Internal Exam -(2019-20) Solution

BCA - Ist Year (Physics)

[Part - I] SET - A

Q.1 What is quantization of charge.

Soln:- All free charges are integral multiple of a unit of charge e, where $e = -1.602 \times 10^{-19}$ C

The charge q on body is always denoted by

$$q = ne \quad (\because n = +ve \text{ or } -ve \text{ integer})$$

Q.2 Explain ohm's Law.

Soln:- If physical condition are same, then the current flowing through the conductor is directly proportional to the potential difference applied across it.

$$I \propto V$$

$$I = \frac{1}{R} V \quad \because [R = \text{Resistance}]$$

Q.3 Define electric Current.

Rate of flow of charge through a conductor is called electric current.

SI Unit is Ampere. Electric current is measured by ammeter.

It can be calculated by

$$I = \frac{Q}{t}$$

Rate at which charge flows through a given surface

$$I = \frac{dQ}{dt}$$

Q.4 Short note on magnetic line of force.

Soln:- The line of force in a magnetic field is that imaginary continuous line.

1) No two lines intersect each other.

2) Magnetic lines of force are in the form of close curve.

3) The number of lines shows the density of magnetic field.

Q.5 Define resistivity and Conductivity.

Soln:- It defines that how strongly a material that opposes the flow of electric current.

Resistivity is defined as ρ (rho).

SI unit of resistivity is ($\Omega \times m$) (ohm x meter)

Resistivity is defined as $\left(\rho = R\frac{A}{l}\right)$

Conductivity :-

It is the reciprocal of electrical resistivity, and measure the material's ability to conduct an electric current.

Conductivity is defined as σ (sigma)

SI unit is Siemens per metre (S/m)

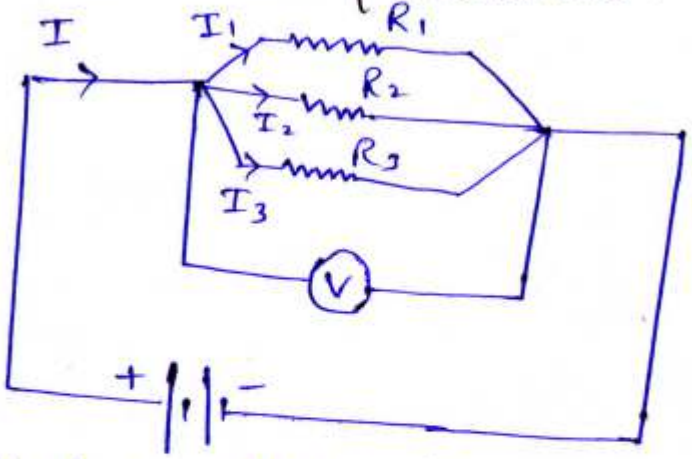
It is defined as

$$\sigma = \frac{1}{\rho}.$$

Part – II

Q. 1(a) Explain the parallel combination of resistance.

Soln:-



The one end of all resistance are connected with first point and second end of all resistance are connected with second point, is called parallel combination of resistance.

The current flowing through each resistance is unequal because at first point the current is divided into I_1, I_2, I_3 .... and so on.

Potential difference is equal at each resistance.

Now according to ohm's law –

$$V = IR$$

$$\Rightarrow I = \frac{V}{R}$$

For R_1 $\Rightarrow I_1 = \frac{V}{R_1}$ —— (1)

For R_2 $\Rightarrow I_2 = V/R_2$ —— (2)

For R_3 = $I_3 = V/R_3$ —— (3)

Total current flowing through circuit

$$I = I_1 + I_2 + I_3$$

Using equation (i), (ii), (iii)

$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\frac{V}{R} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$\boxed{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

For n-no. of resistance joined in parallel, so

$$\boxed{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots \frac{1}{R_n}}$$

(b) There are two resistence R_1 and R_2 having equal resistance equal to 20 Ω and 30 Ω respectively are connected in parallel in an electric field. If the potential difference across the circuit is 5V. Find the electric current flowing through the circuit and the total resistence of the resistor.

