Term-02 G10 ADV EOT Solved

1	Define electric current and identify its SI unit as Ampere (A), 1A=1C/S

Page 92

Rate of flow of charge is called as current

$$I = \frac{Q}{t} \qquad SI\ unit\ of\ current\ is\ ampere\ (A) = \frac{coulomb}{second}$$

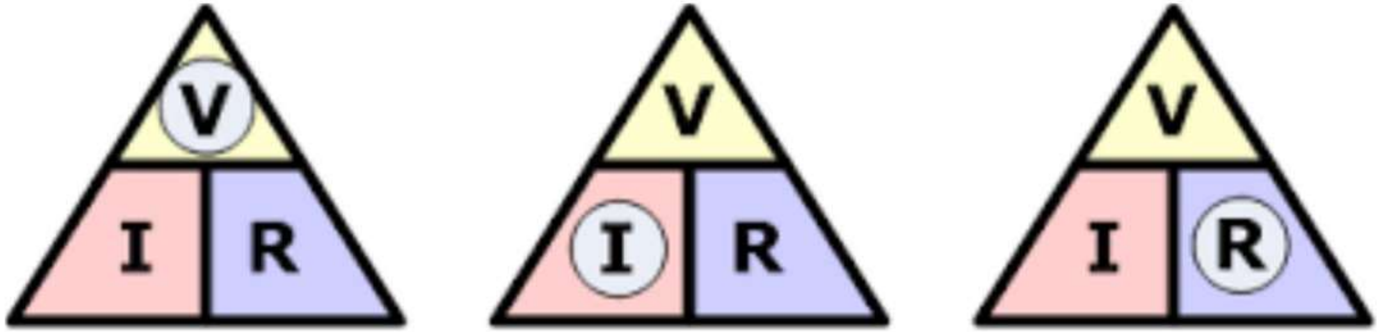
2	Determine the magnitude of the current in terms of the rate of flow of electric charge [I=q/t].

Page 92

The rate of flow of electric charge $\left(\frac{q}{t}\right)$ is called electric current and is measured in coulombs per second. Electric current is represented by I, so $I = \frac{q}{t}$. A flow of electric charge equal to one coulomb per second (1 C/s) is called an **ampere** (A).

3	State Ohm's law and apply it to simple circuits [ΔV=I.R].

What is Ohm's Law? Ohm's law states that the current through a conductor between two points is directly proportional to the voltage across the two points. Therefore, V = RI where R is a constant called resistance. R depends on the dimensions of the conductor and also on the material of the conductor.

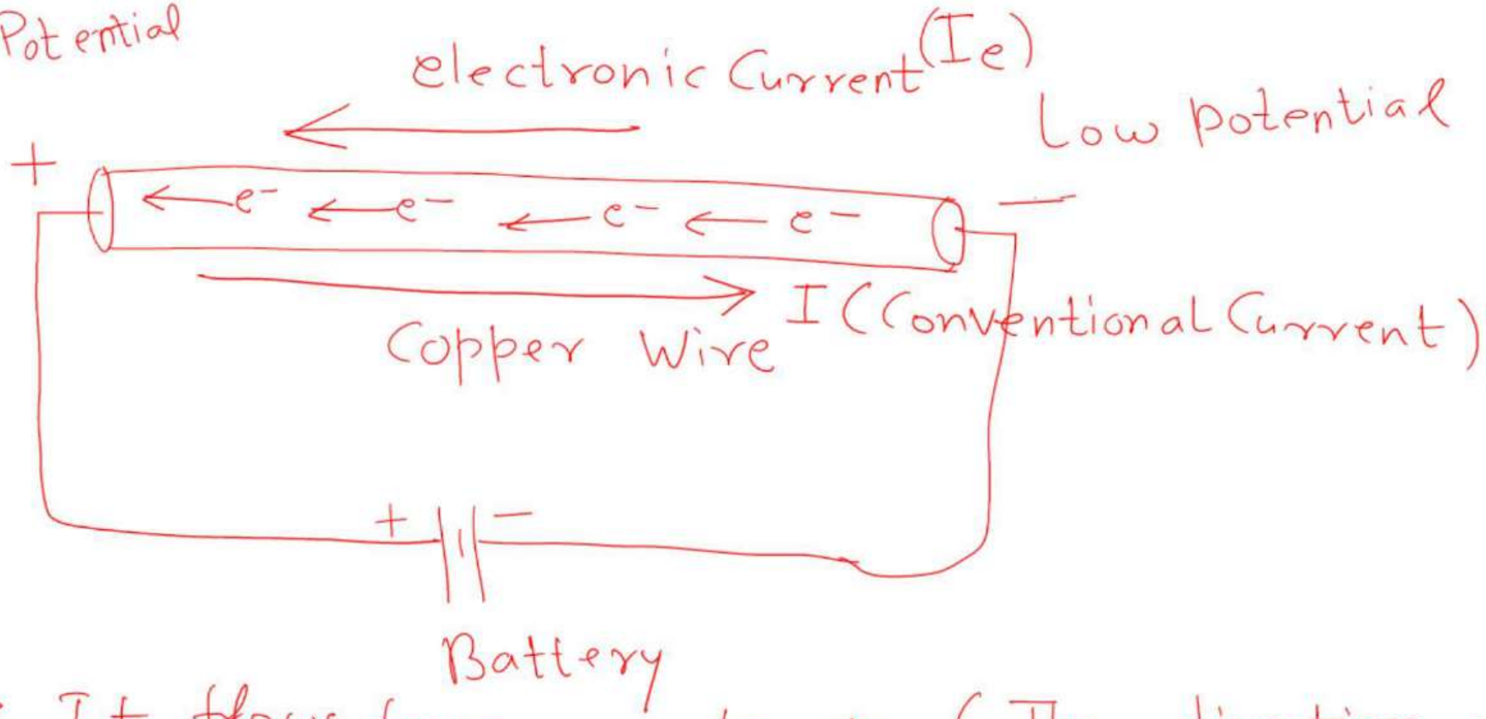


$V = I \times R$ $\quad I = \frac{V}{R}$ $\quad R = \frac{V}{I}$

Nora

Electric Current

Battery provides potential difference between two ends of the conductor



① **Electronic Current** → It flows from − to + (The direction of flow of Electrons)

