Higher Secondary Education Board

Class XI (Science)

1. Physics

New Syllabus

Course Contents

Unit - 1 Mechanics **70 teaching hours**

1. Physical Quantities - Need for measurements; system of units; S.I. unit; Precision and significant figures; Dimensions; Main uses of dimensional equations; (3 hrs)
2. Vectors - Graphical presentation of vectors; Addition and subtraction of vectors: Parallelogram, triangle and polygon laws of vectors; Resolution of vectors; Unit vectors; Scalar and vector products. (6 hrs)
3. Kinematics - Uniform and non-uniform motion; average velocity and acceleration, Instantaneous velocity and acceleration; Equation of motion (graphical treatment); Motion of a freely falling body; Relative velocity; projectile motion. (3 hrs)
4. Laws of Motion - Newton's laws of motion; Inertia, force, linear momentum, impulse, Conservation of linear momentum; Free-body diagrams; Solid frictions: Laws of solid friction and their verifications; Application of Newton's laws: Particles in equilibrium, dynamics of particles. (8 hrs)
5. Work, and Energy - Work; work done by a constant force and a variable force; Power; Energy : Kinetic energy; work - energy theorem, Potential energy; conservation of energy; Conservative and non-conservative forces; elastic and inelastic collision. (4 hrs)
6. Circular Motion - Angular displacement, velocity and acceleration; Relation between angular and linear velocity and acceleration; Centripetal acceleration, centripetal force; Conical pendulum; Motion in a vertical circle; Motion of cars and cyclist round a banked track. (5 hrs)
7. Gravitation - Newton's laws of gravitation; acceleration due to gravity, g; Mass and weight; gravitational field strength, variation in value of 'g' due to altitude, depth and rotation of earth; Weightlessness; Motion of a satellites: Orbital velocity, height and time period of a satellite, geostationary satellite, potential and kinetic energy of a satellite; Gravitational potential: Gravitational potential energy; Escape velocity; Black holes. (9 hrs)
8. Equilibrium - Moment of forces; Torque; Torque due to a couple; Centre of mass; Centre of gravity; Conditions of equilibrium. (2 hrs)
9. Rotational Dynamics- Rotation of rigid bodies; Equation of angular motion; Relation between linear and angular kinematics; Kinetic energy of rotation of rigid bodies; moment of inertia: Radius of gyration, Moment of inertia of a uniform rod; Torque and angular acceleration for a rigid body; Work and power in rotational motion; angular momentum; Conservation of angular momentum. (8 hrs)
10. Elasticity - Hooke's law: Force constant, Verification of Hooke's law; Stress; Strain; Elasticity and plasticity; Elastic modulus: Young modulus and its determination, Bulk modulus, Shear modulus, Poisson's ratio, Elastic potential energy. (6 hrs)
11. Periodic motion - Oscillatory motion; Circle of reference; Equation of Simple Harmonic Motion (SHM); Energy in SHM; Application of SHM; Motion of a body suspended from coiled spring angular SHM; simple pendulum, Damped oscillation; Forced oscillation and resonance. (6 hrs)
12. Fluid mechanics- Fluid statics: Density; Pressure in a fluid; Archimedes Principle; Buoyancy

    Surface tension: Molecular theory of Surface tension; Surface energy; Angle of contact and capillarity; Measurement of coefficient of surface tension by capillary tube method.

    Fluid Dynamics: Newton's formula for viscosity in a liquid; Coefficient of viscosity; Laminar and turbulent flow, Poiseuille's formula (method of dimensions); Stokes law and its applications; Measurement of viscosity of viscous liquid; Equation of continuity; Bernoulli's equation and its applications. (10 hs)

Unit - 2 Heat and Thermodynamics **40 teaching hours**

1. Heat and temperature- Concept of temperature; Thermal equilibrium,

   Thermal expansion: linear expansion, cubical expansions and their relation: Measurement of linear expansivity,

   Liquid Expansion: Absolute and apparent expansion of liquid, Measurement of absolute expansivity by Dulong and Petit method. (5 hrs)
2. Quantity of heat : Heat capacity and specific heat capacity; Newton's law of cooling; Measurement of specific heat capacity of solids by the method of mixture and of liquids by the method cooling.

   Change of phases: Latent heat; Specific latent heat of fusion, and vaporization and their measurements by the method of mixture. (5 hrs)
3. Thermal properties of matter- Equation of state: Ideal gas equation; P-V diagram; Molecular properties of matter; Kinetic- molecular model of an ideal gas: Derivation of pressure exerted by gas, average translational kinetic energy of a gas molecule; Boltzman constant, Root mean square speed; Heat capacities; heat capacities of gases and solids. (8 hrs)

4. Hygrometry- Saturated and unsaturated vapor pressure; Behavior of saturated vapor; Boiling point; Triple point and critical point; Dew point, Absolute humidity; Relative humidity and its determination. (3 hrs)
5. Transfer of heat- Conduction, Thermal conductivity and its determination by Searle's method;
Convection: convective coefficient
Radiation: Ideal radiator; Black body radiation; Stefan-Boltzmann law (4 hrs)
6. First law of thermodynamics- Thermodynamics systems; Work done during volume change, Heat and work; Internal energy and First law of thermodynamics; Thermodynamics processes: Adiabatic, Isochoric, Isothermal, Isobaric processes; Heat capacities of ideal gas at constant pressure and volume and relation between them; Isothermal and Adiabatic processes for an ideal gas. (9 hrs)
7. Second law of thermodynamics- Direction of Thermodynamic processes; Second law of thermodynamics; Heat engines; Internal combustion engines; Otto Cycle, Diesel cycle; Carnot cycle; Kelvin temperature scale; Refrigerators, Entropy and disorder (introduction only) (6 hrs)

Unit - 3 Geometrical Optics **20 teaching hours**

1. Photometry, Reflection at curved mirrors- Convex and concave mirrors; Image in Spherical mirrors, Mirrors formula; Real and Virtual images. (2 hrs)
2. Refraction at plane surfaces- Laws of refraction: Refractive index; Relation between refractive indices; Lateral shift; Total internal reflection and its applications; critical angle; optical fiber. (3 hrs)
3. Refraction through prisms- Minimum deviation; Relation between Angle of prism, minimum deviation and refractive index; Deviation in small angle prism. (3 hrs)
4. Lenses- Spherical lenses; thin lens formula; Lens maker's formula; Power of a lens; Combination of thin lenses in contact. (4 hrs)
5. Dispersion- Spectrum; Spectrometer; Pure spectrum; Dispersive power; Achromatic lenses; Condition for achromatic lenses in contact, Chromatic aberration Spherical aberration; Scattering of light-blue color of the sky. (3 hrs)
6. Optical instruments- The human eye; Defects of vision and their correction, Visual angle; Angular magnification; Magnifier, Camera; Compound microscope, Astronomical Telescope (reflection and refractive type) (5 hrs)

Unit - 4 Electrostatics **20 teaching hours**

1. Electrostatics- Electric charge: Electric charges; Conductors and insulators; Charging by induction, Coulomb's law- Force between two point charges, Force between multiple electric charges. (3 hrs)
2. Electric field - Electric fields; Calculation of electric field due to point charges; Field lines.
Gauss Law: Electric Flux; Gauss Law and its application: Field of a charged sphere, line charge, plane sheet of charge. (7 hrs)
3. Potential: Potential and potential difference, Potential due to a point charge; Equipotential lines and surface; Potential gradient; Potential energy, Electron volt. (3 hrs)
4. Capacitance and dielectrics- Capacitance and capacitor; Charging and discharging of capacitor through a resistor; Parallel plate capacitor; Combination of capacitors; Energy of charged capacitor; Effect of a dielectric; Molecular theory of induced charges; Polarization and displacement. (7 hrs)

A student will perform 20 experiments and 4 activities from the given list:
General instruction: Students are expected to learn general ideas of errors, order of accuracy and graphical analysis.

List of Experiments

A. Mechanics

1. Use of Vernier calipers:
a. Determination of the length, the internal and external diameter of a given tube and calculation of its volume and density.
b. Determination of the volume and density of a given rectangular block and verification of the results using a graduated cylinder.
c. Determination of the internal diameter, depth and volume of a beaker or calorimeter.
2. Use of Spherometer:
   a. Determination of the thickness of a given rectangular thin glass plate and calculation of its area using a graduated cylinder.
   b. Determination of the radii of curvatures of a watch glass.
   c. Determination of the focal length of a spherical mirror.
3. Use of screw gauge:
   a. Determination of the diameter of a tube (or of a rod) and a small spherical bob and calculation of their densities.
   b. Determination of the length, volume and density of a tangle of wire.
4. Determination of the coefficient of friction for the two surface by (i) the horizontal plane method and (ii) an inclined plane method.
5. Verification of the principle of moments and the determination of a mass of a given body
6. Use of Simple pendulum:
   a. Determination of the length of a second pendulum and the value of 'g' in the laboratory.
   b. Verification of law of length and determination of the value of 'g' in the laboratory by log-log plot of lime period versus length of the pendulum

7. Verification of Archimede's Principle and determination of the specific gravity of a solid heavier than and insoluble in water
8. Determination of the specific gravity of
   (a) A liquid
   (b) A solid lighter than and insoluble in water
   (c) A solid heavier than and soluble in water
9. Use of Boyle's law apparatus:
   a. Verification of Boyle's Law
   b. Determination of the atmospheric pressure in the laboratory without reading a barometer and verification of the result by reading a barometer.
10. Use of Young's modulus apparatus
    a. Verification of Hooke's Law
    b. Determination of Young's modulus of elasticity of the material of a given wire
11. Determination of the surface tension of water by capillary tube method
12. Determination of the coefficient of viscosity of liquid by Stoke's method

B. Heat

13. Calibration of a given thermometer and determination of the correct temperature of tap water.
14. Use of Pullinger's apparatus
    Determination of the linear and cubical expansivity of a rod
15. Use of Regnault's apparatus:

a. Determination of the specific heat capacity of a solid by the method of mixture.
b. Determination of the specific heat capacity of a liquid by the method of mixture.

