$u = 5\hat{i}+5\hat{j}$

$\therefore$ Magnitude of velocity $= \sqrt{5^2+5^2} = 5\sqrt{2}$ units

27. A particle moves a distance x in time t according to equation $x = (t + 5)^{-1}$. The acceleration of particle is proportional to –

एक कण दी गई समीकरण $x = (t + 5)^{-1}$ के अनुसार t समय में एक x दूरी तय करता है। कण का त्वरण समानुपाती है –

(a) $(\text{velocity})^{3/2}/(\text{वेग})^{3/2}$ (b) $(\text{distance})^2/(\text{दूरी})^2$

(c) $(\text{distance})^{-2}/(\text{दूरी})^{-2}$ (d) $(\text{velocity})^{2/3}/(\text{वेग})^{2/3}$

AIPMT (Screening)-2010

Ans. (a): Given $x = (t+5)^{-1}$

where x = distance, t = time

Differentiating given eq^n,

$$\frac{dx}{dt} = (v) = -\frac{1}{(t+5)^2} \text{---(i)}$$

Again differentiating eq^n (i),

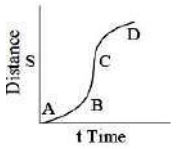
$$\frac{d^2x}{dt^2} = (a) = \frac{2}{(t+5)^3} \text{---(ii)}$$

Comparing equation (i) and (ii) we get,

$\boxed{a \propto v^{3/2}}$

28. A particle shows distance-time curve as given in this figure. The maximum instantaneous velocity of the particle is around the point :

एक कण के लिए दूरी-समय वक्र इस चित्र में दिखाया गया है। इसका अधितम तत्कालिक वेग वक्र के किस बिन्दु के आसपास होगा?

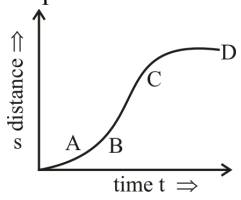


(a) D (b) A

(c) B (d) C

AIPMT-2008

Ans. (d) : Given Graph of s and t.



and we know $\Rightarrow \frac{ds}{dt} = v =$ slope of s, t graph.

So where slope will be maximum there velocity will be maximum.

From given figure we see that at point C, slope is maximum.

Hence Instantaneous velocity at point C will be maximum.

29. 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 (v_x) is:

x-अक्ष की दिशा में गतिमान एक कण के समय t पर त्वरण f को $f_0 = \left(1-\frac{t}{T}\right)$ समीकरण द्वारा व्यक्त किया जा सकता है, जबकि f_0 और T नियतांक है। t=0 पर इस कण का वेग शून्य है। समय t= 0 और उस क्षण के बीच अन्तराल में जबकि f=0 है, कण का वेग (V_x) होगा:-

(a) $\frac{1}{2}f_0T$ (b) f_0T

(c) $\frac{1}{2}f_0T^2$ (d) f_0T^2

AIPMT-2007

Ans. (a) Given acceleration along x-axis $f = f_0\left(1-\frac{t}{T}\right)$

and we know acceleration $f = \frac{dv}{dt}$

$\therefore \quad \frac{dv}{dt} = f_0\left(1-\frac{t}{T}\right)$

integrate both side –

$$v = \int_0^T f_0 \cdot dt - \int_0^T f_0 \frac{t}{T} dt$$

$$= [f_0 t]_0^T - \left[f_0 \frac{t^2}{2T}\right]_0^T = f_0T - f_0\frac{T^2}{2T}$$

$$= f_0T - \frac{1}{2}f_0T$$

$$= \frac{1}{2}f_0T$$

30. The position x of a particle with respect to time t along x-axis is given by $x = 9t^2 - t^3$ where x is in metres and t in seconds. What will be the position of this particle when it achieves maximum speed along the + x direction ?
x-अक्ष पर किसी कण का समय t के संदर्भ में निर्धारित स्थान x, समीकरण $x = 9t^2 - t^3$ द्वारा व्यक्त किया जा सकता है, जबकि x मीटरों में तथा t सेकण्डों में हैं। +x दिशा में कण का स्थान क्या होगा जब उसकी चाल उच्चतम होगी?

(a) 24m (b) 32m

(c) 54m (d) 81m

AIPMT-2007

Ans. (c) : Given : position of particle $x = 9t^2 - t^3$

we know, $v = \frac{dx}{dt}$

$\therefore v = 18t - 3t^2$

$$\frac{dv}{dt} = 18 - 6t$$

For maximum speed $\frac{dv}{dt} = 0$ & $\frac{d^2v}{dt^2} < 0$ (Negative)

So, $18 - 6t = 0 \Rightarrow t = 3s$ & $\frac{d^2v}{dt^2} = -6 < 0$

Maximum speed is at $t = 3s$, So maximum displacement at this position is -

$$x = 9\times(3)^2 - (3)^3$$
$$= 9\times 9 - 27$$
$$= 54m$$

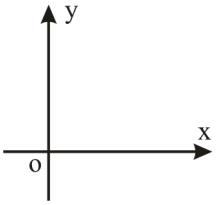
31. A particle moves along a straight line OX. At a time t (in seconds) the distance x (in meters) of the particle from O is given by $x = 40 + 12t - t^3$. How long would the particle travel before coming to rest: -
एक कण सीधे रेखा OX पर चल रहा है। समय t (सेकण्डों में) पर कण की O से दूरी x (मीटरों में) होती है $x = 40 + 12t - t^3$ यहकण विरामा अवस्था तक पहुँचने में कितनी दूरी चल लेगाः-

(a) 24m (b) 40m

(c) 56m (d) 16m

AIPMT-2006

Ans. (d) : Distance x of particle from O is given by $x = 40 + 12t - t^3$



at t = 0, Particle is at, let say x distance from O

$x = 40 + 12(0) - (0)^3 = 40$ m

$\because$ Particle comes to rest that means velocity of particle becomes zero after travelling certain displacement