Soln:- Given $R_1 = 20\,\Omega$, $R_2 = 30\,\Omega$, $V = 5V$

we have to find total resistance (R) = ?

$I = ?$

So the parallel combination

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow \frac{1}{R} = \frac{1}{20\,\Omega} + \frac{1}{30\,\Omega}$$

or $$\frac{1}{R} = \frac{1}{12}\,\Omega$$

Now electric current through circuit $I = \frac{V}{R}$

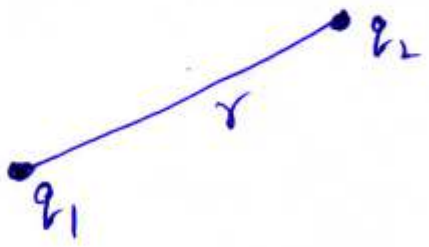
$$I = \frac{5}{12} = 0.416\,A$$

$$R = 12\,\Omega$$

Q.2 Write short note on:-

(a) Coulomb's law.

Soln:- It states that the electrical force between two charge particles. It is directly proportional to the product of quantity of charge and inversely proportional to square of the separation distance between them.



$$F \propto q_1 q_2$$

$$F \propto \frac{1}{r^2}$$

$$F \propto \frac{q_1 q_2}{r^2}$$

$$F = K \frac{q_1 q_2}{r^2}$$

[K = constant called electro-static constant

$= 9 \times 10^9 \ Nm^2/C^2$]

(b) Gauss law of electrostatics.

It states that the total electric flux through a closed surface. According to this law the total flux passing through a closed surface is equal to $4\pi K$ multiple of net charge enclosed by the surface.

$$\phi = 4\pi K \sum q$$

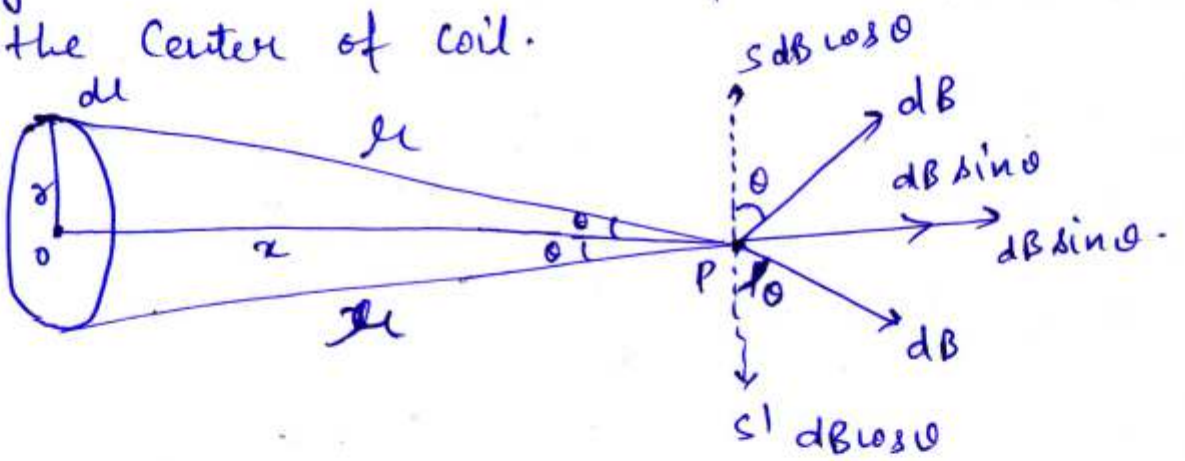
$$= \frac{1}{\varepsilon_0} \sum q$$

$$K = \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \ Nm^2/C^2.$$

Part – C

Q.1 Using biot – Savart law, derive the expression for the magnetic field in the vector form at a point on the axis of a circular current loop.

Soln:- Consider a circular coil of radius r, carrying current I. Consider a point P at distance x from the center of coil.



