Higher Secondary Education Board

Class XII (Science)

1. PHYSICS

Course Content

Unit-1 Waves and Optics — **40 Teaching Hours**

Waves (23 Hrs)

1. Wave motion- Wave motion; Longitudinal and transverse waves; Progressive and stationary waves; Mathematical description of a wave. (4 hrs)
2. Mechanical waves- Speed of wave motion; Velocity of sound in solid and liquid; Velocity of sound in gas; Laplace's correction; Effect of temperature, pressure, humidity on velocity of sound. (5hrs)
3. Wave in pipes and strings- Stationery waves in closed and open pipes; Harmonics and overtones in closed and open organ pipes; End correction in pipes; Resonance Tube experiment; Velocity of transverse waves along a stretched string; Vibration of string and overtones; Laws of vibration of fixed string. (6 hrs)
4. Acoustic phenomena- Sound waves: Pressure amplitude; Characteristics of sound: Intensity; loudness, quality and pitch; Beats; Doppler's effect; Infrasonic and ultrasonic waves; Noise pollution: Sources, health hazard and control. (8 hrs)

Physical Optics (17 Hrs)

1. Nature and propagation of Light- Nature and sources of light; Electromagnetic spectrum; Huygen's principle, Reflection and Refraction according to wave theory; Velocity of light: Foucault's method; Michelson's method. (6 hrs)
2. Interference- Phenomenon of Interferences; Coherent sources; Young's two slit experiment; Newton's ring. (4 hrs)
3. Diffraction- Diffraction from a single slit; Diffraction pattern of image; Diffraction grating; Resolving power of optical instruments. (4 hrs)
4. Polarization- Phenomenon of polarization; Brewster's law; transverse nature of light; Polaroid. (3hrs)

Unit-2 Electricity and Magnetism — **55 Teaching Hours**

Current Electricity (20 Hrs)

1. D.C. Circuit- Electric Currents; Drift velocity and its relation with current; Ohm's law; Electrical Resistance; Resistivity; Conductivity; Super conductors; Perfect Conductors; Current-voltage relations; Ohmic and Non-Ohmic resistance; Resistances in series and parallel, Potential Divider, Conversion of galvanometer into voltmeter and ammeter, Ohmmeter; Electromotive force: Emf of a source, internal resistance; Work and power in electrical circuits; Joule's law and its verification. (9 hrs)
2. Electrical circuits-Kirchhoffs laws; Wheatstone bridge circuit; P.O.Box, Meter Bridge; Potentiometer; Comparison of e.m.f's., measurement of internal resistance of a cell. (7 hrs)
3. Thermoelectric Effect- Seebeck Effect; Thermocouples, Peltier effect: Variation of thermoelectric emf with temperature, Thermopile, Thomson effects. (2 hrs)
4. Chemical effect of current- Faraday's laws of electrolysis; Faraday's constant, Verification of Faraday laws of electrolysis. (2 hrs)

Magnetic field of current (35 Hrs)

1. Magnetic Field-Magnetic field lines and magnetic flux; Oersted's experiment; Force on moving charge, Force on Conductor; Force and Torque on rectangular coil, Moving coil galvanometer; Hall effect; Magnetic field of a moving charge; Biot and Savart law and its application to (i) a circular coil (ii) a long straight conductor (iii) a long solenoid; Ampere's law and its application to (i) a long straight conductor (ii) a straight solenoid (iii) a toroidal solenoid; Forces between two parallel conductors carrying current-definition of ampere. (14 hrs)
2. Magnetic properties of materials-Elements of earth magnetism and their variation; Dip and Dip circle; Flux density in magnetic material; Relative permeability; Susceptibility; Hysteresis, Dia.-Para- and Ferro-magnetic materials. (5 hrs)
3. Electromagnetic Induction-Faraday's laws; Induced electric fields; Lenz's law, Motional electromotive force; AC generators; eddy currents; Self inductance and Mutual inductance; Energy stored in an inductor; Transformer. (8 hrs)

4. Alternating Currents- Peak and RMS Value of AC current and Voltages, AC through resistor, capacitor and inductor; Phasor diagram, Series circuits containing combination of resistor, capacitor and inductor; Series Resonance, Quality factor; Power in AC circuits: Power factor; choke coil. (8 hrs)

Unit-3 Modern Physics 55 teaching hours

1. Electrons and Photons-Electrons: Milikan's oil drop experiment, Gaseous discharge at various pressure; Cathode rays, Motion of electron beam in electric and magnetic fields; Thomson's experiment to determine specific charge of electrons. Photons: Quantum nature of radiation; Einstein's photoelectric equation; Stopping potential; Measurement of Plank's constant, Milikan's experiment (10 hrs)
2. Solids and Semiconductor devices- Structure of solids; Energy bands in solids (qualitative ideas only); Difference between metals, insulators and semi-conductors using band theory; Intrinsic and extrinsic semi-conductors; P-N Junction; Semiconductor diode: Characteristics in forward and reverse bias; Full wave rectification; Filter circuit; Zener diode; Transistor: Common emitter characteristics, Logic gates; NOT, OR, AND, NAND and NOR., Nanotechnology (introductory idea). (11 hrs)
3. Quantization of energy-Bohr's theory of hydrogen atom; Spectral series; Excitation and ionization potentials; Energy level; Emission and absorption spectra, De Broglie Theory; Duality; Uncertainly principle.
   Lasers: He- Ne laser, Nature and production, properties and uses.
   X-rays: Nature and production; uses: X-rays, X-rays diffraction, Bragg's law. (9 hrs)
4. Nuclear physics- Nucleus: Discovery of nucleus; Nuclear density; Mass number; Atomic number; Atomic mass; Isotopes; Einstein's mass-energy relation, Mass Defect; Binding energy; Fission and fusion. (6 hrs)
5. Radioactivity- Alpha-particles; Beta-particles, Gamma rays; Laws of radioactive disintegration; Half-life and decay constant; Geiger-Muller Tube; Radio carbon dating; Medical use of nuclear radiation; Health hazards and safety precautions. (7 hrs)
6. Nuclear energy and other sources of energy- Sources of energy; Conservation and degradation of energy; Transformation of energy. Nuclear energy: Energy released from fission and fusion; Thermal and Hydroelectric power; Wind energy; Biofuels; Solar energy; Solar constant; Solar devices; Global energy consumption pattern and demands; Energy use in Nepal. Fuels and pollution: Global Warming; Acid rain. (9 hrs)
7. Particle physics and cosmology- particles and antiparticles, Quarks and Leptons, baryons, mesons. Universe- Hubble law; Big Bang; Critical density; Dark matter, (3 hrs)

Practical

A student will perform at least 24 experiments from the given list:

Introduction

General instruction: Students are expected to learn general ideas of errors, order of accuracy and graphical analysis. Students are also expected to learn the physical principles and theory of experiments on magnetism not covered in the theory curriculum.

List of experiments

A. Wave and Optics

1. Determination of the wavelength of sodium light by measuring the diameter of Newton's rings.
2. Determination of the wavelength of a given monochromatic source of light by passing a plane diffraction grating.
3. Determination of the refractive index of a given transparent medium and calculation of the speed of the light in the medium.
4. Uses of laser beams:
   i. Determination of the wavelength of He-Ne laser light
   ii. Determination of the diameter of a given hair.
5. Uses of Sonometer:
   i. Determination of the frequency of a given tuning fork
   ii. Comparison of frequencies of two tuning forks
6. Determination of the frequency of A.C. Mains.
7. Use of Resonance tube:
   i Determination of velocity of sound in air at NTP
   ii Comparison of frequencies of two tuning forks
8. Determination of the end correction of the resonance tube apparatus.

B. Electricity

9. Verification of Ohm's Law
10. Use of P.O. Box:
    i. Determination of the resistivity of the material of a given wire
    ii. Verification of the laws of series and parallel resistances
11. Use of meter bridge:
    i. Comparison of resistances of two given wires
    ii. Determination of the resistivity of the material of a given wire
    iii. Verification of the laws of series and parallel resistances
12. Determination of high resistance by substitution method.
13. Determination of the capacitance of the capacitor by charging and discharging a capacitor.
14. Use of potentiometer:
    i. Comparison of emf's of two cells
    ii. Comparison of resistances of two given wires
    iii. Determination of the internal resistance of a cell
15. Conversion of given galvanometer into an ammeter and a voltmeter of desired range.
16. Calibration of a given ammeter and voltmeter.
17. Determination of the half-life of a circuit containing a pure capacitor in series with a resistance in a D. C. circuit.
18. Uses of a series LCR circuit:
    i. Determination of the resonant frequency of a series LCR circuit
    ii. Determination of the quality factor of a series LCR circuit

C. Magnetism

19. Determination of the pole strength and magnetic moment of a bar magnet by locating the neutral points keeping:
    i. North pole pointing towards the geographical south
    ii North pole pointing towards the geographical north
20. Use of deflection magnetometer:
    i. Determination of the pole strength and magnetic moment of a bar magnet
    ii. Comparison of the magnetic moments of two bar magnets
21. Use of oscillation magnetometer:
    i. Determination of the pole strength and magnetic moment of a bar magnet
    ii. Comparison of the magnetic moments of two bar magnets
22. Use of dip circle:
    Determination of the angle of dip in the laboratory

D. Modern Physics

23. Study the characteristics of a junction diode.
24. Study the characteristics of a transistor.
25. Study the characteristics of a Zener diode.
26. Determination of Planck's constant using a photocell

