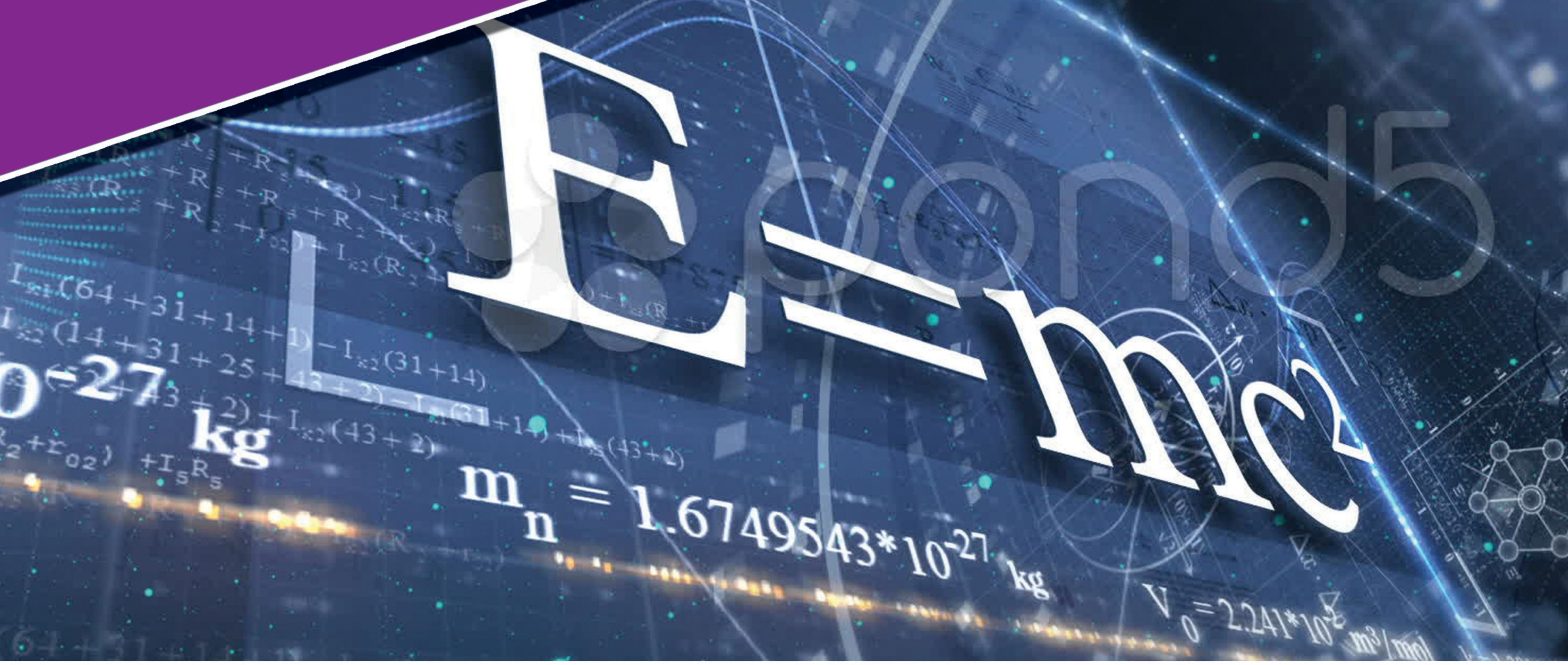
CLASS-XI



Work Book Cum Question Bank with Answers

PHYSICS

SCHEDULED CASTES & SCHEDULED TRIBES
RESEARCH & TRAINING INSTITUTE (SCSTRTI)
ST & SC DEVELOPMENT DEPARTMENT
BHUBANESWAR

WORK BOOK CUM QUESTION BANK WITH ANSWERS

PHYSICS

CLASS - XI

Compiled by :

Dr. (Mrs.) Manorama Bhuyan, M.Sc., Ph.D.
Retired Principal
Government Womens' College, Phulbani

SCHEDULED TRIBE & SCHEDULED CASTE DEVELOPMENT DEPARTMENT
GOVERNMENT OF ODISHA

Prepared by

SCHEDULED CASTES & SCHEDULED TRIBES RESEARCH AND TRAINING INSTITUTE
BHUBANESWAR – 751OO3

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PHYSICS SYLLABUS (1^{ST} YEAR)

Unit-I Physical world and Measurement (10 Periods)

Physics and its scope, Physics, Technology and Society. Measurement, need for measurement, units of measurement, fundamental and derived units, Sl Units, accuracy and precision of measuring instruments, errors in measurement, absolute, relative error, percentage of error, Combination of errors, significant figures.

Dimensions of Physical quantities. Dimensional analysis and its applications.

Unit-II Kinematics. (24 Periods)

1. Motion in a straight line :

Rest and motion, Frame of reference, motion in a Straight line, position - time graph, speed and velocity. Concepts of differentiation and integration for describing motion (elementary idea), uniform and non-uniform motion, average speed and instantaneous velocity, uniformly accelerated motion, velocity - time and position - time graph, Relation for uniformly accelerated motion (graphical treatment)

2. Motion in a plane :

Scalars and vectors, general vectors and their notations, position and displacement vectors, equality of vectors, unit vectors, multiplication of vectors by a real number, addition and subtraction of vectors, relative velocity, resolution of a vector in a plane, rectangular components, Dot and Cross products of two vectors.

Motion in a plane, cases of uniform velocity and uniform acceleration - projectile motion (equation of trajectory, range, time of flight, maximum height); uniform circular motion.

Unit-III Laws of Motion (14 Periods)

Concept of force, Newton's first law, inertia, momentum and Newton's 2nd law, impulse, impulse- momentum theorem, Newton's 3rd law, Law of Conservation of linear momentum and its application. Equilibrium of Concurrent forces, static and Kinetic friction, laws of friction, rolling friction, lubrication.

Dynamics of uniform circular motion, Centripetal force, motion of a vehicle on a level circular road and vehicle on a banked road.

Unit-IV Work, Energy and Power (12 Periods)

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 and non-conservative forces, conservation of mechanical energy (Kinetic and Potential energies), motion in a vertical circle, elastic and in-elastic collisions in one and two dimensions.

Unit-V Motion of System of Particles and Rigid bodies : (18 Periods)

System of Particles and Rotational Motion :

Centre of mass of a two-particle system, momentum conservation and centre of mass motion, centre of mass of rigid bodies, Centre of Mass of a uniform rod.

Moment of a force, torque, angular momentum, conservation of angular momentum with its applications.

Equilibrium of rigid bodies, equations of rotational motion, comparison of linear and rotational motions.

Moment of inertia, radius of gyration, moment of inertia of simple geometrical objects (no derivation). Parallel and perpendicular axes theorem and their applications.

Unit-VI Gravitation (12 Periods)

Newton's law of gravitation, Kepler's laws of planetary motion (only statements), Gravitational field and Potential, gravitational potential energy, acceleration due to gravity and its variation with altitude and depth, Escape velocity, orbital velocity of a satellite, Geostationary satellites.

Unit-VII Properties of Bulk Matter (24 Periods)

1. **Mechanical properties of Solids :**

   Elastic Behaviours, Stress, Strain, Hookes' Law, Stress-Strain diagram, Young's modulus, Bulk modulus, Shear modulus of rigidity, Poisson's ratio, elastic energy.

2. **Mechanical properties of fluids :**

   Pressure due to a fluid column, Pascal's law and its applications (hydraulic lift and hydraulic brakes) effect of gravity on fluid pressure.

   Surface energy and surface tension, angle of contact, excess pressure across a curved surface, application of surface tension ideas to drops, bubbles and capillary rise.

   Viscosity, Stoke's law, terminal velocity, streamline and turbulent flow, critical velocity, Bernoulli's theorem and its application.

3. **Thermal properties of matter :**

   Concepts of heat and temperature, Thermal expansion of solids, liquids and gases, anomalous expansion of water, specific heat capacity : Cp, Cv. Calorimetry, change of state, latent heat capacity.

   Heat transfer: Conduction, Convection and radiation, thermal conductivity, qualitative ideas of block body radiation, wien's displacement law, Stefan's law, Greenhouse effect.

Unit-VIII Thermodynamics (12 Periods)

Thermal equilibrium, definition of temperature (Zeroth law of thermodynamics) heat, work and internal energy. First law of thermodynamics, isothermal and adiabatic processes, second law of thermodynamics, reversible and irreversible processes, Carnot's engine and refrigerator, Efficiency of Carnot's engine (no derivation).

Unit-IX Kinetic theory of gases: (08 Periods)

Equation of state of a perfect gas, work done in compressing a gas.

Kinetic theory of gases- Postulates, concept of pressure, kinetic interpretation of temperature, mean and RMS speed of gas molecules, degrees of freedom, law of equipartition of energy (statement only) and its applications to specific heat of gases, concept of mean freepath and Avogadro's number.

Unit-X Oscillation and waves (26 Periods)

1. **Periodic motion:** Period, Frequency, displacement as a function of time, periodic function. Simple harmonic motion and its equation, phase, oscillation of a spring, Restoring force and force constant, kinetic and potential energy in SHM, simple pendulum, derivation of expression for its time period.

   Free, damped and forced oscillation (qualitative idea only), resonance.

2. **Waves:**

   Wave motion, transverse and longitudinal waves, speed of wave motion, displacement relation for a progressive wave, speed of longitudinal wave in an elastic medium and speed of transverse wave in a stretched string (qualitative idea only), principle of superposition of waves, reflection of waves, standing waves in strings and organ pipes, fundamental mode and harmonics, Beats, Doppler's effect.

QUESTION PATTERN OF CHSE

Theory : 70 marks
Practical : 30 marks
Total : 100 marks

Units	**Subjects**	**Marks**
Unit-I Unit-II Unit-III	Physical World and Measurement Kinematics Laws of Motion	23
Unit-IV Unit-V Unit-VI	Work, Energy and Power Motion of System of Particles and Rigid Body Gravitation	17
Unit-VII Unit-VIII Unit-IX	Properties of Bulk Matter Thermodynamics Kinetic theory of gases	20
Unit-X	Oscillation and Waves	10
TOTAL		**70**

Type of Question	**Mark per Question**	**Total No. of Question**	**Total Marks**
Very Short Answer	1	14	14
Short Answer - I	2	7	14
Short Answer - II	3	7	21
Long Answer	7	3	21
		TOTAL	**70**

Contents

Introduction to Units

Unit - I

Physical world and Measurement.

The world science is derived from latin word. “Scientia” Which means to know. Science is systematical and organised knowledge about various natural phenomena. Which is obtained by careful experimentation, keen observations and accurate reasoning.

[“ Science is a method for describing, creating and understanding human experience” by ‘R’. Bruce Lindsay] The word physics is derived from Greek word ‘fusis’ which means nature.

Thus physics deals with natural science. Thus physics is the branch of science that deals with the study of basic laws of nature and their manifestation in various natural phenomena.

Two basic features of physics are

(1) Unification $\rightarrow$ Attempt to explain various physical phenomena interms of few concepts and laws.

[“ Nature is pleased with simplicity and effects not the pump of superfluous causes” Issac Newton]

(2) Reductionism $\rightarrow$ To explain macroscopic system interms of microscopic constituents.

Scope of physics is very wide extended to all domain of life. Everything in nature is related to physics from giant objects to miniature. Technological advancement owe a great deal to developments in physics. Knowledge gives rise to technology.

Technology is used in benefit of societry. Necessity in society demands the evolution of technology and technology is helpful in progress of society. So both are in hand with each other. Physics deals with improvement of technology which in turn brings progress in society.

In total science particularly physics involves the following steps

* Systematic observation
* Controlled experiments
* Quantitative and qualitative reasoning
* Mathematical moduling
* Predictions
* verification of theory

[“ As knowledge increases, wonder deepens” Charles Morgan]

[“The scientist does not Study nature because it is useful, he studies it because he delights in it and he delights in it because it is beautiful. If nature were not beautiful, it would not be worth knowing, and if nature were not worth knowing, life would not be worth living” Henry Poincare]

Need for measurement :-

The nature of scintific investigations deals with devices for giving an accurate knowledge about nature and natural phenomena. Physics being an exact science gives an accurate knowledge about the nature and natural phenomena around us, So it is necessary to express the phenomena or events in terms of relationship among the parameters or quantities involved. Thus the exactness or accuracy depends upon the accuracy of measurement, techniques and instruments used.

[" When you can measure what you are speaking about and express it in numbers you know something about it. but when you cannot measure it and express it in numbers, your knowledge is of a meagre and unsatisfactory kind, but you have scarcely, in your thoughts, advanced to the stage of science what ever the matter may be"] Lord Kelvin

This chapter aims to explain.

* quantities which explains physical law.
* Standard amount of physical quantity choosen to measure physical quantity of same kind (units)
* Expressing derived physical quantities interms of fundamental or base quantities (dimensions)
* In exactness in measurement
* Knowledge of significant numbers in approximate number measurement.
* Distinguish between precission and accuracy and error calculation.
* Expression of measurement in scientific notations.

Unit - II
Kinematics

The unit deals with mechanics branch of physics which deals with rest or motion of the material objects around the observer. The rest or motion is the expression dealing with the relation of the position and time of an object with respect to some reference. The kinematics is the branch which deals with the study of motion of objects without considering the cause of motion.

* Rest and motion.
* Whether they are reference dependent.
* Absolute and relative state.
* Motion classified in different dimensions.
* Concept of point object

Chapter-I

Motion in one dimension :-

* Change of one coordinate of object with elapse of time.
* Mathematical tools to study.
* Definitions of quantities which describe the motion.
* Position ~ time.
* Variation of position with time.
* Instantaneous and average values (distance, velocity, acceleration)
* Graphical and analytical study of parameters.

Chapter -II

Motion in a plane.

The chapter describes.

* Two dimensional motion
* Necssity for two coordinates to specify the position of particle.
* Introduction of concept of vectors which can take care of the magnitude and direction of motion.

* Derivation of expressions for displacement, velocity, accelartion and relative velocity.
* Description of the motion of a body which is projected to space from ground or at a height moving under the force of gravity.
* Uniform circular motion in a particular plane.

Unit - III

Chapter - I **Laws of motion**

The chapter deals with

* Cause of motion or cause in the change of motion or the factors which affects the motion.

Thus enables to,

* Apply Newton's law of motion.
* Problem solving, using conditions for equilibrium of forces.
* apply the laws of conservation of linear momentum.
* Study the dynamics of circular motion
* have idea of impulse.

Unit - IV

Chapter **Work energy power.**

The knowledge of motion and cause of motion leads to idea of expenditure of energy to execute motion.

Thus the chapter has the following objectives.

After studying through the chapter student should be able to

* Apply work energy theorem
* distinguish between conservative and non conservative forces.
* Solve problems on principle of energy conservation and work energy theorem.
* Interpret energy diagram.
* differentiate between elastic and inelastic collisions.
* Solsve problems on elastic and inelastic collisions.
* Computer power in mechanical systems.

Unit - V

Motion in system of particles and rigid bodies :-

System of particles :-

Till this unit students have studied only the kinematics or dynamics of single particle. or point particle. Newton's laws are valid for point particles.

This unit extends the concepts to describe the bodies which are congregation of infinite point particles .

This chapter deals with kinematics and dynamics of extended objects.

Motion of extended objects may be of two types.

(a) Motion without change in orientation. Where all constituent particles are having identical motion.

(b) Motion of extended body with change of orientation where constituent particles donot have identical motion.

Thus, particle model to describe the motion of an extended object is not sufficient.

So the chapter deals with idea of

* Particles and system of particles.
* internal forces between the particles inside the extended object and external forces applied from out side or by external agency.
* How Newton's law of motion which is applicable to single particle can also describe the motion of extended objects.
* Centre of mass point whose motion represents the motion of extended object.
* Definition of centre of mass :-

  Single point which moves in the same way in which a single particle having the total mass of the system and acted upon by the same external force will move.
* Definition of a rigid body.
* Finding the expression for coordinates of centre of mass for two particle system.

After studying this chapter students should be able to

* define the centre of mass of two body system and rigid body along with relative coordinates and reduced mass.
* Compute the motion of CM applying momentum conservation principle.
* solve some problems regarding two body system and centre of masses.
* derive expression for CM of specific type of rigid bodies like uniform rod.

Chapter II

Kinematics and Dynamics of rotational motion :-

In this chapter

* When a rigid body in motion changes its orientation or it goes as rotatory motion the nagular motion of rigid body is studied interms of the angular motion of a point on it.
* To study the angular motion of a point, related concepts of angular displacement, velocity acceleration to be developed.
* The dynamics of angular motion leads to conception of torque and angular momentum and their relation.
* Development of equation of rotational motion connecting angular displacement, velocity and acceleration as that in linear motion.
* Concept of equilibrium of a rigid body.
* Absence of rot ational motion and absence of translational motion, which is consequence of absence of force and torque both.

Chapter - III

Equivalence of rotational motion and linear motion leads to concept of moment of inertia which plays equivalent role of mass.

* Definition of moment of inertial and knowledge of M.I of some simple geometrical objects and some theorems use to calculate moment of inertia of object around different axes.

Unit - VI

Gravitation

Material objects have important characteristic, that is their mass.

These objects experience a fundamentals force as they posses mass.

That is the amazing gravitational force which controlls motion of falling bodies, flowing of rivers, Motion of satellites and planets, formation of stars and characteristics of universe.

Objective of this unit is to

* Know the laws of gravitation formulated by Newton.
* Infer that the law is universally true.
* Have idea of Kepler's laws which describe the planetary motion.
* Compute gravitational intensity and potential.
* derive expression for gravitational field and potential due to different type of bodies.
* establish relation between acceleration due to gravity and gravitational constant of a particular planet.
* Study the variation of acceleration due to gravity.
* To know about escape velocity which makes a body to fly away from a planet.
* Calculation of orbital velocity of a sattellite to rotate around a planet.
* definition of geo stationary satellite.
* Solve problems.

Unit - VII

Properties of Bulk matter.

Chapter - I Mechanical properties of solids :

Previous chapters dealt with the motion of the rigid body on application of external force. The present chapter deals with the change in shape and size of rigid bodies when external forces and torques act on it. Thus bodies are classified according to their behaviour under action of similar forces. This diverse behaviour of matter is result of their different molecular composition and different inter molecular force.

After going through this chapter a student shuld be able to know.

* Inter atomic or inter molecular force which depends on nature of molecule and inter molecular distance. Which is a short range force.
* Arrangement of molecules which leads to the system to have minimum potential energy to attend stable equilibrium.
* The property of material to resist the deformation and regain original shape and size, on removal of the deforming force.
* how the type and magnitude of deformation depends on the deforming force.
* idea of plasticity and elasticity, quantitative measures of the deforming force and deformation in terms of stress, strain.
* Types of stress, strain how they are related as per Hooke's law.
* Proportionality constants of stress and strain.
* Key words like Young's modulus, Bulk modulus shear modulus, poisson's ratio.
* Elastic energy.

Chapter II

Mechanical properties of fluid Gases and liquids have the ability to flow and hence are called fluids in contrary to solids. Solids have definite shape and size. Liquids have definite volume but takes the shape of the container. Gases donot have definite volume or shape. Inter molecular force is maximum in solids smaller in liquids and minimum in gases. Liquids are incompressible where gases are compressible. Fluid does not sustain shear stress as their layers slide past one another on shear stressing. Fluid motion is not described by molecule rather by small vol ume of fluid. Which is known as fluid particle. If the centre of mass of fluid particle is at rest then fluid is at rest other wise in motion.

Thus this chapter deals with

* Force / Thrust exerted by liquid on the surface in contact with it in perpendicular direction to the surface.
* Pressure which is force per unit area normal to the surface.
* Pascal's law which explains how pressure is transmitted in a fluid and its applications.
* Calculation of expression for pressure exerted by a liquid comlumn and variation of liquid pressure with depth.
* Surface tension property of liquid for which the upper surface of liquid behaves like a stretched membrane, idea of cohesive and adhesive forces
* Terms like surface energy, angle of contact
* Pressure difference across a curved liquid surface.
* Applications of surface tension.
* idea of fluid friction.

  i.e., resistance to relative motion between two adjacent layers of fluid.
* Key words like coefficient of viscocity which gives quantitative idea about fluid friction.
* The influece of fluid resistance in the flow of liquid through tubes.
* Stokes law which explains motion of an object in viscous medium.
* Applications
* Key words terminal velocity.

  Reynold's number.
* Bernoulli's theorem.

Chapter- III

Thermal property of matter.

Energy has reigned all facets of human activity. Heat is one manifestation of energy.

This chapter deals with heat energy and how matter is related to heat energy. Heat energy is form of energy which produces sensation of hotness or coldness and it is the internal energy of molecules.

This chapter deals with

*. Concept of heat and temperature and how they are related.

* When internal energy increases how it affects the molecules inside a solid, liquid and gas.

* How the molecular motion is affected and thus leading to expansion.

* Key words $\rightarrow$ coefficient of thermal expansion and idea of anomalous expansion.

* Specific heat i.e qualitative idea relating heat and temperature of a substance.

* Key words $\rightarrow$ C_P, C_V, thermal capacity. Heat energy required to change a substance from solid to liquid and liquid to gas by affecting the molecular motion.

* Transision of states

* Key words $\rightarrow$ Latent heat.

* Flow of heat to maintain thermal equilibrium.

* Mechanism of heat transfer which needs material medium i.e. conduction and convection.

* Mechanism of heat transfer with out medium is radiation.

* Newton's law of cooling.

* Key words thermal conductivity

* Black body radiation and its graphical representation.

* Wein's displacement law relation between wave length and temperature for maximum radiation.

* Stefan's law (idea of dependence of heat radiation and temperature difference of the radiating body and environment)

* Green house effect.

Unit - VIII

Thermodynamics.

The study of relationship between mechanical and thermal energy is known as thermodynamics. The study of thermodynamics is based on four empirical laws which are derived from experience and they need no proof.

This chapter deals with

* Thermodynamic equilibrium of system having thermal, mechanical and chemical equilibrium.

* Idea of zeroth law of thermodynamics which leads to definition of Temperature.

* All bodies in thermal equilibrium have a common property which is attributed as Temperature.

* Manifestation of heat as internal energy.

* Relation between heat supplied to system, change in internal energy and work done by the system. that is first law of thermodynamics.

* Which also states the conservation of energy.
* Thermodynamic process is associated with the variation of thermodynamic variables of system when system is under going from one equilibrium state to another. i.e. from initial to final state.
* Classification of thermodynamical process as Reversible and Irreversible.
* Isothermal and adiabatic process and equations of state.
* Second law of thermodynamics which gives the idea that cooling is a unidirectional natural process. This law specifies the process consistent with first law of thermodynamics regarding the conservation of energy.
* Claussius statement and kelvin-planck statement
* Idea of carnot engine and refrigerator.

Unit - IX

Kinetic theory of gases.

Thermodynamics is essentially an empirical science. This deals with study of thermic properties without any reference to the nature of substance. Substances are different due to difference in their molecules and the state of substance is determined by the interplay of thermal energy and intermolecular force. When this molecular theory is supplimented by the laws of mechanics for individual molecule it leads to kinetc theory.

Thus this unit deals with

* Assumption of kinetic theory of gases.
* derivation of expressions for macroscopic quantities like pressure, temperature in terms of microscopic properties of constituent molecules.
* Mean and Root mean Square velocities (Mechanical property) in terms of temperature (thermal property.
* degrees of freedom
* equipartition of energy and specific heat.
* Study of transport phenomena of molecules.
* Molecules move randomly, as they have finite size so that leads to collision.
* Concept of mean free path which is average distance travelled by molecule between two succesive collision.
* Deterimination of Avogadro's number.

Unit - X

Oscillation and waves

Chapter - Oscillation :-

In the previous chapters in motion student has gone through motion in different dimension (linear, rotatory) and causes of motion. In the present chapter students will be knowing about periodic, aperiodic, oscillatory and non oscillatory motions.

