

# 5 SETS of 2077

## Physics XII

### SET – I

Time: 3 hrs

Full Marks: 75

Pass Marks: 27

#### Group 'A'

1. Answer, in brief, **any four** questions: [4×2=8]
  - a. Why do we prefer a potentiometer to measure emf of a cell rather than a voltmeter?
  - b. The conductivity of an electrolyte is very low as compared to a metal at room temperature. Why?
  - c. What is retentivity and coercivity of a ferromagnetic material?
  - d. If the number of turns of a solenoid is doubled, keeping the other factors constant, how does the self inductance of the solenoid change?
  - e. A transformer gets heated up while in use. Why?
  - f. Can a charge particle move through a magnetic field without experiencing any force? Explain.
2. Answer, in brief, **any four** questions: [4×2=8]
  - a. If we go on increasing the wavelength of light incident on a metal surface, what changes take place in the number of electrons and energy of the electrons?
  - b. What are logic gates? Give a truth table for a two input NOR gate.
  - c. Even if a hydrogen atom contains an electron, its spectrum consists of a large number of lines. Explain how?
  - d. Write quark composition of proton and neutron.
  - e. A nucleus contains no electrons, yet it ejects them. Explain.
  - f. What do you mean by global warming?
3. Answer, in brief, **any one** question: [2]
  - A. Whistle of an approaching train is shriller, why?
  - b. When sound waves travel through a medium, does the temperature at various points remain constant? Explain.
4. Answer, in brief, **any one** question: [2]
  - a. Distinguish between wave fronts and wavelets.
  - b. Define polarizing angle. How is it related with the refractive index of the medium?

#### Group 'B'

5. Answer **any three** questions: [3×4=12]
  - a. Define drift velocity of electrons. Establish a relation between drift velocity of electrons and current density in the conductor.

- b. State principle of Meter Bridge. Describe how it is used to determine the resistance of a wire.
  - c. Derive an expression for the force per unit length acting on each of the two straight parallel metallic conductors carrying current in the same direction and kept near each other. Why do such current carrying conductors attract each other?
  - d. What is Lenz's law? Deduce an expression for the emf induced in a straight conductor moving in a uniform magnetic field.
6. Answer **any three** questions: [3×4=12]
- a. Describe with necessary theory Thomson's method to determine specific charge of an electron.
  - b. What is an extrinsic semiconductor? Explain the formation of potential barrier and depletion region in a p-n junction.
  - c. Define mass defect and binding energy. Draw a graph showing the variation of Binding energy per nucleus and Atomic number of the elements and explain it.
  - d. What are renewable and non renewable sources of energy? Write with examples. Describe the necessity of conservation of natural resources of energy to reduce energy crisis in the future.
7. Answer **any one** question: [4]
- a. What is a wave motion? Derive progressive wave equation in a medium.
  - b. Describe sound wave as a pressure wave and deduce an expression for the pressure amplitude.
8. Answer **any one** question: [4]
- a. What are coherent sources? Derive an expression for the fringe width in Young's double slit experiment.
  - b. What is Fraunhofer 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.

#### Group 'C'

9. Answer **any two** questions: [2×4=8]
- a. A battery of emf 1.5V has a terminal p.d. of 1.25V when a resistor of  $25\Omega$  is joined to it. Calculate the current flowing, the resistance and terminal p.d. when a resistance of  $10\Omega$  replaces  $25\Omega$  resistor.
  - b. A horizontal wire, of length 5cm and carrying a current of 2A, is placed in the middle of a long solenoid at right angles to its axis. The solenoid has 1000 turns per meter and carries a steady current I. calculate I if the force on the wire is equal to  $10^{-4}\text{N}$ . ( $\mu_0 = 4\pi \times 10^{-7}\text{Hm}^{-1}$ ).
  - c. A coil having inductance and resistance is connected to an oscillator giving a fixed sinusoidal output voltage of 5Vrms. With the

oscillator set at a frequency of 50Hz, the rms current in the coil is 1A and at a frequency of 100Hz, the rms current is 0.625A. Determine the inductance of the coil.

