ST ANDREWS SCOTS SENIOR SECONDARY SCHOOL

PHYSICS NUMERICALS ASSIGNMENT (MCQs)

CLASS 12 | CHAPTERS 1 TO 7 |

CHAPTER 1: ELECTRIC CHARGES AND FIELDS (NUMERICAL MCQs)

Q1. Two point charges +4q and +q are placed a distance L apart. A third charge Q is placed on the line joining them such that the entire system is in equilibrium. The position and magnitude of charge Q are:

A) At distance L/3 from +q, Q = -4q/9
B) At distance 2L/3 from +q, Q = -4q/9
C) At distance L/3 from +q, Q = -2q/3
D) At distance 2L/3 from +q, Q = -2q/3

Q2. An electric dipole of moment $p = 4 \times 10^{-9}$ C·m is aligned at 30° with the direction of a uniform electric field of magnitude $E = 5 \times 10^{4}$ N/C. Calculate the work done by external torque to rotate the dipole from θ = 30° to θ = 180°:

A) 1.86×10^{-4} J
B) 3.73×10^{-4} J
C) 2.73×10^{-4} J
D) 0.86×10^{-4} J

Q3. A thin metallic spherical shell of radius R carries a total charge Q. A point charge q is placed at a distance r (r < R) from the center. The total force experienced by charge q due to the shell is:

A) $(1/4\pi\varepsilon_0)\,(qQ / r^2)$
B) $(1/4\pi\varepsilon_0)\,(qQ / R^2)$
C) Zero
D) $(1/4\pi\varepsilon_0)\,(qQ / (R-r)^2)$

Q4. Three equal charges +q are placed at the vertices of an equilateral triangle of side 'a'. A point charge -Q is placed at the centroid of the triangle. If the net force on each +q charge is zero, then Q is equal to:

A) $q / \sqrt{3}$
B) $q / 3$
C) $q / 2$
D) $2q / \sqrt{3}$

Q5. An electron of mass m and charge e is projected with initial speed v_0 into a uniform electric field E perpendicular to its velocity. The deflection y of the electron after traveling a horizontal distance x is:

A) $(e\,E\,x^2) / (2\,m\,v_0^2)$
B) $(e\,E\,x) / (m\,v_0^2)$
C) $(2\,e\,E\,x^2) / (m\,v_0^2)$
D) $(e\,E\,x^2) / (m\,v_0)$

Q6. The electric flux through a hemispherical surface of radius R placed in a uniform electric field E parallel to the axis of the hemisphere is:

A) $2\,\pi\,R^2\,E$
B) $\pi\,R^2\,E$
C) $4\,\pi\,R^2\,E$
D) Zero

Q7. **Two short dipoles each of dipole moment p are placed along the x-axis with their centers at x = 0 and x = d. If their moments point in the same direction, the force of interaction between them varies as:**

A) $1 / d^2$

B) $1 / d^3$

C) $1 / d^4$

D) $1 / d^5$

Q8. **A uniformly charged ring of radius R has total charge +Q. The electric field intensity along its axis is maximum at a distance x from the center equal to:**

A) R / 2

B) R / √2

C) R √2

D) R / √3

Q9. **A infinite line charge produces a field of 9×10^4 N/C at a distance of 2 cm. The linear charge density λ is:**

A) $10^{-}7$ C/m

B) $10^{-}6$ C/m

C) 2×10^{-7} C/m

D) 5×10^{-7} C/m

Q10. **Four point charges +q, +q, -q, -q are placed at the corners A, B, C, D of a square of side 'a' in order. The magnitude of electric field at the center of the square is:**

A) Zero

B) $(4 \sqrt{2}\, q) / (4\pi\varepsilon_0\, a^2)$

C) $(2 \sqrt{2}\, q) / (4\pi\varepsilon_0\, a^2)$

D) $(4\, q) / (4\pi\varepsilon_0\, a^2)$

CHAPTER 2: ELECTROSTATIC POTENTIAL AND CAPACITANCE (NUMERICAL MCQs)

