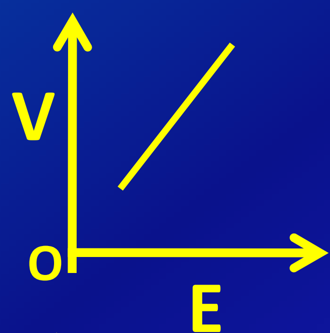
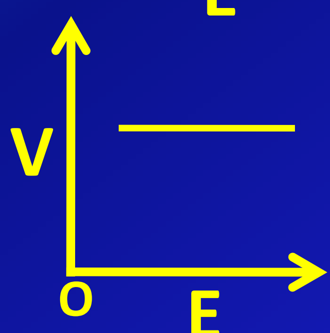
OHM'S LAW AND KIRCHHOFF'S LAW

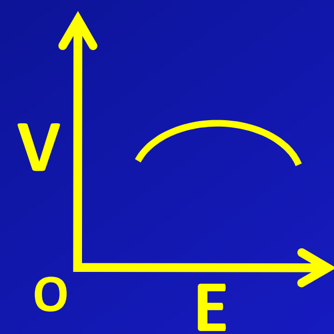
MAGNETIC EFFECT OF AN ELECTRIC CURRENT

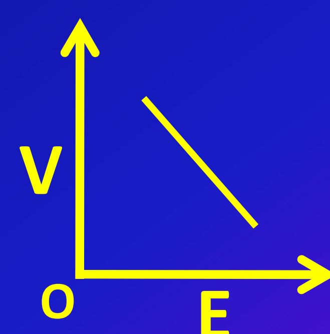
1

A conductor obeys Ohm's law. Which of the following correctly represents the variation of drift velocity 'v' with applied electric field 'E'?

1)


2)


3)


4)


Answer (1)

$v = u + at$

$u = 0$ $a = \frac{Ee}{m}$

$V_d = \frac{eEt}{m}$ or $V_d \propto E$

2

The drift velocity of electrons in a wire of radius ‘r’ is proportional to

1) r
2) r^2
3) r^3
4) none of the above

Answer (4)

$$V_d = \frac{I}{nAe} = \frac{I}{n\pi r^2 l}$$

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

3

A current of 10A flows through a conductor of resistance 10Ω for 10 minutes. The number of electrons moved is

1) 6.25×10^{20}

2) 3.75×10^{22}

3) 6.25×10^{22}

4) 3.75×10^{20}

Answer (2)

$$n = \frac{q}{e} = \frac{It}{e} = \frac{10 \times 600}{1.6 \times 10^{-19}} = 3.75 \times 10^{22}$$

4

A wire of length 2m is stretched uniformly so that the length becomes 6m. Then its resistance will be

1) decreases to 1/3 of the original value

2) increase to 3 times the original value

3) decreases 1/9 times the original value

4) increases to 9 times the original value

Answer (4)

$R_2 = R_1 . n^2$ $n = \frac{6}{2} = 3$

$R_2 = R_1(3)^2$ $= 9R_1$

5

The resistance of a conductor is 5Ω at 50°C and 6Ω at 100°C. Its resistance at 0°C is

1) 4Ω
2) 4.5Ω
3) 5Ω
4) 5.5Ω

Answer (1)

$$\frac{\Delta R}{\Delta t} = \text{constant } \frac{R_2 - R_1}{t_2 - t_1} = \frac{R_1 - R_0}{t_1 - t_0}$$

$$\frac{6 - 5}{100 - 50} = \frac{5 - R_0}{50}$$

$R_0 = 5 - 1 = 4\Omega$

6

The colour of the first three rings in a resistor for a resistance of 1.2 MΩ is

1) brown, orange, green
2) brown, red, blue
3) brown, red, green
4) brown, blue, green

Answer (3)

B.B. R O Y of Great Briton have Very Good Wife

0 1 2 3 4 5 6 7 8 9

1.2 MΩ = $12 \times 10^5 \Omega$

Brown, red , green

7

A 3°C rise of temperature is observed in a conductor by passing a certain current. When the current is doubled the rise of temperature will be

1) 15°C

2) 12°C

3) 9°C

4) 30°C

Answer (2)

$ms\theta = I^2Rt$

$$\frac{\theta_1}{\theta_2} = \frac{I_1^2}{I_2^2} \qquad \theta_2 = \frac{I_2^2}{I_1^2}\theta_1 = (2)\,\theta_1$$

$$\theta_2 = 4x3 = 12°C$$

8

A cell of emf E is connected to a resistance of R, the potential difference between the terminals of the cell is V. Then the internal resistance of the cell must be

1) $\frac{2(E-V)V}{R}$

2) $\frac{2(E-V)R}{E}$

3) $\frac{(E-V)R}{V}$

4) $(E-V)R$

Answer (3)

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

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

$$r = R\,\frac{(E - v)}{v}$$

9

The essential requirements of a fuse wire are

1) high resistance and high melting point
2) high resistance and low melting point
3) low resistance and low melting point
4) low resistance and high melting point

Answer (3)

fuse wire should not consume power so resistance should be low. It should melt quickly on excess current so low melting point.