10. Answer **any two** questions: [2×4=8]
- The work function for the surface of aluminum is 4.2eV. How much potential difference will be required to stop the emission of maximum energy electrons emitted by light of wavelength 2000Å? (Plank's constant,  $h = 6.6 \times 10^{-34} \text{JS}$ )
  - A X-ray tube works at a dc potential difference of 50kV. Only 0.4% of the energy of the cathode rays is converted into x-rays and heat is generated in the target at the rate of 600 watt. Estimate the current passed into the tube and the velocity of the electrons striking the target. (Mass of electron =  $9 \times 10^{-31} \text{kg}$ , charge of electron =  $1.6 \times 10^{-19} \text{C}$ )
  - If 15% of the radioactive material decays in 5 days, what would be the percentage of amount of original material left after 25 days?
11. A wire with mass 40g 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. [4]
12. 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  $1^\circ$  with its original direction. If the distance between the mirrors is 6250m, calculate the velocity of light. [3]

## SET 2

### Group 'A'

1. Answer, in brief, **any four** questions: [4×2=8]
- 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  $R_2$ ?
  - Draw a circuit diagram of Meter Bridge to determine the resistance of a wire. Give the formula used.
  - Does a charged particle moving through a magnetic field always experience a force? Explain.
  - Define angle of dip. What will be its value at a place where the horizontal and vertical components of earth's magnetic field are equal?
  - Why does acceleration of a magnet falling through a long solenoid decrease?
  - What is wattless current?

2. Answer, in brief, **any four** questions: [4×2=8]
- The output of two-input AND gate is fed to a NOT gate. Draw the logic circuit of the combination of gates. Write down its truth table.
  - What is optical pumping in the production of laser?
  - All the nuclei have nearly the same density. Justify.
  - How do the mass number and atomic number of a radioactive element change in an  $\alpha$ -decay?
  - State Hubble's law and write its significance.
  - What is acid rain? Explain.
3. Answer, in brief, **any one** question: [2]
- Distinguish between progressive waves and standing waves.
  - If the pressure amplitude of a sound wave is halved, by what factor does the intensity of the wave change?
4. Answer, in brief, **any one** question: [2]
- Does the interference of light waves obey the law of conservation of energy? Explain.
  - What is polarized light? How is it represented?

### Group 'B'

5. Answer **any three** questions: [3×4=12]
- What is thermoelectric effect? How does the thermo emf of a thermocouple vary with increase in temperature of hot junction, keeping cold junction at  $0^\circ\text{C}$ ? Explain.
  - Describe an experiment to verify Joule's Law of heating.
  - State and explain Biot-Savart law. Use this law to find the magnetic field due to a long straight current carrying conductor.
  - An alternating current passes through a circuit containing a resistor, a capacitor and an inductor in series. Derive an expression for the phase relation between the current and the voltage.
6. Answer **any three** questions: [3×4=12]
- Define photoelectric effect. Discuss Einstein's photoelectric equation. What is meant by stopping potential?
  - Explain the use of a p-n junction diode as a rectifier. Draw the circuit diagram of a full wave rectifier using diodes and explain its working.
  - State Bohr's postulates of hydrogen atom and use them to calculate the radius of  $n^{\text{th}}$  orbit of the hydrogen atom.
  - State the laws of radioactive disintegration. Derive a relation between the half life and decay constant of a radioactive substance.
7. Answer **any one** question: [4]
- 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.

- b. What is end correction of a pipe? Describe the different modes of vibration of air column in an organ pipe closed at one end.
8. Answer **any one** question: [4]
- a. State and explain Huygen's principle. Derive the laws of reflection on the basis of this principle.
- b. Discuss the formation of maxima and minima due to Fraunhofer diffraction at a single slit.

