

Resistance JEE Main PYQ – 3

Total Time: 50 Minute

Total Marks: 80

Instructions

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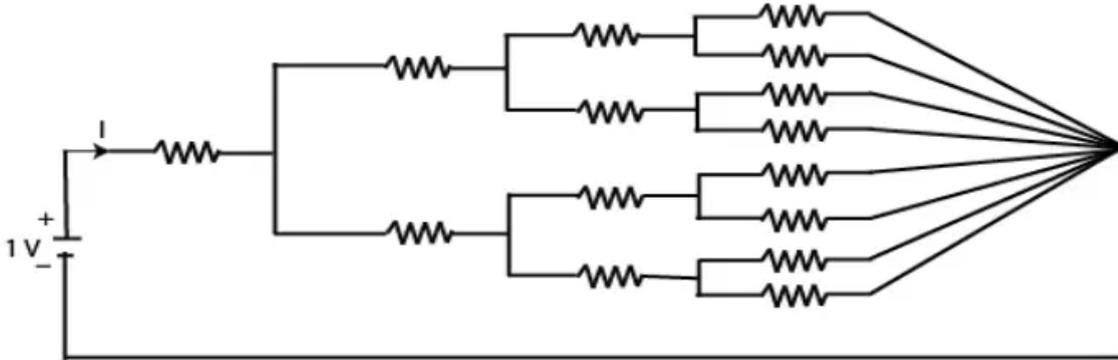
1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Resistance

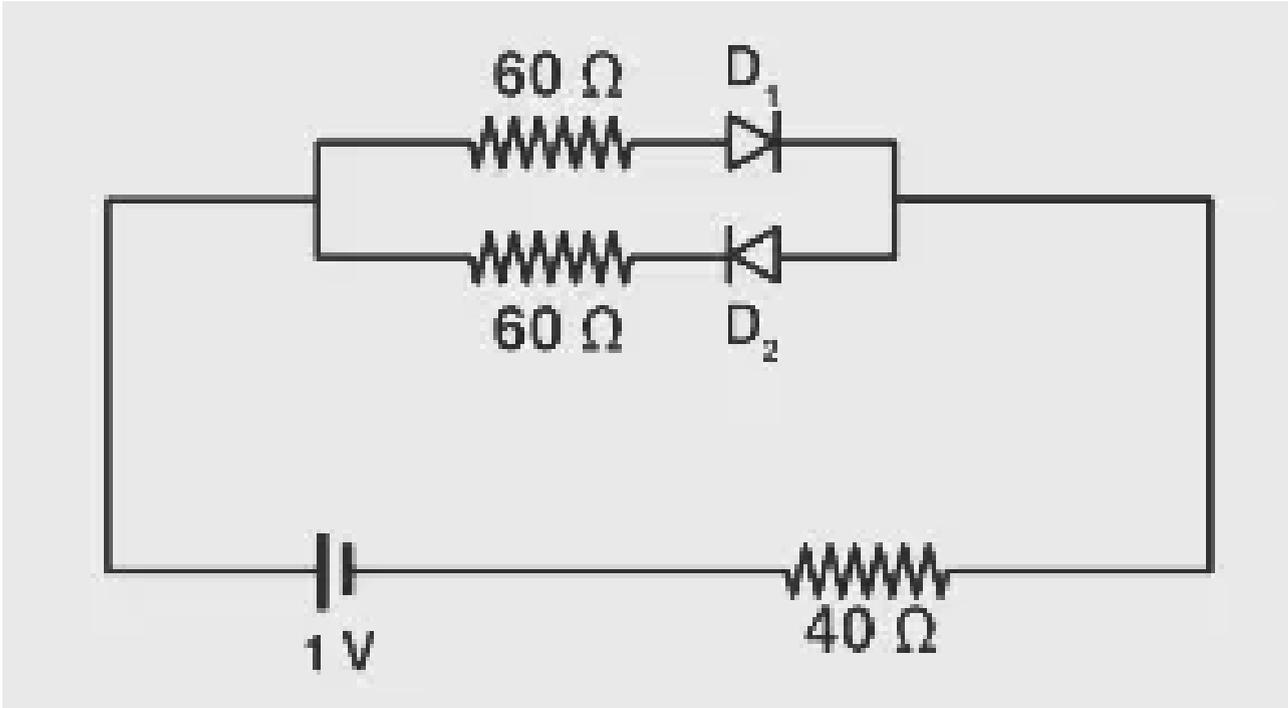
1. All resistances in figure are $1\ \Omega$ each. The value of current 'I' is $\left(\frac{a}{b}\right)$ A. The value of a is _____ and b is _____.



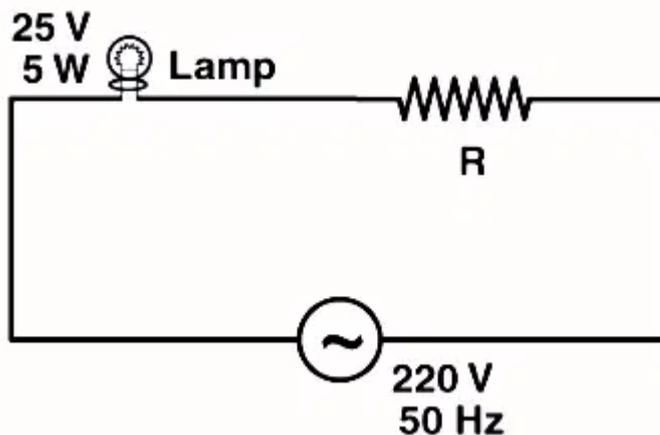
2. An aluminium wire is stretched to make its length, 0.4% larger. The percentage change in resistance is _____.