10

The variation of resistance R of a thermistor with temperature T is represented by $R = a\,e^{b/T}$. In the above relations the units of a and b are respectively.

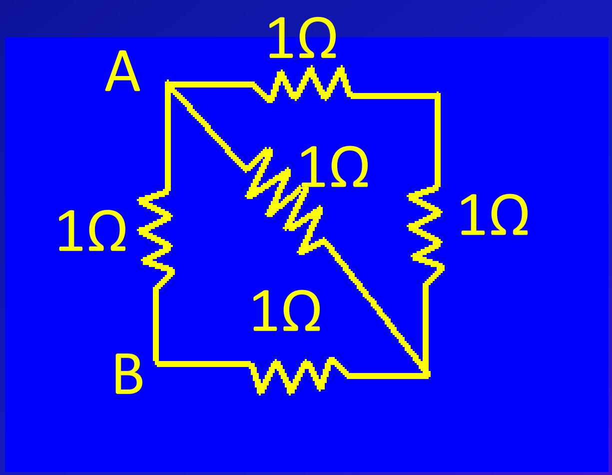
1) ohm, per kelvin
2) ohm, kelvin
3) per ohm, per kelvin
4) both have no units

Answer (2)

power of ‘e’ should be numerical value so ‘b’ should have the same unit of T and ‘a’ should have the same unit of R.

11

The resistance between A and B in the figure is



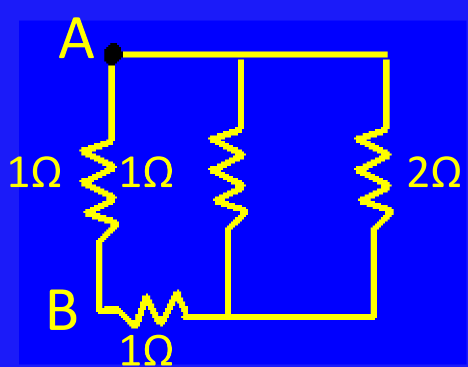
1) 5/8 Ω

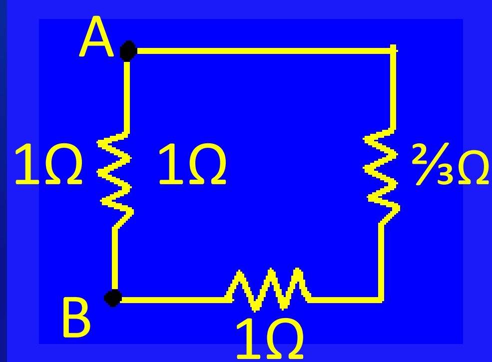
2) 8/5 Ω

3) 3/2 Ω

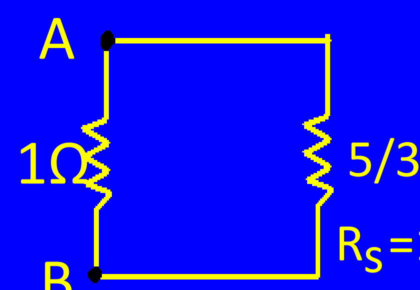
4) 2/3 Ω

Answer (1)





