PHYSICS

Specimen Question Paper

Maximum Marks: 70

Time allowed: One and a half hours

*(Candidates are allowed **15 minutes** for **only** reading the paper)*

ALL QUESTIONS ARE COMPULSORY.

The marks intended for questions are given in brackets [ ].

Select the correct option for each of the following questions.

Question 1.

The ratio of forces between two small spheres having a constant charge 'q' when placed in air to when placed in a medium of dielectric constant K, is: [1]

(a) 1 : K (b) K : 1

(c) $1 : K^2$ (d) $K^2 : 1$

Question 2.

When a soap bubble is given a positive charge, then its radius: [1]

(a) Decreases

(b) Increases

(c) Remains unchanged

(d) Nothing can be predicted as information is insufficient

Question 3.

Four charges are arranged at the corners of a square ABCD , as shown in the adjoining figure. The force on the charge 'Q' kept at the centre O is: [1]

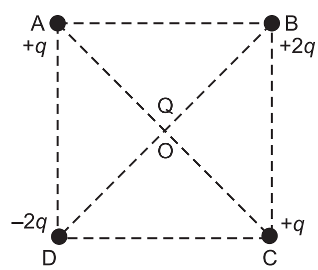


Figure 1

(a) Zero (b) Along the diagonal AC

(c) Along the diagonal BD (d) Perpendicular to side AB

Question 4.

The surface charge density of a conductor, in the absence of another conductor: [1]

(a) Is proportional to the charge on the conductor and its surface area

(b) Inversely proportional to the charge and directly proportional to the surface area

(c) Directly proportional to the charge and inversely proportional to the surface area

(d) Inversely proportional to the charge and the surface area

Question 5.

Which of the following is not the characteristic of resonance in an LCR series circuit? [1]

(a) $X_L = X_C$ (b) $\omega L = \frac{1}{\omega C}$

(c) $2\pi f L = 2\pi f C$ (d) $f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}$

Question 6.

A graph showing variation in impedance Z of a series LCR circuit, with frequency *f* of alternating emf applied to it is shown below. What is the minimum value of this impedance? [1]

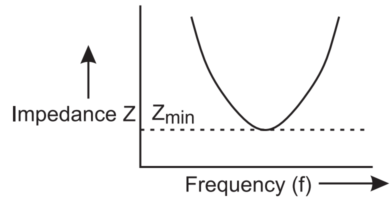


Figure 2

(a) R

(b) $Z = \sqrt{R^2 + (X_L - X_C)^2}$

(c) Z_{min}

(d) $X_L = X_C$

Question 7.

An electric dipole of moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$. It has maximum (negative) potential energy when the angle between $\vec{p}$ and $\vec{E}$ is: [1]

(a) $\frac{\pi}{2}$

(b) Zero

(c) π

(d) $\frac{3\pi}{2}$

Question 8.

A charge placed at a distance from a short electric dipole in the end-on position experiences a force F. If the distance is halved, then the force will become: [1]

(a) 4 F

(b) 8 F

(c) $\frac{F}{4}$

(d) $\frac{F}{8}$

Question 9.

In **figure 3** given below, Electric field intensity 'E' at a point P, at a perpendicular distance '*r*' from an infinitely long line charge X'X having linear charge density λ is given by: [1]

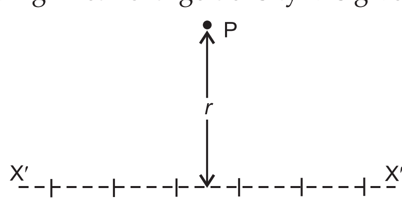


Figure 3

(a) $E = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{2\lambda}{r^2}$

(b) $E = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{2\lambda}{r}$

(c) $E = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{\lambda}{r^2}$

(d) $E = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{\lambda}{r}$

Question 10.

Three capacitors, each of capacitance C, are connected in series. Their equivalent capacitance is C_s. The same three capacitors are now connected in parallel. Their equivalent capacitance becomes C_p. The ratio of C_p to C_s is: [1]

(a) 9 : 1

(b) 1 : 9

(c) 3 : 1

(d) 1 : 3

Question 11.

Note: There is a discrepancy in board's questions,the correct question should be:

The charges $q_1 = 3\mu C$, $q_2 = 4\mu C$ and $q_3 = -7\mu C$ are placed on the circumference of a circle of radius 1.0 m as shown in the figure below. What is the value of charge q_4 placed on the same circle if the potential at the centre is 0? [1]

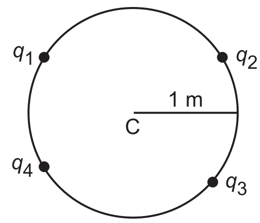


Figure 4

(a) $-4\mu C$ (b) $-3\mu C$ (c) $7\mu C$ (d) 0

Question 12.

Three equal charges of 5.0μC each, are placed at the three vertices of an equilateral triangle of side 5.0cm each. The electrostatic potential energy of the system of charges is: [1]

(a) 13.5 J (b) 17.5 J (c) 27 J (d) 15 J

Question 13.

Note: There is a discrepancy in board's questions,the correct question should be:

Three capacitors $C_1 = 3\mu F$, $C_2 = 6\mu F$ and $C_3 = 10\mu F$ are connected to a 50V battery as shown in the figure below: [1]

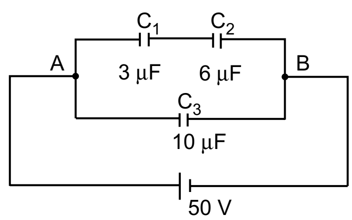


Figure 5

The equivalent capacitance of the circuit between point A and B and the charge on C_1 are…

(a) 12μF, 150μC (b) 4.75μF, 100μC

(c) 12μF, 100μC (d) 4.75μF, 150μC

Question 14.

A substance behaves like a magnet only if there are: [1]

(a) at least some tiny current loops within the magnet

(b) stationary charges within the magnet

(c) magnet within the magnet

(d) none of these

Question 15.

A straight long wire is turned into a loop of radius R = 10 cm, as shown in **figure 6** below. If a current I = 16 A is passed through the wire, then the magnetic field at the centre of the loop is: [1]

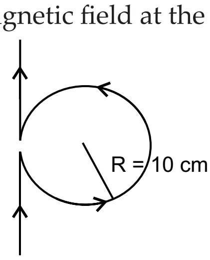


Figure 6

(a) 3.4×10^{-5}T (b) 6.8×10^{-5}T

(c) 1.7×10^{-5}T (d) 5.1×10^{-5}T

Question 16.