By Biot – Savart law the dB due to small element dl is

$$dB = \frac{\mu_0}{4\pi} I \frac{dl}{(x^2+r^2)} \qquad [\sin 90^\circ = 1]$$

Now it can be resolve in two components as shown in figure. SOS' is the perpendicular on OP. So

$$B_x = \frac{\mu_0 I}{2} \frac{r^2}{(x^2+r^2)^{3/2}}$$

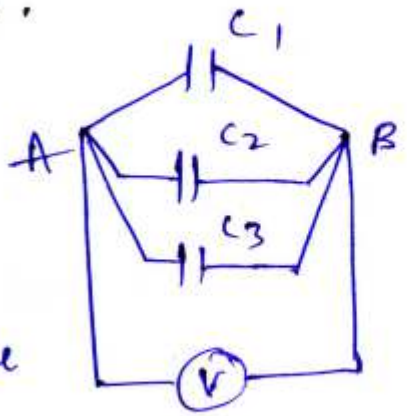
Now for n-turns in the coil

$$B_x = \frac{\mu_0 n I}{2} \frac{r^2}{(x^2+r^2)^{3/2}}$$

μ_0 = permeability.

Q.2 Explain :-

(a) Parallel plate Condenser.



Soln :- The capacitor C_1, C_2, C_3 are connected by point A and B. So that potential difference produced at each capacitor is equal but the charge is different.

We know that

$$C = \frac{Q}{V}$$

So $Q = CV$

For capacitor $C_1 \Rightarrow Q_1 = C_1 V$ —(1)

For $C_2 \Rightarrow Q_2 = C_2 V$ —(2)

For $C_3 \Rightarrow Q_3 = C_3 V$ —(3)

Now total charge $Q = Q_1 + Q_2 + Q_3$

$$CV = C_1V + C_2V + C_3V$$

$$CV = V(C_1 + C_2 + C_3)$$

$$\boxed{C = C_1 + C_2 + C_3}$$

So for n no. of capacitor

$$\boxed{C = C_1 + C_2 + C_3 + \dots C_n}$$

(b) An electric refrigerator rated 400 W operates 8 hour/day. A tube light of 40W is used 10 hour/day. How much energy is consumed in 30 days. What is the cost of the energy to operate these for 30 days at ₹. 3.00 per KWh.

Soln :- The energy consumed by refrigerator in 30 days is

$= 400 \times 8 \times 30$

$= 96000$ WH

$= 96$ KWH $=$ 96 Unit.

The energy consumed by the tube light in 30 days is

$= 40 \times 30 \times 10$

$= 12000$ WH

$= 12$ KWH $= 12$ Unit

The total energy consumed would be

$\Rightarrow 96 + 12 = 108$ Unit

The cost of energy would be

$\Rightarrow 108 \times 3 =$ 324 ₹.

Internal Exam (2019-20) Solution
BCA – Ist Year (Physics)
SET-B

Q.1 What is conservation of charge.

Soln:- In a isolated system net charge does not change in any process occur in the system so net charge for an isolated system is always constant.

Q.2 Explain Capacitance.

Soln:- Potential is directly proportional to the charge given on it.

$$Q \propto V$$

$$Q = CV$$

Here C = capacitance.

Capacitance is ability of a body to store an electric charge.

Unit of C in farad (F)

Q.3 Explain Intensity of electric field.

The ratio of force acting on a charge (q_0) placed at point in a electric field and the amount of charge q_0 is called the intensity of electric field.

$$E = \lim_{q_0 \to 0} \frac{F}{q_0}$$

Q4 Define the magnetic field and magnetic line of force.

Ans:- The field where a magnetic has its impact is called magnetic field.

Magnetic line of force:-

1) No two lines intersect each other.
2) Magnetic line of force are in the form of closed curve.
3) More number of lines shows strong magnetic field.

Q5. Define resistivity and conductivity.

Ans:- It define how strongly a material opposes the flow of electric current.

It is represented by ρ (rho)

It's Unit is ohm x meter (Ωxm)

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

Conductivity:-

It is the inverse of resistivity. It measure the ability to conduct an electric current.