16. Determination of the specific heat capacity of a liquid by the method of cooling.
17. Determination of latent heat of fusion of ice.
18. Determination of latent heat of vaporization of water.
19. Determination of the melting point of a solid by
    (i) Cooling curve method
    (ii) Capillary tube method
20. Determination of the thermal conductivity of a good conductor by Searle's method.

C. Geometrical Optics

21. Reflection of light:
    a. Verification of the laws of reflection of light.
    b. Verification of the law of rotation of light.
22. Use of rectangular glass slab:
    a. Verification of the laws of refraction of light.
    b. Study of the variation of lateral shift with angle of incidence and determination of the thickness of the slab.
23. Use of Travelling Microscope:
    Determination of the refractive index of glass slab
24. Determination of the refractive index of a prism by (i) symmetry method. (ii) I-D curve method.
25. Determination of the focal length of
    a. A concave mirror. b. A convex mirror
26. Determination of the focal length of
    a. A convex lens by double pin method
    b. A convex lens by displacement method
27. Determination of the focal length of a concave lens by using convex lens
28. Determination of the refractive index of the material of a plano-convex lens

List of Activities

1. To study the variation in the range of a jet of water with angle of projection
2. To study the effect of detergent on surface tension by observing the capillary rise
3. To study the factors affecting the rate of loss of heat of a liquid
4. To study the nature and size of the image formed by a convex lens using a candle and a screen.
5. To study the conservation of energy of a ball rolling on inclined plane.

Note: The above are only the specimens of activities. In order to arouse creativity, the students must be encouraged to take up new activities (other than mentioned above) in consultation with the teacher concerned.

Laboratory Manual

I. Certificate Level Physics Practical Guide, U.P. Shrestha, Ratna Pustak Bhandar, Kathmandu
II. Elementary Practical Physics, Dr. Narayan Hari Joshi, Taleju Prakashan

4. Teaching strategies:

- Lecturing
- Group interaction
- Problem solving
- Demonstration
- Evaluation

5. Instructional materials

OHP, LCD, demonstration kits, writing boards etc.

Model Question 2065 (2008)

Time: 3 hrs. Full Marks: 75
Pass Marks: 27

You may use the following values of physical constants wherever necessary:

$c = 3 \times 10^8$ m/s $g = 10$ m/s^2
$k = 1.38 \times 10^{-23}$ Jk^{-1} Density of steel = 7800 kg/m^3
Sp. heat capacity of water = 4200 Jkg^{-1} K^{-1}

Group "A"

1. Answer in brief, any **SIX** questions. 2×6=12
   a) What is the difference between accurate and precise measurement?
   b) A ball having a momentum P hits a bat and its momentum becomes–P. What is the change in the momentum of the ball?
   c) State the conditions of equilibrium of a system of coplanar force.
   d) Does the acceleration of a body moving in a circular path remain constant?
   e) Sand is thrown on the roads covered with snow. Why?
   f) Since the moon is constantly attracted towards the earth by the gravitational interaction, why doesn't it crash into the earth?
   g) Explain in terms of breaking stress why elephant has thicker legs as compared to human beings? **[From Unit 1]**
2. Answer in brief, any **TWO** questions: 2×2=4
   a) Why are two thin blankets warmer than a single blanket of double the thickness?
   b) Distinguish between saturated and unsaturated vapour pressure.
   c) Does the coefficient of linear expansion depend on length? Explain. **[From Unit 2]**
3. Answer in brief, any ONE question: 2×1=2
   a) Can a convex mirror ever form a real image? If so, explain with diagram.
   b) What are grazing incidence and grazing emergence? **[From Unit 3]**
4. Answer in brief, any **ONE** question: 2×1=2
   a) A man inside an insulated metallic cage does not receive shock when the cage is highly charged. Explain.
   b) Is it possible to charge a capacitor to any potential? **[From Unit 4]**

Group "B"

5. Answer any **THREE** questions: 4×3=12
   a) State the principle of conservation of linear momentum. How does Newton's third law of motion lead to the principle of conservation of linear momentum?
   b) Prove that the total mechanical energy in gravitational field is always conserved. Also explain conservative and non-conservative forces.
   c) What is SHM? Show that the motion of a bob of a simple pendulum is simple harmonic. Find its time period.
   d) What is capillarity? Deduce an expression for the rise of a liquid in a capillary tube. **[From Unit 1]**
6. Answer any **TWO** questions: 4×2=8
   a) Define specific latent heat of fusion of a solid. Develop an expression for the determination of the latent heat of fusion of ice.
   b) Define the coefficient of thermal conductivity of a substance. Describe Searle's method for determination of the thermal conductivity of a good conductor.
   c) What is a Carnot engine? Derive an expression for its efficiency. **[From Unit 2]**
7. Answer any **ONE** question: 4×1=4
   a) Define power of a lens. Derive the formula for the effective power of two thin lenses in contact.
   b) Describe the construction and working of a compound microscope and hence derive an expression for its magnifying power. **[From Unit 3]**
8. Answer any **ONE** question: 4×1=4
   a) State Gauss law. Apply it to obtain an expression for electric field outside the charged spherical conductor.
   b) Find the equivalent capacitance of two capacitors when they are in (i) series and (ii) parallel **[From Unit 4]**

Group "C"

9. Solve any **THREE** numerical questions: 4×3=12

a) A ballet dancer spins with 2.4 rev/s with her arms outstretched when the moment of inertia about the axis of rotation is I. With her arms folded, the moment of inertia about the same axis becomes 0.6 I. Calculate the new rate of spin.
[Ans: 4 revs^{-1}]

b) A canoe has a velocity of 0.4 m/s south east relative to the earth. The canoe is on a river that is flowing 0.5 m/s east relative the earth. Find the magnitude and direction of the velocity relative to the river.
[Ans: 0.83 ms^{-1}, 28.06 along West of North]

c) The sun has a mass 330,000 times that of the earth. For a person on earth, the average distance to the center of the sun is 23,500 times the distance to the center of the earth. In magnitude, what is the ratio of the sun's gravitational force on you to the earth's gravitational force on you?
[Ans: 3 : 5000]

d) Castrol oil at 20º C has coefficient of viscosity 2.42 Nsm^{-2} and a density 940 Kgm^{-3}. Calculate the terminal velocity of a steel ball of radius 2.0 mm falling under gravity in the oil.
[Ans: 0.25 ms^{-1}] **[From Unit 1]**

10. Solve any **TWO** numerical questions: 4×2=8

a) A ball of copper of specific heat capacity 400 Jkg^{-1} K^{-1} weighing 400 gm is transferred from a furnace to 1 Kg of water at 20° C. The temperature of water rises to 50º C. What is the initial temperature of the ball?
[Ans: 837.5°C]

b) An ideal gas initially at 4 atmosphere and 350 K is permitted to expand adiabatically to 1.5 times its initial volume. Find the final pressure and temperature if the gas is (i) monatomic and (ii) diatomic with C_V = 5/2 R.
[Ans: 2.05×10^5 Pa, 227K, 2.29×10^5 Pa, 298 K]

c) At what temperature will the average speed of oxygen molecule be sufficient so as to escape form the earth? Escape velocity from the earth is 11.2 Km/s and mass of one oxygen molecule is 5.34×10^{-26} Kg.
[Ans: 9.71×10^4 K] **[From Unit 2]**

11. A microscope is focused on the upper surface of a glass plate. A second plate is then placed over the first. In order to focus on the bottom surface of the second plate, the microscope must be raised 1 mm. In order to focus on the upper surface, it must be raised 2 mm farther. Find the index of retraction of the second plate. 4**[From Unit 3]**
[Ans: 1.5]]

12. Two point charges + 1 μC and + 4 μC are placed at a distance of 0.12 m apart. Determine the point on the line joining two charges where net force acting on the unit positive charges is zero. 3 **[From Unit 4]**
[Ans: 0.04 m]

HSEB Questions

Unit 1 – Mechanics

1. Physical Quantities

Short Questions

1. Obtain dimensions of specific heat capacity and gravitational constant. **[Q.N.1 (a), 2054]**
2. The escape velocity of a body is $V_g = \sqrt{\frac{2GM}{R}}$. Check the correctness of the formula using dimension. **[Q.N.1 (e), 2055]**
3. The density of gold is 19.3 gm/cc. Express its value in SI unit. **[Q.N.1 (i), 2055]**
4. Calculate the dimensional formula for Universal Gravitational Constant 'G'. **[Q.N.1 (e), 2056]**

5. Taking force, length and time to be fundamental quntities, find the dimensional formula for the density. [Q.N.1 (a), 2057]
6. Check the correctness of the formula $v^2 = u^2 + 2as$ using dimensional analysis. [Q.N.1 (a), 2059]
7. Convert 10 ergs in joules. [Q.N.1 (a), 2061]
8. A student writes $\sqrt{\frac{R}{2GM}}$ for escape velocity. Check the correctness of the formula by using dimensional analysis. [Q.N.1 (b), 2062]
9. Is dimensionally correct equation necessarily be a correct physical relation ? What about dimensionally wrong equation ? [Q.N. 1(a), 2063]
10. Check the correctness of formula $t = 2\pi\sqrt{\frac{m}{k}}$ where t be the time period, m is the mass and k is the force per unit displacement. [Q.N. 1(b), 2064]
11. What is the difference between accurate and precise measurement ? 2 [Q.N. 1 (a), 2067]
12. Check the correctness of the formula $t = 2\pi\sqrt{\frac{\ell}{g}}$ using dimensional analysis, t is the time period of simple pendulum, ℓ is the length of simple pendulum and g is the acceleration due to gravity. [Q.N. 1(a), Set 'B' 2069]
13. Name any two physical quantities which have the same dimensions. Can a quantity have unit but no dimension? Explain. [Q.N. 1(a), 2070 'C']
14. If $y = a + bt + ct^2$, where y is the distance and t is the time. What is the dimension and unit of c? [Q.N. 1(b), 2070 'D']