The current in the circuit shown in **figure 7** below, will be: [1]

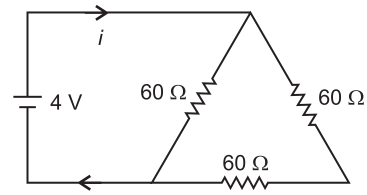


Figure 7

(a) 1/45 A (b) 1/15 A

(c) 1/10 A (d) 1/5 A

Question 17.

A cell of e.m.f. E is connected to an external resistance R. The potential difference across cell is V. The internal resistance of cell will be: [1]

(a) $\frac{(E-V)R}{E}$ (b) $\frac{(E-V)R}{V}$

(c) $\frac{(V-E)R}{V}$ (d) $\frac{(V-E)R}{E}$

Question 18.

The **figure 8** given below shows currents in a part of an electric circuit. The current *i* is: [1]

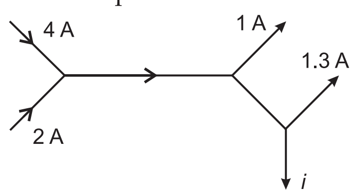


Figure 8

(a) 1.7 A (b) 3.7 A

(c) 2.7 A (d) 4.7 A

Question 19.

n identical cells each of e.m.f. E and internal resistance r are connected in parallel. An external resistance R is connected in series to this combination. The current through R is: [1]

(a) $\frac{nE}{R+nr}$ (b) $\frac{nE}{nR+r}$

(c) $\frac{E}{R+nr}$ (d) $\frac{nE}{R+r}$

Question 20.

The circuit shown in **figure 9** below is used to compare the e.m.f. of two cells E_1 and E_2 where $E_2 > E_1$. The null point is at C when the galvanometer is connected to E_1. When the galvanometer is connected to E_2, the null point will be:

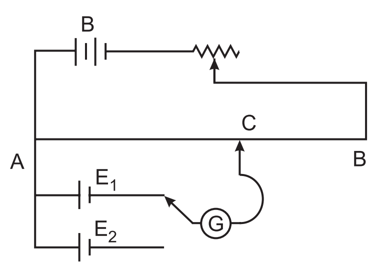


Figure 9

(a) To the left of C (b) To the right of C

(c) At C itself (d) Nowhere on AB

Question 21.

Figure 10 given below shows a graph of emf 'ε' generated by an ac generator verses time. What is the frequency of the emf? [1]

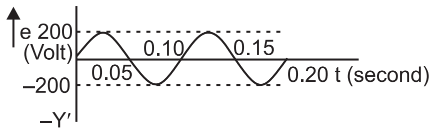


Figure 10

(a) 10 Hz (b) 0.10 Hz

(c) 20 Hz (d) 50 Hz

Question 22.

If m, e, τ and n respectively represent the mass, charge, average relaxation time and density of the electron, then what will be the resistance of a wire of length l and area of cross-section A? [1]

(a) $\frac{ml}{ne^2\tau A}$ (b) $\frac{m\tau^2 A}{ne^2\tau l}$

(c) $\frac{ne^2\tau A}{2ml}$ (d) $\frac{ne^2 A}{2m\tau l}$

Question 23.

The drift velocity of a current carrying conductor is v. What will be the drift velocity if the current flowing through the wire is doubled? [1]

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

(c) $2v$ (d) $4v$

Question 24.

The resistance of a wire is 10 Ω. It is stretched so that its length becomes four times. What will be the new resistance of the wire? [1]

(a) 40 Ω (b) 160.0 Ω

(c) 120 Ω (d) 80.0 Ω

Question 25.

What is the angle between the current element $\vec{dl}$ and the magnetic flux density $\vec{B}$ at point 'P' in the **figure 11** given below? [1]

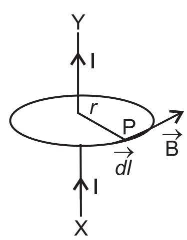


Figure 11

(a) Parallel to each other (b) Perpendicular to each other

(c) Normal to each other (d) Any angle between them is possible

Question 26.

An A.C. generator generating an e.m.f of $\varepsilon = 300 \sin (100\pi)\, t$ is connected to a series combination of 16μF capacitor, 1 H inductor and 100 Ω resistor. What is the frequency of A.C.? [1]

(a) 100 Hz (b) 50 Hz

(c) 300 Hz (d) 25 Hz

Question 27.

Four identical cells each having an e.m.f. of 4 V are connected in parallel. What will be the e.m.f. of this combination? [1]

(a) 1 V (b) 16 V

(c) 1/4 V (d) 4 V

Question 28.

A 2 volt battery, a 15 Ω resistor and a potentiometer of 100 cm length, all are connected in series. If the resistance of potentiometer wire is 5 Ω, then the potential gradient of the potentiometer wire is:

(a) 0.005 V/cm (b) 0.05 V/cm

(c) 0.02 V/cm (d) 0.2 V/cm

Question 29.

The potential gradient along the length of a uniform wire is 20 volt/metre. B and C are the two points at 40 cm and 70 cm point on a meter scale fitted along the wire. What is the potential difference between B and C? [1]

(a) 6 V (b) 0.4 V

(c) 0.6 V (d) 4 V

Question 30.

In an experiment of meter bridge, a null point is obtained at the centre of the bridge wire. When a resistance of 5 is connected in one gap, what is the value of resistance in the other gap? [1]

(a) 10 Ω (b) 5 Ω

(c) 1/5 Ω (d) 500 Ω

Question 31.

What is the locus of an electron, projected perpendicular to a uniform magnetic field? [1]

(a) Circle (b) Right bisector

(c) Parabola (d) Straight line

Question 32.

Which of the following is the right expression to define the magnetic field B? [1]

(a) $\vec{F} = q(\vec{v} \times \vec{B})$ (b) $\vec{F} = B(\vec{I} \times \vec{l})$

(c) $\frac{\vec{F}}{l} = \frac{\mu_0}{2\pi}\frac{l^2}{a}$ (d) $B = \mu_0 ni$

Question 33.

What is the SI (base unit) unit of permeability? [1]

(a) kg ms^{-2} A^{-2} (b) kg m^2s^{-2} A^{-2}

(c) kg m^2s A^{-2} (d) kg ms^2 A^{-2}

Question 34.

