BYJU'S Part Test for Board Term I (CBSE Grade 12)

Date: 17/11/2021

Subject: Physics **Class:** Standard XII

ANSWER KEYS AND SOLUTIONS

BYJU'S Part Test for Board Term I (CBSE Grade 12)

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Subject: Physics

Topic : Section A

Class: Standard XII

1. When a body is charged by induction, then the body

   A. becomes neutral

   B. does not lose any charge

   C. loses whole of the charge on it

   D. loses part of the charge on it

Electrostatic induction is a redistribution of charges in an object, caused by influence of nearby charges. Charging by induction involves transfer of charges from one part to the other of the body. So no charge is lost in the process.

Why this question ?
Bottom line: Electrostatic induction leads to redistribution of charges on account of law of conservation of charge.

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2. Consider three charged bodies P, Q and R. If P and Q repel each other, while P and R attract. What is the nature of force between Q and R ?

   A. Repulsive force

   B. Attractive force

   C. No force

   D. None of these

P and Q repel each other.

$\Rightarrow P$ and Q are similarly charged, thus either P and Q both are $+ve$ or $-ve$ charged body.

Since, P and R attract each other.

$\Rightarrow P$ and R are oppositely charged.

Case (I):
If P is $+ve$ charged body, then

$\Rightarrow Q \rightarrow +ve \quad \& \quad R \rightarrow -ve$

$\therefore Q$ and R will attract each other.

Case (II):
If P is $-ve$ charged body, then

$\Rightarrow Q \rightarrow -ve \quad \& \quad R \rightarrow +ve$

$\therefore Q$ and R will attract each other.

Hence, attractive force will act between Q and R. So option (b) is correct.

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3. Two equal charges are placed at a separation of $1 \mathrm{~m}$. What should be the magnitude of the charges so that the force between them equals the weight of a $50 \mathrm{~kg}$ person ?
(Take $g=10 \mathrm{~m} / \mathrm{s}^{2}$)

A. $3 \times 10^{-4}\ C$

B. $2.3 \times 10^{-4}\ C$

C. $3.2 \times 10^{-4}\ C$

D. $5 \times 10^{-5}\ C$

Given that,
Distance between charges, $r=1 \mathrm{~m}$
Weight of man, $W=m g=500 \mathrm{~N}$

The Coulombic force is given by
$F_{e}=k \frac{q_{1} q_{2}}{r^{2}}$
where q_{1} and q_{2} are charge and k is constant.
$\Rightarrow F_{e}=\frac{9 \times 10^{9} \times q^{2}}{(1)^{2}}\ \left(\because q_{1}=q_{2}=q\right)$
According to question,
$F_{e}=W$
$\Rightarrow 9 \times 10^{9} \times q^{2}=500$
$q^{2}=\frac{500}{9 \times 10^{9}}$
or, $q=\sqrt{\frac{50}{9} \times 10^{-8}}$
$\Rightarrow q=\sqrt{\frac{50}{9}} \times 10^{-4}$
or $q=\frac{5 \sqrt{2}}{3} \times 10^{-4}=1.66 \times 1.414 \times 10^{-4}$
$\therefore q=2.34 \times 10^{-4} \mathrm{~C}$
Hence, option (b) is correct.

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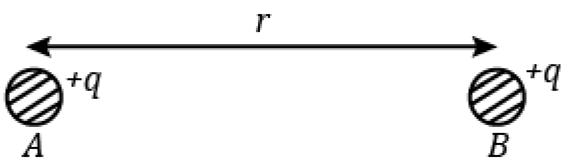
4. Two equally charged identical metallic spheres A and B repel each other with a force 2×10^{-5} N, when placed in air (neglect the dimension of sphere as they are very small). Another identical uncharged sphere C is touched to B and then placed at the mid point of line joining A and B. What is the net electrostatic force on C ?

   ✗ **A.** 1×10^{-5} N, toward BA

   ✓ **B.** 2×10^{-5} N, towards AB

   ✗ **C.** 4×10^{-5} N, towards BA

   ✗ **D.** 0.5×10^{-5} N, towards AB

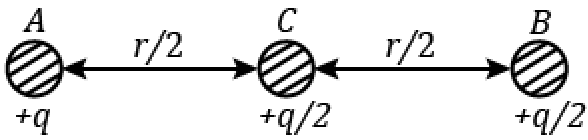


Let the initial charge on the sphere A and B be $+q$ and separated by r. The force of repulsion,

$F=\frac{kq^2}{r^2}=2\times10^{-5}\text{ N}$

When the sphere C is touched with B; the charge of B will get distributed equally on B and C due to their identical nature.

$\therefore q_B=q_C=\frac{q}{2}$



Force on sphere C by A,

$$F_{CA}=\frac{kq^2}{2\left(\frac{r}{2}\right)^2}=\frac{2kq^2}{r^2}=2F$$

F_{CA} is directed from A to B

Similarly, force on the sphere C by sphere B

$$F_{CB}=\frac{k\left(\frac{q}{2}\right)\left(\frac{q}{2}\right)}{\left(\frac{r}{2}\right)^2}=\frac{kq^2}{r^2}$$

$\Rightarrow F_{CB}=F$

and F_{CB} is directed from B to A.

Thus net force on C is,

$F_c=2F-F=F$

$\Rightarrow F_c=2\times10^{-5}\text{ N}$ from A to B

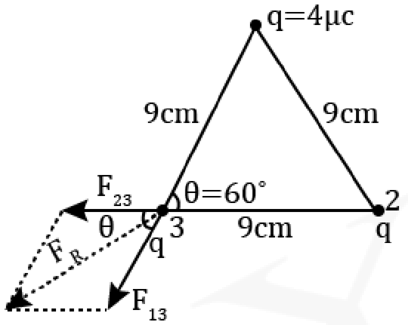
5. Three charges $4 \mu \mathrm{C}$ each are kept at the vertices of an equilateral triangle of side $9 \mathrm{~cm}$. The magnitude of force on one of the charges is

A. $\frac{16 \sqrt{3}}{9} \mathrm{N}$

B. $\frac{160}{9} \sqrt{3} \mathrm{~N}$

C. $\frac{80}{9} \sqrt{3} \mathrm{~N}$

D. $\frac{40}{9} \sqrt{3} \mathrm{~N}$



$q=4 \mu \mathrm{~C}=4 \times 10^{-6} \mathrm{~C} ; \ r=9 \mathrm{~cm}$

The force on one of the charges , $F_{13}=F_{23}=F$

$$F=\frac{1}{4 \pi E_0} \frac{q q}{r^2}$$

$$\Rightarrow F=9 \times 10^9 \times \frac{16 \times 10^{-12}}{\left(9 \times 10^{-2}\right)^2}=\frac{160}{9} \mathrm{N}$$

The resultant force , $F_R=\sqrt{F^2+F^2+2 F^2 \cos 60^{\circ}}$

$$\Rightarrow F_R=F \sqrt{2\left[1+\frac{1}{2}\right]}$$

$$\Rightarrow F_R=F \sqrt{3}=\frac{160}{9} \sqrt{3} \mathrm{~N} .$$

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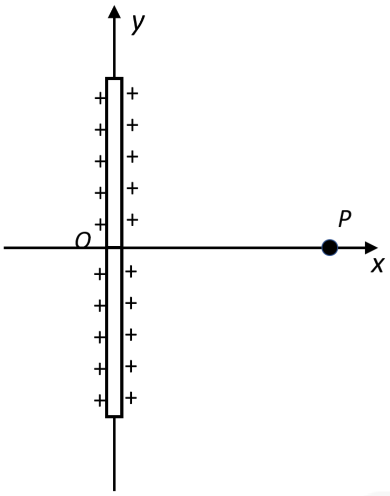
6. Find the direction of electric field at point P for the uniform line charge distribution of finite length as shown in figure, if line OP is equidistant from both the ends.



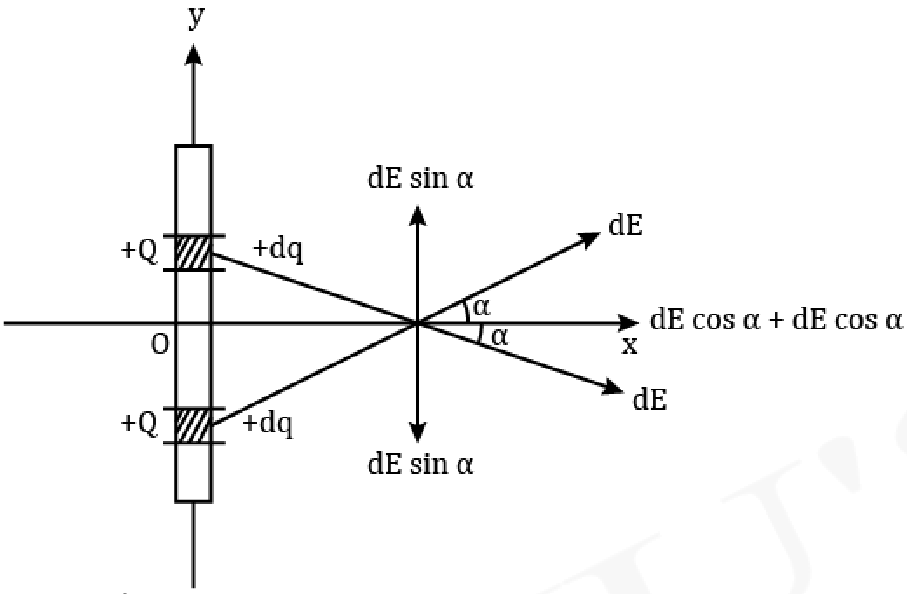
A. Along positive $x-$ axis

B. Along negative $x-$ axis

C. Along positive $y-$ axis

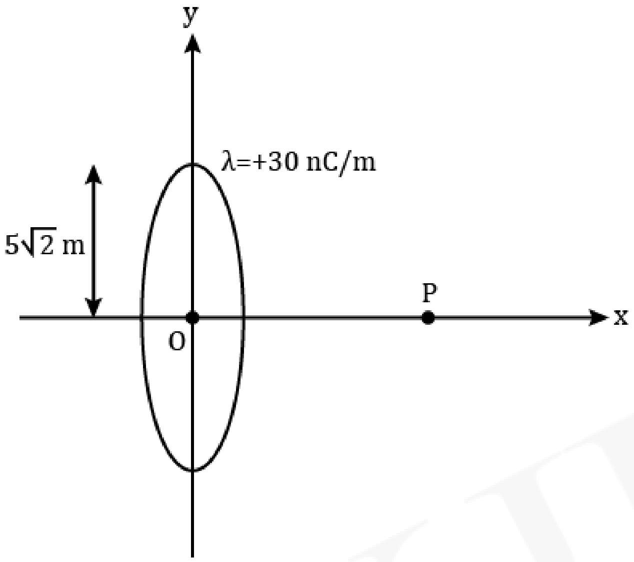
D. Along negative $y-$ axis

Consider a small elemental charge $+dq$ charge, on either side of x-axis as shown.



Electric field due to these elemental charges is as shown,
From the above figure, we can say that
$y-$ components of electric field intensity will cancel each other, and $x-$ components will be added. Hence net electric field due to given charge distribution is directed towards $+x$-axis.

7. At what distance from the centre of a uniformly charged ring, maximum value of electric field will be obtained?



A. $3 \mathrm{~m}$

B. $5 \mathrm{~m}$

C. $7 \mathrm{~m}$

D. $9 \mathrm{~m}$

Given:
$\lambda=+30 \mathrm{~nC} / \mathrm{m} ; \quad R=5 \sqrt{2} \mathrm{~m}$

We know that, maximum value of electric field for a ring of uniformly distributed charge over its circumference will be at

$$\mathrm{OP}=r=\frac{R}{\sqrt{2}}$$

$$\Rightarrow \mathrm{OP}=r=5 \mathrm{~m}$$

Hence, (b) is correct option.