Model Question 2065

Time: 3 hours | **Full Marks: 75**
Pass Marks: 27

(All answers of numerical problems should be expressed in S.I. system)

Group A

Q.1. Attempt any FOUR questions $(2 \times 4 = 8)$

(a) Two wires, one of copper and other of iron, have the same diameter and carry the same current. In which wire will the drift velocity of electrons be more? **[From Unit 2]**

(b) Differentiate between a fuse wire and a heating wire. **[From Unit 2]**

(c) Why are the pole-pieces of magnets cut into cylindrical form in a galvanometer? **[From Unit 2]**

(d) Hall voltage is much more measurable in semiconductor than in metals. Why? **[From Unit 2]**

(e) Explain why two parallel wires carrying current in the opposite direction repel each other? [From Unit 2]

(f) 220V a.c. is more dangerous than 220V d.c., why? [From Unit 2]

Q. 2. Attempt any FOUR questions $(2 \times 4 = 8)$

(a) If the discharge tube is filled up with various gases in turn, will the discharge in all gases take place at the same electrode potential? [From Unit 3]

(b) A photon and an electron have got the same de-Broglie wavelength. Explain which has greater total energy. [From Unit 3]

(c) How is NOT gate realised? [From Unit 3]

(d) It is said that a very powerful crane is required to lift a nuclear mass of microscopic size. Commen on this. [From Unit 3]

(e) Commen on the statement "A nucleus contains no electrons and yet can eject them." [From Unit 3]

(f) What are the effects of pollution on living organisms? [From Unit 3]

Q. 3. Attempt any ONE question $(1 \times 2 = 2)$

(a) How can bats fly around without colliding with objects that come in their way? [From Unit 1]

(b) Longitudinal waves cannot be polarized. Why? [From Unit 1]

Q. 4. Attempt any ONE question $(1 \times 2 = 2)$

(a) Differentiate between wave-front and wavelet? [From Unit 1]

(b) What is the difference between Fresnel and Fraunhofer diffraction? [From Unit 1]

Group – B

Q. 5. Attempt any THREE question $(4 \times 3 = 12)$

(a) State Biot and Savart law and use it to obtain an expression for the magnetic field at the centre of the circular coil. [From Unit 2]

(b) What are the catagories in which magnetic materials are classified? Explain their differences. [From Unit 2]

(c) State Faraday's laws of electrolysis. How will you verify Faraday's second law experimentally? [From Unit 2]

(d) Show that Lenz's law is an example of conservation of energy. [From Unit 2]

Q. 6. Attempt any THREE question. $(4 \times 3 = 12)$

(a) Show, in Bohr's model, that radii of electronic orbits increase an n^2, where n is the quantum number of the orbit. [From Unit 3]

(b) Define decay constant of a radioactive element. How is it related to half-life? [From Unit 3]

(c) Discuss a zener diode and its use as voltage stabilizer. [From Unit 3]

(d) Describe a theory which accounts for the origin and evolution of the universe. [From Unit 3]

Q. 7. Attempt any ONE question. $(4 \times 1 = 4)$

(a) Show that both harmonics, odd and even, can be produced in an organ pipe open at both ends. [From Unit 1]

(b) What is Doppler's effect? Obtain an expression for the apparent pitch when a source moves towards a stationary observer. [From Unit 1]

Q. 8. Attempt any ONE question. $(4 \times 1 = 4)$

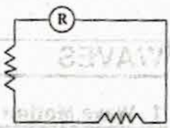
(a) Show that in Young's double slits experiment widths of dark and bright fringes are equal. [From Unit 1]

(b) Describe Focault's method of determining the speed of light. [From Unit 1]

Group – C

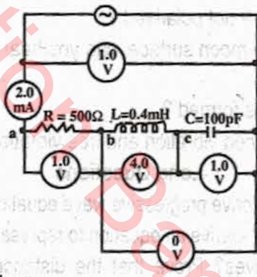
Q.9. Attempt any TWO questions (4 × 2 = 8)

(a) The resistance of the coil of a pivoted-coil galvanometer coil is 9.36Ω and a current of 0.0224A causes it to deflect full scale. We want to convert this galvanometer to an ammeter reading 20.0 A full-scale. The only shunt available has a resistance of 0.025Ω. What resistance R must be connected in series with the coil? **[From Unit 2]**



(b) A standard cell of 1.0185 V, when used in a one meter long slide wire potentiometer balances at 60 cm. Calculate the percentage error in a voltmeter which balances at 65 cm when reading is 1.1 volt. **[From Unit 2]**

(c) The series circuit in figure is a similar to arrangements that are sometimes used in radio tuning circuits. The circuit is connected to the terminals of an a.c. source with a constnant r.m.s. terminal voltage of 1.0 V and a variable frequency. Find (i) the resonance frequency (ii) the inductive reactance and the impenance at the resonance frequency (iii) the r.m.s. current at the resonance and (iv) the r.m.s. voltage across each circuit element at resonance. **[From Unit 2]**



10. Attempt any Two questions (4×2=8)

(a) A city requires 10^8 watts of electrical power on the average. If this is to be supplied by a nuclear reactor of efficiency 20% using $^{235}_{92}U$ as the fuel. Calculate the amount of fuel required for one day's operation. (Given : energy released per fission of $^{235}_{92}U$ = 200 MeV) **[From Unit 3]**

[Ans: 13.5 × 10^{23}]

(b) A clean nickel surface of workfunction 5.1 eV is exposed to light of wavelength 235 nm. What is the maximum speed of the photoelectrons emitted from their surface? **[From Unit 3]**

[Ans: 2.55 × 10^5 ms^{-1}]

(c) An electron moving with a speed of 10^7 m/s is passed into a magnetic field of intensity 0.1 normally. What is the radius of the path of the electron inside the field? If the strength of the magnetic field is doubled, what is the new radius of the path? (e/m = 1.8 × 10^{11}C.kg^{-1}) **[From Unit 3]**

[Ans: 5.56 × 10^{-4}m, 2.78 × 10^{-4}m]

Q.11. What is the difference between the speed of longitudinal waves in air at 27°C and their speed at -13°C? What is the speed at 0°C? **(4)[From Unit 1]**

[Ans: 23.89, 330ms^{-1}]

Q.12. Light traveling in water strikes a glass plate at an angle of incidence of 53°, part of the beam is refracted and part is reflected. If the refracted and reflected portions make an angle of 90° with each other, what is the index of refraction of glass? (4) [From Unit 1]

[Ans: 1.76]

Exam Questions

Unit 1: Waves and Optics

WAVES

1. Wave Motion

Short Questions

1. Distinguish between progressive waves and standing waves. [Q.N.3(a), 2072'D']
2. A radio station broadcasts at 800 KHz. What will be the wavelength of the wave? [Q.N. 3 (b), Set 'B' 2069]
3. Distinguish between light waves and sound waves. [Q.N.3(a),2068 1st Exam.]
4. Longitudinal waves cannot be polarized. Why? [Q.N. 3(b), 2067 1st Exam.]
5. Which types of wave propagate in liquid, explain. [Q.N. 1(c), 2063]
6. Do sound waves under go reflection, refraction and polarization phenomena ? Explain. [Q.N. 2(c), 2062]
7. Why are longitudinal wave not polarized ? [Q.N. 2(b), 2060 Supp.]
8. If you are walking on the moon surface, can you hear the cracking sound behind you? Explain. [Q.N. 1(c), 2058]
9. How are stationary waves formed ? [Q.N. 1(b), 2055]
10. Differentiate between forced vibration and free vibration. [Q.N. 1(b), 2052]

Long Questions

1. What is a wave motion? Derive progressive wave equation in a medium.[Q.N.7(a), 2072'C']
2. Define progressive waves. Derive an equation to represent this wave. [Q.N.7(a), 2072'E']
3. What are stationary waves? Prove that the distance between any two consecutive nodes in a stationary wave is $\frac{\lambda}{2}$. [Q.N. 7 (a), 2070 'C']
4. How is a progressive wave different from a stationary wave? Derive a progressive wave equation. [Q.N. 7 (a), 2070 'D']
5. What is the principle of superposition as applied to wave motion ? Discuss the result of superposing two waves of equal amplitude and same frequency travelling in opposite direction. [Q.N.7(b),2068 2nd Exam.]
6. What is meant by interference of sound ? How the constructive and destructive interference are formed ? [Q.N. 4(a) OR , 2063 Supp.]
7. State and explain the stationary wave. [Q.N. 6(a), 2063]
8. Use the principle of superposition of two waves to find the position of displacement nodes and antinodes in a standing wave. [Q.N. 5(a), 2061]
9. What are stationary waves ? Derive an equation for such a wave. [Q.N. 3(a)(Or), 2060 Supp.]