The loss of power in a transformer can be reduced by: [1]

(a) Increasing the number of turns in primary. (b) Using solid core made of steel.

(c) Increasing ac voltage applied to primary. (d) Using a laminated core of soft iron.

Question 35.

Which is the most harmful radiation entering the atmosphere of earth from outer space? [1]

(a) X - Rays (b) Visible rays

(c) Gamma radiations (d) Radio waves

Question 36.

Radio waves and gamma waves are both transverse in nature and electromagnetic in character and have the same speed in vacuum. In what respects are they different? [1]

(a) Frequency (b) Wavelength

(c) Both (a) and (b) (d) None of these

Question 37.

Which of the following groups belongs only to the electromagnetic spectrum? [1]

(a) alpha rays, beta rays, gamma rays (b) ultra-sonic rays, radio waves, infra red rays

(c) gamma rays, cathode rays, X-rays (d) X-rays, radio waves, infra red rays

Question 38.

Which electromagnetic radiation has wavelength greater than that of X-rays and smaller than that of visible light? [1]

(a) Radio waves (b) Microwaves

(c) Infra Red Rays (d) Ultra Violet Rays

Question 39.

A parallel plate capacitor of plate area A = 600 cm^2 and plate separation d = 2.0 mm is connected to a d.c. source of 200 V. [2]

(i) What is the magnitude of the uniform electric field E between the plates?

(a) $E = 1.0 \times 10^5$ V/m, (b) $E = 1.0 \times 10^7$ V/m,

(c) $E = 0.5 \times 10^5$ V/m, (d) $E = 0.5 \times 10^7$ V/m,

(ii) What is the charge density σ on any one of the two plates?

(a) $\sigma = 8.85 \times 10^{-7}$ C/m^2 (b) $\sigma = 8.85 \times 10^{-9}$ C/m^2

(c) $\sigma = 4.45 \times 10^{-7}$ C/m^2 (d) $\sigma = 4.45 \times 10^{-9}$ C/m^2

Question 40.

A torch bulb rated as 4.5 W, 1.5 V is connected as shown in **figure 12** given below. [2]

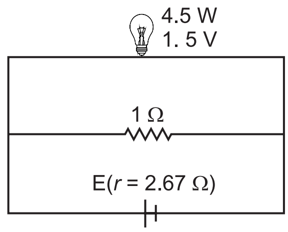


Figure 12

(i) What should be the e.m.f. of the cell required to make this bulb glow at full intensity?

(a) 4.5 V (b) 1.5 V

(c) 2.67 V (d) 13.5 V

(ii) What is the current passing through 1 Ω resistor?

(a) 4.5 A (b) 1.5 A

(c) 2.67 A (d) 13.5 A

Question 41.

The specific resistance of manganin is 50×10^{-8} Ω m. [2]

(i) The resistance of a cube of length 50 m will be:

(a) 10^{-6} Ω (b) 2.5×10^{-5} Ω

(c) 10^{-8} Ω (d) 50×10^{-8} Ω

(ii) The specific resistance of the combination of two cubes of length 50 m in series will be:

(a) 10^{-6} Ω m (b) 2.5×10^{-5} Ω m

(c) 2×10^{-6} Ω m (d) 50×10^{-8} Ω m

Question 42.

A metallic rod CD rests on a thick metallic wire PQRS with arms PQ and RS parallel to each other, at a distance l = 50 cm, as shown in **figure 13** below. A uniform magnetic field B = 0.1T acts perpendicular to the plane of this paper, pointing inwards into the plane. (*i.e.*, away from the reader). [2]

The rod is now made to slide towards right, with a constant velocity of v = 5.0 m/s.

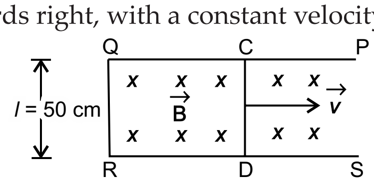


Figure 13

(i) How much emf is induced between the two ends of the rod CD?

(a) 25.0 V (b) 0.25 V

(c) 2.50 V (d) .025 V

(ii) What is the direction in which the induced current flows?

(a) Along 'CQRDC' (b) Along the direction of motion of the conductor

(c) Along 'CDRQC' (d) Against the direction of motion of the conductor

Question 43.

Study the diagram given below: [2]

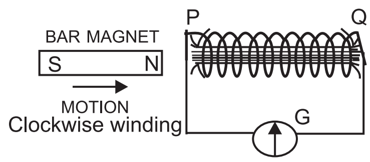


Figure 14

(i) The direction of the current at end 'P' will be:

(a) Anti clockwise (b) Clockwise

(c) Towards the magnet (d) Away from the magnet

(ii) The magnetic poles induced at the end 'Q' of the coil will be:

(a) North pole (b) South pole

(c) Anti clockwise (d) No pole

Question 44.

The resistance of a galvanometer is 50 Ω. It is converted into a voltmeter or an ammeter.

Calculate the resistance of the voltmeter and ammeter to an accuracy of 2sf. Only with the mention below in the subparts. [2]

(i) A voltmeter using a 10 k Ω resistor is:

(a) 10050 Ω (b) 10.050 k Ω

(c) 10000 Ω (d) 10 k Ω

(ii) An ammeter using a 10 m Ω resistor is:

(a) 50 Ω (b) 10 m Ω

(c) 0.0999 Ω (d) 50. 0999 Ω

Question 45.

Two bulbs B_1 and B_2 are connected in series with an source of emf 250 V as shown in the **figure 15** below. The labels on the bulbs read 250 V, 80 W and 250 V, 100 W respectively. [3]

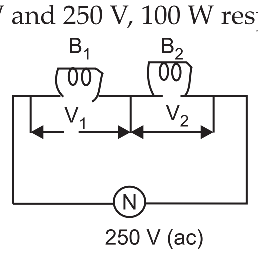


Figure 15

(i) What will be the ratio of the resistance of the bulbs R_1/R_2?

(a) 1.4 A (b) 2.2 A

(c) 2.0 A (d) 1.8 A

(ii) What will be the ratio of the power consumed (P1/P2) when connected in series?

(a) 5 : 4 (b) 4 : 5

(c) 1: 1 (d) 5 : 3

(iii) What is the ratio of the pd across the bulbs (V_1/V_2)?