② **Conventional Current** → The direction of flow of Conventional Current is in the opposite direction to that of Electrons. (from + to −)

Nora

Current

Electronic Current (I_e)
(Negative to Positive)

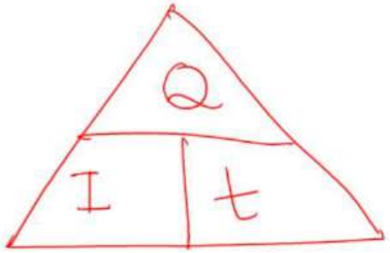
Conventional Current (I)
Positive to Negative

Nora

Electric Current → (Conventional Current) I

The rate of flow of charge in unit time is called Electric Current.

$$\text{Electric Current } (I) = \frac{\text{Charge } (Q)}{\text{time } (t)}$$



$Q = I t$

We know that $Q = n e$ (Q: Charge; n: No. of electrons; e → Charge on Electron)

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

$e = -1.6 \times 10^{-19}$ Coulomb

Unit of Charge = Q ⇒ Coulomb (C)

1	Define electric current and identify its SI unit as Ampere (A), 1A=1C/S

Page 92

Rate of flow of charge is called as current

$$I = \frac{Q}{t}$$ SI unit of current is ampere $(A) = \frac{coulomb}{second}$

Coulomb / Sec

2	Determine the magnitude of the current in terms of the rate of flow of electric charge [I=q/t].

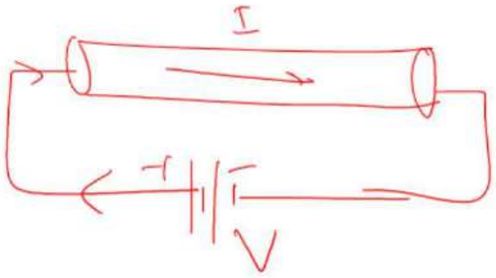
The rate of flow of electric charge $\left(\frac{q}{t}\right)$ is called electric current and is measured in coulombs per second. Electric current is represented by I, so $I = \frac{q}{t}$. A flow of electric charge equal to one coulomb per second (1 C/s) is called an **ampere** (A).

Page 92

Nora

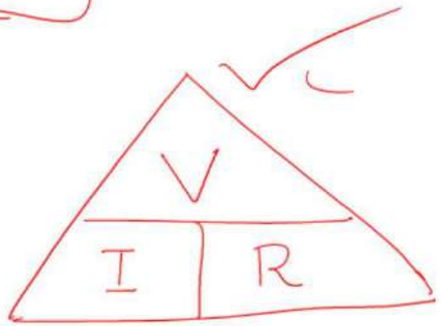
Ohm's Law – "If the Physical Conditions of a Conductor (like the length, area of Cross-Section, material and temperature) remain same. Then the potential difference applied is directly proportional to current

$$V \propto I$$



Ohm's law formula

$$V = IR$$



R is called Resistance of Conductor.

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

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

4	Define a short circuit and describe its effects.

I more current
more Heating

Effects of short-circuit

1. When a short-circuit occurs, the current in the system increases to an abnormally high value while the system voltage decreases to a low value.
2. Short-circuit causes excessive heating which may result in fire or explosion.
3. Sometimes short-circuit takes the form of an arc and causes considerable damage to the system.
4. Low voltage created by the fault has a very harmful effect on the service rendered by the power system. If the voltage remains low for even a few seconds, the consumers' motors may be shut down and generators on the power system may become unstable.

What Is an Electrical Short Circuit?

A short circuit is an abnormal condition in an electrical circuit where the electrical current flows through an unintended, shorter pathway instead of following the circuit.

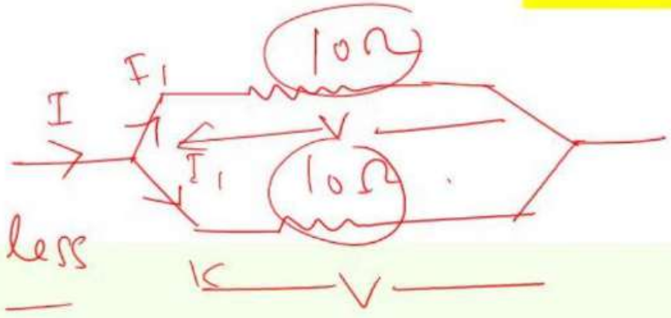
Nora

5	Explain the characteristics of a parallel circuit

Properties

In our house wiring is in parallel

Parallel means equivalent resistance will be less



$$\frac{1}{R} = \frac{1}{10} + \frac{1}{10}$$

$$\frac{1}{R} = \frac{2}{10} = \frac{1}{5}$$

$$R = 5\,\Omega$$

Characteristics of a parallel circuit.

1. Each device joins the same two spots. As a result, each gadget has the same voltage.
2. The circuit's total current is split (divide) between the parallel branches. Each branch's current is proportional to the inverse of its resistance.
3. The sum of the currents in the parallel branches equals the total current in the circuit.
4. The overall resistance of the circuit decreases as the number of branches grows.