$x = 40 + 12t - t^3$

$V = \frac{dx}{dt} = 12 - 3t^2$

at time t = t when particle come to rest

$12 - 3t^2 = 0$

$3t^2 = 12$

$t = 2$

at t = 2, let say x' distance from O

$x' = 40 + 12(2) - (2)^3$

$x' = 56$ m

We have seen that particle started journey when it is 40 m from point O and come to rest at 56 m from point O.

so particle travelled a distance of 56 – 40 = 16 m

32. 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 –
एक कण के विस्थापन x का समय t के प्रति बदलाव दिया जाता है $x = ae^{-\alpha t} + be^{\beta t}$ द्वारा, जबकि a, b, α और β धन स्थिरांक है। इस कण का वेग-

(a) Be independent of α and β
α और β के मानों से स्वतन्त्र होगा

(b) Go on increasing with time
समय के साथ बढ़ता जायेगा

(c) Drop to zero when $\alpha = \beta$
घटकर शुन्य हो जायेगा जब $\alpha = \beta$ होगा।

(d) Go on decreasing with time
समय के साथ घटता जायेगा।

AIPMT-2005

Ans. (b): Given : $x = ae^{-\alpha t} + bd^{\beta t}$

Velocity, $V = \frac{dx}{dt} = -a\alpha e^{-\alpha t} + b\beta e^{\beta t}$

The value of $-a\alpha e^{-\alpha t}$ decreases with time and for second derivative it increases. But the value of $b\beta e^{\beta t}$ always increases with time as a contains positive terms only. So, velocity in entire function will goes on increasing with time.

33. Motion of a particle is given by equation $S = (3t^3 + 7t^2 + 14\ t + 8)$ m. The value of acceleration of the particle at t = 1 sec. is :
एक कण की गति निम्न समीकरण से दी जाती है $S = (3t^3 + 7t^2 + 14\ t + 8)$ m, t = 1 सैकण्ड पर कण के त्वरण का मान है –

(a) 10 m/s^2 (b) 32 m/s^2
(c) 23 m/s^2 (d) 16 m/s^2

AIPMT-2000

Ans. (b) : Equation of motion given,
$S = 3t^3 + 7t^2 + 14t + 8$

Velocity (v) $= \frac{dS}{dt}$

$= 9t^2 + 14t + 14$

Now, acceleration, $a = \frac{d^2s}{dt^2}$

$a = 18t + 14$

at t = 1 sec,

Acceleration of particle $= 18\times1 + 14 = 32\frac{m}{s^2}$

34. A particle moves so that its position vector is given $\vec{r} = \cos\omega t\hat{x} + \sin\omega t\hat{y}$. Where ω is constant. Which of the following is true?
कोई कण इस प्रकार गमन करता है कि उसका स्थिति सदिश $\vec{r} = \cos\omega t\hat{x} + \sin\omega t\hat{y}$ द्वारा निरूपित किया गया है, यहाँ ω एक नियतांक है?
निम्नलिखित में से कौन से कथन सत्य है?

(a) Velocity is perpendicular to $\vec{r}$ and acceleration is directed away from the origin./वेग $\vec{r}$ के लम्बवत् है तथा त्वरण मूल बिन्दु से दूर की ओर निर्देशित है।
(b) Velocity and acceleration both are perpendicular to $\vec{r}$
वेग और त्वरण दोनों ही $\vec{r}$ के लम्बवत् हैं।
(c) Velocity and acceleration both parallel to $\vec{r}$
वेग और त्वरण दोनों ही $\vec{r}$ के समान्तर है।
(d) Velocity is perpendicular to $\vec{r}$ and acceleration is directed towards the origin.
वेग $\vec{r}$ के लम्बवत् है तथा त्वरण मूल बिन्दु की ओर निर्देशित है।

NEET (UG)-01.05.2016
AIPMT-1995

Ans. (d) : The value of position vector

$\vec{r} = \cos\omega t\hat{x} + \sin\omega t\hat{y}$

$\vec{v} = \frac{d\vec{r}}{dt} = \frac{d(\cos\omega t\hat{x} + \sin\omega t\hat{y})}{dt}$

$\vec{v} = -(\sin\omega t)\omega\hat{x} + (\cos\omega t)\omega\hat{y}$

$\vec{v} = -\omega(\sin\omega t\hat{x} - \cos\omega t\hat{y})$

Now

We need to find the acceleration of the particle

$\vec{a} = \frac{dv}{dt}$

$\vec{a} = \frac{d(-\omega\sin\omega t\hat{x} + \omega\cos\omega t\hat{y})}{dt}$

$\vec{a} = -\omega^2\cos\omega t\hat{x} - \omega^2\sin\omega t\hat{y}$

$\vec{a} = -\omega^2(\cos\omega t\hat{x} + \sin\omega t\hat{y})$

$\vec{a} = -\omega^2\vec{r} = \omega^2(-\vec{r})$

Now,

The relation between the velocity vector and position vector

$\vec{v}.\vec{r} = -\omega(\sin\omega t\hat{x} - \cos\omega t\hat{y})\times(\cos\omega t\hat{x} + \sin\omega t\hat{y})$

$\vec{v}.\vec{r} = -\omega(\sin\omega t.\cos\omega t + 0 + 0 - \sin\omega t.\cos\omega t)$

$\therefore \quad \vec{v}.\vec{r} = -\omega(0)$

$\vec{v}.\vec{r} = 0$

So, velocity is perpendicular to $\vec{r}$ and acceleration a = $(\omega^2 r)$ will always be aiming towards the origin.

35. The acceleration of a particle is increasing linearly with time t as bt. The particle starts from origin with an initial velocity v_0. The distance travelled by the particle in time t will be
किसी कण का त्वरण समय t के साथ रैखिक रूप से bt के रूप में बढ़ रहा है। कण आरम्भिक वेग v_0 के साथ मूल बिन्दु से चलना प्रारम्भ करता है। t समय में कण द्वारा तय की गई दूरी होगी:

(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) $v_0t + \frac{1}{2}bt^2$

AIPMT-(1995)

Ans. (c) : Given that,
Acceleration (a) = bt
Given, at time t = 0, the initial velocity is v_0.