(a) 5 : 4 (b) 4 : 5

(c) 1: 1 (d) 5 : 3

Question 46.

A 2 μF capacitor, 100 Ω resistor and 8 H inductor are connected in series with an ac source. At a certain frequency of about 40 Hz for this ac source, the current drawn in the circuit is maximum. If the peak value of e.m.f. of the source is 200V: [3]

(i) What is the peak value of current in the circuit?

(a) 1.4 A (b) 2.2 A

(c) 2.0 A (d) 1.8 A

(ii) What is the phase relation between voltages across inductor and resistor?

(a) $\pi/2$ radian (b) $\pi/3$ radian

(c) $\pi/4$ radian (d) π radian

(iii) What is the phase difference between voltages across inductor and capacitor?

(a) $\pi/2$ radian (b) $\pi/3$ radian

(c) $\pi/4$ radian (d) π radian

Question 47.

Given below is a neat, labelled diagram to obtain balancing condition of Wheatstone bridge. [3]

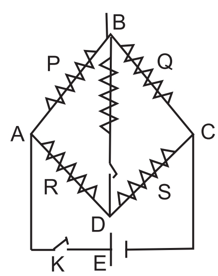


Figure 16

(i) Why is the key 'K' pressed before the key K_1?

(a) There is no such requirement

(b) To avoid a back emf in the closed loops

(c) There is no current till the key 'K' is pressed

(d) None of these

(ii) What is the relation between the potential at 'B' and 'D', when the bridge is balanced?

(a) $V_B > V_D$ (b) $V_B < V_D$

(c) $V_B = V_D$ (d) $V_B \geq V_D$

(iii) What is the galvanometer current when the bridge is balanced?

(a) I_g flows from 'B' to 'D' (b) I_g flows from 'D to 'B'

(c) I_g has no significance in this case (d) $I_g = 0$

Question 48.

Figure 17 shows a right-angled isosceles triangle PQR having its base equal to 'a'. A current of 1.0 A is passing downwards along a thin straight wire cutting the plane of a paper normally as shown at Q. Likewise, a similar wire carries an equal current moving normally upwards at R. Assume the wire is to be infinitely long. [3]

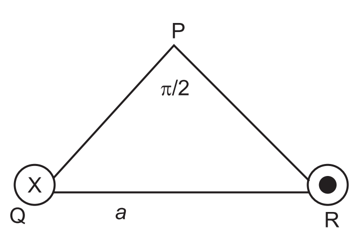


Figure 17

(i) The magnitude and the direction of the magnetic induction B at P due to wire at 'Q':

(a) $B = \frac{\mu_0}{\sqrt{2}} \frac{I}{\pi a}$ acting along PQ
(b) $B = \frac{\mu_0}{\sqrt{2}} \frac{I}{\pi a}$ acting along PR
(c) $B = \frac{\mu_0}{\sqrt{2}} \frac{I}{\pi a}$ towards the mid-point of QR
(d) $B = \frac{\mu_0}{\pi} \frac{I}{a}$ towards the mid-point of QR

(ii) The magnitude and the direction of the magnetic induction B at P due to wire at 'R':

(a) $B = \frac{\mu_0}{\sqrt{2}} \frac{I}{\pi a}$ acting along PQ
(b) $B = \frac{\mu_0}{\sqrt{2}} \frac{I}{\pi a}$ acting along PR
(c) $B = \frac{\mu_0}{\sqrt{2}} \frac{I}{\pi a}$ towards the mid-point of QR
(d) $B = \frac{\mu_0}{\pi} \frac{I}{a}$ towards the mid-point of QR

(iii) The net magnitude and the direction of the magnetic induction B at P:

(a) $B = \frac{\mu_0}{\sqrt{2}} \frac{I}{\pi a}$ acting along PQ
(b) $B = \frac{\mu_0}{\sqrt{2}} \frac{I}{\pi a}$ acting along PR
(c) $B = \frac{\mu_0}{\sqrt{2}} \frac{I}{\pi a}$ towards the mid-point of QR
(d) $B = \frac{\mu_0}{\pi} \frac{I}{a}$ towards the mid-point of QR

Question 49.

An alternating e.m.f of 100 V is applied to a circuit containing a resistance of 40 Ω and an inductance L in series. The current is found to lag behind the voltage by an angle $a = \tan^{-1}¾$. [4]

(i) The inductive reactance in this case is:

(a) 40 Ω
(b) 30 Ω
(c) 50 Ω
(d) $10\sqrt{5}$ Ω

(ii) The impedance of the circuit is:

(a) 40 Ω
(b) 30 Ω
(c) 50 Ω
(d) $10\sqrt{5}$ Ω

(iii) The current flowing through the circuit is:

(a) 2.5 A
(b) 3.33 A
(c) 2.0 A
(d) $10\sqrt{5}$ A

(iv) If the inductance has a value of 0.096 H, and π = 3.14, the approximate frequency of the applied e.m.f.

(a) 40 Hz
(b) 50 Hz
(c) 30 Hz
(d) None of these

Question 50.

The teacher of Priti's school took the students on a study trip to a power generating station, located nearly 250 km away from the city. The teacher explained that electrical energy is transmitted over such a long distance to their city, in the form of alternating current (a.c.) raised to a high voltage. At the receiving end in the city, the voltage is reduced to operate the devices. As a result, the power loss is reduced. Priti listened to the teacher and asked questions about how the ac is converted to a higher or lower voltage. [4]

(i) What is the device used to change the alternating voltage to a higher or lower value?

(a) Transformer
(b) Rectifier
(c) Ammeter
(d) Voltmeter

(ii) What is the cause for power dissipation in the device referred to above?

(a) Hysteresis
(b) Eddy current
(c) Flux loss
(d) All of these

(iii) In the device used above, what is the relation between the power output and power input for an ideal case?

(a) Power output is less than power input
(b) Power output is greater than power input
(c) Power output is equal to power input
(d) It depends upon the situation

(iv) What source input should be used in this device?