### Group 'C'

9. Answer **any two** questions: [2×4=8]
- a. Twelve cells each of e.m.f. 2V and of internal resistance 0.5 ohm are arranged in a battery of n rows and an external resistance 0.4 ohm is connected to the poles of the battery. Estimate the current flowing through the resistance in terms of n.
- b. The coil of a moving coil galvanometer has 50 turns and its resistance is 10Ω. It is replaced by a coil having 100 turns and resistance 50Ω. Find the factor by which the current and voltage sensitivities change.
- c. A long solenoid of 1000 turns and cross sectional area  $2 \times 10^{-3} \text{m}^2$  carries a current of 2A and produces a flux density  $50 \times 10^{-3} \text{T}$  inside it. Calculate the self inductance of the coil.
10. Answer **any two** questions: [2×4=8]
- a. In a Millikan's oil drop experiment, a drop is observed to fall with a terminal speed 1.4mm/s in the absence of electric field. When a vertical electric field of  $4.9 \times 10^5 \text{V/m}$  is applied, the droplet is observed to continue to move downward at a lower terminal speed 1.21mm/s. Calculate the charge on the drop. (Density of oil =  $750 \text{kg/m}^3$ , viscosity of air =  $1.81 \times 10^{-5} \text{kg/ms}$ , density of air =  $1.29 \text{kg/m}^3$ )
- b. Calculate the wave length of electromagnetic radiation emitted by a hydrogen atom which undergoes a transition between energy levels of  $-1.36 \times 10^{-19} \text{J}$  and  $-5.45 \times 10^{-19} \text{J}$ . (Given planks constant =  $6.6 \times 10^{-34} \text{JS}$ )
- c. The energy liberated in the fission of single Uranium-235 atom is  $3.2 \times 10^{-11} \text{J}$ . Calculate the power production corresponding to the fission of 1gram of uranium per day. (Avogadro constant =  $6 \times 10^{23} \text{mol}^{-1}$ )
11. A stationary motion detector sends sound waves of 150KHz towards a truck approaching at a speed of 120km/hr. What is the frequency of wave reflected back to detector? (Velocity of sound in air = 340m/s) [4]
12. 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]

## SET 3

### Group 'A'

1. Answer in brief any **FOUR** questions. [4×2=8]
  - a. Why is there no current established in a conductor in the absence of electric field although a large number of free electrons are moving with high speed?
  - b. A heater coil is cut into two parts and only one of them is used in the heater. What is the heat produced by half coil to that of original coil?
  - c. Why is Sb-Bi thermocouple preferred to Fe-Cu thermocouple?
  - d. A current carrying solenoid tends to contract, why?
  - e. What do you mean by magnetically soft and hard substances? Which substance would you prefer for permanent magnet? Explain?
  - f. Why voltmeter is always connected in a parallel combination?
2. Attempt any **FOUR** questions. [4×2=8]
  - a. In T.V. usually a magnetic field is used to deflect the electron beam and not an electric field, why?
  - b. Why doesn't a wooden table emit photoelectrons from a table lamp?
  - c. Distinguish between electron and hole.
  - d. Why is wave nature of matter not observed in our daily life?
  - e. What is the quark combination of antiproton and antineutron?
  - f. How do you measure the age of the universe?
3. Attempt any **ONE** questions. [1×2=2]
  - a. Velocity of sound increases in cloudy days, why?
  - b. Why is roaring of iron different than the sound of mosquito?
4. Attempt any **ONE** questions. [1×2=2]
  - a. Why is interference pattern not detected when the two coherent sources are far apart?
  - b. Is polarization possible for longitudinal waves?

### Group 'B'

5. Attempt any **THREE** questions. [3×4=12]
  - a. Verify the laws which explain about the production of heat in the conductor on the passage of current through it.
  - b. What is the principle of Wheatstone bridge? How is it applied to find the unknown resistance in meter-bridge?
  - c. Define impedance of the circuit and hence derive the relation for impedance of R – L series circuit. Also find the phase relation between current and voltage.
  - d. State and explain Biot-Savart law. Use this to find the magnetic field due to a solenoid.
6. Attempt any **THREE** questions. [3×4=12]
  - a. Describe with necessary theory of Millikan's oil drop experiment to determine the value of the charge associated with an electron.

- b. What is laser? Explain the construction and working principle of He-Ne laser.
  - c. What are zener diodes? How can a zener diode use as a voltage regulator?
  - d. What are major energy sources? Give a brief account on the global energy consumption pattern and demand.
7. Attempt any **ONE** questions. [1×4=4]
- a. State the laws of transverse vibrations of strings. Describe experiments to verify them.
  - b. What is Doppler's effect? Describe the formula for the apparent frequency of sound when source of the sound is motion.
8. Attempt any **ONE** question. [1×4=4]
- a. State and explain Huygens's principle. Use it to verify the refraction of light.
  - b. What do you mean by polarized and unpolarized light? Prove that the reflected ray and refracted ray are perpendicular to each other when the light is incident on a polarizing angle.

