SAMPLE PAPER

PHYSICS

*A Highly Simulated Practice Questions Paper for CBSE **Class XII** (Term I) Examination*

Instructions

1. This question paper is divided into three sections.
*2. **Section - A** contains 25 questions. Attempt **any 20** questions.*
*3. **Section - B** contains 24 questions. Attempt **any 20** questions.*
*4. **Section - C** contains 6 questions. Attempt **any 5** questions.*
5. Each question carries 0.77 mark.
*6. There is **no** negative marking.*

Roll No. | | | | | | | |

Maximum Marks : 35
Time allowed : 90 min

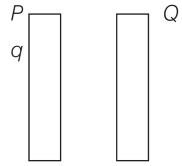
Section A

This section consists of 25 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, only first 20 will be considered for evaluation.

1. A spherical ball with charge $-10e$ is placed at the centre of the hollow sphere which has a charge of $+10e$ on its surface. The charge on the sphere's outer surface will become

(a) $+20\,e$ (b) zero (c) $-10\,e$ (d) $-20\,e$

2. Two conducting plates P and Q with large surface area A are placed as shown in the figure. A charge q is given to plate P. The electric field between the plates at any point is

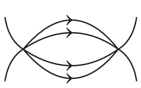
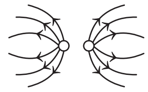
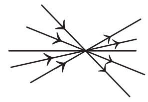
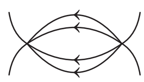


(a) $\frac{q}{3A\varepsilon_0}$ (b) $\frac{q}{2A\varepsilon_0}$ (c) $\frac{q}{A\varepsilon_0}$ (d) $\frac{2q}{A\varepsilon_0}$

3. Two point charges $+2\,\mu C$ and $-4\,\mu C$ are kept at distance r between them in air. The ratio of the magnitude of forces acting on them will be

(a) 2 : 1 (b) 1 : 2 (c) 1 : 1 (d) 4 : 1

4. The correct diagram of electric lines of forces for a system of two positive charges is

(a)  (b)  (c)  (d) 

5. A hemispherical body of radius R is placed in a uniform electric field E. The flux linked with the curved surface, if the field is parallel to the base, is

(a) zero (b) $E\pi R^2$ (c) $-E\pi R^2$ (d) $\frac{\pi R^2}{E}$

6. When a capacitor is charged, the energy resides in

(a) the positive charges
(b) Both the positive and negative charges
(c) the field between the plates
(d) around the edge of the capacitor plates

7. The potential difference between a cloud and the earth is 10^7 V. Calculate the amount of energy dissipated, when the charge of 100 C is transferred from the cloud to the ground due to lightning bolt.

(a) zero (b) 10^9 J (c) 60 J (d) 10^7 J

8. A capacitor of capacity C_1, is charged by connecting it across a battery of emf V_0. The battery is then removed and the capacitor is connected in parallel with an uncharged capacitor of capacity C_2. The potential difference across this combination is

(a) $\frac{C_2}{C_1+C_2}V_0$ (b) $\frac{C_1}{C_1+C_2}V_0$ (c) $\frac{C_1+C_2}{C_2}V_0$ (d) $\frac{C_1+C_2}{C_1}V_0$

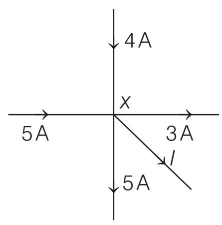
9. Which of the following statement(s) is/are incorrect?

(a) In a balanced Wheatstone bridge, if the cell and the galvanometer are exchanged, the null point is disturbed.
(b) A rheostat can be used as a potential divider.
(c) Kirchhoff's second law represents energy conservation.
(d) Wheatstone bridge is most sensitive, when all the four resistances are of the same order of magnitude.

10. The drift speed of electrons in aluminium wire of diameter d and length l is v. If the potential difference across the wire is halved, then the new drift velocity becomes

(a) $2v$ (b) $v/2$ (c) v (d) $v/4$

11. Five conductors are meeting at a point x as shown in the figure. What is the value of current in fifth conductor?

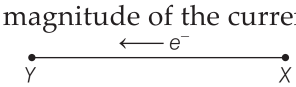


(a) 3A, away from x (b) 1A, away from x (c) 4A, away from x (d) 1A, towards x

12. If resistivity of copper conductor is 1.7×10^{-8} Ω-m and electric field is 100 Vm^{-1}, then current density will be

(a) 6×10^9 Am^{-2} (b) 1.7×10^{-6} Am^{-2} (c) 1.7×10^{-10} Am^{-2} (d) 6×10^7 Am^{-2}

13. Twenty million electrons reaches from point X to point Y in two microsecond as shown in the figure. Direction and magnitude of the current is



(a) 1.5×10^{-10} A from X to Y
(b) 1.6×10^{-6} A from Y to X
(c) 1.5×10^{-13} A from Y to X
(d) 1.6×10^{-4} A from X to Y

14. For a velocity selector in a region of perpendicular electric and magnetic fields, which of the following statement(s) is/are correct?

(a) It dllows charged particles to pass straight, when $v = E/B$.

(b) It does not deflect particles in a direction perpendicular to both **v** and **B**, when $v > E/B$.

(c) It does not deflect particles in the direction of electric field, when $v < E/B$.

(d) It deflects all particles in a direction perpendicular to both **E** and **B**.

15. A solenoid of length 0.2 m has a radius of 5 cm and is made up of 200 turns. If it carries a current of 5 A, then the magnitude of magnetic field inside the solenoid is

(a) $0.2\ \pi \times 10^{-2}$ T (b) $2\ \pi \times 10^{-4}$ T

(c) $2\ \pi \times 10^{-2}$ T (d) $0.02\ \pi \times 10^{-3}$ T

16. Consider a moving charged particle in a region of magnetic field. Which of the following statement(s) is/are correct related to it?

