II PUC - PHYSICS

CHAPTERWISE QUESTIONS NUMERICALS

Chapter 1: Electric Charges and Fields

1. Two point charges $q_A = 3\ \mu C$ and $q_B = -3\ \mu C$ are located 20 cm apart in vacuum.

   (a) What is the electric field at the midpoint O of the line AB joining the two charges?

   (b) If a negative test charge of magnitude 1.5 nC is placed at this point, what is the force experienced by the test charge? **(Ans: E=5.4 x 10^6, F= 8.1 x 10^{-3}N along AB)**

2. Three point charges are placed at the following points on the x axis: 2μC at x=0, -3μC at x=40cm and -5μC at x=120cm. Calculate the force on the -3μC charge. **(Ans:F= 0.548 N towards left)**

3. ABC is an equilateral triangle of side 0.03m. Charges of +5nC +3nC and -5nC are placed at the corners A,B and C respectively. Find the resultant force on the charge placed at B. **(Ans: F=15x10^{-5}N parallel to AC)**

4. Three point charges OF +5nC, +20nC and +5nC are placed at the corners A, B & C of a square ANCD having side 0.8m. Calculate magnitude of electric field at the corner D. **(Ans: E=240 N/C along BD)**

5. Charges of -20nC, +20nC and +40nC are placed at the corners A, B & D of a square of side 2m. Calculate the resultant field at the centre of the square. **(Ans: E=127 N/C $\perp^{lar}$ AB)**

6. Find the point on the line joining the two charges +12nC and +3nC where the resultant field is zero. Distance between the charges is 1.2m. **(Ans: x=0.8m from bigger charge)**

7. Two identical metal spheres having equal and similar charges repel each other with a force of 10^3 N when they are placed 10cm apart in a medium of dielectric constant 5. Determine the charge on each sphere. **(Ans: q=745 x 10^{-7}C)**

8. The electrostatic force of repulsion between two positively charged ions carrying equal charge is 3.7 x 10^{-9}N, when they are separated by a a distance of 5A^0. How many electrons are missing from each ion? **(Ans: n=2 electrons)**

Chapter 2: Electrostatic Potential and Capacitance

1. Two charges 30nC and -20nC are located 15 cm apart. At what points on the line joining the two charges is the electric potential zero? Take the potential at infinity to be zero. **(Ans: x=6cm, 30cm from smaller charge)**

2. Two point charges +1 nC and –4 nC are 1m apart in air. Find the positions along the line joining the two charges at which resultant potential is zero. **(Ans: x=0.2m, 0.33m from smaller charge)**

3. Charges 2μC, 4μC and 6μC are placed at the three corners A, B and C of a square ABCD of

side x metre. Find what charge must be placed at the fourth corner so that net potential at thecentre of the square becomes zero. **(Ans: q=-12μC)**

4. ABCD is a square of side 2m. Point charges of 5nC, 10nC and -5nC are placed at corners A, B, Crespectively. Calculate the work done in transferring a charge of 5μC from D to the point of intersection of diagonals. **(Ans: W=159µJ)**

5. In a parallel plate capacitor with air between the plates, each plate has an area of 6×10^{-3} m^2 and the distance between the plates is 3 mm. Calculate the capacitance of the capacitor. If this capacitor is connected to a 100 V supply, what is the charge on each plate of the capacitor? **(Ans: c=17.7 pF, q=1.77nC)**

6. In a parallel plate capacitor with air between the plates, each plate has an area of 8×10^{-3} m^2 and the distance between the plates is 2 mm. Calculate the capacitance of the capacitor. If this capacitor is connected to a 50 V supply, what is the charge on each plate of the capacitor? (Absolute permittivity of free space = 8.85×10^{-12} Fm^{-1}) **(Ans: C=35.4pF, q=1770pC)**

7. When the two capacitors are connected in series and connected across 4kV line, the Energy stored in a system 8J. The same capacitor is connected in parallel across the same line, energy stored is 36J.Find the capacitance of the capacitors. **(Ans: C_1=3μF, C_2=1.5μF)**

8. Two capacitors of capacitance 600pF & 900pF are connected in series across a 200V supply. Calculate (i) the effective capacitance of the combination, (ii)the pd across each capacitor and (iii) the total charge stored in the system.**(Ans: C_s=360pF, V_1=120V, V_2=80V, q=0.072μC)**

9. A capacitor has capacitance of 10μF and is charged to a potential 200V. A second capacitor has a capacitance 20μF and is charged to a potential of 300V. If, after charging, the two capacitors are connected in parallel. How much energy is dissipated? **(Ans:E_1=1.1J, E_2=1.06J ΔE = 0.033 J)**