$\because \quad a = \frac{\text{change in velocity}}{\text{change in time}}$

$a = \frac{dv}{dt} = bt$

$dv = bt\ .\ dt$

Integrating on both sides,

$$\int_{v_0}^{v} dv = \int_{0}^{t} bt\,dt$$

$$(v - v_0) = b\left[t^2/2\right]_0^t$$

$$= \frac{b}{2}[t^2 - 0]$$

$$v = \frac{b}{2}t^2 + v_0 \qquad \text{... (i)}$$

$$\text{Velocity} = \frac{\text{change in position}}{\text{change in time}}$$

$$v = \frac{dx}{dt}$$

$$\frac{b}{2}t^2 + v_0 = \frac{dx}{dt}$$

$$dx = \left(\frac{bt^2}{2} + v_0\right)dt$$

Integrating on both side,

$$\int_0^x dx = \int_0^t \left(\frac{bt^2}{2} + v_0\right) dt$$

$$\Rightarrow \quad [x]_0^x = \int_0^t \frac{bt^2}{2}\,dt + \int_0^t v_0\,dt$$

$$\Rightarrow \quad [x - 0] = b/2\ [t^3/3]_0^t + v_0[t]_0^t$$

$$\Rightarrow \quad x = \frac{b}{2\times 3}[t^3 - 0] + v_0(t - 0)$$

$$\Rightarrow \quad x = \frac{b}{6}t^3 + v_0 t$$

$$\therefore \quad x = v_0 t + \frac{1}{6}bt^3$$

36. A particle moves along a straight line such that its displacement at any time t is given by $s=(t^3 - 6t^2 + 3t + 4)$ metres. The velocity when the acceleration is zero is

एक कण सरल रेखा में चलता है। इसका t समय के साथ विस्थापन $s = (t^3 - 6t^2 + 3t + 4)$ मी से दिया गया है। त्वरण शून्य होने पर वेग का मान होगा:

(a) 3 m/s (b) 42 m/s

(c) –9 m/s (d) –12 m/s

AIPMT-(1994)

Ans. (c) : Given that,

$$s = (t^3 - 6t^2 + 3t + 4) \text{ meters.}$$

We know that,

$$\text{Velocity (v)} = \frac{\text{change in displacement}}{\text{change in time}} = \frac{ds}{dt}$$

So, differentiate the above equation with respect to time, $\text{Velocity (v)} = \frac{ds}{dt} = \frac{d}{dt}(t^3 - 6t^2 + 3t + 4)$

$$= \frac{d}{dt}(t^3) - \frac{d}{dt}(6t^2) + 3\frac{d}{dt}(t) + \frac{d}{dt}(4)$$

$$v = 3t^2 - 12t + 3$$

$$\text{Acceleration (a)} = \frac{d}{dt}(v)$$

$$= \frac{d}{dt}(3t^2 - 12t + 3)$$

$$= \frac{d}{dt}(3t^2) - \frac{d}{dt}(12t) + \frac{d}{dt}(3)$$

$$a = 6t - 12$$

As per question, acceleration (a) = 0

$$6t - 12 = 0$$

$$t = 2 \text{ sec.}$$

Put the value of time in the velocity equation,

$$v = 3(2)^2 - 12(2) + 3$$

$$= 12 - 24 + 3$$

$$\therefore \quad v = -9 \text{ m/sec.}$$

2.4 Kinetmatic Equation for Motion

37. 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 :

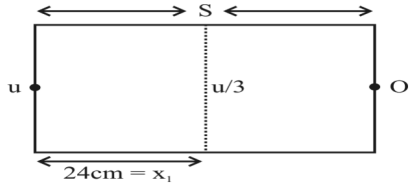
बन्दूक की एक गोली लकड़ी के एक आयताकार गुटके पर u वेग से दागी जाती है। जब गोली गुटके में क्षैतिज दिशा में 24 cm घुस जाती है, गोली का वेग $\frac{u}{3}$ हो जाता है। तब यह पुनः रुकने से पूर्व तक उसी दिशा में लक्ष्य को ठीक दूसरी सतह तक भेदती है। गुटके की कुल लम्बाई है :

(a) 30 cm (b) 27 cm

(c) 24 cm (d) 28 cm

NEET (UG)-07.05.2023

Ans. (b) :



By using eq^n of motion –

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

$$\left(\frac{u}{3}\right)^2 = u^2 - 2a \times 24$$

$$24 \times 2a = \frac{8u^2}{9} \qquad \text{...(i)}$$

Now, again using eq^n of motion –

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

$0 = u^2 - 2as$

$u^2 = 2as$ ...(ii)

On dividing eq^n (i) by eq^n (ii) we get

$$\frac{24 \times 2a}{2as} = \frac{8u^2}{9} \times \frac{1}{u^2}$$

$$\frac{24}{s} = \frac{8}{9}$$

$\boxed{s = 27 \text{ cm}}$

38. 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}) :

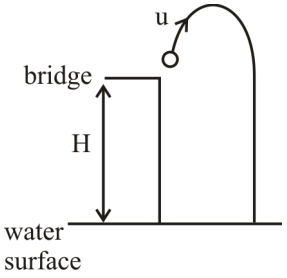
एक नदी पर एक क्षैतिज पुल बनाया गया है। पुल पर खड़ा एक छात्र 4 m s^{-1} के वेग से एक छोटी गेंद ऊर्ध्वाधर ऊपर की ओर फेंकता है। 4 s बाद गेंद पानी की सतह से टकराती है। पानी की सतह से ऊपर पुल की ऊँचाई है। (g = 10 m s^{-2} लीजिए) :