$$R_p = \frac{2 \times 1}{2+1} = 2/3$$



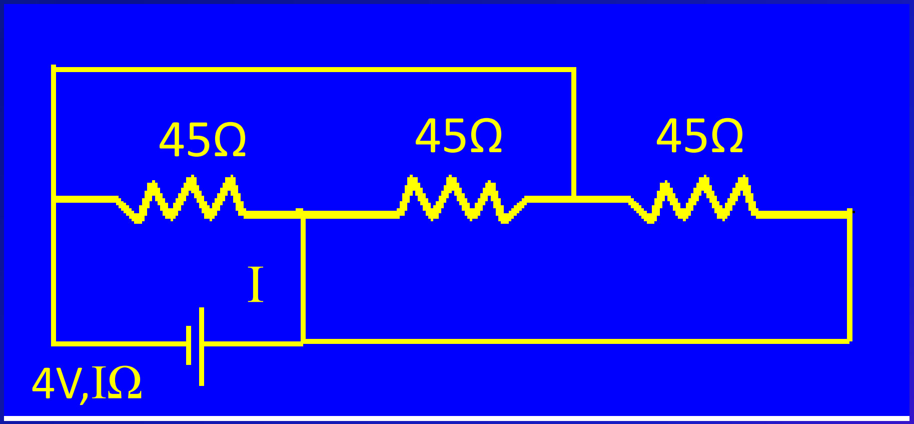
$R_S = 1 + 2/3 = 5/3$

$$R_{AB} = \frac{1 \times 5/3}{1+5/3} = \frac{5/3}{8/3} = 5/8\Omega$$

12

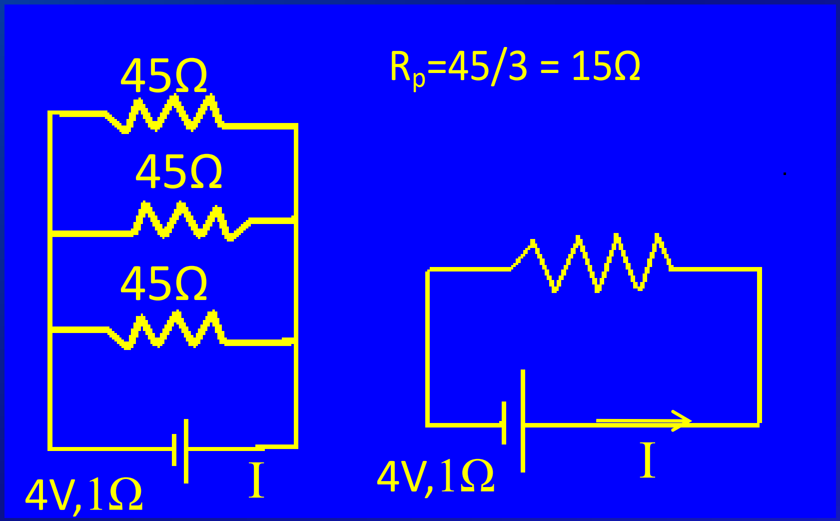
Find the value of I in the following circuit

1) 0.25 A
2) 0.5 A
3) 1 A
4) 2 A



Answer (1)

The equivalent circuit is



$$I = \frac{V}{R+r} = \frac{4}{15+1} = 0.25A$$

13

How many 400Ω resistors connected in parallel are required to carry a total current of 1.5A on a 150V line?

1) 10
2) 20
3) 4
4) 80

Answer (2)

$$R_p = \frac{V}{I} = \frac{150}{1.5} = 100\Omega$$

$$n = \frac{R}{R_p} = \frac{400}{100} = 4$$

KEA

14

The effective resistance of two resistors when connected in parallel is 10Ω. If one of the resistors is 20Ω , then the other resistance is

1) 10 Ω

2) 15 Ω

3) 20 Ω

4) 100 Ω

Answer (3)

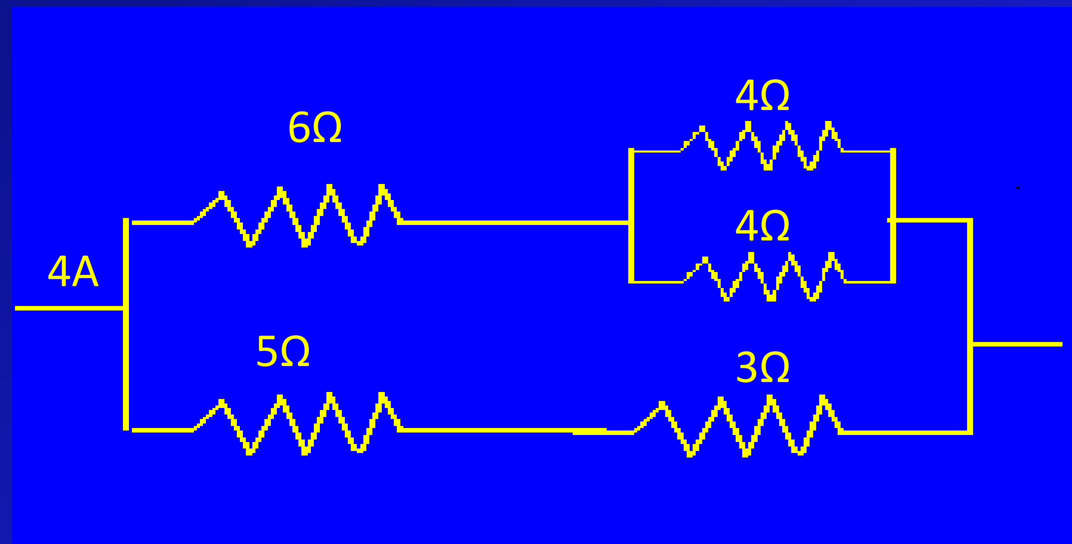
$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} \qquad \frac{1}{R_2} = \frac{1}{R_p} - \frac{1}{R_1}$$