(a) AC source (b) DC source

(c) Half wave rectifier (d) Full wave rectifier

Answers

1. (b) K : 1

Explanation: Let two small spheres having a constant charge q place d in air at a distance r, then the force acting between them is given by

$$F_{air} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{q^2}{r^2}$$

When both changes placed in a medium of dielectric constant K, then

$$F_{medium} = \frac{1}{4\pi\varepsilon_0 K}\cdot\frac{q^2}{r^2}$$

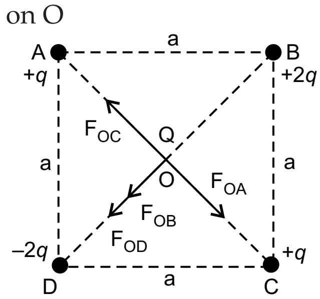
$$\therefore \quad \frac{F_{air}}{F_{medium}} = \frac{K}{1}$$

2. (b) Increases

Explanation: The positive charge is uniformely distributed on the soap bubble it causes repulsive force between charge particles distributed on the bubble due to electrostatic force between them. Hence, its radius increases.

3. (c) Aong the diagonal BD

Explanation: The net force acting on O



$$\vec{F} = \vec{F}_{OB} + \vec{F}_{OD}$$

F_{OC} and F_{OA} are equal and opposite to each other. So, they will cancel out.

$$\therefore \quad F = \frac{1}{4\pi\varepsilon}\cdot\frac{(2q)Q}{\left(\frac{a\sqrt{2}}{2}\right)^2} + \frac{1}{4\pi\varepsilon}\cdot\frac{(+2q)Q}{\left(\frac{a\sqrt{2}}{2}\right)^2}$$

$$= \frac{1}{4\pi\varepsilon}\cdot\frac{8q.Q}{a^2} \text{ Along the diagonal BD}$$

4. (c) Directly proportional to the charge and inversely proportional to surface area.

Explanation: The surface charge density of a conductor is given by

$$\sigma = \frac{q}{A}$$

Where q is the charge on the conductor of area A.

5. (c) $2\pi f L = 2\pi f C$

Explanation: At resonance, $X_L = X_C$

$$\therefore \quad \omega L = \frac{1}{\omega C}$$

$$\omega^2 = \frac{1}{LC}$$

$$(2\pi f_0)^2 = \frac{1}{LC}$$

$$f_0 = \frac{1}{2\neq}\sqrt{\frac{1}{LC}}$$

6. (a) R

Explanation: The impedance of LCR circuit is given by.

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

Value of Z will be minimum if, $X_L = X_C$

$\therefore$ $Z_{min} = R$

7. (b) Zero

Explanation: $U = -pE \cos\theta$

Maximum (*–ve*) potential energy $U_{max} = -pE$ when $\cos\theta = 1$ and $\theta = 0°$ (zero)

8. (b) 8 F

Explanation: Electic field due to electric dipole at charge q placed at a distance r in an axial point is,

$$E = \frac{q}{4\pi\varepsilon_0} \cdot \frac{2p}{r^3}$$

$\therefore$ Force on charged particle having charge q placed at a distance r,

$$F = qE = \frac{q}{4\pi\varepsilon_0} \cdot \frac{2p}{r^3}$$

$$F \propto \frac{1}{r^3}$$

If distance is halved then,

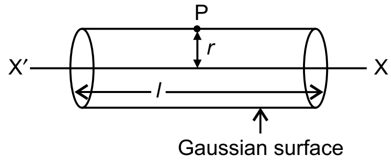
new force $$F' = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2pq}{\left(\frac{1}{2}r\right)^3}$$

$$= \frac{1}{4\pi\varepsilon_0} \cdot \frac{2pq}{(r^3)} \cdot 8 = 8\text{ F}$$

9. (b) $E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2\lambda}{r}$

Explanation: Using Gauss's law of electrostatic

$$\oint E.dA = \frac{q_{enc}}{\varepsilon_0}$$



$$E.2\pi rl = \frac{q}{\varepsilon_0} = \frac{\lambda l}{\varepsilon_0}$$, where λ is line charge density

$$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2\lambda}{r}$$

10. (a) 9 : 1

Explanation: When three capacitors connected in series,

$$\frac{1}{C_s} = \frac{1}{C}+\frac{1}{C}+\frac{1}{C} = \frac{3}{C}$$

$$C_s = \frac{C}{3}$$

Now same three capacitors are connected in parallel

$\therefore$ $$C_p = C + C + C = 3\,C$$

$$\frac{C_p}{C_s} = \frac{3C}{C/3} = 9 : 1$$

11. (d) 0

Explanation: $q_1 = 3\mu C$, $q_2 = 4\mu C$, $q_3 = -7\mu C$, $q_4 = ?$, $V = 0$

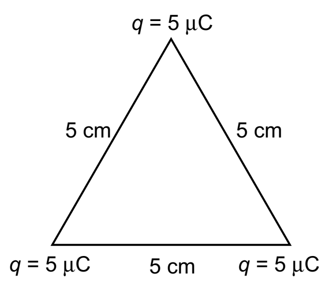
$$V = V_1 + V_2 + V_3 + V_4$$

$$0 = \frac{1}{4\pi\varepsilon_0}\frac{1}{r}\,[q_1 + q_2 + q_3 + q_4] \qquad [\because \text{At centre, } V = 0]$$

$$0 = \frac{1}{4\pi\varepsilon_0}\left[\frac{3\mu C + 4\mu C - 7\mu C + q_4}{r}\right]$$

$$q_4 = 0C$$

12. (a) 13.5 J



Explanation: $$U = \frac{1}{4\pi\varepsilon_0}\left(\frac{3q^2}{r}\right)$$

$$= 9 \times 10^9 \times \frac{(3\times5\times10^{-6}\times5\times10^{-6})}{5\times10^{-2}} = 13.5\text{ J}$$

13. (c) 12μF, 100μC

Explanation: $C_1 = 3\mu F$, $C_2 = 6\mu F$ and $C_3 = 10\mu F$

C_1 and C_2 are connected in series

$\therefore$ $$C_s = \frac{C_1C_2}{C_1+C_2} = \frac{3\mu F.6\mu F}{9\mu F} = 2\mu F$$

C_s and C_3 are connected in parallel

$\therefore$ $$C_p = C_s + C_3 = 2\mu F + 10\mu F = 12\mu F$$

The charge Q on $C_s = C_sV$

$$= 2\mu F.50\text{ V} = 100\mu C$$

The charge on C_1 is 100μC

14. (a) At least some tiny current loops within the magnet

Explanation: A current carrying conductor produces magnetic field around it. Magnetic field can be produced by current.