8. A particle of mass $2 \mathrm{~gm}$ and charge $1 \mu \mathrm{C}$ is held at rest on a frictionless horizontal surface at a distance of $1 \mathrm{~m}$ from the fixed charge of $1 \mathrm{mC}$. If the particle is released, it will be repelled. The speed of the particle when it is at a distance of $10 \mathrm{~m}$ from the fixed charge is

   - ✗ **A.** $45 \mathrm{~ms}^{-1}$
   - ✗ **B.** $60 \mathrm{~ms}^{-1}$
   - ✓ **C.** $90 \mathrm{~ms}^{-1}$
   - ✗ **D.** $100 \mathrm{~ms}^{-1}$

The mass of the particle $m=2 \mathrm{~gm}=2 \times 10^{-3} \mathrm{~kg}$

Charge of the particles $q_1=1 \mu C$

The charge of the fixed particle , $q_2=1 \mathrm{mC}$

Initial distance $r_1=1 \mathrm{~m}$

Final distance $r_2=10 \mathrm{~m}$

Initial Total Energy $=$ Total Final Energy

$\therefore P.E_{initial}=PE_{Final}+K.E.$

$$\frac{1}{4 \pi \varepsilon_0} \frac{q_1 q_2}{r_1}=\frac{1}{4 \pi \varepsilon_0} \frac{q_1 q_2}{r_2}+\frac{1}{2} m v^2$$

$$\frac{q_1 q_2}{4 \pi \varepsilon_0}\left[\frac{1}{r_1}-\frac{1}{r_2}\right]=\frac{1}{2} m v^2$$

Substituting the given data gives,

$$9 \times 10^9 \times 10^{-6} \times 10^{-3}\left[\frac{1}{1}-\frac{1}{10}\right]=\frac{1}{2} \times 2 \times 10^{-3} \times v^2$$

$$\frac{81 \times 10^3}{10}=v^2$$

$$\Rightarrow v=90 \mathrm{~ms}^{-1}$$

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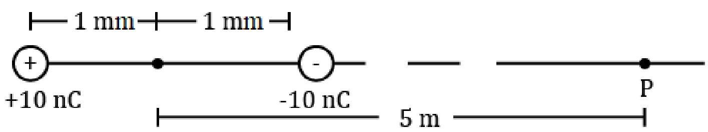
9. Find the net electric field at an axial point P of a dipole as shown in figure.



A. $1.50 \times 10^{-3}\ \mathrm{N/C}$

B. $2.25 \times 10^{-3}\ \mathrm{N/C}$

C. $1.88 \times 10^{-3}\ \mathrm{N/C}$

D. $2.88 \times 10^{-3}\ \mathrm{N/C}$

Given:
Distance of charges from centre of dipole, $l = 1\ \mathrm{mm}$;

Distance of point P from centre of dipole, $x = 5.001 \approx 5\ \mathrm{m}$;

Magnitude of charge, $q = 10\ \mathrm{nC}$;

Here, we can see that $l << x$

Therefore, the net electric field due to a dipole at an axial point is given by

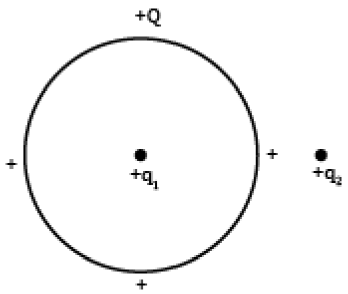
$$|\vec{E}_{ax}| = \frac{2k|\vec{p}|}{x^3} = \frac{2k(q2l)}{x^3} = \frac{4kql}{x^3}$$

$$\Rightarrow |\vec{E}_{ax}| = \frac{4 \times 9 \times 10^9 \times 10 \times 10^{-9} \times 1 \times 10^{-3}}{5^3}$$

$$\Rightarrow |\vec{E}_{ax}| = 2.88 \times 10^{-3}\ \mathrm{N/C}$$

So, option (d) is correct.

10. A thin metallic spherical shell contains a charge Q on its surface. A point charge q_1 is placed at the centre of the shell and another charge q_2 is placed outside the shell. All the three charges are positive. Then, the force on charge q_1 is



A. Towards right

B. Towards left

C. Zero ✓

D. None of these

Force on charge will depend on the electric field intensity at that place.
Considering a spherical Gaussian surface inside the shell.
Here $q_{enclosed} = 0$ because $+q_1$ is a test charge and $+q_2$ and $+Q$ are outside the Gaussian surface.
$\therefore E = 0$

Thus, the force experienced by charge $+q_1$ at centre of shell is zero.

Also since q_1 lies inside the conductor, it is always shielded from outside charges(q_2) and electric field. This process is also known as electrostatic shielding.

So, (c) is the correct choice.

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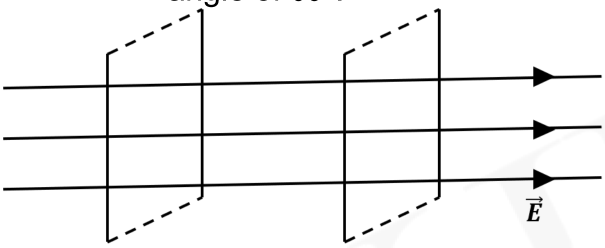
11. Identify the correct statement regarding an equipotential surface:

- **A.** An equipotential surface and electric line of force never intersect each other.
- **B.** An equipotential surface and electric line of force intersect at an angle of 45°.
- **C.** An equipotential surface and electric line of force intersect at an angle of 90°.
- **D.** An equipotential surface and electric line of force intersect at an angle of 60°.



As shown in figure, the electric field lines represent a uniform electric field.

Let us consider two points A and B on the equipotential surface.

Potential difference between those two points is given by

$$V_B - V_A = \int_A^B \vec{E} \cdot \vec{dl}$$

Since, $V_B = V_A$ we can write that,

$$\vec{E} \cdot \vec{dl} = 0$$

$$\Rightarrow \vec{E} \perp \vec{dl}$$

We know that, Electric lines of force will be along the $\vec{E}$ for a uniform electric field. (Electric lines of force are tangential to $\vec{E}$, thus electric lines of force intersect the equipotential surfaces at 90°.

Hence, option (c) is the correct answer.

why this question? Tip: Electric line of forces represents the direction of trajectory for +ve charge in an electric field and is always tangential to $\vec{E}$ at any point.

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12. Electric potential in a region is varying according to the relation $V=\dfrac{3x^2}{2}-\dfrac{y^2}{4}$, where x and y are in meter and V is in volt. Electric field intensity in $\mathrm{N/C}$ at a point $(1\ \mathrm{m},\ 2\ \mathrm{m})$ is

A. $3\hat{i}-\hat{j}$

B. $-3\hat{i}+\hat{j}$

C. $6\hat{i}-2\hat{j}$

D. $-6\hat{i}+2\hat{j}$

Electric potential, $V=\dfrac{3x^2}{2}-\dfrac{y^2}{4}$

Relation between electric potential and electric field intensity is given by,

$$\vec{E}=-\left[\frac{\partial V}{\partial x}\hat{i}+\frac{\partial V}{\partial y}\hat{j}+\frac{\partial V}{\partial z}\hat{k}\right] \qquad \ldots.(1)$$

Now,

$$\frac{\partial V}{\partial x}=\frac{\partial\left(\frac{3x^2}{2}-\frac{y^2}{4}\right)}{\partial x}=3x$$

Similarly,

$$\frac{\partial V}{\partial y}=-\frac{y}{2} \text{ and } \frac{\partial V}{\partial z}=0$$

From (1) equation, we have

$$\vec{E}=-3x\hat{i}+\frac{y}{2}\hat{j}$$

At point $(1\ \mathrm{m}, 2\ \mathrm{m})$

$$\vec{E}=(-3\times 1)\hat{i}+\frac{2}{2}\hat{j}$$

$$\therefore \vec{E}=-3\hat{i}+\hat{j}$$

Hence, option (b) is the correct answer.

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13. A capacitor cannot be used as a battery because

- **A.** It cannot store a large amount of charge
- **B.** It produces too much heat
- **C.** It gets discharged very rapidly
- **D.** It is very costly as compared to a battery

A battery is similar to a tap providing a stream of water at a near constant rate for a prolonged period of time whereas a capacitor is like a bucket full of water. Capacitors release energy in a burst, providing a large amount of energy in a short duration of time, thus discharging very rapidly.

Key concept: Electrostatic energy stored in a capacitor is released promptly in a short interval of time.

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14. The phenomenon of 'outwards bending of electric field lines at the edges' of the plates of a capacitor is called

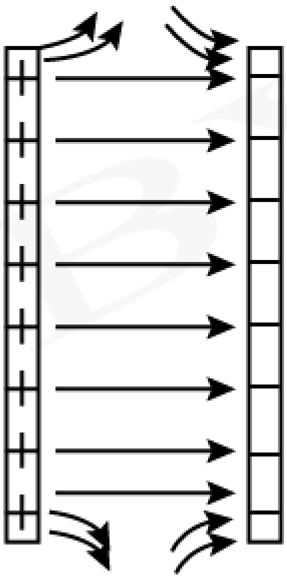
A. Polarization of induced charge

B. Induction of charges

C. Fringing of the field

D. Electric susceptibility

Although the electric field inside the region between the two plates of a capacitor placed very close to each other is uniform, at the edges bending of field lines occurs and slight variation of electric field intensity exists. This phenomenon is called 'fringing of the electric field'. For convenience, we tend to ignore this effect when dealing theoretically with capacitors.



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15. Two conductors of irregular shapes placed near each other are connected to the two terminals of a battery of $50 \mathrm{~V}$. It is observed that the charge on one of the conductors is $2 \mu \mathrm{C}$. The capacitance of this arrangement is

A. $2 \times 10^{-8} \mathrm{~F}$

B. $4 \times 10^{-8} \mathrm{~F}$

C. $10^{-8} \mathrm{~F}$

D. $4 \times 10^{-6} \mathrm{~F}$

Given:
$Q=2 \mu \mathrm{C}=2 \times 10^{-6} \mathrm{~C} ; \quad V=50 \mathrm{~V}$

An arrangement of two conductors of any shape and size kept close to each other is a capacitor. How effective the capacitor will be is decided by the capacitance of the combination.

Apply formula $Q=C V$, we get

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

$$\Rightarrow C=\frac{2 \times 10^{-6} \mathrm{~C}}{50 \mathrm{~V}}=4 \times 10^{-8} \mathrm{~F}$$

So, option (b) is right.

Key concept:- $Q=C V$ is an equation valid for any two conductors placed near to each other.

16. Three capacitors of capacitance $3\ \mu\mathrm{F},\ 10\ \mu\mathrm{F}$ and $15\ \mu\mathrm{F}$ are connected in series to a battery of $100\ \mathrm{V}$. The voltage across $10\ \mu\mathrm{F}$ is

A. 10 Volt

B. 20 Volt

C. 30 Volt

D. 40 Volt

In series combination, the equivalent capacitance is given by

$$\frac{1}{C_{eq}}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}$$

$$\Rightarrow \frac{1}{C_{eq}}=\frac{1}{3}+\frac{1}{10}+\frac{1}{15}=\frac{1}{2}$$

$$\Rightarrow C_{eq}=2\ \mu\mathrm{F}$$

Moreover, in a series combination, the charge on each capacitor is the same, which is the same as the charge on the equivalent capacitor.

Using $Q=CV$, we get

$$Q=2\ \mu\mathrm{F}\times 100\ \mathrm{V}=200\ \mu\mathrm{C}$$

Now we know that the charge on the $10\ \mu\mathrm{F}$ capacitor is $200\ \mu\mathrm{C}$.