(a) If **v** is parallel to **B**, then path of particle is spiral.

(b) If **v** is perpendicular to **B**, then path of particle is a parabola.

(c) If **v** has a component along **B**, then path of particle is helical.

(d) If **v** is along **B**, then path of particle is a circle.

17. Choose the correct option regarding the functioning of the various parts of a galvanometer.

(a) Soft iron core $\rightarrow$ produces deflection torque

(b) Pole pieces $\rightarrow$ produces radial field

(c) Spring $\rightarrow$ increases field strength

(d) Coil $\rightarrow$ produces restoring torque

18. The force between magnetic poles, when their pole strength is halved and the distance between them is doubled, is

(a) increases to two times the previous value

(b) decreases to four times the previous value

(c) no change

(d) decreases to sixteen times the previous value

19. A horizontal circular loop carries a current that loops anti-clockwise, when viewed from above. It is replaced by an equivalent magnetic dipole N-S. Which of the following statement(s) is/are correct?

(a) The line N-S should be along a diameter of the loop.

(b) The line N-S should be parallel to the plane of the loop.

(c) South pole should be below the loop.

(d) North pole should be below the loop.

20. A semi-circular shaped iron rod of diameter L has magnetic moment $\frac{2M}{\pi}$. If it is unbend to become a straight rod, its new magnetic moment will be

(a) $M\pi / 2$ (b) $M\pi$

(c) $2M\pi$ (d) M

21. Two identical circular loops of metal wires are lying on a table without touching each other. Loop P carries a current which is increasing with time. In response, loop Q will

(a) be attracted to P (b) remains stationary

(c) be repelled by P (d) be rotated

22. A wire of circular loop is rotated in a magnetic field. The frequency of change of the direction of the induced emf is

(a) once per revolution
(b) four times per revolution
(c) twice per revolution
(d) six times per revolution

23. What will be the rms value of the alternating voltage represented by the equation $V = \cos\omega t + 2\cos 2\omega t + 3\cos 3\omega t$?

(a) 3.24
(b) 5.19
(c) 2.64
(d) 4.52

24. In an L-R circuit, the inductive reactance is equal to the resistance R of the circuit. An emf $E = E_0 \cos\omega t$ is applied to the circuit. The power consumed in the circuit is

(a) $\frac{E_0^2}{\sqrt{2}R}$
(b) $\frac{E_0^2}{4R}$
(c) $\frac{E_0^2}{2R}$
(d) $\frac{E_0^2}{8R}$

25. A transistor-oscillator using a resonant circuit with an inductor L (of negligible resistance) and a capacitor C in series produce oscillation of frequency f. If L is halved and C is doubled, the frequency will be

(a) $f/2\sqrt{2}$
(b) $2f$
(c) $f/2$
(d) f

Section B

This section consists of 24 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, only first 20 will be considered for evaluation.

26. A condenser of capacity 20 μF is first charged and then discharged through a 10 mH inductor. Neglecting the resistance of the coil, the frequency of the resulting vibrations will be

(a) 356 cycles/s
(b) 35.6 cycles/s
(c) 356×10^3 cycles/s
(d) 3.56 cycles/s

27. Which of the following statement(s) is/are incorrect?

(a) The magnetic field possesses what is called a cylindrical symmetry.
(b) The lines of constant magnitude of magnetic field form concentric circles called magnetic field lines, originating from negative charges.
(c) Even though the wire is infinite, the field due to it at a non-zero distance is not infinite.
(d) The direction of magnetic field is given by right-hand rule in which fingers will curl around in the direction of the magnetic field.

28. Two identical thin bar magnets each of length l and pole strength m are placed at right angles to each other with north pole of one touching south pole of the other. Magnetic moment of the system is

(a) ml
(b) $2ml$
(c) $\sqrt{2}ml$
(d) $\frac{1}{2}ml$

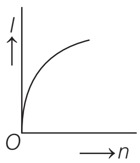
29. Two cities are 150 km apart. Electric power is sent from one city to another city through copper wires. The fall of potential per km is 8 V and the average resistance per km is 0.5 Ω. The power loss in the wire is

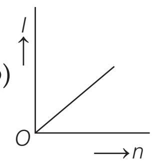
(a) 19.2 W
(b) 19.2 kW
(c) 19.2 J
(d) 12.2 kW

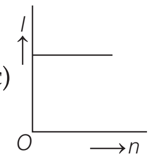
30. A choke coil and capacitor are connected in series and the current through the combination is maximum for AC of frequency n. If they are connected in parallel, at what frequency is the current through the combination minimum?

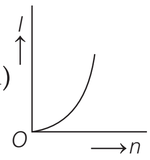
(a) n
(b) $n/2$
(c) $2n$
(d) None of these

31. A battery consists of a variable number (n) of identical cells (having internal resistance r each) which are connected in series. The terminals of the battery are short-circuited and the current I is measured. Which of the graphs shows the correct relationship between I and n?

(a) 

(b) 

(c) 

(d) 

32. If the angles of dip at two places are 30° and 45° respectively, then the ratio of horizontal components of earth's magnetic field at the two places will be

(a) $\sqrt{3}:\sqrt{2}$ (b) $1:\sqrt{2}$ (c) $1:\sqrt{3}$ (d) $1:2$

33. A proton and an α-particle both enter a region of uniform magnetic field B, moving at right angles to the field B. If the radius of circular orbits for both the particles is equal and the kinetic energy acquired by proton is 1 MeV, the energy acquired by the α-particle will be

(a) 4 MeV (b) 0.5 MeV (c) 1.5 MeV (d) 1 MeV

34. In an L-R circuit, the value of L is $\left(\frac{0.4}{\pi}\right)$ H and the value of R is 30 Ω. If in the circuit, an alternating emf of 200 V at 50 cycle s^{-1} is connected, the impedance of the circuit and current will be

(a) 11.4 Ω, 17.5 A (b) 30.7 Ω, 6.5 A (c) 40.4 Ω, 5 A (d) 50 Ω, 4 A

35. The galvanometer cannot be used as an ammeter to measure the value of current in a given circuit.

Which of the following statement(s) is/are incorrect about given information?