Chapter 3: Electric Current

1. A battery of internal resistance 3Ω is connected to 20Ω resistor and potential difference across the resistor is 10V. If another resistor of 30 Ω is connected in series with the first resistor and battery is again connected to the combination, calculate the emf and terminal p.d across the combination. **(Ans: E=11.5V, pd=10.84V)**

2. A wire of length 2m, diameter 1mm and resistivity 1.963×10^{-6} Ωm is connected in series with abattery of emf 3V and internal resistance 1Ω. Calculate the resistance of the wire and thecurrent in the circuit. **(Ans: R =5Ω, I=0.5A)**

3. Two identical cells either in series or in parallel combination, gives the same current of 0.5A through external resistance of 4Ω. Find the emf and internal resistance of each cell. **(Ans: E=3V, r=4Ω)**

4. Two cells of emf 2V and 4V and internal resistance 1 Ω and 2Ω respectively are connected in parallel so as to send the current in the same direction through an external resistance of 10Ω. Find the potential difference across 10 Ω resistor. **(Ans: I = 0.25A, V=2.5V)**

5. The number density of free electrons in a copper conductor is 8.5×10^{28} m^{-3}. How long does an electron take to drift from one end of a wire 3.0m long to its other end? The area of cross section of the wire is 2.0 x 10^{-6} m^2 and it is carrying a current of 3.0A.**(Ans: v_d=0.00011 m/s, t=27200 s)**

6. At room temperature (27.0 °C) the resistance of a heating element is 100Ω . What is the temperature of the element if the resistance is found to be 117 Ω, given that the temperature coefficient of the material of the resistor is 1.70 × 10^{-4} °C^{-1}. **(Ans: T = 1027 ^{0}C)**

7. Resistances in cyclic order in a Whetstone's network are 2Ω, 3 Ω, 1 Ω and 2 Ω. Resistance of the galvanometer is 10 Ω. Emf of the cell is 1.2V and its internal resistance is negligible. What is the current through the galvanometer?**(I_g=0.026A)**

Chapter 4: Moving Charges and Magnetism

1. In a chamber, a uniform magnetic field of 6.5 x 10^{-4} T is maintained. An electron is shot into the field with a speed of 4.8 x 10^6 m/s normal to the field. Determine the radius of the circular orbit described by the electron. Also calculate the period, frequency and angular velocity of the electron.**(Ans: r=4.2cm, T=5.5 x 10^{-8}s, ω=1.14 rad/sec)**

2. A circular coil of 20 turns of mean radius 0.06m carries a current of 1A. Calculate the magnetic field at (i) the centre of the coil (ii) a point on the axis distant 0.08m from its centre. Given μ_0=4π x 10^{-7} Tm/A. **(Ans: B_{centre}= 0.209 mT, B_{axis}=0.042mT)**

3. Two identical circular coils are placed concentrically with their planes perpendicular to each other. A current of 2A passes through each coil of 50 turns. If the radius of either coil is 0.3m, find the resultant magnetic field at their common centre. **(Ans: 0.29 mT).**

4. Three straight wires A,B and C are in same plain. B is between A & C such that AB=2cm & AC =8cm. Currents in A, B & C are 1A, 1.5A & 2A in the same direction. Calculate the resultant force per unit length on B. Also find the net force on C if the current through it is reversed?**(Ans: F_B=0.5 x 10^{-5} N/m towards A, F_c= 1.5 x 10^{-5} N/m away from C)**

5. A galvanometer having coil of resistance 12Ω gives full scale deflection for a current of 4mA.

(i) How can it be converted into a voltmeter of range 0-24V? **(Ans: R=5988 Ω)**

(ii) How can it be converted into a ammeter of range 0 -5A? **(Ans: S=0.0096Ω)**

Chapter 6: Electromagnetic Induction

1. Current in a coil falls from 2.5A to 2.0A in 0.01 s, calculate the induced emf in a coil if its self inductance is 5mH. **(Ans: e=0.25V)**

2. A square loop of side 10cm and resistance 0.5Ω is placed vertically in the east-west plane. A uniform magnetic field of 0.1T is setup across the plane in the north-east direction. The magnetic field is decreased to zero in 0.7s at a steady rate. Determine the magnitudes of induced emf and current during this time interval.**(Ans: e=0.001V, I=0.002A)**

3. A circular coil of radius 10cm and 25turns is rotated about its vertical diameter with an angular speed of 40 rads^{-1} in a uniform horizontal magnetic field of magnitude 5 x 10^{-2}T. Calculate the emf induced in the coil. Also find the current in the coil if the resistance of the coil is 15Ω.**(Ans: e=1.57V, I=0.11).**

4. A conductor of length 3m moving in a uniform magnetic field of strength 100T. It covers a distance of 70m in 5sec. Its plane of motion makes an angle 0f 30^0 with the direction of magnetic field. Calculate the emf induced in it.**(Ans: e=2100V).**