15. (b) 6.8×10^{-5} T

Explanation: Magnetic field $\vec{B} = \vec{B_1} - \vec{B_2}$

Where $\vec{B_1}$ is magnetic field due to straight wire at centre of loop in inward direction and $\vec{B_2}$ is the magnetic field at a centre of loop due to current loop in outward direction. So direction of B_1 and B_2 are opposite to each other.

$$\therefore \quad \vec{B} = \frac{\mu_0}{4\pi}\cdot\frac{2i}{R} - \frac{\mu_0 i}{2R}$$

$$= \frac{\mu_0 i}{2R}\left[\frac{1}{\pi} - 1\right]$$

$$= \frac{4\pi \times 10^{-7} \times 16}{2 \times 10^{-1}} \times \left[\frac{1}{3.14} - 1\right]$$

$$= 6.8 \times 10^{-5} \text{ T (outword direction)}$$

16. (c) $\frac{1}{10}$ A

Explanation:

$$R_s = 60 + 60 = 120\ \Omega$$

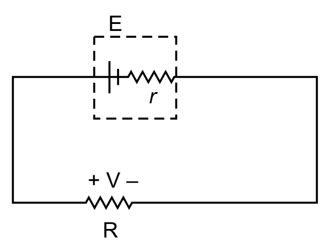
R_s and $R_3 = 60\ \Omega$ connected in parallel

$$R_p = \frac{R_s R_3}{R_s + R_3} = \frac{120 \times 60}{120 + 60} = \frac{120 \times 60}{180} = 40\ \Omega$$

$$i = \frac{V}{R} = \frac{4}{40} = \frac{1}{10} \text{ A}$$

17. (b) $\left(\frac{E - V}{V}\right)R$

Explanation:



$$\frac{V}{R} = \frac{E}{R + r}$$

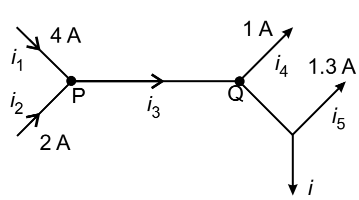
$$\frac{R + r}{R} = \frac{E}{V}$$

$$1 + \frac{r}{R} = \frac{E}{V}$$

$$r = \left(\frac{E}{V} - 1\right)R = \left(\frac{E - V}{V}\right)R$$

18. (b) 3.7A

Explanation:



By applying KCL at node P, $i_1 + i_2 = i_3$

$$i_3 = 4 + 2 = 6\text{A}$$

Again by applying KCL at node Q, $i_3 = i_4 + i_5 + i$

$$6 = 1 + 1.3 + i$$

$$4.7 = i$$

$$i = 3.7\text{A}$$

19. (b) $\dfrac{n\text{E}}{n\text{R}+r}$

Explanation: n identical cells each of e.mf. E and internal resistance r are in parallel and connected in series with R.

Then, $$i = \frac{\text{E}}{\text{R}+\dfrac{r}{n}} \qquad \left[\because \frac{1}{r_{\text{total}}} = \frac{1}{r}+\frac{1}{r}+\frac{1}{r}...n \text{ times} = \frac{n}{r}, r_{\text{total}} = \frac{r}{n}\right]$$

$$i = \frac{n\text{E}}{n\text{R}+r}$$

20. (b) To the right of C

Explanation: We know that, in potentiometer

$$\frac{\text{E}_1}{l_1} = \frac{\text{E}_2}{l_2} = \text{Constant} \qquad \text{...(i)}$$

In Case 1,

Let $\text{AC} = l_1$ (When galvonometer is connected to E_1)

In Case 2, E_2 is connected with galvonometer

$\because$ By equation (i),

$$\text{E}_1 l_2 = \text{E}_2 l_1 = \text{Constant}$$

Given, $\text{E}_2 > \text{E}_1$

$\therefore$ $l_2 > l_1$

$\therefore$ $l_2 > \text{AC}$

21. (a) 10 Hz

Explanation: Time period = 0.1 sec.

Frequency of the emf is given by

$$f = \frac{1}{\text{T}} = \frac{1}{0.1} = 10 \text{ Hz}$$

22. (a) $\dfrac{ml}{ne^2\tau\text{A}}$

Explanation: We know that,

$$\text{The current, } i = \frac{ne^2\text{A}\tau\text{V}}{ml}$$

$$\text{By comparing, } i = \frac{\text{V}}{\text{R}}$$

$$\text{R} = \frac{ml}{ne^2\text{A}\tau}$$

23. (c) $2v$

Explanation: $i = ne\text{A}v_d$

$$v_d \propto i$$

If current is doubled then v_d will become double.

24. (b) 160 Ω

Explanation: $R = 10\ \Omega$

If it streched four times, then length become increase fourth time but volume remains constant.

$$\therefore \quad \pi r_1^2 l_1 = \pi r_2^2 l_2$$

$$\frac{l_2}{l_1} = \frac{r_1^2}{r_2^2} \quad \ldots(i)$$

Now, $R = \rho \frac{l}{A}$ Where ρ is specific resistances

$$\frac{R_1}{R_2} = \frac{l_1}{l_2}\cdot\frac{A_2}{A_1} = \frac{l_1}{l_2}\cdot\frac{\pi r_2^2}{\pi r_1^2} = \frac{l_1}{l_2}\times\frac{l_1}{l_2} \quad \text{[By using (i)]}$$

$$= \frac{l_1^2}{l_2^2}$$

$$R_2 = \frac{l_2^2}{l_1^2}\times R_1 = (4)^2 R_1 = 16 R_1 = 160\ \Omega$$

25. (a) Parallel to each other

Explanation: The current element *dl* and magnetic flux density $\vec{B}$ at any point P are always tangential to each other.

26. (b) 50 Hz

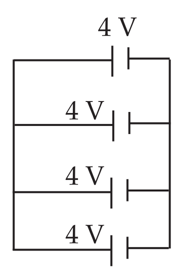
Explanation: $\varepsilon = 300 \sin (100\pi)t$

By comparing, $\varepsilon = \varepsilon_0 \sin \omega t$

$$\omega = 100\pi$$
$$2\pi f = 100\pi$$
$$2f = 100$$
$$f = 50 \text{ Hz}$$

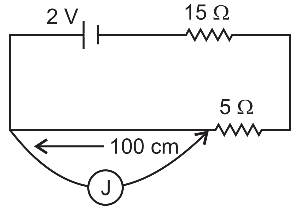
27. (d) 4V

Explanation: In the parallel combination potential difference or emf are same. The combined emf is 4 volt.