Using $V=Q/C$, we get

$$V=\frac{200\ \mu\mathrm{C}}{10\ \mu\mathrm{F}}=20\ \mathrm{Volt}$$

Alternate:

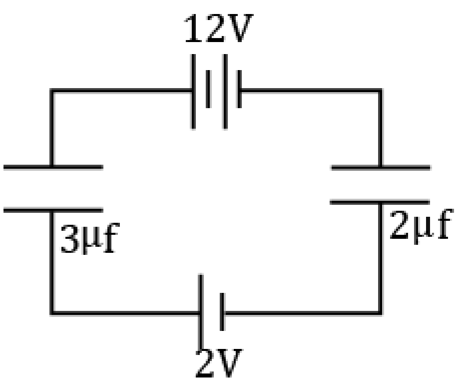
In a series combination, the charge on each capacitor is the same, which is the same as the charge on the equivalent capacitor.

$$Q=C_{eq}V_{eq}=C_2V_2$$

$$\Rightarrow V_2=\frac{C_{eq}V_{eq}}{C_2}=\frac{2\times 100}{10}=20\ \mathrm{V}$$

Hence, option (b) is correct.

17. For the circuit shown in the figure, the total energy stored in the capacitors is

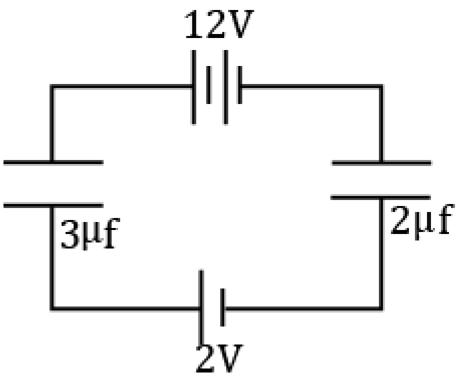


A. $120\ \mu J$

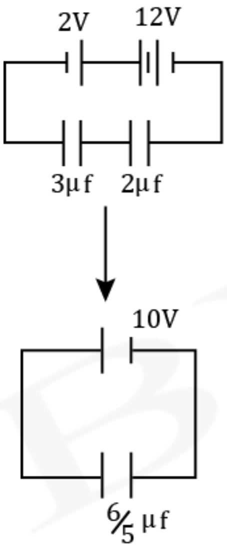
B. $30\ \mu J$

C. $60\ \mu J$

D. $20\ \mu J$



As you can observe, this is series arragement the circuit can be redrawn like this



$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{6}{5}\mu F$$

Energy stored in the capacitors is given by

$$U = \frac{1}{2} C_{eq} V^2 = \frac{1}{2} \times \frac{6}{5} \times 100$$

$$= 60\,J$$

18. Which of the following cannot be used as a dielectric in a capacitor ?

A. Paper

B. Glass

C. Copper

D. Oil

A dielectric is basically an insulator or a very poor conductor. Of the given options, copper is a metal, hence a conductor of electricity. It cannot be used to make a dielectric. Paper, glass and oil are insulators and can be used to make a dielectric.

The dielectric material is an insulator, so it's surface molecules become polarized by the electric field between the capacitor plates. This polarization acts to reduce the strength of the electric field between the plates for a given capacitor charge, which allows somewhat more charge to be deposited into the capacitor for a given voltage across the capacitor terminals.

Key concept- Metal as a dielectric medium.

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19. An air capacitor of capacity $10\ \mu\mathrm{F}$ is connected to a battery of $12\ \mathrm{V}$. Now the space between the plates is filled with a liquid of dielectric constant 5. The additional charge that flows to the capacitor is

A. $120\ \mu\mathrm{C}$

B. $600\ \mu\mathrm{C}$

C. $480\ \mu\mathrm{C}$

D. $24\ \mu\mathrm{C}$

Before the dielectric is inserted, charge on capacitor,

$Q = CV = 10 \times 12 = 120\ \mu\mathrm{C}$

After the dielectric is inserted with battery connected, new charge,

$Q' = KCV = 5 \times 120 = 600\ \mu\mathrm{C}$

The additional charge that flows to the capacitor is given by

$Q' - Q = 600 - 120 = 480\ \mu\mathrm{C}$

Hence, option (c) is correct.

Key concept: The capacitance increases by a factor K with the introduction of a dielectric material completely occupying the space between the plates.

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20. What will be the number of electrons passing through a heater wire in one minute, if it carries a current of $8\ \text{A}$?

A. 3×10^{21} ✓

B. 3×10^{28} ✗

C. 3×10^{30} ✗

D. 3×10^{12} ✗

If n number of electrons passes through a cross- section in t seconds then, total charge passing in t seconds will be ne.

And we know that

Current, $I = \frac{q}{t} = \frac{ne}{t}$

$\Rightarrow n = \frac{It}{e} = \frac{8 \times 60}{1.6 \times 10^{-19}}$

$\therefore n = 3 \times 10^{21}$ electrons

Hence, option (a) is correct.

Key takeaway - electric current through an area is the rate of transfer of charge from one side of the area to the other.

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21. Two wires , each of the radius r but of different materials are connected together end to end (in series). If the densities of charge carried in the two wires are in the ratio $1:4$, the drift velocity of electrons in the two wires will be in the ratio of.

A. $1:2$

B. $2:1$

C. $4:1$

D. $1:4$

If the wires are connected together end to end (in series), then current in them will be same, which is given by,

$$i = neAv_d$$

Where,
$n \rightarrow$Number of electrons per unit volume (Number density),
$e \rightarrow$Charge of an electron$= 1.6 \times 10^{-19}\mathrm{C}$,
$A \rightarrow$Area of cross section,
$v_d =$Drift velocity.

As current and area are same then

$$n_1 eAv_{d_1} = n_2 eAv_{d_2}$$

$$\Rightarrow \frac{v_{d_1}}{v_{d_2}} = \frac{n_2}{n_1}$$

Given, charge density, $\frac{n_1}{n_2} = \frac{1}{4}$

So,
$$\frac{v_{d_1}}{v_{d_2}} = \frac{4}{1}$$

Hence, option (c) is the correct answer.

Why this question?
If two wires are connected in series connection,then current in them will be same.

Key Formula:
If electrons are moving with velocity v_d, A is area of cross section and n is number of free electrons per unit volume then,

$$i = neAv_d$$

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22. Across a conductor of length $40 \mathrm{~cm}$, a potential difference of $10 \mathrm{~V}$ is maintained. The mobility of electrons if the drift velocity of electrons is $5 \times 10^{-6} \mathrm{~m} / \mathrm{s}$ is

A. $2 \times 10^{-7} \mathrm{~m}^2 / \mathrm{Vs}$

B. $1 \times 10^{-7} \mathrm{~m}^2 / \mathrm{Vs}$

C. $4 \times 10^{-6} \mathrm{~m}^2 / \mathrm{Vs}$

D. $0.5 \times 10^{-7} \mathrm{~m}^2 / \mathrm{Vs}$

Given:
$v_d=5 \times 10^{-6} \mathrm{~m} / \mathrm{s}$;
$V=10 \mathrm{~V}$; $l=40 \mathrm{~cm}=0.4 \mathrm{~m}$

From definition of mobility,

$$\mu=\frac{v_d}{E}$$

$$\Rightarrow \mu=\frac{v_d l}{V} \quad (\because E=V / l)$$

putting the value

$$\Rightarrow \mu=\frac{5 \times 10^{-6} \times 0.4}{10}$$

$$\therefore \mu=2 \times 10^{-7} \mathrm{~m}^2 / \mathrm{Vs}$$

Hence, option (a) is correct

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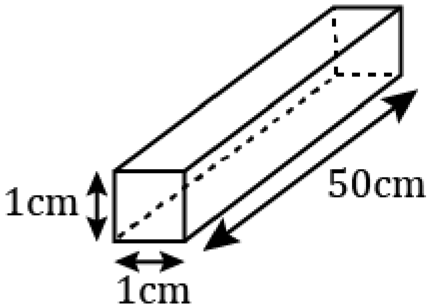
23. A rectangular carbon block has dimension $1.0 \text{ cm} \times 1.0 \text{ cm} \times 50 \text{ cm}$. Resistances are measured, first across two square ends and then across two rectangular ends, respectively. If resistivity of carbon is $3.5 \times 10^{-5}\ \Omega\text{m}$, then values of measured resistances respectively are:



- A. $\frac{35}{2} \times 10^{-2}\ \Omega,\ 7 \times 10^{-5}\ \Omega$ ✔
- B. $7 \times 10^{-5}\ \Omega,\ \frac{15}{2} \times 10^{-2}\ \Omega$ ✖
- C. $\frac{35}{2} \times 10^{-4}\ \Omega,\ 7 \times 10^{-7}\ \Omega$ ✖
- D. $\frac{15}{2}\ \Omega,\ 7 \times 10^{-2}\ \Omega$ ✖

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Given:
$\rho = 3.5 \times 10^{-5}\ \Omega\text{m}$

By formula of resistance

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

For square ends,

$$A = 1\ \text{cm}^2; \quad l = 50\ \text{cm}$$

$$R_{square} = \frac{3.5 \times 10^{-5} \times 50 \times 10^{-2}}{(10^{-2})^2}$$

$$\Rightarrow R_{square} = \frac{35}{2} \times 10^{-2}\ \Omega$$

For rectangular ends,

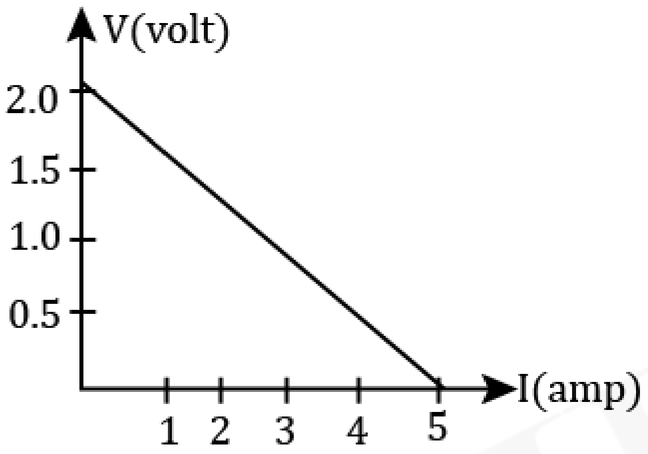
$$A = 50\ \text{cm}^2; \quad l = 1\ \text{cm}$$

$$R_{rectangle} = \frac{3.5 \times 10^{-5} \times [1 \times 10^{-2}]}{(50 \times 10^{-4})}$$

$$\Rightarrow R_{rectangle} = 7 \times 10^{-5}\ \Omega$$

Hence, option (a) is correct.

24. For a cell, a graph is plotted between the potential difference V across the terminals of the cell and the current I drawn from the cell (figure). The emf and the internal resistance of the cell are E and r respectively. Then



A. $E = 2\ \mathrm{V},\ r = 0.5\ \Omega$

B. $E = 2\ \mathrm{V},\ r = 0.4\ \Omega$

C. $E > 2\ \mathrm{V},\ r = 0.5\ \Omega$

D. $E > 2\ \mathrm{V},\ r = 0.4\ \Omega$

When current is drawn from the cell, potential difference across the terminals of it is given as: $V = E - Ir$

When $I = 0$, the potential reading is $2\ \mathrm{V}$. Hence emf, $E = 2\ \mathrm{V}$

When $V = 0$, the current is $I = 5\ \mathrm{A}$

Using, $V = E - Ir$

$\Rightarrow 0 = 2 - 5r$

This gives $r = 0.4\ \Omega$

Alternate method:
Slope of the $V - I$ graph gives us the resistance.

Slope $= \tan\theta = \dfrac{2}{5} = 0.4\ \Omega$

25. How much work is required to carry a $6\ \mu\mathrm{C}$ charge from the negative terminal of a $9\ \mathrm{V}$ cell to the positive terminal?