(a) Galvanometer gives full scale deflection for a small current.
(b) Galvanometer has a large resistance.
(c) A linear scale cannot be designed, so that $I \propto \alpha$.
(d) A galvanometer can give accurate values.

36. Three point charges $+q_1$, $-2q$ and $-2q$ are placed at the vertices of an equilateral triangle of side a. The work done by some external force to increase their separation to $2a$ will be

(a) $\frac{1}{4\pi\varepsilon_0}\frac{2q^2}{a}$ (b) $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{2a}$ (c) $\frac{1}{4\pi\varepsilon_0}\frac{\delta q}{a^2}$ (d) zero

37. Which of the following statement(s) is/are correct?

(a) In case of resistor, both V and i reach zero, minimum and maximum values at the different time.
(b) The sum of the instantaneous current values over one complete cycle is unity and the average current is one.
(c) The average power dissipated in a resistance is $P_{avg} = \frac{1}{2} I_m^2 R$.
(d) To show phase relationship between voltage and current in an AC circuit, we use the notion of scalars.

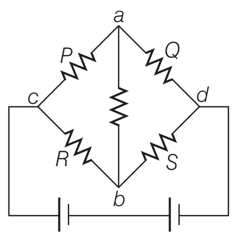
38. Two cells of equal emf and of internal resistances r_1 and $r_2 (r_1 > r_2)$ are connected in series. On connecting this combination with an external resistance R, it is observed that the potential difference across the first cell becomes zero. The value of R will be

(a) $r_1 + r_2$ (b) $r_1 - r_2$ (c) $\frac{r_1 + r_2}{2}$ (d) $\frac{r_1 - r_2}{2}$

39. Two similar coils of radius r are lying concentrically with their planes at right angle to each other. The current flowing in them are I and $3I$, respectively. The resultant magnetic field induction at the centre will be

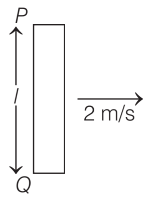
(a) $\frac{\sqrt{5}\mu_0 I}{2R}$ (b) $\frac{\sqrt{10}\mu_0 I}{2R}$ (c) $\frac{\mu_0 I}{2R}$ (d) $\frac{\mu_0 I}{R}$

40. In the following Wheatstone bridge, $R = S$ and $P > Q$. The direction of the current between ab will be



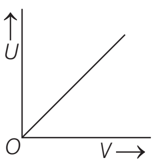
(a) from a to b (b) from b to a through c
(c) from b to a (d) from a to b through c

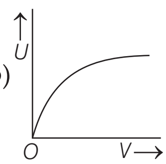
41. A conducting rod of unit length moves with a velocity of 2 m/s in a direction perpendicular to its length. Also, it is perpendicular to the uniform magnetic field of magnitude 0.2 T. The emf induced between the ends of the stick is

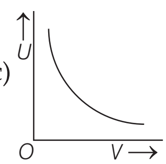


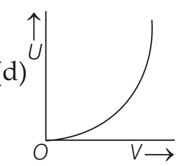
(a) 2 V (b) 6 V
(c) 9 V (d) 0.4 V

42. Which of the following graphs correctly represents the variation of heat energy (U) produced in a metallic conductor in a given time as a function of potential difference (V) across the conductor?

(a) 

(b) 

(c) 

(d) 

43. Which of the following statement(s) is/are incorrect?

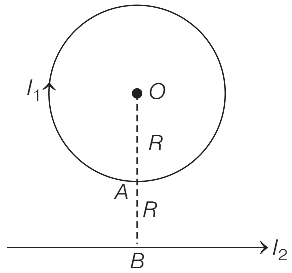
(a) A varying current in a coil can induce emf in a neighbouring coil, whose magnitude depends upon the rate of change of current and mutual inductance of the two coils.

(b) Electromotive force is induced in a single isolated coil due to change of flux through the coil by means of varying the current through it and this process is called self-inductance.

(c) For the current I at an instant in a circuit, the rate of work done is $\frac{dW}{dt} = |\varepsilon| I$ and total work done is $W = \int dW = \int_0^I LI\, dI$.

(d) The flux linked with one coil will be the difference of two fluxes which exists independently (when current is flowing simultaneously in two nearby coils).

44. In the diagram, I_1, I_2 are the strengths of the current in the loop and straight conductors respectively and $OA = AB = R$. The net magnetic field at the centre O is zero. Then, the ratio of the current in the loop and the straight conductor is



(a) π
(b) 2π
(c) $\frac{1}{\pi}$
(d) $\frac{1}{2\pi}$

ASSERTION-REASONING MCQs

Direction (Q. Nos. 45-49) *For given questions two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below*

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false and R is also false.

45. Assertion When the capacitor is connected to an AC source, it limits or regulates the current, but does not completely prevent the flow of charge.

Reason The capacitor is alternately charged and discharged as the current reverses each half-cycle.

46. Assertion If the inner solenoid is much shorter than (and placed well inside) the outer solenoid, then the flux linkage ($N_1\ \phi_1$) can still be calculated.

Reason The inner solenoid is effectively immersed in a uniform magnetic field due to the outer solenoid.

47. Assertion A positive point charge initially at rest, when placed in a uniform electric field, it starts moving along electric lines of force (neglect all other forces except electric forces).

Reason A point charge released from rest in an electric field always moves along the line of force.