- 0.4%
- 0.2%
- 0.8%
- 0.6%

3. The cut-off voltage of the diodes (shown in figure) in forward bias is 0.6 V . The current through the resistor of $40\ \Omega$ is _____ mA.

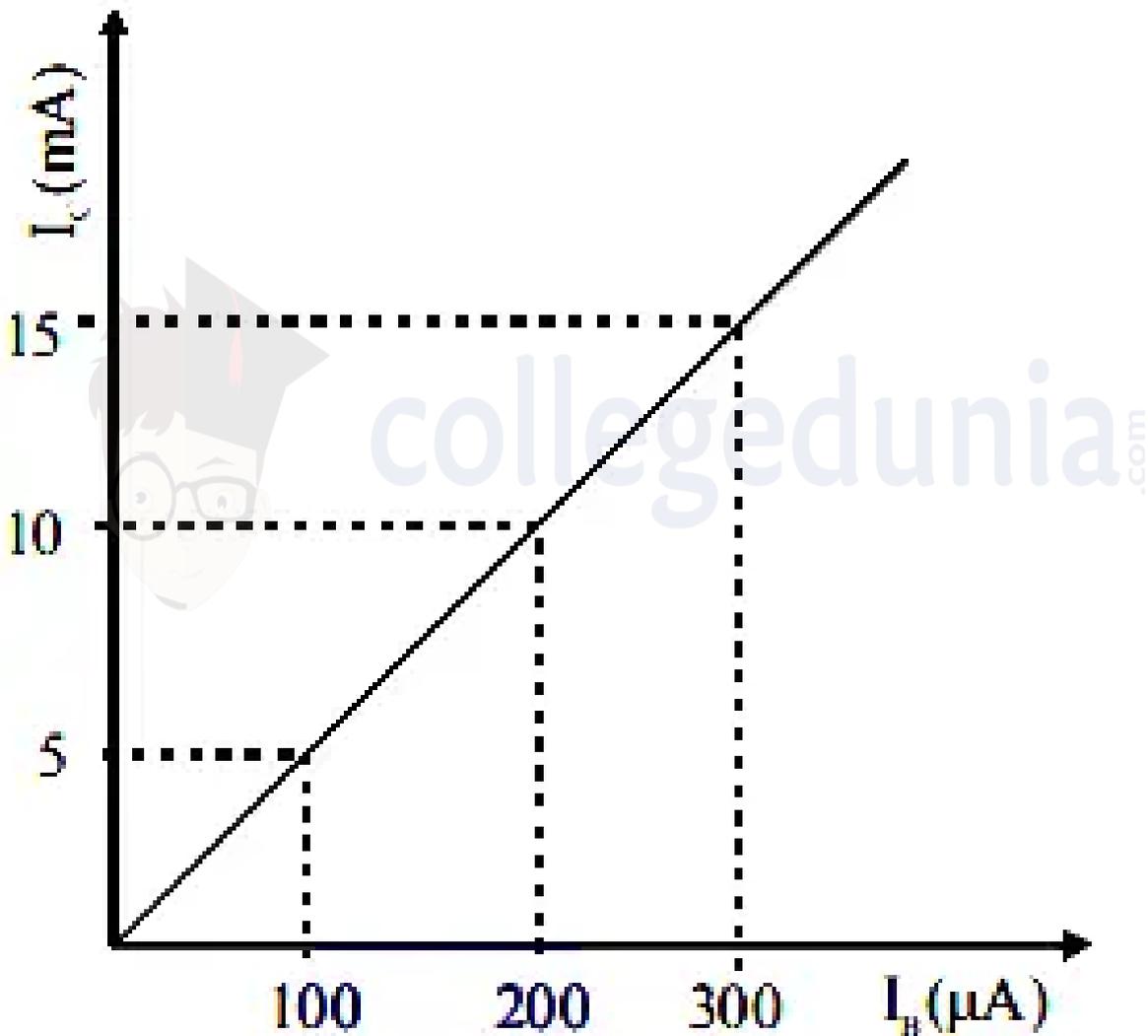


4. In the given circuit 'a' is an arbitrary constant. The value of m for which the equivalent circuit resistance is minimum, will be $\frac{\sqrt{x}}{2}$. The value of x is _____ . (+4, -1)
-
5. The current density in a cylindrical wire of radius 4 mm is $4 \times 10^6 \text{ Am}^{-2}$. The current through the outer portion of the wire between radial distances $\frac{R}{2}$ and R is _____ π A. (+4, -1)
-
6. A cell, shunted by a 8Ω resistance, is balanced across a potentiometer wire of length 3 m. The balancing length is 2 m when the cell is shunted by 4Ω resistance. The value of internal resistance of the cell will be _____ Ω . (+4, -1)
-
7. A 220 V, 50 Hz AC source is connected to a 25 V, 5 W lamp and an additional resistance R in series (as shown in figure) to run the lamp at its peak brightness, then the value of R (in ohm) will be _____ . (+4, -1)