2. Vectors

Short Questions

1. Is momentum of a moving body a vector or a scalar ? [Q.N.1 (x), 2050]
2. If **B** is added to **A**, under what condition does the resultant vector have a magnitude equal to **A+B** ? Under what conditions is the resultant vector equal to zero ? [Q.N.1 (b), 2054]
3. If the scalar product of two vectors is equal to the magnitude of their vector product, find the angle between them. [Q.N.1 (a), 2060]
4. Can the sum of two equal vectors be equal to either of the vectors ? Explain. [Q.N.1 (c), 2061]
5. What is the difference between scalar and vector products of two vectors ? Explain. [Q.N.1 (e), 2062]
6. The magnitude of two vectors are 3 and 4, and their product is 6. What is the angle between them ? [Q.N. 1(b), 2063]
7. Two vectors $\vec{A}$ and $\vec{B}$ are such that $\vec{A} - \vec{B} = C$ and $A - B = C$. Find the angle between them. [Q.N. 1(a), 2064]
8. If $\vec{A} \cdot \vec{B} = 0$, what is angle between $\vec{A}$ and $\vec{B}$. [Q.N. 1(a), 2065]
9. $\vec{C}$ is the vector sum of $\vec{A}$ and $\vec{B}$ i.e. $\vec{C} = \vec{A} + \vec{B}$ for $C = A + B$ to be true, what is the angle between $\vec{A}$ and $\vec{B}$? 2 [Q.N. 1 (b), 2067]
10. If the scalar product of two vectors in equal to the magnitude of their vector product, find the angle between them. [Q.N.1(a),2068]
11. If $\vec{A}$ and $\vec{B}$ are non zero vectors, is it possible for $\vec{A} \times \vec{B}$ and $\vec{A} \cdot \vec{B}$ both to be zero? Explain. [Q.N. 1(d), Set 'A' 2069]
12. $\hat{i}$, $\hat{j}$ and $\hat{k}$ are the unit vectors of a force along X, Y and Z axes respectively. Find the magnitude and direction of the vector product of two forces $\vec{F_1}$ and $\vec{F_2}$ if $\vec{F_1} = 3\hat{i}$ and $\vec{F_2} = -2\hat{k}$ [Q.N. 1(a), Supp. 2069]

13 If $\hat{i}$, $\hat{j}$ and $\hat{k}$ are unit vectors a long x, y and z-axis respectively, find $\hat{i}.(\hat{k}\times\hat{j})$ [Q.N. 1(b), 2070 'C']

14. The angle between two vectors $\overrightarrow{A}$ and $\overrightarrow{B}$ is θ. Find the magnitude and direction of $\overrightarrow{A}\times\overrightarrow{B}$ and $\overrightarrow{A}.\overrightarrow{B}$. [Q.N. 1(a), 2070 'D']

Long Questions

1. State the parallelogram law of vector addition. Derive the magnitude and direction of the resultant vector. [Q.N.2 (Or), 2055]
2. State triangle law of vector addition. Obtain an expression for the resultant of two vectors P and Q inclined at angle θ. [Q.N.5. (a), 2066]
3. State the parallelogram law of vector addition. Deduce the expressions for the magnitude and direction of the resultant of two vectors inclined at an angle θ from each other. [Q.N. 5(a), Supp. 2068]
4. State the parallelogram law of vector addition. Derive the expressions for the magnitude and direction of the resultant of two vectors inclined at an angle θ from each other. [Q.N. 5(a), Set 'A' 2069]

3. Kinematics

Short Questions

1. Because of air resistance, two objects of unequal mass do not fall at precisely the same rate. If two bodies of identical shape but unequal mass are dropped simultaneously from the same height, which one reaches the ground first ? [Q.N.1 (i), 2050]
2. Give with an example a case where the velocity of an object is zero but its acceleration is not zero. [Q.N.1 (i), 2051]
3. A projectile fired at an angle of 18^0 has certain horizontal range. State another angle of projection for the same horizontal range. [Q.N.1 (e), 2052]
4. A car is moving on the road when the rain is falling vertically downwards. Why does the front wind screen get wet ? [Q.N.1 (b), 2053]
5. Can an object have an eastward velocity experiencing a westward acceleration ? Give reason. [Q.N.1 (f), 2056]
6. A ball is dropped gently from the top of a tower and another ball is thrown horizontally at the same time. Which ball hit the ground earlier ? Explain. [Q.N.1 (b), 2057]
7. What would be the effect on maximum range in doubling the initial velocity of a projectile? [Q.N.1 (a), 2058]
8. Two stones are projected simultaneously from a height. One falls freely while the other is projected horizontally. Which one reaches the ground first? Explain. [Q.N.1 (b), 2059]
9. Find the angle of projection at which the horizontal range and maximum height of a projectile are equal. [Q.N.1 (b), 2061]
10. A ball is dropped gently from the top of a tower and another ball is thrown horizontally from the same point at the same time. Which ball will hit the ground earlier ? [Q.N.1 (c), 2062]
11. A swimmer wants to reach to a point just opposite on the other bank of the river. How should he swim and why ? [Q.N. 1(b), 2065]
12. Can an object with constant acceleration reverse its direction? Explain. [Q.N.1. (a), 2066]
13. From a high tower, one ball is dropped from rest and the second ball is simultaneously projected horizontally. Neglecting air resistance, which ball will reach the ground earlier ? [Q.N.1(b),2068]
14. When a rifle is fired at a distant target, the barrel is not lined up exactly on the target. Why not? Does the angle of correction depend on the distance of the target? [Q.N. 1(a), Supp. 2068]
15. Can an object with constant acceleration reverse its direction? Explain. [Q.N. 1(b), Set 'B' 2069]

15. Angle between the velocities $\overrightarrow{V_A}$ and $\overrightarrow{V_B}$ of two bodies A and B is θ. Explain, with figure, the difference between the relative velocity of (i) A with respect to B and (ii) B with respect to A. **[Q.N. 1(f), Supp. 2069]**

16. Rain drops hitting the side windows of a car in motion often leave diagonal streaks. Why? **[Q.N. 1(c), 2070 'C']**

17. A projectile moves in a parabolic path without air resistance. Is there any point at which its acceleration is perpendicular to the velocity? Explain. **[Q.N. 1(c), 2070 'D']**

Long Questions

1. A stone is projected with a velocity in a direction making an angle θ with horizontal. Derive expression for:
(i) maximum height (ii) time of flight (iii) horizontal range.
Also find the condition for maximum horizontal range. **[Q.N. 3(a)(Or), 2064]**

2. Derive expressions for maximum height, range of projectile fired at angle 'θ' with horizontal. 3 **[Q.N. 5 (a), 2067]**

3. Prove that the path of a projectile motion is a parabola. Hance find the maximum height attained by it. **[Q.N. 5(a), Supp. 2069]**

Numerical Problems

1. A body is projected horizontally from the top of a tower 100 m high with a velocity of 9.8 ms $^{-1}$. Find the velocity with which it hits the ground.
[Ans: 45.8 ms^{-1}, 77.64° with horizontal] **[Q.N.2 (b), 2060]**

2. An object is dropped from the top of the tower of height 156.8 m. and at the same time another object is thrown vertically upward with the velocity of 78.1 ms^{-1} from the foot of the tower, when and where the object meet ?
[Ans: 2 seconds, 20 m from the top] **[Q.N. 2,(b) 2063]**

3. A projectile is fired from the ground level with a velocity of 500 ms^{-1} at 30° to horizon. Find the horizontal range, and greatest vertical height to which it rises. What is the least speed with which it could be projected in order to achieve the same horizontal range ? [g = 10 N kg^{-1}].
[Ans: 21650.6 m, 3125 m, 465.3 ms^{-1}] 4 **[Q.N. 2(b), 2065]**

4. A projectile is fired from ground level with a velocity 500 m/s at 30° to the horizontal. Find its horizontal range, the greatest height and the time to reach the greatest height. **[Q.N.9. (a), 2066]**
[Ans: 21650.6m, 3125m, 25S]

5. An airplane pilot wishes to fly due west. A wind of 80km/hr is blowing towards the south. If the speed of the plane in still air is 320km/hr, in which direction should the pilot head? What is the speed of the plane with respect to the ground? **[Q.N. 9(a), Supp. 2068]**
[Ans: 14.5° North of West, 310 km/hr]

6. A man wishes to swim across a river 600m wide. If he can swim at the rate of 4km/h in still water and the river flows at 2km/h. Then in what direction must he swim to reach a point exactly opposite to the staring point and when will he reach it?
[Ans: 120°; 625s] **[Q.N. 9(a), Set 'A' 2069]**

7. A base ball is thrown towards a player with an initial velocity 20ms^{-1} and 45º with the horizontal. At the moment the ball is thrown, the player is 50 m from the thrower. At what speed and in what direction must he run to catch the ball at the same height at which it was released?
(Ans: 3.75 ms^{-1} towards' the thrower) **[Q.N. 9 (a), Set 'B' 2069]**

8. An object with mass m moves along the x-axis. Its position as a function of time is given by x(t) = At- Bt^3, where A and B are constants. Calculate the net force on the object as a function of time.
[Ans: 6 B mt] **[Q.N. 9(a), Supp. 2069]**