$$R_2 = \frac{R_p R_1}{R_1 - R_p} = \frac{10 \times 20}{20 - 10} = 20\Omega$$

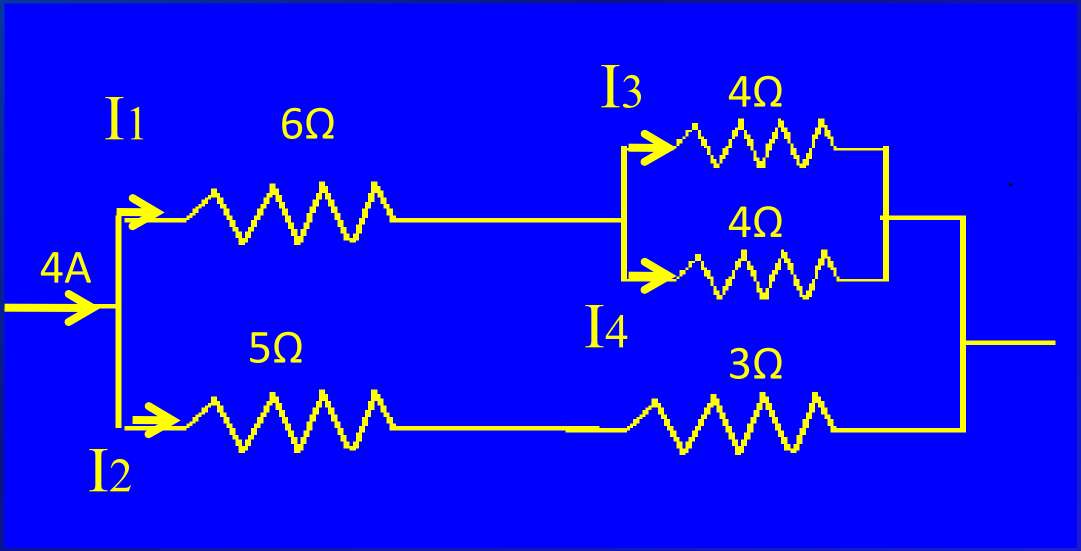
15

What is the p.d. across 4Ω ?

1) 3.2 V
2) 8V
3) 4 V
4) 2 V



Answer (3)



Equivalent resistance of 4Ω and 4Ω in parallel is $\frac{4}{2} = 2\Omega$
(6+2)Ω = (5+3) Ω

$\therefore I_1 = I_2 = 2A$

P.D. across 4Ω is V=IR=1x4=4V

16

In a metre bridge, when the resistances in the two gaps are in the ratio 3 : 5, then the balancing length ‘ℓ’ is given by

1) 0.475 m

2) 0.5 m

3) 0.375 m

4) 0.675 m

Answer (3)

$\frac{R}{S} = \frac{l}{1-l}$ $\frac{3}{5} = \frac{l}{1-l}$

$3(1-l)=5l$

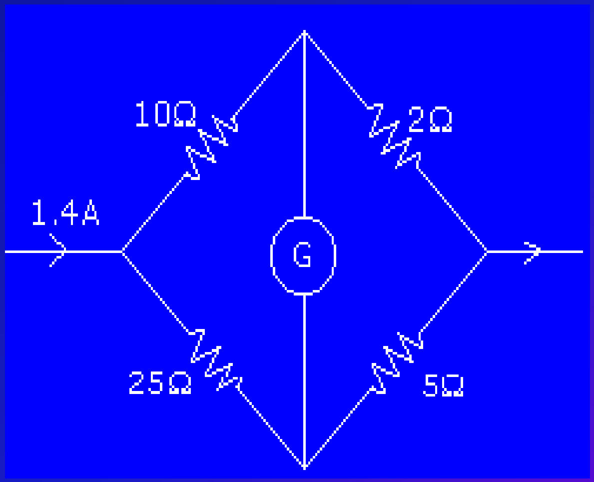
$3-3l = 5l$ $3 = 8l$

$\therefore l = 0.375\text{m}$

17

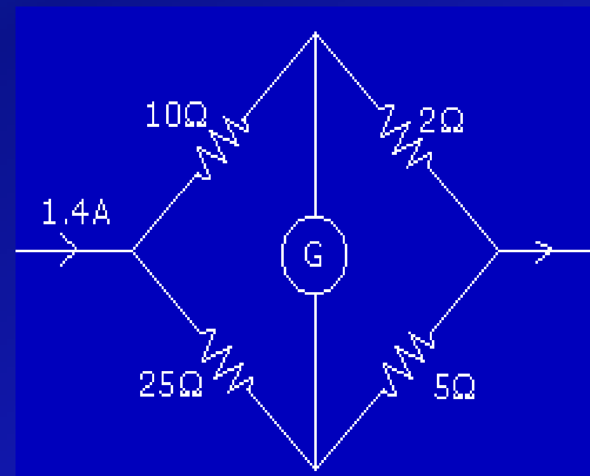
In the circuit shown in the figure, the current through two ohm resistor is