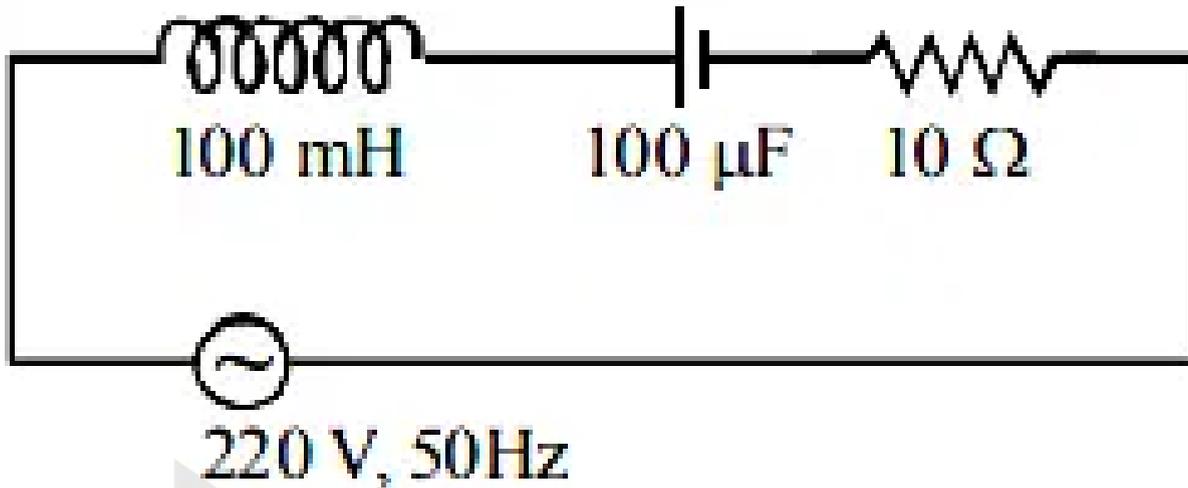
8. A potentiometer wire of length 10 m and resistance 20Ω is connected in series with a 25 V battery and an external resistance 30Ω . A cell of emf E in secondary circuit is balanced by 250 cm long potentiometer wire. The value of E (in volt) is $\frac{x}{10}$. The value of x is _____.

9. In an experiment of CE configuration of $n-p-n$ transistor, the transfer characteristics are observed as given in figure.



If the input resistance is 200Ω and output resistance is 60Ω , the voltage gain in this experiment will be _____.

10. In a series LCR circuit, the inductance, capacitance and resistance are $L = 100$ mH, $C = 100 \mu\text{F}$ and $R = 10 \Omega$ respectively. They are connected to an AC source of voltage 220 V and frequency of 50 Hz. The approximate value of current in the circuit will be _____ A. (+4, -1)



11. The length of a given cylindrical wire is increased to double of its original length. The percentage increase in the resistance of the wire will be _____%. (+4, -1)

12. Resistance of the wire is measured as 2Ω and 3Ω at 10°C and 30°C respectively. Temperature co-efficient of resistance of the material of the wire is: (+4, -1)

- a. 0.033°C^{-1}
- b. $-0.033^\circ\text{C}^{-1}$
- c. 0.011°C^{-1}
- d. 0.055°C^{-1}

13. A 72Ω galvanometer is shunted by a resistance of 8Ω . The percentage of the total current which passes through the galvanometer is (+4, -1)

- a. 0.1%
- b. 10%

- c. 25%
 - d. 0.25%
-

14. A transistor is used in common-emitter mode in an amplifier circuit. When a signal of 10 mV is added to the base-emitter voltage, the base current changes by 10 mA and the collector current changes by 1.5 mA. The load resistance is 5 kW. The voltage gain of the transistor will be _____. (+4, -1)

15. If n represents the actual number of deflections in a converted galvanometer of resistance G and shunt resistance S . Then the total current I when its figure of merit is K will be (+4, -1)

- a. $\frac{KS}{S+G}$
 - b. $\frac{G+S}{nKs}$
 - c. $\frac{nKs}{G+S}$
 - d. $\frac{nK(G+S)}{s}$
-

16. Two cells of same emf but different internal resistances r_1 and r_2 are connected in series with a resistance R . The value of resistance R , for which the potential difference across second cell is zero, is (+4, -1)

- a. $r_2 - r_1$
 - b. $r_1 - r_2$
 - c. r_1
 - d. r_2
-

17. An object of mass 5 kg is thrown vertically upwards from the ground. The air resistance produces a constant retarding force of 10 N throughout the motion. The ratio of time of ascent to the time of descent will be equal to [Use $g = 10 \text{ ms}^{-2}$]. (+4, -1)

- a. 1:1
- b. $\sqrt{2} : \sqrt{3}$
- c. $\sqrt{3} : \sqrt{2}$
- d. 2:3

18. Two identical cells each of emf 1.5 V are connected in parallel across a parallel combination of two resistors each of resistance 20 W. A voltmeter connected in the circuit measures 1.2 V. The internal resistance of each cell is (+4, -1)

- a. 2.5 W
- b. 4 W
- c. 5 W
- d. 10 W

19. What will be the most suitable combination of three resistors A = 2 Ω, B = 4 Ω, C = 6 Ω so that $(22/3)$ Ω is equivalent resistance of combination? (+4, -1)

- a. Parallel combination of A and C connected in series with B.
- b. Parallel combination of A and B connected in series with C
- c. Series combination of A and C connected in parallel with B.
- d. Series combination of B and C connected in parallel with A.