After studying this chaper students should be able to

* differentiate between periodic, aperiodic and oscilatory, non oscillatory motion.
* State the basic criteria of specific oscillatory motion called simple harmonic motion.
* establish the differential equation for SHO and expressions for displacement, velocity and acceleration.
* define the amplitude, phase, frequency for the simple harmonic oscillator.
* Compute the potential and kinetic energy of SHO.
* Study different type of simple harmonic oscillators.
  (a) spring oscillation with time period calculation.
  (b) simple pendulum
  (c) some day to day oscillators.
* qualitative idea about free damped, forced oscillation.
  (a) free oscillation under action of restoring force (Amplitude unchanged)
  (b) damped oscillation under action of restoring as well as some resisting force (Amplitude decreases)
  (c) forced vibration under action of restoring, resisting and external applied periodic force.
  (d) When the frequency of free vibration matches with that of the external applied periodic force the amplitude is maximum and phenomenon is resonance.

Chapter - II Waves

In the previous chapter a student studies the characteristic of isolated oscillator. But in a medium there may be coupled oscillators as atomic oscillators inside a body. Coupling leads to energy exchange from point to point. Large number of coupled oscillators give rise to wave motion. Thus the wave motion is that which deals with transfer of energy or disturbance from point to point due to repeated vibration of particles around their mean position without permanent shifting of particles from their positions.

Thus this chapter gives

* basic concepts of wave motion

  Type of waves, propagation of waves, their graphical representation relation between phase velocity, wavelength, frequency and time period
* Energy transported
* Wave velocity in longitudinal and transverse wave
* reflection of waves and supuposition of waves giving rise to standing waves and beats.
* application of standing waves.
* Doppler effect

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Important formula to be remember

Unit - I

Formula of error calculation

If $z = A \pm B \quad \Delta z = \pm \Delta A \pm \Delta B$

$$z = AB \qquad \frac{\Delta z}{z} = \left(\frac{\Delta A}{A} + \frac{\Delta B}{B}\right)$$

$$z = \frac{A}{B} \qquad \frac{\Delta z}{z} = \pm\left(\frac{\Delta A}{A} + \frac{\Delta B}{B}\right)$$

$$z = A^n$$

$$\frac{\Delta z}{z} = \pm \frac{n \, \Delta A}{A}$$

Formula used for conversion of one system of units to other.

$$n_2 = \frac{n_1 u_1}{u_2}$$

$n_1 \rightarrow$ number for system u_1

$n_2 \rightarrow$ number for system u_2

Unit - II

Chapter -I $\vec{u} = \vec{u} + \vec{a}t$

$$\vec{x} = \vec{x}_0 + \vec{u}t + \frac{1}{2}\vec{a}t^2$$

$$v^2 = u^2 + 2\vec{a}.\left(\vec{x} - \vec{x}_0\right)$$

$$\vec{S}_{nth} = \vec{u} + \frac{\vec{a}}{2}(2n - 1)$$

Chapter - II $\vec{A} = \hat{i}A_x + \hat{j}A_y + \hat{k}A_z \quad = \quad \hat{i}A_x + \hat{j}A_y + \hat{k}A_z$

$$\hat{A} = \frac{\vec{A}}{|\vec{A}|} = \frac{\hat{i}A_x + \hat{j}A_y + \hat{k}A_z}{\left[A_x^2 + A_y^2 + A_z^2\right]^{1/2}}$$

$$\vec{A}.\vec{B} = AB\cos\theta$$

$$\hat{i}.\hat{i} = \hat{j}.\hat{j} = \hat{k}.\hat{k} = 1$$

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

$$\vec{A} \times \vec{B} = \vec{C} \qquad |\vec{C}| = AB\sin\theta$$

For projectile

$$V_y = u_y + a_y t$$

$$R = u_x\sqrt{\frac{2h}{g}} \quad = \quad T = \frac{2h}{g}$$

Unit - III

$$\vec{F} = m\vec{a} = \frac{d\vec{p}}{dt}$$

Impulse = change in momentum = Ft

= Force × time

Coefficient of friction $\mu = \frac{F_{friction}}{\text{Normal Reaction}}$

$$\mu = \frac{ma}{mg} = \frac{a}{g}$$

$\mu = \text{Tan}\,\theta$ θ is angle of friction

For motion of connected bodies of masses M_1, M_2

$$a = \frac{M_1 - M_2}{M_1 + M_2} g$$

$$T = \frac{2\,M_1\,M_2}{M_1 + M_2} \times g$$

Formula used for banking of tracks

$$V\max \leq \sqrt{\mu g R}$$

$$\text{Tan}\,\theta = \frac{v_0^2}{R g}$$

$$V\max = V_0 \left(\frac{(1 + \mu \cot\theta)}{1 - \mu\,\text{Tan}\,\theta} \right)^{1/2}$$

Unit - IV

$$\vec{F}.\vec{S} = \text{work} = \frac{1}{2} MV^2 - \frac{1}{2} M\,U^2$$

$$K.E. = \frac{1}{2}\,mV^2 = \frac{P^2}{2m}$$

Work by gravitational force Mg h

Work by spring $\frac{1}{2}\,k\,x^2$

Vertical circle (Looping of loops)

$$\sqrt{2 g \ell} < V_0 < \sqrt{5 g \ell}$$

Unit - V

Torque = $\vec{r} \times \vec{F} = I \propto$

$I = \sum_i M_i\, r_i^2$ = Moment of inertia, radial acceleration = $\omega^2 r$

Tangential acceleration = $r \propto$

$$I = I_C + Md^2$$

$I_2 = I_x + I_y$
$L = Iw - m v r$

Angular impulse $= I(\omega_1 - \omega_2)$

Unit - VI

$F = \frac{G\ m_1\ m_2}{r^2}$, $F_{gravity} = mg$ $\quad g = \frac{G\ M_E}{R^2}$

$T^2 \propto a^3$

$g^1 = g_0\left(1 - \frac{2h}{R}\right)$ h – height above earth.

$g^1 = g_0\left(1 - \frac{h}{R}\right)$ h depth.

$V_{escape} = \sqrt{\frac{2\ G\ M_E}{Re}} = \sqrt{2\ gR}$

$V_0 = V_{orbital} = \sqrt{\frac{G M}{R + h}}$ $\quad h << R \quad V_o = \sqrt{gR}$

Time period of revolution of a

Satellite $= 2\pi \sqrt{\frac{(R+h)^3}{G M}}$

Unit - VII

Stress $= F / A$

Strain $= \frac{\Delta e}{\ell}$ or $\frac{\Delta v}{v}$ or $\frac{\Delta x}{x}$

Modulus $= \frac{\text{Stress}}{\text{Strain}}$

$Y = \frac{FL}{A \Delta L}$ $\quad B = \frac{F}{A}\frac{V}{\Delta V}$

$\eta = \frac{F}{x^2}\frac{x}{\Delta x}$ $\quad \sigma = \frac{\Delta R}{R} \Big/ \frac{\Delta L}{L}$

Elastic P.E $= \frac{1}{2}$ Stress $\times$ Strain $\times$ Volume

Buoyant force = Weight of liquid displaced, loss of weight in liquid = weight of liquid displaced.

eqation of continuity

$a_1 v_1 = a_2 v_2$

$\frac{p}{\rho} + gh + \frac{1}{2}v^2$ = constant, Bernoulli's theory, velocity of effelux $= \sqrt{2\,gh}$

Viscosity $Q = \frac{p\,\pi\,r^4}{8\eta\ell}$

$F = 6\pi\ \eta r v$

$$V_{terminal} = \frac{2}{9}\frac{r^2\left(\rho-\rho^1\right)g}{\eta}$$

Surface tension $S = F/L$

Surface energy $=$ $S \times$ increase in area numerically.

Capillary rise $h = \dfrac{2S\cos\theta}{r\rho\, g}$

Excess pressure $\dfrac{2S}{R}$ for liquid drop

Excess pressure $\dfrac{4S}{R}$ for soap bubble

Thermal property :- $\alpha = \dfrac{\Delta L}{L\,\Delta t}$ $\beta = \dfrac{\Delta A}{A\,\Delta t}$ $\gamma = \dfrac{\Delta v}{V\,\Delta t}$

Coefficient of expansions. $\alpha,\ \beta,\ \gamma$ are related

$\beta = 2\alpha$ $\gamma = 3\alpha$

$\Delta\theta = m\,s\,\Delta T =$ mass $\times$ sp heat $\times$ Temperature

$Q = M\,L$ (L, Latent heat)

$Q = -KA\dfrac{dT}{dx}$

$Q = \sigma A\,T^4$ – Stefan Boltzman law

Unit - VIII

Thermodynamics

$\Delta\theta = \Delta U + \Delta W$

$= \Delta U + Pdv$ – 1st law

Specific heat $= \dfrac{1}{mass}\dfrac{\Delta Q}{\Delta T}$

Isothermal $\Delta T = 0$ $PV =$ constant

Adiabatic $\Delta Q = 0$ $PV^r =$ constant

$C_P - C_V = R$ $\dfrac{C_P}{C_V} = \gamma$

Carnot engine efficiency $\eta = 1 - \dfrac{T_2}{T_1} = \dfrac{W}{Q}$.

Coefficient of performance for refrigerator $\beta = \dfrac{T_2}{T_1 - T_2}$

Unit - IX

Kinetic theory of gases.

Pressusre $P = \dfrac{1}{3}\dfrac{M}{V}V_{rms}^2$

$$\bar{V}_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\text{K.E for a molecule} = \frac{3}{2}RT$$

$$V_{rms} \propto \sqrt{T}$$

$$V_{rms} \propto \frac{1}{\sqrt{M}}$$

$$\text{Average speed} = \sqrt{\frac{8K_BT}{m\pi}}$$

For triatomic molecule (linear gas)

$$C_V = \frac{7}{2}R$$

$$C_P = \frac{9}{2}R \qquad \gamma = 1.28$$

for a triatomic (non linear gas)

$C_V = 3R \quad C_P = 4\,R$

$\gamma = 1.33$

Unit - X
Oscillations

$$\vec{F} = -k\vec{y}$$

$$Y = A\sin(\omega t + \theta) = \text{displacement}$$

$$\text{Velocity} = A\omega\cos(\omega t + \theta)$$

$$V = \pm\ \omega[A^2 - y^2]^{1/2} \qquad V_{max} = A\,\omega$$

$$\text{Potential energy} = \frac{1}{2}kx^2$$

$$\text{Kinetic energy}\ \frac{1}{2}K\left(A^2 - Y^2\right)$$

$$\text{Total energy} = \frac{1}{2}KA^2$$

Maximum acceleration = $\omega^2 A$

$A \rightarrow$ Amplitude

$$\text{Time period}\ T = \frac{2\pi}{\omega} = \frac{1}{f}$$

$$T = 2\pi\sqrt{\frac{m}{K}}$$

$$\text{For pendulum} \quad T = 2\pi\sqrt{\frac{e}{g}}$$

$$\text{Spring constant} \quad K = \frac{|\vec{F}|}{y}$$

Spring in series combination

$$\frac{1}{K} = \frac{1}{K_1} + \frac{1}{K_2} + \frac{1}{K_3} + ...$$

For parallel combination

$$K = K_1 + K_2 + K_3 + ...$$

Waves

$$\lambda = \frac{v}{f} = \frac{\text{velocity}}{\text{frequency}} = \text{wavelength}$$

Speed of transverse wave in the string $= \sqrt{\frac{T}{\mu}}$

$T \rightarrow$ tension $\quad \mu \rightarrow$ mass per unit length

A wave travelling along +ve direction

Wave equation $= A\sin\left(\frac{2\pi}{\lambda}x - \frac{2\pi t}{T}\right) = y = g(x - vt) = A\sin\frac{2\pi}{\lambda}(x - vt)$

Newton's formula for velocity of sound $= v = \sqrt{\frac{B_{\text{isothermal}}}{\rho}} = \sqrt{\frac{P}{\rho}}$

Laplace's correction $V = \sqrt{\frac{\gamma P}{\rho}} \quad \gamma = \frac{C_P}{C_V}$

$$\frac{V_2}{V_1} = \sqrt{\frac{\rho_1}{\rho_2}} \quad \text{or} \quad \frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}}$$

Wave equation for stationary wave

$$y = 2A \sin\frac{2\pi}{\lambda}x \cos\frac{2\pi}{\lambda}vt$$

For sonometer $f = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}}$

Open organ pipe

Fundamental frequency $f_1 = \frac{v}{2\ell}$

nth one $f_n = \frac{nv}{2\ell}$. $\quad n = 1, 2, 3......$

Closed organ pipe

fundamental $v_1 = \frac{v}{4L}$

3rd harmonic 1st overtone

$$v_2 = 3v_1$$

$v_3 = 5v_1 \quad \rightarrow \quad$ 2nd overtone

Beat frequency = difference of frequencies of two waves.

◆◆◆

Group - A

Choose the correct option -

Unit - I

1. Which of the following pairs does not have similar dimensions ?
   (a) Stress and pressure (b) Angle and strain
   (c) Tension and surface tension
   (d) Plank's constant and angular momentum

2. If the energy E velocity V and force (F) be taken as fundamental quantity then the dimensional formula for mass will be
   (a) $F V^{-2}$ (b) $F V^{-1}$ (c) $E V^{-2}$ (d) EV^{2}

3. Dimensions of plank's constant are same as that of
   (a) energy (b) momentum
   (c) angular momentum (d) power

4. The density of a material in the shape of a cube is determined by measuring three sides of the cube and its mass. If the relative error in measuring the mass and the length are 1.5% and 1% respectively the maximum errors in determining the density is
   (a) 2.5 % (b) 4.5 % (c) 6 % (d) 1.5 %

5. If the unit of force 1 kelo newton the length is 1 km and time 100 S then the unit of mass
   (a) 10000 kg (b) 1000 kg (c) 10 kg (d) 1 kg

6. The leasr count of the stop watch is 0.5sec. The time of 40 oscillations is found to be 40 sec So the percentage of errors is
   (a) 0.5% (b) 0.25% (c) 0.75% (d) 1.25%

7. Parsec is unit of
   (a) time (b) distance (c) Force (d) Frequency

8. Which of the following quantity has dimension $[M L^{2} T^{-3}]$
   (a) Power (b) Work (c) Pressure (d) impulse

9. Plank's constant h, speed of light C and universal gravitational constant G are three fundamental constants. Which of the following combination will give the dimension of length.
   (a) $\sqrt{\frac{hC}{G}}$ (b) $\sqrt{\frac{GC}{h^{3/2}}}$ (c) $\frac{\sqrt{hG}}{C^{3/2}}$ (d) $\sqrt{\frac{hG}{C^{5/2}}}$

10. How many centimeters are in one Fermi
    (a) 10^{-8} (b) 10^{-13} (c) 9.5×10^{17} (d) 10^{-6}

Unit - II

11. The linear velocity perpendicular to radius vector of a particle moving with angular velocity $\vec{w} = 2\vec{k}$ at position vector
    $\vec{r} = 2\hat{i} + 2\hat{j}$ is
    (a) 4 (i – j) (b) $4(\hat{j}-\hat{i})$ (c) $4\hat{i}$ (d) $-4\hat{i}$

12. In a straight line motion the distance travelled is proportional to $t^{3/2}$ where t stands for time of travel then acceleration will be proportional to

(a) V^2 (b) $\frac{1}{V^2}$ (c) $V^{-1/2}$ (d) V^{-1}

13. A wheel f radius R rolls on the ground with a uniform velocity V the relative acceleration of topmost point of the wheel to the bottom most point is

(a) $\frac{V^2}{R}$ (b) $\frac{2V^2}{R}$ (c) $\frac{V^2}{2R}$ (d) $\frac{4V^2}{R}$

14. Four holes of radius R are cut from a thin square plate in XY plane of side 4R and Mass M. The moment of inertia of remaining portion about Z axis at the origin

(a) $\frac{\pi}{12}MR^2$ (b) $\left(\frac{4}{3}-\frac{\pi}{4}\right)MR^2$

(c) $\left(\frac{8}{3}-\frac{10\pi}{16}\right)MR^2$ (d) $\left(\frac{4}{3}-\frac{\pi}{6}\right)MR^2$

15. A particle moves in a circular path with decreasing speed choose the correct statement.
(a) angular momentum remains constant
(b) Acceleration is towards the centre
(c) particle moves in a spiral path with decreasing radius
(d) The direction of angular momentum remains constant.

16. A child is standing with folded hands at the centre of a platform rotating about the central axis with kinetic energy K. The child now stretches his arms and moment of inertia doubles then the K.E of system is

(a) 2 K (b) $K/2$ (c) $K/4$ (d) 4 K

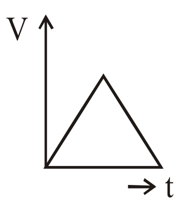
17. A particles covers half of the distance with speed V_1 and rest half distance with V_2. Its average speed in covering the distance is

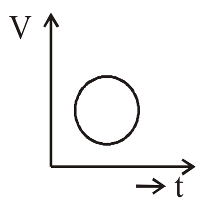
(a) $\frac{V_1^2 V_2^2}{V_1^2 + V_2^2}$ (b) $\frac{V_1 + V_2}{2}$ (c) $\frac{V_1 V_2}{V_1 + V_2}$ (d) $\frac{2 V_1 V_2}{V_1 + V_2}$

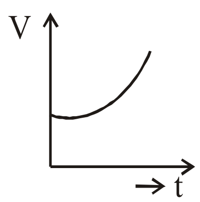
18. A particle moves along a straight line where $X = 40 + 12t - t^3$. How long the particle will move before coming to rest
(a) 56 m (b) 24 m (c) 16 m (d) 40 m

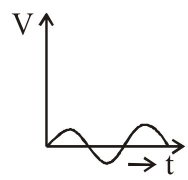
19. What will be the ratio of distances moved by a freely falling body from rest in 4th and 5th seconds of journey.
(a) 4 : 5 (b) 7 : 9 (c) 16 : 25 (d) 1 : 1

20. Which of the following curves does not represent motion in one dimension.

(a) 

(b) 

(c) 

(d) 

21. A car moving with a speed of 40 km/h can be stopped by applying brakes after at least 2 m. If the same car is moving with velocity of 80 km/h what is the minimum stopping distance

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

22. The X and Y coordinates of the particle at any time are $X = 5t - 2t^2$ $Y = 10t$, respectively. The acceleration of particle at t = 2 sec is

(a) 0 (b) $5 m/sec^2$ (c) $- 4 m / sec^2$ (d) $-8 m/sec^2$

Unit - VI

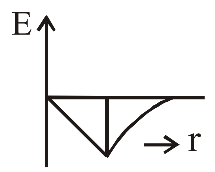
23. Two spheres of masses M_1 and M_2 are in air and gavitational force between them is $\vec{F}$. If they are kept in a liquid medium of relative density ρ_r. What will be the gravitational interaction

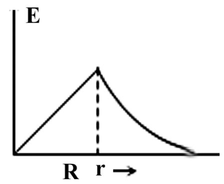
(a) $\rho_r F$ (b) $\frac{F}{\rho_r}$ (c) $F \rho_r^2$ (d) F

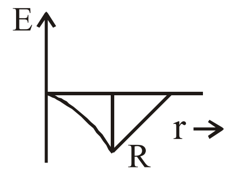
24. What will be the formula of mass of earth in terms of g, G, R (Radius of earth)

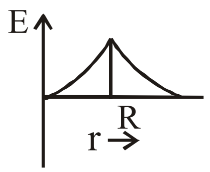
(a) $G\frac{R}{g}$ (b) $\frac{g R^2}{G}$ (c) $g^2 R/G$ (d) $G\frac{g}{R}$

25. Dependence of intensity of gravitational field E of earth with distance r from the centre of earth is correctly represented by

(a)


(b)


(c)


(d)


26. A geo stationary satellite is orbiting the earth at a height of 5R above the surface of earth. R is radius of earth. The time period of another satellite in hours at a height of 2 R from the surface of earth is

(a) 5 (b) 10 (c) $6\sqrt{2}$ (d) $\frac{6}{\sqrt{2}}$

27. For a satellite moving in an orbit around the earth in a circular orbit then ratio of kinetic energy to potential energy is

(a) $\frac{1}{2}$ (b) $\frac{1}{\sqrt{2}}$ (c) 2 (d) $\sqrt{2}$

Unit - VII

28. A wire alongates by ℓ mm when a load W is hanged from it. If the wire goes on a pulley and two weights W hung from each end the elongation of the wire will be

(a) $\ell/2$ (b) ℓ (c) 2ℓ (d) 0

29. It S is stress and Y is Young's modulos of wire the energy stored in the wire per unit volume is

(a) $\frac{2Y}{S}$ (b) $\frac{S}{2Y}$ (c) $2S^2Y$ (d) $\frac{S^2}{2Y}$

30. A pendulum made of a uniform wire of cross sectional area A and time period T. If mass M is added to the bob the time period is T_m then.

Y = Young's modulus is

(a) $\left[\left[\left(\frac{Tm}{T}\right)^2 - 1\right]\frac{A}{Mg}\right]^{-1}$ (b) $\left[\left[\left(\frac{Tm}{T}\right)^2 - 1\right]\frac{Mg}{A}\right]^{-1}$

(c) $\left[\left[1 - \left(\frac{Tm}{T}\right)^2\right]\frac{A}{mg}\right]^{-1}$ (d) $\left[\left[1 - \left(\frac{T}{Tm}\right)^2\right]\frac{A}{mg}\right]^{-1}$

31. In old age arteries in the human body becomes narrow resulting in increase of blood pressure. This follows from

(a) Pascal's law (b) Stoke's law

(c) Bernoulli's principle (d) Archemedis principle

32. Two spherical soap bubbles of radii a and b in vaccuum coalasce under isothermal condition then the resulting bubble has a radius given by.

(a) $\frac{a+b}{2}$ (b) $\frac{ab}{a+b}$ (c) $\sqrt{a^2+b^2}$ (d) a + b

33. A sphere of solid material of relative density ρ has a concentric spherical caviry and just sinks in water If R - Radius of sphere r radius of cavity then

(a) $r^3 = \frac{8}{9}R^3$ (b) $r^3 = \frac{2}{3}R^3$ (c) $r^3 = \frac{\sqrt{8}}{3}R^3$ (d) $r^3 = \sqrt{\frac{2}{3}}R^3$

34. Force constant of spring is anonymous to

(a) $\frac{YA}{L}$ (b) $\frac{YL}{A}$ (c) $\frac{AL}{Y}$ (d) ALY

35. Two wires A and B have same length and same area of cross section. But Young's Modulus of A is twice that of B then the ratio of force constant of A to that of B is

(a) 1 (b) 2 (c) $\frac{1}{2}$ (d) $\sqrt{2}$

36. One end of horizontal thick copper wire of length 2L and radius 2R is welded to an end of an other thin copper wire of length L and radius R. When the arrangement is stretehed by applying forces at two ends, the ratio of the alongation in thin wire to thick wire is

(a) 0.25 (b) 1 (c) 4 (d) 2

37. Which of the following is not the unit of surface tension

(a) N/m (b) Joule / M^2 (c) kg / sec^2 (d) dyne / CM

38. When a rubber band is stretched by distance x the restoring force $F = ax + bx^2$ (a, b are constants). Thus the work done in stretching the band by L is

(a) $aL^2 + bL^3$ (b) $\frac{1}{2}\left(aL^2 + bL^3\right)$ (c) $\frac{aL^2}{2} + \frac{bL^3}{3}$ (d) $aL + bL^2$

39. The potential energy of 1 kg particle free to move along the x axis is given by

$$V(x) = \frac{x^2}{4} - \frac{x^2}{2} \text{ in Joules}$$

The total mechanical energy of the particle is 2 Joule. Then the maximum speed is

(a) $\frac{1}{\sqrt{2}}$ (b) 2 (c) $\frac{3}{\sqrt{2}}$ (d) $\sqrt{2}$

40. A aparticle is moving in a circle of radius r under the action of force $F = ar^2$ which is directed towards the centre of the circle Total mechanical energy of the particle is (at r= 0 P.E = 0)

(a) $\frac{1}{2}ar^3$ (b) $\frac{5}{6}ar^3$ (c) $\frac{4}{3}ar^3$ (d) ar^3

41. The ratio of momentum and kinetic energy of a particle is inversly proportional to the time Then this is the case of a

(a) uniformly accelerated motion (b) uniform motion

(c) uniformly retarded motion (d) Simple harmonic motion

42. A force F acting on a body depends on its displacement S as $F \propto S^{-1/3}$. Then the power delivered by Force F will depend on displacement as

(a) $S^{2/3}$ (b) $S^{-5/3}$ (c) $S^{1/2}$ (d) S^0

43. At what temperature will the rms speed of oxygen molecule becomes just sufficient for escaping from the earth's atmosphere ?