5. A long solenoid with 15 turns per cm has a small loop of area 2.0cm^2 placed inside the solenoid normal to its axis. If the current carried by the solenoid changes steadily from 2.0A to 4.0A in 0.1s, what is the induced emf in the loop while the current is changing?**(Ans: e=7.5μV)**

Chapter 7: Alternating Current

1. A pure inductor of 25.0 mH is connected to a source of 220 V & 50Hz. Find the inductive reactance and rms current and peak current in the circuit **(Ans: X_L=7.85Ω, I_0=39.6A).**

2. An inductor and bulb are connected in series to an AC source of 220V, 50 Hz ac source. A current of 11A flows in the circuit and phase angle between voltage and current is π/4 radian. Calculate the impedance and inductance of the circuit. **(Ans: Z=20Ω, L=0.045H)**

3. A sinusoidal voltage of peak value 238 V and frequency 50 Hz is applied to a series LCR circuitin which R = 3Ω, L = 25.48 mH, and C = 786 μF. Find (a) the impendence of the circuit; (b) the phase difference between the voltage across the source and the current (c) the power factor (d) Average power dissipated in the circuit. **(Ans: X_L=8Ω, X_C=4Ω, Z=5Ω, ϕ=53.3^0, cosϕ=0.6)**

4. A sinusoidal voltage of peak value 285 V is applied to a series LCR circuit in which R = 5Ω, L =28.5 mH, and C = 800 μF. Find (a) resonant frequency (b) Calculate the impedance, current andpower dissipated at resonance. **(Ans: f_r=33.32Hz, Z=5Ω, I_{rms}=40.3A, P=8.1kW)**

5. A resistor 100Ω, a pure inductance coil of L = 0.5 H and capacitor are in series in a circuit containing an ac of 200V, 50 Hz. In the circuit current is ahead of the voltage by 30°. Find the value of the capacitance. **(Ans: C=14.82μF)**

6. A source of alternating emf of 220V, 50 Hz is connected in series with a resistance of 200Ω, inductance of 100mH and capacitance of 30μF. Does the current lead or lag the voltage and by what angle? **(Ans: X_L=31.42Ω, X_C=106.1Ω, ϕ=20.5^0).**

Chapter 9: Ray Optics and Optical Instruments

1. Two convex lenses of focal lengths 0.20 m and 0.30 m are kept in contact. Find the focal lengthof the combination. Calculate powers of two lenses and combination. **(Ans: f=0.12m, P=8.33D)**

2. An equilateral prism produces a minimum deviation of 40°. What is the R.I of the material of theprism? Calculate the angle of incidence. **(Ans: n=1.532, i=50^0).**

3. The angle of a prism of RI 1.6 is 60^0. A ray of light incident on one face just emerges from the other face. Calculate the angle of incidence at the first face.**(Ans: i=35.45^0)**

4. Calculate the angle of minimum deviation produced by prism of angle 60^0 and refractive index 1.5.**(Ans: D=37.2^0)**

5. An equiconvex lens of glass of RI 1.5 is immersed in a liquid of RI 1.6. If the radius of curvature of each surface is 0.1m, find the nature and focal length of the lens.**(Ans: f=-0.8m)**

6. A convex lens has focal length of 0.1m in air. Calculate its power. If the lens is completely immersed in water, what will be the change in the power of the lens? Given n_g=3/2, n_w=4/3. **(Ans: P=10D, f_w=0.4m, P_w=2.5D, ΔP=7.5D)**

7. A small bulb is placed at the bottom of a tank containing water to a depth of 1m. Find the critical angle for water air interface. Also calculate the radius, diameter and area of the circular bright patch of light formed on the surface of water? Given n_w=4/3.**(Ans: C=48.6^0, r=1.13m, A=$4.04m^2$).**

8. An object is placed in air at a distance of 20cm from a convex surface of a medium of RI 1.6, If a virtual image is formed at a distance of 50cm from the surface, find the radius of curvature of the surface. **(Ans: R=33.33cm)**

9. A beam of light converges at a point P. Now a lens is placed in the path of the convergent beam 12cm from P. at what point does the beam converge if the lens is

   (a) A convex lens of focal length 20cm, and

   (b) A concave lens of focal length 16cm? **(Ans: v=+7.5cm, v'=+48cm)**

Chapter 10: Wave optics

1. A beam of light consisting of two wavelengths 420 nm and 560 nm is used to obtain interference fringes in Young's double slit experiment. The distance between the slits is 0.3 mm and the distance between the slits and the screen is 1.5 m. Compute the least distance of the point from the central maximum, where the bright fringes due to both the wavelengths coincide.**(Ans: x=8.4mm)**