20. The equivalent resistance between A and B as shown in the figure is: (+4, -1)



- a. 5 Ω

b. 10Ω

c. 20Ω

d. 40Ω



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Answers

1. Answer: 8 – 8

Explanation:

Let the current is i

Using kirchhoff's law

$$iR + \frac{i}{2R} + \frac{i}{4R} + \frac{i}{8R} = 3$$

$$i = \frac{3 \times 8}{15} = \frac{8}{5} A$$

Since, $I = \left(\frac{a}{5}\right)A$

$$\Rightarrow a = 8$$

So, value of a is 8

Concepts:

1. Resistance:

Resistance is the measure of opposition applied by any object to the flow of **electric current**. A resistor is an electronic constituent that is used in the circuit with the purpose of offering that specific amount of resistance.

$$R = V/I$$

In this case,

v = Voltage across its ends

I = Current flowing through it

All materials resist current flow to some degree. They fall into one of two broad categories:

- **Conductors:** Materials that offer very little resistance where electrons can move easily. Examples: silver, copper, gold and aluminum.
- **Insulators:** Materials that present high resistance and restrict the flow of electrons. Examples: Rubber, paper, glass, wood and plastic.

Resistance measurements are normally taken to indicate the condition of a component or a circuit.

- The higher the resistance, the lower the current flow. If abnormally high, one possible cause (among many) could be damaged conductors due to burning or corrosion. All conductors give off some degree of heat, so overheating is an issue often associated with resistance.
- The lower the resistance, the higher the current flow. Possible causes: insulators damaged by moisture or overheating.

2. Answer: c

Explanation:

When the wire is stretched, volume remains constant. If length is increased by 0.4% area will decrease by 0.4%.

$$\text{From, } R = \frac{\rho l}{A}$$

$$\frac{dR}{R} \times 100 = \frac{dl}{l} \times 100 + \frac{dA}{A} \times 100$$

The percentage change in resistance,

$$\%R = 0.4 + 0.4$$

$$\%R = 0.8\%$$

So, the correct option is (C): 0.8%

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3. Answer: 4 - 4

Explanation:

D_1 : *conducting* and D_2 : *opencircuit*

$$\Rightarrow i = \frac{1-0.6}{60+40} A$$

$$= \frac{0.4}{100} A$$

$$\Rightarrow i = 4 \text{ mA}$$

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4. Answer: 3 - 3

Explanation:

$$\begin{aligned}R_{net} &= \frac{ma}{3} + \frac{a}{2m} \\&= a \left[\frac{m}{3} + \frac{1}{2m} - \frac{2}{\sqrt{6}} + \frac{2}{\sqrt{6}} \right] \\&= a \left[\left(\sqrt{\frac{m}{3}} - \frac{1}{\sqrt{2m}} \right)^2 + \sqrt{\frac{2}{3}} \right]\end{aligned}$$

This will be minimum when

$$\sqrt{\frac{m}{3}} = \frac{1}{\sqrt{2m}} \text{ or } m = \sqrt{\frac{3}{2}}$$

so $x = 3$

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5. Answer: 48 – 48

Explanation:

$$\begin{aligned}i &= A \times j \\&= \pi(R_2 - \frac{R_2}{4})j \\&= \frac{3\pi R^2}{4} \times j \\&= \frac{3\pi \times (4 \times 10^{-3})^2}{4} \times 4 \times 10^6 \\&= 48 \pi\end{aligned}$$

Let given that the current through the outer portion of the wire between radial distances $\frac{R}{2}$ and R is $x\pi$ A.

Then, the value of $x = 48$.

So, the answer is 48.

Concepts:

1. Electric Current:

Defining Electric Current

It is the rate of flow of electrons in a conductor. SI Unit - Ampere (A).

Electrons are negatively charged particles hence when they move a number of charges moves.

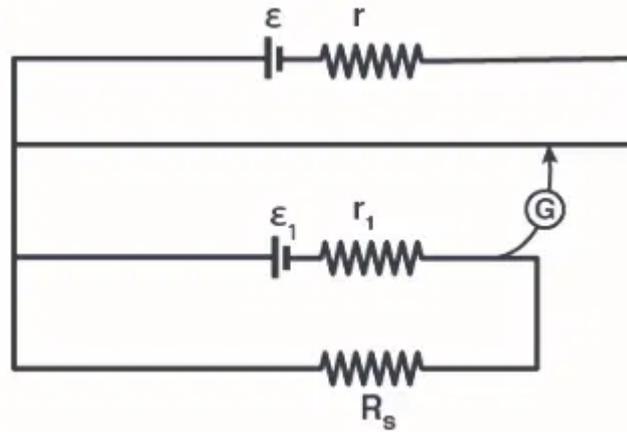
Note:- The ability of a particular substance to conduct electricity depends on the number of electrons that are able to move. Some of the materials allow current to flow better than others.

What is an Electromotive Force?

If a force acts on electrons to make them move in a particular direction, then up to some extent random motion of the electrons will be eliminated. An overall movement in one direction. The force which acts on the electrons to move them in a certain direction is known as electromotive force and its quantity is known as voltage and is measured in V.