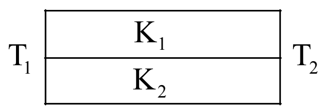
$$M \text{ of } O_2 = 2.76\times10^{-26}\ \text{kg}\ k_B = 1.38\times10^{-23}\ 5k^{-1}$$

(a) 5.016×10^4 K (b) 8.360×10^4 K (c) 1.254×10^4 K (d) 2.508×10^4 K

44. For a diatomic gas it does work of $\frac{Q}{4}$. when a heat of Q is supplied to it then the molar heat capacity is

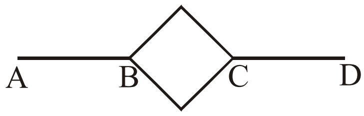
(a) $\frac{2}{5}R$ (b) $\frac{5}{2}R$ (c) $\frac{10}{3}R$ (d) $\frac{6}{7}R$

45. Two rods A and B of different materials are welded together their thermal conductivities are K_1 and K_2 the thermal conductivity of the composite rod will be



(a) $\frac{K_1 + K_2}{2}$ (b) $\frac{3(K_1 + K_2)}{2}$ (c) $K_1 + K_2$ (d) $2(K_1 + K_2)$

46. Six identical conducting rods are joined as in figure :



Temperature at A and D are 200^0C and 20^0C respectively Temperatute at B will be

(a) 120^0 C (b) 100^0C (c) 140^0 (d) 180^0C

47. Due to voltage fluctuation the temperature of an electric bulb rises from. 2000 K to 3000 K. The percentage rise in electric power is

(a) 406.25 (b) 511 (c) 325.3 (d) 459.3

Unit - VIII

48. A gas is expanded to double its volume by two different processes. One is isobaric and other is isothermal Let the work done are W_1 and W_2 respectively then

(a) $W_2 = W_1 \ell n(2)$ (b) $W_2 = \frac{W_1}{\ell n 2}$

(c) $W_2 = \frac{W_1}{2}$ (d) none of the above

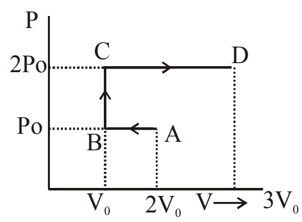
49. If two rods of length L and 2L having coefficient of linear expansion α and 2α respectively and are connected then the average coefficient of linear expansion of composite rod is

(a) $3/2\,\alpha$ (b) $\frac{5}{2}\alpha$ (c) $\frac{5}{3}\alpha$ (d) $\frac{2}{3}\alpha$

50. Two moles of helium are mixed with n moles of hydrogen. The root mean square velocity of gas molecules in mixture is $\sqrt{2}$ times the speed of sound in the mixture then the value of n is

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

51. PV diagram of an ideal gas is shown in the fig. work done by the gas in process ABCD is



(a) $4 P_0 V_0$
(b) $2 P_0 V_0$
(c) $3 P_0 V_0$
(b) $P_0 V_0$

52. The relation between U, P, V for an ideal gas is in adiabatic case U = 2 + 3 PV. Then the gas is

(a) mono atomic (b) diatomic
(c) polyatomic (d) may be mono or diatomic

53. When a copper sphere is heated percentage change is

(a) maximum in radius (b) maximum change in volume
(c) maximum change in density (d) equal in all above three cases

54. The magnitude of displacement of a particle moving in a circle of radius a with a constant angular velocity W varies with the time t as

(a) $2 a \sin \omega t$ (b) $2a\frac{\sin \omega t}{2}$ (c) $2 a \cos \omega t$ (d) $2a \cos \frac{wt}{2}$

Unit - II

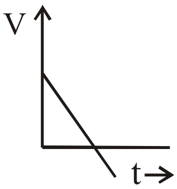
55. A particle is projected from ground at an angle of θ with the horizontal with an initial speed of u. Time after which the velocity will be perpendicular to initial velocity is

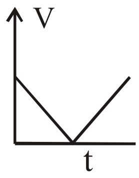
(a) $U/g\sin\theta$ (b) $U/g\cos\theta$ (c) $2U/g\sin\theta$ (d) $12\,U\,\text{Tan}\,\theta$

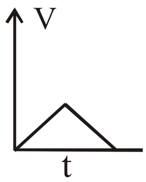
56. In the projectile motion the modulus of rate of change of speed

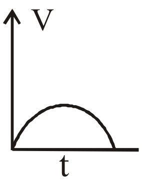
(a) is constant (b) first increases then decreases
(c) First decreases then increases (d) non of the above

57. A ball is thrown vertically upward. Ignoring the air resistance, which one represents the velocity- time plot for the period ball remains in air

(a) 

(b) 

(c) 

(d) 

58. Two cars P and Q start from a point at the same time in a straight line and their positions are represented by

$X_p(t) = at + bt^2$ $X_Q(t) = ft - t^2$ At what time do the cars have same velocity ?

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

59. A body is thrown up with a velocity U_0 and another body drops from height H, they meet at height $H/2$ then U_0 is

(a) $\sqrt{2gH}$ (b) $\sqrt{g\,H}$ (c) $\frac{1}{2}\sqrt{g\,H}$ (d) $\sqrt{\dfrac{2g}{H}}$

Unit - X

60. The equation of a travelling wave given as $Y = 5\sin 10\pi\,(t - 0.01\,x)$ along x axis, all quantities being in SI unit. The phase difference between points separated by distance 10 m is

(a) $\pi/2$ (b) π (c) 2π (d) $\pi/4$

61. The equation of a wave disturbance is given as $Y = 0.02\cos\left(\pi/2 + 50\pi t\right)\cos(10\pi x)$ all are in SI units. Choose the wrong statement.

(a) antinode occurs at x = 0.3 m (b) the wavelength is 0.2 m
(c) The speed of wave is 3s/sec (d) node occurs at 0.15 m.

62. An open and closed pipe have same length. The ratio of frequencies of their nth overtone is

(a) $\dfrac{n+1}{2n+1}$ (b) $\dfrac{2(n+1)}{2n+1}$ (c) $\dfrac{n}{2n+1}$ (d) $\dfrac{n+1}{2n}$

63. The equation for the vibration of a string fixed at both ends vibrating in its third harmonic is given by

$$Y = 2\text{ cm} \sin(0.6\text{ cm}^{-1} x) \cos[500\ \pi s^{-1} t)$$

The length of the string is

(a) 24.6 cm (b) 12.5 cm (c) 20.6 cm (d) 15.7 cm

64. The ratio of speed of sound in nitrogen gas to that of helium gas at 300 K is

(a) $\sqrt{\frac{2}{7}}$ (b) $\sqrt{\frac{1}{7}}$ (c) $\frac{\sqrt{3}}{5}$ (d) $\frac{\sqrt{6}}{5}$

65. A whistle giving out 450 Hz approaches a stationary observer at a speed of 33 m/s. The frequency heard by the observer in Hz is

(a) 409 (b) 429 (c) 517 (d) 500

(Sound velocity is 330 M/sec)

Unit - II

66. Particle is projected at an angle of 60^0 above the horizontal with a speed 10m/sec. After some time it makes angle 30 with horizontal then the velocity at that time is

(a) $\frac{5}{\sqrt{3}}$ m/sec (b) $5\sqrt{3}$ m/sec (c) 5 m/sec (d) $\frac{10}{\sqrt{3}}$ m/sec.

67. A particle located at x = 0 at time t = 0 starts in +ve x direction and velocity $V = a\sqrt{x}$. The displacement of the particle varies as

(a) $t^{1/2}$ (b) t^3 (c) t^2 (d) t

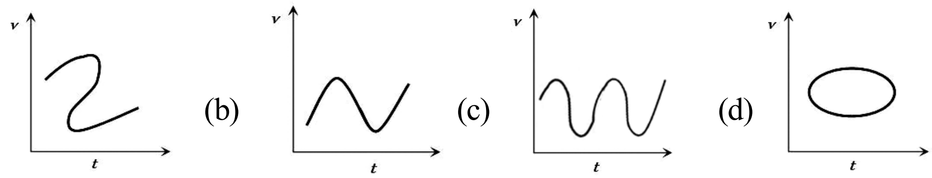
68. A particle moving in one dimension with a constant acceleration 2m/sec^2 covers 5 m during a particular second the distance covered by particle in next one second

(a) 5 (b) 6 (c) 7 (d) 10

69. A ball thrown upward from the top of a tower with speed v reaches the ground in t_1 seconds. If this ball is thrown down ward from the same tower with speed V it reaches ground in t_2 seconds. What will be time of descend to touch ground if ball starts from rest from the top of tower

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

70. Which of the following velocity - time graph shows a realistic situation of motion ?



(a) (b) (c) (d)

71. A body starts from rest and moves with a uiform acceleration the ratio of distance covered in the nth second to the distance covered in n second is

(a) $\frac{2}{n}-\frac{1}{n^2}$ (b) $\frac{1}{n^2}-\frac{1}{n}$ (c) $\frac{2}{n^2}-\frac{1}{n^3}$ (d) $\frac{2}{n}+\frac{1}{n^2}$

72. A ball is dropped from a height at t = 0 with v = 0. After 6 secs another ball is thrown downward from same height with a speed v both meet at t = 18 sec, speed v is

(a) 73.5 m/sec (b) 64 m/sec (c) 84 m/sec (d) 94 m/sec

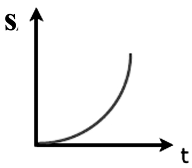
73. A car moves from x to y with uniform speed v_u and return to *x* from *y* with speed v_d. The average speed of the round trip is

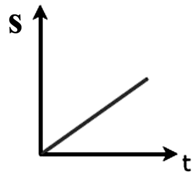
(a) $\sqrt{v_u v_d}$ (b) $\frac{v_u v_d}{v_u + v_d}$ (c) $\frac{v_u + v_d}{2}$ (d) $\frac{2 v_d v_u}{v_d + v_u}$

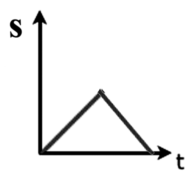
74. Velocity time curve for a body projected vertically upward is

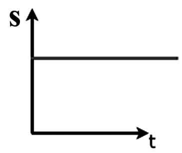
(a) ellipse (b) hyperbola (c) parabola (d) straight line

75. Which of the fllowing distance time graph shows accelerated motion ?

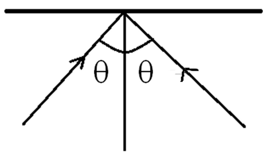
(a) 

(b) 

(c) 

(d) 

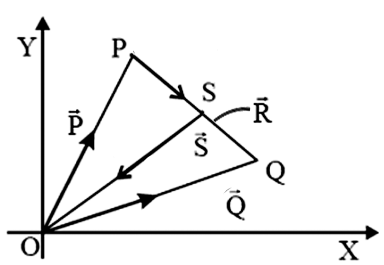
76. A ray of light travelling in the direction $\frac{1}{2}\left(\hat{i}+\sqrt{3}\hat{j}\right)$ is incident on a plane mirror and reflected ray direction is $\frac{1}{2}\left(\hat{i}-\sqrt{3}\hat{j}\right)$. The angle of incidence is



(a) 30^0 (b) 45^0 (c) 60^0 (d) 75^0

77. Three vectors $\vec{P}$, $\vec{Q}$ and $\vec{R}$ are shown in the Figure

if $\left(\overrightarrow{PS}\right) = b\left|\vec{R}\right|$ then general relation between $\vec{P}$, $\vec{Q}$ and $\vec{S}$



(a) $\vec{S}=(b-1)\vec{P}+b\vec{Q}$ (b) $\vec{S}=\left(1-b^2\right)\vec{P}+b\vec{Q}$

(c) $\vec{S}=(1-b)\vec{P}+b^2\vec{Q}$ (d) $\vec{S}=(1-b)\vec{P}+b\vec{Q}$

78. The coordinates of a moving particle at any time t are given by $x = \alpha t^3$ and $y = \beta t^3$. The speed of particle at time t is given by

(a) $3t\sqrt{\alpha^2+\beta^2}$ (b) $3t^2\sqrt{\alpha^2+\beta^2}$ (c) $t^2\sqrt{(\alpha^2+\beta^2)}$ (d) $\sqrt{\alpha^2+\beta^2}$

79. A boy can throw a stone up to maximum height of 10 m. The maximum horizontal distance he can throw is

(a) $20\sqrt{2}$ m (b) 10 m (c) $10\sqrt{2}$ m (d) 20 m

80. For a particle in uniform circular motion the acceleration at a point P(R, Q) on the circle of radius R and Q is measured from x axis is

(a) $\frac{v^2}{R}\hat{i}+\frac{v^2}{R}\hat{j}$ (b) $-\frac{v^2}{R}\cos\theta\,\hat{i}+\frac{v^2}{R}\sin\theta\,\hat{j}$

(c) $-\frac{v^2}{R}\sin\theta\,\hat{i}+\frac{v^2}{R}\cos\theta\,\hat{j}$ (d) $-\frac{v^2}{R}\cos\theta\,\hat{i}-\frac{v^2}{R}\sin\theta\,\hat{j}$

81. The value of P so that the vectors $2\hat{i}-\hat{j}+\hat{k}$, $\hat{i}+2\hat{j}-3\hat{k}$ and $3\hat{i}+p\hat{j}+5\hat{k}$ are co planar should be

(a) 16 (b) – 4 (c) 4 (d) – 8

Unit - I

82. If force F velocity V and time T are taken as fundamental units, the dimensions of mass are

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

83. The dimension of the quantity L/C is identical to

(a) resistance^{-1} (b) $(\text{Time})^{-2}$ (c) $(\text{resistance})^2$ (d) non of these

84. The dimensions of angular momentum / magnetic momentum

(a) $M^3L\,T^{-2}A^2$ (b) $M\,A^{-1}\,T^{-1}$ (c) $M\,L^2\,A^{-2}\,T$ (d) $M^2\,L^{-3}\,A\,T^2$

Unit - II

85. If the angle between the vectors $\vec{A}$ and $\vec{B}$ is θ. The value of the products $(\vec{B}\times\vec{A}).\vec{A}$ is

(a) $B\,A^2\cos\theta$ (b) $BA^2\sin\theta$ (c) $BA^2\sin\theta\cos\theta$ (d) zero

86. $\vec{a}$, $\vec{b}$, $\vec{c}$ are the unit vectors along the incident ray reflected ray and the out ward normal to the reflector, then

(a) $\vec{b}=\vec{a}-\vec{c}$ (b) $\vec{b}=\vec{a}+(\vec{a}.\vec{c})\vec{c}$

(c) $\vec{b}=2\vec{a}-\vec{c}$ (d) $\vec{b}=\vec{a}-2(\vec{a}.\vec{c})\vec{c}$

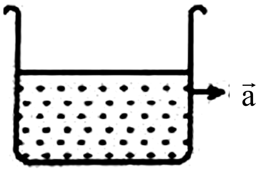
87. The relation between time t and distance x is $t = ax^2 + bx$ a,b are constants then acceleration is

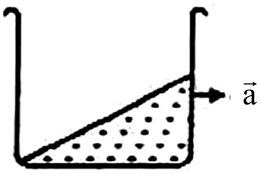
(a) $-2\,abv^2$ (b) $-2\,b\,v^3$ (c) $-2\,a\,v^3$ (d) $-2\,a\,v^2$

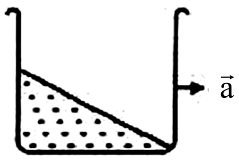
88. An object moving with a speed of 6.25 m/sec its occeleration $-2.5\sqrt{v}$, v is instantaneous speed. So stopping time will be

(a) 1 sec (b) 2 sec (c) 4 sec (d) sec

89. A vessel containing water is given a constant acceleration $\vec{a}$ towards right along a straight horizontal path which of the following figures represent the surface of water.

(a) 

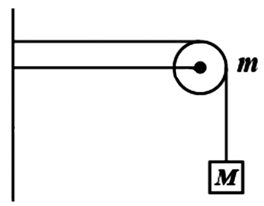
(b) 

(c) 

(d) Non of the above

Unit - III

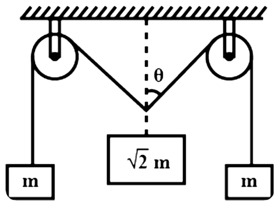
90. A string of negligible mass going over a clamped pully of mass m supports a mass M as shown in the figure. The force on the pulley by the clamp is given by



(a) $\sqrt{2\ Mg}$ (b) $\sqrt{2}$ Mg

(c) $\sqrt{2}$ mg (d) $\left[(M+m)^2+M^2\right]^{\frac{1}{2}}g$

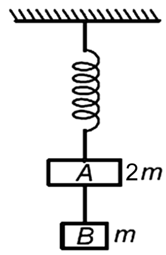
91. Two pulleys and strings are shown in the figure are weight less and friction less. For the system to remain in equilibrium. The angle θ is



(a) 30 (b) 60

(c) 15 (d) 45

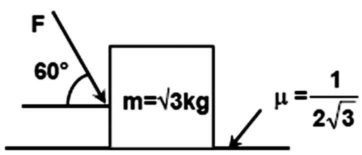
92. Two blocks A and B of masses 2m and m are connected by massless string while system is suspended by a massless spring. The magnitude of acceleration of A and B after the string is cut are



(a) $g, g/2$ (b) $g/2, g$

(c) g, g (d) $g/2, g/2$

93. What is the maximum value of Force F such that the block does not move



(a) g Newton (b) 2g Newton (c) $g/2$ Newton (d) $\frac{3}{2}$g Newton

94. When a bicycle is in motion the force of friction exerted by ground on two wheels is such that it is

(a) in forward direction in the rear wheel and in back ward divection in the front wheel.

(b) in both the wheels in back ward direction

(c) in both the wheels in for ward direction

(d) in forward direction in the front and backward direction in the back wheel

95. A block of mass M is pulled along a horizontal friction less surface by rope of mass m if a force P is applied at the free end of the rope the force exerted by the rope on the block is

(a) $\frac{Pm}{M+m}$ (b) $\frac{Pm}{M-m}$ (c) P (d) $\frac{PM}{m+M}$

96. A smooth block is released at rest on a 45^0 inclined plane then slides distance d. The time taken to slide through same distance in smooth and rough surfaces is 1:n then coefficient of friction is

(a) $\mu_k = 1-\frac{1}{n^2}$ (b) $\mu_k = \sqrt{1-\frac{1}{n^2}}$ (c) $\mu_s = 1-\frac{1}{n^2}$ (d) $\mu_s = \sqrt{1-\frac{1}{n^2}}$

97. A hollow ring with inner and outer radius R_1 and R_2 is rolling without slipping with a uniform angular speed. The ratio of the forces $\frac{F_1}{F_2}$ experienced by two identical particles situated on the inner and outer parts of the ring is

(a) $\frac{R_2}{R_1}$ (b) $\left(\frac{R_1}{R_2}\right)^2$ (c) 1 (d) $\frac{R_1}{R_2}$

98. A particle is acted upon by a force of constant magnitude and always is perpendicular to its velocity. The motion takes place in a plane then

(a) the velocity is constant (b) acceleration is constant

(c) kinetic energy is constant (d) It moves in a straight line

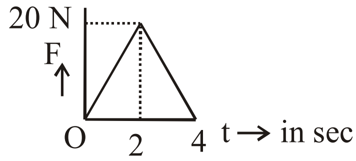
99. A light string passing over a smooth light pulley connects two blocks of masses m_1 and m_2 vertically. If the acceleration of the system is $g/8$ then the ratio of the masses m_2/m_1 is

(a) 8 : 1 (b) 9 : 7 (c) 4 : 3 (d) 5 : 3

100. A body of mass 2 kg moves with an acceleration $3\ m/s^2$ The change in momentum in one second is

(a) $\frac{2}{3}\,kg\,ms^{-1}$ (b) $\frac{3}{2}\,kg\,ms^{-1}$ (c) $6\ kg\ ms^{-1}$ (d) non of these

101. A body is initially at rest on a smooth surface A force F as per the figure acts on it for a duration of 4 secs. The momentum of the ball at the end of 4secs is

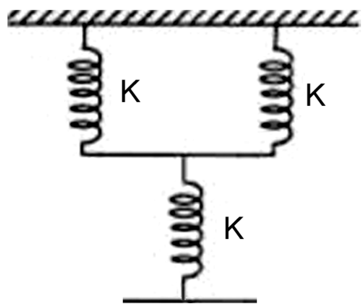


(a) 10 N S (b) 20 N S (c) 30 N S (d) 40 N S

102. What is the time period of a pendulum inside a satellite ?

(a) 0 (b) $2\pi\sqrt{\frac{\ell}{g}}$ (c) $\sqrt{\frac{\ell}{g}}$ (d) non of these

103. Three springs have same length same spring constant. They are fixed as in figure. The effective spring constant is



(a) k (b) $\frac{2}{3}$ k (c) $\frac{1}{2}$ k (d) $\frac{k}{3}$

Unit - X

104. If the frequency of oscillation of a particle doing SHM is n\ then the frequency of kinetic energy is

(a) 2n (b) n (c) $n/2$ (d) 4 n

105. For any SHM amplitude is 6 CM. If the instantaneous potential energy is half of the total energy then distance of particle from its mean position is

(a) 3 CM (b) 4.2 CM (c) 5.8 CM (d) 6 CM

106. Two particles are executing S.H.M in a straight line both have same amplitude and same time period at time t = 0. One is at +A and other is at $-A/2$. They are approaching towards each other. After what time they will cross each other.