Q1. **A 4 μF capacitor is charged to 400 V and then disconnected from the supply. It is then connected in parallel across an uncharged 2 μF capacitor. The loss of electrostatic energy in the process is:**

A) 0.32 J
B) 0.107 J
C) 0.213 J
D) 0.426 J

Q2. **Two isolated concentric conducting spherical shells of radii R_1 and R_2 ($R_1 < R_2$) carry charges Q_1 and Q_2 respectively. The potential difference between the inner shell and outer shell $V_1 - V_2$ is:**

A) $(Q_1 / 4\pi\varepsilon_0)\,(1/R_1 - 1/R_2)$
B) $(Q_2 / 4\pi\varepsilon_0)\,(1/R_1 - 1/R_2)$
C) $((Q_1+Q_2) / 4\pi\varepsilon_0)\,(1/R_1 - 1/R_2)$
D) Zero

Q3. **A parallel plate capacitor with plate area A and separation d is filled with two dielectrics of thickness d/2 each, with dielectric constants $K_1 = 3$ and $K_2 = 6$. The net capacitance C is:**

A) $4\,\varepsilon_0\,A / d$
B) $2\,\varepsilon_0\,A / d$
C) $9\,\varepsilon_0\,A / d$
D) $4.5\,\varepsilon_0\,A / d$

Q4. **The electric potential in a region of space is given by $V(x, y, z) = 6x - 8xy - 8y + 6yz$. The magnitude of electric force experienced by a charge of 2 C at the point (1, 1, 1) is:**

A) 7 N
B) 14 N
C) 28 N
D) 35 N

Q5. **Four identical metal plates each of area A are arranged parallel to each other at equal separation d. Alternating plates 1,3 and 2,4 are connected together. The equivalent capacitance between terminals is:**

A) $\varepsilon_0\,A / d$
B) $2\,\varepsilon_0\,A / d$
C) $3\,\varepsilon_0\,A / d$
D) $4\,\varepsilon_0\,A / d$

Q6. **A 10 μF capacitor is charged to 50 V and connected to a battery. If the plate separation is doubled while keeping the battery connected, the work done by the battery is:**

A) -1.25 mJ
B) -2.5 mJ
C) +1.25 mJ
D) +2.5 mJ

Q7. **Small spherical drops of mercury each of radius r and potential V = 10 V coalesce to form a single drop of radius R. If 64 such drops combine, the potential of the combined big drop is:**

A) 40 V
B) 160 V
C) 640 V
D) 320 V

Q8. **The work done to dismantle a system of three equal point charges +q placed at the vertices of an equilateral triangle of side 'a' into infinite separation is:**

A) $(3\,q^2) / (4\pi\varepsilon_0\,a)$

B) $(q^2) / (4\pi\varepsilon_0\,a)$

C) $(-3\,q^2) / (4\pi\varepsilon_0\,a)$

D) $(\sqrt{3}\,q^2) / (4\pi\varepsilon_0\,a)$

Q9. A parallel plate air capacitor has capacitance C_0. A dielectric slab of thickness t = (3/4)d and dielectric constant K is inserted between plates. New capacitance C is:

A) $C_0\,[4K / (K + 3)]$

B) $C_0\,[4K / (3K + 1)]$

C) $C_0\,[K / (K + 4)]$

D) $C_0\,[3K / (K + 1)]$

Q10. An electric dipole of moment p is placed at a distance r from an isolated point charge +q along its axis. The electrostatic interaction energy of the system is proportional to:

A) $1 / r$

B) $1 / r^2$

C) $1 / r^3$

D) $1 / r^4$

CHAPTER 3: CURRENT ELECTRICITY (NUMERICAL MCQs)

Q1. **In a potentiometer circuit, a cell of emf 1.25 V gives a balance point at 35.0 cm length of wire. If another cell of unknown emf E replaces it, the balance point shifts to 63.0 cm. The value of unknown emf E is:**