(a) 68 m (b) 56 m

(c) 60 m (d) 64 m

NEET (UG)-07.05.2023

Ans. (d) :



By equation of motion –

$$S = ut - \frac{1}{2}gt^2$$

$$-H = 4 \times 4 - \frac{1}{2} \times 10 \times (4)^2$$

$$-H = 16 - 80$$

$$-H = -64$$

$\boxed{H = 64 \text{ m}}$

39. The ratio of the distances travelled by a freely falling body in the 1st, 2nd, 3rd and 4th second

स्वच्छंद रूप से गिरते हुए किसी पिण्ड द्वारा पहले, दूसरे, तीसरे एवं चौथे सेकेण्ड में तय की गई दूरियों का अनुपात होगा:

(a) 1 : 1 : 1 : 1 (b) 1 : 2 : 3 : 4

(c) 1 : 4 : 9 : 16 (d) 1 : 3 : 5 : 7

NEET (UG)-17.07.2022

Ans. (d): We know that the equation of motion for the n^{th} second.

$$S_n^{th} = u + \frac{a}{2}(2n-1)$$

$\because$ Body is freely falling so, u = 0 and a = g = constant

$$= 0 + \frac{a}{2}(2n-1)$$

$$S_n^{th} \propto (2n-1)$$

$$= S_{1sd} : S_{2sd} : S_{3sd} : S_{4sd}$$

$$= [2(1)-1] : [2(2)-1] : [2(3)-1] : [2(4)-1]$$

= 1 : 3 : 5 : 7

40. A car starts from rest and accelerates at 5 m/s^2. At t = 4 s, a ball is dropped out of a window by a person sitting in the car. What is the velocity and acceleration of the ball at t = 6 s?

एक कार विरामावस्था से प्रारम्भ करती है तथा 5 मी./से.^{2} से त्वरित होती है। t = 4 सेकण्ड पर कार में बैठे व्यक्ति द्वारा एक गेंद खिड़की के बाहर गिरायी जाती है। t = 6 सेकण्ड पर गेंद का वेग तथा त्वरण क्या होता है? (दिया है : g = 10 मी./से.^{2})

(a) $20\sqrt{2}$ m/s, 10 m/s^2 (b) 20 m/s, 5 m/s^2

(c) 20 m/s, 0 (d) $20\sqrt{2}$ m/s, 0

NEET (UG)-12.09.2021

Ans. (a) : Motion of car in horizontal direction Velocity of car at t = 4 sec-

$v_x = u_x + at$ ($\because$ a = 0)

$v_x = at = 4 \times 5 = 20$ m/s

So, horizontal velocity of car = 20 m/s

According to question-

At t = 4sec, a ball is dropped out of window of car.

$\therefore$ After 2sec, Horizontal velocity of ball = 20 m/sec

Vertical velocity of ball at t = 6 sec i.e after 2 sec of free fall

$v_y = u_y + gt$

$v_y = 20$m/s ($\because u_y = 0$, g = 10)

So, Net velocity of ball = $\sqrt{20^2 + 20^2} = 20\sqrt{2}$ m/s

& once it starts falling, acceleration is only 'g' ie. 10m/s^2.

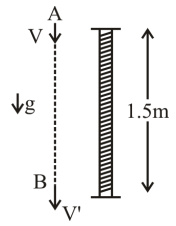
41. A person sitting in the ground floor of a building notices through the window of height 1.5 m, a ball dropped from the roof of the building crosses the window in 0.1 s. What is the velocity of the ball when it is at the topmost point of the window ? (g = 10 m/s^2)

किसी भवन के भूतल पर बैठा कोई व्यक्ति 1.5m ऊँचाई की किसी खिड़की से ये नोट करता है कि भवन की छत से गिरायी गयी कोई गेंद उस खिड़की को 0.1 s में पार करती है। जब यह गेंद इस खिड़की के शीर्ष बिन्दु पर थी, तब इसका वेग क्या था? (g = 10 m/s^2)

(a) 20 m/s (b) 15.5 m/s
(c) 14.5 m/s (d) 4.5 m/s

NEET (UG)-14.10.2020, Phase-II

Ans. (c) :



Given

For journey from A to B. {upward direction is taken as + ve }

Distance ball has to travel, s = h = – 1.5 m

$$\text{Acceleration (a)} = -g = -10\ \frac{m}{s^2}$$

Initial velocity of Ball = – V

– sign represents downward direction

Time taken by ball to cross window = t = 0.1 sec.

From equation of motion, $s = ut + \frac{1}{2}at^2$

$$-1.5 = (-V)(0.1) + \frac{1}{2}(-10)(0.1)^2$$

$$\boxed{V = 14.5 \text{ m/s.}}$$

42. A ball is thrown vertically downward with a velocity of 20 m/s from the top of a tower. It hits the ground after some time with a velocity of 80 m/s. The height of the tower is : (g = 10 m/s^2)/किसी मीनार के शिखर से किसी गेंद को 20 m/s के वेग से उर्ध्वाधर अधोमुखी फेंका गया है। कुछ समय पश्चात यह गेंद धरती से 80 m/s के वेग से टकराती है। इस मीनार की ऊचाई है: (g = 10 m/s^2)

(a) 340 m (b) 320 m
(c) 300 m (d) 360 m

NEET (UG)-13.09.2020

Ans. (c) : Given that,

Initial velocity of ball, $u = 20\frac{m}{s}$

Final velocity of Ball, $v = 80\frac{m}{s}$

(acceleration due to gravity) $g = 10\ m/s^2$

According to equation of motion for constant accelerating motion -

$\because v^2 = u^2 + 2gh$

$80^2 = 20^2 + 2\times10\times h$

h = 300 m

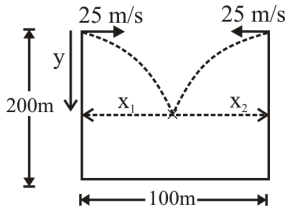
43. Two bullets are fired horizontally and simultaneously towards each other from roof tops of two buildings 100 m apart and of same height of 200 m, with the same velocity of 25 m/s. When and where will the two bullets collide? (g = 10 m/s^2)