28. (a) 0.005 V/cm

Explanation:



The voltage across the potentiometer, $E = \frac{2}{15+5} \times 5 = \frac{10}{20} = 0.5 \text{ V}$

$$\text{Potential gradient, } K = \frac{E}{l} = \frac{0.5}{100} = 0.005 \text{ V/cm}$$

29. (a) 6 V

Explanation: $K = 20$ V/m

Two points at 40 cm and 70 cm point on meter scale fitted along the wire. Let potential difference between B and C is E′

$\because$ $$K = \frac{E}{l} = 20 \text{ V/m}$$

$\therefore$ $$E' = Kl' = 20 \times (0.70 - 0.40) = 20 \times 0.3 = 6 \text{ V}$$

30. (b) 5 Ω

Explanation: A null point is obtained at the centre of the bridge.

$\therefore$ $$\frac{R_1}{R_2} = \frac{l}{100-l} = \frac{50}{100-50} = \frac{50}{50} = 1$$

$$R_2 = R_1 = 5\ \Omega$$

31. (a) Circle

Explanation: When an electron projected perpendicular to a uniform magnetic field it moves along a circular path.

32. (a) $\vec{F} = q(\vec{v} \times \vec{B})$

Explanation: When a charge particle moving in a magnetic field, there is a force actng on a particle *i.e.,* $F = q(\vec{v} \times \vec{B})$.

33. (a) kg. m.sec.$^{-2}$.A^{-2}

Explanation: We know that the force per unit length acting between two wire.

$$\frac{F}{l} = \frac{\mu_0}{4\pi} \cdot \frac{2I_1I_2}{r}$$

$$\mu_0 = \frac{F.4\pi.r}{l.2I_1I_2} = \frac{\text{kg.}\frac{\text{m}}{\text{sec}^2}.\text{m}}{\text{m.A.A}} = \text{kg. m.sec.}^{-2}.\text{A}^{-2}$$

34. (d) Laminated core of soft iton.

Explanation: Due to the constantly changing magnetic field. There is a loss of current in the core. This current is known as eddy current. To reduce eddy current losses, we use a laminated core of soft iron.

35. (c) gamma radiation

Explanation: The most harmful radiation entering the atmosphere of earth from outer space is UV radiation or gamma radiations.

36. (c) Both (a) and (b)

Explanation: The frequency and wavelength of radiowave and gamma wave are different.

37. (d) X-ray, radiowaves, infra-red rays.

Explanation: In eletromagnetic spectrum, the group of rays are radiowave, infra-red, visible rays, UV-rays, X-ray and gamma rays.

38. (d) Ultra Violet Rays

Explanation: $\lambda_{\text{X-ray}} < \lambda_{\text{UV}} < \lambda_{\text{Visible}}$

39. (i) (a) 1×10^5 V/m

Explanation: $A = 600 \text{ cm}^2 = 6 \times 10^{-2} \text{ m}^2$

$$d = 2 \times 10^{-3} \text{ m}$$

$$V = 200 \text{ V}$$

By $V = E.d$ [where E is electric field]

$$E = \frac{V}{d}$$

$$= \frac{200}{2\times10^{-3}} = 10^5 \text{ V/m}$$

(ii) (a) 8.05×10^{-7} c/m^2

Explanation: $E = \frac{\sigma}{\varepsilon_0}$

$\therefore$ $\sigma = E\varepsilon_0$

$$= 10^5 \times 8{,}85 \times 10^{-12} = 8.85 \times 10^{-7} \text{ c/m}^2$$

40. (i) (d) 13.5 V

Explanation: P = 4.5, V = 1.5 V, R′ = 1Ω

Resistance of bulb, $R = \frac{V^2}{P} = \frac{(1.5)^2}{4.5} = 0.5\ \Omega$

$$\frac{1}{R''} = \frac{1}{R} + \frac{1}{R'} = 2 + 1 \quad \Rightarrow R'' = \frac{1}{3} = 0.33\ \Omega$$

$$R_{total} = r + R'' = 2.67 + 0.33 = 3\ \Omega$$

$$\frac{E}{r + R''} = \frac{V}{R''} \quad \Rightarrow \frac{E}{3\Omega} = \frac{1.5}{1/3} \quad \Rightarrow E = 13.5 \text{ V}$$

(ii) (b) 1.5 A

Explanation: Voltage across 1Ω resister $V_{1\Omega} = 1.5$ V

$$i = \frac{V}{R'} = \frac{1.5}{1} = 1.5 \text{ A}$$

41. (i) (c) $10^{-8}\ \Omega$

Explanation: $R = \rho\frac{l}{A}$

$$= 50 \times 10^{-8} \times \frac{50}{50\times50} = 10^{-8}\ \Omega$$

(ii) (d) $50 \times 10^{-8}\ \Omega$ m

Explanation: Specific resistance does not depend upon area and length. Therefore, the value will remain constant *i.e.*, $50 \times 10^{-8}\ \Omega$ m.

42. (i) (b) 0.25 V

Explanation: $e = Bvl$

$$= 0.1 \times 5 \times 0.5 = 0.25 \text{ Volt}$$

(ii) (c) Along CDRQC

Explanation: By using fleming's right hand rule, the direction of induced current is clockwise.

43. (i) (a) Anti-clockwise

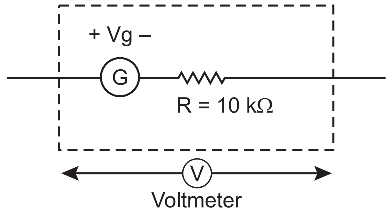
Explanation: The motion of magnet is towards the coil PQ. The point P will become north pole which opposes the relative motion between coil and magnet. Therefore, anti-clockwise current will flow at P.

(ii) (b) South pole

Explanation: The magnetic poles induced at P and Q are north pole and South pole respectively.

44. (i) (a) 10050 Ω

Explanation: Galvanometer resistance = 50 Ω



A voltmeter can be formed by connecting a high resistance in the series with Galvonometer.