1) 1.2 A
2) 1 A
3) 0.8 A
4) 0.4 A

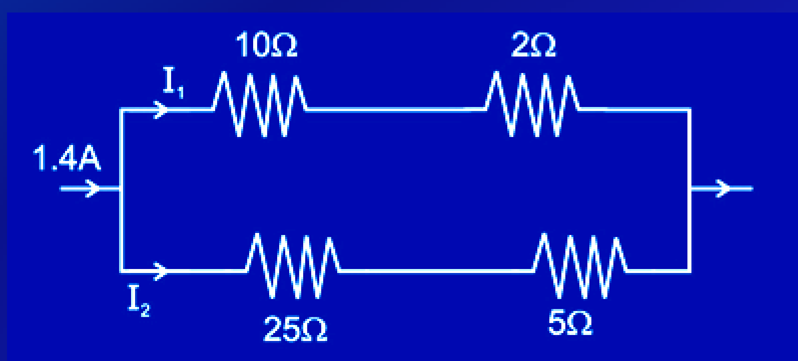


$\frac{15}{12} = \frac{R}{4}$

Answer (2)



Balanced Wheatstone's network so Ig=0.



$$I_1 = \frac{I \times 30}{42} = \frac{1.4 \times 30}{42} = 1\text{A}$$

18

Four resistances 15, 12, 4 and 10Ω are connected in cyclic order to form Wheatstone network. The resistance to be connected in parallel with 10 Ω to balance the network is

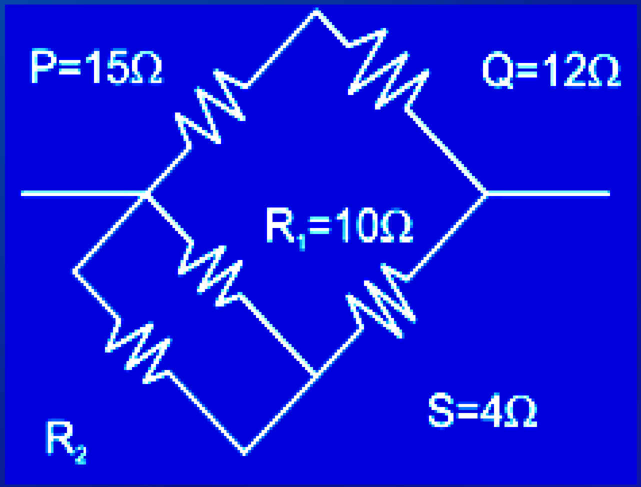
1) 5 Ω

2) 10 Ω

3) 8 Ω

4) 20 Ω

Answer (2)



$$\frac{P}{Q} = \frac{R_p}{S} \qquad \frac{15}{12} = \frac{R_p}{4} \qquad R_p = 5\Omega$$

$$R_2 = \frac{R_1 R_p}{R_1 - R_p} = \frac{10 \times 5}{10-5} = 10\Omega \qquad R_2 = 10\Omega$$

19

Consider the following statements

i) Kirchhoff's voltage law follows from the law of conservation of energy

ii) Kirchhoff's Current law follows from the law of conservation of charge

iii) Kirchhoff's voltage law propounds the conservation nature of electric field

The correct statements are

1) i) and ii)

2) i) and iii)

3) ii) and iii)

4) all the three

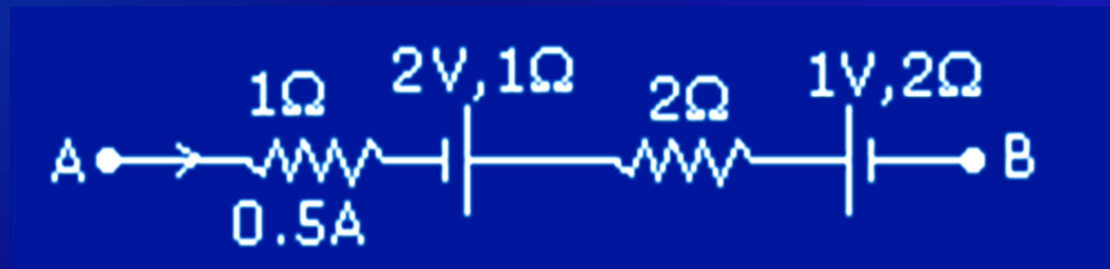
Answer (4)