48. Assertion At increased temperature, average speed of the electrons, which acts as the carriers of current increases, resulting in more frequent collisions.

Reason The average time of collisions τ decreases with increasing temperature.

49. **Assertion** When coil in galvanometer with metallic core oscillates, then electromagnetic damping occurs.

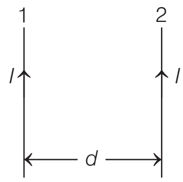
Reason Eddy currents generated in the core oppose the motion and bring the coil to rest quickly.

Section C

This section consists of 6 multiple choice questions with an overall choice to attempt any 5. In case more than desirable number of questions are attempted, only first 5 will be considered for evaluation.

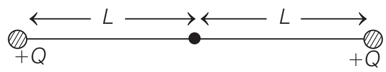
50. Two very long, straight and parallel wires carry same steady current I flowing in the same direction. The distance between the wires is d. At a certain instant of time, a point charge q is at a point equidistant from the two wires in the plane of the wires. Its instantaneous velocity v is perpendicular to this plane.

The magnitude of the force due to the magnetic field acting on the charge at this instant is



(a) $\frac{\mu_0 Iqv}{2\pi d}$ (b) $\frac{\mu_0 Iqv}{\pi d}$ (c) $\frac{2\mu_0 Iqv}{\pi d}$ (d) zero

51. Two small spheres each having the charge $+Q$ are suspended by insulating threads of length L from a hook. This arrangement is taken in space, where there is no gravitational effect, then which of the following statement(s) is/are correct?



I. The angle between the two suspensions and tension in each thread will be respectively 180° and $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{(2L)^2}$.

II. The angle between the two suspensions and tension in each thread will be respectively 90° and $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$.

III. The angle between the two suspensions and tension in each thread will be respectively 180° and $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2L^2}$.

(a) Only I (b) Only II (c) Both I and III (d) Only III

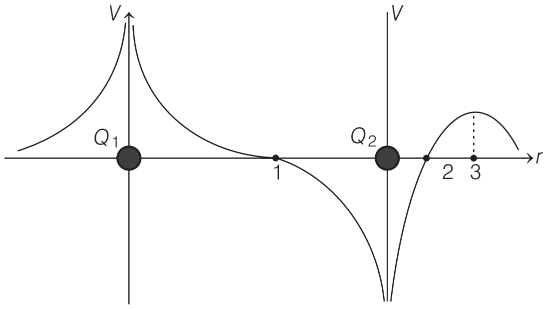
Case Study

Read the following paragraph and answer the questions.

Potential of Two Point Charges

The potential at any observation point of a static electric field is defined as the work done by the external agent (or negative of work done by electrostatic field) in slowly bringing a unit positive point charge from infinity to the observation point. Work done on a test charge by the electrostatic field due to any given charge configuration depends only on the position of initial and final points. The figure given below shows the potential variation along the line of charges.

Two point charges Q_1 and Q_2 lie along a line at a distance from each other.



52. At point 3, which of the following quantity is zero?

(a) Coulomb's force (b) Magnetic flux

(c) Electric field (d) Electric dipole

53. Which of the following statement is correct about the potential?

(a) Due to charges Q_1 and Q_2 are equal in magnitude.

(b) Due to charge Q_1 is zero but due to Q_2 is non-zero.

(c) Due to charge Q_1 is greater than Q_2.

(d) Due to charge Q_1 is smaller than Q_2.

54. In the graph shown above, it can be concluded that

(a) Q_1 is positive and Q_2 is negative

(b) Q_1 is negative and Q_2 is positive

(c) Both the charges are positive in nature

(d) None of the above

55. Two charges of magnitude $+q$ and $-3q$ are placed 100 cm apart. The distance from $+q$ between the charges, where the electrostatic potential is zero will be

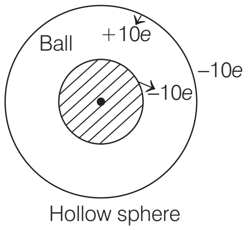
(a) 25 cm (b) 50 cm (c) 75 cm (d) 80 cm

Answers

1. (b)	**2.** (b)	**3.** (c)	**4.** (b)	**5.** (a)	**6.** (c)	**7.** (b)	**8.** (b)	**9.** (a)	**10.** (b)
11. (b)	**12.** (a)	**13.** (b)	**14.** (a)	**15.** (a)	**16.** (c)	**17.** (b)	**18.** (d)	**19.** (c)	**20.** (a)
21. (c)	**22.** (c)	**23.** (c)	**24.** (b)	**25.** (d)	**26.** (a)	**27.** (b)	**28.** (c)	**29.** (b)	**30.** (a)
31. (c)	**32.** (a)	**33.** (d)	**34.** (d)	**35.** (c)	**36.** (d)	**37.** (c)	**38.** (b)	**39.** (b)	**40.** (c)
41. (d)	**42.** (d)	**43.** (d)	**44.** (d)	**45.** (a)	**46.** (a)	**47.** (c)	**48.** (a)	**49.** (a)	**50.** (d)
51. (a)	**52.** (c)	**53.** (c)	**54.** (a)	**55.** (a)					

SOLUTIONS

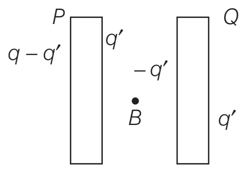
1. According to the question, the charge distribution is shown below



As, the hollow sphere has a charge of $+10e$.

$\therefore$ Charge on outer surface $= +10e - 10e = 0$

2. Charge distribution will be as shown below



Field at point B between the plates,

$$E_B = \frac{q-q'}{2A\varepsilon_0} + \frac{q'}{2A\varepsilon_0} + \frac{q'}{2A\varepsilon_0} - \frac{q'}{2A\varepsilon_0} = \frac{q}{2A\varepsilon_0}$$

3. The electric force is an action-reaction pair, i.e. the two charges exert equal and opposite forces on each other. Thus, Coulomb's law obeys Newton's third law.