2. In Young's double slit experiment distance between the slits is 0.5 mm. When the screen is kept at a distance of 100 cm from the slits the distance of 9^{th} bright fringe from the central fringe system is 8.835 mm. Find the wavelength of light used. **(Ans: λ=4908A^0)**

3. In YDSE the slits are separated by 0.28mm and screen is place at a distance of 1.4m away from the slits. The distance between the central bright fringe and the fifth dark fringe is measured to be 1.35cm. Calculate the wavelength of light used.. **(Ans: λ=6000A^0)**

4. In Young's double-slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path difference is λ, is K units. What is the intensity of light at a point where path difference is λ/3? **(Ans: K/4)**

Chapter 11: Dual Nature of Radiation and Matter

1. The work function of cesium metal is 2.14 eV. When light of frequency 6×10^{14}Hz is incident on the metal surface, photoemission of electrons occurs. What is the (a) energy of the incident photons (b) maximum kinetic energy of the emitted electrons? (c) Stopping potential and (d) maximum speed of the emitted photoelectrons? Given h = 6.63×10^{-34} Js, e = 1.6×10^{-19} C, $m_e = 9.1 \times 10^{-31}$kg **(Ans: E=2.48eV, KE_{max}=0.346eV)**

2. A photon of wavelength 540nm is incident on a metal of threshold wavelength 600nm. Calculate (i) Maximum KE of photon (ii) Stopping potential and (iii) Maximum velocity of photo electrons. Given:$m_e = 9.1 \times 10^{-31}$ kg, h = 6.63×10^{-34}Js, c= 3×10^{8}m/s.**(Ans: 0.368×10^{-19}J, V_s=0.23V, $v_{max}=0.28 \times 10^{6}$m/s).**

3. The work function of Cesium is 2.14eV. Find threshold frequency for Cesium and wavelength of incident light if the photo current is brought to zero by a stopping potential of 0.6V.**(Ans: $\nu_0=0.5164 \times 10^{15}$Hz, λ=4536A^0)**

4. The wavelength of light from the spectral emission line of sodium is 589nm. Find the KE at which (a) an electron, and (b) a neutron, would have the same de Broglie wavelength. **(Ans: a. KE=4.34 μeV, b. 0.236neV)**

5. What is the (a) momentum, (b) speed, and (c) de Broglie wavelength of an electron with kinetic energy of 120eV. **(Ans: p=5.91×10^{-24}kg m/s, v=6.5×10^{6} m/s, λ=0.112nm)**

Chapter 12: Atoms

1. The radius of the innermost electron orbit of a hydrogen atom is 5.3×10^{-11} m. What are the radii of the n = 2 and n =3 orbits?. (**Ans:2.12 A^0, 4.77 A^0).**

2. A hydrogen atom initially in the ground level absorbs a photon, which excites it to the n=4 level. Determine the wavelength and frequency of photon.**(Ans: λ=97.44nm)**

Chapter 13: Nuclei

1. Calculate the mass defect and specific binding energy of $_7N^{14}$, given that the rest mass of nitrogen nucleus is 14.00307 u, m_P = 1.00783 u and m_n = 1.00867 u. **(Ans: Δm=0.11243 u, SBE=7.48 MeV)**

2. Calculate binding energy and binding energy per nucleon of an oxygen nucleus $_8O^{16}$. Rest mass of oxygen nucleus is 15.995 u, mass of proton = 1.007825 u and mass of neutron = 1.008665u. **(Ans: BE=127.54 MeV, SBE=7.97 MeV)**

3. Calculate the energy released in joules by 0.5mg mass of U-235 in the following reaction.

[1eV=1.6×10^{-19}J)

$_{92}U^{235} + {}_0n^1 \longrightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3\,{}_0n^1$ + Energy

Given: Rest mass of U^{235} = 235.044 u

Rest mass of Ba^{141} = 140.918 u

Rest mass of Kr^{92} = 91.885 u

Rest mass of $_0n^1$ = 1.009 u

Mass of fissile material = 0.5mg = 0.5 x 10^{-3}g**(Ans: E=4.25 x 10^7J)**

4. (a) Two stable isotopes of lithium $_3Li^6$ and $_3Li^7$ have respective abundances of 7.5% and 92.5%. These isotope have masses 6.01512 u and 7.01600 u, respectively. Find the atomic mass of lithium. (b) Boron has two stable isotopes, $_5B^{10}$ and $_5B^{11}$. Their respective masses are 10.01294 u and 11.00931 u, and the atomic mass of boron is 10.811 u. Find the abundances of $_5B^{10}$ and $_5B^{11}$.**(Ans: (a) 6.941u (b) 19.9% and 80.1%)**