A. $54 \times 10^{-3}\ \mathrm{J}$

B. $54 \times 10^{-9}\ \mathrm{J}$

C. $54 \times 10^{-6}\ \mathrm{J}$

D. $54 \times 10^{-12}\ \mathrm{J}$

E.M.F of the cell is $9\ \mathrm{V}$.

From the definition of E.M.F of cell,

$$\mathcal{E} = \frac{W}{q}$$

Where W is work done by the cell in taking the $+ve$ charge from one terminal to the other.

$$\Rightarrow 9\ \mathrm{V} = \frac{W}{6\ \mu\mathrm{C}}$$

$$\Rightarrow W = 9 \times 6 = 54\ \mu\mathrm{J}$$

$$\therefore W = 54 \times 10^{-6}\ \mathrm{J}$$

Hence, option (c) is the correct.

Why this question?
Emf of the cell is the work done by cell in moving a unit positive charge in closed circuit i.e, from its one terminal to the another one.

BYJU'S Part Test for Board Term I (CBSE Grade 12)

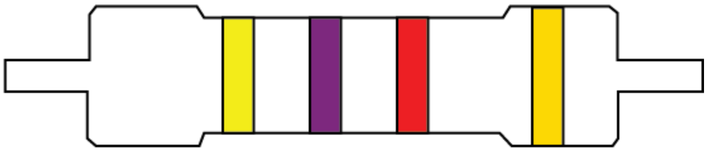
Date: 17/11/2021

Subject: Physics

Topic : Section B

Class: Standard XII

1. What is the resistance of this 4 strip resistor ?



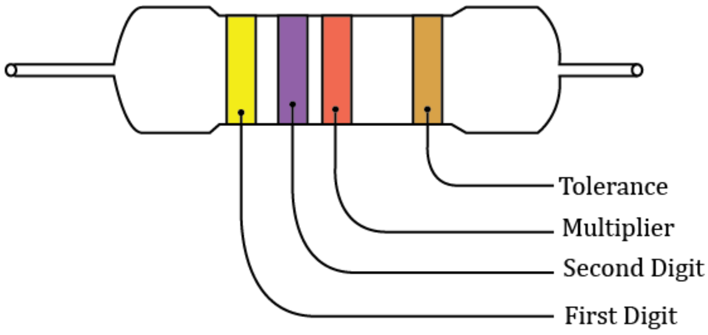
Colour are in order- Yellow, violet, red, golden.

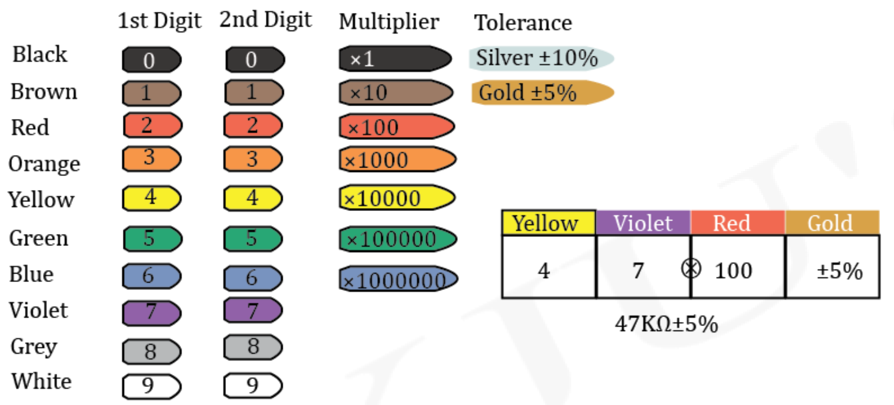
A. $[4.7 \pm 5\%]\ \mathrm{k}\Omega$

B. $[3.6 \pm 5\%]\ \mathrm{k}\Omega$

C. $[4.7 \pm 10\%]\ \mathrm{k}\Omega$

D. $[3.6 \pm 10\%]\ \mathrm{k}\Omega$





From above data, we get

First digit$= 4$; Second digit$= 7$; Multiplier$= 100$

Tolerance $= \pm 5\%$

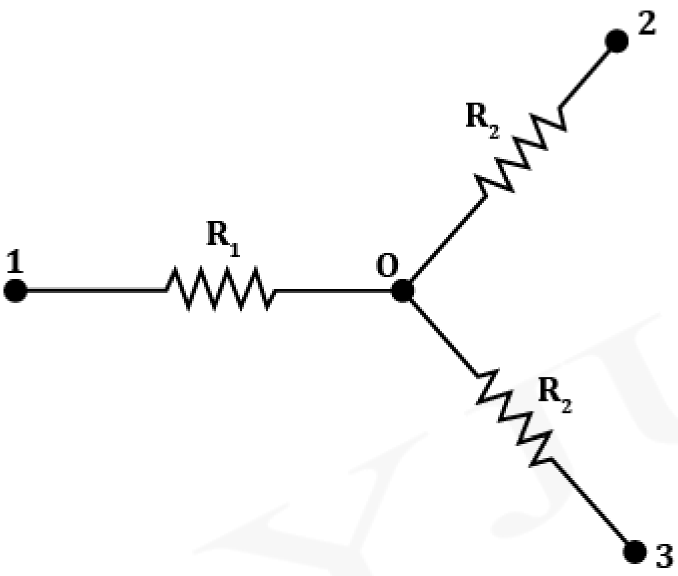
The resistance R of given carbon resistor is given as

$R = 47 \times 10^2 \pm 5\%$

$\Rightarrow R = [4.7 \pm 5\%]\ \text{k}\Omega$

Hence, option (a) is correct.

2. Find the current flowing through the resistance R_1 of the circuit shown in figure, if the resistances are equal to $R_1 = 10\ \Omega$, $R_2 = 10\ \Omega$ and $R_3 = 10\ \Omega$, and the potential of points $1,\ 2$ and 3 are equal to $V_1 = 10\ \mathrm{V}$, $V_2 = 6\ \mathrm{V}$ and $V_3 = 5\ \mathrm{V}$.



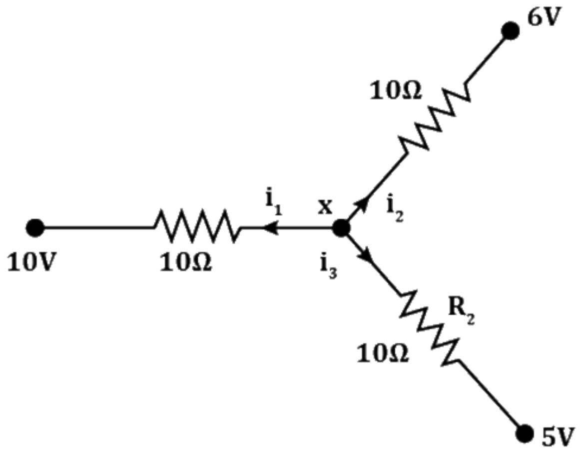
A. $0.1\ \mathrm{A}$

B. $0.2\ \mathrm{A}$

C. $0.3\ \mathrm{A}$ ✔

D. $0.4\ \mathrm{A}$

BYJU'S Part Test for Board Term I (CBSE Grade 12)



Assume potential at the junction to be x and apply KCL.

$i_1 + i_2 + i_3 = 0$

$$\Rightarrow \frac{x-10}{10} + \frac{x-6}{10} + \frac{x-5}{10} = 0$$

$\Rightarrow x = 7\text{ V}$

So,

$$i_1 = \frac{x-10}{10} = \frac{7-10}{10} = -0.3\text{ A}$$

So, the direction of current will be opposite to the assumption.

Therefore, option (c) is correct.

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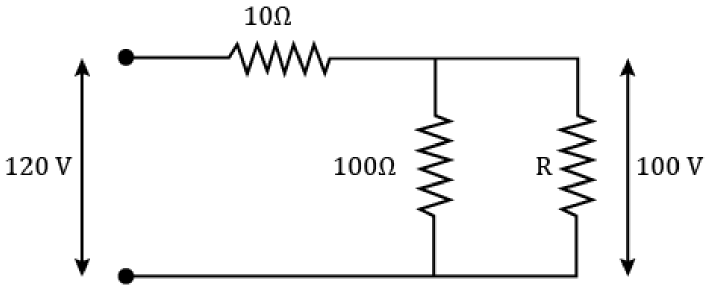
3. Find out the value of resistance R in figure.

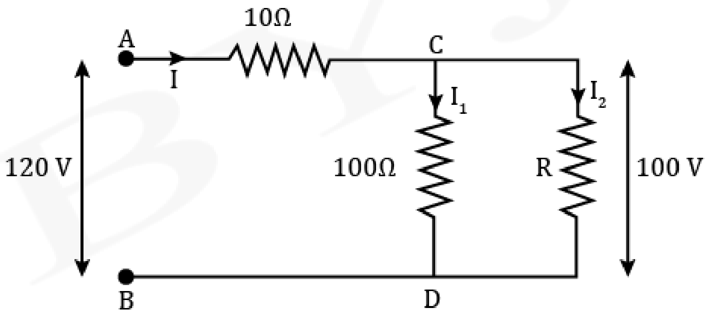


A. $100\ \Omega$ ✔

B. $200\ \Omega$

C. $500\ \Omega$

D. $150\ \Omega$



From the figure, we can see that potential difference across C and D is $100\ \mathrm{V}$.

Hence, $I_1 = \dfrac{100}{100} = 1\ \mathrm{A}$

$V_{AC} = 120 - 100 = 20\ \mathrm{V}$

Also, $I = \dfrac{20}{10} = 2\ \mathrm{A}$

Hence, $I_2 = 2 - 1 = 1\ \mathrm{A}$

$\therefore R = \dfrac{V}{I} = \dfrac{100}{1} = 100\ \Omega$

Hence, option (a) is correct.

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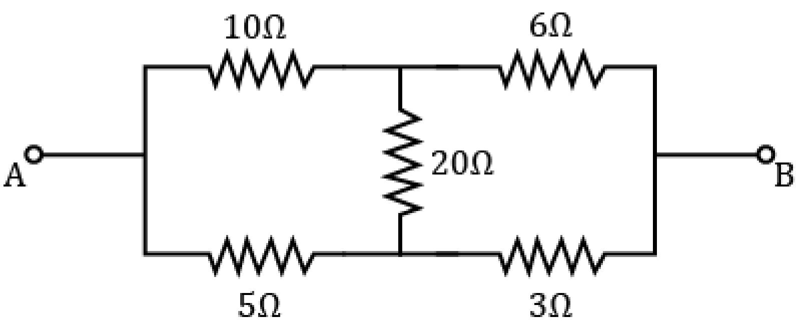
4. Find equivalent resistance of the circuit between the terminal A and B.



A. $\frac{4}{3}\Omega$

B. $\frac{8}{3}\Omega$

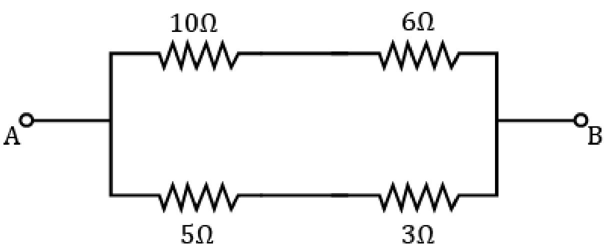
C. $\frac{16}{3}\Omega$

D. $\frac{32}{3}\Omega$

The given circuit is wheat stone bridge and it is in balance condition.

$$\because \frac{10}{5} = \frac{6}{3}$$

Current through $20\ \Omega$ will not flow, so this can be discarded from the circuit.



Resistances $10\ \Omega$ and $6\ \Omega$ are in series and also $5\ \Omega$ and $3\ \Omega$ are in series.