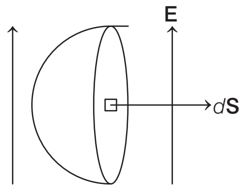
i.e. $\mathbf{F}_{12} = -\mathbf{F}_{21}$

Hence, the ratio of the magnitude of forces acting on $2\,\mu C$ and $-4\,\mu C$ charges is 1 : 1.

4. Electric lines of forces emerge from a single positive charge and goes to infinity.

However, electric lines of forces enter into a single negative charge coming from infinity. So, electric lines of forces are repelled away, when they are produced by the pair of positive charges as shown in option (b) .

5. We know that, flux passing through closed surface, $\phi = \oint \mathbf{E}\cdot d\mathbf{S} = \frac{q_{\text{in}}}{\varepsilon_0}$



Charge inside hemisphere, $q_{\text{in}} = 0$.

i.e. $\oint \mathbf{E}\cdot d\mathbf{S} = 0$

$\Rightarrow \quad \phi_{\text{curved}} + \phi_{\text{plane}} = 0$

$\Rightarrow \phi_{\text{curved}} + ES\cos 90^\circ = 0 \Rightarrow \phi_{\text{curved}} = 0$

6. As, the electric field outside the capacitor plates is zero and the field exist only in between the plates. Thus, the energy will resides in the field which is present in between the plates.

7. Given, $q = 100$ C

and potential difference between the cloud and the earth,

$V = 10^7$ V

Thus, energy dissipated, $W = qV$

$= 100 \times 10^7 = 10^9$ J

8. In parallel combination, $C_{\text{net}} = C_1 + C_2$

$\therefore \quad V = \frac{q_{\text{net}}}{C_{\text{net}}} = \frac{C_1 V_0}{C_1 + C_2}$

9. In a balanced Wheatstone bridge, there is no effect on position of null point, if we exchange the battery and galvanometer. So, statement given in option (a) is incorrect.

10. We know that, drift velocity, $v = \frac{eE\tau}{m} = \frac{e\tau}{m}\frac{V}{l}$

where, V is the potential difference.

$\Rightarrow \quad v \propto V$

Given, $V_1 = V$, $V_2 = V/2$

$\Rightarrow \quad \frac{v_1}{v_2} = \frac{V_1}{V_2} = \frac{V}{V/2} = 2$

$\Rightarrow \quad v_2 = \frac{v_1}{2} = \frac{v}{2} \qquad (\because v_1 = v)$

11. According to Kirchhoff's first law,

$$5 + 4 - 3 - 5 - I = 0$$

$$\Rightarrow \quad I = 1\text{ A}$$

So, current in fifth conductor is 1A flowing away from x.

12. Current density, $J = \sigma E$

where, σ = conductivity = $\frac{1}{\text{resistivity}}$

$$= \frac{1}{\rho} = \frac{1}{1.7\times10^{-8}\,\Omega\text{-m}}$$

$$\Rightarrow \quad J = \frac{1}{1.7\times10^{-8}}\times100$$

$$= \frac{100}{17}\times10^{9} \simeq 6\times10^{9}\,\text{Am}^{-2}$$

13. Given, number of electrons,

$n = 20$ million $= 2\times10^{7}$

Total charge on twenty million electrons,

$$q = ne$$

$$= 2\times10^{7}\times1.6\times10^{-19} \quad (\because e = 1.6\times10^{-19}\text{C})$$

$$= 3.2\times10^{-12}\text{C}$$

Now, time taken by twenty million electrons to pass from point X to point Y,

$$t = 2\,\mu\text{s} = 2\times10^{-6}\text{s}$$

$$\Rightarrow \quad i = \frac{q}{t} = \frac{3.2\times10^{-12}}{2\times10^{-6}} = 1.6\times10^{-6}\text{ A}$$

Since, the direction of the current is always opposite to the direction of flow of electrons. Therefore, due to flow of electrons from point X to point Y, the current will flow from point Y to point X.

14. In a velocity selector, let F_e and F_B are electric and magnetic forces.

Case I When $v = E/B \Rightarrow F_e = F_B$

i.e. Particles pass straight undeflected through the region.

Case II When $v > E/B \Rightarrow F_e < F_B$

i.e. Particles deflects in a direction perpendicular to both **v** and **B**.

Case III When $v < E/B \Rightarrow F_e > F_B$

i.e. Particles deflects in the direction of electric field.

So, statement in option(a) is correct and rest are incorrect.

15. Given, current, $i = 5$A

Total number of turns, $N = 200$

Length of solenoid, $l = 0.2$ m

Radius, $r = 5$ cm $= 5\times10^{-2}$ m

Number of turns per unit length,

$$n = \frac{N}{l} = \frac{200}{0.2} = 1000\text{ turns/m}$$

Magnitude of magnetic field inside the solenoid, $B = \mu_0 ni = 4\pi\times10^{-7}\times1000\times5$

$$= 0.2\pi\times10^{-2}\text{T}$$

16. Statement given in option (c) is correct but rest are incorrect and these can be corrected as,

When **v** is parallel to **B** or **v** is along **B**, then path of the particle is straight line.

When **v** is perpendicular to **B**, then path of particle is a circle.

17. In a moving coil galvanometer, soft iron core increases field strength, pole pieces produces radial field, spring produces restoring torque and coil produces deflecting torque.

18. Force of attraction between the magnetic poles is given as, $F \propto \frac{m_1 m_2}{r^2}$

$$\therefore \quad \frac{F_2}{F_1} = \frac{\dfrac{\frac{m_1}{2}\times\frac{m_2}{2}}{(2r)^2}}{\dfrac{m_1\times m_2}{r}} = \frac{1}{16}$$

or $\quad F_2 = (1/16)F_1$

$\therefore$ The force decreases to 16 times its previous value.