4. Laws of Motion

Short Questions

1. The acceleration of a falling body is measured in elevator traveling at a constant speed of 9.8 m/s. What result is obtained ? **[Q.N.1 (v), 2050**
2. A rigid, lighter than air balloon filled with Helium can not continue to rise indefinitely. Why ? **[Q.N.1 (ix), 2050]**
3. State Newton's Second Law of motion. **[Q.N.2 (a), 2050]**
4. When a balloon filled with air and its mouth downwards is released, it moves upwards, why ? **[Q.N.1 (iv), 2051]**
5. If action and reaction are always equal and opposite, why don't they always cancel each and leave no force for acceleration of the body ? **[Q.N.1 (a), 2052]**
6. State Newton's second law of motion. **[Q.N.2 (a), 2052]**
7. Give reasons why a man getting out of moving bus must run in the same direction for a certain distance. **[Q.N.1 (c), 2053]**
8. Explain why a cricketer moves his hands backwards while catching a ball ? **[Q.N.1 (c), 2054]**
9. The leaves fall when a tree is shaken. Give reason. **[Q.N.1 (b), 2056]**
10. Why is it difficult to run fast on sand ? **[Q.N.1 (c), 2056]**
11. If a moving bullet striking a block of wood on a frictionless table embeds inside it what happens to the KE of the bullet? **[Q.N.1 (b), 2058]**
12. Is friction a necessary evil? Explain. **[Q.N.1 (c), 2059]**
13. Can a body be regarded in a state of rest as well as in motion at the same time? Give an example. **[Q.N.1 (b), 2060]**
14. Why do we slip on a rainy day ? **[Q.N.1 (e), 2060]**
15. Explain how Newton's first law of motion follows from the second law. **[Q.N.1 (d), 2061]**
16. Why is the kinetic friction less than the limiting friction ? **[Q.N.1 (f), 2061]**
17. Explain why a coin placed on a cardboard covering a glass falls into the glass when the cardboard is pulled suddenly to one side ? **[Q.N. 1(d), 2063]**
18. Why a man getting out of a moving bus must run in the same direction for a certain distance ? **[Q.N. 1(d), 2065]**
19. When a large heavy truck collides with a passanger car, the occupants of the Car are more likely to be hurt than the truck driver. Why? **[Q.N.1. (b), 2066]**
20. A woman in an elevator lets go of her briefcase but it does not fall to the floor. How is elevator moving? **[Q.N. 1(c), Supp. 2068]**
21. When rain falls from the sky, what happens to its momentum as it hits the ground? Is your answer also valid for Newton's famous apple? **[Q.N. 1(d), Supp. 2068]**
22. A man drops his briefcase in a elevator but it does not fall to the floor. What can be concluded about the situation? **[Q.N. 1(f), Set 'A' 2069]**
23. When a large heavy truck collides with a passenger car, the occupants of the car are more likely to be hurt than the truck driver. Why? **[Q.N. 1(c), Set 'B' 2069]**

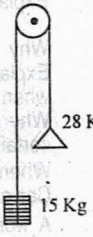
Long Questions

1. State the principle of the conservation of linear momentum and show how it follows from Newton's Second Law of motion. **[Q.N.6, 2050]**
2. What are the laws of friction ? How are they experimentally verified ? **[Q.N.6, 2051]**
3. Show that the principle of conservation of linear momentum can be verified by using Newton's laws. **[Q.N.2 (b), 2052]**
4. State and prove the principle of conservation of linear momentum. **[Q.N.2 (b), 2054]**
5. State the laws of limiting friction. How would you measure the coefficient of friction between a body and an inclined plane. **[Q.N.5, 2055]**
6. State the principle of conservation of linear momentum. Show that in collision between two moving bodies in which no external forces act, the conservation of linear momentum may be deduced directly from Newton's laws of motion. **[Q.N.2 (a), 2060]**

7. What do you understand by friction ? Explain its cause. Show that the coefficient static friction is equal to the angle of repose. [Q.N.3 (a), 2062]
8. What is the angle of repose ? Show that when a body just begins to slide down on an inclined plane, the coefficient of friction is equal to the tangent of inclination of the plane. [Q.N. 2,(a) 2063]
9. State Newton's laws of motion. Show that Newton's first law of motion defines force and second law of motion defines the unit of force. [Q.N. 2(a), 2064]
10. State the principle of conservation of linear momentum. How does the Newton's third law of motion lead to the principle of conservation of linear momentum? [Q.N. 5(c), Set 'A' 2069]

Numerical Problems

1. The mass of gas emitted from the rear of toy rocket is initially 0.2 kgs^{-1}. If the speed of the gas relative to the rocket is 40 ms^{-1}, and the mass of rocket is 4 kg, what is the initial acceleration of the rocket ?
[Ans: 2 ms^{-2}] [Q.N.2 (b), 2057]
2. A lift moves (i) up and (ii) down with an acceleration of 2ms^{-2}. In each case, calculate the reaction of the floor on a man of mass 50 kg standing in the lift.
[Ans: 600N, 400N] [Q.N.2 (b), 2059]
3. A typical car weighs about 1200 N. If the coefficient of rolling friction is $\mu_r = 0.015$. What horizontal force is needed to make the car move with constant speed of 72 km/h on a level road ? Also calculate the power developed by the engine to maintain this speed. 4 [Q.N. 9 (a), 2067]
[Ans: 18N, 360W]
4. A 15 Kg. load of bricks hangs from one end of a rope that passes over a small, frictionless pulley. A 28 kg. counterweight is suspended from the other end of the rope as shown in figure. The system is released from rest. Using free body diagram method, find the magnitude of upward acceleration of the load and the tension in the rope while the load is moving.
(Ans: 3.02 m/s^2, 195.3 N) [Q.N.9(a),2068]



5. A cricket ball of mass 145 gm is moving with a velocity of 14m/s and is being hit by a bat, so that the ball is turned back with a velocity of 22m/s. The force of blow acts on the ball for 0.015 sec. Find the average force exerted by the bat on the ball.
[Ans: 348N] [Q.N. 9(c), Set 'A' 2069]
6. A body falls freely from the top of a tower and during the last second of its fall, it falls through 25m. Find the height of tower. [Q.N. 9(c), Set 'B' 2069]
(Ans: 45m)
7. A block is pushed 1.5m along a horizontal tabletop with horizontal force of 2.4N. If the frictional force between the surfaces in contact is 0.6N, what is (i) work done on the block by the frictional force and (ii) the total work done on the block? [Q.N. 9(b), Supp. 2069]
[Ans: – 0.9 J, 2.7J]
8. A light rope is attached to a block with mass 4kg that rests on a frictionless, horizontal surface. The horizontal rope passes over a frictionless pulley and a block with mass m is suspended from the other end. When the blocks are released, the tension in the rope is 10N. Draw free body diagrams and calculate the acceleration of either block and the mass m of the hanging block.
[Ans: 2.5 ms^{-2}, 4 kg] [Q.N. 9(a), 2070 'C']
9. In a physics lab experiment, a 6kg box is pushed across a flat table by a horizontal force F. If the box is moving at a constant speed of 0.35m/s and the coefficient of kinetic friction is 0.12, find the magnitude of force F. What is the magnitude of force F if the box is moving with a constant acceleration 0.18m/s^2? [Q.N. 9(a), 2070 'D']
[Ans: 7.2 N, 8.28 N]

5. Work and Energy

Short Questions

1. In a syphon, water is lifted above its original level during its flow from one container to another. Where does it get the needed potential energy from ? [Q.N.1 (ii), 2050]
2. What is meant by elastic and non–elastic collision ? [Q.N.2 (a), 2054]
3. Differentiate between conservation of kinetic energy and conservation of linear momentum. [Q.N.1 (a), 2055]
4. Distinguish between conservative and non-conservative force. [Q.N.1 (c), 2057]
5. How does the K.E. of an object change if its momentum is doubled ? [Q.N.1 (d), 2060]
6. "The earth moving round the sun is an orbit is acted upon by a force, hence the work must be done on the earth by this force." Do you agree with this statement ? [Q.N. 1(c), 2063]
7. Two bodies of different masses are moving with the same kinetic energy of translation. Which one has more momentum ? [Q.N. 1(e), 2064]
8. What are elastic and inelastic collisions ? Give examples of each. [Q.N.1(d),2068]
9. How does the kinetic energy of a body change if its momentum is halved? [Q.N. 1(a), Set 'A' 2069]
10. Are conservative and non-conservative forces related with the path of a force involved? Explain in brief. [Q.N. 1(g), Supp. 2069]

Long Questions

1. What is principle of conservation of energy ? Show that total mechanical energy of a body is conserved when it moves under the action of gravitational field. [Q.N.2 (a), 2057]
2. What are elastic and inelastic collision? Give an example of each. Write the energy and momentum equations for an inelastic collision. [Q.N.3 (a), 2059]
3. State and prove conservation of the mechanical energy. 1+3 [Q.N. 2(a), 2065]
4. What are conservative and non-conservative forces? Illustrate your answer by reference to the energy changes occuring in a body whilst falling freely under gravity. [Q.N.5. (d), 2066]
5. Define work. Derive an expression to calculate work done by a variable force. 3 [Q.N. 5 (b), 2067]
6. What is the principle of conservation of energy? Show that total mechanical energy of a body is conserved when it moves under the action of gravitational field. [Q.N. 5 (a), Set 'B' 2069]
7. What is elastic collision? Show that in an elastic collision between two particles, the relative velocity of separation after collision is equal to the relative velocity of approach before collision. [Q.N. 5(a), 2070 'C']
8. Define work. Derive an expression to calculate the work done by a variable force. [Q.N. 5(a), 2070 'D']

Numerical Problems

1. Find the power of an engine in kilowatts which pulls a train of mass 600 tonnes up an incline of 1 in 100 at the rate of 60 km/hr. The weight of the engine is 200 tonnes and the resistance due to friction is 50 Newton's per tonne. [Q.N.3 (Or), 2050]
   [Ans: 2000 kw]
2. A bullet of mass 10g is fired from a gun of mass 1 kg. with a velocity of 100 ms^{-1}. Calculate the ratio of the kinetic energy of the bullet and the gun.
   [Ans: 100] [Q.N.5, 2051]
3. A bullet of mass 20 g. travelling horizontally at 100 ms^{-1} embeds itself in the centre of a block of wood mass 1 kg which is suspended by light vertical string 1 m. in length. Calculate the maximum inclination of the string to the vertical.
   [Ans: 36°] [Q.N.3, 2053]