एक दूसरे से 100 m दूरी पर स्थित 200 m ऊँचाई के दो भवनों की छतों से एक-दूसरे की ओर क्षैतिज दिशा में समान वेग 25 m/s से दो गोलियाँ एक ही क्षण दागी गयी है। ये दोनों गोलियाँ कब और कहाँ एक-दूसरे से संघट्ट करेंगी? (g = 10 m/s^2)

(a) They will not collide/ये गोलियाँ संघट्ट नहीं करेंगी
(b) After 2s at a height of 180 m/ 2s के पश्चात 180 m की ऊँचाई पर
(c) After 2s at a height of 20 m/ 2s के पश्चात 20 m की ऊँचाई पर
(d) After 4 s at a height of 120 m/ 4s के पश्चात 120 m की ऊँचाई पर

NEET (UG)-20.05.2019, (Odisha)

Ans. (b) :



Given data

$V_A = 25$ m/s , $V_B = -25$ m/s

Distance (d) = 100m

$V_{AB} = V_A - V_B = 25 - (-25)$

$= 50$ m/s

$$\text{Time } t = \frac{d}{V_{AB}} = \frac{100}{50} = 2\text{sec.}$$

Calculating vertical distance traveled by bullets given initial velocity $U_y = 0$ m/s

Acceleration a = 10 m/s

$$y = U_y + \frac{1}{2}at^2$$

$$= 0 + \frac{1}{2}(10)\times(2)^2$$

y = 20

Calculating height from ground-

h = 200m – 20m

$\boxed{h = 180 \text{ m}}$

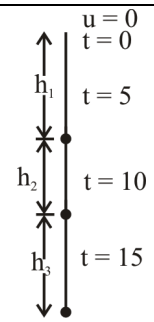
44. A stone falls freely under gravity. It covers distances h_1, h_2 and h_3 in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between h_1, h_2 and h_3 is "-

एक पत्थर मुक्तरूप से गुरूत्वाधीन गिरता है। यह पत्थर पहले पाँच (5) सेकंडों में h_1 दूरी, उससे अगले 5 सेकंडों में h_2 दूरी तथा उससे अगले 5 सेकंड में h_3 दूरी तय करता है, तो h_1, h_2 तथा h_3 में संबंध है-

(a) $h_1 = h_2 = h_3$ (b) $h_1 = 2h_2 = 3h_3$
(c) $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$ (d) $h_2 = 3h_1$ and $h_3 = 3h_2$

NEET (UG)-05.05.2013

Ans. (c):



S = distance
t = time
a = acceleration
g = acceleration due to gravity (10 m/sec^2)
Second law of motion,

$$S = ut + \frac{1}{2}at^2$$

For h_1

$$h_1 = 0 \times 0 + \frac{1}{2} \times g \times 5^2$$

$$h_1 = 125m \quad \text{.....(i)}$$

For $h_1 + h_2$

$$h_1 + h_2 = 0 \times 0 + \frac{1}{2} \times g \times 10^2$$

$$125 + h_2 = 500$$

$$h_2 = 375m \quad \text{.....(ii)}$$

For $h_1 + h_2 + h_3$

$$h_1 + h_2 + h_3 = 0 \times 0 + \frac{1}{2} \times g \times 15^2$$

$$125 + 375 + h_3 = 1125$$

$$h_3 = 625m \quad \text{.....(iii)}$$

Hence

$$\boxed{h_1 = \frac{h_2}{3} = \frac{h_3}{5}}$$

45. The displacement 'x' (in meter) of a particle of mass 'm' (in kg) moving in one dimension under the action of a force, is related to time 't' (in sec) by $t = \sqrt{x} + 3$. The displacement of the particle when its velocity is zero, will be

(a) 2 m (b) 4 m
(c) 0 m (zero) (d) 6 m

NEET (UG)-18.05.2013, Karnataka

Ans. (c) : Given displacement = x
mass = m
time = t

Given relation $t = \sqrt{x} + 3$

$$\sqrt{x} = (t - 3)$$

$$x = (t - 3)^2$$

$$\frac{dx}{dt} = v = 2(t - 3)$$

$v = 0$
$2(t - 3) = 0$
$t = 3$ sec

Velocity will be zero at t = 3 sec displacement at 3 sec also be zero.

46. A boy standing at the top of a tower of 20 m height drops a stone. Assuming g = 10 ms^{-2}, the velocity with which it hits the ground is:/एक बालक 20 m ऊँची मीनार के शीर्ष पर खड़ा है और वह एक पत्थर गिराता है। यदि g = 10 ms^{-2} हो, तो पत्थर का पृथ्वीतल पर टकराते समय वेग होगा :

(a) 5.0 m/s (b) 10.0 m/s
(c) 20.0 m/s (d) 40.0 m/s

AIPMT (Screening)-2011

Ans. (c) : Given –
Height of tower (h) = 20m
Initial velocity (u) = 0, $g = 10 \text{ m/s}^2$
Final velocity (v) = ?

When there is a free fall we can directly use the equation of motion :

$v^2 = u^2 + 2gh$ { $\because$ u = 0 for free fall }

So, $v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = \sqrt{400} = 20$m/s.