Hence this is equivalent to

$$R_{eq} = \frac{16 \times 8}{16 + 8} = \frac{16}{3}\Omega$$

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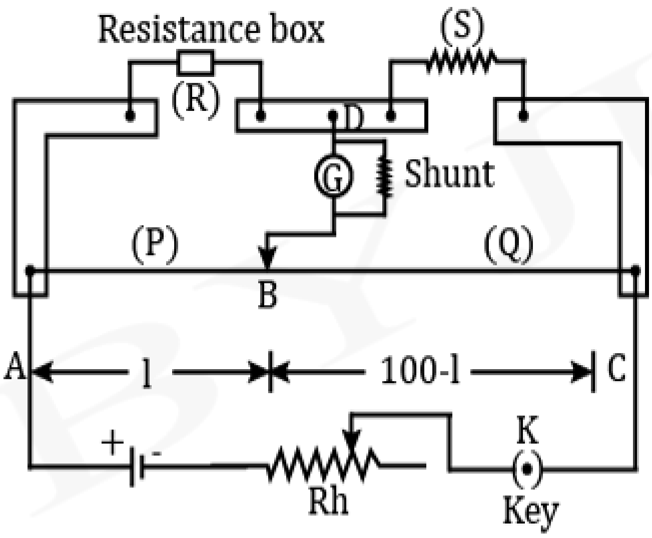
5. In a meter bridge experiment, the value of unknown resistance is 2Ω. To get the balancing point at 40 cm distance from the same end, then what will be the resistance in the resistance box?

- A. $3\ \Omega$ ✔
- B. $6\ \Omega$
- C. $8\ \Omega$
- D. $9\ \Omega$



From above diagram, given data is
$S = 2\ \Omega;\quad 100 - l = 40 \text{ cm}$

Apply condition for balanced meter bridge,

$$\frac{R}{l} = \frac{S}{100 - l}$$

$$\frac{R}{60} = \frac{2}{40}$$

$$\therefore R = 3\ \Omega$$

Hence, option (a) is correct.

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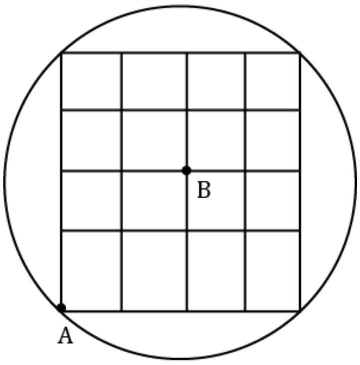
6. A finite square grid with each link having resistance r is fitted in a resistanceless conducting circular wire. The equivalent resistance between A and B will be:
(Given, $r = 80/7\ \Omega$)



A. $6\ \Omega$

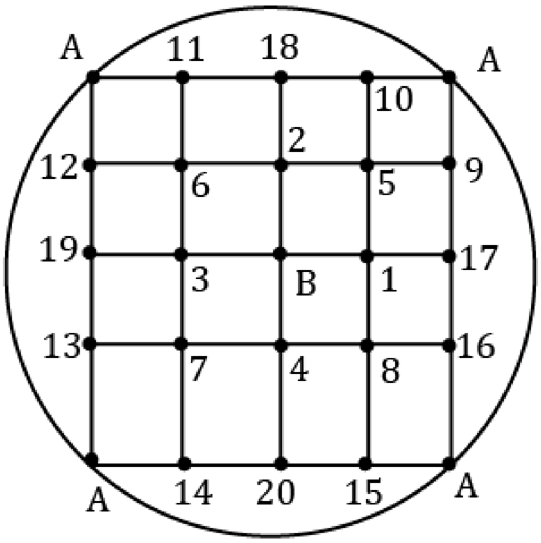
B. $8\ \Omega$

C. $12\ \Omega$

D. $15\ \Omega$

The circular wire is a resistance less conducting wire, hence all points lying on it will have the same potential.

Also, the square grid have symmetric arrangements of component segments (links) with respect to point A and B, thus all points at symmetric/equivalent position w.r.t A and B will have same electric potential.



We can observe from above diagram that points $(9, 10), (11, 12), (13, 14)$ &

$(15, 16)$ are at equivalent or identical position w.r.t A.

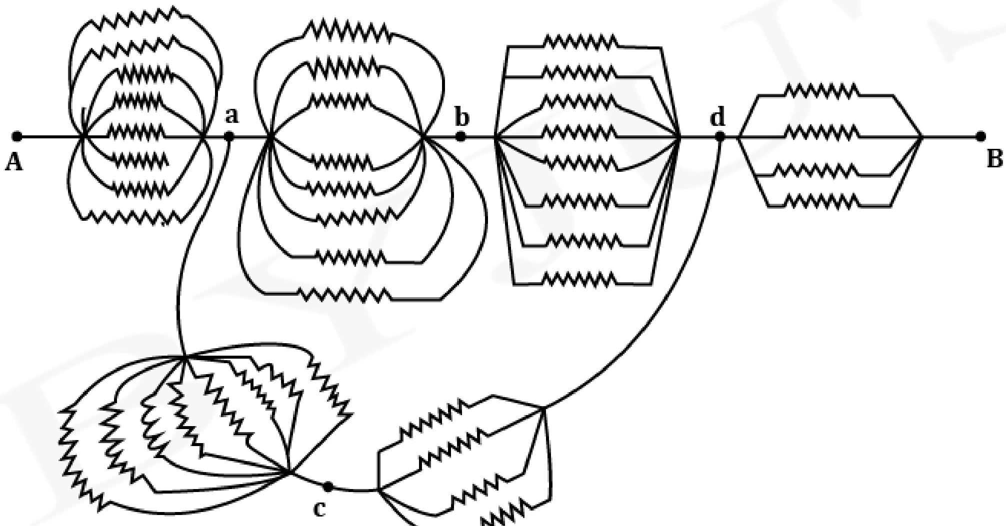
Hence, $(9, 10, 11, 12, 13, 14, 15, 16)$ will have same potential.

Similarly, points $(5, 6, 7, 8)$ are at identical position w.r.t B. Hence, they will be at same potential.

Also points $(1, 2, 3, 4)$ will be at same potential, as they are at symmetric position w.r.t B.

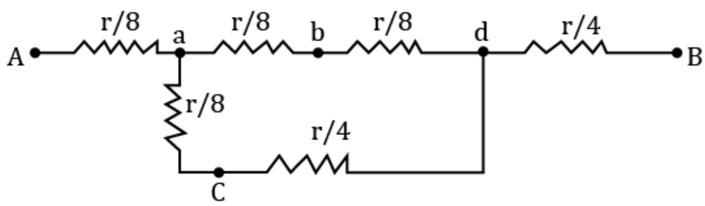
Again points $(17, 18, 19, 20)$ being at symmetrical location w.r.t B will have same potential.

Now redrawing the circuit with each segment having resistance r.



Here $a \rightarrow (9, 10, 11, 12, 13, 14, 15, 16)$
$b \rightarrow (5, 6, 7, 8)$
$c \rightarrow (17, 18, 19, 20)$
$d \rightarrow (1, 2, 3, 4)$

We can just count the number of respective resistance connected between these points and redrawing the circuit with effective resistance.



The equivalent resistance R_{eq} between A and B will be

$$R_{eq} = \frac{r}{8} + \frac{(3r/8)(r/4)}{(3r/8) + (r/4)} + \frac{r}{4}$$

$$\Rightarrow R_{eq} = \frac{r}{8} + \frac{3r}{20} + \frac{r}{4}$$

$$\Rightarrow R_{eq} = \frac{21r}{40} = \frac{21}{40} \times \frac{80}{7} \quad (\because r = 80/7\ \Omega)$$

$$\therefore R_{eq} = 6\ \Omega$$

Hence, option (a) is correct.

Why this question ?
It intends to challenge the identification of points located at symmetric or equivalent position in a complex geometric pattern and offers a lot of learning !!!

Tip: Point B in the grid is a central point, and due to conducting circular wire circumscribing grid, the corner points become equivalent to point A. Thus whole grid can be simplified by observing equipotential points.

7. In Oersted's experiment, deflection in magnetic needle

- **A.** decreases if current is increased in the wire
- **B.** reverses if current is reversed in the wire
- **C.** remains constant if current is increased
- **D.** All above statements are true

In Oersted's experiment,

1. Deflection in the magnetic needle decreases when the current through the wire is decreased and vice versa.

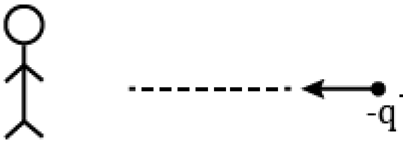
2. If the direction of current is reversed in the wire, the deflection in magnetic needle also reverses.

Based on these observations, Oersted concluded that moving charges or current produce a magnetic field in surrounding space.

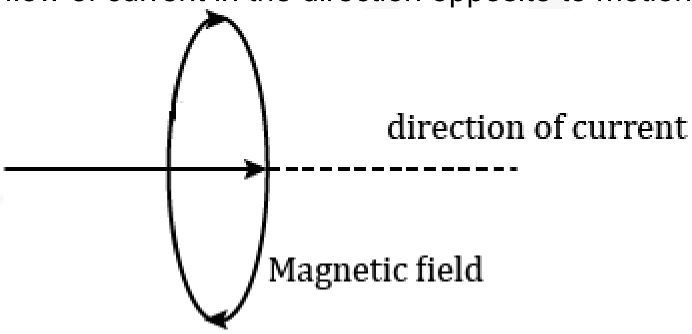
So, option (b) is correct.

8. A negative charge is coming towards an observer. The direction of the magnetic field produced by it will be: (As seen by observer)

- ✔ **A.** Clockwise
- ✘ **B.** Anticlockwise
- ✘ **C.** In the direction of motion of charge
- ✘ **D.** In the direction opposite to motion of charge



The motion of -ve charge can be visualized as flow of current in the direction opposite to motion of charge.



Thus according to right hand thumb rule, the direction of magnetic field is in clockwise direction.

Why this question? Tip: Right hand thumb states that if we place the thumb pointing in direction of current, the direction of curl will give the direction of magnetic field.

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9. A particle carrying charge equal to 100 times the charge of an electron is performing one rotation per second in a circular path of radius $0.8\ \mathrm{m}$. The value of magnetic field produced at the centre will be
($\mu_0 =$ permeability for vaccum)

A. $\dfrac{10^{-7}}{\mu_0}\mathrm{T}$

B. $10^{-17}\mu_0\ \mathrm{T}$ ✔

C. $10^{-6}\mu_0\ \mathrm{T}$

D. $10^{-16}\mu_0\ \mathrm{T}$

As the charge is performing one rotation per second, so comparing this with an equivalent current in a circular wire,

$$i = \frac{q}{t} = \frac{100 \times e}{1}$$

$$i = 100 \times 1.6 \times 10^{-19}\ \mathrm{A}$$

Now the magnetic field due to the loop at the centre is,

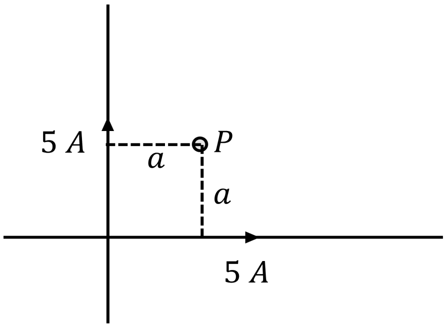
$$B = \frac{\mu_0 i}{2R} = \frac{\mu_0 \times 100 \times 1.6 \times 10^{-19}}{2 \times 0.8}$$

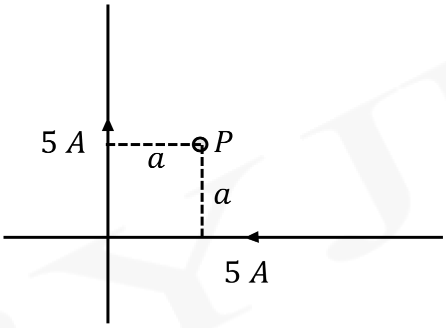
$$= 10^{-17}\mu_0\ \mathrm{T}$$

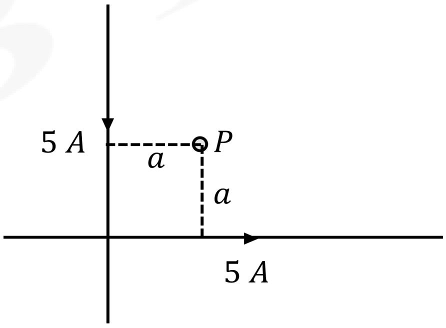
Hence, option (b) is correct.