6. Answer: 8 - 8

Explanation:



$$\frac{\frac{\epsilon_1 8}{r_1 + 8} 3c}{\frac{\epsilon_1 4}{r_1 + 4} 2c} = \frac{3}{2}$$

Then, the value of internal resistance of the cell,

$$\Rightarrow r_1 = 8 \Omega$$

So, the answer is 8Ω .

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7. Answer: 975 – 975

Explanation:

$$R_b = \frac{(25)^2}{5} = 125 \Omega$$

$$R_b = 125 \Omega$$

rms value of current.

$$I_{rms} = \sqrt{\frac{5}{125}} = \frac{1}{5} A$$

$$I_{rms} = \frac{1}{5} A$$

$$\Rightarrow \frac{220}{R+125} = \frac{1}{5}$$

$$\Rightarrow R = 1100 - 125$$

$$\Rightarrow R = 975 \Omega$$

So, the answer is 975 Ω .

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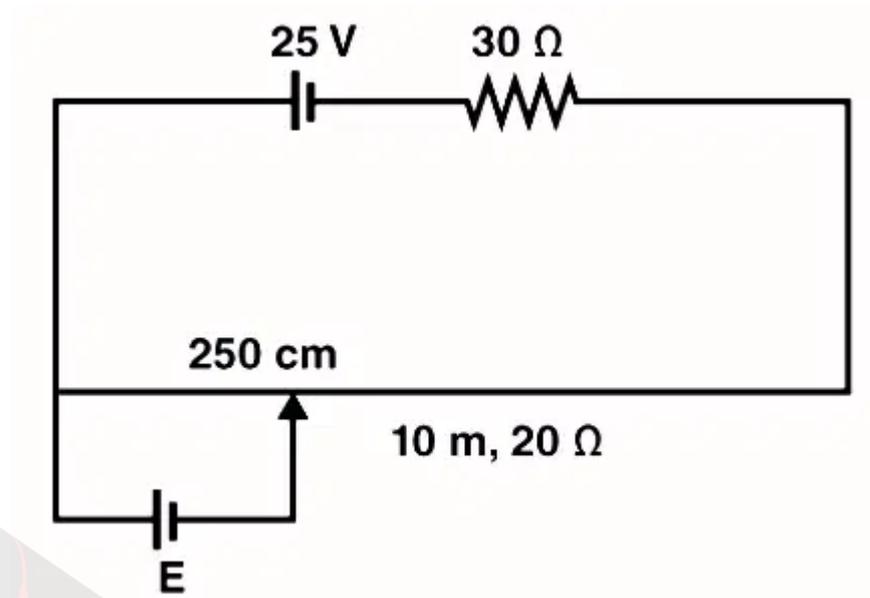
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8. Answer: 25 – 25

Explanation:



$$E = I \times \left(\frac{20}{4}\right)$$

$$E = \frac{25}{(30+20)} \times \left(\frac{20}{4}\right)$$

$$E = \frac{1}{2} \times 5$$

$$E = 2.5 \text{ volts}$$

$$E = \frac{25}{10} \text{ volts}$$

Given that, The value of E (in volt) is $\frac{x}{10}$.

On comparing,

$$x = 25$$

So, the answer is 25.

Concepts:

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In this case,

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All materials resist current flow to some degree. They fall into one of two broad categories:

- **Conductors:** Materials that offer very little resistance where electrons can move easily. Examples: silver, copper, gold and aluminum.
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Resistance measurements are normally taken to indicate the condition of a component or a circuit.

- The higher the resistance, the lower the current flow. If abnormally high, one possible cause (among many) could be damaged conductors due to burning or corrosion. All conductors give off some degree of heat, so overheating is an issue often associated with resistance.
- The lower the resistance, the higher the current flow. Possible causes: insulators damaged by moisture or overheating.

9. Answer: 15 – 15

Explanation:

Voltage gain

$$= \frac{L_C R_O}{L_B R_i}$$

$$= \frac{(10mA)(60\Omega)}{(200\mu A)(200\Omega)}$$

$$\Rightarrow \text{Voltage gain} = 15$$

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10. Answer: 22 – 22

Explanation:

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

$$= \sqrt{10^2 + [10\pi - \frac{100}{\pi}]^2 \Omega}$$

$$\approx 10 \Omega$$

⇒ Current

$$= \frac{220}{10} A = 22 A$$

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11. Answer: 300 – 300

Explanation:

Volume is constant so on length doubled

Area is halved so

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

and

$$R' = \rho \frac{2l}{\frac{A}{2}} = 4\rho \frac{l}{A} = 4R$$

So percentage increase will be

$$R\% = \frac{4R - R}{R} \times 100 = 300$$

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- The lower the resistance, the higher the current flow. Possible causes: insulators damaged by moisture or overheating.

12. Answer: a

Explanation:

$$R_{10} = 2 = R_0(1 + \alpha \times 10)$$

$$R_{30} = 3 = R_0(1 + \alpha \times 30)$$

On solving

$$\alpha = \frac{0.033}{1^\circ C}$$

$$\alpha = 0.033^\circ C$$

So, the correct option is (A): $0.033^\circ C$

Concepts:

1. Temperature Dependence of Resistance:

The [temperature dependence of resistance](#) is a fundamental property of all materials that conduct electricity. Generally, the resistance of a conductor increases with an increase in temperature. This phenomenon is known as a positive temperature coefficient of resistance.