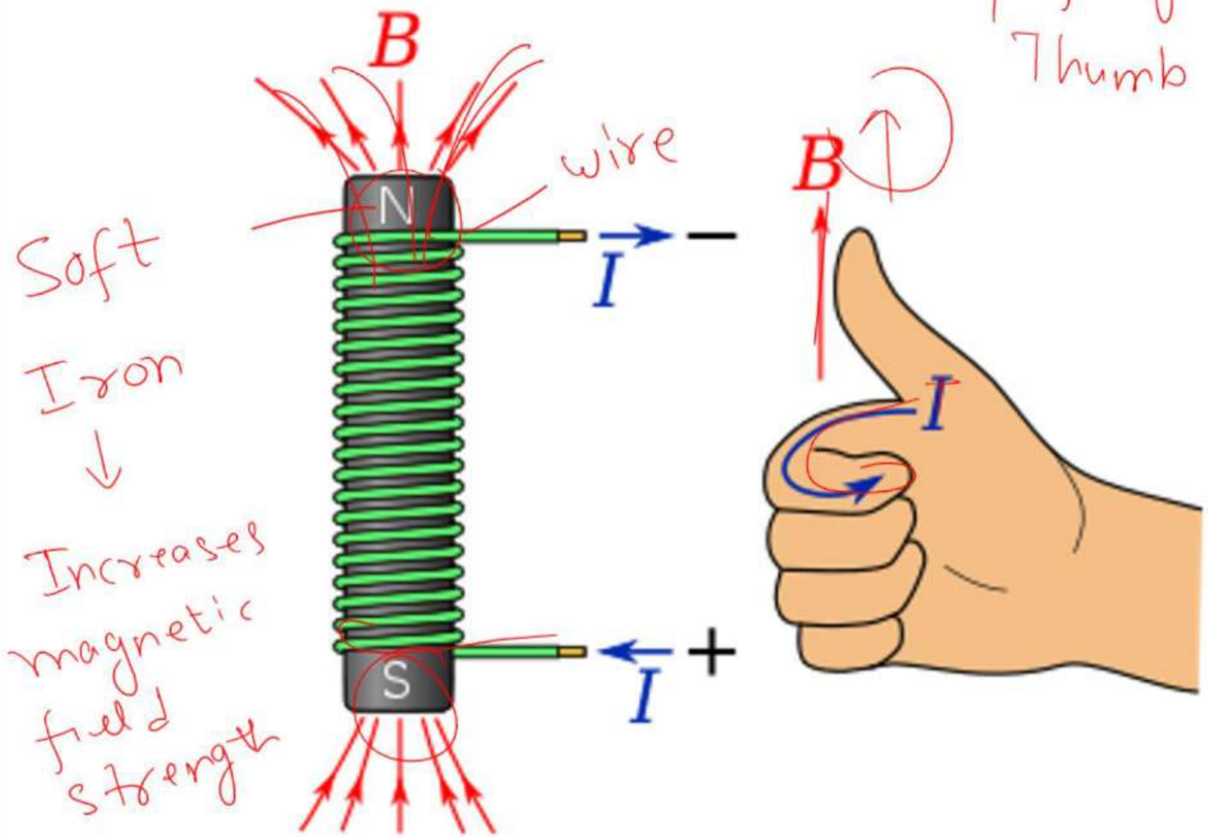
Nora

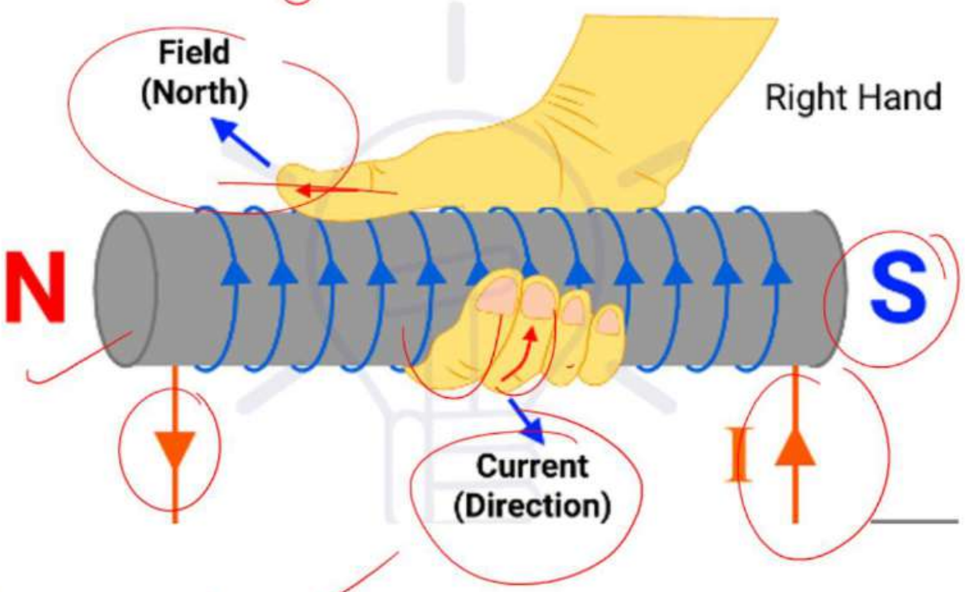
6	Apply the right-hand rule to indicate the direction of the magnetic field in and around a solenoid carrying current.