A) 2.25 V
B) 2.00 V
C) 1.75 V
D) 2.50 V

Q2. **An infinite ladder network is constructed using identical 1 Ω resistors. The equivalent resistance between input terminals A and B is:**

A) 1 Ω
B) $(1 + \sqrt{5}) / 2$ Ω
C) $(1 + \sqrt{3})$ Ω
D) 2 Ω

Q3. **A wire of uniform cross-section area A and length L has resistance R. It is stretched so that its length increases by 0.1%. The percentage change in its resistance is:**

A) 0.1%
B) 0.2%
C) 0.05%
D) 0.4%

Q4. **Three identical bulbs each of rating 60W, 220V are connected in series across a 220V supply. Total power consumed by the combination is:**

A) 180 W
B) 60 W
C) 20 W
D) 120 W

Q5. **Two cells of emf $E_1 = 6V$, $r_1 = 1\Omega$ and $E_2 = 4V$, $r_2 = 2\Omega$ are connected in parallel assisting each other. The equivalent emf and internal resistance of the combination are:**

A) 5.33 V, 0.67 Ω
B) 5.0 V, 1.5 Ω
C) 10 V, 3.0 Ω
D) 2.0 V, 0.67 Ω

Q6. **The drift velocity of free electrons in a copper wire of cross-sectional area 1 mm^2 carrying current of 1.5 A (given electron density $n = 8.5 \times 10^{28}$ m^{-3}) is approximately:**

A) 1.1×10^{-4} m/s
B) 2.2×10^{-4} m/s
C) 4.4×10^{-4} m/s
D) 0.55×10^{-4} m/s

Q7. **A copper wire of resistance 10 Ω is cut into 5 equal parts, and these 5 parts are then connected in parallel. The effective resistance of the parallel combination is:**

A) 2 Ω
B) 0.4 Ω
C) 0.5 Ω
D) 1 Ω

Q8. **In a meter bridge experiment, balance point is obtained at 40 cm from left end when a resistance of 10 Ω is in right gap. If a 10 Ω resistor is connected in parallel with right gap resistance, new balance point shifts by:**

A) 10 cm right
B) 20 cm right
C) 17.1 cm right
D) 15 cm left

Q9. A battery of emf 12 V and internal resistance 2 Ω is connected to a variable resistor R. The maximum power that can be delivered by the battery to resistor R is:

A) 72 W
B) 36 W
C) 18 W
D) 144 W

Q10. When a current of 2 A flows through a conductor for 5 minutes, 1200 J of electrical energy is converted into heat. The resistance of the conductor is:

A) 2 Ω
B) 1 Ω
C) 4 Ω
D) 0.5 Ω

CHAPTER 4: MOVING CHARGES AND MAGNETISM (NUMERICAL MCQs)

Q1. **A proton, a deuteron, and an alpha particle enter a uniform magnetic field perpendicularly with the same kinetic energy. The ratio of their radii of circular paths $r_p : r_d : r_\alpha$ is:**

A) 1 : 1 : 1
B) 1 : √2 : 1
C) 1 : 2 : 1
D) √2 : 1 : 1

Q2. **A long straight solid copper wire of radius R carries a steady current I uniformly distributed over its cross-section. The magnetic field B at distance r from axis (r < R) varies as:**

A) $B \propto 1 / r$
B) $B \propto r$
C) $B \propto 1 / r^2$
D) Independent of r

Q3. **A galvanometer coil has resistance G = 50 Ω and full-scale deflection current I_g = 2 mA. To convert it into a voltmeter reading up to 10 V, the series resistance R required is:**

A) 4950 Ω
B) 5000 Ω
C) 4900 Ω
D) 5050 Ω

Q4. **Two long parallel wires separated by 20 cm carry currents I_1 = 10 A and I_2 = 20 A in opposite directions. The net magnetic field at the midpoint between the two wires is:**