(a) $T/3$ (b) $T/4$ (c) $\frac{5T}{6}$ (d) $T/6$

107. Two simple harmonic motions $y_1 = A \sin wt$ and $y_2 = A \cos wt$ are super imposed on a particle of mass m. Total energy

(a) $\frac{1}{2}$ mw^2 A^2 (b) m w^2 A^2 (c) $\frac{1}{4}$ mw^2 A^2 (d) 0

Unit - VIII

108. A gas expands in such a manner that PV^2 = constant. The gas on expansion will

(a) cool (b) heated

(c) remain as it is (d) nothing of the above

109. In an adiabatic process the state of gas is changed from $P_1\ V_1\ T_1$ to P_2, V_2, T_2 which of the following condition is correct

(a) $T_1V_1^{r-1} = T_2V_2^{r-1}$ (b) $P_1V_1^{r-1} = P_2V_2^{r-1}$

(c) $T_1P_1^{r} = T_2P_2^{r}$ (d) $T_1V_1^{r} = T_2V_2^{r}$

110. A given quantity of an ideal gas is at pressure P. The isothermal bulk modulus is

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

111. During an adiabatic process of a gas $P \propto T^3$ [pressure $\propto$ (Absolute temp)^3]. Then the ratio of C_P / C_V for gas is

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

Unit - IV

112. In elastic collision 100% energy transfer takes place when

(a) $m_1 = m_2$ (b) $m_1 > m_2$ (c) $m_1 < m_2$ (d) $m_1 = 2m_2$

113. If momentum decreases by 20%. K.E. will decrease by

(a) 40% (b) 36% (c) 18% (d) 8%

Unit - V

114. If a person standing on a rotating disc stretches out his hands the angular speed will

(a) increase (b) decrease (c) remains same (d) non of the above

115. A disc is rolling on the inclined plane. The ratio of rotational K.E. to total K.E.

(a) 1 : 3 (b) 3 : 1 (c) 1 : 2 (d) 2 : 1

◆◆◆

ANSWERS

Group - A

Multiple Choice

1. (c)	2. (c)	3. (c)	4. (b)	5. (a)	6. (d)	7. (b)
8. (a)	9. (c)	10. (b)	11. (b)	12. (d)	13. (b)	14. (c)
15. (d)	16. (b)	17. (d)	18. (a)	19. (b)	20. (b)	21. (c)
22. (c)	23. (d)	24. (b)	25 (a)	26. (c)	27. (a)	28. (b)
29. (d)	30. (a)	31. (c)	32. (c)	33. (a)	34. (a)	35. (b)
36. (d)	37. (c)	38. (c)	39. (c)	40. (b)	41. (a)	42. (d)
43. (b)	44. (c)	45. (a)	46. (c)	47. (a)	48. (a)	49. (c)
50. (a)	51. (c)	52. (c)	53. (b)	54. (b)	55. (a)	56. (c)
57. (a)	58. (b)	59. (b)	60. (b)	61. (c)	62. (b)	63. (d)
64. (c)	65. (d)	66. (d)	67. (c)	68. (c)	69. (c)	70. (b)
71. (a)	72. (a)	73. (d)	74. (d)	75. (a)	76. (a)	77. (d)
78. (b)	79. (d)	80. (d)	81. (b)	82. (c)	83. (c)	84. (b)
85. (d)	86. (d)	87. (c)	88. (b)	89. (c)	90. (d)	91. (d)
92. (b)	93. (b)	94. (a)	95. (d)	96. (c)	97. (d)	98. (c)
99. (b)	100. (c)	101. (d)	102. (a)	103. (b)	104. (a)	105. (b)
106. (d)	107. (b)	108. (a)	109. (a)	110. (b)	111. (d)	112. (a)
113. (b)	114. (b)	115. (a)				

◆◆◆

Group - B

Fill in the blanks : -

Unit - I

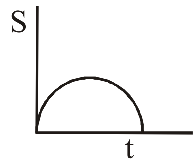
1. The dimensions of linear momentum in terms of velocity v, density ρ and frequency f as fundamental quantities are _________.
2. The inductance L, capacitance C and resistance R are so combined as _________ to give dimension of frequency.
3. A vernier callipers as 1 mm mark on the main scale. It has 20 equal divisions on vernier scale which match with 16 main scale divisions. Thus the least count is __________.

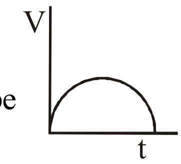
State true or false

Unit - II

4. With positive value of acceleration a particle must be speeding up

   Where $X(t_2) = x(t_1) + V(t_1)(t_2 - t_1) + \frac{1}{2}a(t_2 - t_1)^2$

5. The graph of displacement versus time is 

   The corresponding velocity time graph will be 

6. When a body is dropped or thrown horizontally from the same height it would reach the ground at the same time.

Unit - I

7. Both statements are equal or not

   (i) 8 (5km/hour north) (ii) 8 hours (5km/hour north)

8. Correct the statement

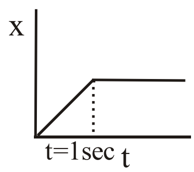
   Whether 1 m N = 1 nm

Unit - III

9. Coefficient of friction changes if weight of the body is doubled.
10. The angle between the frictional force and direction of instantaneous velocity is 90^0.
11. Definition of force comes from Newton's 3rd law.

Fill in the blanks :

12. Position time graph of a body of mass 1 kg is in the figure. The net force acting on a body for time interval $0 < t < 1$ is ________.



13. Coefficient of static friction is __________ than that of kinetic friction.

14. A body is moving in a circular path with constant speed yet ________ force is acting on it.

15. Angle of banking depends on ________ , _________ and _________.

16. A vector $\vec{A}$ is rotated by a very small angle to get a new vector $\vec{B}$ then $|\vec{B} - \vec{A}|$ is ________.

Fill in the blanks

17. The span of long jump depends on _______ and ________ .

18. The angle between $(\hat{i} + \hat{j})$ and $(\hat{i} - \hat{j})$ is ________.

19. The direction of $\vec{A}$ is vertically upwards and direction of $\vec{B}$ is in north direction. Then the direction of $\vec{A} \times \vec{B}$ is __________.

20. If $\vec{A} = \vec{B} + \vec{C}$ and $|\vec{A}|, |\vec{B}|, |\vec{C}|$ are 13, 12, 5 respectively then the angle between and $\vec{A}$ and $\vec{C}$ is ________.

21. A body executing uniform circular motion, then velocity and acceleration are at _______ angle to each other.

22. A boy weighs 30 kg f inside the lift when lift goes down with acceleration g/4 and boy will weigh ________ when lift goes upwards with g/4 acceleration.

23. A monkey is descending from the branch of a tree with constant acceleration. If the breaking strength is 75 % of the weight of the Monkey. The minimum acceleration with which the monkey can slide down without breaking the branch is _________.

Unit - IV

24. Coefficient of limiting friction is dyne/cm

Correct the statement if necessary :

25. K.E. of a body can be negative.

26. Killowatt is unit of energy.

27. When air buble rises in water its potential energy increases.

Fill in the blanks.

28. Gravitational force is _________ force .

29. ________ and ________ are conserved in elastic collision

30. A bullet gets embedded into a block of wood the loss in energy is converted into _____ and _______ energy.

Unit - III

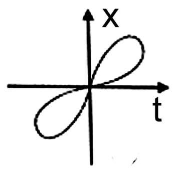
31. The work done by a centripetal force in moving a body through half cycle on the circular path of radius 20 cm is ________.

32. A particle moves a distance x in time t according to equation $x = (t+5)^{-1}$ then the acceleration is related to velocity as ________ .

Correct the statements

33. A particle may have zero acceleration with variable speed.

34. Say in yes or no whether



this graph represents one dimensional motion of a particle.

35. What is the numerical ratio of velocity to speed ?

36. Will the displacement of an object change on shifting the position of origin of coordinate axes ?

Fill in the blanks :

Unit - VI

37. The ratio of acceleration due to gravity at a depth h below the surface of earth and at a height h above the surface of earth ________ linearly with h provided h<<R (increases, decreases)

    Correct the statement by changing the last expression.

38. The ratio of the energy required to raise the satellite upto a height h above the earth to that the kinetic energy at the satellite in the orbit is $\frac{2h}{3R}$

39. The distance of two planets from the sun are 10^{13} m and 10^{12}m respectively. The ratio of time periods of the planets is ________.

40. The escape velocity from a planet is V_e. If its mass is increased 8 times and its radius is increasesd by 2 times then the new escape velocity will be _________.

41. **Correct the statement** $\rightarrow$ acceleration due to gravity increases from pole to-equator.

42. Gravitational force is a nonconservative force.

43. A missile is launched with a velocity less than the escape velocity. Then the sum of its kinetic energy and potential energy is positive or negative ?

Correct the statement :

44. The ratio of SI unit to C.G.S unit of angular momentum is 10^5.

Unit - V

45. A circular ring and circular disc of same radius have equal MI about any diameter of ring and disc then the ratio of their masses is3:1

46. Torque is represented by product of moment of inertia and angular velocity.

47. Planck's constant has same dimension as angular acceleration.

Fill in the blanks :-

48. If the CM of a system of particle is at origin then the heavier particle is _______ to the origin. (nearer or Farther)

49. In absence of any external force the velocity of C.M is ___________.

50. Locus of all the points in a plane on which the moment of inertia of a rigid body is same is _________.

    (circle, straight line, ellipse or parabola)

Answer with yes or no

Unit - II

51. A block of mass M at the end of a string whirled round a vertical circle of radius R. The critical speed of the block at the top of swing is $\left(R/g\right)^{\frac{1}{2}}$ (yes or no)

52. A person is standing in an elevator. He finds his weight less when the elevator moves up ward with constant acceleration (yes or no)

Correct the statements

Unit - III

53. The motion of a rocket is based on the principle of conservation of kinetic energy.

54. The driver in a vehicle moving with a constant speed on a straight road is an inertial frame of reference.

55. During turning cyclist leans outwards of the curve.

56. A quick collision between two bodies is less violent than a slow collision.

57. A particle is moving in a circular path of radius r under the action of potential energy $U = \frac{-K}{2r^2}$ its total energy is $\frac{K}{2r^2}$

58. If momentum decreases by 20% kinetic energy will reduce by 40%

Correct the statements

Unit - VII

59. A thick long wire of a denser material is suspended from a rigid support. It is not under any stress.

60. If the length of a wire is doubled and diameter is reduced to half the Young's modulus will be affected.

61. A liquid withstands a shear stress.

Fill in the blanks :

62. Surface tension of liquids generally ___________ with temperature.

63. For solids with the elastic modulus of rigidity the shearing force is proportional to _______ while for fluids it is proportional to ____________.

64. Value of poisson's ratio lies between ___________ and ___________.

65. Isothermal bulk modulus of a gas is __________.

66. Which will fall faster _________ ? (Big or small rain drops)

67. When the velocity of liquid is greater than critical velocity the flow becomes _________.

68. Hot soup tastes better because it has ____________ surface ternion.

Fill in the blanks :

69. The unit and dimensional formula for thermal resistance are _________ and __________.

Unit - IX

70. The efficiency of any heat engine is less or equal _________.

71. Rusting of Iron is __________ process. (Reversible, Irreversible)

72. In case of refrigerator 2nd law of thermodynamics is ____________.

(violated, not violated)

73. A heat engine is 20% efficient. If the engine does 500 J of work every second then heat exhausted by engine in every second is __________.

Correct the statements :

74. The excess pressure in two soap bubbles 1:3. Thus the volume ratio is 1 : 9.

75. Radiation is the process by which heat is transmitted from one place to another by heating the intervening medium.

76. An ideal gas heat engine is operating between 227^0C and 127^0C. It absorbs 10^4 J of heat at higher temperature. The amount of heat converted to work is 4000 J.

Unit - X

77 . The ratio of root mean square speeds of the molecule of an ideal gas at 270 K and 30 K is 9 : 1

Correct the statement

78. In a given process of an ideal gas dw=0 and $dQ < 0$ then for the gas the temperature will increase.

79. An ideal diatomic gas is heated at constant pressure the fraction of heat energy supplied increases the internal energy of gas is $\frac{3}{5}$.

80. The temperature of an ideal gas is increased from 120 K to 480 K. If root mean square velocity of the gas molecule is V at 120 K then belocity at 480 K it becomes $V/2$.

81. Work is one of the parameters which characterise the thermodynamic state of Matter.

Unit - VII

82. The rate of dissipation of heat by a black body at temperature T is Q then the rate of dissipation of another body at temperature 2T and emissivity 0.25 is 2Q.

83. The presence of gravitational field is required for heat transfer by conduction.

Unit - X

84. Velocity and acceleration in SHM are having phase difference of π.

85. In the equation Y = A sin wt. The kinetic energy of S.H.O will be $\frac{1}{4}$ of the maximum value at $y = A/2$.

86. Acceleration displacement graph of SHO is parabola.

87. The amplitude of simple harmonic oscillator is doubled then its time period changes and maximum velocity remains unchanged.

88. Two identical springs of force constant K each are connected in series the equivalent force constant is __________.

89. The time period of a simple pendulum at the centre of the earth is __________ .

90. The frequency of SHO for y = 0.2 sin (99t + 0.36) is _________.

91. Displacement time equation is $X = A\sin\left(wt + \pi/6\right)$. Time taken by the particle to go directly from $x = -A/2$ to $X = +A/2$ is __________.

92. A particle starts oscillating simple harmonically. Then the ratio of kinetic energy to the potential energy of the particle at time $T/12$ is _________.

93. If a acceleration of a particle is $a = -\beta(x-2)$, β is +ve constant x is the position from origin then time period of oscillation is _________ .

Fill in the blanks:

94. String 1 has twice length twice radius twice the tension twice the density of another string 2. The relation between fundamental frequencies of 1 and 2 is ________.

95. Velocity of sound in an open organ pipe is 330 m/sec. The frequency of wave is 1.1 KHz and length of the tube is 30 cm. The frequency corresponds ______ harmonic.

96. In an experiment string vibrates with n loops when mass M is placed on the pan. Mass placed on the pan to have 2n loops in the string is _________.

Correct the statement :

97. A harmonic wave trayelling in a medium has period T and wave length λ. The distance travelled by the wave in time T is $\lambda/2$.

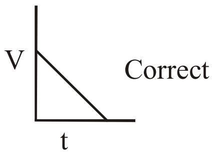
98. Fundamental frequency of a closed organ pipe will increase if the pipe is filled with a gas heavierthan air.

99. The condition for formation of beats is the amplitudes of both waves be nearly equal.

100. Angle between particle velocity and wave velocity in transverse wave is zero.

◆◆◆

<u>**ANSWERS OF GROUP - B**</u>

1. $Pv^4 f^{-3}$
2. R/L or $\sqrt{\frac{1}{LC}}$
3. 0.2 mm
4. no it may also down slow if its initial velocity is negative.
5. false 

6. Yes, as vertical velocity is zero in both cases.
7. No
8. false 1 mN = 1 milli Newton
   1 nM = 1 nanometer
9. Coefficient of friction does not change
10. no 180^0
11. From Newton's first law
12. Net force is zero as $a = 0$, $V \rightarrow$ uniform
13. more
14. Centripetal force
15. Velocity, Radius curvature, acceleration due to gravity
16. $A \Delta \theta$
17. initial velocity and angle
18. 90^0
19. west
20. $\cos^{-1}\frac{5}{13}$
21. 90^0
22. 50 kgf
23. $\frac{g}{4}$
24. unit less
25. no, then v will be imaginary
26. Unit of power
27. P.E. decreases
28. Central and conservative
29. linear momentum and kinetic energy
30. heat and sound
31. zero
32. $a = 2(-v)^{3/2}$
33. false wih zero acceleration speed can not vary
34. no
35. may be $\pm 1:1$
36. no
37. increases
38. $\frac{2h}{R}$
39. $10\sqrt{10}$
40. 2 Ve
41. decreases
42. conservative
43. negative
44. 10^7
45. $\left.\begin{array}{l}\text{Disc } \frac{1}{4}M_1 R^2 \\ \text{Ring } \frac{1}{2}M_2 R^2\end{array}\right\}$ So $\frac{1}{4}M_1 = \frac{1}{2}M_2$, $\frac{M_1}{M_2} = 2:1$
46. Torque = $MI \times$ angular acceleration
47. Angular momentum dimension same as that of planck's constant
48. Farther
49. constant
50. circle
51. No, $\sqrt{Rg}$
52. No, less when elevator moves down-ward
53. conservation of inear momentum
54. inertial
55. Turns inward
56. more violent

57. correct
58. by 36% not 40%
59. Yes it is under stress due to its own weight
60. Not affected
61. does not stand a shear stress
62. decreases
63. shear strain and rate of shear strain
64. –1 and 0.5
65. P
66. Big one as Terminal velocity $\propto$ (radius)^2
67. Turbulent
68. less surface tension
69. k w^{-1}, $M^{-1} L^{-2} T^3$ k
70. one
71. irreversible process
72. does not violet
73. 2000 J.
74. $\frac{P_1}{P_2} = \frac{1}{3} = \frac{4T}{R_1} \times \frac{R_2}{4T} = \frac{R_2}{R_1} = \frac{1}{3}$

$\frac{V_1}{V_2} = \frac{27}{1}$
75. Conduction is the process ....
76. 2000 J = work
77. 3 : 1 $V \propto \sqrt{T}$
78. decreases
79. $\frac{5}{7}$
80. 2 V
81. No
82. not 2Q it is 4Q
83. no it is done by convection
84. $\pm\frac{\pi}{2}$
85. No it will be $\frac{3}{4}$ P.E. will be $\frac{1}{4}$
86. graph is a straight line with negative slope.
87. Time period does not change
88. $\frac{K}{2}$
89. g = 0 $T = \infty$
90. $f = \frac{99}{2\pi}$ Hz
91. $\frac{T}{2}$
92. 3 : 1
93. $\frac{2\pi}{\sqrt{\beta}}$
94. $f_2 = 4 f_1$
95. 2nd harmonic
96. $m/4$
97. λ
98. decreases as $f \propto \frac{1}{\sqrt{P}}$
99. frequencies of both wave should differ by small amount.
100. 90^0.

◆◆◆

Group - C

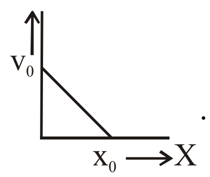
Short questions of 2 or 3 : -

Unit - I

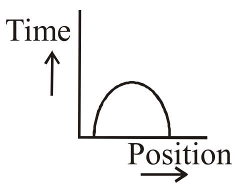
1. Distinguish between dimension and unit.
2. Give examples of dimensional and non dimensional constants and variables.
3. State three physical quantities having same dimension and state their dimension.
4. State different types of errors.
5. Show that the maximum error in the quotient of two quantities is equal to sum of their individual fractional errors.

Unit - II

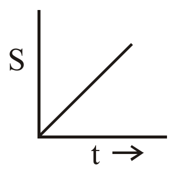
6. When rain is falling vertically down ward the front screen of moving car gets wet while the back screen remains dry why ?
7. Can a body be at rest and motion simultaneously.
8. The velocity - displacement graph of a particle is shown in the figure. Write the relation / equation between V and X and obtain expression for acceleration for the above case



9. The displacement - time graphs for two particles A and B are straight lines inclined at angles of 30^0 and 45^0 with time axis. What is the ratio of $V_A : V_B$?
10. Is the time variation of position shown in the figure observed in nature ?



11. Let rate of change of acceleration is SLAP. Then write the unit and dimension of slap.
12. Displacement time graph is



Draw velocity time graph.

13. Show that scalar product of two vectors is equal to the sum of product of their corresponding rectangular components.
14. A projectile of mass M is thrown with velocity v from the ground at an angle of 45^0 with horizontal what is the magnitude change in momentum between leaving and arriving back at the ground

Unit - III

15. How does banking of roads reduce wear and tear of the tyres.
16. Two objects of mass 2 kg and 4 kg are having same momentum calculate he ratio of their speeds.
17. If normal forces is doubled then what wil happen to coefficient of friction ?
18. A particle of mass 4 kg is acted upon by steady forceof 4 N. Calculate the distance travelled by the particle in 4 seconds.
19. What is the physical quantity which is conserved in both elastic and in elastic collision ?
20. If a particle of mass m is moving in a horizontal circular path with uniform speed v Then what is momentum difference at two diametrical opposite points.
21. A particle moves from a point $-2\hat{i}+5\hat{j}$ to $\left(4\hat{j}+3\hat{k}\right)$ when a force $\left(4\hat{i}+3\hat{j}\right)$ N is applied. Calculate the work done by the force.

Unit - IV

22. Standing is not allowed in a double decker bus why ?
23. Is radius of gyration a constant quantity ?
24. The speed of whirl wind in a tornado is high why ?
25. Can there be motion in two dimension with an acceleration in one direction. Give one examaple.

Unit - III

26. It is easy to catch a table tennis ball than a cricket ball of same velocity.
27. Why has the horse to pull a cart harder during the first few steps of his motern.
28. A bucket containing water is rotated in a vertical circle why the water does not full.
29. A man stands on a lift going down wards with uniform velocity. He experiences a loss of weight at the starting but not after words.
30. Can a single isolated force exist in nature ?
31. Why are wheels of automobiles made circular ?

Unit - II

32. Two bodies of different masses are allowed to fall form a height with equal air resistance for both. Will the two bodies reach the ground simultaneously.
33. An astronaut accidentally gets thrown out of the space ship accelerating in inter stellar space at a constant rate of 100 m/sec^2. Discuss what will be the acceleration of astro naut ?
34. The distance travelled by a body is directly proportional to time. What force is acting on the body ?
35. Why it is necessary to bend knees while jumping from greater height ?
36. A ball is droped from a height. Find the ratio of work done by force of gravity in the first second and third second of the motion.
37. A ball whose kinetic energy is E. It is projected at an angle of 60^0 to the horizontal, what will be the kinetic enegy of the ball at the highest point ?

38. Show that coefficient of restitution for one dimensional collision is one.

39. What is maximum vertical height a cricketer can throw a ball if he can throw it to maximum horizontal distance 160 m.

40. If you have two vectors $\vec{A}$ and $\vec{A}$. How would you combine them to have resultant force of magnitude $\vec{A}$.

Unit - II

41. Prove the following statement "For elevations which exceeds or fall short at 45^0 by equal amounts the ranges are equal.

42. What is a conservative force ? Explain with one example.

43. Draw the variation of potential energy and kinetic energy of block attached to a spring.

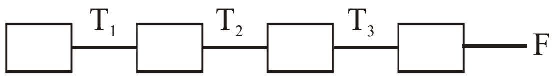
44. Show that mechanical energy of a body falling freely under gravity is conserved.

45. A particle of mass m revolves in a horizontal circle of radius r under a centripetal force $-\frac{k}{r^2}$ Find the total mechanical energy of the particle.

46. The maximum range of projectile is 2 times the actual range What is the angle of projection.

47. Two bodies are thrown with same initial velocity at an angles α and 90-α with the horizontal at what value of α the maximum heights will be same.

48. Four blocks of same mass m connected by cords and pulled by a force F



Determine T_1, T_2 and T_3.

49. Show that the Newton's second law of Motion is the real law of motion.

Ans. 1st law and third law can be derived from 2nd law.
F = 0 is particular case of 2nd law.

50. Derive law of conservation of momentum from Newton's second law

$$\frac{dp^{-1}}{dt} = 0 \quad \text{if } F = 0 \quad p \to \text{constant}$$

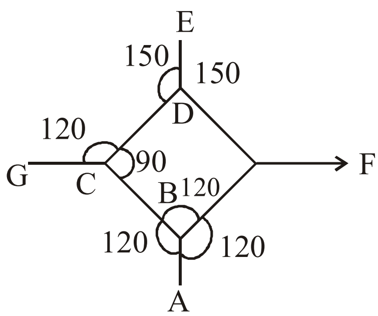
51. What is impulse. Is it scalar of vector ? How it is related to momentum.

$$\vec{F}\Delta t = d\vec{p}$$

52. Define angle of repose Derive its relation with coefficient of friction $\mu_s = \text{Tan}\,\theta$

53. A space craft of mass M moving with a velocity V explodes into two pieces. A mass m is left stationary what will be the velocity of other part.

54. From this figure section AB is stretched by a force of 10 N calculate the tension in the section BC and BF



Unit - IV

55. Two rings of same radius r and mass m placed in such a way their centres coincide but their planes are perpendicular to each other. What will be the moment of inertia of the system about an axis passing through the centre and perpendicular to plane of one ring?

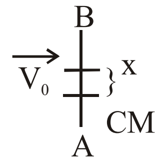
56. A uniform stick of length ℓ and mass M lies on a table and rotates with angular velocity W about an axis perpendicular to the table and through one end of the stick. What will be angular momentum ?

57. A disc is rotating with angular speed w_0 A constant retarding torque is applied on it to stop the disc The angular velocity becomes half after n rotations. How many more rotations will it make before coming to rest.

58. A solid sphere rolls down on two different inclined planes of same height but different inclinations what will happen to its speed and time of descend in both cases ?

59. A wheel of radius R rolls on the ground with a uniform velocity. What will be relative acceleration of topmost point of the wheel with respect to the bottom most point ?

60. A uniform rod AB of length ℓ and mass M is lying on a smooth table. A small particle of mass m strikes the rod at a point X distance from the CM with velocity V_0. If A remains at rest what will be value of x ?

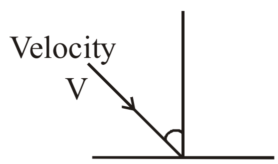


Unit - II

61. A gun fires a shell and re coils horizontally. If the shell travells along the barrel with speed v what will be ratio of speed with which the gun recoils. If the barrel is horizontal and inclined at an angle of 30^0 with the horizontal.