Numerical Problems

1. A wave has the equation (x in metres and t in seconds)
   Y = 0.02 sin(30 t -4x)
   Find:
   i) its frequency, speed and wave length.
   ii) The equation of wave with double amplitude but travelling in the opposite direction. [Q.N. 3(Or), 2053]

   [Ans : 4.77 Hz, 1.57 m, 7.5 ms^{-1} , y = 0.04 sin (30t + 4x)]

2. Mechanical Waves

Short Questions

1. When sound waves travel through a medium, does the temperature at various points remain constant? Explain. [Q.N.3(b), 2072'C']
2. Why does sound travel faster in metals than in air? [Q.N. 3 (a), Set 'D' 2071]
3. The speed of sound in humid air is more than that in dry air, why? [Q.N.3(a), 2070 'Supp']
4. Although the density of solid is high, the velocity of sound is greater in solid, explain. [Q.N. 3 (a), 2070 'C']
5. Velocity of sound increases on a cloudy day. Why? [Q.N. 1(c), 2066]
6. Sound at a distance can be heard distinctly at night than in the day time. Why? [Q.N.1(c), 2065]
7. Explain why the velocity of sound in solids is greater than that in gases, though the densities of solids are greater than that of gases. [Q.N. 2(d), 2064]
8. Although the density of solid is high, the velocity of sound is great in solid, explain. [Q.N. 2(a), 2063]
9. Do sound waves need a medium to travel from one point to other point in space? What properties of the medium are relevant? [Q.N. 1(c), 2062]
10. Why sound produced at a distance can be heard distinctly at night than in day time? [Q.N. 2(c), 2060]
11. Why are sounds heard better on a wet day than on a dry day? [Q.N. 1(c), 2056]
12. Is velocity of sound more in damp air or in dry air? Explain. [Q.N. 1(b), 2054]
13. Why sound made at a distance can be heard distinctly at night than in the day time? [Q.N. 1(c), 2052]

Long Questions

1. Write down the Newton's formula for the velocity of sound in air. Explain why this formula has to be modified. Discuss Laplace's correction on it. [Q.N.7(a), 2072'D']
2. Write the Newton's formula for the velocity of sound in air. Explain why this formula has to be modified. Discuss Laplace's correction. [Q.N.7(a), Supp. 2071]
3. Describe the Newton's formula for velocity of sound in air with Laplace's correction. [Q.N. 7 (a), Set 'C' 2071]
4. What is Laplace correction. Discuss the effect of temperature and pressure on the velocity of sound. [Q.N. 7 (b), Supp. 2069]
5. Discuss the significance of Laplace's corrections to Newton's formula for the velocity of sound. Also explain how different factors affect the velocity of sound. [Q.N. 7 (b), Set 'B' 2069]
6. Discuss Newton's formula for the velocity of sound in air with Laplace's correction. [Q.N.7(a),2068 1st Exam.]
7. Discuss Newton's formula for the velocity of sound in a gas with Laplace's correction. [Q.N. 7(b), 2067 1st Exam.]
8. Write down the factors on which the velocity of sound in air depends with necessary explanation. [Q.N. 5(a), 2066]
9. Explain the significance of Laplace's correction of Newton's formula for the velocity of sound and derive the corrected formula. [Q.N.5(a, or), 2065]
10. State Newton's formula for the velocity of sounddd in gases. What correctiooon was made by Lapace on it? [Q.N. 3(a) OR 2062 Supp.]
11. State Newton's formula for the velocity of sound in gases. What correction was done by Laplace on it? [Q.N. 5(a)Or, 2061]
12. Derive an expression for the velocity of sound in a medium by dimensional method. Discuss the effect of change in pressure and temperature on the velocity of sound in air. [Q.N. 5(a), 2060]
13. Discuss Laplace's correction and derive the formula for the velocity of sound in a gas. [Q.N. 2, 2056]

14. Describe Newton's expression for the velocity of sound in a gas with Laplace correction. [Q.N. 2, 2055]
15. What is Newton's formula for the velocity of sound ? What correction was made by Laplace ? [Q.N. 2, 2053]
16. Discuss the effect of pressure, temperature and density of elastic medium on the velocity of sound. [Q.N. 2, 2052]

Numerical Problems

1. A sources of sound produces a note of 512Hz is air at 17°C with wavelength 66.5cm. Find the ratio of molar heat capacities at constant pressure to constant volume at NTP. Densities of air and mercury at NTP are 1.293 kg/m^3 and 13600kg/m^3 respectively.
[Ans: 1.4] 4[Q.N.11, 2072'E']
2. A source of sound of frequency 512 Hz emits waves of wavelength 64.5 cm in air at 20°C. What would be the velocity of sound at 0°C? 4[Q.N. 11, Set 'D' 2071]
[Ans : 318.76 m/s]
3. In a stormy day a boy observes a lighting flash which is followed by a thunder 3secs. later. How would you estimate the distance of the lighting strike from the boy. (given velocity of sound on that day = 332 m/s, velocity of light c = 3 × 10^8 m/s) 4
[Ans: 996 m] [Q.N.11, 2070 'Supp']
4. When a detonator is exploded on a railway line, an observer standing on the rail 2km away hears two sounds. What is the time interval between them? (Young's modulus of steel = 2×10^{11} Nm^{-2}, density of steel = 8 × 10^3 kg m^{-3}, density of air = 1.4 kg m^{-3}, γ – for air = 1.4, atmospheric pressure = 10^5 Nm^{-2})
[Ans: 5.92 sec) [Q.N. 11, Set 'A' 2069]
5. A source of sound of frequency 512 Hz emits waves of wavelength 670 mm in air at 20°C. What is the velocity of sound in air at this temperature ? What would be the wavelength of sound from the source in air at 0°C ?
[Ans : 343 ms^{-1}, 644 × 10^{-3} m] [Q.N. 5(b), 2064]
6. At what temperature, the velocity of sound in air is increased by 50%to that at 27°C?
[Ans : 675 K] [Q.N. 5(b), 2058]
7. A man standing at one end of a closed corridor 57 m long blow a short blast on a whistle. He found that the time from the blast to the sixth echo was 2 seconds. If the temperature was 17°C,what was the velocity of sound at 0°C?
[Ans : 331.8 ms^{-1}] [Q.N. 5(b), 2057]
8. The interval between the flash of lighting and the sound of thunder is 2 seconds, when temperature is 10°C. How far is the storm if the velocity of sound in air at 0°C is 330ms^{-1} ? [Q.N. 3(Or), 2052]
[Ans: 336 m]

3. Wave in Pipes and Strings

Short Questions

1. A turning fork has two prongs. Why? [Q.N.3(a), 2072'E']
2. Does the frequency of sound produced by an organ pipe change with its diameter ? Explain. [Q.N.3(a), Supp. 2071]
3. How can we consider sound waves as pressure waves ? [Q.N.3(b), Supp. 2071]
4. What happens to the frequency of transverse vibration of a stretched string if its tension is halved and the area of cross section of the string is doubled? [Q.N. 3 (b), Set 'C' 2071]
5. A tuning fork produces a feeble sound. But when it is pressed against a table, a loud sound is heard. Why? [Q.N. 3 (b), Set 'D' 2071]
6. When the tension in a given string is increased by four times, by what factor does the velocity of wave in the string change? [Q.N. 3 (a), 2070 'D']
7. What happens to the frequency of transverse vibration of a stretched string if its tension is halved and the area of cross section of the string is doubled? [Q.N. 3 (b), Set 'A' 2069]

8. If the frequency of a fundamental note of a closed pipe and that of an open pipe are the same, what will be the ratio between their lengths ? [Q.N.3(b),2068 1st Exam.]
9. Is it possible to have a longitudinal wave on a stretched string ? Why or Why not ? [Q.N.3(b),2068 2nd Exam.]
10. When the tension in a given stretched string is increased by four times, by what factor does the velocity of transverse wave in the string change? [Q.N. 3(a), 2067 1st Exam.]
11. Would you expect the pitch of an organ pipe to change with an increase in temperature? How? [Q.N. 3(a), 2067 2nd Exam.]
12. Is the wave speed the same as the speed of any part of the string for transverse waves? Explain the difference between these two speeds.[Q.N. 3(b), 2067 2nd Exam.]
13. Why are rubbers used as vibration absorber ? [Q.N. 1(d), 2063]
14. How does the temperature affect the frequency of an organ pipe ? [Q.N. 2(c), 2061]
15. Why is the loud sound heard at resonance ? [Q.N. 1(a) 2060 Supp.]
16. Explain why sound produced by a vibrating fork becomes louder when its stem is placed in contract with a table. [Q.N. 2(a) 2060 Supp.]
17. One of the "Nine Jewels" of Emperor Akbar, widely known as Tansen, the king of Music was able to break a glass by singing the appropriate note. What physical phenomenon could account for this? [Q.N. 2(d), 2059]
18. What do you mean by resonance? [Q.N. 1(d), 2057]
19. Why is sonometer box hollow from inside ? [Q.N. 1(a), 2056]
20. Relate the fundamental note with overtones for an open pipe. [Q.N. 1(a), 2055]
21. Why is an end correction necessary for an organ pipe ? [Q.N. 1(a), 2054]
22. The frequency of organ pipe changes with temperature. Does it increase with increase in temperature ? [Q.N. 1(a), 2053]
23. Explain why soldiers are ordered to break steps while crossing a bridge.[Q.N.1(c),2053]
24. The frequency of fundamental note of an open organ pipe is double than for closed pipe of same length. Why ? [Q.N. 1(a), 2052]