### Group 'C'

9. Attempt any **TWO** questions. [2×4=8]
- a. Resistance of  $1000\Omega$  and  $2000\Omega$  are placed in series with a 100V mains supply, what will be the reading on a voltmeter of internal resistance  $5000\Omega$  when placed across the  $2000\Omega$  resistance.
  - b. A jet plane is flying due west at the speed of 1800 km/hr. What is the voltage difference developed between the ends of the wings 25 m long of the earth's magnetic field at that location is  $5 \times 10^{-4}$  T and the angle of dip is  $45^\circ$ ?
  - c. Assuming the Faraday constant  $F$  to be  $96500 \text{ C mole}^{-1}$ . Calculate (i) The charge needed to deposit 1.6g of oxygen in the electrolytes of water. (ii) The time required if a steady current of 2.5A is used. (Relative molecular mass of hydrogen and oxygen = 2 and 32 respectively)
10. Attempt any **TWO** questions. [2×4=8]
- a. Calculate the wavelength of the first line of the Balmer series, if the wavelength of the second line of this series is  $4.86 \times 10^{-7} \text{ m}$ .
  - b. The deflecting plate in a Thomson's set up are 5cm long and 1.5cm apart. The plates are maintained at a p.d. of 240V. Electrons accelerated to an energy of 2KeV enters from one edge of the plates midway in a direction parallel to the plates. What is the deflection at the other edge of the plates? ( $e/m = 1.8 \times 10^{11} \text{ C kg}^{-1}$ )
  - c. A piece of wood of 20gm shows an activity of 140 disintegrations per minutes. The living plant shows an activity of 12 disintegrations per minute per gram. If the activity is due to  $\text{C}^{14}$  whose half life is 5730 years? Calculate the age of the piece of wood?

11. A stone is dropped into a well and a splash is heard after 2.6 seconds. Calculate the depth of well. (Velocity of sound = 334m/s) [4]
12. 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  $5.89 \times 10^{-7}$  m, determine the slit separation and the angle made by the central bright fringe at the slit. [3]

## SET 4

### Group "A"

1. Answer Any Four questions. {4×2=8}
  - a. The element of heater is very hot while the wire carrying current is cold why?
  - b. Sometimes balance point is not obtained on potentiometer wire, why?
  - c. What do you mean by impedance of an A.C. circuit?
  - d. Define one ampere current in terms of force between current carrying conductors.
  - e. How does a current carrying coil behave as a bar magnet?
  - f. Why does a current carrying conductor placed in a magnetic field experience a force?
2. Answer Any Four questions. {4×2=8}
  - a. Why are the neutrons used to initiate fission reaction?
  - b. Write down the quark combination for proton & antineutron.
  - c. If energy is conserved, why is there an energy crisis?
  - d. What are logic gates? Give the truth table & Boolean expression for a two input AND gates.
  - e. If matter wave has a wave nature, why is it not observable in our daily experiences?
  - f. Explain, why it is not possible to define the total life of a radioactive Substance?
3. Answer Any One question. {1×2=2}
  - a. An echo is sound reflected from a distant object such as wall or cliff. Explain how you can determine how far away the object is timing the echo?
  - b. For transverse wave on a string, is the wave speed the same as the speed of any part of the string? Explain the difference between these two speeds. Which one is constant?
4. Answer Any One question. {1×2=2}
  - a. Could the young Double-slit interference be performed with gamma rays?
  - b. When light travels from a rarer to denser medium, it loses its speed. Is there a reduction in energy carried by light wave?