62. In one dimensional collision between two particles, velocities are interchanged in which condition ?

63. A ball of mass m collides with angle α with vertical. If collision time is t seconds what will be the average force exerted by the ground on the ball ?



64. In a one dimensional collision between two identical particles A and B. B is the stationary A has a momentum P before impact. If J is the impulse given by B to A during impact then what will be the coefficient of restitution.

65. A particle of mass m, kinetic energy K and momentum P collides head on elastically with another particle of mass 2m at rest what will be the momentum of first particle and kinetic energy of second particle.

Unit - IV

66. A wire of length ℓ and mass m is bent in the form of a rectangle ABCD with $\frac{AB}{BC} = 2$ what will be the moment of inertia of the wire frame about the side BC.

67. A capillary is dipped in water vessel kept on a freely falling lift what will be value of height of water.

68. A metallic wire of density ρ floats horizontal in water What will be the maximum radius of wire so that the wire may not sink ? T $\rightarrow$ surface tension and angle of contact is zero.

69. In the bottom of a vessel with mercury of density ρ there is a round hole of radius r, At what maximum height of the mercury layer will the liquid still not flow out through this hole.

70. What is the radius of a steel sphere that will float on water with exactly half the sphere submerged ?

$$\rho_{steel} = 7.9\times10^3 \text{ kg} / \text{M}^3$$

$$T_{water} = 7\times10^{-2} \text{ N}.$$

71. A capillary tube of radius r is immersed in water and water rises to height h. The mass of water in the capillary tube is m. Another capillary of radius 2r is immersed in water what will be the mass of water rise in the 2nd tube.

72. Water flows in a stream line manner through a capillary tube of radius a the pressure difference is P rate of flow is Q. If the radius is reduced to $a/2$ and pressure is increases to 2P, what will be rate of flow ?

73. What is the height to which a liquid rises between two long parallel plates d distance apart.

Unit - V

74. The time period of an artificial satellite in a circular orbit of radius R is 2 days and orbital velocity is v_0. If time period of another satellite is 16 days then what will be its radius

75. If the earth be one half of its present distance from the sun then a year will be having how many days ?

76. The radius of a planet is double that of the earth but their average densities are the same if the escape velocities at the planet and of the earth V_p and V_E Then find the relation between V_P and V_E

77. At a point above the surface of the earth the gravitational potential is -5.12×10^7 J / kg and $g = 6.4 \text{ m}/\text{s}^2$ $R_{earth} = 6400 \text{ km}$. What is the height of the point.

78. If the period of revolution of an artificial satellite just above the earth's surface be T and density of earth is p. Show that pT^2 $\rightarrow$ universal constant.

79. If the period of revolution of an artificial Satellite just above the earth's surface is T and density of earth is ρ then calculate what will be value of pT^2.

80. The magnitude of potential energy per unit mass of the object at the surface of the earth is E. Calculate the escape velocity.

81. If the angular velocity of planet about its own axis is halved calculate the distance of geostationary satellite of that planet from the centre of the planet.

82. A simple pendulum has a time period T_1 on earth surface and T_2 when taken to a height R above the earth surface What will be value of T_2/T_1 ? R-Radius of the earth.

83. A hole is drilled from the surface of earth to its centre. A particle is dropped from rest at the surface. What will be velocity of particle at the centre and how it is related to escape velocity ?

84. A planet has a mass eight times of mass of earth and density is also eight times that of earth. What will be the value of acceleration due to gravity on the surface of that planet in terms of g.

Unit - VII

85. Why are clear nights are colder than cloudy nights

86. Which object will cool faster when kept in open air whose teemperature is 300^0C or whose temperature is 200^0C.

87. Why do animals curl into a ball when they fell cold ?

88. Why it is much hotter above the fire than by its sides ?

89. Why there are ventillators at the top of the wall ?

90. Two bodies of specific heats C_1 and C_2 having same heat capacities are combined to form a single composite body what is the specific heat of the compsite body ?

91. Two rods A and B are of equal length and temperature difference across both ends of both rods are equal, state the condition when the flow rate of heat will be equal through both.

92. Two vessels of different material but have identical shape size and wall thickness. They are filled with ice. ice melting rates are 100 g / minute and $\frac{150\,g}{minute}$ respectively calculate the ratio of thermal conductivities of both vessels. assuming that the heat enters through walls only.

Unit - VIII

93. What is a cyclic process ? What is the change in energy of a system after it completes one cycle of such process.

94. A gas does work during isothermal and adiabatic expansion. What are the sources of Mechanical energy in both cases.

95. Why does air pressure in a car tyre increases during driving ?

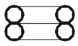
96. Can two isothermal curves intersect ?

97. Is the efficiency of heat engine more in hilly areas ?

98. Define coefficient of thermal conductivity ? Write its SI and C.G.S. units.

99. Surface temperature of stars are 727^0C and 327^0C . Find the ratio of heat radiated per second by the two stars.

100. When water is heated from 0^0C to 10^0C. What happen to its volume ?

101. Two rods of same length, radius and material are joined like  Fig(1) transfer given amount of heat in 12 sec s. But when they are joined as  Fig (2) calculate the time taken to transfer same amount of heat.

Unit - X

102. Why frequency is the most fundamental property of wave ?

103. How energy is transmitted in wave motion.

104. State important properties of the medium responsible for wave propagation.

105. Why longitudinal waves are called pressure wave.

106. What does cause the rolling sound of thunder ?

107. Some times in a stringed instrument a thick wire is wrapped by a thin wire why ?

108. Why does the pitch of a note produced by a wooden open organ pipe becomes sharpen when the temperature increases ?

109. Why the beats are not heard if the difference in frequency is more ?

110. Is it necessary for beat production amplitudes should be equal.

111. What points of the stretched string between two fixed point must be plucked to excite 2nd harmonic.

112. Two organ pipes of same length open at both ends produce sound of different frequencies if they are of different diameter why ?

113. In resonance tubes if different type of liquids will be used, How will the frequency be affected ?

114. A mass M is suspended from a spring of negligible mass. The spring is pulled a little and then released to make it oscillate simple harmonically. If the mass is increased by m the time period changes to $^{5T}/_{3}$. What is the ratio $^{m}/_{M}$?

115. A simple pendulum has time period T_1, the point of suspension is now moved upwards with relation $y = k t^2$ and $k = 1$ M/sec^2 y is the vertical displacement. Find the ratio of $\frac{T_1^2}{T_2^2}$ where T_2 is the changed time period.

116. Can a pendulum be used in an artificial satellite ?

117. In SHM if $a = -16x$. Find the time period.

118. The angular velocity and amplitude of S.H.M are W and A. Find the ratio of K.E and P.E at X. X is distance from mean position.

119. Give unit of epoch.

120. Amplitudes of two oscillators are 2 cm and 5 cm with same K. Find the ratio of energies.

◆◆◆

Answer to group - C

Short question of 2 marks.

1. Refer text. Standard amount to choose a physical quantity is unit.

   dimension $\rightarrow$ power to which fundamental quantity be raised

2. Dimensional constants $\rightarrow$ planck's constant universal gravitational constant constant in coulomb's law

   dimension less constant $\rightarrow$ pure number

   dimension less variable $\rightarrow$ $\sin\theta$

   Dimensional variables $\rightarrow$ velocity, Momentum.

3. work, energy, Torque $M L^2 T^{-2}$

4. Errors $\rightarrow$ Instrumental, personal, External causes, wrongly arranged experiment

   There may be random error or instrumental errors.

   errors may be calculated as absolute, relative gross and percentage of error.

5. $Z = \frac{A}{B}$

$$Z \pm \Delta Z = \frac{A + \Delta A}{B \pm \Delta B}$$

$$= \frac{A}{B}\left(1 + \frac{\Delta A}{A}\right)\left(1 \pm \frac{\Delta B}{B}\right)^{-1}$$

$$= \frac{A}{B}\left(1 + \pm\frac{\Delta A}{A} \mp \frac{\Delta B}{B} \mp \frac{\Delta A\,\Delta B}{A B}\right)$$

$$\frac{A}{B}\left[1 \pm \frac{\Delta Z}{Z}\right] = \frac{A}{B}\left[1 \pm \frac{\Delta A}{A} \mp \frac{\Delta B}{B}\right]$$

So $\frac{\Delta Z}{Z} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$ } maximum.

6. Even the rain is falling vertically downwards it strikes car in the direction of relative velocity of rain with respect to the car.

7. An object may be in relative rest or relative motion with reference to different references. A person sitting in side running train is in motion with respect to person on the platform but at rest with respect to person sitting inside train

8. Slope $= \frac{V_0}{x_0} \quad \frac{dv}{dx} = -\frac{v_0}{x_0}$

$$\int dv = \int -\frac{v_0}{x_0}dx$$

$$V = -\frac{v_0}{x_0}x + C$$

at $x = 0\, v = 0$

So $c = v_0$

$$v = -\frac{v_0}{x_0}x + v_0$$

$$\frac{dv}{dt} = -\frac{v_0}{x}\frac{dx}{dt} = -\frac{v_0}{x_0}\left(-\frac{v_0}{x_0}x + v_0\right)$$

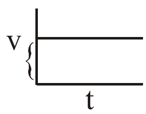
$$\frac{dv}{dt} = \frac{v_0^2}{x_0^2}\,x\; - \frac{v_0^2}{x_0} = \text{acceleration.}$$

9. $\frac{V_A}{V_B} = \frac{\text{Tan } 30}{\text{Tan } 45}$

10. No a body can not be at two places at same time.

11. $\frac{da}{dt} = \text{Slap} \quad \frac{LT^{-2}}{T} = LT^{-3}$.

    Meter / sec^3

12. 

13. $\vec{A}.\vec{B} = \left(\hat{i}\,Ax + \hat{j}\,Ay\right).\left(\hat{i}\,Bx + \hat{j}\,By\right)$

$$= Ax\,Bx + Ay\;By\;\; \hat{i}\,.\,\hat{j} = 0$$

$$\hat{i}.\hat{i} = \hat{j}.\hat{j} = 1$$

14. Horizontal velocity v cos 45^0 at both point but vertical velocity v sin 45 and – v sin 45

So change in momentum is

$$2mv \sin 45 = 2mv \frac{1}{\sqrt{2}} \frac{V_1}{V_2} = \sqrt{2}\, mv$$

15. When circular road is banked horizontal component of reaction of road provides the centripetal force. Thus the friction reduces and no wear and tear.

16. $2V_1 = 4V_2 \qquad \frac{V_1}{V_2} = \frac{4}{2}$

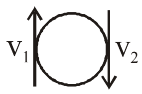
17. Coefficient of friction will be unchanged

18. F = 4N m = 4 kg a = 1 m/sec^2

$$S = \frac{1}{2}at^2 \quad = \frac{1}{2} \times 1 \times 16 = 8 \text{ mt}$$

19. linear momentum

20. $mv - (-mv) = 2mv$



21. $\vec{S} = 4\hat{j} + 3\hat{k} - (-2\hat{i} + 5\hat{j})$

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

$$\vec{F}.\vec{S} = (4\hat{i} + 3\hat{j}).(2\hat{i} - \hat{j} + 3\hat{k})$$

$$= 8 - 3 = 5 \text{ J}$$

22. C.G. is raised causing instability.

23. No it depends upon axis positions.

24. MI small as r is small so w large as angular momentum $I\omega$ constant in absence of torque.

25. Projectile motion.

26. Due to small mass table tennis ball has less momentum so less force is required to stop it than the cricket ball.

27. During first few steps of his motion there is static friction which is more than the kinetic motion after it starts moving.

28. Weight of water causing fall of water is utilised to provide centripetal force so water donot fall down.

29. When lift starts it starts from zero velocity to attain uniform velocity so there is an acceleration in intial stage but after that there is no acceleration so man experiences a small effective g' (g-a) so he experiences a loss of weight. after words a = 0 so weight is mg.

30. No every action force is having a reaction force.

31. Rolling friction is smaller than sliding friction.

32. No because acceleration will not be same $a = g - \frac{F}{m}$ heavier mass will be having greater acceleration so it will reach early.

33. If there is no gravitational attraction for space ship from any nearby object then there will be no force so no acceleration.

34. S = kt V = K constant a = 0 so force = 0

35. To give more time, less force on foot. Impulse = Force × time bending knees slowly value of time impact inceases

36. $\frac{g}{2}(2n-1) = S_{nth}$

So 1st $S_1 = \frac{g}{2}$ 2nd second $S_2 = \frac{3g}{2}$

$$S_3 = \frac{5g}{2}$$

So, work done 1 : 3 : 5

as W = F S

37. ball is having energy $E = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2E}{M}}$ at the highest point only

horizontal component of velocity

$v\cos\theta = v\cos 60^0 = \sqrt{\frac{2E}{m}}\cos 60$

$= \sqrt{\frac{2E}{m}}\ \frac{1}{2}$

$\frac{1}{2}m\left(v\cos 60^0\right) = \frac{1}{2}m\frac{2E}{m}\frac{1}{4} = \frac{E}{4}$

38. $e = -\frac{v_1 - v_2}{u_1 - u_2}$

In perfectly elastic collision K.E. and momentum conserved

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$m_1\left(u_1 - v_1\right) = m_2\left(v_2 - u_2\right)$ — (1)

$\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$

$m_1\left(u_1^2 - v_1^2\right) = m_2\left(v_2^2 - u_2^2\right)$ — (2)

dividing $u_1 + v_1 = u_2 + v_2$

$u_1 - u_2 = v_2 - v_1$

so $e = 1$

39. $\text{range} = \frac{u^2\sin 2\theta}{g} = 160$

maximumm so $\theta = 45$

$\frac{u^2}{g} = 160$

maximum height $\frac{u^2}{2g}$ so 80 mt.

40. $A^2 + A^2 + 2A^2\cos\theta = A^2$

$2 + 2\cos\theta = 1$

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

$\cos\theta = -\frac{1}{2}$

$\theta = 120^0$

angle between of $\vec{A}$ and $\vec{A}$ is 120^0

41. range $\frac{u^2\sin 2\theta}{g}$

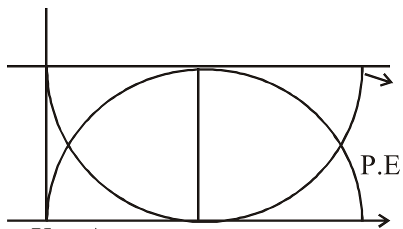
$\sin 2\theta = \sin\left(180 - 2\theta\right) = \sin 2\theta_1$

$2\theta_1 = 180 - 2\theta$

$\theta_1 = 90 - \theta$

42. Conservaive force is the force such that work done by the force is independent of path. It is derivable from potential. Coulomb force, gravitational force

43.



44. at the top P.E = mgh K.E = 0 at some point x from top.

$mg\left(h - x\right) = P.E$

$V^2 = 2gx$

$K.E = \frac{1}{2}mV^2 = mgx$

So P.E + KE = mg (h–x) + mg x = mg h

at the ground $\frac{1}{2}mv^2 = mgh = KE$

P.E. = 0

Total energy = mgh

45. $\frac{K}{2r^2}$

46. $\frac{u^2}{g} = 2\frac{u^2}{g}\sin 2\theta$

$\sin 2\theta = \frac{1}{2}$ $\quad 2\theta = 30 \quad \theta = 15^0$

47. Maximum height $\frac{u^2}{2g}\sin^2\theta$

$\frac{u^2 \sin^2\alpha}{2g} = \frac{u^2}{2g}\sin^2(90-\alpha)$

$\sin^2\alpha = \sin^2(90-\alpha) = \cos^2\alpha$

$\text{Tan}^2\alpha = 1 \qquad \alpha = 45^0$

48. $T_1 = \frac{F}{4} \qquad T_2 = \frac{F}{2} \qquad T_3 = \frac{3}{4}F$

49. As first law and third law are specific cases of 2nd law.

$\vec{F} = m\vec{a}$ if $\vec{a} = 0 \quad \vec{F} = 0$ first law.

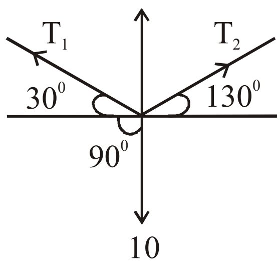
50. $\frac{d\vec{p}}{dt} = 0$ if $F = 0$ P constant

51. $\vec{F}\Delta t = d\vec{p}$ vector

52. $\mu_S = \tan\theta$ from text

53. $MV = m \times 0 + (M-m)\, v_1$

$v_1 = \frac{Mv}{M-m}$ momentum conservation.

54. 

$T_1 \cos 30 = T_2 \cos 30$

$T_1 = T_2$

$T_1 \sin 30^0 + T_2 \sin 30^0 = 10\,N$

$2T_1 \frac{1}{2} = 10 \quad T_1 = 10\,N$

$T_2 = 10\ N$

55. $\frac{MR^2}{2} + MR^2 = \frac{3MR^2}{2}$

56. $MI = \frac{M\ell^2}{3}$

So $\vec{L} = I\omega = \frac{M\ell^2}{3}\omega$

57. $\left(\frac{\omega_0}{2}\right)^2 = \omega_0^2 - 2\alpha\,\theta_1$

$0 = \frac{\omega_0^2}{4} - 2\,\alpha\,\theta_2$

Initial velocity ω_0. Final velocity 0.

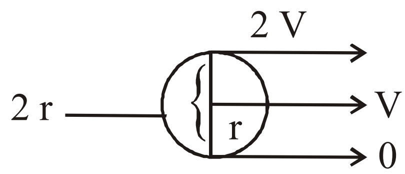
$\frac{\theta_1}{\theta_2} = 3:1$ f or θ_2, $n/3$ rotations

58. In both cases mechanical energy is same as height is same.

So $\frac{1}{2}\,I\,\omega^2$ is same

$|v| = \omega r$ also same.

but acceleration $\alpha \sin\theta$ where θ is angle of inclination so time of descend will be different.

59. 

$V_{relative} = 2V$

$\text{acceleration} = \frac{(\text{velocity})^2}{\text{radius}}$

$\text{acceleration} = \frac{4v^2}{2r} = \frac{2v^2}{r} = \frac{2v^2}{r}$,

where $r \rightarrow$ radius

60. Angular momentum is conserved

$mv_0\,x = \frac{ML^2}{12}\omega$

Linear momentum

$mV_0 = MV$

$$MVx = \frac{ML^2}{12}\omega$$

$$v = \frac{WL}{2}$$

$$\frac{\omega L}{2}x = \frac{L^2}{12}\omega, \quad x = \frac{L}{6}.$$

61. Mass of gun $\rightarrow$ M mass of shell $\rightarrow$ m

$$MV_1 = m\ (v - v_1) \qquad v_1 = \frac{mV}{M+m}$$

$$M\left(v\cos 30^0 - v_2\right) = mv_2$$

$$v_2 = \frac{m\,v\,\sqrt{3}}{2(M+m)}$$

So $\dfrac{v_1}{v_2} = \dfrac{2}{\sqrt{3}}$

62. – mass same and elastic collision

63. Impulse = change in momentum = Ft
= meu cos α – (–mu cos α)
= (e+1) mu cos α

$$F = \frac{mu\cos\alpha(e+1)}{t}$$

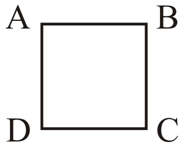
64. Before impact P $\rightarrow$ momentum of A
0 $\rightarrow$ momentum of B
After impact say for B, momentum = P_1, then impulse, change in momentum
So impulse $J = P_1$
but for A momentum $P - P_1$ impulse change in momentum.

So $e = \dfrac{[P_1] - [P - P_1]}{P} = \dfrac{P_1 - (P - P_1)}{P}$

$$= \frac{J + J - P}{P} = \frac{2J}{P} - 1$$

65. m $\xrightarrow{\ p\ }$ • 2 m momentum of 1st mass will be $-\dfrac{P}{3}$ and K.E of 2nd will be $\dfrac{8K}{9}$

66. $\dfrac{AB}{BC} = 2$



$2AB + 2BC = \ell$
$4\ BC + 2\ BC = \ell$

$$BC = \frac{\ell}{6}$$

$AB = \dfrac{\ell}{3} = DC \qquad AD = BC = \dfrac{\ell}{6}$

$I = \dfrac{7}{162}M\ell^2$ by applying MI formula of rod $M_{AB} = M_{DC} = \dfrac{M}{3}$

$$\frac{M}{6} = M_{BC} = M_{AD}$$

$$= \quad I = 2I_{AB} + I_{AD} + I_{BC}$$

$$= \quad 2\frac{M}{3}\left(\frac{\ell}{3}\right)^2\frac{1}{3} + \frac{M}{6}\left(\frac{\ell}{3}\right)^2 + 0$$

$$= \frac{7}{162}m\ell^2$$

67. Entire tube will be filled with water

$h = \dfrac{2T}{rpg}$ free fall means. g = 0

68. $2T \times \ell = \pi r^2 \ell \rho g$ = Surface tension force
= weight of the wire
$\ell \rightarrow$ length $\qquad$ r $\rightarrow$ radius

$\dfrac{2T}{\pi r^2 \rho g} = 1 \qquad \dfrac{2T}{\pi \rho g} = r^2$

$$r = \sqrt{\frac{2T}{\pi pg}}$$

69. Mercury meniscus is convex so the pressure difference is $\dfrac{2T}{r}$

$hpg = \dfrac{2T}{r} \qquad h = \dfrac{2T}{rpg}$

70. Surface tension force + upthrust = weight

$$2\pi r T + \frac{2}{3}\pi r^3 \rho_\omega g = \frac{4}{3}\pi r^3 \rho_{steel} g.$$

Putting value of T, $\rho_{steel}, \rho_\omega$

$$\rho_\omega = \frac{1 kg}{M^3} \qquad g = 9.8 Mt/sec^2$$

r = 1.2 mm.

71. $h = \frac{2T}{r\rho g}$ $\quad m = \pi r^2 h \rho =$

$$\pi r^2 \frac{2T}{rpg}\rho \qquad M = \frac{2\pi r T}{g}$$

When 2r, $h^1 = \frac{2T}{2rpg}$

$$M^1 = \pi(2r)^2 \frac{T}{r_1 \, p \, g} p$$

So $\quad M \propto r$

So in the second tube mass will be 2 m

$$M^1 = 2M$$

72. $Q = \frac{\Delta p}{\frac{8\eta \ell}{\pi r^4}}$ $\quad Q \propto \Delta P \, r^4,$

$$\frac{Q_1}{Q_2} = \frac{\Delta p r^4}{2\Delta p\left(\frac{r}{2}\right)^4} = \frac{8}{1}$$

73. $\frac{2T}{\rho g d}$ $\quad$ as $2T = d\ell\rho g$

So $\ell = \frac{2T}{d\rho g}$

$$\frac{T_1^2}{T_2^2} = \frac{4}{16\times 6} = \left(\frac{1}{8}\right)^2$$

$$\frac{T_1}{T_2} = \frac{1}{64} = \frac{R_1^3}{R_2^3}$$

$$\frac{R_1}{R_2} = \frac{1}{4}$$

75. $T_2 \propto R^3$ year will be having 129 days.