A) 2×10^{-5} T
B) 6×10^{-5} T
C) 4×10^{-5} T
D) Zero

Q5. **A circular coil of radius 10 cm having 50 turns carries a current of 2 A. It is suspended vertically in a uniform horizontal magnetic field of 0.5 T. The maximum torque on coil is:**

A) 0.157 N·m
B) 0.314 N·m
C) 1.57 N·m
D) 0.078 N·m

Q6. **An electron enters a region of uniform electric field E = 3×10^4 V/m and magnetic field B = 0.4 T acting perpendicular to each other. If electron passes undeflected, speed v is:**

A) 7.5×10^4 m/s
B) 1.2×10^5 m/s
C) 7.5×10^5 m/s
D) 3.0×10^4 m/s

Q7. **A charged particle of mass m and charge q enters a uniform magnetic field B at an angle of 45° with velocity v. The pitch of the resulting helical path is:**

A) $(2 \pi m v) / (q B)$
B) $(\sqrt{2} \pi m v) / (q B)$
C) $(\pi m v) / (q B)$
D) $(2 \sqrt{2} \pi m v) / (q B)$

Q8. **A square loop of side 'a' carries current I. The magnetic field at the center of the square loop is:**

A) $(2 \sqrt{2} \mu_0 I) / (\pi a)$
B) $(\mu_0 I) / (2\pi a)$

C) $(4 \mu_0 I) / (\pi a)$

D) $(\sqrt{2} \mu_0 I) / (\pi a)$

Q9. To convert a galvanometer of resistance 100 Ω (full scale current 1 mA) into an ammeter of range 0 - 1 A, the required shunt resistance S is approximately:

A) 0.1 Ω

B) 0.01 Ω

C) 1.0 Ω

D) 10 Ω

Q10. A solenoid of length 50 cm and radius 1 cm has 500 turns. If it carries a current of 5 A, the magnetic energy density inside the solenoid is:

A) 1.97 J/m^3

B) 3.94 J/m^3

C) 0.98 J/m^3

D) 7.88 J/m^3

CHAPTER 5: MAGNETISM AND MATTER (NUMERICAL MCQs)

Q1. **At a certain location, the horizontal component of Earth's magnetic field is $B_H = 0.3$ Gauss and total field $B = 0.6$ Gauss. The angle of dip θ at this place is:**

A) 30°
B) 45°
C) 60°
D) 90°

Q2. **A short bar magnet placed with its axis at 30° with a uniform external magnetic field of 0.25 T experiences a torque of magnitude 0.045 N·m. The magnetic moment of magnet is:**

A) 0.36 A·m²
B) 0.18 A·m²
C) 0.72 A·m²
D) 0.09 A·m²

Q3. **A magnetic needle of magnetic moment 6.7×10^{-2} A·m² and moment of inertia 7.5×10^{-6} kg·m² performs 10 complete oscillations in 6.7 seconds in magnetic field B. Value of B is:**

A) 0.01 T
B) 0.02 T
C) 0.04 T
D) 0.05 T

Q4. **A bar magnet of length 10 cm and pole strength 20 A·m is split along its axis into two equal parts. The magnetic moment of each half is:**

A) 1 A·m²
B) 2 A·m²
C) 0.5 A·m²
D) 4 A·m²

Q5. **The magnetic susceptibility of a paramagnetic material at -73°C is 0.0075. Its susceptibility at +127°C is:**

A) 0.00375
B) 0.0150
C) 0.0025
D) 0.0050

Q6. **The work done in rotating a bar magnet of magnetic moment M in a uniform field B from direction parallel to field to direction anti-parallel to field is:**

A) MB
B) 2 MB
C) zero
D) -2 MB

Q7. **If the vertical component of Earth's field is √3 times the horizontal component B_H, the angle of dip is:**

A) 30°
B) 45°
C) 60°
D) 0°

Q8. **A compass needle free to turn in horizontal plane is placed at the center of a circular coil of 30 turns and radius 12 cm. Current in coil is 0.35 A. If needle points West-to-East, magnitude of Earth's horizontal field B_H is:**