BYJU'S Part Test for Board Term I (CBSE Grade 12)

10. Two infinitely long wires carrying currents of $5\ \mathrm{A}$ each are shown in the options. For which of the following figures, the value of magnetic field at point $P(a, a)$ is zero?

A. 

B. 

C. 

D. None of these

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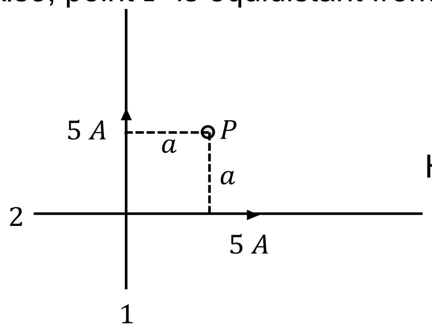
Using right-hand thumb rule, we can see that, magnetic field at P due to wire 1 will be inward and due to wire 2 will be outward.

Also, point P is equidistant from both the wires.



Hence, magnetic field $\left(B = \frac{\mu_o I}{2\pi a}\right)$ due to both wires will cancel each other at point P as the same current flows through the wires and the point is equidistant from the wires.

Therefore, net magnetic field will be zero at point P.

So, option a is correct.

Why this Question ?
This question will help the students to properly recall the application of Right-hand curl rule.

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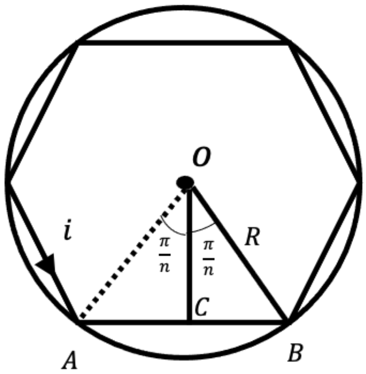
11. A current i flows in a thin wire in the shape of a regular polygon with n sides. what will be the magnetic field at the centre of polygon? [R is the circum-radius of the polygon]

   A. $\frac{\mu_0 n i}{2\pi R}\tan\frac{\pi}{6}$

   B. $\frac{\mu_0 n i}{2\pi R}\tan\left(\frac{\pi}{n}\right)$

   C. $\frac{\mu_0 i}{2 n R}$

   D. Zero



For $n-$ sided polygon $\angle AOB = \frac{2\pi}{n}$

Perpendicular distance $\mathrm{OC} = R\ cos\frac{\pi}{n}$

Now, Magnetic field due to wire AB is given by,

$$B = \frac{\mu_0 i}{4\pi d}(sin\theta_1 + sin\theta_2)$$

$$B = \frac{\mu_0 i}{4\pi\ Rcos\frac{\pi}{n}} 2\ sin\frac{\pi}{n} \quad (\because d = Rcos\frac{\pi}{n}, \theta_1 = \theta_2 = \frac{\pi}{n})$$

B due to all the wires at the centre O points perpendicular to the plane and outwards.

So, $B_{net} = nB$

$$B_{net} = \frac{\mu_0 ni}{4\pi\ Rcos\frac{\pi}{n}} 2sin\frac{\pi}{n}$$

$$B_{net} = \frac{\mu_0 ni}{2\pi R} tan\frac{\pi}{n}$$

Hence, option (b) is the correct answer.

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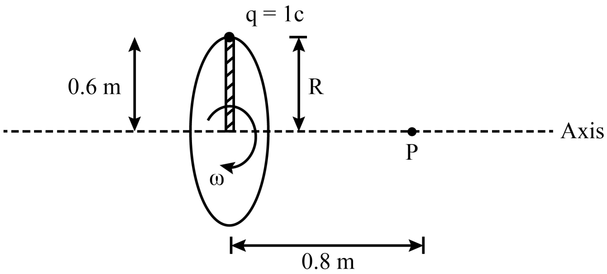
12. A charge of $1\ \mathrm{C}$ is placed at one end of a non-conducting rod of length $0.6\ \mathrm{m}$. The rod is rotated in a vertical plane about a horizontal axis passing through the other end of the rod with angular frequency $10^4\pi\ \mathrm{rad/s}$. The magnetic field at a point on the axis of rotation at a distance $0.8\ \mathrm{m}$ from centre of the circular path will be:

    A. $1.13 \times 10^{-3}\ \mathrm{T}$

    B. $2.44 \times 10^{-3}\ \mathrm{T}$

    C. $1.75 \times 10^{-3}\ \mathrm{T}$

    D. $3.25 \times 10^{-3}\ \mathrm{T}$



The rotation of the rod will lead to an equivalent current in the circular path, because the charge q will pass through any point on the circle after a time interval of one time period (T).

$$\therefore i = \frac{q}{T} = qf$$

$$i = q \times \left(\frac{\omega}{2\pi}\right) = 1 \times \left(\frac{10^4\,\pi}{2\pi}\right)$$

$$i = 5 \times 10^3 \text{ A}$$

The magnetic field at point P due to equivalent current carrying circular loop at axis will be.

$$B_P = \frac{\mu_0 i R^2}{2(R^2 + x^2)^{3/2}}$$

Here, $R = 0.96 \text{ m};\ x = 0.8 \text{ m};\ i = 5 \times 10^3 \text{ A}$

$$B_P = \frac{4\pi \times 10^{-7} \times (5 \times 10^3) \times (0.6)^2}{2[(0.6)^2 + (0.8)^2]^{3/2}}$$

$$B_P = \frac{4\pi \times 10^{-7} \times 5 \times 10^3 \times 36 \times 10^{-2}}{2 \times (1)^{3/2}}$$

$$\therefore B_p = 1.13 \times 10^{-3} \text{ T}$$

Why this Question ?
Tip: The pivoted end of the rod serves as the centre of the circular path in which charge q is rotating.

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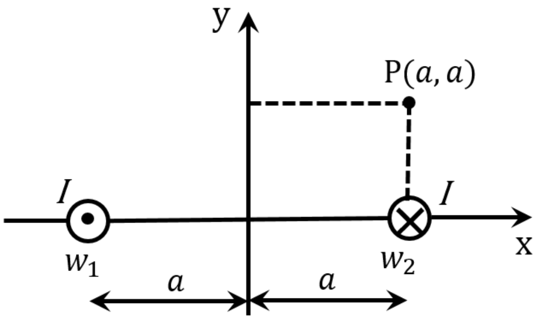
13. In the figure shown, two long wires w_1 and w_2, each carrying current I are placed parallel to each other and parallel to z- axis. The direction of current in w_1 and w_2 is perpendicularly outward and inward to the plane respectively. The $\vec{B}$ at point P will be given as:



A. $\vec{B}=\frac{2\mu_0 I}{5\pi a}\hat{i}+\frac{\mu_0 I}{5\pi a}\hat{j}$

B. $\vec{B}=\frac{\mu_0 I}{2\pi a}\hat{i}-\frac{\mu_0 I}{5\pi a}\hat{j}$

C. $\vec{B}=\frac{2\mu_0 I}{5\pi a}\hat{j}$

D. $\vec{B}=\frac{\mu_0 I}{5\pi a}\hat{i}-\frac{\mu_0 I}{5\pi a}\hat{j}$

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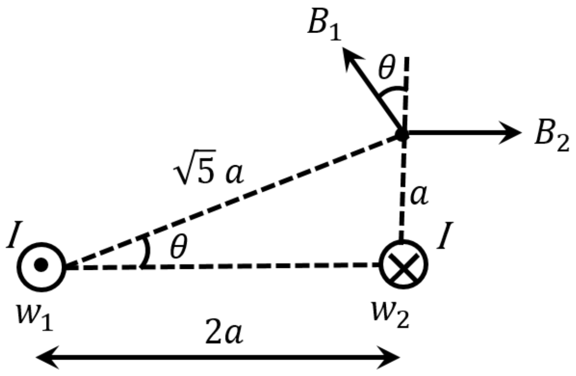
By using right- hand thumb rule we can find the direction of $\vec{B}$ at point P due to both wires.



From geometry,

$$\sin\theta = \frac{a}{\sqrt{5}a} = \frac{1}{\sqrt{5}} \text{ and } \cos\theta = \frac{2a}{\sqrt{5}a} = \frac{2}{\sqrt{5}}$$

The magnetic field due to infinite wire is given by

$$B = \frac{\mu_0 I}{2\pi d}$$

For wire w_2, perpendicular distance from point P is $d_2 = a$

And for wire w_1, perpendicular distance from point P is $d_1 = \sqrt{4a^2 + a^2} = \sqrt{5}a$

So,

$$B_1 = \frac{\mu_0 I_1}{2\pi d_1} = \frac{\mu_0 I}{2\sqrt{5}\pi a}$$

And, $B_2 = \dfrac{\mu_0 I_2}{2\pi d_2} = \dfrac{\mu_0 I}{2\pi a}$

So, the net magnetic field at point P due to both wires will be

$$\vec{B}_{net} = \vec{B}_1 + \vec{B}_2$$

$$\vec{B}_{net} = -B_1 \sin\theta\, \hat{i} + B_1 \cos\theta\, \hat{j} + B_2\, \hat{i}$$

putting the value of given data,

$$\vec{B}_{net} = -\frac{\mu_0 I}{2\sqrt{5}\pi a}\frac{1}{\sqrt{5}}\hat{i} + \frac{\mu_0 I}{2\sqrt{5}\pi a}\frac{2}{\sqrt{5}}\hat{j} + \frac{\mu_0 I}{2\pi a}\hat{i}$$

$$\therefore \vec{B}_{net} = \frac{2\mu_0 I}{5\pi a}\hat{i} + \frac{\mu_0 I}{5\pi a}\hat{j}$$

Hence, option (a) is correct.

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14. An α particle is moving along a circle of radius R with a constant angular velocity ω. Point A lies in the same plane at a distance $2R$ from the centre, and it records magnetic field produced by α particle. If the minimum time interval between two successive times at which A records zero magnetic field is t, the angular velocity ω is:

A. $\frac{2\pi}{t}$

B. $\frac{2\pi}{3t}$

C. $\frac{\pi}{3t}$

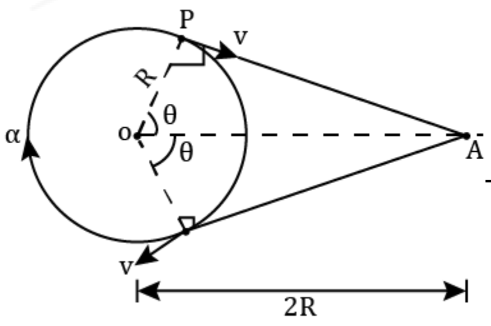
D. $\frac{\pi}{t}$

We can assume α particle to be a current element in the circular path.

From Biot- Savart law,

$$\overrightarrow{dB} = \frac{\mu_0 i(\overrightarrow{dl} \times \overrightarrow{r})}{4\pi r^2}$$

Here $\overrightarrow{dl}$ is in the direction of current i.e along the direction of velocity of $\alpha-$ particle at any position in the circular path.



The value of magnetic field will be zero

when

$$\overrightarrow{dl} \times \overrightarrow{r} = 0$$

Thus, the condition for $\overrightarrow{dl} \times \overrightarrow{r} = 0$ is achieved when velocity of $\alpha-$ particle is parallel or antiparallel to the direction of position vector $(\overrightarrow{r})$, as shown in figure at P and Q.

At P and Q two tangents can be drawn from point A.