76. $V_{escape} = \sqrt{\frac{2GM}{R}} = R\sqrt{\frac{8}{3}G\pi\rho}$

earth $\rightarrow V_{escape} = R\sqrt{\frac{8}{3}G\pi p}$

planet $\rightarrow$ vescape $= 2R\sqrt{\frac{8}{3}G\pi p}$

$$V_E / V_P = \frac{1}{2}$$

77. $V = -\frac{GM}{r}$ $\quad g = -\frac{GM}{r^2}$

Ans – 8000 km

78, 79. $T^2 = \frac{4\pi^2 R^3}{GM_E} = \frac{4\pi^2 R^3}{G\frac{4}{3}\pi R^3 \rho}$

$$T^2 = \frac{3\pi}{G\rho} \qquad \text{So } \rho T^2 = \frac{3\pi}{G}.$$

80. energy $= E = \frac{1}{2}mv^2$

$$v = \sqrt{\frac{2E}{m}}$$

81. $\omega^1 = \frac{1}{2}\omega$ $\quad$ Then $T = 2T$

$$T^2 \propto R^3 \qquad R' = 2^{2/3} R$$

82. $T \; \alpha \sqrt{\frac{1}{g}}$ $\quad \frac{T_2}{T_1} = \sqrt{\frac{g_1}{g_2}}$

$$g_2 = \frac{g_1}{\left(1+\frac{h}{R}\right)^2} \qquad \text{but } h = R$$

$g_2 = \frac{g_1}{4}$ $\qquad \frac{T_2}{T_1} = \sqrt{\frac{4g_1}{g_1}} = 2:1$

83. Kinetic energy

$$= -\frac{GMm}{R} - \left(-\frac{3}{2}G\frac{Mm}{R}\right)$$

$$= \frac{1}{2}\frac{GMm}{R}$$

$$\frac{1}{2}mv^2 = \frac{1}{2}\frac{GMm}{R}$$

$$v = \sqrt{\frac{GM}{R}} = \sqrt{gR} = \frac{v_{escape}}{\sqrt{2}}$$

as $v_{escape} = \sqrt{2gR}$

$$g = \frac{GM}{R^2} \qquad R = \left(\frac{3M}{4\pi p}\right)^{\frac{1}{3}}$$

$$g \propto M^{1/3}\ \rho^{2/3}$$

$$\frac{g_{planet}}{g} = (8)^{1/3}\ 8^{2/3} = \frac{g_{planet}}{g} = 8.$$

85. Clouds are opaque to heat radiation

86. object with higher temperature will cool faster as per Newton's law of cooling.

87. To minimise the surface area of exposure so less heat will be emitted out.

88. On above heat emission is due to conduction, convection and radiation but at sides only due to conduction and radiation.

89. To remove air breathen out which is warm and goes up due to convection

90. heat capacities equal

$M_1C_1 = M_2\ C_2$

$(M_1 + M_2)\ C\ = M_1\ c_1 + M_2\ C_2 = 2\ M_1\ C_1$

$$C = \frac{2M_1C_1}{M_1 + M_1\frac{C_1}{C_2}} = \frac{2c_1\ c_2}{c_1 + c_2}$$

91. $\frac{K_1A_1(T_1 - T_2)}{x}$

$$= K_2\ A_2\frac{(T_1 - T_2)}{x}$$

$$= K_2A_2\frac{(T_1 - T_2)}{x}$$

Heat flow rate $K_1\ A_1 = K_2\ A_2$

$$K \propto \frac{1}{A}$$

92. $K_1\ A\frac{(T_1 - T_2)t}{x} = m_1L$

$$K_2\ A\frac{(T_1 - T_2)t}{x} = m_2L$$

$$\frac{K_1}{K_2} = \frac{m_1}{m_2} = \frac{100}{150} = \frac{2}{3}$$

93. When the thermodynamic state of a system changes in a such a manner that it returns to its initial state is cyclic process.
So energy change is zero.

94. In case of isothermal process source of mechanical energy is conversion of heat to work. Heat is supplied from or to the system from sorrounding. In adiabatic process internal energy get converted to mechanical work as $dQ = 0$.

95. Due to friction it gets heated, temp increase means pressure increases.

96. No if two isotherms intersect then pressure and volume of gas are same at two different temperatures.

97. In hilly areas the temperature of sorrounding is lower than in plains so the ratio $\frac{T_2}{T_1}$ is less in hilly areas

$\eta = 1 - \frac{T_2}{T_1}$ so η is more in hilly areas.

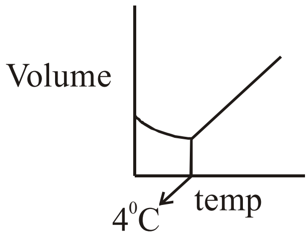
98. From text, k of material is quantity of heat that flows per unit time through unit cube with 1^0 temperature gradient

unit $J S^{-1} m^{-1} k^{-1}$

Cal S^{-1} CM^{-1} $^0C^{-1}$

99. $\frac{H_1}{H_2} = \frac{(727+273)^4}{(327+273)^4} = \left(\frac{5}{3}\right)^4 = \frac{625}{81}$

100. Explain anomalous expansion of water. At 4^0C the volume is minimum density is maximum



101. —— In one it is series combination other is parallel combination

$\frac{H}{12} = \frac{H}{t}$ = Heat current

for parallel combination time 12 sec

$\frac{H}{12} = (T_1 - T_2)\left(\frac{1}{R} + \frac{1}{R}\right) = (T_1 - T_2)\frac{2}{R}$

$\frac{H}{t} = \frac{T_1 - T_2}{R+R} = \frac{T_1 - T_2}{2R}$

$12(T_1 - T_2)\frac{2}{R} = t\left(\frac{T_1 - T_2}{2R}\right)$

$t = 48$ seconds.

102. v, λ changes Frequency constant

103. by oscillating neighbouring particle disturbance is transferred and energy is also transfered.

104. elasticity and inertia.

105. Alternate compression and expansion zone travells.

106. Due to multiple refraction of sound.

107. To increase mass per unit length so frequencies of low value can be produced.

108. fundamental frequency $= \frac{v}{2L}$

v increases with temperature so frequency increases

109. If per second there will be more beats due to persistency of hearing one will not be able to distinguish between beats.

110. May not but equality will increase the clarity of beats.

111. In second harmonic node is in between two antinodes so wire should be plucked at $\frac{1}{4}\ell$ and touched at $\frac{\ell}{2}$.

112. frequency will be affected due to end correction $f = \frac{v}{2(L+0.3D)}$

Length $-$ L Diameter $\rightarrow$ D

113. frequency is independent of density.

114. $T = 2\pi\sqrt{\frac{M}{K}}$

$\frac{5T}{3} = 2\pi\sqrt{\frac{M+m}{K}}$

$\frac{5}{3}2\pi\sqrt{\frac{M}{K}} = 2\pi\sqrt{\frac{M+m}{K}}$

$\left(\frac{5}{3}\sqrt{M}\right)^2 = (M+m)$

$\frac{25}{9}M = M + m$

$\frac{m}{M} = \frac{16}{9}$

115. $T_1 = 2\pi\sqrt{\frac{\ell}{g}}$ $y = Kt^2$,

$\frac{dy}{dt} = 2Kt, \frac{d^2y}{dt^2} = 2K$

$a = \text{acceleration} = 2m/sec^2$

$T_2 = 2\pi\sqrt{\frac{\ell}{g+a}}$

$\frac{T_1^2}{T_2^2} = \frac{g+a}{g} = \frac{10+2}{10}$

$\frac{T_1^2}{T_2^2} = \frac{6}{5}$.

116. No as $g = 0$ so $T = \infty$

117. $a = -\omega^2 x$ $\omega = 4$

$T = \frac{2\pi}{4}$

118. $\frac{1}{2}K\ A^2 = \text{Total energy}$

$P.E. = \frac{1}{2}K\ x^2$

$K.E = \frac{1}{2}K\left(A^2 - x^2\right)$,

$\frac{P.E}{K.E} = \frac{x^2}{A^2 - x^2}$

119. radian

120. $\frac{A_1^2}{A_2^2} = \frac{4}{25}$.

◆◆◆

Group - D

3 Marks Questions :-

Unit - I

1. $G^p C^q h^r$ Find the value of p, q, r. Where G $\rightarrow$ gravitational constant C$\rightarrow$ velocity of light h $\rightarrow$planck's constant.

2. Find the dimensions of a/b in the equation $F = a\sqrt{x} + bt^2$ where F $\rightarrow$ Force x distance, t is the time.

3. The specific resistance ρ of a thin wire of radius rcm, resistance $R\Omega$ and length Lcm.

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

$r = 0.26 \pm 0.02\,cm$ $R = 32 \pm 1\ \Omega$ $L = 78 \pm 0.01\ cm$

Find the percentage of error in ρ.

4. Why SI is rational in comparison to MKS in measuring energy ?

5. If g is acceleration due to gravity λ is wavelength the n $\sqrt{\lambda g}$ represents what physical quantity?

6. State the number of significant figures in 0.007 m and 2.67×10^{-24} kg

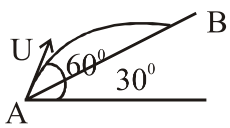
Unit - II

7. Draw the following graphs for an object projected upward with velocity v_0 and which comes back after some time.
   (a) acceleration verses time graph.
   (b) speed verses time graph
   (c) Velocity verses time graph

8. Can two vectors of unequal magnitudes be combined to give zero resultant. So what is the minimum number of coplanar vectors which will be giving zero resultant.

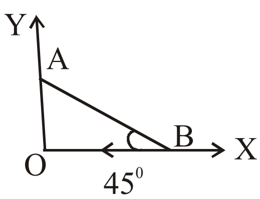
9. What is the maximum number of components a vector can be resolved ?

10. Time taken by the projectile to reach from A to B is t seconds. Calculate the distance AB from this figure.



11. Two particles A and B are connected by a rigid rod AB The rod slides along the perpendicular rail the velocity of B towards left is 20 m/sec.

What will be the speed of A when $\angle OBA = 45^0$.



12. In a car race can A takes time t less than car B and passes the finishing point with a velocity V more than the velocity with which car B passes the point. Cars start from rest and travel with acceleration a_1 a_2. Find the value of V.

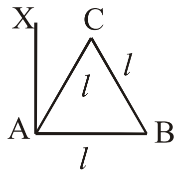
13. If x is distance and t is time for travelling and $t = ax^2 + bx$ where a, b are constants. Express instantaneous acceleration in terms of instantaneous velocity.

14. A bullet fired into a fixed target looses half of its velocity after penetrating 3 cm. How much further it will penetrate before coming to rest provided there is a constant resistance.

Unit - V

15. Two identical cylinders start from rest at the top of an inclined plane. One slides without rolling and other rolls without slipping. Assuming no loss of energy which one will reach first.

16. Three particle each of masses M are situated at the vertices of an equilateral triangle of side ℓ. Find the moment of inertia of the system about line Ax perpendicular to AB and in the plane of triangle ABC .



17. A body of mass 1 kg is rotating on a circular path of diameter 2m at the rate of 10 rotations in 31.4 S. Calculate the angular momentum and rotational kinetic energy.

18. A tube of length ℓ filled with a liquid of mass M is rotated about one of the end in a horizontal plane with angular velocity w. What amount of force will be exerted by liquid at the other end.

19. Initial angular velocity of a circular disc of mass M is w_1 Two small spheres of mass m are attached to two diametrically opposite points on the edge of disc. What is the final angular velocity of the disc.

Unit - VI

20. Why the law of gravitation called the universal law ?

21. If the forces of gravity acts on all bodies in proportion to their masses why does a heavy body not fall faster ?

22. Earth is continuously pulling moon towards its centre still it does not fall to the earth.

23. If the diameter of earth becomes twice how the weight of the substance will vary when M_{Earth} is constant.

24. If the radii of two planets be R_1 and R_2 and their mean densities are ρ_1 and ρ_2 then find the ratio of g_1 and g_2.

25. The weight of a body is less inside the earth than on surface why ?

26. What you feel while moving on a merry go round ?

27. The mass and diameters of a planet are twice those of earth what will be time period of pendulum which is a seconds pendulum in earth ?

28. Where will a body weigh more 1 km above the earth or 1 km below the surface of earth.

29. What are the factors which determine whether the planet will have an atmosphere or not.

30. What is the effect of rotation of earth on the acceleration due to gravity ?
31. State important features of gravitational force.
32. Define intensity of gravitational field at a point. Explain.
33. Define gravitational potential at apoint and write the equation connecting gravitational field and potential.
34. Define escape velocity and explain.
35. State kepler's laws of planetary motion.
36. What is weightless ness ?
37. Two similar objects are dropped from same height at poles and equator. How their motion will be affected ?
38. What will happens if capillary tube is dipped in water vessel kept on a freely falling lift ?
39. When does a cyclist appears to be stationary with respect to another moving cyclist ?
40. Draw position time graph for two objects having zero relative velocity.
41. Is it possible to have a constant rate of change of velocity when velocity changes both in magnitude and direction ? If yes justify with example.

Unit - VII

42. Why sand is drier than clay ?
43. How is the rise of liquid affected if the top of the capillary tube is closed ?
44. Water gets depressed in a glass tube whose inner surface is coated with wax. Why ?
45. What makes water proof rain coat water proof ?
46. Two soap bubbles of un equal sizes are blown at the ends of the cappillary tube. What will happen to both the bubbles. Explain with reason.
47. Hotter liquids move fatser why ?
48. An ice piece with an air bubble in it is floting in a vessel containing water. What will happen to water level when ice completely melts.
49. What is the value of bulk modulus for an incompressible liquid.
50. A spiral spring is stretched by a force what type of strain is produced ?
51. Springs are made up of steel and not of copper why ?
52. To keep a piece of paper horizontal you should blow over it why ?
53. The size of the needle of a syringe or thumb pressure of the doctor at time of adminstering an injection controlls the flow rate better ?
54. State Hooke's law and explain graphically.
55. Define elastic limit and elastic fatigue.
56. Which is more elastic rubber or steel ?
57. Define elastic constants and their units and dimensions.
58. Derive an expression for energy stored in a wire due to extension.
59. Define poisson's ratio what is significance of negative sign ?
60. How does ploughing fields help in preservation of moisture in the soil.
61. What is Reynold number ?

62. Derive poiseuille's formula on dimensional analysis.
63. Define terminal velocity. On which factors terminal velocity depends ?
64. Draw velocity profile for viscous and non viscous liquids.
65. State and explain Bernoulle's principle.
66. Define surface tension and surface enegy and state their relation.
67. Derive an expression for excess pressure inside a liquid drop.
68. Wire of length ℓ and diameter d is replaced by another wire of length ℓ and diameter 3d. How the elongation produced in wire will be affected if the load is same.
69. Justift railway tracks are laid on large wooden sleepers.
70. Give reasons that two holes are made to empty an oil tin.
71. Two liquids of different cefficient of viscosity are stirred vigorously. Which will come to rest earlier if stirring is stopped.
72. It is advised not to stand near the edge of the platform, when first running train is approaching. Why ?
73. It is often observed that a sinking ship turns over as it becomes immersed in water.
74. When a pipe through which water is flowing out is partially closed by the fingure. What happens to water stream and why ?
75. If viscocity of air is taken in to account then how the orbital velocity of satellite moving close to earth wil be affected ?
76. A rubber ballon has 200 g of water in it neglecting the weight of balloon what will be apparent weight of water ?

Unit - V

77. Should centre of mass of a body necessarily lie inside the body ?
78. A body is in rotational motion. Is it necessary that a torque is acting on it ?
79. Why a force is applied at right angles to heavy door at the outer edge at the time of opening or closing ?
80. About which axis would a uniform cube have a minimum rotational inertia ?
81. A disc is recasted into a cylinder of same radius how the moments of inertia about axis passing through the centre and perpendicular to disc will be related to MI of cylinder around its axis.
82. Show graphically how MI of a solid sphere about an axis parallel to diameter and at distance x varies with x.
83. Why the speed of a whirl wind in a tornado is alarmingly high ?
84. What is the use of fly wheel in rail way engine ?

Unit - VII

85. If two identical springs of steel and copper are pulled by equal forces then in which case more work will have to be done.
86. If two idential springs of steel and copper are having equal stretching then in which case more work will be done.
87. Two wires of same length and material but different radii are suspended from rigid support. Both carry same load. How stress, strain and extensions are related to their radii.

88. When elastic restoring forces are conservative ?

89. Distinguish between elasticity and plasticity.

90. Why dust generally settles down in a closed room ?

91. Why do clouds are seen floating in the sky ?

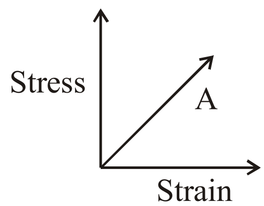
92. Why parachut is used while jumping from an aeroplane.

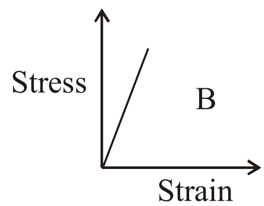
93. Why an aeroplane runs for some distance on the run way before taking off ?

94. What happens to the external energy maintaining the flow of liquid when the flow becomes turbulent when a liquid wets a solid ?

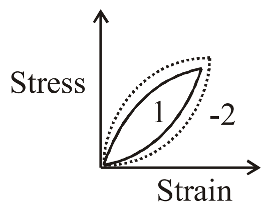
95. Why machine parts get jammed in the winter ?

96. From the stress strain graph which material is having larger Young's modulus.



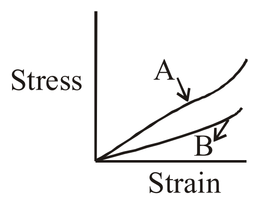


97. Stress strain curve for two different types of rubber are shown $1 \rightarrow$ solid line 2 — dashed line.



Which will dissipate more amount of heat energy.

98. In the plot



Which has more tensile strength ?

99. A thick wire is suspended from a rigid support with out any load on its free end. Whether it is stressed ?

100. Is it possible to double the length of wire ?

101. Among solid, liquid and gas which posseses all type of elastic modulii.

102. What is the difference between pressure and stress ?

103. How young's modulus changes with temperature ?

Unit - VIII and IX

104. Solid sphere of copper of radius R and hollow sphere of the same material of inner radius r and outer radius R heated to same temperature and are allowed to cool in the same environment which will cool faster.

105. The difference between lengths of two rods of diferent materials can remain same at all temperatures explain.

106. Why does a solid expands on heating ?

107. Is J a physical quantity ?

108. Why most telephone or power lines are loose ?

109. Why is invar used in making a clock pendulum ?

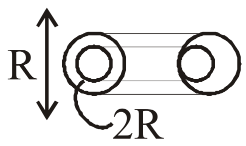
110. Explain why a beaker filled with water at 4^0C over flows on heating or cooling ?

111. Why is water used as on effective coolant in radiator ?

112. Why birds are often seen to swell their feathers in winter ?

113. When walking on marble bare footed one feels cold why ?

114. One cylinder of radius R is sorrounded by another hollow cylinder of internal radius R and outer radius 2R.

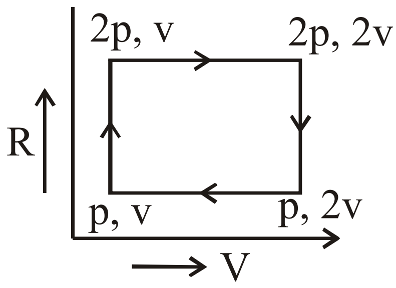


If k_1 and k_2 are their thermal conductivity, Ends are at same temperature then find the effective k for the system in steady state.

115. What is the difference between heat and work ?

116. If one is asked to increase the efficiency of carnot engine by increasing the temperature of source or by reducing the temperature of sink by same amount which method will be preferable ?

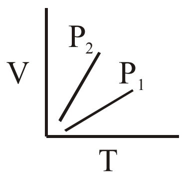
117.



An ideal gas is taken around the cycle as in P-V diagram. Calculate the work done.

118. Show that slope of an diabatic curve at any point is γ times the slope of an isothermal curve at the corresponding point.

119. The volume verses temperature T graphs for a certain amount of a perfect gas at two pressures p_1 and p_2 which p_1 or p_2 is greater ?



120. The coolant in a nuclear plant should have a high specific heat why ?

121. A refrigerator is to maintain eatables kept inside at 9^0C calculate the coefficient of performance.

122. Air pressure in a car tyre increases during driving way ?

123. State first law of thermodynamics and information it gives ?

125. The increase in internal energy of a system is equal to work done on the system which process the system under goes.

126. A reversible engine converts one sixth of the heat input into work. When the temperature of sink is reduced by 62^0C the eficiency is doubled. What are the temperature of source and sink.

127. At what temperature does all molecular motion ceases and why ?

128. For an ideal gas the internal energy is only translational kinetic energy. Why ?

129. Two gases each at temp T, volume V and pressure P are mixed such that the temperature of mixture is also T and volume V, what will be pressure of mixture on the basis of kinetic theory.

Waves and Oscillations Unit - X

129. Give one example of oscillatory motion and periodic motion which are not simple harmonic.

130. State what provides restoring force for simple harmonic oscillation in case of (a) simple pendueum (b) spring (c) column of liquid in a U tube.

131. What is the displacement amplitude if a_0 is the maximum acceleration and V_0 is the maximum velocity.

132. If the bob of a vibrating pendulum is made of ice. How the time period will be affected when ice gets melted.

133. $y = \sin^2 wt$ represents a periodic or simple harmonic motion. What is the period of the motion.

134. A body is executing

$y = 14 \sin\left(100\pi t + \pi/6\right)$. Find its maximum speed and acceleration.

135. Find the phase differences between displacement, velocity and acceleration in SHM.

136. Differentiate between longitudinal and transverse wave.

137. Differentiate between stationary and progressive wave.

138. All harmonics are overtones but all overtones are not harmonic justify.

139. Why sound produced in air not heard by person deep inside water.

140. What is the effect of pressure on the speed of sound ?

141. Derive Laplaces correction to Newton's formula for sound velocity.

Refer text book.

142. Define wave velocity, frequency and wave length and establish their relation.

143. Discuss the effect of temperature and humidity on sound velocity.

Refer text book.

144. What you mean by wave motion.

145. Differentiate between the mechanical & electro magnetic and matter waves.

146. State illustrate super positons of waves.

147. State the laws of vibration in stretched string.

148. On the basis of dimensional analysis derive expression for velocity of wave on a stretched string.

149. A body is executing S.H.M at what distance from mean position the energy is half kinetic and half potential.

150. What is meant by simple harmonic motion. Show that x(t) = a cos wt + b sin wt is simple harmonic.

151. Show that the total energy of the particle executing simple harmonic motion is directly proportional to square of amplitude and frequency.

152. A ball of mass m fits smothly in the cylindrical neck of an air chamber of volume V. The neck area is A. Show that the oscillations of the bulb is SHM and find the time period.

153. What are beats prove that the beat frequency is difference in frequencies of two superimposing waves.

154. What is dopper effect ?

155. Show that all harmonic are present in open organ pipe.

156. State differences between stationary and progressive wave.

157. If the tension of stretched wire is increased to 4 times how does the wave speed change?

158. Two sound sources produce 12 beats in 4 seconds By how much do their frequencies differ ?

159. Show that a simple harmonic oscillator has its velocity at a distance $\frac{\sqrt{3}}{2}$ of its amplitude from the central position is half of its velocity in central position.

160. A girl is swinging in the sitting position. How will the period of swing change if she stands up?

◆◆◆

Answer to Group - D

1. $P=\frac{1}{2},\ q=\frac{3}{2},\quad r\frac{1}{2}$

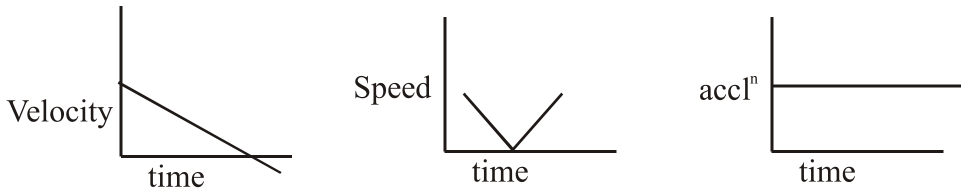
2. $\frac{a}{b}=L^{-1/2}\ \ T^{2}$

3. Nearly 18%

4. In M.K.S energy is measured in different ways heat – calorie
   electrical energy – watt – meter
   but in SI energy unit is Joule every where.

5. $\sqrt{\lambda g}\ \longrightarrow$ velocity

6. In both 3 significant figures

7. 