19. The statement given in option (c) is correct but rest are incorrect and these can be corrected as,

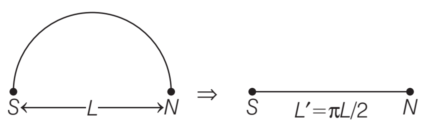
Since, a current carrying circular loop behaves as a magnetic dipole whose magnetic moment's direction is perpendicular to the plane of the loop.

Therefore, when dipole is replaced by equivalent bar magnet, then the line joining N-S will be perpendicular to the plane of loop. As current is anti-clockwise, so north-pole lies above the loop and south-pole lies below the loop.

20. On unbending the rod, its pole strength remains unchanged whereas its magnetic moment changes.

Magnetic moment of semi-circular rod,

$$M = mL \quad \ldots\text{(i)}$$



New magnetic moment, $M' = mL'$

$$= \frac{m\pi L}{2} = \frac{\pi M}{2} \quad [\because \text{from Eq. (i)}]$$

21. As the current in loop P increases, magnetic field associated with Q also increases. Thus, in response, current will flow in the loop Q.

So, in accordance with Lenz law, the direction of the current in loop Q will be in such a way that it opposes the cause of effect. If current in loop P is in clockwise direction, then current in loop Q will also be clockwise direction. Hence, they both will repel each other.

22. When wire loop is rotated in a magnetic field, the frequency of change of the direction of the induced emf is two times per revolution.

23. RMS value of voltage, $V_{\text{rms}} = \sqrt{\frac{V_1^2}{2} + \frac{V_2^2}{2} + \frac{V_3^2}{2}}$

$$= \sqrt{\frac{1^2}{2} + \frac{2^2}{2} + \frac{3^2}{2}} = 2.64 \text{ unit}$$

24. Given $X_L = R \Rightarrow Z = \sqrt{2}R$

$$\therefore \quad P = \left(\frac{V_{\text{rms}}}{Z}\right)^2 \cdot R = \left(\frac{E_0/\sqrt{2}}{\sqrt{2}R}\right)^2 \cdot R = \frac{E_0^2}{4R}$$

25. Frequency of L-C oscillation, $f = \frac{1}{2\pi\sqrt{LC}}$

$$\Rightarrow \frac{f_1}{f_2} = \frac{1}{\sqrt{L_1C_1}}\sqrt{L_2C_2} = \left(\frac{L_2C_2}{L_1C_1}\right)^{1/2}$$

$$= \left(\frac{L/2 \times 2C}{L \times C}\right)^{1/2} = (1)^{1/2}$$

$$\therefore \quad \frac{f_1}{f_2} = 1$$

As, $f_1 = f \Rightarrow f_2 = f$.

26. Given, $C = 20\mu\text{F} = 20 \times 10^{-6}$ F

and $L = 10 \text{ mH} = 10 \times 10^{-3}$ H

$$\therefore f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{20 \times 10^{-6} \times 10 \times 10^{-3}}}$$

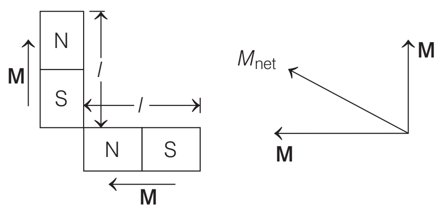
$= 356$ Hz or cycles/s

27. Statement given in option (b) is incorrect and it can be corrected as,

The lines of constant magnitude of magnetic field form concentric circles called magnetic field lines. They originate from positive charges and ends at negative charges.

Rest statements are correct.

28. Net magnetic moment of the system is given by



$$M = \sqrt{M^2 + M^2} = \sqrt{2}M = \sqrt{2}ml$$

29. Given, distance between two cities, $d = 150$ km

Fall of potential per km, $V = 8$ V

Average resistance per km, $R = 0.5\ \Omega$

Power loss per km, $P_1 = \frac{V^2}{R} = \frac{8^2}{0.5} = 128$ W

$\therefore$ Total power loss in wire $= P_1 \times d = 128 \times 150$

$= 19200$ W

$= 19.2$ kW

30. When the X_L is in resonance with X_C, then the current is minimum and the frequency,

$$f = \frac{\omega}{2\pi} \quad \ldots \text{(i)}$$

We have given series frequency,

$$f = \frac{\omega}{2\pi\sqrt{LC}} = n$$

Putting in Eq. (i), we get

$$f = n\sqrt{LC}$$

Since, current in a parallel L-C circuit is $I = \frac{V}{Z}$, where Z is the impedance and V is the voltage.

When the impedance is maximum, the current through a circuit is minimum. Therefore, at resonance the frequency will be n.

31. If n identical cells are connected in series, then equivalent emf of the combination, $E_{\text{eq}} = nE$.

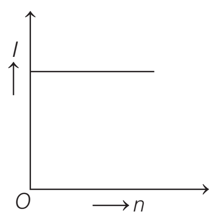
Equivalent internal resistance, $r_{\text{eq}} = nr$

$\therefore$ Current, $I = \frac{E_{\text{eq}}}{r_{\text{eq}}} = \frac{nE}{nr}$

or $\quad I = \frac{E}{r} = \text{constant}$

Thus, current I is independent of the number of cells n present in the circuit.

Therefore, the graph showing the relationship between I and n would be as shown below



This is correctly shown in option (c).