The reason for this temperature dependence of resistance is related to the interaction of electrons with the crystal lattice of the material. At lower temperatures, the lattice vibrations are minimal, and the electrons are free to move through the material with minimal scattering. This results in a low resistance to the flow of current. However, as the temperature increases, the lattice vibrations increase, causing the electrons to scatter more frequently, which increases resistance.

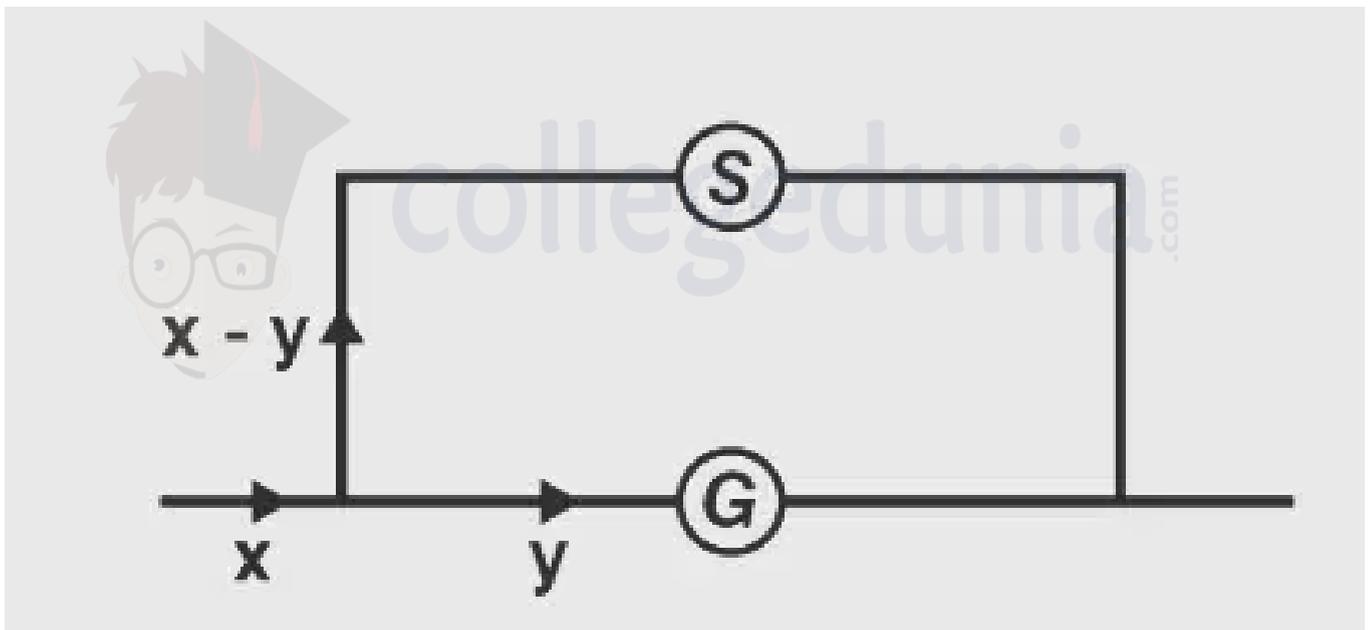
This phenomenon is governed by the relationship between resistance and temperature known as the temperature coefficient of resistance. The temperature coefficient of resistance is defined as the rate at which resistance changes with respect to temperature. The temperature coefficient of resistance is positive for most metals and semiconductors, meaning that resistance increases with increasing temperature.

However, there are a few materials, such as carbon and certain semiconductors, which exhibit a negative temperature coefficient of resistance. In these materials, the resistance decreases as the temperature increases.

The temperature dependence of resistance has important practical implications in the design and operation of electrical circuits and devices. For example, it is essential to consider the effect of temperature on the resistance of electronic components to ensure reliable and efficient operation of devices over a range of temperatures.

13. Answer: b

Explanation:



From the given setup

$$y \times R_G = (x - y)(R_S)$$

$$\Rightarrow y \times 72 = (x - y) \times 8$$

$$\Rightarrow 9y = x - y$$

$$\Rightarrow y = \frac{x}{10} \text{ or } 10\% \text{ of } x$$

Therefore, the correct Option is (B): 10%

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- The lower the resistance, the higher the current flow. Possible causes: insulators damaged by moisture or overheating.

14. Answer: 750 – 750

Explanation:

$$r_i = \frac{10mV}{10\mu A} = 10^3 \Omega$$

$$\beta = \frac{1.5mA}{10\mu A} = 150$$

$$A_V = \left(\frac{R_0}{r_i} \right) \beta = \left(\frac{5000}{1000} \right) \times 150$$
$$= 750$$