8. No, minimum three

9. infinite number

10. $\frac{u\,t}{\sqrt{3}}$ $\qquad U_H = U\cos 60=\frac{U}{2}$

$$AB=\frac{ut}{2}\sec 30=\frac{ut}{\sqrt{3}}$$

11. $x^2+y^2=\ell^2$ $\qquad \frac{dx}{dt}=\frac{y}{x}\frac{dy}{dt}\ \ y=x\ \ $ as $\theta=45^0$

so $\frac{dx}{dt}=\frac{dy}{dt}=20\,m/sec$

12. $V_1-V_2=V \qquad t_2-t_1=t$

$S=\frac{1}{2}\quad a_1t_1^2=\frac{1}{2}a_2t_2^2 \qquad v_1=a_1t_1\ \ v_2=a_2t_2$

$t_1^2=\frac{2s}{a_1}\ t_2^2=\frac{2s}{a_2} \qquad S=\frac{v_1t_1}{2}=\frac{v_2t_2}{2}$

$$\frac{v_1-v_2}{t_2-t_1}=\frac{v}{t}=\left[\frac{\frac{2s}{t_1}-\frac{2s}{t_2}}{t_2-t_1}\right]=\frac{2s}{t_1t_2}=\sqrt{a_1a_2}\ t$$

13. $t = ax^2 + bx \quad \frac{dx}{dt} = \frac{1}{2ax+b} \qquad \frac{d^2x}{dt^2} = \text{acceleration} = \frac{dv}{dx}\ \frac{dx}{dt}$

$$\frac{dv}{dx} = \frac{-2a}{(2ax+b)^2}$$

$$\text{So} \quad a = -\frac{2a}{(2ax+b)^3} = -2a\ v^3$$

14. $v^2 - u^2 = 2as \quad \left(\frac{u}{2}\right)^2 - u^2 = 2as. \quad a = -\frac{u^2}{8}$

$$v = 0 \quad a = \frac{u^2}{8}$$

$$\frac{-u^2}{4} = 2.\left(-\frac{u^2}{8}\right)s \quad \text{So} \quad S = 1\ \text{CM}$$

15. $E = \frac{1}{2}mv^2 \qquad v = \sqrt{\frac{2E}{m}}$

$$\frac{1}{2}mv'^2 + \frac{1}{2}I\omega = \frac{1}{2}mv'^2 + \frac{1}{4}mv'^2 = \frac{3}{4}mv'^2 = E$$

$$v' = \sqrt{\frac{4E}{3m}}$$

Sliding cylinder will reach first

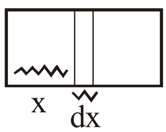
16. $\frac{m\ell^2}{4} + m\ell^2 = \frac{5m\ell^2}{4}$

17. $w = 2\pi f = 2 \qquad I = mr^2 = 1\text{kg m}^2$

$$L = I\omega = 1 \times 2\ \frac{\text{kg m}^2}{\text{sec.}}$$

18. Weight of the water is utilised to provide the centripetal force

$$dF = m\,\omega^2\,r \quad = \frac{M}{L}\,dx.x\ \omega^2\ L$$



$$F = \frac{M}{L}\omega^2 \quad \int_0^L x\,dx = \frac{M}{2}\ \omega^2\ L$$

19. for Disc $L_1 = I_1\,\omega_1 = \frac{1}{2}MR^2\omega_1$

later $I_2 = \frac{1}{2}\ MR^2 + 2\ mR^2$

$L_2 = I_2\ \omega_2 \qquad L_1 = L_2$

$$\omega_2 = \frac{M}{M+4m}\omega_1$$

20. As it is applicable to all bodies in universe which posses mass.
21. Force is produt of masses

$F = \dfrac{G M_1\ M_2}{R^2} \qquad$ So acceleration $= \dfrac{\text{Force}}{\text{Mass}}$

$M_1 > M_2 \qquad$ acceleration $a_1 = \dfrac{G\ M_2}{R^2} \quad a_2 > a_1$

$$a_2 = \frac{G M_1}{R^2}$$

22. Earth and moon both are pulling each other pull is supplying centripetal force. Gravitational force acts $\perp^r$ to the velocity of moon.
23. $g = \dfrac{G M_E}{R^2} \quad g^{/} = \dfrac{g}{4}$

$g^{/} = \dfrac{G M_E}{4\ R^2} \quad M g^{/} = \dfrac{m g}{4}$

24. $g_1 = \dfrac{4}{3}\pi\ G\ R_1\ \rho$

$g_2 = \dfrac{4}{3}\pi G\ R_2\ \rho_2 \qquad \dfrac{g_1}{g_2} = \dfrac{R_1\ \rho_1}{R_1\ \rho_2}$

25. Value of g decreases due to decrease in attracting mass.
26. It appears as if weight increases going up and decreases going doen
27. $g = \dfrac{G M}{R^2} \quad g^{/} = \dfrac{2\ G M}{4R^2} = \dfrac{g}{2}$

$T = 2\pi\sqrt{\ell/g} \qquad T^{/} = 2\sqrt{2}$ sec.

28. $g_h = g_o \left(1 - \dfrac{2h}{Re}\right]$

$g_d = g_o \left(1 - \dfrac{d}{Re}\right]$

$h = d = 1$ km.

$g_n = go \left(1 - \dfrac{2}{Re}\right] \quad gd = g_o C\left(1 - \dfrac{1}{Re}\right]$

$g_d > g_n$.

29. g value and temperature.

30. decreases due to rotation of earth, maximum effect at equator.

31. Gravitational force – basic force possessed by bodies having mass.
(1) long range (2) central (3) conservative
(4) attractive does not depend on medium.

32. Definition. Force per unit mass of test particles placed at that point

$$E = \frac{\vec{F}}{Mo} \text{ dimension } L\ T^{-2} \text{ unit } 1\ N/kg.$$

33. Definition, the potential energy per unit mass at a point in the gravitational field.
Work done in bringing unit mass from infinity to that point in existing gravitational field.

$$v(r) = -\int_{\infty}^{r} \bar{E}_g . d\vec{r} \quad \text{or} \quad Eg(\vec{r}) = -\frac{d\ v(r)}{d r}$$

34. Definition of escape velocity, minimum speed with which a body is projected will escape from earth. derivation of expression $Ve = \sqrt{2g\ R}$

35. Statements of Kepler's law.

36. When acceleration is equal to g example freely falling elevator. Normal reaction from surface is zero.

37. As g is different so g is more at pole than at equator.

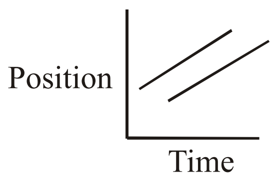
$$h = -\frac{1}{2} g_1 t_1^2 = -\frac{1}{2} g_2\ t_2^2$$

$$\frac{g_1}{g_2} = \frac{t_2^2}{t_1^2} \qquad g_{pole} > g_{equator}$$

$$t_{equator} > t_{pole}$$

38. acceleration is zero so height will be infinity the entire tube will be filled with water.

39. When both move parallel to each other with same velocity, relative velocity is zero.

40. 

41. Yes projectile motion.

42. Due to narrow pores in clay, water rises in clay and keeps it damp but not in sand.

43. As the liquid rises in capillary tube the air gets compressed in between closed end and meniscus. The compressed air opposes the rise of liquid, liquid rises till opposing force balances surface tension force. So liquid rises to smaller height.

44. The angle of contact between water and wax is obtuse contrary to water and glass which is accute. $\cos\theta = -ve$ water gets depressed $h = \frac{-2T\ \cos\theta}{r g\ \rho}$

45. The angle of contact between water and material of rain coat is obtuse. So rain water does not wet rain coat.

46. The bigger one will grow at expense of smaller one. $P \propto \frac{1}{r}$ so P is less for r large so air will flow from higher to lower one.

47. Viscosity is less when temperature more. So hot liquid move faster.

48. The level of water will be unchanged volume of ice is same as volume of water displaced.

49. $\Delta v = 0$ so Bulk modulus is infinite.

50. Shear strain

51. Depends upon young's modulus, the greater is y value stretching will be more for same applied force, steel has greater Y value and it will come back to original state by removal of weight.

52. According to Bernoull'is principle velocity increases means pressure decreases so blowing over paper pressure decreases above and pressure is same as atmospheric below. paper remains horizontal.

53. Equation of continuity

$$A_1 V_1 = A_2 V_2$$

$$A_1 > A_2 \quad V_1 < V_2$$

Thumb area is more so area more, velocity smaller in side than that in needle.

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

$V \rightarrow$ more means more effective size of nedle is having more controlling than the thumb pressure.

54. From text

55. From text

56. Steel it comes back to original state at removal of force.

57. From text

58. From text

59. Lateral strain longitudinal strains are of opposite sign, definition.

60. Due to cappillary rise.

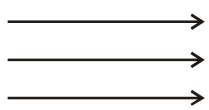
61. From text

62. From text

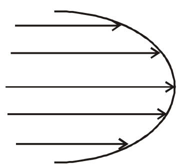
63. terminal velocity of a body is the vertical velocity, air resistance balances weight

$$V = \frac{2}{9\eta} v^2 (\rho - \sigma) g$$

64.



nonviscous



viscous

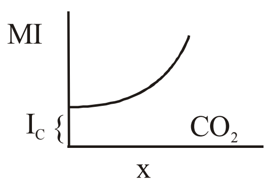
65. From text
66. From text
67. From text
68. $\Delta\ell \propto \frac{F}{A}$ or $\Delta\ell \propto \frac{F}{d^2}$

$$\left.\begin{aligned} \Delta\ell_1 &\propto \frac{1}{d^2} \\ \Delta\ell_2 &\propto \frac{1}{9d^2} \end{aligned}\right\} \quad \frac{\Delta\ell_1}{\Delta\ell_2} = \frac{9}{1}.$$

69. To spread force on larger area.
70. Air comes through one hole, pressure inside the tin is maintained.
71. The liquid with large η value will come to rest earlier.
72. Bernoulli's equation, high velocity low pressure, so sorrounding pressure will push.
73. C.G. goes above the meta centre A couple is created due to weight and buoyant force.
74. Area decreases so velocity increases, range is increased water falls unto greater distance.
75. Due to friction energy deceases, $-\frac{GMm}{2r}$ decreases so r increases.

orbital velocity increases untill it falls on earth.
76. Weight = upthrust
So apparent weight = zero
77. It may lie outside.
78. If body is in uniform angular motion no torque is required.
79. To have maximum torque.

$$\vec{r} \times \vec{F} = |r|\,|F| \sin\theta$$

$\theta = 90^0$ $\sin\theta \rightarrow$ maximum value.
80. diagonal of cube
81. equal.
82. 

$I = I_C + Mx^2$
$x = 0$ $I = I_C$
83. r small I small L = $I\omega$
I small ω lorge
84. Fly wheel has large I
$L = I\omega$ so if there is change in L change in ω is small.
85. Steel has greater Y value but strain is less in steel than in copper work done is more in copper.

86. Y is more stretching may be same in case of steel so more force is required to stretch same amount incase of steel so more work done in steel.

87. Stress depends upon (radius)^2

$\text{Stress} = \frac{\text{Force}}{\text{area}}$ $\quad\quad$ $\text{Stress} \propto \frac{1}{r^2}$

strain = modulus × Stress

$\text{Strain} \propto \frac{1}{r^2}$

$\text{extension} \propto \frac{1}{r^2}$

as $Y = \frac{mg\ell}{\pi r^2 \Delta\ell}$

88. Elastic restoring force conservative within limit of Hooks law

89. From text

90. Dust particles are spherical bodies but of small radii, terminal velocity of dust $\propto$ (radius)^2 radius small so terminal velocity small. So due to air friction after some time dust particles settle down.

91. Clouds consist of tiny droplets of water which are very small so gravitation attraction is small and they appear to float due to buyancey.

92. Due to huge size experiences large viscous force so terminal velocity small for safe landing

93. velocity more and pressure will be less.

94. eddy current is produced

95. Due to decrease in temperature the viscosity of lubricating oil is more. Oil gets thicken Machine get jammed.

96. B slope is more as $Y = \frac{\text{Stress}}{\text{strain}}$

97. 2 area is more which represents ebergy

98. Whose slope is more has more tensile strength.

99. it is stressed by its its own weight

100. No within elastic limit strain is only order of 10^{-3} so wire will break before its length will be twice.

101. Solid posseses all type of elastic modulii.

102. Stress is restoring force per unit area, pressure is applied force per unit area.

103. Young's modulus decreases with rise of temperature, inter atomic distance more, larger strain at high temp.

104. Hollow one because of larger surface area.

$$MC\left(\frac{-d\theta}{dt}\right) = \sigma A\left(T^4 - T_0^4\right)$$

Mass same

105. No coeffiient of expansion different $\frac{\ell_1}{\ell_2} = \frac{\alpha_2}{\alpha_1}$

106. Heating makes atoms to vibrate vigorusly so interatonic distance increases thus solid expands.

107. J is a conversion factor between work and Heat.

108. To adjust contraction in winter

109. Very low coefficient of thermal expansion so length will not change in different seasons.

110. Due to anomalous expansion of water.

111. Specific heat of water is high

112. To enclose air inside the feathers as air is a bad conductor of heat.

113. Marble is better conductor of heat.

114. This is a parallel combination.

$$R_{eff} = \frac{R_1 R_2}{R_1 + R_2}$$

$$R_{eff} = \frac{\frac{\ell}{K_1 \pi R^2} \frac{\ell.}{K_2 \pi\left(4R^2 - R^2\right)}}{\frac{\ell}{K_1 \pi R^2} + \frac{\ell}{K_2 \pi\left(4R^2 - R^2\right)}} = \frac{\ell}{4\pi R^2 K}$$

$$\frac{1}{4K} = \frac{1}{3K_2 + K_1} \qquad K = \frac{3K_2 + K_1}{4}$$

115. Heat is transferred of energy by changing temperature. Work is transfer of energy due to mechanical work.

116. By decreasing sin K temperature.

$$\eta_1 = 1 - \frac{T_2}{T_1 + x} \qquad \eta_2 = 1 - \frac{T_2 - x}{T_1}$$

$$\eta_2 - n_1 = \frac{T_2}{T_1 + x} - \frac{T_2 - x}{T_1} = \frac{T_2T_1 - T_1T_2 + T_1 x - xT_2 + x^2}{T_1\left(T_1 + x\right)}$$

$$\eta_2 - \eta_1 = \frac{x\left(T_1 - T_2\right) + x^2}{T_1\left(T_1 + x\right)} = +ve$$

So $\eta_2 > \eta_1$

117. Work done = area of loop

$\omega = \left(2P - P\right)\left(2V - V\right) = PV$

118. Iso thermal process

PV = constant

$$PdV + V\,dp = 0 \qquad \frac{dp}{dv} = -r\frac{P}{V}$$

Adia batic process.

$$PV^{r} = \text{constant}$$

$$P\,r\,v^{2-1}\ dv + V^{r}\,dp = 0$$

$$\frac{dp}{dv} = -r\,\frac{P}{V}.$$

119. Slope of VT graph $\propto \frac{1}{P}$ as PV = nRT

So P_1 is greater than P_2

120. Coolant to have high specific heat to absorb more heat.

121. T_1 = 309 k + Normal temp 273+36 = 309 k

T_2 = 273 + 9 = 282 k

$$\beta = \frac{T_1}{T_1 - T_2} = \frac{309}{309-282} = 10.4\%$$

122. Due to friction temperature increases thus pressure increases.

123. $dQ = du + pdv = du + d\omega$

conservation of energy

124. $du = -dw$, $dQ = 0$

adiabatic process

125. $\eta = 1 - \frac{T_2}{T_1} = \frac{1}{6}$ $\qquad \frac{T_2}{T_1} = 5/6$

$\frac{1}{3} = 1 - \frac{T_2 - 62}{T_1}$ $\qquad T_1 = 372\ K$

$T_2 = 310\ K$

126. $E = 3/2\ K_B T$

at T = 0, absolute zero. temp E = 0

127. no attraction so no potential energy, no rotational or, no vibrational energy.

128. $P = \frac{1}{3}\,\frac{M}{V}\,u^2$ $\qquad u \rightarrow$ rms speed

$u^2 \propto T$ $\qquad P \propto T$.

$$P \propto \frac{M}{V}\,T.$$

as T and V are same but mass is doubled so P is also doubled.

129. Ball returning from an elastic surface is oscillatory.

Planetary motion periodic.

130. force of gravity, tension in string and weight of liquid.

131. $a_0 = A\omega^2 \qquad \frac{v_0^2}{a_0} = \text{Amplitude}$

$v_0 = A\omega$

132. If a small bob, then centre of gravity does not change, so no change in length, no change in time period but for larger bob C.G position changes, moment of inertia changes, there is decrease in T.

133. $y = \sin^2 wt$

$$\frac{d^2y}{dt^2} = 2\ \omega^2\ \cos 2\,wt$$

$\frac{d^2y}{dt^2}$ is not proportional to y so not SHM, period $= \frac{2\pi}{2\omega} = \pi/\omega$.

134. $y = 14\ \sin\left(100\pi t + \pi/6\right)$

$V_{max} = 14 \times 100\,\pi\ mt/sec \qquad a_{max} = 14 \times (100\pi)^2\ \frac{Meter}{sec^2}$

135. Phase difference between displacement and velocity is $\pi/2$ that between displacement acceleration is π.

136. From text

137. From text

138. Overtones which are integral multiple of fundamentals are harmonics if non intergal multiple then not harmonics

139. Most of sound gets reflected back from the surface of water into air v_{sound} in water $= 4 \times V_{sound}$ in air $\mu = 0.25$ critical angle is nearly 14^0 so for $2 > 14^0$ sound will be reflected back to air.

140. Its magnitude depends on pressure but does not change with variation of pressure as P/ρ ratio remain constant.

141. From text

142. Refer text

143. Refer text

144. Refer text

145. Mechanical wave needs material medium to move electro magnetic wave does not require a medium to travel, oscillations of electric and magnetic field.

Matter wave associated with matter. Every matter has dual characteristics particle form and wave form.

146. graphical and analytical superposition.

147. refer Text

148. Velocity LT^{-1}

V depends on length, mass per unit length and Tension.

$$LT^{-1} = L^x \ F^y \left(\frac{M}{L}\right)^z = L^x \ M^y \ L^y \ T^{-2y} \ M^z \ L^{-z}$$

$$\left.\begin{array}{l} 1 = x + y - z \\ -1 = -2y \\ y + z = 0. \end{array}\right\} \begin{array}{l} y = 1/2 \\ z = -1/2 \\ x = 0. \end{array}$$

$$\text{velocity} = \left[\frac{T}{\left(\frac{M}{L}\right)}\right]^{1/2} = \sqrt{\frac{T}{\mu}}$$

149. $E_K = E_P \ \frac{1}{2} M \ w^2 \ x^2 = \frac{1}{2} m \ w^2 \left(A^2 - x^2\right)$

$$x^2 = \frac{A^2}{2} \quad x = \pm\frac{A}{\sqrt{2}}$$

either side of the mean position

150. S.H.M. where $F \propto x$ $\quad F = -kx$

acceleration $\propto$ displacement

$x = a \cos ut + b \sin wt$

$v = -aw \sin wt + bw \cos ut$

acceleration $= -\ aw^2 \cos wt = bw^2 \ \sin wt$

$= -\omega^2 \ (a \cos ut + b \sin wt) = -\ w^2x$

So it is SHM.

151. Total energy $\frac{1}{2} mv^2 + \frac{1}{2} k x^2$

$$\frac{1}{2} mw^2 x^2 + \frac{1}{2} \ m \ w^2 \left(A^2 - X^2\right)$$

$$= \frac{1}{2} mw^2 A^2$$

$$= \frac{1}{2} m\left(2\pi f\right)^2 \ A^2$$

$$E \propto f^2 \quad E \propto A^2$$

152. If ball is pressed by distance y then air is compressed and change in volume Ay

Bulk modulus $= -\dfrac{P}{\frac{Ay}{V}}$ $\qquad$ Pressure $= -B\dfrac{Ay}{V}$

$$P \times A = Force = -\frac{BA^2 y}{V} \quad Force \ \alpha \, y \ \text{so SHM}$$

$$F = -Ky \qquad K = \frac{BA^2}{V}$$

$$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{mv}{rA^2}}$$ but B = P for isothermal process.

$$T_{isothermal} = \frac{2\pi}{A}\sqrt{\frac{mV}{P}}$$

$$T_{adiabutic} = \frac{2\pi}{A}\sqrt{\frac{mV}{nP}}$$ as B = r P.

153. From the text
154. Refer text
155. Refer text
156. Refer text
157. $V \propto \sqrt{\frac{T}{\mu}}$ if $T^1 = 4T$. $V^1 = 2V$
158. beat frequency is 3 so frequencies differ by 3.
159. $V^2 = \omega^2 \left(A^2 - X^2\right)$

if $x = \frac{\sqrt{3}}{2} A$

$$V^2 = \omega^2 \left(A^2 - \frac{3A^2}{4}\right) = \frac{\omega^2 A^2}{4}.$$

$V = \omega \, A/2$ $\quad \omega A$ – velocity at central position.

160. C.G. is raised. The distance between point of suspension and C.G. decreases ℓ decreases so time period decreases.

◆◆◆

Long Questions

Long Questions :-

Unit - II

1. Derive expression for displacement in t seconds in terms of uniform acceleration and initial velocity.

Ans. $\frac{d\vec{v}}{dt} = \vec{a}$ $\int_U^v \overrightarrow{dv} = \int_0^t \vec{a}\,dt = \int_0^t \vec{a}\ dt$ $\vec{v} - \vec{u} = \vec{a}t$

$\vec{v} = \vec{u} + \vec{a}t$ $\vec{v} = \frac{\overrightarrow{ds}}{dt}$ $=$ $\int_0^t \vec{v}\,dt = \int_{S_0}^{S} \overrightarrow{ds}$

$\int_0^t (u + at)\,dt = S - S_0$ $S = S_0 + ut + \frac{1}{2}at^2$

2. Deferentiate between distance, displacement and instantaneous velocity and average velocity.

Ans. distance $\rightarrow$ Scalar, displacement $\rightarrow$ vector, Magnitude of displacement may be equal to may not be equal to distance.
Definition of both velocities.

3. What is relative velocity ? explain with example. Definition and examples of bodies moving in same direction, opposite direction and moving in direction with an angle.

4. Derive expression for distance covered in nth second.

$$S_{nth} = S_n - S_{n-1} = un + \frac{1}{2}a\,n^2 - u(n-1) - \frac{1}{2}\,a(n-1)^2$$

5. Derive relations between acceleration velocity and distance from plot of s~t , v~t , a~t curve. Example area of vt graph gives distance but slope gives acceleration. area of a~t graph gives velocity.

6. Give uses of dimensional analysis and using this find the relation between physical quantities. State limitations of this analysis.

Ans. Velocity in stretched string can be derived. limitation but no idea about proportionality constant

7. Define relative velocity of one with respect to other. Draw position time graph for two objects when their relative velocity is zero.

Ans. Definition of relative velocity

8. Derive equation $v^2 - u^2 = 2\vec{a}.\vec{s}$

Ans. $\vec{v} = \vec{u} + \vec{a}t$ $(u + at)^2 - u^2 = 2\vec{u}.\vec{a}t + a^2t^2$

$= 2\vec{a}\left(\vec{u}t + \frac{1}{2}\vec{a}t^2\right)$

$= 2\vec{a}.\vec{s}\cdot$

9. State parallelogram law of vector addition and find the magnitude and direction of the resultant of two vectors.

Ans. Statement of law, Figure, construction, then apply pythagorous theorem to get the resultant.

10. State triangle law of addition of vectors and obtain analytically the magnitude and direction of resultant of two two vectors.

(a) statement

(b) Figure

(3) construction

(4) Magnitude of the resultant calculation

11. What is projectile motion ? Derive an expression for height, time of flight, range

Definition, Figure $u_{vertical} = u \sin\theta$, $u_{horizontal} = u \cos\theta$ $v_{horizontal}$ time of flight from vertical velocity = 0. Height from equation $v^2 - u^2 \sin^2\theta = 2gh$.

range = time of flight x $u \cos\theta$.

Unit - III

12. Define centripetal force. Derive expression for centripetal acceleration for a body moving in a horizontal plane in circular path with uniform angular velocity.

Definition, Figure, expression for $\vec{v}$ then that of $\vec{a}$.