4. A ball of mass 4 kg moving with a velocity $10ms^{-1}$ collides with another body of mass 16 kg moving with $4ms^{-1}$ from the opposite direction and then coalesces into a single body. Compute the loss of energy on impact.
[Ans: 313.6 J] **[Q.N.2 (b), 2056]**

5. A ball A of mass 0.1 kg moving with a velocity of $6ms^{-1}$ collides directly with a ball B of mass 0.2 kg at rest. Calculate their common velocity if both balls move off together. If ball A had rebounded with a velocity of $2ms^{-1}$ in the opposite direction after collision, what would be the new velocity of B?
[Ans: $2 ms^{-1}$, $4 ms^{-1}$] **[Q.N.2 (b), 2058]**

6. A car of mass 1000kg moves at a constant speed of $20ms^{-1}$ along a horizontal road where the friction force is 200 N. Calculate the power developed by the engine.
[Ans: 4000 W] **[Q.N.3 (b), 2058]**

7. A train of mass 2×10^5 kg moves at a constant speed of 72 kmh^{-1} up a straight inclined against a frictional force of 1.28×10^4N. The incline is such that the train rises vertically 1.0m for every 100m travelled along the incline. Calculate the necessary power developed by the train.
[Ans: 1.28×10^4 N] **[Q.N.2 (b), 2061]**

8. A car of mass 1000 kg moves at a constant speed of 25 m/s along a horizontal road where frictional force is 200 N. Calculate the power developed by the engine.
[Ans: 5 kw] **[Q.N.9. (c), 2066]**

9. A stationary mass explodes into two parts of mass 4 units and 40 units respectively. If the larger mass has an initial kinetic energy of 100J; what is the initial kinetic energy of the smaller mass ?
(Ans: 1000 J) **[Q.N.9(b),2068]**

10. A dock worker applies a constant horizontal force of 80 N to a block of ice on a smooth horizontal floor. The frictional force is negligible. The block starts from rest and moves 11 m in 5 sec. (i) What is the mass of the block of ice? (ii) If the worker stops pushing at the end of 5 sec., how far does the block move in the next 5 sec.? **[Q.N. 9(b), Supp. 2068]**
[Ans: 90.9 kg, 22 m]

11. A 0.15 kg glider is moving to the right on a frictionaless horizontal air track with a speed of $0.80ms^{-1}$. It has a ahead on collision with a 0.300 kg glider that is moving to the left with a speed of 2.2 ms^{-1}. Find the final velocity (magnitude and direction) of each glider if the collision is elastic.
(Ans: $-3.2 ms^{-1}$, $-0.2ms^{-1}$) **[Q.N. 9 (b), Set 'B' 2069]**

12. A petrol engine car of mass 1500kg and efficiency 15% accelerates from rest to 37 m/s in seconds. If one gallon of petrol produces 1.3×10^8J of energy when burnt, how many gallons of petrol this car use during the acceleration?
[Ans: 0.1 **[Q.N. 9(c), Supp. 2069]**

6. Circular Motion

Short Questions

1. When a bus takes a turn, passengers are thrown away from the centre of the curved path. Why ? **[Q.N.1 (f), 2052]**
2. A solid tied at the end of a string is revolved in vertical. At what point the tension in the string will be the greatest ? **[Q.N.1 (g), 2052]**
3. What is meant by angular velocity ? **[Q.N.2 (a), 2053]**
4. Explain why a cyclist inclines himself to the vertical while moving round a circular path ? **[Q.N.1 (e), 2054]**
5. Why does a cyclist bend while going along curved road ? **[Q.N.1 (g), 2055]**
6. The positively charged nucleus of an atom attracts the electron in the orbits. Why do the electrons not collapse into the nucleus ? **[Q.N.1 (a), 2056]**
7. Why are roads banked on curved path? **[Q.N.1 (d), 2059]**
8. What is the source of centripetal force to a satellite revolving round the earth ? **[Q.N.1 (c), 2060]**

9. Why are curved roads banked ? Explain. [Q.N.1 (a), 2062]
10. The positively charged nucleus of an atom attracts the electrons in the orbit. Why do electrons not collapse into the nucleus ? [Q.N. 1(e), 2063]
11. Explain why a cyclist inclines himself to the vertical while moving round a circular path. 2 [Q.N. 1 (c), 2067]
12. In uniform circular motion the acceleration is perpendicular to the velocity at every instant. Is this still true when the motion is not uniform? [Q.N. 1(b), Supp. 2068]
13. Can the direction of the velocity of a body be changed when its acceleration is constant? [Q.N. 1(c), Set 'A' 2069]

Long Questions

1. Why a force is necessary to keep a body moving with uniform speed in a circular motion ? Deduce its expression. [Q.N.2 (i), 2051]
2. Derive an expression for the force required to make a particle of mass m move in a circle of radius r with uniform angular velocity ω. [Q.N.2 (b), 2053]
3. Define centripetal force. Calculate the force acting on a body moving with a uniform speed along a circular path. [Q.N.2 (a) (Or), 2056]
4. Define centripetal acceleration. Derive an expression for it. [Q.N.2 (a) (Or), 2058]
5. Explain what is meant by angular velocity. Show that the acceleration of a body moving in a circle path of radius r with uniform speed v is v^2/r. [Q.N.2 (a), 2061]
6. What is centripetal force ? Derive it in the case of motion of a bi-cycle on a curved road. [Q.N.3 (a) (Or), 2062]
7. What is conical pendulum? Show that the period of oscillation of this pendulum is given by $T = 2\pi\sqrt{l\cos\theta / g}$ where symbols have their usual meanings. [Q.N.5. (c), 2066]
8. What is conical pendulum ? Show that the period of oscillation of this Pendulum is given by: $T = 2\pi\sqrt{\frac{l\cos\theta}{g}}$ Where the symbols have their usual meanings. [Q.N.5(c),2068]

Numerical Problems

1. A coin placed on a disc rotates with speed of $33\frac{1}{3}$ rev. min^{-1} provided that the coin is not more than 10 cm. from the axis. Calculate the coefficient of static friction between the coin and the disc.
   [Ans: 0.122] [Q.N.3, 2052]
2. An object of mass 8.0 kg is whirled round in a vertical circle of radius 2m with a constant speed of $6ms^{-1}$. Calculate the maximum and the minimum tensions in the string.
   [Ans: 224N, 64N] [Q.N.3 (b), 2059]
3. A particle of mass 0.3 kg. vibrates with a period of 2 seconds. If its amplitude is 0.5m what is its maximum kinetic energy ?
   [Ans: 0.37 J] [Q.N.3 (b), 2060]
4. A mass of 1kg is attached to the lower end of a string 1m long whose upper end is fixed. The mass is made to rotate in a horizontal circle of radius 60m. If the circular speed of the mass is constant, find the tension in the string and the period of motion. [Q.N. 9(b), 2070 'C']
   [Ans: 12.5 N, 1.77 sec]
5. A certain string breaks when a weight of 25N acts on it. A mass of 500 gram is attached to one end of the string of 1m long and is rotated in a horizontal circle. Find the greatest number of revolutions per minute which can be made without breaking the string. [Q.N. 9(b), 2070 'D']
   [Ans: 0.01 rev/min]

7. Gravitation

Short Questions

1. What will happen to the value of 'g' if the earth stops rotating? [Q.N.1 (v), 2051]
2. Obtain an expression for gravitational potential energy and establish its dimension. [Q.N.1 (d), 2052]
3. The weight of a body is less inside the earth than on the surface. Explain. [Q.N.1 (d), 2053]
4. Why an astronaut in a space capsule orbiting the earth experiences a feeling of weightlessness ? [Q.N.1 (d), 2054]
5. How does 'g' at a point vary with the distance from the centre of the earth ? Where is the highest value of g ? Explain. [Q.N.1 (b), 2055]
6. Explain why the moon has no atmosphere? [Q.N.1 (d), 2058]
7. What do you mean by geo-stationary satellite ? Explain. [Q.N.1 (d), 2062]
8. If earth suddenly stops rotating about its axis, what would be the effect on g ? [Q.N. 1(f), 2064]
9. If the sun somehow collapsed to from a black hole, what effect would this event have on the orbit of the earth ? [Q.N.1. (c), 2066]
10. If the sun somehow collapsed to form a black hole, what effect would this event have on the orbit of the earth ? 2 [Q.N. 1 (d), 2067]
11. If the force of gravity acts on all bodies in proportion to their masses, why does not a heavy body fall faster than a light body ? [Q.N.1(e),2068]
12. Which takes more fuel, a voyage from the earth to the moon or from the moon to the earth? Explain. [Q.N. 1(g), Supp. 2068]
13. If the sun some how collapsed to form a black-hole, what effect would this event have on the orbit of the earth? [Q.N. 1(b), Set 'A' 2069]
14. Explain the concept of weightlessness with an example. [Q.N. 1(b), Supp. 2069]
15. What will happen to the value of acceleration due to gravity if the earth stops rotating about its axis? [Q.N. 1(g), 2070 'C']

Long Questions

1. Assuming the earth to be perfectly spherical, give sketch graphs to show how:
   a) The acceleration due to gravity, and
   b) The gravitational potential due to earth's mass vary with distance from the surface of the earth to points external to it. [Q.N.6 (Or), 2050]
2. Discuss the variation of acceleration due to gravity below the earth's surface. [Q.N.4, 2053]
3. What is a satellite ? Calculate the orbital velocity of an artificial satellite. [Q.N.2 (a), 2056]
4. What is gravitational potential ? Derive the relation for gravitational potential at a point due to a point mass. [Q.N.3 (a), 2057]
5. What is acceleration due to gravity? Explain how it varies with the altitude. [Q.N.3 (a), 2058]
6. Define escape velocity of a body on a planet. Derive an expression for it. [Q.N.2 (a), 2059]
7. Explain what is meant by the universal gravitational constant. Discuss the variation of acceleration due to gravity with depth and derive an expression for its value at depth d below the surface of the earth. [Q.N.3 (a), 2060]
8. Explain what is meant by the universal gravitational constant. Discuss the variation of acceleration due to gravity with altitude and derive an expression for its value at height h above the surface of the earth. [Q.N.3 (a), 2061]
9. Suppose that a strong man can throw a stone so that it will never return to the surface of earth. How much work does he have to do in throwing up the stone of mass 'm' and find an expression for its minimum velocity ? [Q.N. 3,(a) 2063]
10. How does acceleration due to gravity vary with distance from the centre of earth above and below its center ? [Q.N. 3(a), 2064]
11. What do you mean by parking orbit ? Derive an expression for the orbital velocity and hence find time period of the satellite revolving around the earth. [Q.N. 3(a, or), 2065]
12. What is a satellite ? Obtain an expression of the total energy of a satellite orbiting round the earth. 3 [Q.N. 5 (c), 2067]