32. As, $H = B\cos\theta$

$$\Rightarrow \frac{H_1}{H_2} = \frac{B\cos\theta_1}{B\cos\theta_2} = \frac{\cos\theta_1}{\cos\theta_2} = \frac{\cos 30°}{\cos 45°}$$

$$= \frac{\sqrt{3}}{2} \times \sqrt{2} = \frac{\sqrt{3}}{\sqrt{2}}$$

33. Radius of circular orbit of a particle in magnetic field,

$$R = \frac{mv}{qB} = \frac{\sqrt{2mE}}{qB}$$

$$\left[\because \text{ Kinetic energy, } E = \frac{1}{2}mv^2 \Rightarrow mv = \sqrt{2mE}\right]$$

and total energy of a moving particle in a circular orbit,

$$E = \frac{q^2B^2R^2}{2m}$$

For a proton entering in a region of magnetic field,

$$E_1 = \frac{e^2 \times B^2 \times R^2}{2 \times m_p} \quad \ldots(i)$$

where, m_p is the mass of proton.

Similarly, for an α-particle moving in an uniform magnetic field,

$$E_2 = \frac{(2e)^2 \times B^2 \times R^2}{2 \times (4m_p)}$$

$$(\because q_\alpha = 2e \text{ and } m_\alpha = 4m_p) \ldots(ii)$$

Dividing Eq. (ii) by Eq. (i), we get

$$\frac{E_2}{E_1} = \frac{(2e)^2 \times B^2 \times R^2}{2 \times (4m_p)} \times \frac{2 \times m_p}{e^2 \times B^2 \times R^2}$$

$$\frac{E_2}{E_1} = 1 \Rightarrow E_2 = E_1 = 1 \text{ MeV}$$

34. Given, $X_L = \omega L = 2\pi f L = 2\pi \times 50 \times \frac{0.4}{\pi} = 40\,\Omega$

$R = 30\,\Omega$

$\therefore \quad Z = \sqrt{R^2 + X_L^2}$

$= \sqrt{(30)^2 + (40)^2} = 50\,\Omega$

$\therefore \quad I_{rms} = \frac{V_{rms}}{Z} = \frac{200}{50} = 4\text{ A}$

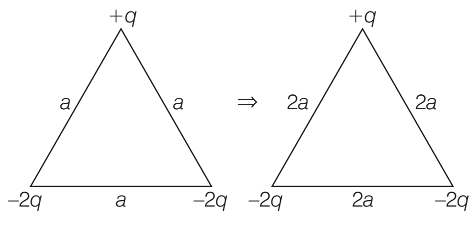
35. Statements (a), (b) and (d) are correct but (c) is incorrect and it can be corrected as,

As the deflection (α) of the coil is proportional to the current passed through it, so a linear scale can be used to measure the deflection.

i.e. $\quad I \propto \alpha$

36. Work done in increasing the separation from a to $2a$ is

$$W = U_f - U_i \quad \ldots(i)$$



Here,

$$U_i = \frac{1}{4\pi\varepsilon_0}\left[\frac{q(-2q)}{a} + \frac{q(-2q)}{a} + \frac{(-2q)(-2q)}{a}\right]$$

$$= \frac{1}{4\pi\varepsilon_0 a}[-2q^2 - 2q^2 + 4q^2] = 0$$

Similarly, $U_f = \frac{1}{4\pi\varepsilon_0(2a)}(-2q^2 - 2q^2 + 4q^2) = 0$

Hence, from Eq. (i)

$$W = U_f - U_i = 0$$

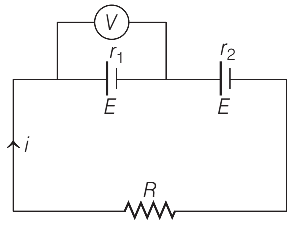
37. Statement given in option (c) is correct but rest are incorrect and these can be corrected as,

In case of a resistor, both V and i reach zero, minimum and maximum values at the same time. Clearly, the voltage and current are in phase with each other.

Like applied voltage, the current varies sinusoidally and has corresponding positive and negative values during each cycle. Thus, the sum of instantaneous current values over one complete cycle is zero and the average current is zero.

To show phase relationship between voltage and current in an AC circuit, we use the notion of phasors. A phasor is a vector which rotates about the origin with angular speed ω.

38. Let the voltage across first cell is V, then



$$V = E - ir_1 = E - r_1\left(\frac{2E}{r_1 + r_2 + R}\right)$$

$$\left(\because i = \frac{E_{eq}}{R_{eq}}\right)$$

But $\quad V = 0$

$\Rightarrow E - \frac{2Er_1}{r_1 + r_2 + R} = 0$

$\Rightarrow \quad r_1 + r_2 + R = 2r_1$

$\Rightarrow \quad R = r_1 - r_2$

39. The magnetic field (B) at the centre of circular current carrying coil of radius R and current I,

$$B = \frac{\mu_0 I}{2R}$$

Similarly, if current $= 3I$, then

Magnetic field $= \frac{\mu_0 3I}{2R} = 3B$

So, resultant magnetic field

$$= \sqrt{B^2 + (3B)^2} = \sqrt{10 B^2}$$

$$= \sqrt{10} B = \frac{\mu_0 I \sqrt{10}}{2R}$$

40. For the balanced Wheatstone bridge,

In the part cbd,

$$V_c - V_b = V_b - V_d$$

$$\Rightarrow \quad V_b = \frac{V_c + V_d}{2} \quad \text{...(i)}$$

In the part $c\,a\,d$,

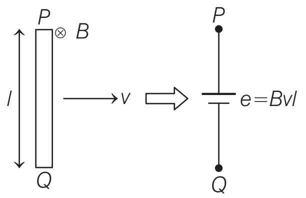
$$V_c - V_a > V_a - V_d \quad [\because P > Q]$$

$$\Rightarrow \quad \frac{V_c + V_d}{2} > V_a$$

$$\Rightarrow \quad V_b > V_a \quad \text{[using Eq. (i)]}$$

$\therefore$ The current flows from b to a.

41.