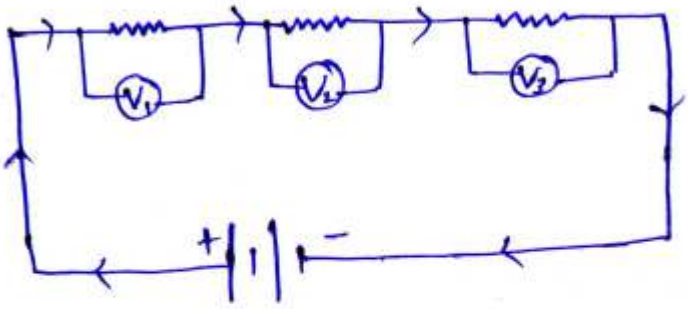
It is represented by (σ). SI Unit = (S/m)

conductivity $(\sigma) = \frac{1}{\rho}$

Part – B

Q.1 Explore the series combination of resistance.

Soln:-



In series combination the current flowing through each resistance wire is "equal".

The potential difference produces at each resistance wire is unequal.

According to ohm's law

$$V = IR$$

For resistance R_1

$$V_1 = IR_1 \quad \text{——(1)}$$

For resistance R_2

$$V_2 = IR_2 \quad \text{——(2)}$$

For resistance R_3

$$V_3 = IR_3 \quad \text{——(3)}$$

The total potential difference

$$V = V_1 + V_2 + V_3$$

Now using equation (I), (II), (III)

$$IR = IR_1 + IR_2 + IR_3$$

$$\boxed{R = R_1 + R_2 + R_3}$$

If n no. of wires are joined in series

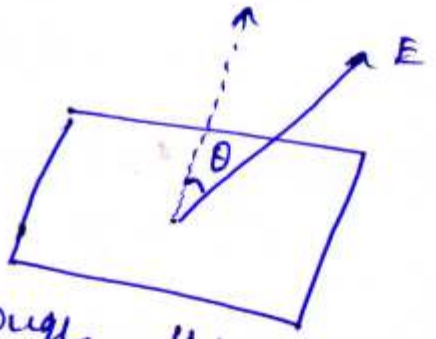
$$[R = R_1 + R_2 + R_3 + \dots - R_n]$$

Q.2 Write short note on :-

(a) Electric flux.

The number of field line crossing a unit area, placed normal to the field at the point is known as electric flux.

Consider a plane surface in a uniform electric field.



The line of force passing through this area electric flux.

The electric flux is represented

$$\Delta\phi = E\Delta S \cos\theta.$$

If E is ⊥r to surface, $\theta = 0$

$$\Delta\phi = E\Delta S\cos\theta \Rightarrow E\Delta S \text{ (maxm)}$$

If $\theta = \pi$

$$\Delta\phi = E\Delta S\cos\theta = -E\Delta S$$ (minimum) in opp. dirn

If $\theta = \pi/2$

$$\Delta\phi = 0 \quad \text{(minimum)}$$

(b) Energy and Electrical power :-

Soln :- The amount of consumed energy depends on current (I) voltage (V) and time (t)

According to defination of electric current

$$Q = It$$

Acc. to definition of potential difference.

$$V = \frac{W}{Q}$$

$$W = VQ$$

$$\Rightarrow \boxed{W = VIt}$$

Power :-

The rate at which electric energy is consumed in an electric circuit, called electric power.