13. What is escape velocity ? Derive its expression on the surface of the earth. [Q.N.5(a),2068]
14. What is escape velocity? Show that the escape velocity of a body is $\sqrt{2}$ times the orbital velocity. [Q.N. 5(b), Supp. 2068]
15. What is geostationary satellite? Obtain an expression for the total energy of a satellite orbiting round the earth? [Q.N. 5(b), Set 'A' 2069]
16. What do you mean by the terms black hole and event horizon? Obtain an expression for the schwarzschild radius. [Q.N. 5 (c), Set 'B' 2069]
17. Define escape velocity. Find an expression for the escape velocity from the surface of the earth. [Q.N. 5(b), 2070 'C']
18. What is gravitational potential energy? Obtain an expression for the gravitational potential energy of a body at a distance r from the centre of the earth. [Q.N. 5(b), 2070 'D']

Numerical Problems

1. A 200 kg. satellite is lifted to an orbit of 2.2×10^4 km. radius. If the radius and mass of the earth are 6.37×10^6 m. and 5.98×10^{24} kg. respectively, how much additional potential energy is required to lift the satellite ?
[Ans: 4.47×10^7 J] [Q.N.3, 2051]
2. Calculate the period of revolution of a satellite revolving at a distance of 20 km above the surface of the earth, (Radius of the earth = 6400 km. acceleration due to gravity = 10 m/s^2)
[Ans: 505.013 sec] [Q.N.3, 2054]
3. What is the period of revolution of a satellite of mass m that orbits the earth in a circular path of radius 7880 km about 1500 km above the surface of the earth?
[Ans: 6979.13S] [Q.N.9. (d), 2066]

8. Equilibrium

Short Questions

1. Is it possible for a solid body to have no matter at it centre of gravity ? [Q.N.1 (vi), 2050]
2. What is the difference between centre of gravity and centre of mass of a system. [Q.N.1 (ii), 2051]
3. Why is a cow more stable than a man ? [Q.N.1 (vi), 2051]
4. State principle of moment and give an example. [Q.N.1 (b), 2052]
5. Explain why a man carrying a load on his back leans forward. [Q.N.1 (e), 2053]
6. What is meant by the moment of a couple ? [Q.N.1 (g), 2053]
7. Can a body be in equilibrium if it is in motion ? Explain. [Q.N.1 (f), 2054]
8. Why is a horse more stable than a man ? [Q.N.1 (f), 2055]
9. A man carrying a bucket of water on his hand always leans to the opposite side. Explain why? [Q.N.1 (e), 2058]
10. Define terms: Couple and moment of couple. [Q.N. 1(d), 2064]
11. Why a wrench of longer arm is preferred in comparision to a wrench of short arm ? [Q.N. 1(c), 2065]
12. During pregnancy, women often develop back pains from leaning backward while walking. Why do they have to walk this way ? 2 [Q.N. 1 (e), 2067]
13. Explain why a man carrying a load on his back leans forward. [Q.N.1(c),2068]
14. Does the centre of gravity of a solid always lie within the material of the body? If not, give a counter example. [Q.N. 1(d), Set 'B' 2069]
15. The cap of the bottle can be easily opened with the help of two fingers than with one finger. Why? [Q.N. 1(e), Set 'B' 2069]
16. Does the centre of gravity of a solid body always lie within the material of the body? Explain. [Q.N. 1(d), 2070 'C']
17. When four–legged animals walk, they always have three of their legs on the ground at any instant. Explain why? [Q.N. 1(e), 2070 'D']

Long Questions

1. What do you mean by centre of mass ? Derive an expression for centre of mass of a two particle system. [Q.N.4 (Or), 2053]

2. State principle of moments. Explain how you verify the principle of moment in your laboratory. [Q.N.3 (a) (Or), 2059]
3. Define the terms: couple and moment of a couple. Derive an expression for the work down by a couple. [Q.N.2 (a), 2062]

Numerical Problems

1. A roller whose diameter is 1.0 m. weighs 360 N. What horizontal force is necessary to pull the roller over a brick 0.1 m. high when the force is applied at the centre ?
[Ans: 1800 N] [Q.N.4, 2050]

9. Rotational Dynamics

Short Questions

1. Why is it easier to hold down a 10 kg. body in your hand at your side than to hold it with your arm extended horizontally ? [Q.N.1 (iii), 2050]
2. A fan with blades takes longer time to come to rest than without the blades, why ? [Q.N.1 (iii), 2051]
3. If the earth is struck by meteorites, the earth will slow down slightly. Why ? [Q.N.1 (f), 2053]
4. Suppose that only two external forces act on a rigid body and the two forces are equal in magnitude but opposite in direction. Under what conditions will the body rotate. [Q.N.1 (h), 2054]
5. What is the counterpart of the mass and force in rotational motion ? [Q.N.1 (c), 2055]
6. Explain why spokes are fitted in the cycle wheel. [Q.N.1 (d), 2056]
7. A dancer girl is rotating over a turntable with her arms outstreched. If she lowers her arms how does this effect her motion ? [Q.N.1 (e), 2057]
8. A ballet dancer stretches her arms to reduce her motion. Explain. [Q.N.1 (c), 2058]
9. Can a single force applied to a body change both its translational and rotational motion? Explain. [Q.N. 1(e), Supp. 2068]
10. A fan with blades takes longer time to come to rest than without blades. Why? [Q.N. 1(g), 2070 'D']

Long Questions

1. What is meant by moment of inertia ? How is it related with the rotational kinetic energy of a body ? [Q.N.4 (Or), 2051]
2. Define moment of inertia. Obtain a relation for the moment of inertia of a circular disc. [Q.N.6 (Or), 2052]
3. Define moment of inertia. How is it related with rotational kinetic energy of a body ? [Q.N.3 (a) (Or), 2057]
4. Explain the meaning of the term 'moment of inertia'. Show that the quantity $\frac{1}{2} I\omega^2$ is the Kinetic energy of rotation of a rigid body rotating about an axis with angular velocity ω. [Q.N.3 (a) (Or), 2060]
5. Define moment of inertia and angular momentum. Establish a relation between them. [Q.N.5(b),2068]
6. Define moment of inertia and angular momentum. Deduce a relationship between them. [Q.N. 5(c), Supp. 2068]
7. Define torque and angular acceleration of a rigid body. Hence find expression for work and power in its rotational motion. [Q.N. 5(b), Supp. 2069]
8. Derive a relation between torque applied and angular acceleration produced in a rigid body and hence define moment of inertia. [Q.N. 5(c), 2070 'C']
9. Derive a relation between angular momentum and moment of inertia of a rigid body and hence define moment of inertia. [Q.N. 5(d), 2070 'D']

Numerical Problems

1. Speed of a body spinning about an axis increase from rest to 100 rev. min^{-1} in 5 sec., if a constant torque of 20 Nm is applied. The external torque is then removed at the body comes to rest in 100 sec. due to friction. Calculate the frictional torque. [Q.N.3 (Or), 2052]
[Ans: 1 Nm]

2. A constant torque of 500 Nm turns a wheel which has a moment of inertia 20 kg m^2 about its centre. Find the angular velocity and kinetic energy gained in 2 seconds.
[Ans: 50 rods^{-1}, 25000 J] **[Q.N.5, 2054]**

3. A constant torque of 200 Nm turns a wheel about its centre. The moment of inertia about it is 100 kg.m^2. Find the kinetic energy gained after 20 revolutions when it starts from rest.
[Ans: 25132.5 J] **[Q.N.3, 2055]**

4. A constant torque of 500 Nm turns a wheel which has a moment of inertia 20 kgm^2 about its centre. Find the angular velocity gained in 2 seconds and kinetic energy gained.
[Ans: 50 rad S^{-1}, 25000 J] **[Q.N.3 (b), 2061]**

5. A constant torque of 200 Nm turns a wheel about its centre. The moment of inertia about this axis is 100 kg m^2. Find the kinetic energy gained after 20 revolutions.
[Ans: 25/32.5 J] **[Q.N. 3,(b) 2063]**

6. A disc of moment of inertia 5×10^{-4} kg m^2 is rotating freely about the axis through its centre at 40 rpm. Calculate the new revolution per minute of some wax of mass 0.02 kg is dropped gently on to the disc 0.08 m from the axis.
[Ans: 0.53rps (32 rpm)] **[Q.N.9. (b), 2066]**

7. An electric fan is turned off, and its angular velocity decreases uniformly from 500 rev/min to 200 rev/min in 4.00s (a) Find the angular acceleration and the number of revolutions made by the motor in 4.00s interval. (b) How many more seconds are required for the fan to come to rest if the angular acceleration remains constant. 4 **[Q.N. 9 (b), 2067]**
[Ans: – 7.85 rad s^{-2}, 23.3, 2.66 sec]

8. A ballet dancer spins with 2.4rev/sec with her arms outstretched when the moment of inertia about the axis of rotation is I. With her arms folded, the moment of inertia about the same axis becomes 0.6I. Calculate the new rate of spin.
[Ans: 4 rev sec^{-1}] **[Q.N. 9(b), Set 'A' 2069]**