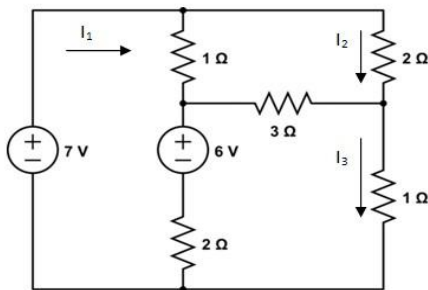


### GROUP "B"

5. Answer Any Three questions. {3×4=12}
- What is drift velocity of electron? Establish the relation between drift velocity and current?
  - What is neutral temperature? Discuss the Variation of thermo- emf with the temperature of hot junction.
  - Using Biot-Savart law, derive an expression for the magnetic field due to straight current carrying conductor.
  - Describe the construction and working of a transformer.
6. Answer Any Three questions. {3×4=12}
- Discuss the electric discharge through gas at various low pressure.
  - What is p-n junction diode? Describe the application of junction diode as a full wave rectifier.
  - Describe the modern method of production of x-rays. Discuss crystal diffraction.
  - What is ozone hole? Mention the causes and effects of depletion of ozone layer.
7. Answer Any One question. {1×4=4}
- Prove with necessary diagram, that both types of harmonic odd and even can be produced in an open organ pipe.
  - What is Doppler's effect ?Obtain an expression for apparent frequency heard by a stationary observer when (i) the source of sound moving towards him/her and (ii) the source of sound moving away from him/her.
8. Answer Any One question. {1×4=4}
- Describe the diffraction of light at a single slit and find the condition for secondary maxima and minima.
  - Describe Foucault's method for the determination of speed of light.

### GROUP "C"

9. Attempt Any Two questions. {2×4=8}
- Find  $I_1, I_2$  and  $I_3$  in the following figure.



- An inductor of 80 mH is in series with a 20  $\Omega$  resistor and 100 V- 50 Hz A.C. source. Calculate a) the rms value of current b) phase angle between the current and applied voltage c) power factor.

- c. The plane of a  $5.0\text{cm} \times 8.0\text{cm}$  rectangular loop of wire is parallel to a  $0.19\text{ T}$  magnetic field. The loop carries a current of  $6.2\text{ A}$ . (a) what torque acts on the loop? (b) What is the magnetic moment of the loop? (c) What is the maximum torque that can be obtained with the same total length of wire carrying the same current in this magnetic field?
- 10. Attempt Any Two questions. {2×4=8}**
- a. A sample of  $\text{Ra}^{226}$  has half life of 1620 years. What is the mass of the sample which undergoes 2000 decays/ sec?
- b.  ${}^{62}_{28}\text{Ni}$  may be described as the most strongly bound nucleus because it has the highest B.E. per nucleon. Its neutral atomic mass is  $61.928349\text{ amu}$ . Find its mass defect, its total binding energy and binding energy per nucleon.  
Given, mass of neutron =  $1.008665\text{ amu}$   
Mass of proton =  $1.007825\text{ amu}$   
 $1\text{ amu} = 931.5\text{ MeV}$ .
- c. Light of frequency  $5 \times 10^{14}\text{ Hz}$  liberates electrons with energy  $2.31 \times 10^{-19}\text{ J}$  from a certain metallic surface what's the wave length of U.V. light which liberates electrons of energy  $3.93 \times 10^{-19}\text{ J}$  from the same surface.
- 11. At what temperature would the velocity of sound in oxygen be the same as that in nitrogen at  $10^0\text{C}$  the density of oxygen and nitrogen at NTP are in the ratio 16:14. {4}**
- 12. For what incident angle is the light reflected from the surface of the glass ( $\mu = 1.65$ ) completely plane polarized if it is immersed in water of refractive index  $4/3$ ? {3}**

## SET 5

### GROUP "A"

- 1. Answer Any Four questions. {4×2=8}**
- a. Can the potential difference across a battery be greater than its emf?
- b. Why does voltmeter measure current more accurately than an ammeter?
- c. Why is choke coil preferable to resistor?
- d. What is a radial magnetic field? How is it obtained in moving coil galvanometer?
- e. We prefer semi-conductor than metal for Hall effect, why?
- f. A stream of protons is moving parallel to a stream of electrons. Do the two streams tend to come closer or move apart?
- 2. Answer Any Four questions. {4×2=8}**
- a. Write down the difference between cathode rays and gamma rays.
- b. Would there be any advantage to adding n-type on p-type impurities to copper? Why or why not?
- c. Define population inversion & optical pumping.