47. A ball is dropped from a high rise platform at t = 0 starting from rest. After 6 seconds another ball is thrown downwards from the same platform with a speed v. The two balls meet at t = 18 s. What is the value of v ?/एक गेंद को एक ऊँचे प्लेटफार्म से t = 0 से विराम से छोड़ा गया है। 6 सेकण्ड पश्चात् एक गेंद को इसी प्लेटफार्म से V चाल से नीचे की ओर फेंका गया है। दोनों गेंदे t = 18 s पर आपस में मिलती हैं। V का मान क्या है ?
(take g = 10 m/s^2)

(a) 75 m/s (b) 55 m/s
(c) 40 m/s (d) 60 m/s

AIPMT (Screening)-2010

Ans. (a) : Initial speed of ball, u = 0 and t = 18 sec

$$s_1 = ut + \frac{1}{2}gt^2$$

$$s_1 = \frac{1}{2} \times g \times (18)^2 \text{ ---(i)}$$

For second ball initial velocity v

$$s_2 = vt_2 + \frac{1}{2}gt_2^2$$

$t_2 = 12$ sec

$$s_2 = 12v + \frac{1}{2}g(12)^2 \text{ ----(ii)}$$

From eqn (i) and (ii),

$$\Rightarrow s_1 = s_2$$

$$\frac{1}{2}g(18) \times (18) = 12v + \frac{1}{2}g(12 \times 12)$$

$v = 75$ m/s

48. A particle has initial velocity $(3\hat{i}+4\hat{j})$ and has acceleration $(0.4\hat{i}+0.3\hat{j})$. Its speed after 10 s is–

एक कण $(3\hat{i}+4\hat{j})$ प्रारम्भिक वेग तथा $(0.4\hat{i}+0.3\hat{j})$ त्वरण रखता है। 10 s पश्चात् इसकी चाल होगी –

(a) 7 units (b) $7\sqrt{2}$units
(c) 8.5 units (d) 10 units

AIPMT (Screening)-2010

Ans. (b) : Initial Velocity = 3i+4j
Acceleration = 0.4i + 0.3j
t = 10 second
First equation of motion-
v = u + at
v = 3i + 4j + 10(0.4i + 0.3j)
v = 7i + 7j
$|v| = \sqrt{7^2+7^2}$
$\boxed{v = 7\sqrt{2}}$

49. A particle starts its motion from rest under the action of a constant force. If the distance covered in first 10 seconds is S_1 and that covered in the first 20 seconds is S_2 then:

एक कण अचर बल के प्रभाव में विरामावस्था से गति प्रारम्भ करता है। यदि इसकी पहले 10 सेकण्ड में चली दूरी S_1 तथा पहले 20 सेकण्ड में चली दूरी S_2 हों, तो:

(a) $S_2 = S_1$ (b) $S_2 = 2S_1$
(c) $S_2 = 3S_1$ (d) $S_2 = 4S_1$

AIMPT-2009

Ans. (d) : Given – motion start from rest so initial velocity u = 0 for action under constant force so acceleration will be same.

we know $s = ut + \frac{1}{2}at^2$

when S_1 distance covered $\Rightarrow$

$S_1 = 0\times t + \frac{1}{2}\times a\times(10)^2 = \frac{1}{2}\times a\times 100$

$S_1 = 50a$ ..... (i)

when S_2 distance covered $\Rightarrow$

$S_2 = 0\times t + \frac{1}{2}\times a\times(20)^2 = \frac{1}{2}\times a\times 400$

$S_2 = 200a$ ..... (ii)

Dividing eq^n (i) and eq^n (ii) we see that $S_2 = 4\ S_1$

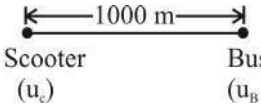
50. A bus is moving with a speed of 10ms^{-1} on a straight road. A scooterist wishes to overtake the bus in 100s. If the bus is at a distance of 1 km from the scooterist, with what speed should the scooterist chase the bus?

किसी सड़क पर एक बस 10 मीटर/सेकण्ड की चाल से जा रही है। एक स्कूटर वाला बस को 100 सेकण्ड में पकड़ना चाहता है। यदि बस स्कूटर वाले से 1 कि.मी. की दूरी पर हो तो स्कूटर वाले को बस का पीछा किस चाल से करना होगा?

(a) 10 ms^{-1} (b) 20 ms^{-1}
(c) 40 ms^{-1} (d) 25 ms^{-1}

AIMPT-2009

Ans. (b) : Given – Speed of bus u_B = 10 m/s
Time taken = 100 sec



As scooter will overtake bus so acceleration will not vary.

We know $S = ut + \frac{1}{2}at^2$

$S_c = u_c t + \frac{1}{2}at^2$ ...(i)

$S_B = u_B t + \frac{1}{2}at^2$ ....(ii)

Subtracting equation (ii) from (i) –
$S_c - S_B = (u_c - u_B)t$
$1000 = (u_c - 10)100$
$10 = u_c - 10$
$u_c = 20$ m/s

51. The distance travelled by a particle starting from rest and moving with an acceleration $\frac{4}{3}$ ms^{-2}, in the third second is –

एक कण विराम अवस्था से आरम्भ कर $\frac{4}{3}$ms^{-2} के त्वरण से गतिमान है। विराम अवस्था से तीसरे सेकण्ड में यह कितनी दूरी चलेगा?

(a) $\frac{10}{3}$m (b) $\frac{19}{3}$m
(c) 6m (d) 4m

AIPMT-2008

Ans. (a) : Given – Particle starts from rest $\Rightarrow$ u = 0

Acceleration $a = \frac{4}{3}m/s^2$

n = 3

Distance travelled by a particle in nth second

$S_{n^{th}} = u + \frac{1}{2}a(2n-1)$

$S_{3rd} = 0 + \frac{1}{2}\times\frac{4}{3}(2\times3-1)$

$= \frac{2}{3}(5)$

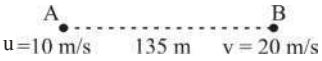
$= \frac{10}{3}$ m

52. A particle moves in a straight line with a constant acceleration. It changes its velocity from 10 ms^{-1} to 20 ms^{-1} while passing through a distance 135 m in t second. The value of t is –
एक कण अचर त्वरण के साथ एक सीधी रेखा पर चल रहा है। गति पथ में एक स्थान पर t सैकण्ड में 135 m मीटर दूरी चलने पर इसका वेग 10 ms^{-1} से 20 ms^{-1} हो जाता है। t का मान होगा :-