10. Elasticity

Short Questions

1. Explain in terms of breaking stress, why elephant has thicker legs as compared to human beings ? **[Q.N.1. (f), 2066]**
2. Explain why soldiers are ordered to break steps while crossing a bridge. **[Q.N.1(g),2068]**
3. Compare the mechanical properties of a steel cable, made by twisting many thin wires together, with those of solid steel rod of the same diameter. **[Q.N. 1(f), Set 'B' 2069]**

Long Questions

1. Derive an expression for the energy stored in stretched wire. Define the term energy density of a body under strain. 3 **[Q.N. 5 (d), 2067]**
2. Define stress and strain. Derive an expression for energy stored in a stretched wire. **[Q.N.5(d),2068]**
3. Derive an expression for the energy stored in a stretched rod. Define the term energy density of a body under strain. **[Q.N. 5(d), Set 'A' 2069]**
4. What are the proportional limit and the elastic limit? Derive an expression for the energy stored in a stretched wire? **[Q.N. 5 (b), Set 'B' 2069]**
5. Explain the difference between elasticity and plasticity from the concept of Hooke's law. Also define Poisson's ratio. **[Q.N. 5(c), Supp. 2069]**

Numerical Problems

1. How much force is required to punch a hole 1cm in diameter in a steel sheet 5 mm thick whose shearing strength is $2.76 \times 10^8 Nm^{-2}$. **[Q.N. 9 (d), Set 'B' 2069]**
(Ans: 4.3×10^4N)

2. A vertical brass rod of circular section is loaded by placing a 5 kg weight on top of it. If its length is 50cm and radius of cross section is 1cm, find the contraction of rod and the energy stored in it.

[Ans: 2.27 μm, 5.6×10^{-5} J] **[Q.N. 9(c), 2070 'C']**

3. Calculate the work done in stretching a steel wire 100 cm in length end of cross sectional area $0.03cm^2$ when a load of 100N is slowly applied without the elastic limit being reached. **[Q.N. 9(c), 2070 'D']**

[Ans: 8.3×10^{-3} J]

11. Periodic Motion

Short Questions

1. If a pendulum clock is taken to a mountain top, does it gain or lose time ? **[Q.N.1 (iv), 2050]**
2. If length of a simple pendulum increased by 4 times its original length, will its time period change ? If yes, by how much ? **[Q.N.1 (c), 2052]**
3. On what factors does the period of a simple pendulum depend ? **[Q.N.1 (d), 2057]**
4. What are the drawbacks of simple pendulum? **[Q.N.1 (e), 2059]**
5. A pendulum clock is taken to moon. Will it gain or lose time ? **[Q.N. 1(e), 2065]**
6. A body is moving in a circular path with constant speed. Is this motion a simple harmonic? Why? **[Q.N.1. (d), 2066]**
7. Simple pendulum clock is assumed to be better in use as compared to the conical pendulum. Why? **[Q.N. 1(e), Supp. 2069]**

Long Questions

1. Define simple harmonic motion. Show that a system of spring hung from a support with a mass hanging at free end move simple harmonically. **[Q.N.4, 2052]**
2. What is a simple pendulum ? Show that motion of the bob of a simple pendulum is simple harmonic. Obtain an expression for its time period. **[Q.N.4, 2054]**
3. What is simple harmonic motion starts ? Derive the relation between the acceleration and displacement of the practical executing S.H.M. **[Q.N.14, 2055]**
4. Define simple harmonic motion. Show that the vertical oscillations of a mass suspended by a light helical spring are simple harmonic. **[Q.N.3 (a), 2056]**
5. Show that the motion of a simple pendulum is a simple harmonic motion. Derive its time period. **[Q.N.2 (a), 2058]**
6. Define simple harmonic motion. Show that the oscillation of mass suspended from helical spring is simple harmonic. **[Q.N.3 (a) (Or), 2061]**
7. Obtain an expression for the time period of a mass 'm' attached with a spring placed horizontally on a smooth table. **[Q.N. 3,(a)(or) 2063]**
8. What is meant by simple harmonic motion ? Show that the bob of a simple pendulum may move with simple harmonic motion and find its time period. **[Q.N. 3(a), 2065]**
9. What is simple pendulum? Show that motion of the bob of the simple pendulum is simple harmonic. Obtain an expression for its frequency. **[Q.N. 5 (d), Set 'B' 2069]**
10. What do you understand by circle of reference in an oscillatory motion? Write down the equation of a simple harmonic motion and hence obtain and expression for its total energy. **[Q.N. 5(d), Supp. 2069]**

Numerical Problems

1. A simple pendulum 4 m. long swings with an amplitude of 0.2 m.
   a) Compute the velocity of the pendulum at its lowest point.

   [Ans: 0.628 ms^{-1}]

   b) Compute its acceleration at the end of its path. **[Q.N.5, 2050]**

   [Ans: 1.974 ms^{-2}]

2. A small mass rests on a horizontal platform which vibrates in simple harmonic motion with a period of 0.25s. Find the maximum amplitude of the motion which will allow the mass to remain in contact with the platform throughout the motion.
[Ans: 0.0158 m] **[Q.N.5, 2053]**
3. A simple pendulum 4m long swings with an amplitude of 0.2m. Compute the velocity of the pendulum at its lowest point and its acceleration at extreme ends.
[Ans: 0.32 ms^{-1}, 0.5 ms^{-2}] **[Q.N.2 (b), 2062]**
4. The displacement y of a mass vibrating with simple harmonic motion is given by $y = 20 \sin 10\pi t$. Where y is in millimeter and t is in second. What is :
(i) amplitude (ii) The period (iii) The Velocity at t = 0
[Ans: (i) 2×10^{-3} m, (ii) 0.2 s, (iii) 0.628 ms^{-1}] **[Q.N. 2(b), 2064]**
5. Calculate the period of oscillation of a simple pendulum of length 1.8m with a bob of mass 2.2 kg. If the bob of this pendulum is pulled aside a horizontal distance of 20 cm and released. What will be the values of (i) the K.E. and (ii) the velocity of the bob at the lowest point of the swing ?
[Ans: 024J, 0.47 ms^{-1}] **4 [Q.N. 9 (c), 2067]**
6. A simple pendulum has a period of 4.2 second, when the pendulum is shortened by 1m the period is 3.7 second. From these measurements, calculate the acceleration of free fall and the original length of the pendulum.
(Ans: 10 m/s^2, 4.5 m) **[Q.N.9(c),2068]**
7. After landing on an unfamiliar planet, a space explorer constructs a simple pendulum of length 50cm. She finds that the pendulum makes 100 complete swings in 136s. What is the value of g on this planet?
[Ans: 10.7 m^{-2}] **[Q.N. 9(c), Supp. 2068]**
8. A simple pendulum 5m long swings with an amplitude 25cm. Find the velocity of the pendulum at its lowest point and the acceleration at the end of its path.
[Ans: 0.5 ms^{-2}] **[Q.N. 9(d), 2070 'C']**
9. A body is vibrating with simple harmonic motion of amplitude 15cm and frequency 4Hz. Calculate the maximum value of acceleration and velocity.
[Ans: 3.76 m/s, 94.7 m/s^2] **[Q.N. 9(d), 2070 'D']**

12. Fluid Mechanics

Short Questions

1. Why does ice float in water ? **[Q.N.1 (viii), 2050]**
2. Why is the bottom of a ship is made heavy ? **[Q.N.1 (vii), 2051]**
3. Steel balls sink in water but they don't sink in mercury. Why ? **[Q.N.1 (i), 2052]**
4. The height h through which water of surface tension T and density d rises in a capillary tube of radius r is given by $\frac{2T}{rdg}$. Check the correctness of the relation using the method of dimensions. **[Q.N.1 (a), 2053]**
5. Does a ship sink more in river water or in sea water ? Explain. **[Q.N.1 (h), 2053]**
6. Lead has a greater density than iron, and both are denser than water. Is the buoyant force on a lead object greater than, less than, or equal to the buoyant force on an iron object of the same volume. **[Q.N.1 (i), 2054]**
7. State the laws of floatation. **[Q.N.1 (d), 2055]**
8. What are centre of buoyancy and metacentre ? **[Q.N.1 (f), 2057]**
9. A piece of ice is floating in water. Will the water level rise if the ice melts completely? Explain. **[Q.N.1 (f), 2058]**
10. Why is it easier to lift a body in a liquid than in air? **[Q.N.1 (f), 2059]**
11. A helium filled balloon rises to a certain height and then halts. Why ? **[Q.N.1 (f), 2060]**
12. A cork is floating in water. What is the apparent weight of the cork ? **[Q.N.1 (e), 2061]**
13. How will you make difference between density and specific gravity of a body ? **[Q.N.1 (f), 2062]**
14. A body floats in a liquid contained in a beaker. The whole system falls under gravity. What is upthrust on the body due to liquid ? **[Q.N. 1(f), 2063]**