Page 116

Curly fingers represent Current

Thumb Represent - magnetic field





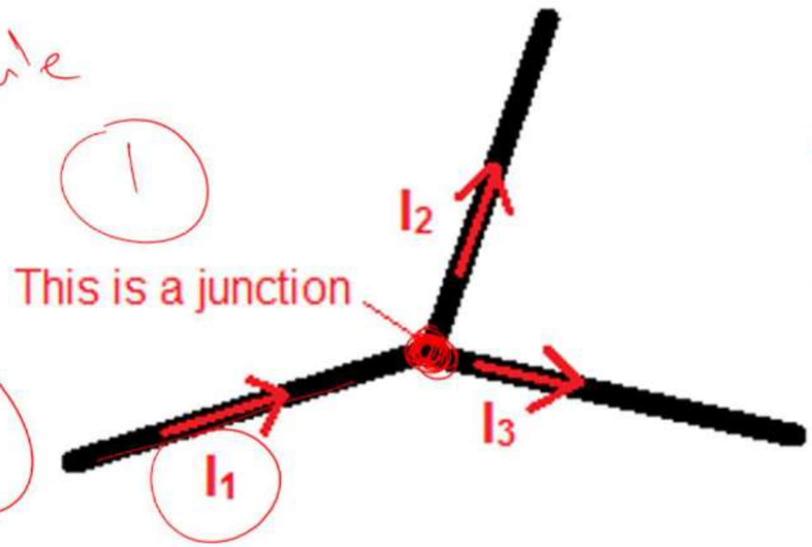
Right Hand Thumb Rule

7	Apply Kirchhoff's junction rule to electric circuits.

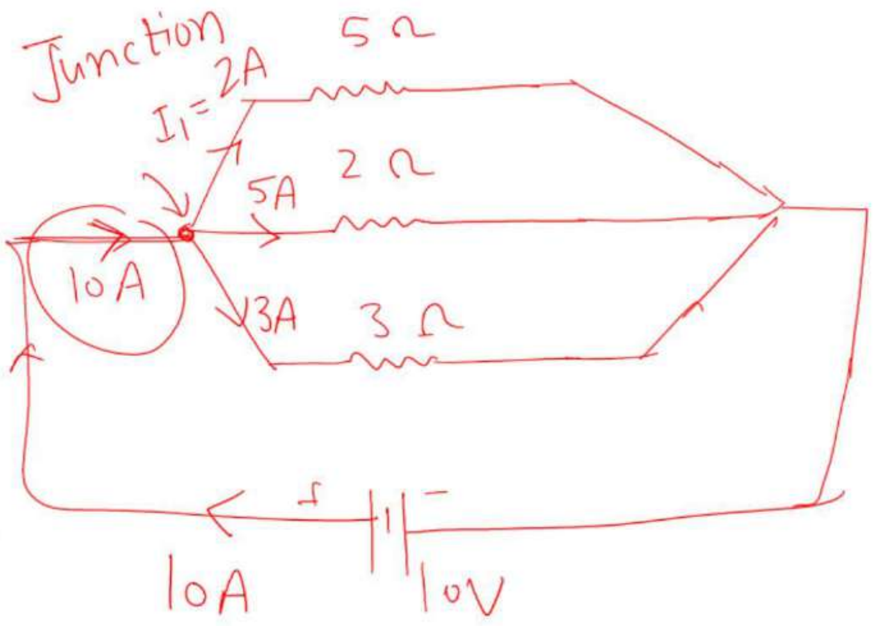
Page 94

Junction Rule

(1)



$I_1 = I_2 + I_3$



Kirchhoff's Junction Rule:

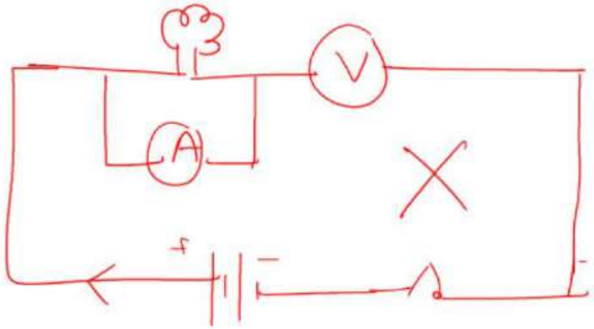
Current In = Current Out

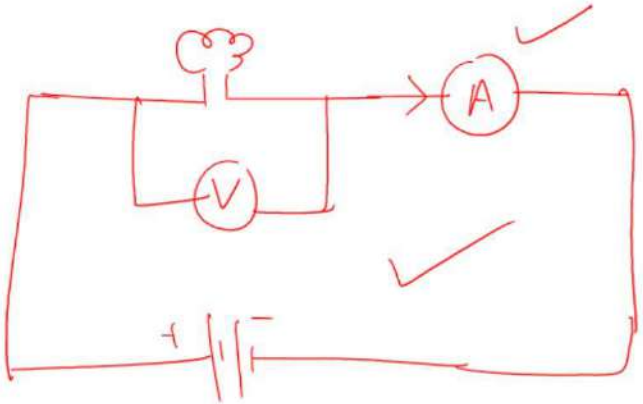
$I_1 = I_2 + I_3$

I_{in} = Sum of Current out

$I = I_1 + I_2 + I_3$

Nora

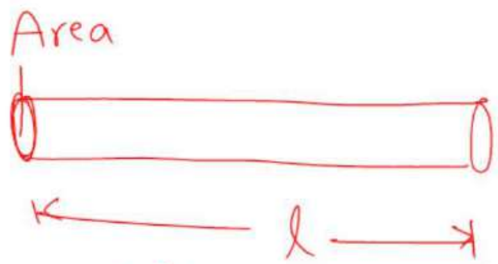




(V) Voltmeter → Always we connect in parallel

(A) Ammeter → Always connected in series.

Factor Affecting the resistance



① Length of Conductor –

more the length, more the resistance

linear $\boxed{R \propto l}$ ✓ —— ①

ρ (Rho)

② Area of Cross-Section (A)

more area less will be the resistance

Inverse $\boxed{R \propto \frac{1}{A}}$ —— ②

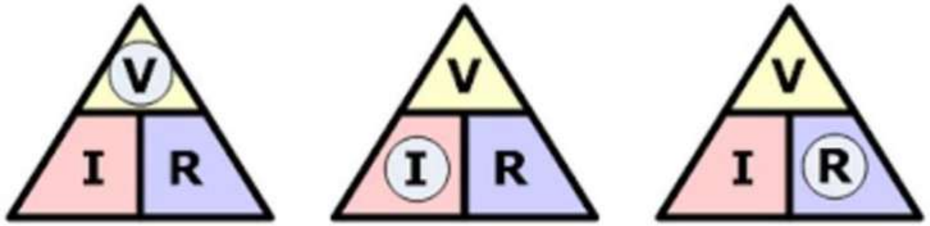
③ Temperature – more the temperature more will be the resistance.