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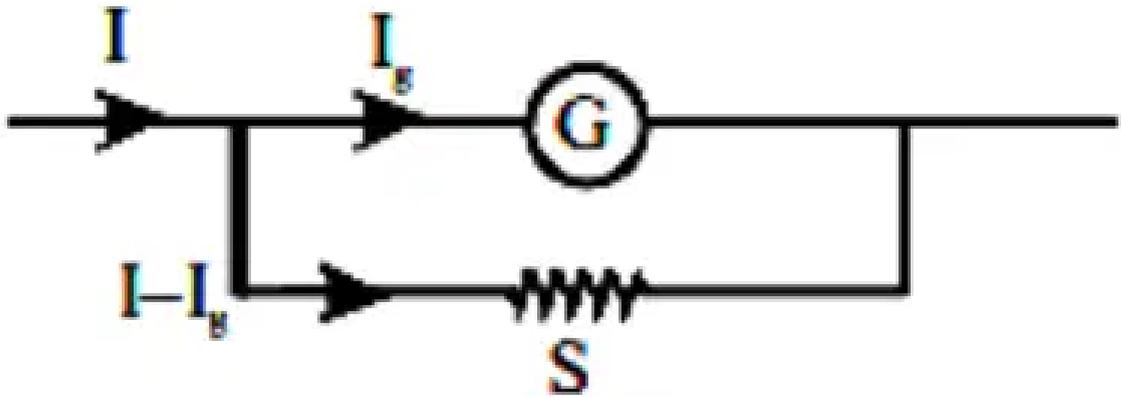
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15. Answer: a

Explanation:

The correct option is (D): $\frac{nK(G+S)}{s}$

According to the information, current through galvanometer = nK



$$\Rightarrow \frac{s}{s+G}i = nK$$

$$\Rightarrow i = \frac{nK(S+G)}{s}$$

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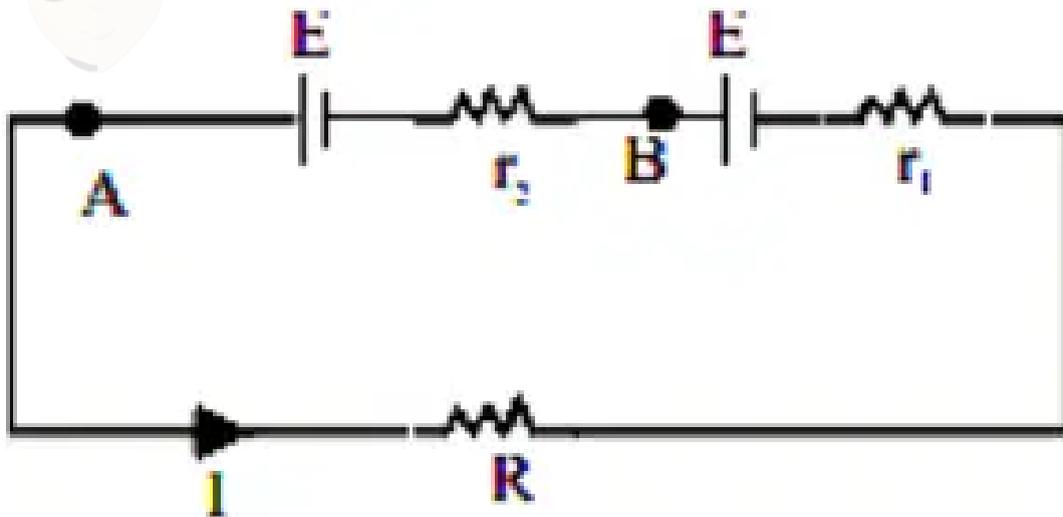
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- The higher the resistance, the lower the current flow. If abnormally high, one possible cause (among many) could be damaged conductors due to burning or corrosion. All conductors give off some degree of heat, so overheating is an issue often associated with resistance.
- The lower the resistance, the higher the current flow. Possible causes: insulators damaged by moisture or overheating.

16. Answer: a

Explanation:

The correct option is (A): $r_2 - r_1$.



$$I = \frac{2\varepsilon}{R+r_1+r_2}$$

As per the question,

$$\frac{2\varepsilon}{R+r_1+r_2} \times r_2 - \varepsilon = 0$$

$$\Rightarrow R = r_2 - r_1$$

Concepts:

1. Temperature Dependence of Resistance:

The [temperature dependence of resistance](#) is a fundamental property of all materials that conduct electricity. Generally, the resistance of a conductor increases with an increase in temperature. This phenomenon is known as a positive temperature coefficient of resistance.

The reason for this temperature dependence of resistance is related to the interaction of electrons with the crystal lattice of the material. At lower temperatures, the lattice vibrations are minimal, and the electrons are free to move through the material with minimal scattering. This results in a low resistance to the flow of current. However, as the temperature increases, the lattice vibrations increase, causing the electrons to scatter more frequently, which increases resistance.

This phenomenon is governed by the relationship between resistance and temperature known as the temperature coefficient of resistance. The temperature coefficient of resistance is defined as the rate at which resistance changes with respect to temperature. The temperature coefficient of resistance is positive for most metals and semiconductors, meaning that resistance increases with increasing temperature.

However, there are a few materials, such as carbon and certain semiconductors, which exhibit a negative temperature coefficient of resistance. In these materials, the resistance decreases as the temperature increases.

The temperature dependence of resistance has important practical implications in the design and operation of electrical circuits and devices. For example, it is essential to consider the effect of temperature on the resistance of electronic components to ensure reliable and efficient operation of devices over a range of temperatures.