A) 5.5×10^{-5} T
B) 2.75×10^{-5} T
C) 1.1×10^{-4} T
D) 3.5×10^{-5} T

Q9. The coercivity of a small bar magnet is 3×10^3 A/m. To demagnetize it completely by inserting inside a solenoid of length 10 cm with 100 turns, current required is:

A) 3 A

B) 6 A

C) 1.5 A

D) 30 A

Q10. A bar magnet of magnetic dipole moment M is bent into a semicircular arc. The new effective magnetic dipole moment of the bent bar magnet is:

A) M / π

B) $2 M / \pi$

C) M

D) $\pi M / 2$

CHAPTER 6: ELECTROMAGNETIC INDUCTION (NUMERICAL MCQs)

Q1. A metal rod of length L = 1 m rotates with angular velocity ω = 100 rad/s about an axis passing through one end and perpendicular to a uniform magnetic field B = 0.2 T. Induced emf between ends is:

A) 10 V
B) 20 V
C) 5 V
D) 100 V

Q2. The magnetic flux linked with a coil varies with time t as $\Phi = 5t^3 - 10t^2 + 4t - 5$ (in Wb). The magnitude of induced emf at t = 2 seconds is:

A) 24 V
B) 44 V
C) 14 V
D) 34 V

Q3. A coil of self-inductance L = 2 H and resistance R = 10 Ω is connected to a 20 V DC battery. The rate of growth of current at the instant battery is connected (t = 0) is:

A) 10 A/s
B) 20 A/s
C) 5 A/s
D) Zero

Q4. Two coaxial solenoids S_1 and S_2 have radii r_1 = 2 cm, r_2 = 4 cm and turns N_1 = 1000, N_2 = 2000 over length l = 50 cm. The mutual inductance M between them is approximately:

A) 6.32 mH
B) 12.64 mH
C) 3.16 mH
D) 25.28 mH

Q5. A square loop of wire of side a = 10 cm and resistance R = 0.5 Ω is pulled out of a uniform magnetic field B = 1 T with constant velocity v = 2 m/s. Thermal power dissipated in loop is:

A) 0.08 W
B) 0.16 W
C) 0.04 W
D) 0.32 W

Q6. A metallic aircraft of wingspan 30 m flies horizontally towards East with speed 720 km/h. If Earth's vertical field component B_V = 4×10^{-5} T, potential difference developed between wingtips is:

A) 0.24 V
B) 0.48 V
C) 0.12 V
D) 2.4 V

Q7. An inductor of self-inductance L = 50 mH carries steady current of 4 A. When circuit is broken, current drops to zero in 0.01 s. Average induced emf across inductor is:

A) 20 V
B) 40 V
C) 200 V
D) 10 V

Q8. A copper disc of radius 10 cm rotates at 20 revolutions per second in a uniform magnetic field of 0.1 T perpendicular to disc plane. Induced emf between center and rim is:

A) 0.0628 V
B) 0.1256 V
C) 0.0314 V
D) 0.628 V

Q9. A coil of 100 turns and area 0.05 m^2 is placed perpendicular to magnetic field B = 0.2 T. If field is reversed in direction in 0.1 s, average induced emf in coil is:

A) 10 V
B) 20 V
C) 5 V
D) 40 V

Q10. Energy stored in an inductor of inductance L = 4 H carrying current I = 3 A is:

A) 18 J
B) 36 J
C) 12 J
D) 9 J

CHAPTER 7: ALTERNATING CURRENT (NUMERICAL MCQs)

Q1. **In a series LCR circuit with L = 100 mH, C = 100 μF and R = 20 Ω connected to an AC source V = 220 sin(100t) V, the resonant angular frequency ω_0 and Q-factor are:**

A) 316 rad/s, Q = 1.58
B) 100 rad/s, Q = 1.58
C) 316 rad/s, Q = 3.16
D) 100 rad/s, Q = 0.79

Q2. **A 220 V, 50 Hz AC source is connected across a series combination of a 50 Ω resistor and a 100 μF capacitor. The impedance Z and phase angle φ are approximately:**