$R \propto \frac{l}{A} \Rightarrow \boxed{R = \rho \frac{l}{A}}$ (V. Imp)

ρ (Rho) ⇒ Resistivity of material

10	State Ohm's law and apply it to simple circuits [ΔV=I.R].

Page 97

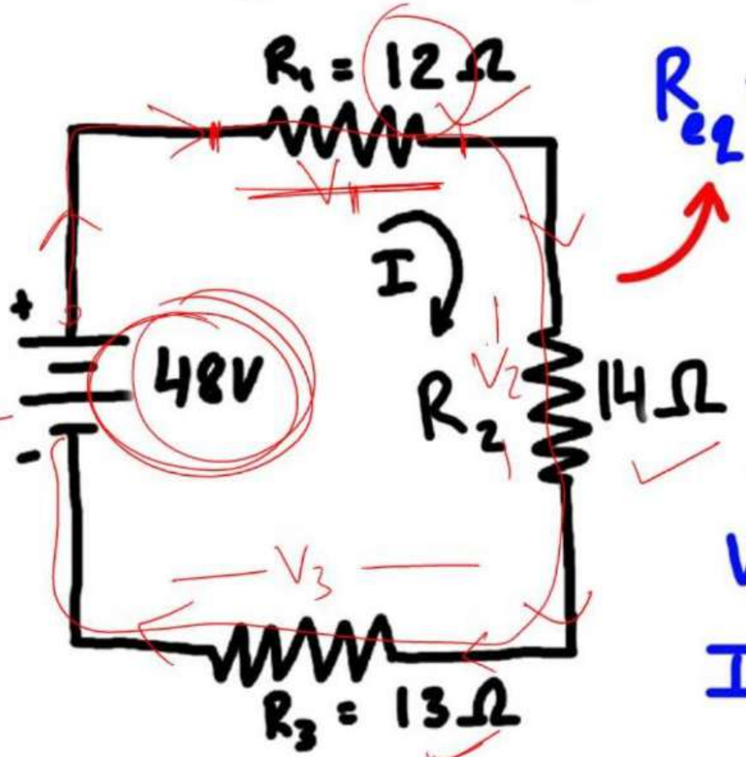


$V = I \times R$ $I = \frac{V}{R}$ $R = \frac{V}{I}$

$R = R_1 + R_2 + R_3$
$= 12 + 14 + 13 = 39\,\Omega$

$I = \frac{V}{R} = \frac{48}{39} = 1.23\,A$

Example :



$R_{eq} = R_1 + R_2 + R_3 = 39\,\Omega$

$V = IR$

$I = \frac{V}{R} = \frac{48\,V}{39\,\Omega} = 1.23\,A$

$V_1 = I R_1$
$V_1 = 1.23 \times 12 =$
$V_2 = I R_2 = 1.23 \times 14 =$
$V_3 = I R_3 = 1.23 \times 13 =$

11	Calculate the amount of energy transformed to thermal energy by a resistor (if power is transformed at a constant rate) using the equation E=Pt=I2 Rt=((ΔV)2/R)t

Energy (E) = Work done

Page 93

EXAMPLE 1

Power = $\frac{W}{t} = \frac{E}{t}$

ELECTRIC POWER AND ENERGY A 6.0 V battery delivers a 0.50 A current to an electric motor connected across its terminals.

a. What power is delivered to the motor?

b. If the motor runs for 5.0 min, how much electrical energy is delivered?

(1) $E = P \times t$

(2) $E = V \times I \times t$

(3) $E = I^2 R t$

(4) $E = \frac{V^2}{R} \times t$

(a) $P = V \times I = 6 \times 0.5 = 3$ Watt

(b) $t = 5$ min $= 5 \times 60 = 300$ sec

$E = 6 \times 0.5 \times 300 = \_\_\_\_$ J

Nora

Type here to search

27°C Partly cloudy

8:46 PM

3/8/2023

12	Define a kilowatt-hour as a unit for measuring electrical energy and is equal to 1000 watts delivered continuously for 3600 s (or 1h)

If we use 1000 Watt appliences for 1 hour then Electrical Energy Consumed is 1 KWh.

1 Unit = 1 KWh = 1000 Watt × 60 min = 1000 Watt × 60 × 60

(K → Kilo, W → Watt, h → hour)

= 3600 × 1000 Joule

1 kWh = 3.6×10^6 Joule

Rate

2350 Units × 0.25 = ______ AED

4	Define a short circuit and describe its effects.

Effects of short-circuit

- When a short-circuit occurs, the current in the system increases to an abnormally high value while the system voltage decreases to a low value.
- Short-circuit causes excessive heating which may result in fire or explosion.
- Sometimes short-circuit takes the form of an arc and causes considerable damage to the system.
- Low voltage created by the fault has a very harmful effect on the service rendered by the power system. If the voltage remains low for even a few seconds, the consumers' motors may be shut down and generators on the power system may become unstable.

What Is an Electrical Short Circuit?

A short circuit is an abnormal condition in an electrical circuit where the electrical current flows through an unintended, shorter pathway instead of following the circuit.