20

In the diagram $V_A - V_B$ =

1) 2 V
2) 1 V
3) 3.5 V
4) 1.5 V

Answer (4)



$V = \sum E - \sum IR$

R = 6Ω

V = 1-2 – (-0.5x6)

$\therefore V = 1 - 2 + 3 = 2$ volt

21

When a current flows in a conductor, the order of magnitude of drift velocity of electrons through it is

1) 10^{-7} ms^{-1}

2) 10^{-5} ms^{-1}

3) 10^{4} ms^{-1}

4) 10 ms^{-1}

Answer (2)

22

When a current I is set up in a wire of radius 'r', the drift speed is 'v_d' If the same current is set up through a wire of radius '2r' the drift speed will be

1) $v_d / 4$

2) $v_d / 2$

3) $2 v_d$

4) $4 v_d$

Answer (1)

$$V_d \propto \frac{1}{r^2} \qquad V_d^1 = V_d \times \frac{r^2}{(2r)^2} = \frac{V_d}{4}$$

23

If the flash gun of a camera operates for a milli second and during this time 0.05 coulomb of charge flows then the current will be

1) 5×10^{-3} A

2) 5×10^{-5} A

3) 0.02 A

4) 50 A

Answer (4)

$$I = \frac{q}{t} = \frac{0.05}{10^{-3}} = 50A$$

24

Two aluminium wires are of same length, one is twice as thick as the other. The resistances are in the ratio

1) 16 : 1

2) 8 : 1

3) 4 : 1

4) 2 : 1

Answer (3)

$$\mathrm{R}\ \alpha\ \frac{1}{A}\ ,\ \mathrm{R}\ \alpha\ \frac{1}{\pi r^2}$$

$$\frac{R_1}{R_2} = \frac{r_2^2}{r_1^2} = 4\,\frac{r_1^2}{r_1^2} = \frac{4}{1}$$

25

The temperature coefficient of resistance of a wire is 0.00125/°C. At 0°C its resistance is 1Ω. The resistance of the wire will be 2Ω at

1) 800°C
2) 1073°C
3) 125°C
4) 400°C

Answer (1)

$R_t = R_0(1+\alpha t)$

$2 = 1\,(1+0.00125t)$

$1 = 0.00125t$

$$t = \frac{1}{0.00125} = 800°C$$

26

‘Ampere second’ is the unit of

1) Current
2) Power
3) Charge
4) emf

Answer (3)

q = It

27

A 100 W and 25 W bulb are designed for the same voltage. They have filament of same length and material. The ratio of the diameter of the 100 W bulb to that of the 25W bulb is

1) 4 : 1

2) 2 : 1

3) $\sqrt{2}$: 1

4) 1 : 2

Answer (2)

$$P = \frac{V^2}{R}$$

$$\frac{P_1}{P_2} = \frac{R_2}{R_1} \qquad \frac{100}{25} = \frac{R_2}{R_1} = \frac{4}{1} \qquad R_2=4R_1$$

$$\frac{R_2}{R_1} = \frac{r_2^2}{r_1^2} \qquad \frac{r_1}{r_2} = \sqrt{\frac{4R_1}{R_1}} = \frac{2}{1}$$

$$\frac{D_1}{D_2} = \frac{2}{1}$$

28

The resistivity of a wire depends upon its

1) length
2) mass
3) material
4) area of cross-section

Answer (3)

29

The colour bands in a certain resistor are in the order red-orange-brown. The resistance of the resistor is

1) 230 Ω

2) 2300 Ω

3) 320 Ω

4) 32 Ω

Answer (1)

B.B. R O Y of Great Briton have Very Good Wife

0 1 2 3 4 5 6 7 8 9

red, orange, brown 230Ω

30

The essential requirements for a good heating element are

1) high resistivity and low melting point
2) high resistivity and high melting point
3) low resistivity and low melting point
4) low resistivity and high melting point

Answer (2)

31

An electron is moving in a circle of radius ‘r’ in a uniform magnetic field B. Suddenly the field is reduced to B/2. The radius of the circle now becomes