(a) 12 (b) 9
(c) 10 (d) 1.8

AIPMT-2008

Ans. (b) : Given–: Let acceleration = constant
Distance travelled s = 135m
Time = t second



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

$(20)^2 = (10)^2 + 2 \times 135 \times a$

$\Rightarrow a = \frac{300}{270} = \frac{10}{9} m/s^2$

Using first equation of motion

$v = u + at$

$20 = 10 + \frac{10}{9} \times t$

$\Rightarrow t = 10 \times \frac{9}{10} = 9$ second

$t = 9$ s

53. Two bodies, A(of mass 1kg) and B(of mass 3kg), are dropped from heights of 16 m and 25 m respectively. The ratio of the time taken by them to reach the ground is:-
दो पिण्डों A (द्रव्यमान 1 kg) और B (द्रव्यमान 3 kg) को क्रमानुसार ऊँचाईयों 16 m और 25 m से छोड़ा गया है। इनके पृथ्वी तल तक पहुँचने के क्रमागत समयों का अनुपात होगा:-

(a) $\frac{5}{4}$ (b) $\frac{12}{5}$
(c) $\frac{5}{12}$ (d) $\frac{4}{5}$

AIPMT-2006

Ans. (d) : Given :-
$m_A = 1$ kg $h_A = 16$ m
$m_B = 3$ kg $h_B = 25$ m
When body is dropped from height initial velocity u = 0

So, $h = ut + \frac{1}{2}gt^2$

$h = \frac{1}{2}gt^2$

$h_A = \frac{1}{2}gt_A^2$ ...(i)

$h_B = \frac{1}{2}gt_B^2$ ...(ii)

From eq^n (i) divided by question (ii).

$\frac{h_A}{h_B} = \frac{\frac{1}{2}gt_A^2}{\frac{1}{2}gt_B^2}$

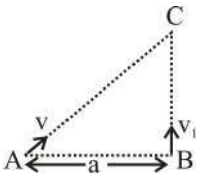
So, $\frac{t_1}{t_2} = \sqrt{\frac{h_1}{h_2}} = \sqrt{\frac{16}{25}} = \frac{4}{5}$

54. 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 in a time t, where t is –
दो लड़के एक मैदान के A और B सिरों पर खड़े है दूरी AB = a है। B पर खड़ा लड़का v_1 वेग से AB रेखा से लम्बवत् दिशा में भागना आरम्भ कर देता है। उसी क्षण बिन्दु A का लड़का वेग v से भागना आरम्भ करता है और वह दूसरे लड़के को समय t में पकड़ लेता है जब कि t होगा-

(a) $\frac{a}{\sqrt{v^2 + v_1^2}}$ (b) $\sqrt{\frac{a^2}{v^2 - v_1^2}}$
(c) $\frac{a}{(v - v_1)}$ (d) $\frac{a}{(v + v_1)}$

AIPMT-2005

Ans. (b) :



Let two boys meet at point C after time t from the starting. Then,
Distance, AC = vt
Distance, BC = $v_1 t$
AB = a

So, $(AC)^2 = (AB)^2 + (BC)^2$

$v^2t^2 = a^2 + v_1^2 t^2$

$t^2 (v^2 - v_1^2) = a^2$

$t^2 = \frac{a^2}{v^2 - v_1^2}$

$\Rightarrow t = \sqrt{\frac{a^2}{v^2 - v_1^2}}$

55. A ball is thrown vertically upward. It has a speed of 10m/sec when it has reached one half of its maximum height. How high does the ball rise? Take g = 10 m/s^2 –

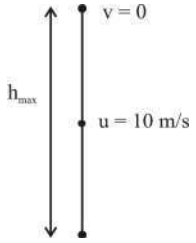
एक गेंद को ऊर्ध्ववत ऊपर फेंका गया है। जब यह अपनी अधिकतम पहुंच से आधी ऊँचाई से आधी ऊँचाई तक पहुँचता है तो इसकी गति 10 मीटर/ सैकण्ड होती है। गेंद कितनी ऊँचाई तक जा पायेगा? (माना लो g = 10 m/s^2)

(a) 5m (b) 15m

(c) 10m (d) 20m

AIPMT-2005, 2001

Ans. (c) :



Given, Initial Speed u = 10m/s.

Height = one half of its maximum height

Now,

From third equation of motion , $v^2 = u^2 - 2gh$

for half way, $h = h_{max}/2$

$$0 = u^2 - 2g(h_{max}/2)$$

$$h_{max} = \frac{u^2}{g} = \frac{10\times10}{10} = 10m$$

$\therefore$ Ball rise to 10 m.

56. If a ball is thrown vertically upwards with speed u, the distance covered during the last 't' seconds of its ascent is:

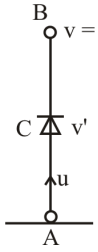
यदि एक गेंद को ऊर्ध्वाधर दिशा में ऊपर की ओर u चाल से फेंका जाता है, तब अधिकतम ऊँचाई पर पहुँचने से पहले अन्तिम 't' सेकण्डों में चली गई दूरी होगी:

(a) ut (b) $\frac{1}{2}gt^2$

(c) $ut - \frac{1}{2}gt^2$ (d) (u + gt)t

AIPMT-2003

Ans. (b):



Let the body take (T) second to reach maximum height.

$$v = u - gT$$
$$0 = u - gT$$
$$T = \frac{u}{g}$$

Velocity attained by the body in (T-t) sec. is-

$$v' = u - g(T - t)$$
$$v' = u - gT + gt$$
$$v' = u - g\times\frac{u}{g} + gt$$
$$v' = gt$$

Distance travelled in the last t second is-

$$CB = v't - \frac{1}{2}gt^2$$
$$= gt^2 - \frac{1}{2}gt^2$$
$$\boxed{CB = \frac{1}{2}gt^2}$$