A) 59.1 Ω, φ = 32.4° (current leads)
B) 50.0 Ω, φ = 45°
C) 81.8 Ω, φ = 52.4°
D) 59.1 Ω, φ = 32.4° (current lags)

Q3. **In an ideal step-down transformer connected to 2200 V primary line, primary turns N_p = 4000 and secondary turns N_s = 200. If output power is 6.6 kW, secondary current I_s is:**

A) 60 A
B) 30 A
C) 120 A
D) 15 A

Q4. **An AC voltage V = 100 √2 sin(100 t) V is applied across a pure capacitor of capacitance C = 1 μF. The reading of AC ammeter connected in circuit is:**

A) 10 mA
B) 10 √2 mA
C) 20 mA
D) 5 mA

Q5. **In a series LCR circuit, voltage across L, C, and R are V_L = 80 V, V_C = 40 V and V_R = 30 V respectively. Total applied AC voltage V_rms is:**

A) 50 V
B) 150 V
C) 110 V
D) 70 V

Q6. **An inductor of reactance X_L = 40 Ω and resistor R = 30 Ω are connected in series across 200 V AC source. Average power dissipated in circuit is:**

A) 480 W
B) 800 W
C) 640 W
D) 960 W

Q7. **A series LCR circuit has R = 10 Ω, X_L = 50 Ω, X_C = 50 Ω. Current in circuit is I = 5 A. Power factor cos φ of circuit is:**

A) 1.0 (Unity)
B) 0.5
C) Zero
D) 0.707

Q8. **The frequency of AC source at which inductive reactance of a 2 H inductor equals capacitive reactance of a 2 μF capacitor is:**

A) 79.6 Hz
B) 159.2 Hz

C) 50 Hz

D) 100 Hz

Q9. An AC source of V = 200 sin(314 t) V is connected across a 100 Ω resistor. The thermal energy produced in 10 minutes is:

A) 120 kJ

B) 240 kJ

C) 60 kJ

D) 180 kJ

Q10. In an LC circuit containing L = 20 mH and C = 50 μF, maximum charge on capacitor is Q_o = 1 mC. Maximum current in circuit during oscillation is:

A) 1 A

B) 0.5 A

C) 2 A

D) 0.1 A

ANSWER KEY & HINTS - NUMERICAL MCQs (CHAPTERS 1 TO 7)

Chapter 1: Electric Charges and Fields

Q1: (A) Q2: (B) Q3: (C) Q4: (A) Q5: (A)
Q6: (B) Q7: (C) Q8: (B) Q9: (A) Q10: (B)

Chapter 2: Electrostatic Potential and Capacitance

Q1: (B) Q2: (A) Q3: (A) Q4: (C) Q5: (C)
Q6: (A) Q7: (B) Q8: (A) Q9: (A) Q10: (B)

Chapter 3: Current Electricity

Q1: (A) Q2: (B) Q3: (B) Q4: (C) Q5: (A)
Q6: (A) Q7: (B) Q8: (C) Q9: (C) Q10: (B)

Chapter 4: Moving Charges and Magnetism

Q1: (B) Q2: (B) Q3: (A) Q4: (B) Q5: (A)
Q6: (A) Q7: (B) Q8: (A) Q9: (A) Q10: (B)

Chapter 5: Magnetism and Matter

Q1: (C) Q2: (A) Q3: (A) Q4: (A) Q5: (A)
Q6: (B) Q7: (C) Q8: (A) Q9: (A) Q10: (B)

Chapter 6: Electromagnetic Induction

Q1: (A) Q2: (A) Q3: (A) Q4: (A) Q5: (A)
Q6: (A) Q7: (A) Q8: (A) Q9: (B) Q10: (A)

Chapter 7: Alternating Current

Q1: (A) Q2: (A) Q3: (A) Q4: (A) Q5: (A)
Q6: (A) Q7: (A) Q8: (A) Q9: (A) Q10: (A)