15. If a cork be released from the bottom of a jar filled with water, what will happen and why ? [Q.N. 1(c), 2064]
16. Distinguish between density and specific gravity. [Q.N. 1(f), 2065]
17. A boy can lift a maximum load of 250 N of water. How many liters of mercury (density 13600 kg m^{-3}) can he lift if contained in an identical vessel? [Q.N.1. (e), 2066]
18. When a smooth-flowing stream of water comes out of a faucet, it narrows as it falls. Explain why this happens. [Q.N.1. (g), 2066]
19. The tip of the nib of a pen is split. Why ? 2 [Q.N. 1 (f), 2067]
20. Explain why a suction effect is experienced by a person standing close to the platform at a station when a fast train passes. 2 [Q.N. 1 (g), 2067]
21. What will happen if a capallary tube of insufficient height is dipped in water ? [Q.N.1(f),2068]
22. The purity of gold can be tested by weighing it in air and in water. How? [Q.N. 1(f), Supp. 2068]
23. In hot air ballooning, a large balloon is filled with air heated by a gas burner at the bottom. Why must the air be heated? [Q.N. 1(e), Set 'A' 2069]
24. An ice cube floats in a glass of water. When the ice melts, will the water level in the glass rise, fall or remain unchanged? Explain. [Q.N. 1(g), Set 'A' 2069]
25. Why the antiseptics used for cuts and wounds in human flesh have low surface tension? [Q.N. 1(g), Set 'B' 2069]
26 Explain the meaning of velocity gradient in fluid motion. [Q.N. 1(c), Supp. 2069]
27. Why is the tip of the nib of a pen split? Explain. [Q.N. 1(d), Supp. 2069]
28. Soap bubbles are almost perfect spheres. Why? [Q.N. 1(e), 2070 'C']
29. In still air, a helium filled balloon rises up to a certain height and then stops rising. Why? [Q.N. 1(f), 2070 'C']
30. When a smooth-flowing stream of water comes out of a faucet, it narrows as it falls. Explain. [Q.N. 1(d), 2070 'D']
31. Why is soap solution a better cleansing agent than ordinary water? [Q.N. 1(f), 2070 'D']

Long Questions

1. Derive an expression for terminal velocity of a small spherical ball of radius "a" dropped gently in a viscous liquid of density ρ and coefficient of viscosity η. [Q.N.5. (b), 2066]
2. Define terminal velocity. Deduce an expression to determine the coefficient of viscosity of a fluid. [Q.N. 5(d), Supp. 2068]
3. State and prove Bernoulli's theorem for the flow of non–viscous fluids. [Q.N. 5(d), 2070 'C']
4. Define terminal velocity and hence describe the method of determining the coefficient of viscosity of a liquid using Stoke's law. [Q.N. 5(c), 2070 'D']

Numerical Problems

1. The density of ice is 971 kg m^{-3}, and the approximate density of sea-water in which an iceberg floats is 1025 kg. m^{-3}. What fraction of the iceberg, is beneath the water surface ? [Q.N.3 (Or), 2051]
   [Ans: 0.95]
2. A 25 cm. thick block of ice floating on fresh water can support an 80 kg man standing on it, what is the smallest area of the ice block ? (sp gr. of ice = 0.917).
   [Ans: 4 m^2] [Q.N.5, 2052]
3. A string supports a solid iron object of mass 180g totally immersed in a liquid of density 800 kg/m^3. The density of iron is 8000 kg/m^3. Calculate the tension in the string. [Q.N.5 (Or), 2054]
   [Ans: 1.62 N]
4. A piece of gold-aluminium alloy weighs 100 g in air and 80 g in water. What is the weight of the gold in the alloy if the relative density of gold is 19.3 and that of aluminium is 2.5. [Q.N.6 (Or), 2055]
   [Ans: 0.057 kg]

5. An iceberg having a volume of 2060 cc floats in sea-water of density 1030 kg m^{-3} with a portion of 224 cc above the surface. Calculate the density of ice. [Q.N.3 (b), 2056]
[Ans: 918 J]

6. A string supports a solid iron of mass 200 kg totally immersed in a liquid of density 900 kg m^{-3}. Calculate the tension in the string if the density of iron is 8000 kg m^{-3}.
[Ans: 1.8 N] [Q.N.3 (b), 2057]

7. A string supports a solid iron object of mass 200gm totally immersed in a liquid of density 800kgm^{-3}. The density of iron is 8000 kgm^{-3}. Calculate the tension in the string.
[Ans: 1.8 N] [Q.N.3 (b), 2062]

8. An alloy of mass 588 gm and volume 100 c.c. is made of iron of density 8.0 gm/c.c. and aluminium of density 2.7gm/c.c. Calculate the proportion by (i) volume (ii) by mass of the constituents of the alloy. [Q.N. 3(b), 2064]
[Ans: (i) 6×10^{-5} m^3, 4×10^{-5} m^3, (ii) 0.48 kg, 0.108 kg]

9. A string supports a solid iron object of mass 200 gm totally immersed in a liquid of specific gravity 0.9. Calculate the tension in the string if the density of iron is 8000 kg m^{-3}.
[Ans: 1.775 N] [Q.N. 3(b), 2065]

10. Three spherical raindrops of equal size are falling vertically through air with a terminal velocity of 0.150 m/s. What would be the terminal velocity if these three drops were to coalesce to form a larger spherical drop? 4 [Q.N. 9 (d), 2067]
[Ans: 0.31 ms^{-1}]

11. Water flows steadily through a horizontal pipe of non-uniform cross section. If the pressure of water is 4×10^4 Nm^{-2} at a point where the velocity of flow is 2ms^{-1} and cross section is 0.02m^2, what is the pressure at a point where cross section reduces to 0.01m^2 ?
[Ans: 3.4×10^4 N/m^2] [Q.N.9(d),2068]

12. A slab of ice floats on fresh water lake. What minimum volume must the slab have for a 45 kg woman to be able to stand on it without getting her feet wet?
[Ans: – 0.563 m^3] [Q.N. 9(d), Supp. 2068]

13. Castor oil at 20° C has a coefficient of viscosity 2.42Ns/m^2 and density 940kg/m^3. Calculate the terminal velocity of a steel ball of radius 2mm falling under gravity in the oil.
[Ans: 0.25 m/s] [Q.N. 9(d), Set 'A' 2069]

14. Three spherical raindrops of equal size are falling vertically through air with terminal velocity of 0.2m/s. What would be the terminal velocity if these three drops were to coalesce to form a larger spherical drops.
[Ans: 0.28 ms^{-1}] [Q.N. 9(d), Supp. 2069]

Unit 2 – Heat and Thermodynamics

1. Heat and Temperature

Short Questions

1. Two bodies made of the same material have the same external dimensions and appearance, but one is solid and the other is hollow. When they are heated, is the overall volume expansion the same or different ? [Q.N.7 (i), 2050]
2. Metal knob of door is colder than wooden parts at the same temperature. Why ? [Q.N.7 (b), 2052]
3. Water level initially falls in a vessel when it is heated. Why ? [Q.N.7 (c), 2052]
4. Why is it sometimes possible to loosen caps on screw top bottles by dipping the cap briefly in hot water ? [Q.N.7 (d), 2052]
5. Why do frozen water pipe burst ? [Q.N.7 (e), 2052]
6. Explain why a column of mercury in thermometer first descends slightly and then rises when placed in hot water ? [Q.N.7 (b), 2054]
7. Does the coefficient of linear expansion depend on length ? Explain. [Q.N.7 (d), 2055]

8. Why is mercury used commonly as a thermometric substance ? Give two reasons. [Q.N.7 (e), 2055]
9. Fishes stay alive in frozen pond in winter. Explain. [Q.N.4 (a), 2058]
10. Why mercury is used in thermometer? [Q.N.4 (c), 2058]
11. What are the differences between heat and temperature? [Q.N.4 (a), 2059]
12. At what point of thermometric scale does kelvin scale reading coincide with Fahrenheit scale reading ? [Q.N.4 (b), 2061]
13. Why a column of mercury in a thermometer first descends slightly and then rises when placed in hot water ? Explain. [Q.N.4 (a), 2062]
14. Why does a thick glass tumbler crack when boiling water is poured on it ? [Q.N. 4(a), 2063]
15. Two bodies made of the same material have the same external dimension and appearance, but one is solid and the other is hollow. When they are heated, is the overall volume expansion the same or different ? [Q.N. 4(a), 2064]
16. Why are glass windows possible to be cracked in very cold region ? [Q.N. 4(a), 2065]
17. When a metallic block with hole in it is heated, why does not the material around the hole expand into the hole and make it smaller? [Q.N.2. (b), 2066]
18. Frozen water pipes often burst, will a mercury thermometer break if the temperature of the thermometer is brought below the freezing point of mercury? [Q.N. 2(a), Set 'A' 2069]
19. Explain the significance of Kelvin temperature scale. How is it different from the celsius one? [Q.N. 2(b), Supp. 2069]
20. A hole is drilled in a flat metal sheet. What happens to the diameter of the hole as the metal sheet is heated to higher temperature? [Q.N. 2(a), 2070 'C']
21. Does the cubical expansivity of a liquid depend on its original volume? Explain. [Q.N. 2(a), 2070 'D']

Long Questions

1. Obtain an expression for the change in density of a gas due to the thermal expansion. [Q.N.8, 2051]
2. Define linear and cubical expansivities. Derive a relation between them. [Q.N.5 (a), 2056]
3. Why do substances expand on heating? Show that $\alpha = \frac{\gamma}{3}$ where α and γ are the coefficient of linear, and cubical expansion of a substance. [Q.N.5 (a), 2059]
4. Define linear, superficial, and cubical expansivities. Show that $\beta = 2\alpha$ where α and β are linear and superficial expansivities. [Q.N.5 (a), 2060]
5. Define linear and cubical expansions of solid, and establish a relation between their coefficients. [Q.N.6. (a), 2066]
6. Define linear and cubical expansivities of solids. Derive an expression for the variation in density of a solid when its temperature is raised from θ_1^0 C to θ_2^0 C. [Q.N. 6(a), Set 'A' 2069]
7. Describe a method of measurement of linear expansivity of a solid rod in the laboratory. Can one estimate its cubical expansivity? How? [Q.N. 6(a), Supp. 2069]
8. Describe a method to determine the linear expansivity of a solid. Can the cubical expansivity be derived from this value? [Q.N. 6(a), 2070 'C']
9. Define the coefficient of real and apparent expansions of a liquid and derive a relation between them. [Q.N. 6(a), 2070 'D']

Numerical Problems

1. An aluminum rod when measured with a steel scale, both being at 25^0C appears to be 1 m long. If the scale is correct at 0^0C, what will be the length of the rod at 0^0C ? (linear expansivity of aluminium $26 \times 10^{-6} k^{-1}$ and of steel = $12 \times 10^{-6} k^{-1}$) [Q.N.8, 2053]
[Ans: 0.9996 m]