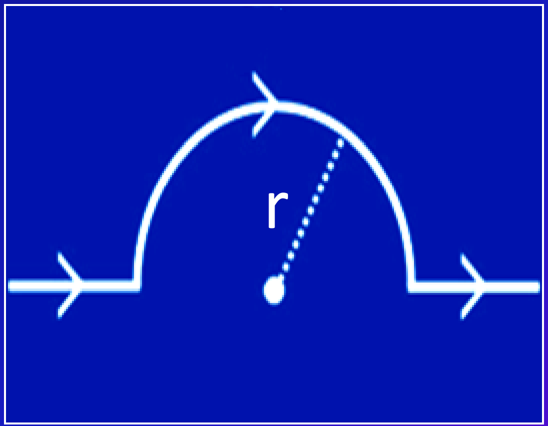
1) r/2
2) r/4
3) 2r
4) 4r

Answer (3)

$$B = \frac{\mu_o n I}{2r} \qquad \frac{r_2}{r_1} = \frac{B_1}{B_2} = \frac{B}{B_2} = 2 \qquad r_2 = 2r_1$$

32

A portion of a long straight wire carrying a current I, is bent in the form of a semicircle of radius 'r' as shown in the figure. The magnetic field at the centre O of the semicircle, in tesla is



1) $\frac{\pi I}{2r} \times 10^{-7}$

2) $\frac{\pi I}{2r}$

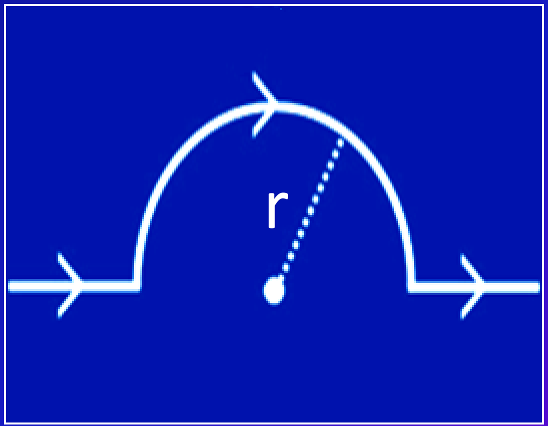
3) $\frac{\pi I}{r} \times 10^{-7}$

4) Zero

Answer (3)

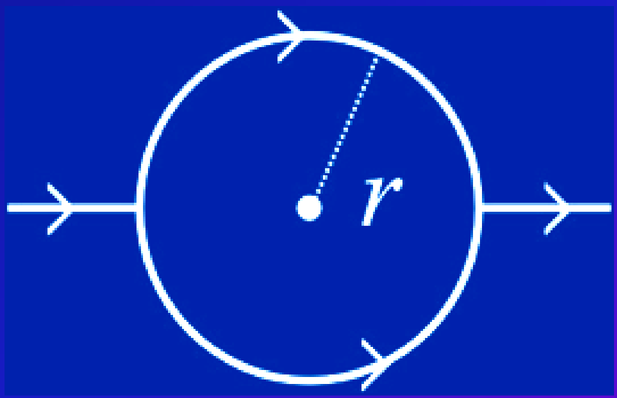
$$B = \frac{\mu_o}{4\pi} \cdot \frac{2\pi n I}{r} \qquad n = {}^{1}/_{2} \text{ number of turns}$$

$$= 10^{-7} \frac{\pi I}{r}$$



33

A straight conductor carrying a current I, is split into a circular loop of radius 'r' as shown in the figure. The magnetic field at the centre O of the circle, in tesla is



1) $\frac{\mu_o I}{\pi r}$

2) $\frac{\mu_o I}{2\pi r}$

3) $\frac{\mu_o I}{2r}$

4) Zero

Answer (4)

Field at the centre due to each half of the loop is same and opposite to each other.

$\therefore$ zero.

34

A current I flows in a circular arc of wire which subtends an angle 3π/2 at the centre. If the radius of the circle is r, then the magnetic induction B is

1) $\frac{\mu_o I}{2r}$

3) $\frac{2\mu_o I}{4r}$

2) $\frac{\mu_o I}{\pi r}$

4) $\frac{3\mu_o I}{8r}$

Answer (4)

$$B = \frac{\mu_o n I}{2r} \quad n = \frac{\frac{3\pi}{2}}{2\pi} = \frac{3}{4} \qquad B = \frac{\mu_o I}{r} \quad \frac{3}{8}$$

35

A current I flows along infinitely long straight thin conductor, then the magnetic field at any point on the conductor is

1) ∞

2) 0

3) $\frac{\mu_o I}{4\pi}$

4) $\frac{\mu_o I}{2\pi}$

Answer (2)

$$dB = \frac{\mu_o}{4\pi} \frac{Idl\sin\theta}{r^2}$$

$\theta = 0°$ or 180° so dB=0

36

A circular current carrying coil has a radius R. The distance from the centre of the coil on the axis where B will be $^{1}/_{8}$ of its value at the centre of the coil is

1) $r / \sqrt{3}$

2) $\sqrt{3}\, r$

3) $2\sqrt{3}\, r$

4) $2r / \sqrt{3}$

Answer (2)