Power P is given by :-

$$P = \frac{W}{t} = \frac{VIt}{t} = VI$$

Unit ⇒

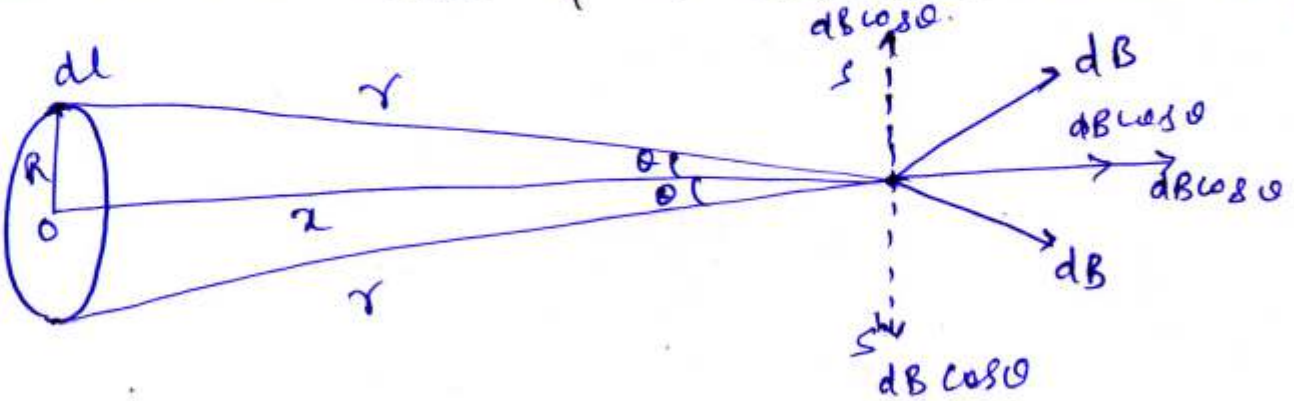
(1) Joule per second

(2) Watt

(PART – C)

Q.1 Using biot – Savart law, derive the expression for the magnetic field in the vector form at a point on the axis of a circular current loop.

Soln :-



Consider a circular coil of radius r, carrying current I. Consider a point P at distance x from the center of coil.

By Biot – Savart law the dB due to small element dl is

$$dB = \frac{\mu_0}{4\pi} \frac{I\, dl}{(x^2+r^2)} \quad [\sin 90^\circ = 1]$$

Now it can be resolve in two components as shows in figure. So S and S1 is the perpendicular on o/p.

So

$$B_x = \frac{\mu_0 I}{2} \frac{r^2}{(x^2+r^2)^{3/2}}$$

For n – turns in the coil

$$B_x = \frac{\mu_0 n I}{2} \frac{r^2}{(x^2+r^2)^{3/2}}$$

μ_0 = Permeability.

Q.2(b) A hotel has 20 rooms. Each room has a tube light of 40W and a fan of 100 W. If on the average the tube light is operated for 6 hours and fan for 10 hours per day how much electric energy is consumed in a month of 30 days. What is the cost of the energy for operate these for 30 days at ₹. 4.00 per KWh

Soln:- Consuption of electric energy by a tube light per day ⇒ 40 × 6 = 240 watt-hour.

Consuption of electric energy by a fan per day ⇒ 100 × 10 = 1000 watt-hour

Total Consuption per day = 240 + 1000
= 1240 watt-hour

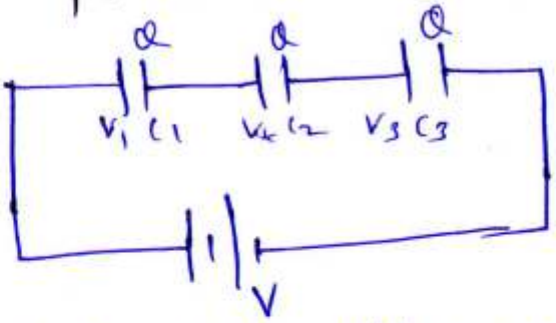
Total consuption in a month ⇒ 1240 × 30
= 37200 watt-hour
= 37.2 KWH

Thus the cost of energy to operate these would be :-

37.2 × 4 = 148.80 ₹.

Q. 2 (a) Series plate Condensor :-

Soln :-



Let the potential difference across the condensor C_1, C_2, C_3 are V_1, V_2, V_3 respectively.

$\therefore V = \frac{Q}{C}$

For capacitor $C_1 \Rightarrow V_1 = \frac{Q}{C_1}$ —(1)

For capacitor $C_2 \Rightarrow V_2 = \frac{Q}{C_2}$ —(2)

For capacitor $C_3 \Rightarrow V_3 = \frac{Q}{C_3}$ —(3)

The total potential difference

$V = V_1 + V_2 + V_3$

Using eqn (1), (11) (111)

$$\frac{Q}{C} = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$$

$$\Rightarrow \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

For n - no. of capacitor join in series

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots + \frac{1}{C_n}$$