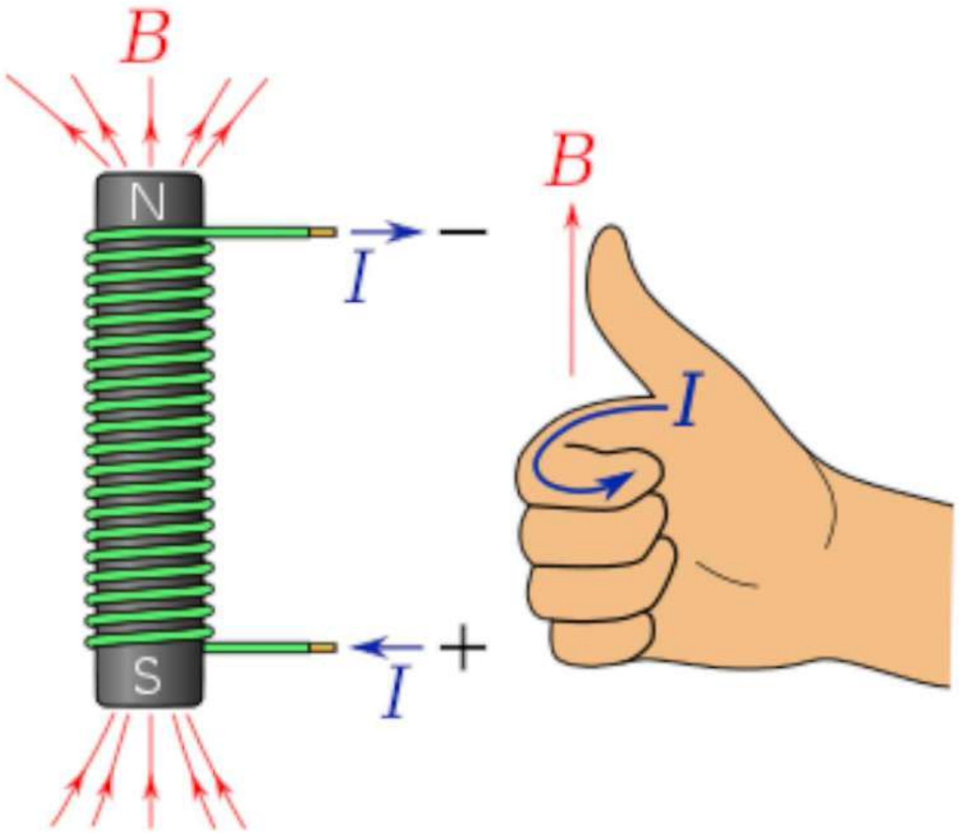
5	Explain the characteristics of a parallel circuit

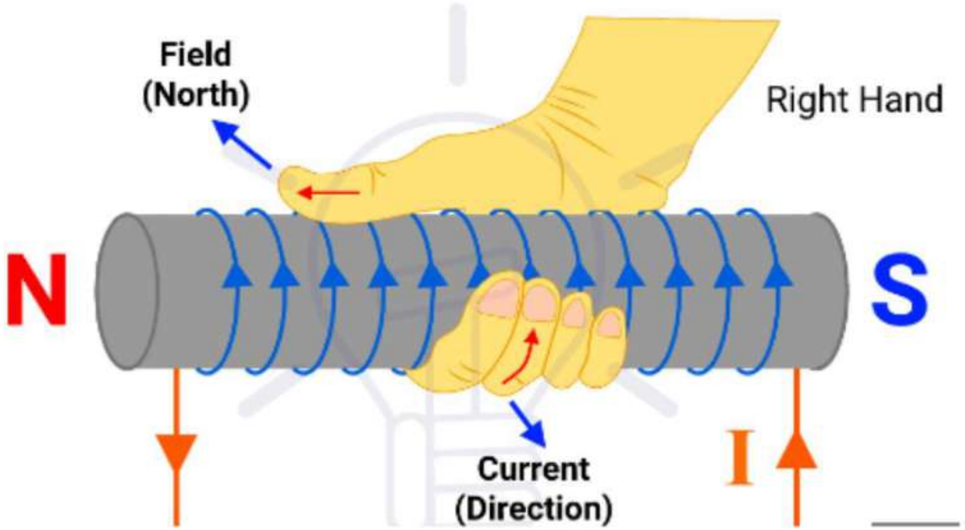
Characteristics of a parallel circuit.

1. Each device joins the same two spots. As a result, each gadget has the same voltage.
2. The circuit's total current is split between the parallel branches. Each branch's current is proportional to the inverse of its resistance.
3. The sum of the currents in the parallel branches equals the total current in the circuit.
4. The overall resistance of the circuit decreases as the number of branches grows.

Nora

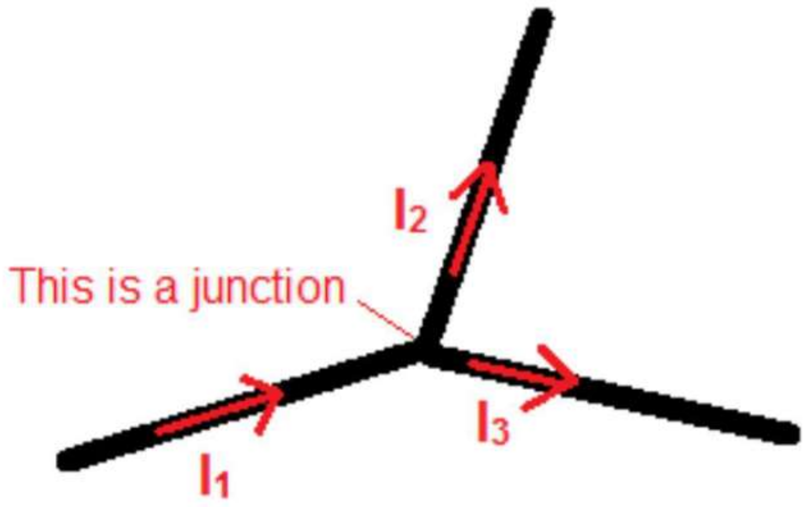
6	Apply the right-hand rule to indicate the direction of the magnetic field in and around a solenoid carrying current.





Nora

7	Apply Kirchhoff's junction rule to electric circuits.



Kirchhoff's Junction Rule:

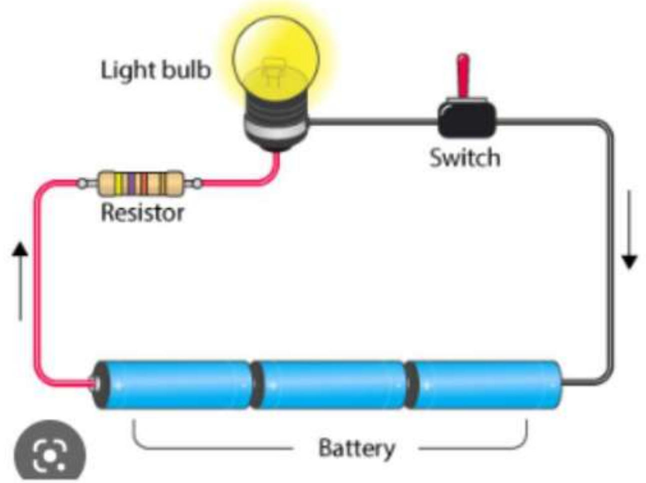
Current In = Current Out

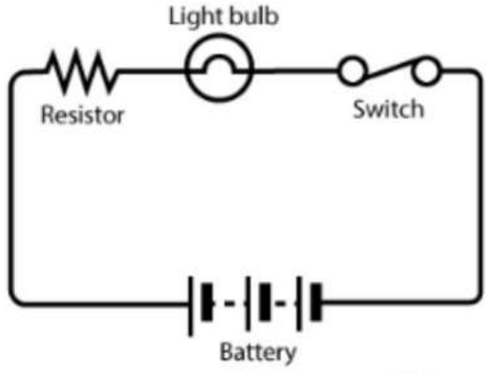
$$I_1 = I_2 + I_3$$

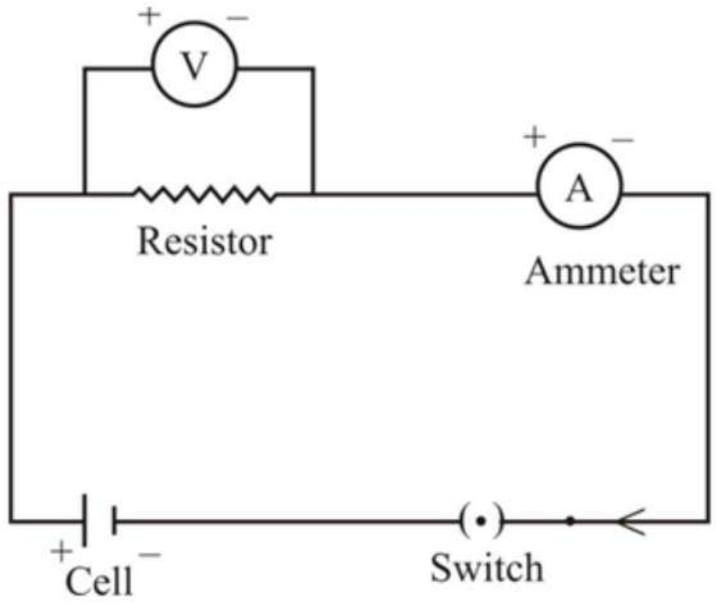
Nora

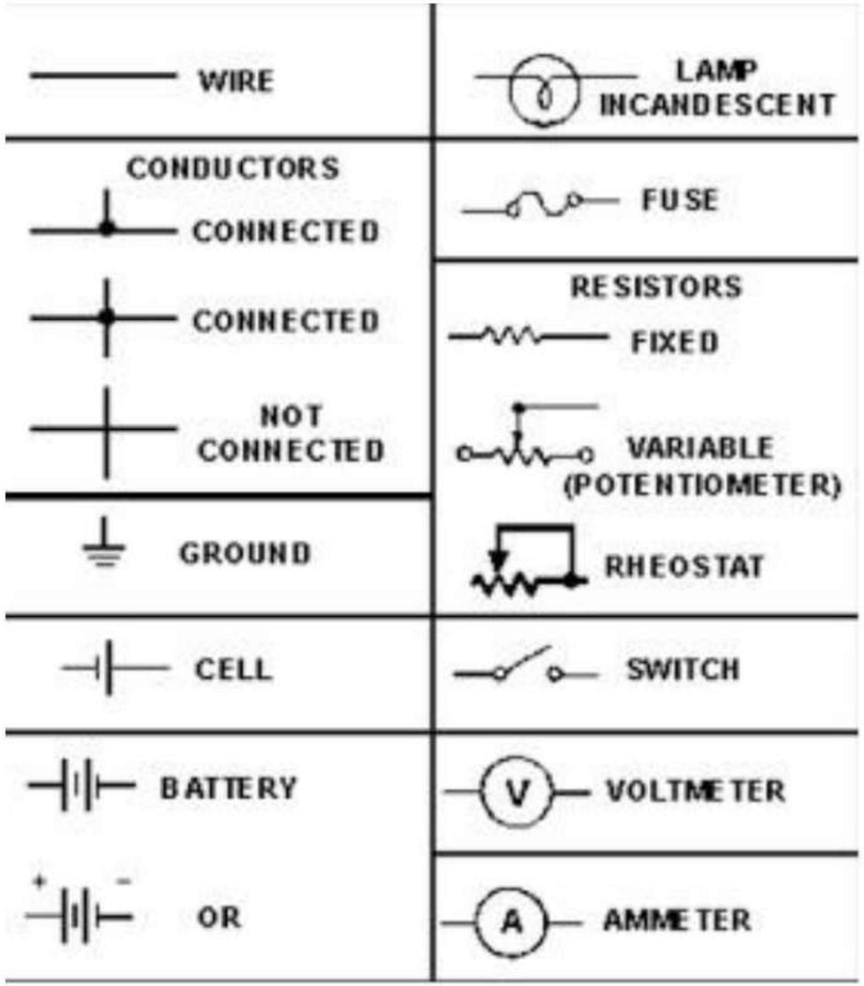
8	Draw schematic circuit diagrams with different components along with ammeters and voltmeters correctly connected to measure current and voltage

Page 95









Nora

9	Explain the factors (like length, cross-sectional area, temperature and material of the conductor) that affect the resistance of a conductor.