Long Questions

1. What is end correction of a pipe? Describe the different modes of vibration of air column in an organ pipe closed at one end. [Q.N.7(b), 2072'D']
2. Prove, with necessary diagrams, that both types of harmonics odd and even can be produced in an organ pipe open at both ends. [Q.N.7(b), Supp. 2071]
3. Define end correction. Show that both harmonics, odd and even, can be produced in an organ pipe open at both ends. [Q.N. 7 (b), 2070 'C']
4. What is resonance? Describe an experiment to determine the velocity of sound in air and end correction of the tube by resonance method. [Q.N. 7 (a), Set 'D' 2071]
5. What are overtones? Explain the formation of overtones in a closed pipe. [Q.N. 7 (a), Supp. 2069]
6. Show that both harmonics, odd and even, can be produced in an open organ pipe. What is end correction? [Q.N. 7 (a), Set 'A' 2069]
7. What is meant by resonance ? Explain in detail how you would use sonometer to determine frequency of a given tuning fork. [Q.N.7(a),2068 2nd Exam.]
8. Describe an experiment giving the necessary theory by which the speed of sound in air may be determined using resonance air column method.[Q.N. 7(a), 2067 2nd Exam.]
9. What do you understand by ìharmonicsî and ìovertoneî in the case of organ pipe. Also prove that only odd harmonics are produced in closed ended organ pipe.[Q.N.5(a), 2065]
10. State and explain principle of superposition and formation of stationary waves. Show that the frequency of the fundamental note of a closed organ pipe is half as compared to that of an open pipe of the same length. [Q.N. 5(a)Or, 2064]
11. Describe the resonance tube experiment of determine the velocity of sound in air at N.T.P. ? [Q.N. 4(a), 2063 Supp.]
12. Discuss the different modes of vibrations of air column in closed pipe. [Q.N. 6a(Or), 2063]

13. What do you mean by stationary wave ? Discuss the possible of vibration of column of air in an open pipe. **[Q.N. 3(a), 2062 Supp.]**
14. State the laws of transverse vibration of string. Describe an experiment to verify the law of mass, and law of length. **[Q.N. 6(a)Or, 2062]**
15. Describe the natural modes of vibration of air in an organ pipe closed at one end and explain the term "end correction". **[Q.N. 3.(a), 2060. Supp.]**
16. State the laws of transverse vibrations of string. Using only dimensions, show that the speed of propagation of a transverse wave depends only on tension and mass per unit length. **[Q.N. 5(a)Or, 2059]**
17. Prove that both types of harmonics, odd and even, can be produced in an organ pipe open at both ends. **[Q.N. 5(a)Or, 2058]**
18. Describe the various modes of vibration of the air column in a closed organ pipe. **[Q.N. 5(a)Or, 2057]**
19. Describe the various modes of vibrations of the air column in an organpipe. **[Q.N. 2, 2054]**

Numerical Problems

1. A wire with mass 40 g is stretched so that its ends are tied down at points 80cm apart. The wire vibrates in its fundamental mode with frequency 60Hz. Calculate the speed of propagation of transverse waves in the wire and the tension in the wire.
   [Ans : T = 9.21 N, v = 13.57 m/s] **[Q.N.11, 2072'C']**
2. A cord of length 1.5m is fixed at both ends. Its mass per unit length is 1.2 g/m and the tension is 12N. **[Q.N.11, Supp. 2071] 4**
   (a) What is the frequency of fundamental oscillation ?
   [Ans : 27.21 Hz]
   (b) What tension is required if the n = 3 mode has frequency of 0.50 kHz ?
   [Ans : 450N]
3. In a resonance tube experiment. The first and the second resonance positions were observed at 17 cm and 52.6cm respectively. The tuning fork used was a frequency 512Hz and the temperature was 27°C. Calculate the velocity of sound in air at 0°C and the end correction of the tube. **4[Q.N. 11, Set 'C' 2071]**
   [Ans : 347.7 m/s, 0.8 cm]
4. In a resonance tube experiment the first and the second resonance positions were observed respectively at 17 cm and 52.6 cm with a tuning fork of frequency 512 Hz at 27°c. Calculate the velocity of sound in air at 0 ∫ c and the end correction on the tube.
   [Ans : 347.7 m/s, 0.8 cm] **4 [Q.N. 11, 2070 'D']**
5. An open pipe 30 cm long and a closed pipe 23 cm long, both of the same diameter, each sounds their first overtone. If they are in resonance find the end correction of these pipes. **[Q.N. 11, Set 'B' 2069]**
   (Ans: 1 cm)
6. A piano string 1.5 m long is made of steel of density 7800 kg/m^3 and Young's modulus 2×10^{11} N/m^2. It is maintained at a tension which produced an elastic strain of 1% in the string. Calculate the frequency of transverse vibration of the string when it is vibrating in second mode of vibration.
   [Ans: 168.8 Hz] **[Q.N11,2068 1st Exam.]**
7. An open pipe 30 cm long and a closed pope 23 cm long, both of the same diameter, are each sounding its first overtone, and these are in unison. What is the end correction of these pipes ?
   [Ans: 0.01 m) **[Q.N.11,2068 2nd Exam.]**
8. An open pipe 30 cm long and a closed pipe 23 cm long, both of the same diameter, are each sounding its first overtone, and these are in resonance. What is the end correction of these pipes?
   [Ans: 1cm] **[Q.N. 11, 2067 1st Exam.]**

9. An observer travelling with constant velocity of 20m/s, passes close to a stationary source of sound and notices that there is a change of frequency of 50 HZ as he passes the source. What is the frequency of the source? Speed of the sound in air = 340 m/s.
[Ans: 425 Hz] **[Q.N. 11, 2067 2nd Exam.]**

10. A uniform tube 60 cm long stands vertically with its lower end dipping into water. When the length above the water is 14.8 cm and again when it is 48 cm, the tube resounds to a vibrating tuning fork of frequency 512 Hz. Find the lowest frequency to which the tube will resound when it is open at both ends. **[Q.N. 5(b), 2066]**
(Ans: – 267 Hz)

11. Resonance was observed with an air column when its length was 16 cm and again when it was 50 cm. It the frequency of the tuning fork is 512 Hz, calculate
(i) the velocity of sound, (ii) end correction **[Q.N. 3(b), 2062 Supp]**
[Ans : (i) 348.16 ms^{-1} (ii) 0.01 m]

12. A piano string has a length of 2m and a density of 8000 kgm^{-3}. When the tension in the string produces a strain of 1%, the fundamental note obtained from the string in transverse vibration is 170 Hz. Calculate the young's modulus value for the material of string. **[Q.N. 5(b), 2061]**
[Ans : 3.7×10^{10} Nm^{-2}]

13. A wire of diameter 0.04 cm. and made of steel of density 8000 $kgm^{-3}$is under a constant tension of 80 N. What length of this wire should be plucked to cause it to vibrate with a frequency of 840 Hz ? **[Q.N. 5(b), 2060]**
[Ans : 0.168 m]

14. An organ pipe is tuned to a frequency of 440 Hz when the temperature is 27°C. Find its frequency when the temperature drops to 0°C. Assume both ends of the pipe open.
[Ans : 400.4 Hz] **[Q.N. 3(Or), 2056]**

15. A piano string has length of 2m and a density of 800 kgm^{-3}. When the tension in the string produces a string of 1%, the fundamental note obtained from the string in the transverse vibrations in 170Hz. Calculate Young's modulus for the material of the string. **[Q.N. 3, 2055]**
[Ans: 3.7×10^{10} Nm^{-2}]

16. A wire of diameter 0.04cm and made of steel of density 8000 kgm^{-3} is under constant tension of 80N. What length of this wire should be plucked to cause it to vibrate with a frequency of 840 Hz ? **[Q.N. 3, 2053]**
[Ans: 0.168 m]

17. A steel wire of 2m long whose mass is 3g is under tension of 500N and is tied down at bothends. Calculate the frequency and wavelength for fundamental mode of vibration.
[Ans : 144 Hz, 4 m] **[Q.N. 3, 2052]**

4. Acoustic Phenomena

Short Questions

1. Whistle of an approaching train is shriller, why? **[Q.N.3(a), 2072'C']**
2. If the pressure amplitude of a sound wave is halved, by what factor does the intensity of the wave change? **[Q.N.3(b), 2072'D']**
3. What is the threshold of hearing? Define one bel. **[Q.N.3(b), 2072'E']**
4. Whistle of an approaching train is shriller. Why? **[Q.N. 3 (a), Set 'C' 2071]**
5. How can we recognize a person just by hearing her voice without seeing her face ? **[Q.N.3(b), 2070 'Supp']**
6. Why is sounding board used in a string instrument? **[Q.N. 3 (b), 2070 'C']**
7. An empty vessel sounds more than a filled one when it is struck. Why? **[Q.N. 3 (b), 2070 'D']**
8. Bells are made of metals and not of wood. Why? **[Q.N. 3 (a), Supp. 2069]**
9. What is meant by ultrasonic and infrasonic waves? **[Q.N. 3 (b), Supp. 2069]**