57. A man throws ball with the same speed vertically upwards one after the other at an interval of 2 seconds. What should be the speed of the throw so that more than two balls are in the sky at any time ? (Given g = 9.8 m/s^2)

एक व्यक्ति, समान गति से ऊर्ध्व दिशा में ऊपर की ओर, 2 सेकण्ड के अन्तराल पर गेंदे फेंकता है। गेंद फेंकने की गति कितनी होनी चाहिए ताकि किसी भी समय आकाश में 2 से अधिक गेंदे हो : (दिया है g = 9.8 m/s^2)

(a) More than 19.6 m/s/19.6 m/s से उच्चतर

(b) At least 9.8 m/s /कम से कम 9.8 m/s

(c) Any speed less than 19.6 m/s/ कोई भी चाल 19.6 m/s से कम

(d) Only with speed 19.6 m/s/ केवल 19.6 m/s की गति

AIPMT-2003

Ans. (a): Given-

$$t = 2s$$
$$g = 9.8\ m/s^2$$

When the ball is thrown upward the final velocity become zero, v = 0

$$v = u - gt$$
$$0 = u - gt$$
$$u = gt$$

$$\Rightarrow \quad t = \frac{u}{g}$$

Since the ball first goes up then comes down so, total period be 2t and minimum period should more than 4 sec.

$$\Rightarrow t < \frac{2u}{g}$$

$\Rightarrow 4 < \frac{2u}{g}$

$\Rightarrow u > \frac{4\times 9.8}{2} \geq 19.6\ m/s$

So, the speed of throw should be more than 19.6 m/s, so more than two balls are in the sky at any time.

58. A mass of 1kg is thrown up with a velocity of 100 m/s. After 5 seconds, it explodes into two parts. One part of mass 400 g comes down with a velocity 25 m/s Calculate the velocity of other part :
1 kg द्रव्यमान के एक पिण्ड को 100 m/s के प्रारम्भिक वेग से ऊपर की ओर फेंका जाता है। 5s पश्चात यह विस्फोटित होकर दो भागों में विभाजित हो जाता है। यदि पहला भाग 400 gm का 25 m/s के वेग से नीचे की ओर गति करता है तो दूसरे भाग का वेग होगा –

(a) 40 m/s upward/ऊपर की ओर
(b) 40 m/s downward/नीचे की ओर
(c) 100 m/s upward/ऊपर की ओर
(d) 60 m/s downward/ऊपर की ओर

AIPMT-2000

Ans. (c) : Mass of 1 kg is thrown up with a velocity of 100 m/s.

$\because v = u + at$ where, v = final velocity
also, a = –g as particle is thrown up i.e. against the gravity — u = initial velocity, a = acceleration, t = time

$v = u + at$
$v = 100 - g\times 5$
$v = 100 - 10\times 5$
$v = 50$ m/s

Given Data-
$m_1 = 400\ g = 0.4kg$
$v_1 = -25$ m/s
$m_2 = 600g = 0.6kg$
$v_2 = ?$

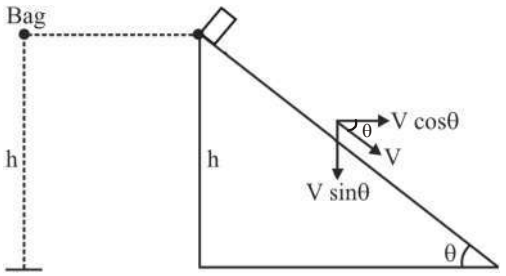
Now, From law of conservation of momentum,
$mv = m_1 v_1 + m_2 v_2$
$\Rightarrow 1\times 50 = 0.4\times(-25) + 0.6v_2$
$\Rightarrow v_2 = 100$ m/s
Hence, velocity of the part whose mass is 600g is 100 m/s.

59. A man is slipping on a frictionless inclined plane & a bag falls down from the same height. Then the speed of both is related as :
समान ऊँचाई से एक आदमी नत तल पर फिसलता है, तथा एक बैग समान ऊँचाई से उसी घर्षण रहित नत तल पर नीचे की ओर गिरता है तो नीचे उनके वेगों का अनुपात होगा –

(a) $V_B > V_m$
(b) $V_B < V_m$
(c) $V_B = V_m$
(d) V_B and V_m can't related
V_B, V_m के मध्य सम्बन्ध नहीं हो सकता

AIPMT-2000

Ans. (c) :



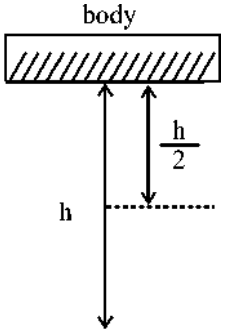
Given condition- A man is slipping on a frictionless inclined plane and a bag falls down from same height.
Now, from equation of motion-
For Bag,
$v_B^2 = u^2 + 2as$
$v_B^2 = 0 + 2(g)(h)$
$v_B^2 = 2gh$ ...(i)
Similarly for man
$v_m^2 = u^2 + 2as$
$v_m^2 = 0 + 2(g\sin\theta)\left(\frac{h}{\sin\theta}\right)$
$v_m^2 = 2gh$ ...(ii)
From (i) and (ii)
Velocity of Bag = Velocity of man

60. A body starts falling from height 'h' and travels distance h/2 during last second of motion then time of flight is (In second)/एक वस्तु h ऊँचाई से गिरना प्रारम्भ करती है तथा गति के अन्तिम सैकण्ड में h/2 दूरी तय करती है, तो वस्तु का उड्डयन काल क्या होगा (सैकण्ड में)-

(a) $\sqrt{2}-1$ (b) $2+\sqrt{2}$
(c) $\sqrt{2}+\sqrt{3}$ (d) $\sqrt{3}+2$

AIPMT-1999

Ans. (b) :



Initial velocity of body zero at height (h)
$\therefore h = ut + \frac{1}{2}gt^2$
Let total time of fall = T