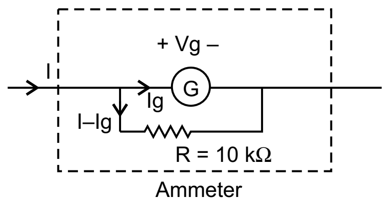
$$\frac{V_g}{G} = \frac{V - V_g}{R}$$ where V is voltage of voltmeter

Resistance of voltmeter is $R_V = G + R$

$= 50 + 10000 = 10050\ \Omega$

(ii) (d) 10 m Ω

Explanation: Ammeter can be formed by connecting galvonometer with very low resistance in parallel.



$$\frac{1}{R_A} = \frac{1}{R} + \frac{1}{G}$$

$$= \frac{100}{1} + \frac{1}{10000} = \frac{1000000+1}{10000}$$

Resistance of ammeter, $R_A = \frac{10000}{1000001} = 0.0099\ \Omega \simeq 10\ \text{m}\ \Omega$

45. (i) (a) 5 : 4

Explanation: $R_1 = \frac{V_1^2}{P_1}, R_2 = \frac{V_2^2}{P_2}$

$$\frac{R_1}{R_2} = \left(\frac{V_1}{V_2}\right)^2 . \frac{P_2}{P_1}$$

$$= \left(\frac{250}{250}\right)^2 \times \frac{100}{80} = \frac{5}{4}$$

(ii) (b) 4 : 5

Explanation: $\frac{P_1}{P_2} = \left(\frac{V_1}{V_2}\right)^2 \frac{R_2}{R_1} = \frac{4}{5}$ [$\because R_1 : R_2 = 5 : 4$]

(iii) (c) 1 : 1

Explanation: $V_1 = V_2 = 250$ Volt

46. (i) (c) 2.0 A

Explanation: In LCR Circuit, $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$$= \sqrt{(100)^2 + \left(2\pi f L - \frac{1}{2\pi f C}\right)^2}$$

$$= \sqrt{10000 + \left(6.28 \times 40 \times 8 - \frac{1}{6.28 \times 40 \times 2 \times 19^{-6}}\right)^2}$$

$$= \sqrt{10000 + 19^2} = 101.78\ \Omega$$

$$i_0 = \frac{V_0}{Z} = \frac{200}{101.70} = 1.96 \text{ A} \sim 2 \text{ A}$$

(ii) (a) $\frac{\pi}{2}$ radian

Explanation: Inductor is leading by $\frac{\pi}{2}$ to resistor.

(iii) (d) π radian

Explanation: There is phase difference of π between inductor and capacitor.

47. (i) (a) There is no current till key 'K' is pressed.

Explanation: If K is open then there is no current flow in the bridge.

(ii) (c) $V_B = V_D$

Explanation: When the bridge is balanced the potential at B and D are same.

$$V_B = V_D$$

(iii) (d) $I_g = 0$

Explanation: At balanced condition, there is no current flow through Galvonometer (BD).

i.e., $$I_g = 0$$

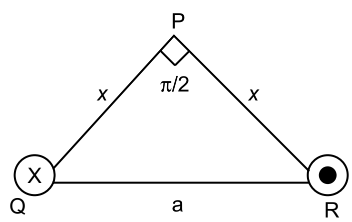
48. (i) (b) $B = \frac{\mu_0}{\sqrt{2}} \cdot \frac{i}{\pi a}$ acting along PR

Explanation: Let $PQ = PR = x$

$$\sqrt{2x^2} = a$$

$$\sqrt{2}x = a$$

$$x = \frac{a}{\sqrt{2}}$$



Magnetic field B at P due to wire Q, $B = \frac{\mu_0}{4\pi} \cdot \frac{2i}{\frac{a}{\sqrt{2}}}$

$$= \frac{\mu_0}{\sqrt{2}\pi} \cdot \frac{i}{a} \text{ acting along PR}$$

(ii) (a) $B = \frac{\mu_0}{\sqrt{2}\pi} \cdot \frac{i}{a}$ acting along PQ

Explanation: Magnetic field B due to wire R, at point P

$$B = \frac{\mu_0}{\sqrt{2}\pi} \cdot \frac{i}{a} \text{ acting along PQ}$$

(iii) (d) $B = \frac{\mu_0}{\sqrt{2}\pi} \cdot \frac{i}{a}$ towards the mid-point of QR

Explanation: Magnetic field at P,

$$B_{net} = \sqrt{B_{PQ}^2 + B_{PR}^2} = \sqrt{2}B \qquad [\because B_{PQ} = B_{PR} = B]$$

$$B = \frac{\mu_0}{\pi} \cdot \frac{i}{a} \text{ towards the mid-point of QR}$$

49. (i) (b) 30 Ω

Explanation: $X_L = \omega L = 2\pi f L$

In LR circuit, resistance and inductance are connected in series.

$$\therefore \quad \tan a = \frac{3}{4} = \frac{X_L}{R} \qquad \left(\because \tan a = \frac{V_L}{V_R} = \frac{IX_L}{IR}\right)$$

$$X_L = \frac{3}{4} R = \frac{3}{4} \times 40 = 30\ \Omega$$

(ii) (c) 50 Ω

Explanation: Impedance of the circuit, $Z = \sqrt{R^2 + X_L^2}$

$$= \sqrt{40^2 + 30^2} \qquad (\because X_L = 30\ \Omega)$$

$$= 50\ \Omega$$

(iii) (c) 2.0 A

Explanation: Current flow, $I = \frac{V}{Z} = \frac{100}{50} = 2\text{ A} \qquad (\because Z = 50\ \Omega)$

(iv) (b) 50 Hz

Explanation:

$$L = 0.096\text{ H}$$

$$\text{Calculated, } X_L = 30\ \Omega$$

$$2\pi f L = 30$$

$$2 \times 3.14 \times f \times 0.096 = 30$$

$$f = \frac{30}{2 \times 3.14 \times 0.096} = 49.76\text{ Hz} = 50\text{ Hz}$$

50. (i) (a) Transformer

Explanation: A transformer is used to change the AC voltage to higher to lower value or lower to higher value.

(ii) (d) All of these

Explanation: A transformer's output power is always slightly less than the input power. There is power dissipation in the transformer due to hysteresis losses, eddy current and flux losses.

(iii) (c) Power output is equal to power input

Explanation: Power input = Power output

In ideal case, effeciency should be 1

i.e. $$\eta = 1 = \frac{P_{out}}{P_{in}}$$

(iv) (a) AC source

Explanation: A transformer is generally operated on AC. If converted AC voltage to higher to lower value and viva-versa.