10. An empty vessel sounds more than a filled one. Why? [Q.N. 3 (a), Set 'A' 2069]
11. Is there a physical difference between intensity and intensity level of a wave? How are these quantities related? [Q.N. 3 (a), Set 'B' 2069]
12. Which has a more direct influence on the loudness of a sound wave: the displacement amplitude or the pressure amplitude ? Explain your reasoning. [Q.N.3(a),2068 2nd Exam.]
13. Why are all string instruments provided with hollow boxes? [Q.N. 2(c), 2066]
14. Explain with a figure the meaning of beats. [Q.N.2(d), 2065]
15. Bells are made of metal and not of wood, why ? [Q.N. 1(c), 2064]
16. What is the good and bad effect of echo ? [Q.N. 1(a) 2063 Supp.]
17. A violin note and a guitar note may have the same frequency yet we can distinguish them just by hearing them why ? [Q.N. 2(a), 2063 Supp.]
18. Why we cannot hear echo in small room ? [Q.N. 1(a) 2062 Supp.]
19. Define beats and beat frequency. [Q.N. 1(c), 2061]
20. Whistle of an approaching train is shriller. Why ? [Q.N. 1(c), 2060]
21. What do you mean by the term threshold of hearing? [Q.N. 1(c), 2059]
22. Why does an empty vessel produce more sound then a filled one? [Q.N. 2(d), 2058]
23. Why is the roaring of a lion different than the sound of a mosquito? [Q.N. 2(d), 2057]
24. How is it that one can recognise a friend from his voice without seeing him ? [Q.N. 1(b), 2056]
25. Distinguish between ultrasonics and supersonics. [Q.N. 1(c), 2055]
26. What are ultrasonics and infrasonics ? [Q.N. 1(c), 2054]
27. How are beats produced ? What is beat frequency ? [Q.N. 1(b), 2053]

Long Questions

1. Describe sound wave as a pressure wave and deduce an expression for the pressure amplitude. [Q.N.7(b), 2072'C']
2. What is Doppler effect? Find the change in frequency when an observer moves towards a stationary source and then moves away from the source. [Q.N.7(b), 2072'E']
3. Define intensity of sound. prove that it is proportional to the square of the amplitude of vibration for the given source of sound. [Q.N. 7 (b), Set 'C' 2071]
4. What is Doppler's effect in sound? Obtain an expression for the apparent frequency of the sound when an observer moves towards a stationary source of sound. [Q.N. 7 (b), Set 'D' 2071]
5. What are beats ? Obtain an expression for the beat frequency produced by the superposition of two waves of slightly different frequencies. [Q.N.7(a), 2070 'Supp']
6. Define Doppler's effect. Derive an expression for the change in frequency observed by a stationary observer when a moving source just crosses the observer. [Q.N.7(b), 2070 'Supp']
7. What are beats? Show that the number of beats heard per second is equal to the difference between the frequencies of two superposing waves. [Q.N. 7 (b), 2070 'D']
8. What is Doppler's effect? Obtain an expression for the apparent pitch when an observer moves towards a stationary source. [Q.N. 7 (b), Set 'A' 2069]
9. How does the frequency of sound change when sound source is moving:
   i) towards the stationary listner and
   ii) away from the stationary listener. [Q.N. 7 (a), Set 'B' 2069]
10. What is Doppler's effect ? Deduce an expression for the apparent frequency heard by a stationary observer when a source approaches towards him. [Q.N.7(b),2068 1st Exam.]
11. What are beats? Obtain the expression for the beat frequency when beats are produced by superposing two waves of slightly different frequencies. [Q.N. 7(a), 2067 1st Exam.]
12. Define intensity and deduce it in terms of amplitude of vibration, density of medium, angular velocity of the wave. [Q.N. 3(b), 2067 2nd Exam.]
13. Define the intensity of sound and prove that $I = \frac{1}{2}\rho v r^2 \omega^2$ where the symbols have their usual meaning. [Q.N. 5(a)Or, 2066]

14. Define intensity of sound. Show that the intensity of sound for a given frequency is directly proportional to the square of amplitude of vibration. [Q.N. 5(a), 2064]
15. Discuss the phenomenon of Doppler's effect. Find the change in frequency when a moving source of sound passes a stationery observer. [Q.N. 6(a), 2062]
16. What are beats ? Prove that the number of beats per second is equal to the difference between the frequencies of two superposing waves. [Q.N. 5(a)Or, 2060]
17. What is Doppler's effect? Derive the change in frequency when an observer moves towards a stationary source. [Q.N. 5(a), 2059]
18. What do you mean by intensity and intensity level of sound ? Define bel and decibel. [Q.N. 5(a), 2058]
19. What is Doppler's effect? Derive an expression for the apparent frequency received by a stationary observer when a source is moving away from him. [Q.N. 5(a), 2057]
20. Deduce the expressions for the frequency herd by an observer, when the observer is approaching the stationary sound source. [Q.N. 2(Or), 2055]

Numerical Problems

1. A stationary motion detector sends sound waves of 150KHz towards a truck approaching at a speed of 120 km/hr. What is the frequency of wave reflected back to detector? (Velocity of sound in air = 340 m/s) 4[Q.N.11, 2072'D']
   [Ans : 182.6 k Hz]
2. A car, sounding a horn and producing a note of 500 Hz, approaches and then passes a stationary observer at a steady speed of 20 ms^{-1}, Calculate the change in frequency heard by the observer. Velocity of sound is 340 ms^{-1}.
   [Ans : 59 Hz] 4 [Q.N. 11, 2070 'C']
3. Water at 20°c has a bulk modulus of 2.2×10^9Pa, and the speed of sound in water at this temperature is 1480m/s. For 1000 Hz sound waves in water at 20°c, what displacement amplitude is produced if the pressure amplitude is 3×10^{-2}Pa?
   [Ans : 3.2×10^{-12} m] [Q.N. 11, Supp. 2069]
4. An observer travelling with constant velocity of 20m/s, passes close to a stationary source of sound and notices that there is a change of frequency of 50 HZ as he passes the source. What is the frequency of the source? Speed of the sound in air = 340 m/s.
   [Ans: 425 Hz] [Q.N. 11, 2067 2nd Exam.]
5. A car is moving away from a stationary listener with a velocity of 20 m/s. If the horn is sounding at frequency 512 Hz, calculate the change in pitch of the sound received by the listener. (Velocity of sound in air = 330 ms^{-1})
   [Ans: 29 Hz] [Q.N.5(b), 2065]
6. A locomotive is moving towards a bridge with a velocity of 10 ms^{-1}. It is sounding a whistle of frequency 600 Hz. Sound is reflected from bridge. Calculate the beat frequency heard by the person sitting in the locomotive. (Velocity of sound = 340 ms^{-1})
   [Ans : 36.4 beats] [Q.N. 4(b), 2063 Supp.]
7. The intensity level from a loud speaker is 100 dB at a distance of 10 m. What is its intensity level at a distance of 200 m. ? [Q.N. 6(b), 2063]
   [Ans : 73.97 dB]
8. The intensity level from a loud speaker is 100 dB at a distance of 10m. What is its intensity level at a distance of 100m. ? [Q.N. 6(b), 2062]
   [Ans : 80 dB]
9. A stationary motion detector sends sound waves of 0.15 MHz towards a truck approaching at a speed of 45 ms^{-1}. What is the frequency of the wave reflected back to the detector ? [Q.N. 3(b), 2060 Supp.]
   [Ans : 1.7×10^5 Hz]

10. A note produces 2 beat / s with a tuning fork of frequency 480 Hz and 6 beats / s with a tuning fork of 472 Hz. Find the frequency of the note.
[Ans : 478 Hz] **[Q.N. 1(b), 2059]**
11. The noise from an airplane engine 25.0 m from an observer is found to have an intensity of 45 db. What will be the intensity in decibel when the plane flies overhead at an attitude of 2.0 km. ? **[Q.N. 3, 2056]**
[Ans : 6.94 db]
12. Two observers A and B are provided with source of sound of frequency 500 Hz. A remains stationery and B moves away from him at a velocity of 1.8 ms^{-1}. How many beats per second are observed by B, the velocity of sound in air being 330 ms^{-1} ?
[Ans: 27 beats/S] **[Q.N. 3(Or), 2054]**
13. A column of air is set into vibration and the note emitted gives 10 beats per second when a tunning fork of frequency 440 Hz is sounded, the temperature being 20°C. The frequency of beats decreases when the tunning fork is loaded with a small piece of wax. At what temperature will the unloaded fork and the air column will be in unison ?
[Ans : 306.33 K) **[Q.N. 3, 2054]**

PHYSICAL OPTICS

1. Nature and Propagation of Light

Short Questions

1. Distinguish between wave fronts and wavelets. **[Q.N.4(a), 2072'C']**
2. Explain with proper sketch, the differences between wave fronts and wavelets. **[Q.N.4(a), 2072'E']**
3. If light travels from one medium to another, its velocity changes ? Is it due to change in frequency or wavelength ? Explain. **[Q.N.4(a), Supp. 2071]**
4. Distinguish between wave fronts and wavelets. **[Q.N. 4 (a), Set 'C' 2071]**
5. A normally incident wave front does not deviate, when it travels from one medium to another. Explain. **[Q.N.4(a), 2070 'Supp']**
6. Distinguish between wave fronts and wavelets. **[Q.N. 4 (b), 2070 'C']**
7. What is a wave front ? **[Q.N.4(b),2068 2nd Exam.]**
8. What is Huygens's principle? **[Q.N. 4(b), 2067 2nd Exam.]**
9. State Huygen's principle. Does it apply to sound waves in air? **[Q.N.4(a), 20671st Exam.]**
10. Write down the advantages of Focault's method over Fizeau's method of measuring speed of light. **[Q.N.1(d), 2065]**
11. Write the advantages of Foucault's method over Fizeau's method of measuring speed of light. **[Q.N. 2(c), 2064]**
12. Which parameters of light does not change on refraction ? **[Q.N. 2(b), 2063]**
13. Does the energy of light change when it travel from one medium to another ? Give reasons. **[Q.N. 2(b), 2062 Supp.]**
14. Differentiate between a plane wave front and a spherical wave front. **[Q.N. 2(d), 2062]**
15. What are the advantages of Foucault's method over Fizeau's method of measuring speed of light ? **[Q.N. 2(d), 2060]**