The negative terminal is that end towards which electrons are moving due to magnetic force and the magnetic force on electron is acting along Q, hence Q is negative terminal of battery.

As we know that, induced emf for a moving rod is given by

$$\Rightarrow \quad e = Bvl = 0.2 \times 2 \times 1$$

$$= 0.4 \text{ V}$$

42. According to Joule's law of heating, $U = \frac{V^2}{R} t$.

It shows that, the graph between heat energy (U) and potential difference (V) is upwards parabola and is represented by option (d).

43. Statement given in option (d) is incorrect and it can be corrected as,

The flux linked with one coil will be the sum of two fluxes which exist independently (when current is flowing simultaneously in two nearby coils).

$\therefore N_1\phi_1 = M_{11}I_1 + M_{12}I_2$, where M_{11} represents inductance due to the same coil.

44. Magnetic field at centre O due to current I_1 in loop,

$$B_1 = \frac{\mu_0}{4\pi} \frac{2\pi I_1}{R}$$

Magnetic field at centre O due to current I_2 through straight conductor,

$$B_2 = \frac{\mu_0}{4\pi} \frac{2 I_2}{2R} = \frac{\mu_0}{4\pi} \frac{I_2}{R}$$

As, net magnetic field at O is zero (given).

$$\therefore \quad B_1 = B_2$$

$$\frac{\mu_0}{4\pi} \frac{2\pi I_1}{R} = \frac{\mu_0}{4\pi} \frac{I_2}{R}$$

$$\Rightarrow \quad \frac{I_1}{I_2} = \frac{1}{2\pi}$$

45. When the capacitor is connected to an AC source, it limits or regulates the current, but does not completely prevent the flow of charge.

It is because, the capacitor is alternately charged and discharged as the current reverses each half cycle.

Therefore, both A and R are true and R is the correct explanation of A.

46. If the the inner solenoid is much shorter than (and placed well inside) the outer solenoid, then the flux linkage $(N_1\phi_1)$ can still be calculated.

It is because, the inner solenoid is effectively immersed in a uniform magnetic field due to the outer solenoid.

Therefore, both A and R are true and R is the correct explanation of A.

47. When a positive charge initially at rest is placed in a uniform electric field, then it moves along the electric lines of force.

But if a point charge is released from rest in a direction making an angle with the field, then it follows a parabolic path.

Therefore, A is true, but R is false.

48. With increase in temperature, average speed of the electrons, which acts as the carriers of current increases, resulting in more frequent collisions.

Thus, the average time of collisions τ decreases with increasing temperature.

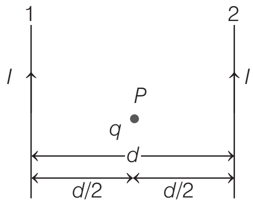
Therefore, both A and R are true and R is the correct explanation of A.

49. Certain galvanometers have a fixed core made of non-magnetic metallic material.

When the coil oscillates, the eddy currents generated the core oppose the motion and bring the coil to rest quickly. This is called electromagnetic damping.

Therefore, both A and R are true and R is the correct explanation of A.

50. The given situation can be drawn as below



The magnetic field $\mathbf{B}_1$ at mid-point P due to first wire is in downward direction, according to right-hand rule. Similarly, magnetic field $\mathbf{B}_2$ due to second wire is in upward direction.

Let the charge q is moving with instantaneous velocity $\mathbf{v}$ in upward direction, then magnitude of force on q, due to first wire is

$$F_1 = q(\mathbf{v} \times \mathbf{B}_1) = qvB_1 \sin\theta = qvB_1 \sin 180° = 0$$

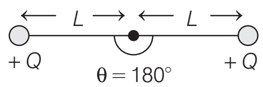
Similarly, magnitude of force on q, due to second wire is

$$F_2 = q(\mathbf{v} \times \mathbf{B}_2) = qvB_2 \sin\theta = qvB_2 \sin 0° = 0$$

Thus, net magnitude of force on q,

$$F_{\text{net}} = F_1 + F_2 = 0$$

51. Two small spheres of charge $+Q$ are suspended by threads of length L as shown below



When this arrangement is in space, i.e. there is no gravitational force, then angle between two suspensions will be 180° due to repulsive force.

∴ Tension in each thread,

$$T = \frac{KQQ}{(2L)^2} = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{(2L)^2} \qquad \left[\because K = \frac{1}{4\pi\varepsilon_0}\right]$$

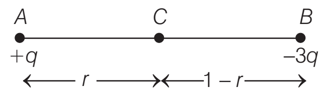
52. Here, we will use the relation $E_r = \frac{-dV}{dr}$. The negative slope of the V *versus* r curve represents the component of the electric field along r. The slope of the curve is zero only at point 3, therefore the electric field is zero at point 3.

53. From the figure, it can be seen that the net potential due to two charges is positive everywhere in the region left to charge Q_1. Therefore, the magnitude of potential due to charge Q_1 is greater than Q_2.

54. Near a positive charge, net potential is positive and near a negative charge, net potential is negative. Thus, charge Q_1 is positive and Q_2 is negative.

55. Let two charges be placed 100 cm (1 m) apart at points A, B and C be a point of zero potential at a distance r from $+q$.

Potential at point C due to two charges will be



$$V = \frac{1}{4\pi\varepsilon_0}\left[\frac{q}{r} + \frac{(-3q)}{1-r}\right] = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r} - \frac{3q}{1-r}\right)$$

Since, potential at point C is zero, i.e. $V = 0$.

$$\Rightarrow \quad \frac{q}{r} - \frac{3q}{1-r} = 0$$

$$\Rightarrow \quad \frac{q}{r} = \frac{3q}{1-r}$$

or $\quad 3r = 1 - r$

or $\quad r = \frac{1}{4} = 0.25 \text{ m} = 25 \text{ cm}$