- d. Describe OR gate with Boolean expression & truth table and realization circuit.
  - e. How do you get emission of  $\beta$ - particles from the nucleus although there are no electrons with it?
  - f. Why photoelectric effect cannot be observed with all wavelength of light?
3. Answer Any One question. {1×2=2}
- a. Would you expect the pitch (or frequency) of an organ pipe to increase or decrease with increasing temperature? Explain.
  - b. When sound travels from air into water, does the frequency of the wave change? The speed? The wavelength? Explain your reasoning.
4. Answer Any One question. {1×2=2}
- a. Does it make sense to talk about the polarization of a longitudinal wave, such as a sound wave? Why or why not?
  - b. Differentiate between a plane Wave front & a spherical wave front.

### GROUP "B"

5. Answer Any Three questions. {3×4=12}
- a. What is Potentiometer? How can you use it to measure internal resistance of a cell?
  - b. Derive an expression of current flowing through an A.C. circuit containing a resistor and capacitor. Obtain the expression of power factor of this circuit?
  - c. Derive an expression for the force experienced by a conductor carrying current when placed in a uniform magnetic field.
  - d. Using Ampere's circuital law, derive an expression for the magnetic field at the center of the current carrying solenoid.
6. Answer Any Three questions. {3×4=12}
- a. Write down the schemes for nuclear fusion & nuclear fission. How can the release energy in any of these reaction estimated? What do you mean by Q-value of nucleus reaction?
  - b. What is water pollution? Discuss its adverse effects & give some measures to control it.
  - c. Write down the postulates of Bohr's model of hydrogen atom & obtain expression for the energy of  $n^{\text{th}}$  orbit of electron.
  - d. Explain how universe expands? Explain the Hubble's law.
7. Answer Any One question. {1×4=4}
- a. Derive one expression for velocity of sound in any medium by dimensional method. Discuss the factors affecting the velocity of sound in air medium.
  - b. What is intensity of sound? Derive its expression  $I = \frac{1}{2} V \rho A^2 W^2$
8. Answer Any One question. {1×4=4}
- a. Describe Michelson's method to determine the speed of light. What are the advantages of this method over Foucault's method?

- b. Describe Young's double slit experiment for the interference of light and show that bright and dark fringes are equally spaced.

### GROUP "C"

**9. Attempt Any Two questions. {2×4=8}**

- a. 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  $1.74\Omega$ . What is the resistivity of the metal?
- b. The length of 600 cm of a potentiometer wire is required to balance the emf of a cell. When a  $20\Omega$  resistor is connected across the terminal of the cell the length required for balance is 550 cm. calculate the internal resistance of the cell.
- c. A 50V, 50 Hz, ac supply is connected to a resistor of resistance  $40\Omega$  in series with a solenoid having inductance 200 mH with same resistance. The potential difference across the ends of the  $40\Omega$  resistor is found to be 20 V. Find the resistance of the wire of the solenoid.

**10. Attempt Any Two questions. {2×4=8}**

- a. A radioactive source which has the half life of 130 days, contains initially  $1 \times 10^{22}$  atoms, & the energy released per decay is  $8 \times 10^{-13}\text{J}$ , calculate the activity of the source after 260 days elapsed & total energy released during this period.
- b. A beam of electron is under potential difference of  $1.36 \times 10^4\text{V}$  applied across two parallel plates 4 cm apart & a magnetic field  $2 \times 10^{-3}\text{T}$  at right angles to each other. If two fields produce no deflection in the electronic beam, calculate
  1. The velocity of electrons.
  2. The radius of the orbit in which the beam will move, if the electric field made zero.
- c. Light of wavelength  $6000\text{\AA}$  fall a photosensitive plate of work function 1.9 eV. Find the speed of the photo electrons emitted.

**11. A pianoforte wire having a diameter of 0.90mm is replaced by another wire of same material but with diameter 0.93 mm. If the tension of the wire is the same as before what is the percentage change in the frequency of the fundamental note? What percentage change in the tension would be necessary to restore the original frequency? {4}**

**12. A parallel beam of sodium light of wavelength  $5893\text{\AA}$  is incident normally on a diffraction grating. The angle between the two first order spectra on either side of the normal is  $28^\circ$ . Find the number of ruling line per mm on the grating. {3}**