From geometry,

$$\cos\theta = \frac{R}{2R} = \frac{1}{2}$$

$$\therefore \theta = 60^\circ$$

Since, arc PQ subtends angle 120° at centre, so time taken by $\alpha-$ particle to reach from P to Q is :

$$t = \frac{\Delta\theta}{\omega} = \frac{\left(\frac{2\pi}{3}\right)}{\omega}$$

$$\therefore \omega = \frac{2\pi}{3t}$$

Hence, option (b) is correct.

Why this question?
Tip: Focus on the direction of $\overrightarrow{dl}$ and then use Biot- Savart law to obtain the condition when magnetic field $\overrightarrow{dB}$ will become zero.

15. A long straight wire of radius a carries a steady current I. The current is uniformly distributed across its cross-section. The ratio of the magnetic field at distance $\frac{a}{2}$ and $2a$ from axis of wire is

A. $\frac{1}{2}$

B. $\frac{1}{4}$

C. 4

D. 1

Here, current is uniformly distributed across the cross-section of the wire, thus current per unit cross-sectional area is

$$\frac{i}{A} = \frac{I}{\pi a^2}$$

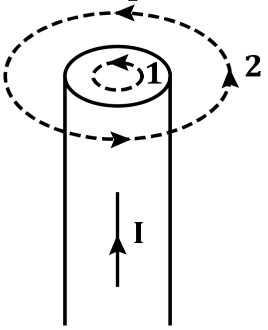
Case 1: B at a distance $r = \frac{a}{2}$

The current enclosed by loop 1 is,

$$\Rightarrow i_1 = \frac{i}{A} \times \pi \left(\frac{a}{2}\right)^2$$

or, $i_1 = \frac{I}{\pi a^2} \times \frac{\pi a^2}{4}$

or, $i_1 = \frac{I}{4}$



Using Ampere circuital law on loop 1 we have,

$$\oint \overrightarrow{B_1} . \overrightarrow{dl} = \mu_0 I_{en}$$

$$B_1 \oint dl = \mu_0 \frac{I}{4} \qquad (\because \theta = 0, I_{enc} = \frac{I}{4})$$

$$\Rightarrow B_1\left(2\pi\frac{a}{2}\right)=\mu_0\left(\frac{I}{4}\right)$$

or, $B_1=\dfrac{\mu_0 I}{4\pi a}$

Case 2: B at a distance $r=\dfrac{a}{2}$

Similarly, for loop $2,\ r=2a$

$$\oint \overrightarrow{B_2}.\vec{dl}=\mu_0 I_{en}$$

$$B_2(2\pi\times 2a)=\mu_0 I\quad (\because I_{en}=I)$$

$$B_2=\frac{\mu_0 I}{4\pi a}$$

$$\therefore \frac{B_1}{B_2}=1$$

Why this Question ?
Key point- Magnetic field calculation with the help of Ampere circuital law is easily possible only under highly symmetric conditions.
Ampere circuital law is given by,

$$\oint \vec{B}.\vec{dl}=\mu_0 I_{en}$$

BYJU'S Part Test for Board Term I (CBSE Grade 12)

16. Determine the amount of current flowing through the solenoid having 5000 turns per unit length, if the magnetic field at the edge of the solenoid is $2.2\pi \times 10^{-5}$ T.

A. 0.02 A

B. 0.2 A

C. 0.002 A

D. 2 A

Given:
$n = 5000; \quad B = 2.2\pi \times 10^{-5}$ T

We know that, magnetic field at the edge of the solenoid is given by

$$B = \frac{\mu_0 ni}{2}$$

$$\therefore i = \frac{2B}{\mu_0 n} = \frac{2 \times 2.2\pi \times 10^{-5}}{4\pi \times 10^{-7} \times 5000}$$

$$i = \frac{1.1 \times 10^{-5}}{5 \times 10^{-4}} = \frac{1.1 \times 10^{-1}}{5}$$

$$\therefore i = \frac{0.11}{5} = 0.02 \text{ A}$$

Hence, option (a) is correct.

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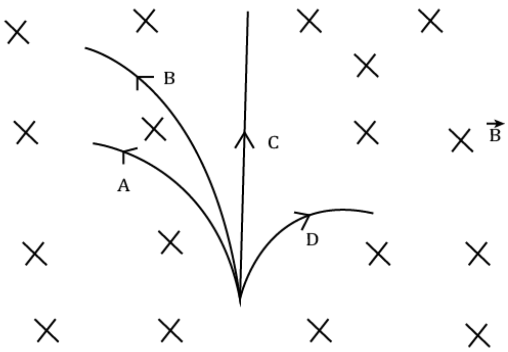
17. A neutron, a proton, an electron and an α particle enter a region of constant magnetic field with equal velocity. The $\vec{B}$ is along the perpendicularly inward to the plane of the paper. The path followed by each particle is shown in the figure.



The path followed by α particle is represented by:

A. B

B. A

C. D

D. C

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The charge on the neutron, $q_n = 0$

From relation,

$$\vec{F} = q(\vec{V} \times \vec{B})$$

$$F_n = 0$$

Hence, it will go undeviated, represented by path C.

And we know that electron has negative charge so it will follow path D opposite to A & B.

Now rest of the charged particle will move on a circular path, whose radius is;

$$r = \frac{mv}{qB}$$

For same value of V and B as mention in question,

$$r \propto \frac{m}{q} \; \ldots .(1)$$

$$\because m_\alpha = 4m_p; \;\; q_\alpha = 2q_p$$

$$\frac{r_\alpha}{r_p} = \frac{m_\alpha \; q_p}{q_\alpha \; m_p} = \frac{4m_p \; q_p}{2q_p \; m_p} = 2$$

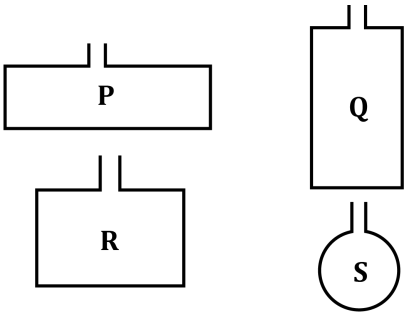
$$\therefore r_\alpha > r_p$$

Both of these positive charge will move/deviate in the same sense.
Hence, path A and B represent moment of proton and α particle.

$$\because r_B > r_A$$

Therefore, B represents path of αparticle.

18. Four wires of equal lengths are bent in the shapes of four loops $\mathrm{P}, \mathrm{Q}, \mathrm{R}$ and S as shown in the figure. If each loop carries same current I in the same sense, which loop will have highest magnetic moment ?



A. P

B. Q

C. R

D. S

For a current carrying loop:

$$\overrightarrow{M} = NI\overrightarrow{A}$$

For all loops, N and I are the same. So, the loop having the largest area will have the highest magnetic moment.

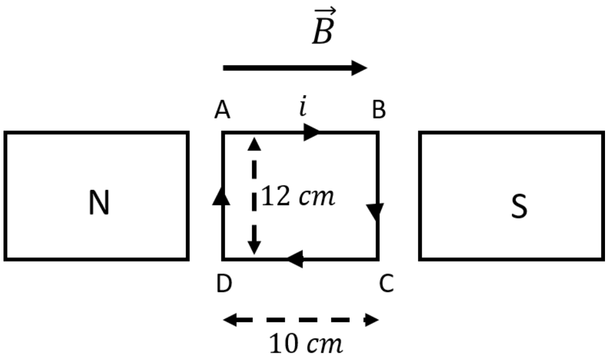
As each loop is made of wires having equal lengths, so the perimeter of each loop will be same.

For the same perimeter, circle has the largest area.

Hence, loop S will have the highest magnetic moment.

Hence, option (D) is the correct answer.

19. A coil of 50 turns is placed in a magnetic field of magnitude $B = 0.25$ Weber as shown in figure. A current of 2 A is flowing in the coil. The torque acting on the coil will be:



A. 0.15 N

B. 0.30 N

C. 0.45 N

D. 0.60 N

Using Right-hand thumb rule the direction of area vector $\vec{A}$ is perpendicular to the magnetic field.

The magnetic moment $\vec{M}$ is perpendicular to $\vec{B}$

$\Rightarrow \theta = 90^o$

Torque on the coil will be,

$\vec{\tau} = \vec{M} \times \vec{B}$

or, $\tau = MB \sin\theta$

$\tau = (niA)B \sin 90^o$

$\tau = [50 \times 2 \times (12 \times 10 \times 10^{-2})] \times 0.25 \times 1$

$\therefore \tau = 0.3$ N

Hence, option (B) is the correct answer.

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20. In the given question, a statement of Assertion (A) is given, followed by a corresponding statement of Reason (R) just below of it. Mark the correct answer.

Assertion(A) : To draw more current at low potential difference through a low external resistance, parallel connection of identical cells is preferred.

Reason(R) : In parallel connection, current $i = \frac{nE}{r}$, if $r >> R$
[where r-internal resistance, E - emf of the cell and n - number of cells]

A. Both (A) and (R) are true and (R) is the correct explanation of (A)

B. Both (A) and (R) are true and (R) is not the correct explanation of (A)

C. (A) is true and (R) is false

D. (A) is false and (R) is true

When identical cells are connected in parallel, the current through the external resistance is,

$$i = \frac{E}{R + \left(\frac{r}{n}\right)}$$

If $R << r$ then,

$$i = \frac{E}{\left(\frac{r}{n}\right)}$$

$$i = \frac{nE}{r}$$

Hence, (A) is the correct answer.

BYJU'S Part Test for Board Term I (CBSE Grade 12)

21. Assertion $(A)-$ A current flows in a conductor only when there is an electric field within the conductor.
Reason $(R)-$ The drift velocity of electron in presence of electric field decreases

Of the following mark the correct statement.

A. Both $'A'$ and $'R'$ are true and $'R'$ is the correct explanation of $'A'$.

B. Both $'A'$ and $'R'$ are true and $'R'$ is not the correct explanation of $'A'$

C. $'A'$ is true and $'R'$ is false

D. $'A'$ is false and $'R'$ is true

The expression for drift velocity
$V_d = \dfrac{\sigma E}{ne}$
e - change of the e^-
E - electric field
n - electron density
σ - conductivity

As $V_d \propto E$, Drift velocity increases with increase of electric field.

22. In the given question, a statement of Assertion (A) is given, followed by a corresponding statement of Reason (R) just below of it. Mark the correct answer.

Assertion(A) : An uncharged conducting slab is placed normally in a uniform electric field. The resultant electric field inside the slab is zero.

Reason(R) : The charge in the conductor exists only on its surface

A. Both (A) and (R) are true and (R) is the correct explanation of (A)

B. Both (A) and (R) are true and (R) is not the correct explanation of (A)

C. (A) is true and (R) is false

D. (A) is false and (R) is true

Electric field is zero inside a charged conductor.

For a charged conductor, the charges will lie on the surface of the conductor.So, there will not be any charges inside the conductor. When there is no charge there will not be electric field.

Hence, (A) is the correct answer.

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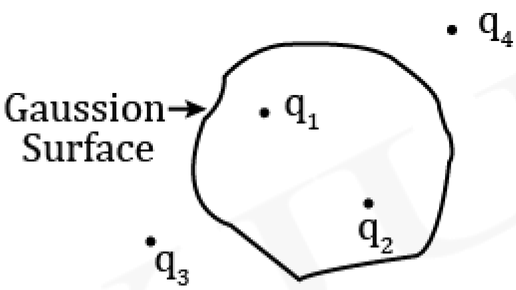
23. In the given question, a statement of Assertion (A) is given, followed by a corresponding statement of Reason (R) just below of it. Mark the correct answer.