Long Questions

1. State and explain Huygen's principle. Derive the laws of reflection on the basis of this principle. **[Q.N.8(a), 2072'D']**
2. Describe Michelson's method to measure the velocity of light. **[Q.N.8(a), 2072'E']**
3. What is meant by wavefront ? Verify Snell's law on the basis of wave theory of light. **[Q.N.8(a), Supp. 2071]**
4. Describe Michelson's method for the determination of speed of light. **[Q.N. 8 (a), Set 'C' 2071]**
5. State and explain Huygens' principle and use it to verify Snell's law. **[Q.N. 8 (a), Set 'D' 2071]**

6. State and use Huygen's principle of wave theory of light to verify the laws of refraction of light. **[Q.N.8(b), 2070 'Supp']**
7. State and explain Huygen's principle. Use it to prove Snell's law. **[Q.N. 8 (a), 2070 'D']**
8. Describe Michelson method of determining the speed of light with the help of a labelled diagram. **[Q.N. 8 (a), Supp. 2069]**
9. Describe Foucault's method for the determination of speed of light. **[Q.N. 8 (a), Set 'A' 2069]**
10. Describe Foccault's experimental method of the measurement of the velocity of light with necessary theory. **[Q.N. 8 (b), Set 'B' 2069]**
11. State and explain Huygen's principle. Use the principle to show that a plane wave incident obliquely on a plane mirror is reflected as a plane wave so that the angle of incidence is equal to the angle of reflection. **[Q.N.8(a),2068 1st Exam.]**
12. Describe Focault's method for the determination of speed of light. **[Q.N.8(a),2068 2nd Exam.]**
13. Describe Michelson's method to determine the speed of light. Write advantages of this method over foucault's method. **[Q.N. 8(b), 2067 1st Exam.]**
14. Describe Michelson's method for the determination of speed of light. **[Q.N. 8(a), 2067 2nd Exam.]**
15. State and explain Huygen's principle. Use the principle to verify the laws of refraction of light on the basis of wave theory. **[Q.N. 6(a), 2064]**
16. Explain the focault's method to determine the velocity of light. **[Q.N. 3(a)(Or), 2063 Supp.]**
17. Define Huygen's principle and prove Snell's law by the help of wave theory of light. **[Q.N. 5a(Or), 2063]**
18. Prove the laws of reflection of light using the wave theory. **[Q.N. 6(a), 2061]**
19. State and explain Huygen's principle. Use the principle to show that a plane wave front incident obliquely on a plane mirror is reflected as a plane wave front so that the angle of incidence is equal to the angle of reflection. **[Q.N. 6(a), 2060]**

Numerical Problems

1. A beam of light after reflection at a plane mirror, rotating 2000 times per minute, passes to a distant reflector. It returns to the rotating mirror from which it is reflected to make an angle of 1° with its original direction. If the distance between the mirrors is 6250m, calculate the velocity of light. **3[Q.N.12, 2072'C']**
   [Ans : 2.99×10^8 m/s]
2. In a Michelson experiment for measuring speed of light, the distance travelled by light between two reflections from the rotating mirror is 4.8km. The rotating mirror has a shape of regular octagon. At what frequency of rotation of mirror the image is formed at the position where non-rotating mirror forms it. **[Q.N.12, Supp. 2071] 3**
   [Ans : 7821.5 rev/sec]
3. A beam of light after reflection at a plane mirror rotating 2000 times per minute, strikes the distant reflector. It returns to the rotating mirror from which it is reflected to make an angle of 1° with the original direction. If the distance between the mirrors is 6250m, calculate the velocity of light.
   [Ans : 2.99×10^8 m/s] **[Q.N.12, 2070 'Supp']**
4. A beam of light is reflecting by a rotating mirror on to a fixed mirror, which sends it back to the rotating mirror which it is again reflected making an angle of 18° with its original direction. The distance between the two mirrors is 10 km and the rotating mirror is making 375 revolutions per second. Calculate the velocity of light.
   [Ans : 3×10^8 m/s] **[Q.N. 12, 2070 'C']**
5. A beam of light is reflected by a rotating mirror onto a fixed mirror which sends back to the rotating mirror from which it is again reflected and then makes an angle of 3.6° with the original direction. The distance between the two mirror is 1 km and the rotating mirror is making 750 rev s^{-1}.Calculate the velocity of light.
   [Ans : 3×10^8 m/s] **[Q.N. 5(b), 2063]**

6. The radius of curvature of the curved mirror is 20 m and the plane mirror is rotated at 20 revs^{-1}, calculate the angle in degrees between a ray incident on the plane mirror and then reflected from it after the light has travelled to the curved mirror and back to the plane mirror. (C = 3×10^8 m s^{-1}) [Q.N. 6(b), 2058]
[Ans : 1.92×10^{-3} degree]

2. Interference

Short Questions

1. Does the interference of light waves obey the law of conservation of energy? Explain. [Q.N.4(a), 2072'D']
2. What are the conditions for constructive and destructive interference of light waves? [Q.N. 4 (b), Set 'C' 2071]
3. What should be the path difference between two interfering waves for constructive interference and destructive interference? Q.N. 4 (a), 2070 'C']
4. What do you understand by coherent sources? [Q.N. 4 (a), Supp. 2069]
5. In young's double slit experiment, how is the fringe width altered if the separation between the slits is doubled and the distance between the slits and the screen is halved ? [Q.N.4(a),2068 1st Exam.]
6. What do you understand by coherent sources ? [Q.N.2(c), 2065]
7. Distinguish between interference and diffraction. [Q.N. 1(d), 2064]
8. Why have the two sources of light to be close to each other for the production of good interference pattern? [Q.N. 2(c), 2058]
9. Can two independent sources of light produce interference? [Q.N. 2(c), 2057]

Long Questions

1. What are coherent sources? Derive an expression for the fringe width in Young's double slit experiment. [Q.N.8(a), 2072'C']
2. Describe Young's double slit experiment and derive an expression for the fringe width. [Q.N. 8 (b), Set 'D' 2071]
3. Discuss the Young's double slit experiment and determine the expression for fringe width. [Q.N.8(a), 2070 'Supp']
4. What are coherent sources of light? Deduce an expression for the fringe width in Young's double slits experiment. [Q.N. 8 (b), 2070 'D']
5. Prove analytically that the bright and dark fringes in Young's double slit experiment are equally spaced. [Q.N. 8 (b), Set 'A' 2069]
6. What are the main characteristics of coherent sources? Describe Young's double slit interference experiment to determine the wavelength of the source of light. [Q.N. 8 (a), Set 'B' 2069]
7. Prove analytically that the bright and dark fringes in young's double slit experiment are equally spaced. [Q.N. 8(a), 2067 1st Exam.]
8. Describe Young's double slits experiment for the interference of light and show that widths of bright and dark fringes are the same. [Q.N. 6(a), 2066]
9. What are coherent sources ? How are they achieved ? Describe Young's double slit experiment for the measurement of wave length of monochromatic source of light. [Q.N. 4, 2062 Supp.]
10. What do you understand by interference of light ? Derive an expression for the fringe width in a Young's double slit experiment. [Q.N. 5(a), 2062]
11. What are coherent sources ? Prove analytically that the bright and dark fringes in young's double slit experiment are equally spaced. [Q.N. 4(a), 2060 Supp.]
12. Derive the fringe width from Young's double slit experiment. [Q.N. 6(a), 2057]

Numerical Problems

1. In young's double slit experiment, the slits are 0.03 cm apart and the screen is placed 1.5m away. The distance between the central bright fringe and fourth bright fringe is 1cm. Calculate the wave length of light used. 3[Q.N.12, 2072'D']
   [Ans : 5×10^{-7} m]
2. Two coherent sources A and B of radio waves are 5m apart. Each source emits waves with wavelength 6m. Consider points along the line between two sources, at what distances, if any, from A is the interference constructive. 3[Q.N.12, 2072'E']
   [Ans: 2.5 m]
3. Two slits spaced of 0.45 mm apart are placed 75 cm from a screen. What is the distance between the second and third dark lines of the interference pattern on the screen when the slits are illuminated with monochromatic light of wavelength 500 nm ?
   [Ans: 0.833 mm] [Q.N.12,2068 1st Exam.]
4. In a Young's slits experiment, the separation of four bright fringes is 2.5 mm when the wavelength used is 6.2×10^{-7} m. The distance from the slits to the screen is 0.80 m. Calculate the separation of the two slits.
   [Ans: 7.9×10^{-4} m) [Q.N.12,2068 2nd Exam.]
5. In a two-slit interference experiment, the slits are 0.200 mm apart, and the screen is a distance of 1.00 m. The third bright fringe is found at 9.49 mm from the central fringe. Find the wavelength of the light used.
   [Ans: 6.326×10^{-7} m] [Q.N. 12, 2067 2nd Exam.]
6. In a Young's double slit experiment, the separation between the first and fifth bright fringes is 2.5 mm when the wavelength of light used is 6.2×10^{-4} mm. The distance from the slits to the screen is 80 cm.
   Calculate the separation of the two slits. [Q.N. 6(b), 2064]
   [Ans : 8×10^{-4} m]
7. In an experiment using Young's slits the distance between the centre of the interference pattern and the tenth bright fringe on either side is 3.44 cm. Distance between the slits and the screen is 2.0 m. If the wavelength of the light used is 5.89×10^{7} m, determine the slit separation and the angle made by the central bright fringe at the slit. [Q.N. 6(b), 2060]
   [Ans : 3.42×10^{-4}m, 1.72×10^{-3} radian]
8. Two slits are 0.3 mm apart and placed 50 cm from a screen. What is the distance between the second and third dark lines of the interference pattern when the slits are illuminated with a light of 600 mm wavelengths ? [Q.N. 6(b), 2059]
   [Ans : 10^{-3} m]