13. Explain the terms friction and limiting friction. State laws of limiting friction.

Statements

Explain kinetic and static friction.

14. Define angle of friction and angle of repose. Establish relation between them.

Explanation, Definition, show that they are numerically equal with a figure.

15. What is banking of roads ? Obtain expression for maximum speed that can have a vehicle not to skid

Explanation , Figure

$$R \sin\theta + f \cos\theta = \frac{mv^2}{r}$$

$$mg + f \sin\theta = R \cos\theta \qquad f = \mu R.$$

$$v^2 = rg\left[\frac{\mu + \text{Tan}\theta}{1 - \mu\,\text{Tan}\theta}\right].$$

16. Discuss the motion of a body in a vertical circle. Find the expression for velocity at highest and lowest point. So that body can be looping a loop.

Fig $\rightarrow$ Calculation of tension then calculation of velocity .

Unit - IV

17. State work energy theorem prove it for variable force.

Ans. Statement , $dw = \vec{F}.\vec{ds} = m\vec{a}.d\vec{s}$

$$= m\frac{\vec{dv}}{dt}.\vec{ds} = m\vec{dv}\frac{\vec{ds}}{dt} = m\,\vec{v}.d\,\vec{v}$$

$$w = \frac{1}{2} m \left(v^2 - v^2\right). = \text{ work done} = \text{change in k - E}$$

18. Define elastic collision. Explain it for two bodies. Calculate the velocities after the collision discuss the special cases.

Ans. Write the momentum and kinetic energy conservation equations.

Then solve

$$V_1 = \frac{m_1 - m_2}{m_1 + m_2} \quad u_1 + \frac{2 m_2}{m_1 + m_2} u_2$$

$$V_2 = \frac{m_2 - m_1}{m_1 + m_2} \quad u_2 + \frac{2 m_1}{m_1 + m_2} u_1 \quad m_1 = m_2$$

with $u_1 = 0$ or $u_2 = 0$

or $m_1 >> m_2$ or $m_1 <<< m_2$

19. A large mass M_1 moving with a velocity u collides with a mass m_2 at rest. calculate the energy lost by M_1 after collision $m_2 <<< M$.

Ans. Derive velocity expression

then K.E then $\rightarrow$ K.E. lost

energy = $2m_2 v^2$.

Unit - V

20. Define centre of mass of a system. Derive expression for centre of mass of two body system.

Ans. Expression for acceleration of both $\rightarrow$

Force = mass $\times$ acceleration

$$\vec{F} = m_1 \vec{a}_1 + m_2 \vec{a}_2 = \left(m_1 + m_2\right) \vec{a}_{CM}$$

$$\frac{d^2 \ R_{CM}}{dt^2} = \frac{d^2}{dt^2} \frac{\left(m \vec{r}_1 + m_2 \vec{r}_2\right)}{m_1 + m_2}$$

$$\vec{R}_{CM} = \frac{M_1 \vec{r}_1 + M_2 \vec{r}_2}{M_1 + M_2}$$

21. Derive equations of rotational motion under constant angular acceleration.

$$\alpha = \frac{dw}{dt} \qquad w \rightarrow w_0 + \alpha t$$

$$\frac{d\theta}{dt} = w \qquad \theta = w_0 t + \frac{1}{2} \alpha t^2 + \theta_0$$

$$w^2 - w_0^2 = 2\alpha\theta$$

22. Prove that the rate of change of angular momentum of a system of particles about a reference point is equal to total torque acting on the system.

$$\vec{L} = \sum \vec{r}_1 \times \vec{p}_1$$

$$\vec{\tau} = \sum \vec{r}_i \times \vec{F}_C$$

$$\frac{d\vec{L}}{dt} = \sum_i \frac{d\vec{r}_i}{dt} \times \vec{P}_i + \sum_i \vec{r}_i \times \frac{d\vec{p}_i}{dt}$$

$$\frac{d\vec{L}}{dt} = \sum_i \vec{r}_i \times \vec{F}_e = \sum_i \vec{\tau}_i$$

23. Explain Moment of inertia. State perpendicular axis ad parallel axis theorem of moment of inertia.

Ans. Explanation and statement with Figure.

24. Derive expression for the total work done on a rigid body executing both translational and rotational Motion Hence deduce the condition for equilibrium.

Ans. $\Delta\vec{r} = \vec{v}_0 \, \Delta t + \vec{w} \, \Delta t \times \vec{r}$

$$dw = \vec{F}.\ \Delta\vec{r} = \vec{F}.\Delta\vec{s} + \vec{F}.\left(\overrightarrow{\Delta\phi} + \vec{r}\right)$$

$$= \vec{F}.\overrightarrow{\Delta S} + \vec{i}.\overrightarrow{\Delta\phi}$$

$$w = \sum \vec{F}.\overrightarrow{\Delta s} + \vec{\tau}.\overrightarrow{\Delta\phi}$$

$\Delta s \rightarrow$ linear displacement $\Delta\phi \rightarrow$ angular displacement

$\vec{F} = 0,\ \vec{\tau} = 0$ are conditions for equilibrium.

25. State expressions for moment of inertia of ring, disc, rod, sphere about any axis using parallel axis and perpendicular axis theorem.

Text book (any).

26. Establish relationship between angular momentum, torque with moment of inertia.

$$|\tau| = |r\,F| = |r\ m\ a| = r\ m\ \alpha\ r = mr^2\alpha = I\alpha$$

$\alpha \rightarrow$ angular acceleration

$a \rightarrow$ linear acceleration

$$|\vec{L}| = Pr = m\,v\,r = m\ w\ r\ r = mr^2w$$

$$= Iw$$

Unit - VI

27. State Newton's law of gravitation. Hence define universal gravitational constant. Give the value and dimension of G. How g is related to G.

Ans. Statement, Definition of G

value = 6.67×10^{-1} M m^2 kg^{-2}

Dimension $\rightarrow M^{-1}\ L^3\ T^{-2}$

$$\frac{M_e\ M_b\ G}{R_e^2} = M_b\,g \quad / \quad g = \frac{M_e\,G}{R_e^2}$$

28. What do you mean by acceleration due to gravity. Discuss the variation of g with altitude and depth. If the body is taken to a height $R/4$ find the percentage loss in weight.

Ans. Definition of g, $g = \frac{G\ Me}{R^2}$ So $g_h = g\left(1 - \frac{2h}{R}\right)$

$$g_n = \frac{G\,Me}{(R+h)^2}$$ h is the height for depth

$$g = \frac{G\,Me}{R^2} \qquad g_d = \frac{G\ M^1}{(R-d)^2}$$

$$M' = \frac{4}{3}\pi\,(R-d)^3\,\rho$$

So $g_d = g\left(1 - \frac{d}{R}\right)$..

Problem → $\frac{g_h}{g} = \frac{R^2}{\left(R + R/4\right)^2} = \frac{16R^2}{25R^2} = \frac{16}{25}$

$$\frac{mg - mg_h}{mg} = \left(1 - \frac{16}{25}\right) \times 100 = 36\,\%$$

29. State kepler's laws of planetary motion. Deduce Newton's law of gravitation from kepler's law.

Ans. Statements

$$F = \frac{m v^2}{r} \qquad v = \frac{2\pi r}{T} \qquad F = \frac{4\pi^2 m r}{T^2}$$

$$T^2 \propto r^3 \qquad F = \frac{4\pi^2 m r}{k r^3} = F \propto \frac{M}{r^2}$$
$$T^2 = Kr^3$$

$$F \propto \frac{M}{r^2} \qquad F = \frac{G M m}{r^2}$$

as $\frac{4\pi^2}{k} \propto M$

30. What is escape velocity ? Obtain expression on earth.

Definition, $F = \frac{G M m}{x^2}$, $\int dw = \int_R^\infty \frac{G m M}{x^2} dx$

$$W = \frac{G M m}{R} = \frac{1}{2} m v_e^2 \qquad v_e = \sqrt{2gR}$$

31. What are geostationary sattellite ?

Find the expression for total energy of satellite on the surface of earth.

Ans. Satellite having same time period as earth

$$U = -\frac{GMm}{r} \qquad K.E. = \frac{1}{2} m v_0^2 = \frac{1}{2}\frac{mGM}{r}$$

Total energy $-\frac{1}{2}\frac{GMm}{r}$ –ve sign suggests attraction.

32. What do you mean by centre of mass of a system. How does it differ from centre of gravity ?

(1) Definition (2) CM represents the motion of the entire body. (3) Absence of force leads to contanst velocity of CM (4) Total momentum is equal to total mass × velocity of C M.

Centre of mass is the point where entire mass is said to be concentrated CG is the point where entire gravitational force is concentrated. Both may coincide may not coincide.

33. Derive expression for C M of two particle system

(1) Figure (2) $\vec{a}_1 = \frac{d^2 \vec{r}_1}{dt^2} \quad \vec{a}_2 = \frac{d^2 \vec{r}_2}{dt^2}$

$$M_1\vec{a}_1 + M_2\vec{a}_2 = \vec{F}_{12} + \vec{F}_{21} + \vec{F}_1 ext + \vec{F}_2 ext = \vec{F}_{12} + \vec{F}_{21} + \vec{F}$$

$$\vec{F}_{12} = -\vec{F}_{21}$$

$$M_1\vec{a}_1 + m_2\vec{a}_2 = F$$

$$M\,\vec{a}_{CM} = F$$

$$\vec{a}_{CM} = \frac{1}{M}\frac{d^2}{dt^2}\left(m_1\vec{r}_1 + m_2\vec{r}_2\right) = \frac{d^2\,\vec{R}_{cm}}{dt^2}$$

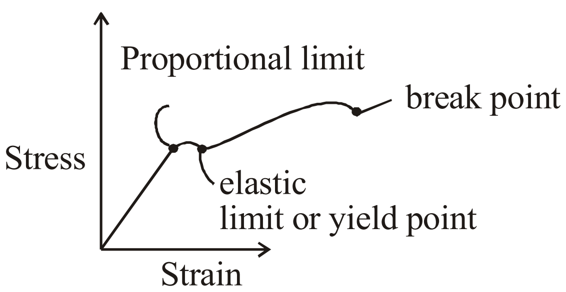
So, $\vec{R}_{CM} = \frac{1}{M}\left(m_1\vec{r}_1 + m_2\vec{r}_2\right) = \frac{m_1\vec{r}_1 + m_2\vec{r}_2}{m_1 + m_2}$

Unit - VII

34. State Hook's law Graphically show the elastic limit, yield point, break point or fracture point. Define modulus of elasticity.

Statement Hook's law

Statement.



Modulus of elasticity = Stress / Strain.

35. Define Young's modulus, Bulk modulus rigidity modulus and poisson's ratio. give their units and dimensions.

Definition- unit - dimensions From text

36. Derive an expression for the elastic potential energy stored in a stretehed wire under stress. Define the terms elastic after effect and fatigue.

$$\text{Total energy volume} = \frac{1}{2}\ \text{Stress} \times \text{Strain} = \text{energy density}$$

Definition of both.

37. What are the conditions of floatation of bodies in static equilibrium ? Explain.

Ans. Weight of the body must be equal to weight of fluid displaced by the immersed portion of the body.

Centre of bouyancy and centre of gravity must lie on the same vertical line. Meta centre should be above centre of gravity.

38. Explain the terms surface tension and surface energy of liquid. Derive an expression for rise of water in capillary tube. Definition and calculation of height.

From text

39. Derive an expression for excess pressure in side water drop and soap buble

$$\text{liquid} \rightarrow P = \frac{2T}{r} \qquad \text{Soap} \rightarrow P = \frac{4\,T}{r}.$$

Unit - VIII

40. Describe a carnot engine. Derive expression for its efficiency.

Figure - explanation of source, sink, piston, working substance, η calculation.

41. Distinguish between isothermal and adiabatic process. Derive expression for the work done in both process.

$$w = \int_{v_1}^{v_2} P\,dv = n\,RT \log \frac{v_2}{v_1} \quad \text{(isothermal)}$$

$$p = \frac{n\,RT}{v}$$

$$w = \int_{v_1}^{v_2} P\,d\,v = \int_{v_1}^{v_2} \frac{A}{v^r} dr$$

$$w = \frac{P_2\,v_2 - P_1\,v_1}{1-r} = n\,C_v\,(T_1 - T_2) \quad \text{(adiabatic)}$$

42. State and explain first law of thermodynamics, Hence prove C_p - C_v = R.

Ans. Statement, explanation, conservation of energy.

$$C_P = \frac{d\,U}{dt}| \text{ constant pressure}$$

$$C_V = \frac{dU}{dt}\Big|\text{ constant volume}$$

$PV = nRT$

$d\theta = ncrdT + pdv$

$d\theta = ncvdT + nRdT = nCpdT$

$Cp - Cv = R$

43. Prove for adiabatic process

$$Pv^r = \text{constant}$$

Ans. $dT = \frac{pdv + vdp}{nR}$

$nC_v dT + pdv = 0.$

$$nC_v\left(\frac{pdv + vdp}{nR}\right) + pdv = 0.$$

$C_p - C_v = R$ So $nC_v vdp + nCp Pdv = 0$

$$\frac{Cp}{Cv}\frac{dv}{v} = -\frac{dp}{p} \rightarrow pv^r = \text{constant}$$

Unit - IX

44. Derive expression of root mean square velocity in terms of Temperature.

$$P = \frac{1}{3}\rho V_{rms}^2 = \frac{1}{3}\frac{M}{V}V_{rms}^2$$

$V \rightarrow$ volume $M \rightarrow$ mass $\rho \rightarrow$ density

$$PV = \frac{2}{3}\frac{1}{2}MV_{rms}^2 = \left(2/3\right)\text{ K.E}$$

$= RT$

T.E = K.E (as P.E = 0)

$$E = \frac{3}{2}RT \quad V_{rms}^2 = \sqrt{\frac{3RT}{M}}$$

45. Derive all gas laws from kinetic theory.

(1) Boyle's law $P = \frac{1}{3}\rho V_{rms}^2 = PV = \frac{1}{3}MV_{rms}^2$.

If T constant $M\bar{V}_{rms}^2$ constant.

So PV = constant $P \propto \frac{1}{V}$

(2) Charle's law

$$P = \frac{1}{3}\frac{M}{V}V_{rms}^2$$

$\overline{V}_{rms}^2 \propto T$ So $P \propto T$. if v constant

rms

also $V \propto T$ if P constant

$$PV \propto \overline{V}_{rms}^2 \propto T.$$

PV = RT. gas law

Avogadro's law if pressure and temp. same

$$\frac{1}{3}\frac{M_1 n_1 v_1^2}{V} = \frac{1}{3}\frac{m_2 n_2 v_2^2}{v}$$

$$M_1 n_1 v_1^2 = m_2 n_2 v_2$$

but K.E. is also same

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

So $n_1 = n_2$

Dalton's law $\rightarrow P_1 + P_2 + P_3 ..... = P$

$$P = \frac{1}{3}\frac{m_1 n_1}{V}V_1^2 + \frac{1}{2}\frac{m_2 n_2 v_2^2}{v}..........$$

$$= \frac{1}{3V}(n_1 + n_2.......)\ m v_{rms}^2$$

as Temperature same So $M_1 v_1^2 = m_2 v_2^2 ... = mv^2 = K.E.$

$$P = \frac{1}{3}\frac{n}{v}m\ v_{rms}^2$$

$v \rightarrow$ volume $\quad n \rightarrow$ no density

Unit - VIII

46. State 2nd law of thermodynamics. How both the statements are equivalent ? Statement and explanation.

Unit - VII

47. Describe Searle's method for determining value of thermal conductivity.
    Figure. Description of experiment the expression for k value.
45. State Stefan's law and Newton's law of cooling. How Newton's law of cooling can be derived from Stefan's law.
    Statement of both law.
    at low Temperature differene

$$T^4 - T_0^4 \longrightarrow T - T_0 .$$

Unit - IX

49. Give basic postulates of kinetic theory of gas. Derive expression for pressure of gas.

From text book

Postulates $\rightarrow$ low P.E , point identical rigid spherical molecules and elastic scattering. Collision time is less comparable to time between collisions. Expression for pressure from text.

50.. Prove that pressure exerted by a gas is $P = \frac{1}{3}\rho\ C^2$ where $\rho \rightarrow$ density and C is root mean square velocity.

Change in momentum –2 mv_x

Total momentum change

$$= \quad 2\,m\,v\,x \times \frac{1}{2} A\,V_x\ \Delta t\ n$$

$A \rightarrow$ area

$\Delta t \rightarrow$ time internal $n \rightarrow$ no density

$V_x \rightarrow$ velocity component

$$F = \frac{\Delta \vec{p}}{\Delta t} = An\ m\ v_x^2,\ \frac{F}{A} = P = n\,m\,v_x^2 \qquad \vec{p} \rightarrow \text{momentum.}$$

$P \rightarrow$ Pressure.

$$v_x^2 = \frac{1}{3}\ C^2 \quad \text{So} \quad P \;=\; \frac{1}{3}\ nm\ C^2 = \frac{1}{3}\ \rho\ C^2$$

51. Define coefficients of thermal expansion and establish relation among them relations $\beta = 2\alpha$ $\quad r = 3\alpha$. Give definitions.

52. State and explain 1st law of thermodynamics. From text.

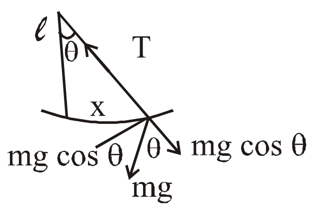
53. Explain three modes of transmission of heat

(a) conduction (b) convection (c) radiation, def^n, medium dependency.

Unit - X

54. Show that for small oscillations the Motion of a simple pendulum is simple harmonic. Derive expression for its time period. Does it depends upon the mass of the bob.

Fig:



$$F = -\,mg\sin\theta \quad \text{for small } \theta\ \sin\theta = \theta$$

$$F = -\ mg\ \theta \qquad\qquad x = \ell\theta$$

$$F = -mg\frac{x}{\ell} = ma \qquad\qquad \theta = x/\ell$$

$$a = -\frac{g\,x}{e} = -w^2x \qquad T = 2\pi\sqrt{\frac{\ell}{g}}$$

no mass dependence.

55. A pendulum clock shows accurate time if length is increases by 0.1 % Deduce the error in time per day.

per day no of seconds = 8 6 400 = ν, let error be $\rightarrow x$

no of seconds $x + 864\,00$ $\qquad$ $\nu^{/}$ – modified frequency

$$\nu \propto \frac{1}{\sqrt{\ell}} \qquad \frac{\nu^{/}}{\nu} = \sqrt{\frac{\ell}{\ell^{/}}} \qquad x = -43.2\,\text{sec}$$

56. Derive expressions for kinetic energy and potential energy of a harmonic oscillator Hence show that total energy is conserved

$$X = A\sin(wt + \phi)$$

$$V - A\,w\,\cos(wt+\phi) \quad K.E = \frac{1}{2}\,mA^2\,w^2\cos^2(wt+\phi).$$

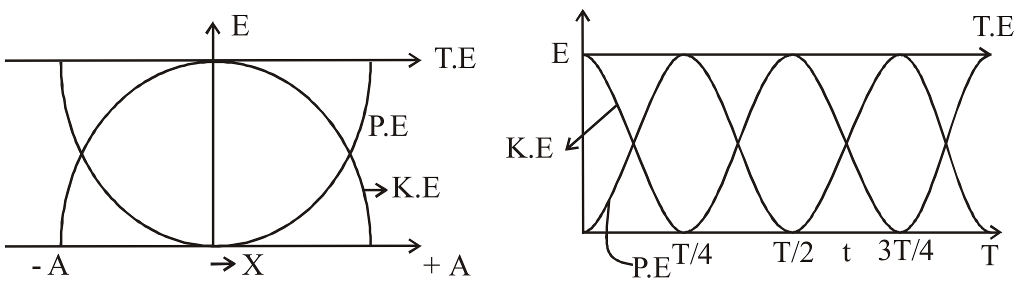
$$P.E = \int_0^x F\,dx = \int_0^x -K(\vec{x}.d\vec{x}) = \int_0^x k\,x\,dx = \frac{1}{2}k\,x^2$$

$\theta \rightarrow 180^0$ in between force and dx.

$$\frac{1}{2}mw^2\;A^2\;\sin^2\;(wt+\phi) = P.E.\text{ as } \frac{k}{m} = w^2$$

So total $E = \frac{1}{2}\;kA^2$

57. Give graphical variation of KE, PE with time and displacement in S.H.M. What is the frequency of these energies with respect to the frequency of simple harmonic oscillator ?



$$X = A\;\sin\;(wt+\phi)$$

$$P.E = \frac{1}{2}\;k\;x^2 = \frac{1}{2}\;k\;A^2\;\sin^2\;(wt+\phi)$$

$$K.E = \frac{1}{2}\;M\;A^2\;w^2\cos^2\;(wt+\phi)$$

if $\phi = 0$ P.E. at $t = 0$ K.E maximum

at $T = T/4$ P.E maximum, K.E = 0

Time period of each being $T/2$

So frequency is twice.

58. What is spring factor ? Derive the resultant spring constant expression when two springs are connected in series and in parallel.

Parallel $F_1 = K_1 y$ $F_2 = -K_2 y$ $F = -(k_1 + k_2)y$ as $F = F_1 + F_2$

So $K = k_1 + k_2$

Series $F = -K_1 x_1 = -K_2 x_2$

So $x_1 + x_2 = \left(\frac{-F}{k_1} + \frac{-F}{k_2}\right) = x = -F\left(\frac{1}{k_1} + \frac{1}{k_2}\right) = \frac{-F}{k}$

$$\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2}$$

59. Find the expression for time period of a body dropped in a tunnel dug along the diameter of earth.

Ans. $T = 2\pi\sqrt{\frac{R}{g}}$ R radius of earth.

60. Time period calculation of a body floating in the liquid with h as submerged length.

Ans. $\rightarrow$ $T = 2\pi\sqrt{\frac{h}{g}}$

$F = Mg - A(h+x)\rho g = -Ax\rho g$

$M = Ah\rho$. $\vec{a} = \frac{A\rho gx}{Ah\rho} = \frac{x}{h} g$

Thus $w = \sqrt{\frac{g}{h}}$ $T = 2\pi\sqrt{\frac{h}{g}}$

$T = 2\pi\sqrt{\frac{h}{g}}$ $\rho \rightarrow$ density of liquid

$L \rightarrow$ length of the body.

61. Derive Newton's formula for speed of sound in ideal gas. What are limitations of this formula. Apply Laplaces correction to the formula.

Text Book.

62. What are stationary waves.

If $y_1 = a\sin\frac{2\pi}{\pi}(vt - x)$ and $\frac{1}{2} = a\ \sin\ \frac{2\pi}{\lambda}(vt + x)$

Derive equation for stationary wave due to their superpositions.

63. Calculate the position of nodes and antinodes. $y = y_1 + y_2$

Ans. $y = 2a\sin\frac{2\pi}{\lambda}vt\ \cos\frac{2\pi}{\lambda}x$

$= 2a\ \cos\frac{2\pi}{\lambda}x \qquad \sin\frac{2\pi}{\lambda}vt$

So $x = 0, \lambda/2, \lambda, 3\lambda/2$ .... antinodes.

$x = \lambda/4,\ 3\lambda/4,\ 5\lambda/4$ .... nodes.

64. Give characteristics of stationary wakes.

Ans refer Text book

65. Compare progressive and stationary wave

Refer the text.

66. Find the frequency of different modes generated in a stationary wave in a stretched string.

Text

67. Derive expression for frequency of different modes in closed and open organ pipe. How fundamentals of both are linked ?

Text

68. Explain what you mean by beats ? How this can be used to know the frequencies of a tuning force ?

Text

69. Explain Doppler effect in sound obtain an expression for the apparent frequencies when source and observer are in relative motion.

Text.

70. State laws of vibration of a string.

Ans. $\nu \propto \frac{1}{\ell} \qquad \nu \propto \sqrt{T} \qquad \nu \propto \frac{1}{\mu}$

Refer text.

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