$B_c = \frac{\mu_o n I}{2r}$ B = $\frac{\mu_o n I r^2}{2(r^2+x^2)^{3/2}}$

$\frac{B}{B_c} = \frac{r^3}{(r^2+x^2)^{3/2}} = \frac{1}{8}$ so $\frac{r}{(r^2+x^2)^{1/2}} = \frac{1}{2}$

$(r^2+x^2)^{1/2}$ = 2r or $(r^2+x^2) = 4r^2$

$3r^2 = x^2$ x=$\sqrt{3}\,r$

37

A charge 'q' coulomb is circulating in an orbit of radius 'r' metres making 'n' revolutions per second. The magnetic field produced at the centre of the circle in N/Am is

1) $\frac{2\pi q}{nr} \times 10^{-7}$

2) $\frac{2\pi q}{r} \times 10^{-7}$

3) $\frac{2\pi nq}{r} \times 10^{-7}$

4) $\frac{2\pi rn}{q} \times 10^{-7}$

Answer (3)

Current I = $\frac{q}{T}$ = qn

B = $\frac{\mu_o}{4\pi} \times \frac{2\pi I}{r}$, magnetic field due to a current loop

= $10^{-7} \times \frac{2\pi nq}{r}$

38

Two tangent galvanometers A and B are connected in series a current flowing through them produces deflection of 30° and 60° respectively. The reduction factors of the galvanometers in the ratio

1) $\sqrt{3} : 1$
2) $1 : \sqrt{3}$
3) 3:1
4) 1:3

Answer (3)

Since T.G.s are in series connection current is same

$K_1 \tan\theta_1 = K_2 \tan\theta_2$

$$\frac{K_1}{K_2} = \frac{\tan\theta_2}{\tan\theta_1} = \frac{\sqrt{3}}{1} \times \sqrt{3} = 3$$

39

Two tangent galvanometers A and B have radii in the ratio 2 : 3 and turns in the ratio 1 : 3. When a certain current flows through both of them a deflection of 30° is produced in A. What is the deflection produced in B?

1) $\theta = \tan^{-1} (2/\sqrt{3})$

2) $\theta = \tan^{-1} (3/2)$

3) $\theta = \tan^{-1} (\sqrt{3})$

4) $\theta = \tan^{-1} (\sqrt{2})$

Answer (1)

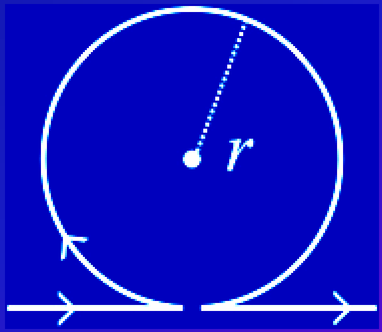
$I = \frac{2r B_H}{\mu_o n} \tan\theta$ $I_1 = \frac{2r_1 B_H}{\mu_o n_1} \tan\theta_1$ $I_1 = \frac{2r_2 B_H}{\mu_o n_2} \tan\theta_2$

$\tan\theta_2 = \tan\theta_1 \text{ x } \frac{r_1}{r_2} \text{ x } \frac{n_2}{n_1}$

$= \frac{1}{\sqrt{3}} \text{ X } 2/3 \text{ X } 3/1 = \frac{2}{\sqrt{3}}$

40

A long straight conductor carrying a current I; is bent into the shape shown in the figure. The radius of the circular loop is r. The magnetic field at the centre of the loop is



1) $\frac{\mu_o I}{2r}(1-\frac{1}{\pi})$ into the page

3) $\frac{\mu_o I}{2r}(1-\frac{1}{\pi})$ out of the page

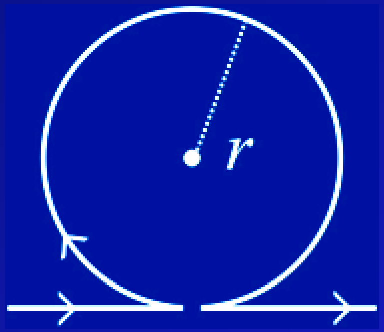
2) $\frac{\mu_o I}{2r}(1+\frac{1}{\pi})$ out of the page

4) $\frac{\mu_o I}{2r}(1+\frac{1}{\pi})$ into the page

Answer (1)

Field due to straight wire

$B_2 = \frac{\mu_0 I}{2\pi r}$ out of the page



Field due to circular wire at the centre.

$B_1 = \frac{\mu_0 I}{2r}$ into the page

Total field $B_1 - B_2 = \frac{\mu_0 I}{2r}\left[1 - \frac{1}{\pi}\right]$ in to the page

THANK YOU