3. Diffraction

Short Questions

1. The diffraction of sound waves is more evident in daily experience than that of light waves. Why? [Q.N. 4 (a), Set 'D' 2071]
2. Radio waves diffract around buildings but not light waves, why? [Q.N. 4 (a), 2070 'D']
3. What is the difference between Fresnel's and Fraunhofer's diffractions? [Q.N. 4 (b), Supp. 2069]
4. Why is the diffraction of sound waves more evident in daily experience than that of light waves? [Q.N. 4 (a), Set 'A' 2069]
5. What are the characteristic elements associated with a diffraction grating? How is plane transmission grating constructed? [Q.N. 4 (a), Set 'B' 2069]
6. Describe what happens to the single slit diffraction pattern when the width of the slit is less than the wavelength of the wave. [Q.N.4(a),2068 2nd Exam.]
7. Radio waves diffract around buildings but light waves do not. Why?
   [Q.N. 4(b), 2067 1st Exam.]

8. What is diffraction of light ? [Q.N. 1(d), 2062]
9. What happens to the Fraunhofer single slit diffraction pattern if the whole apparatus is immersed into water ? [Q.N. 1(b), 2060 Supp.]
10. Diffraction grating is better than a two-slit set up for measuring the wave length of a monochromatic light. Explain. [Q.N. 2(c), 2059]

Long Questions

1. Define Fraunhofer diffraction. How is transmission grating constructed? Describe necessary theory of diffraction grating. [Q.N.8(b), 2072'C']
2. Discuss the formation of maxima and minima due to Fraunhofer diffraction at a single slit. [Q.N.8(b), 2072'D']
3. What do you mean by diffraction of light? Explain the diffraction pattern due to single slit to find the angular width of the central band. [Q.N.8(b), 2072'E']
4. Explain the formation of maxima and minima due to diffraction through a single slit and central maximum. [Q.N.8(b), Supp. 2071]
5. Discuss Fraunhofer's diffraction at a single slit. [Q.N. 8 (b), Set 'C' 2071]
6. Discuss the theory of diffraction of light at single slit. [Q.N. 8 (a), 2070 'C']
7. What is the basic difference between interference and diffraction ? Discuss Fraunhofer diffraction at a single slit. [Q.N.8(b),2068 1st Exam.]
8. What is Fraunhoffer diffraction ? Explain the formation of maxima and minima due to diffraction. Show that the width of central maxima is inversely proportional to the distance between the two slits. [Q.N.8(b),2068 2nd Exam.]
9. Describe diffraction of light through a single slit. [Q.N. 8(b), 2067 2nd Exam.]
10. What are the differences between interference and diffraction ? Explain the theory of diffraction of light through a singe slit. [Q.N.6(a, or), 2065]
11. What do you understand by diffraction of light ? Describe the construction of diffraction grating and discuss the formula $(a + b)\sin\theta_n = n\lambda$ where the symbols have their usual meaning. [Q.N. 3(a), 2063 Supp.]
12. Describe the diffraction of light at a single slit and find the condition for secondary maxima and minima. [Q.N. 6(Or), 2061]
13. What is diffraction of light? How does it differ from interference of light? [Q.N. 6(a)Or, 2058]

Numerical Problems

1. A parallel beam of sodium light is incidents normally on a diffraction grating. The angle between the two first order spectra on either side of the normal is 27°42'. Assuming that the wavelength of light is 5.893×10^{-7}m, find the number of rulings per mm on the grating.
   [Ans : 406 per mm] [Q.N. 12, Set 'D' 2071]
2. Monochromatic light from a distant source is incident on a slit 0.75 mm wide. On a screen 2 m away, the distance from the central maxima of diffraction pattern to the first minima is measured to be 1.35 mm. Calculate the wavelength of light.
   [Ans : 506 nm] [Q.N. 12, Supp. 2069]
3. A diffraction grating has 400 lines per mm and is illuminated normally by a monochromatic light of wavelength 6000Å. Calculate the grating spacing, the angle at which first order maximum is seen and the maximum number of diffraction maxima obtained. [Q.N. 12, Set 'A' 2069]
   [Ans: 0.25×10^{-5} m, 4)
4. A parallel beam of sodium light of wavelength 589.3 nm is incident normally on a diffraction grating. The angle between the two first order spectra on either side of the normal is 27°42'.What will be the number of lines per mm on the grating?
   [Ans: 406 per mm) [Q.N. 12, Set 'B' 2069]
5. How wide is the central diffraction peak on a screen 3.5m behind a 0.010 mm. slit illuminated by 500 nm light ? [Q.N. 5(b), 2062]
   [Ans : 0.35 m]

6. A diffraction grating has 400 lines per mm and is illuminated normally by monochromatic light of wavelength 600 nm. Calculate the grating spacing and the number of diffraction. [Q.N. 4(b), 2060 Supp.]
[Ans : 0.25×10^{-5}m/line]

4. Polarization

Short Questions

1. Define polarizing angle. How is it related with the refractive index of the medium? [Q.N.4(b), 2072'C']
2. What is polarized light? How is it represented? [Q.N.4(b), 2072'D']
3. Is polarization possible for longitudinal waves? Justify. [Q.N.4(b), 2072'E']
4. Does polarizing angle depend on wavelength of light. [Q.N.4(b), Supp. 2071]
5. Light waves can be polarized. What about sound waves? Explain. [Q.N. 4 (b), Set 'D' 2071]
6. In which medium is the angle of polarization greater, rarer or denser ? [Q.N.4(b), 2070 'Supp']
7. What is polarizing angle? Does it depend on the wavelength of light used? [Q.N. 4 (b), 2070 'D']
8. Is there any difference between an analyzer and a polarizer? Explain. [Q.N. 4 (b), Set 'B' 2069]
9. Is polarization possible for longitudinal waves? Explain. [Q.N. 4 (b), Set 'A' 2069]
10. What is polarizing angle ? Does it depend on the wavelength of light ? [Q.N.4(b),2068 1st Exam.]
11. Light waves can be polarized. What about sound waves? Explain. [Q.N. 4(a), 2067 2nd Exam.]
12. Is polarization possible for longitudinal waves? Why? [Q.N. 1(d), 2066]
13. Can sound waves be polarized ? Explain. [Q.N. 1(d), 2060]

Long Questions

1. What is polarization of light? State and prove Brewster's law. [Q.N. 8 (b), 2070 'C']
2. What is polarization? Derive a relation between polarising angle and the refractive index of the medium. [Q.N. 8 (b), Supp. 2069]
3. Distinguish between a plane polarized and unpolarized light.
   Show that : Tanθp = n.
   n = refractive index of the medium.
   θp = angle of polarization or polarizing angle [Q.N. 5(a)Or, 2062]
4. What do you mean by polarization of light ? Show that $\tan \theta_p = n$, where θ_p is the angle of polarization and n is the refractive index of the transparent medium. [Q.N. 4(a), 2059]

Numerical Problems

1. A beam of light is incident at polarizing angle on a piece of transparent material of refractive index 1.62. What is the angle of refraction for the transmitted beam?
   [Ans : 31.65°] 3 [Q.N. 12, Set 'C' 2071]
2. Calculate the polarizing angle for the light travelling from water of refractive index 1.33 to glass of refractive index 1.53.3
   [Ans : 49°] 3 [Q.N. 12, 2070 'D']
3. A parallel beam of unpolarized light in air is incident at an angle of 55° on a plane glass surface. If the reflected beam is completely plane polarized, find the refractive index of the glass and the angle of refraction of the transmitted beam.
   [Ans: 1.428; 35] [Q.N. 12, 2067 1st Exam.]
4. Calculate the polarizing angle for light travelling from water of refractive index 1.33 to glass of refractive index 1.53.. [Q.N. 3(b), 2063 Supp.]
   [Ans : 49°)