Assertion(A) : Four point charges q_1, q_2, q_3 and q_4 are as shown in figure. The flux over the shown Gaussian surface depends only on charges q_1 and q_2

Reason(R) : Electric field at all points on Gaussian surface depends only on charges q_1 and q_2



A. Both (A) and (R) are true and (R) is the correct explanation of (A)

B. Both (A) and (R) are true and (R) is not the correct explanation of (A)

C. (A) is true and (R) is false

D. (A) is false and (R) is true

From Gauss's law, net flux through any closed surface is directly proportional to net charge enclosed by the surface. But electric field at any point on the Gaussian surface depends on all the charges near the vicinity.

Hence, the assertion is true, but the reason is false.

Hence, (C) is the correct answer.

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24. In the given question, a statement of Assertion (A) is given, followed by a corresponding statement of Reason (R) just below of it. Mark the correct answer.

Assertion(A) : AlNiCo is used for making permanent magnets.

Reason(R) : It has a high retentivity and high coercivity.

- **A.** Both (A) and (R) are true and (R) is the correct explanation of (A)
- **B.** Both (A) and (R) are true and (R) is not the correct explanation of (A)
- **C.** (A) is true and (R) is false
- **D.** (A) is false and (R) is true

As we know, permanent magnet has higher retentivity and high coercivity.

AlNiCo has high retentivity and high coercivity. Hence, it is prefered for making permanent magnets.

Hence, (A) is the correct answer.

BYJU'S Part Test for Board Term I (CBSE Grade 12)

Date: 17/11/2021

Subject: Physics

Topic : Section C

Class: Standard XII

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1. Case study (1)

A car battery with a $12 \mathrm{~V}$ emf and an internal resistance of 0.04Ω is being charged with a current of $50 \mathrm{~A}$.

(i)The potential difference V across the terminals of the battery is

A. $10 \mathrm{~V}$

B. $14 \mathrm{~V}$

C. $16 \mathrm{~V}$

D. $12 \mathrm{~V}$

Given, EMF of the battery , $E=12 \mathrm{~V}$

Internal resistance, $r=0.04 \Omega$

The given battery is charging with current, $i=50 \mathrm{~A}$

During charging, $V>E$

$V=E+ir$

$=12+(50 \times 0.04)$

$=12+2$

$V=14 \mathrm{~V}$

Hence, (B) is the correct answer.

2. Case study (1)

A car battery with a 12 V of emf and an internal resistance of $0.04 \ \Omega$ is being charged with a current of 50 A.

(ii)The rate at which energy is being dissipated as heat inside the battery is

- **A.** 100 W
- **B.** 200 W
- **C.** 700 W
- **D.** 600 W

Given, $i = 50 \text{ A} \ ; \ r = 0.04 \ \Omega$

The rate at which energy is being dissipated as heat is,

$$H = \frac{Q}{t} = i^2 \, r$$

$$= (50)^2 \times 0.04 = 50 \times 50 \times 0.04$$

$$= 100 \text{ W}$$

Hence, (A) is the correct answer.

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3. Case study (1)

A car battery with a $12\ \mathrm{V}$ of emf and an internal resistance of $0.04\ \Omega$ is being charged with a current of $50\ \mathrm{A}$.

(iii)The rate of energy conversion from electrical to chemical is

A. $100\ \mathrm{W}$

B. $500\ \mathrm{W}$

C. $600\ \mathrm{W}$

D. $700\ \mathrm{W}$

The rate of energy conversion from electrical to chemical is

= Total energy for charging - Energy dissipated as heat

$= VI - H = (14 \times 50) - 100$

Here, $[H = 100\ \mathrm{W}\ \ ;\ \ V = 14\ \mathrm{V}]$

$= 700 - 100 = 600\ \mathrm{W}$

Hence, (C) is the correct answer.

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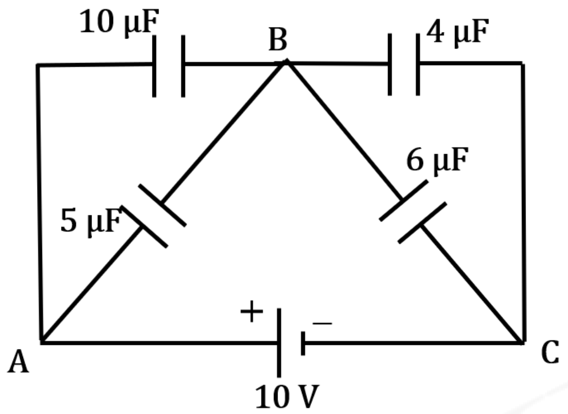
4. Case study (2)

In the circuit shown in the figure, four capacitors are connected to a battery.



(i)The equivalent capacitance of the circuit is

- ✗ **A.** $8.4\ \mu\text{F}$
- ✓ **B.** $6\ \mu\text{F}$
- ✗ **C.** $10\ \mu\text{F}$
- ✗ **D.** $25\ \mu\text{F}$

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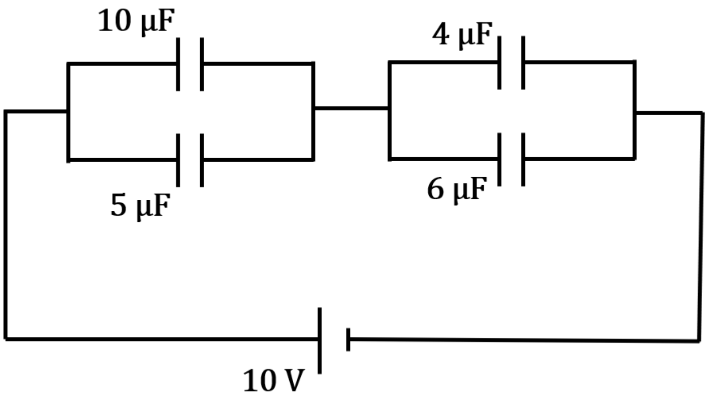
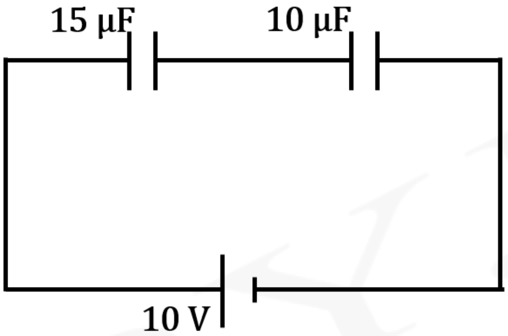
We can redraw the given circuit as follows,





The resultant capacitance of the given circuit is,

$$C_R = \frac{C_1 \times C_2}{C_1 + C_2} = \frac{15 \times 10}{15 + 10}$$

$$\therefore \quad C_R = \frac{150}{25} = 6\ \mu\text{F}$$

Hence, (B) is the correct answer.

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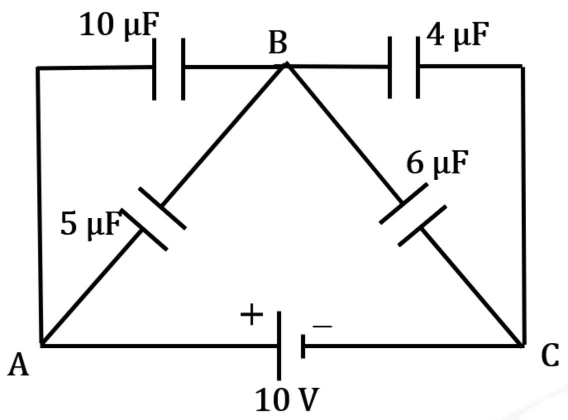
5. Case study (2)

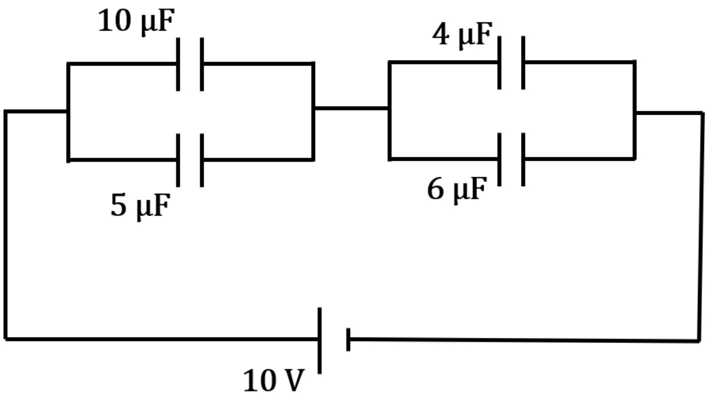
In the circuit shown in the figure, four capacitors are connected to a battery.

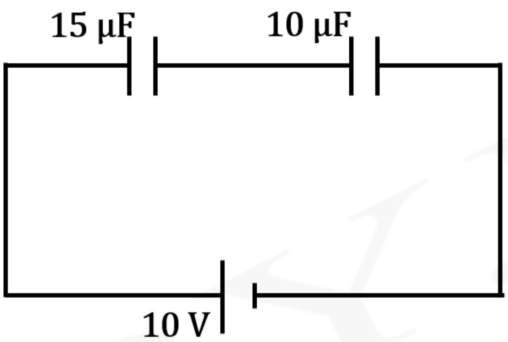


(ii)The charge flowing out of the battery is

- ✔ **A.** $60\ \mu C$
- ✘ **B.** $6\ \mu C$
- ✘ **C.** $600\ \mu C$
- ✘ **D.** $36\ \mu C$

We can redraw the given circuit as follows,





The resultant capacitance of the given circuit is,

$$C_R = \frac{C_1 \times C_2}{C_1 + C_2} = \frac{15 \times 10}{15 + 10}$$

$$\therefore \quad C_R = \frac{150}{25} = 6\ \mu\text{F}$$

Net charge out of the battery is $C_R V = \ 60\ \mu C$

Hence, (A) is the correct answer.

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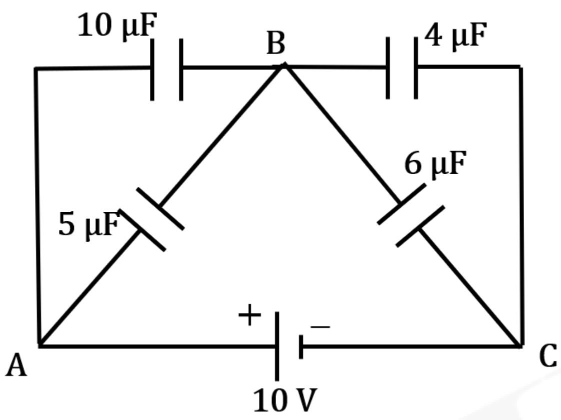
6. Case study (2)

In the circuit shown in figure, four capacitors are connected to a battery.



(iii)The potential difference across the $6\ \mu\mathrm{F}$ capacitor is

- A. $6\ \mathrm{V}$ ✔
- B. $4\ \mathrm{V}$
- C. $5\ \mathrm{V}$
- D. $7\ \mathrm{V}$

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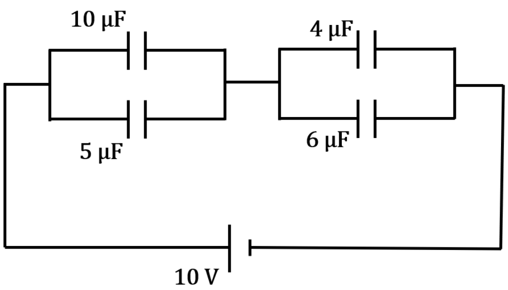
We can redraw the given circuit as follows,



The net charge through the battery is,

$$Q_{net} = C_{eq}V = 6 \times 10 = 60\ \mu\text{C} \quad [\because C_{eq} = 6\ \mu\text{F}]$$

Now, charge through $6\ \mu\text{F}$ capacitor is,

$$q_{6\ \mu\text{F}} = \frac{6}{10} \times 60\ \mu\text{C} = 36\ \mu\text{C}$$

Now, potential difference across the $6\ \mu\text{F}$ capacitor is,

$$V_{6\ \mu\text{F}} = \frac{Q}{C} = \frac{36}{6} = 6\ \text{V}$$

Hence, (A) is the correct answer.