17. Answer: b

Explanation:

Let time taken to ascent is t_1 and that to descent is t_2 . Height will be same so

$$H = \frac{1}{2} \times 12t_1^2 = \frac{1}{2} \times 8t_2^2$$

$$\Rightarrow \frac{t_1}{t_2} = \frac{\sqrt{2}}{\sqrt{3}}$$

Concepts:

1. Resistance:

Resistance is the measure of opposition applied by any object to the flow of **electric current**. A resistor is an electronic constituent that is used in the circuit with the purpose of offering that specific amount of resistance.

$$R = V/I$$

In this case,

v = Voltage across its ends

I = Current flowing through it

All materials resist current flow to some degree. They fall into one of two broad categories:

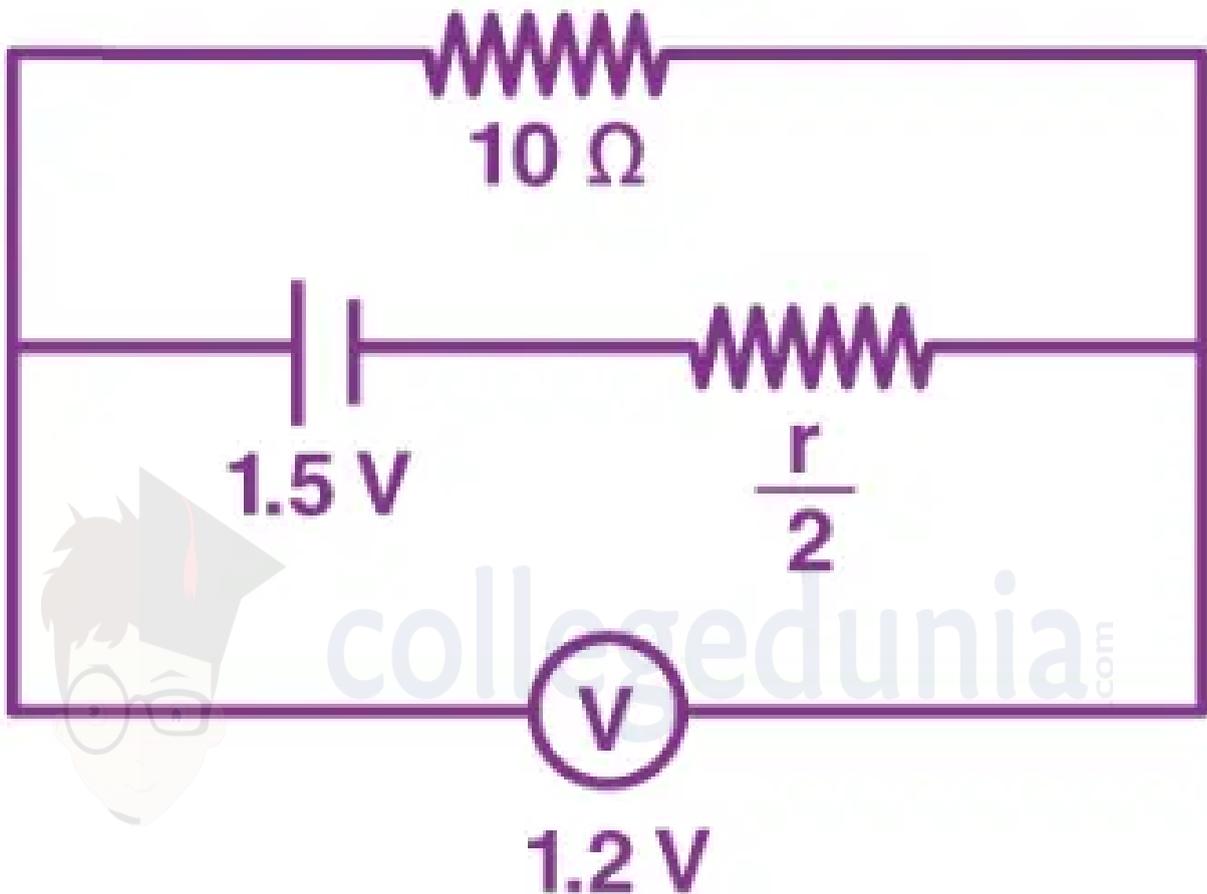
- **Conductors:** Materials that offer very little resistance where electrons can move easily. Examples: silver, copper, gold and aluminum.
- **Insulators:** Materials that present high resistance and restrict the flow of electrons. Examples: Rubber, paper, glass, wood and plastic.

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18. Answer: c

Explanation:



$$\frac{1.5 \times 10}{10 + \frac{r}{2}} = 1.2$$

$$\Rightarrow r = 5 \Omega$$

The correct option is (C) : 5 W

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19. Answer: b

Explanation:

$$R_{eq} = \frac{2 \times 4}{2+6} + 6 = \frac{22}{3}$$

⇒ A and B are in parallel and C is in series.

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20. Answer: a

Explanation:

The circuit consists of three resistors: $20\text{ k}\Omega$, $20\text{ k}\Omega$, and $10\text{ k}\Omega$, connected in parallel. The equivalent resistance of resistors in parallel is given by:

$$\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Substitute $R_1 = 20\text{ k}\Omega$, $R_2 = 20\text{ k}\Omega$, and $R_3 = 10\text{ k}\Omega$:

$$\frac{1}{R_{\text{eq}}} = \frac{1}{20} + \frac{1}{20} + \frac{1}{10}$$

Simplify:

$$\frac{1}{R_{\text{eq}}} = \frac{1}{20} + \frac{1}{20} + \frac{2}{20} = \frac{4}{20} = \frac{1}{5}$$

Solve for R_{eq} :

$$R_{eq} = 5 \text{ k}\Omega.$$

Final Answer: The equivalent resistance between A and B is:

$$\boxed{5 \text{ k}\Omega}.$$

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