Unit 2 – Electricity and Magnetism

Current Electricity

1. D.C. Circuit

Short Questions

1. Resistors R_1 and R_2 are connected in series to an emf source that has negligible internal resistance. What happens to the current through R_1 when a third resistor R_3 is connected in parallel with R_2? **[Q.N.1(a), 2072'D']**
2. Batteries are always labeled with their emf; for instance an AA flashlight battery is labeled '1.5 volts'. Would it also be appropriate to put a label on batteries stating how much current they provide? Why or why not? **[Q.N.1(a), 2072'E']**
3. Ammeters often contain fuses that protect them from large currents while voltmeters seldom do. Explain. **[Q.N.1(a), Supp. 2071]**
4. What is the difference between an emf and a potential difference? Under what circumstances are the potential difference between the terminals of a battery and the emf of the battery equal to each other? **[Q.N. 1(a), Set 'C' 2071]**
5. A voltmeter has high resistance. Explain why? **[Q.N. 1(a), Set 'D' 2071]**
6. Can the potential difference between the terminals of a battery ever be opposite in direction to the emf ? **[Q.N.1(a), 2070 'Supp']**
7. Two copper wires of different diameters are joined end-to-end. If a current flows in the wire combination, what happens to the drift velocity of the electrons when they move from the larger-diameter wire to the smaller-diameter wire? **[Q.N. 1(a), 2070 'C']**
8. When the ends of a wire are connected to a battery, initially the current is slightly larger, but soon it decreases slowly and becomes steady at a lower value although the emf of the battery remains unchanged. Explain. **[Q.N. 1(a), 2070 'D']**
9. A wire is stretched to double its length. What happens to its resistance and resistivity? **[Q.N. 1(a), Supp. 2069]**
10. Why are connecting wires made of copper? **[Q.N. 1(b), Supp. 2069]**
11. Batteries are always labeled with their emf. Would it also be appropriate to put a label on batteries stating how much current they provide? Why or why not?**[Q.N. 1(a), 2069 Set A]**
12. Give an example of non-ohmic conductor and present its current voltage characteristic graph. **[Q.N. 1(a), Set 'B' 2069]**
13. What is the ratio of maximum to minimum resistance obtainable from n wires of resistance R each? **[Q.N.1(a), 1st Exam 2068]**
14. Why is it essential that the resistance of a voltmeter be very high? **[Q.N.1(b), 1st Exam 2068]**
15. The resistance of an ammeter must essentially be very small. Why? **[Q.N. 1(a), 2067 1st Exam.]**
16. Water boils in an electric kettle in 15 minutes after being switched on. Using the same main supply. Should the length of the heating element be increased or decreased if the water is to boil in 10 minutes? Explain. **[Q.N. 1(b), 2067 1st Exam.]**
17. The energy that can be extracted from a storage battery is always less than the energy that goes into it while charging. Why? **[Q.N. 1(a), 2067 2nd Exam.]**
18. A wire is stretched to double its length. What happens to resistance and resestivity? **[Q.N. 10(a), 2065]**
19. When a motor car be started, its light becomes slightly dim, why? **[Q.N. 10(b), 2065]**
20. Why heat is generated across a resistor when the electric field is applied? **[Q.N. 10(a), 2064]**
21. Why do electrons acquire a steady drift average velocity? **[Q.N. 10(b), 2064]**
22. Why ammeter is always connected in series? **[Q.N. 10(c), 2064]**
23. The element of heater is very hot while the wire carrying current are cold, why ? **[Q.N. 10(a), 2063]**

24. You are given 2 wires each of resistance R. What is the ratio of maximum to minimum resistance that can be obtained from these wires? [Q.N. 10(c), 2063]
25. Explain the significance of a shunt with a diagram. [Q.N.10 (a), 2062]
26. A large number of free electrons are present in metals. Why is there no current in the absence of electric field across it? [Q.N.10 (b), 2061]
27. Why are alloys constantan and manganin used to make standard resistors? [Q.N.10 (a), 2060]
28. Why is a voltmeter always connected in parallel with the load resistance? [Q.N.10 (b), 2059]
29. Two bulbs have the filament of the same length. If one is of 40 watt and the other 60 watt, which one has thicker filament? [Q.N.10 (c), 2059]
30. You are given n wires each of resistance RΩ. What is the ratio of maximum to minimum resistance that can be obtained from these wires? [Q.N.10 (a), 2058]
31. Is terminal p.d. always greater than its emf? [Q.N.10 (c), 2058]
32. What are the factors on which the resistance of a conductor depend? [Q.N.10 (a), 2057]
33. Can the potential difference across a battery be greater than its emf? [Q.N.10 (b), 2057]
34. Two bulbs of 60W and 100W are connected in series and this combination is connected across the mains. Which bulbs will glow more bright ? [Q.N.10 (c), 2057]
35. Why do we use connecting wires made of copper? [Q.N.10 (b), 2056]
36. An ammeter is always connected in series. Why? [HSEB 2056]
37. What do you mean by resistivity of a material? What is its unit? [HSEB 2054]
38. Why do electrons acquire a steady drift velocity? [HSEB 2053]
39. What are the factors on which the resistance of a conductor depend? [HSEB 2053]
40. Which of the combination will be preferred if you have to draw large current if external resistance is negligible compared to internal resistance of a cell? [HSEB 2052]
41. An ammeter is always connected in series. Why? [HSEB 2052]
42. Why is heat generated across a resister when electric field is applied? [HSEB 2052]
43. Why do we use connecting wires made of copper? [HSEB 2051]

Long Questions

1. Define drift velocity of electrons. Establish a relation between drift velocity of electrons and current density in the conductor. [Q.N.5(a), 2072'C']
2. Why has an ammeter a very low resistance? How can you convert a galvanometer into an ammeter? [Q.N.5(a), 2072'E']
3. Define emf, terminal p.d. and internal resistance. Derive the relation between them for the circuit drawing current. [Q.N.5(a), Supp. 2071]
4. Describe the mechanism of metallic conduction and derive a relation between current density and drift velocity of the electrons. [Q.N. 5 (a), Set 'C' 2071]
5. What is the difference between an electromotive force and the terminal potential difference? How are they related? [Q.N. 5 (b), Set 'B' 2069]
6. Discuss mechanism of metallic conduction. Derive a relation between current density and drift velocity of the electrons. [Q.N. 5 (a), 2069 Set A]
7. Discuss the mechanism of metallic conduction. Derive a relation between current density and drift velocity. [Q.N.5(a),2068 1st Exam.]
8. Distinguish between resistance and resistivity. Derive expression for the effective resistance of number of resistors connected in series and parallel. [Q.N.5(d), 2nd Exam 2068]
9. State and explain Ohm's law. Two resistors are connected in parallel and third resistor be connected in series with the combination of parallel resistors. If this combination be connected with a battery of the negligible internal resistance, find the potential difference across each resistor. [Q.N. 11(a), 2064]
10. What do you meant by shunt? How will you convert a galvanometer into an ammeter? [Q.N. 11,(a) 2063]
11. State and explain Joule's laws of heating effect of electric current. Discuss how they are verified experimentally. [Q.N. 11(a), 2061]

12. Discuss the mechanism of metallic conduction. Derive J = nev where J is current density, e is electronic charge and v is drift velocity. **[Q.N.11 (a), 2060]**

13. What is drift velocity of an electron? Derive a relation between the current through a metallic conductor and the drift velocity in terms of the number of free electrons per unit volume of the conductor. **[Q.N. 11(a), 2059]**

14. What do you mean by a shunt? Describe its use in converting a galvanometer into an ammeter. **[Q.N. 11(a) (or), 2057]**

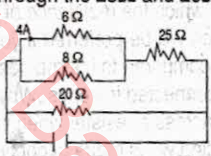
15. Deduce an expression for the heat developed in a wire by the passage of an electric current. **[Q.N. 11(a), 2056]**

Numerical Problems

1. The resistance of a galvanometer coil is 9.36Ω, and the current required for full scale deflection is 0.0224A. We went to covert this galvanometer to an ammeter reading 20A full scale. The only shunt available has a resistance of 0.025Ω. What resistance must be connected in series with the coil. **[Q.N.9(a), 2072'C']**
[Ans : 13Ω]

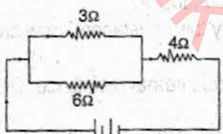
2. A battery of 6V and internal resistance 0.5Ω is joined in parallel with another of 10V and internal resistance 1Ω. The combination sends a current through an external resistance of 12Ω. Find the current through each battery. **[Q.N.9(a), 2072'D']**
[Ans : I_1 = 2.27A, I_2 = 2.87A]

3. Consider the figure below. The current through 6Ω resistor is 4A in the direction shown. What are the currents through the 25Ω and 20Ω resistors ?



[Ans : 7A, 9.95A] **[Q.N.9(a), Supp. 2071]**

4. In the given figure, the current through the 3Ω resistor is 0.8A. Find the potential drop across 4Ω resistor. **[Q.N. 9 (b), Set 'D' 2071]**



[Ans : 4.8V]

5. A potential difference of 4.5 v is applied between the ends of wire that is 2.5 m long and has radius of 0.654 mm. The resulting current through the wire is 17.6A. What is the resistivity of the wire ?
[Ans : 1.35×10^{-7}Ωm] **[Q.N.9(a), 2070 'Supp']**

6. A tightly coiled spring having 75 coils, each 3.50 cm in diameter, is made of insulated metal wire 3.25 mm in diameter. An ohm meter connected across its opposite ends reads 1.74Ω. What is the resistivity of the metal? **[Q.N. 9 (a), 2070 'C']**
[Ans : 5.38×10^{-4}Ωm]

7. A voltmeter coil has resistance 50Ω and a resistor of 1.15KΩ is connected in series. It can read potential differences upto 12 volts. If the same coil is used to construct an ammeter which can measure currents upto 2A, what should be the resistance of the shunt used?
[Ans : 0.25 Ω] **[Q.N. 9 (a), 2070 'D']**

8. An electric bulb is marked 100w, 220v. If the supply voltage drops to 110V, what is the energy dissipated by the bulb in 10 minutes.
[Ans : 1.5×10^4 J] **[Q.N. 9 (a), Supp. 2069]**