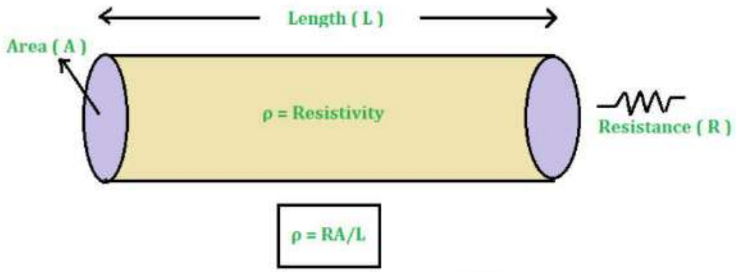
Factors Affecting Resistance

1. The length L of the material. Longer materials have greater resistance.

2. The cross-sectional area A of the material. Larger areas offer LESS resistance.

3. The temperature T of the material. The higher temperatures usually result in higher resistances.

4. The kind of material. Iron has more electrical resistance than a geometrically similar copper conductor.



$\rho = 1.3 \times 10^{-7}\ \Omega m$

$L = 1\ m$, $A = 0.25\ m^2$

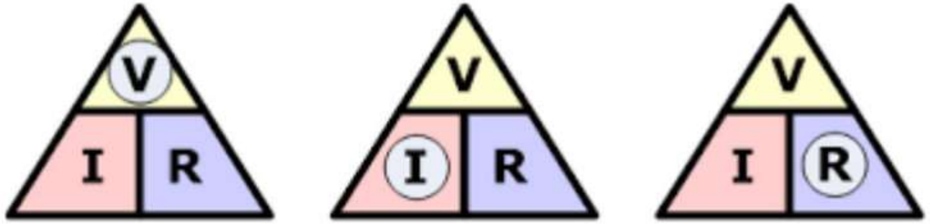
$$R = \frac{\rho L}{A}$$

ρ = resistivity
L = length
A = cross sectional area

$R = \frac{1.3 \times 10^{-7} \times 1}{0.25} =$

Nora

10	State Ohm's law and apply it to simple circuits [ΔV=I.R].

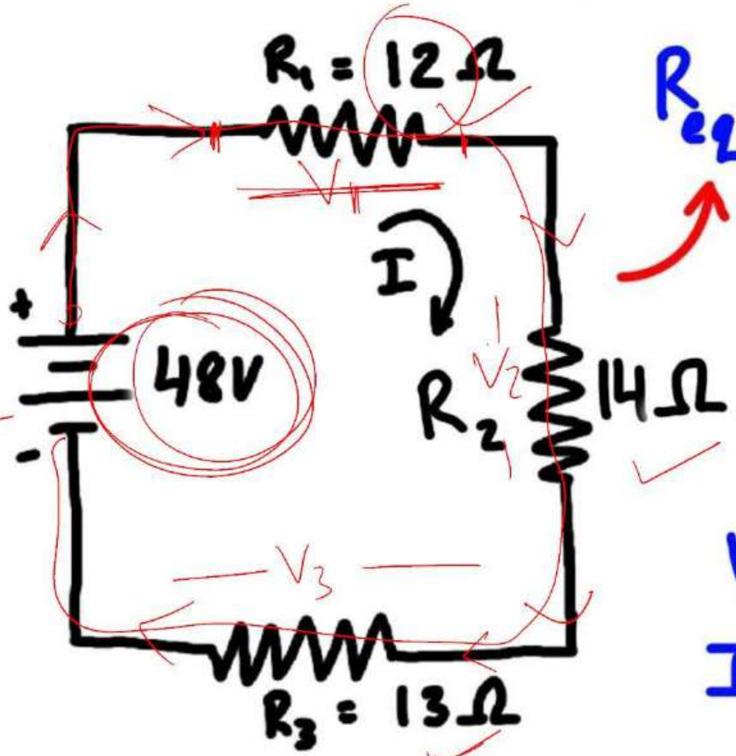


$V = I \times R$ $\quad I = \frac{V}{R}$ $\quad R = \frac{V}{I}$

$R = R_1 + R_2 + R_3$
$= 12 + 14 + 13 = 39\,\Omega$

$I = \frac{V}{R} = \frac{48}{39} = 1.23A$

Example :



$R_{eq} = R_1 + R_2 + R_3 = 39\,\Omega$

$V_1 = I R_1$
$V_1 = 1.23 \times 12 =$
$V_2 = I R_2 = 1.23 \times 14 =$
$V_3 = I R_3 = 1.23 \times 13 =$

$V = IR$

$I = \frac{V}{R} = \frac{48\,V}{39\,\Omega} = 1.23A$

Nora

11	Calculate the amount of energy transformed to thermal energy by a resistor (if power is transformed at a constant rate) using the equation E=Pt=I2 Rt=((ΔV)2/R)t

Energy (E) = Work done

EXAMPLE 1

Power = $\frac{W}{t}$ = $\frac{E}{t}$

ELECTRIC POWER AND ENERGY A 6.0 V battery delivers a 0.50 A current to an electric motor connected across its terminals.

a. What power is delivered to the motor?

b. If the motor runs for 5.0 min, how much electrical energy is delivered?

① $E = P \times t$

② $E = V \times I \times t$

③ $E = I^2 R t$

④ $E = \frac{V^2}{R} \times t$

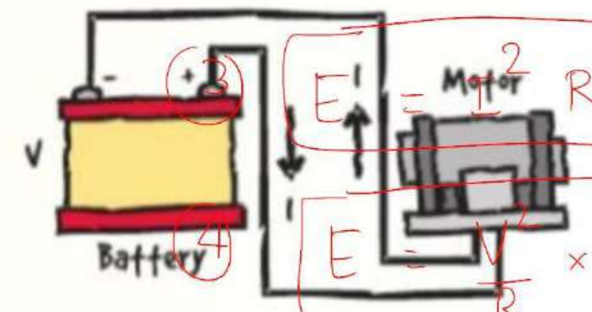
1 ANALYZE AND SKETCH THE PROBLEM

(a) $P = V \times I = 6 \times 0.5 = 3$ Watt

- Draw a circuit showing the positive terminal of a battery connected to a motor and the return wire from the motor connected to the negative terminal of the battery.
- Show the direction of conventional current.

(b) $t = 5$ min $= 5 \times 60 = 300$ sec

$E = 6 \times 0.5 \times 300 =$ ______ J



KNOWN	UNKNOWN
$\Delta V = 6.0$ V	$P = ?$
$I = 0.50$ A	$E = ?$
$t = 5.0$ min	

Nora

2 SOLVE FOR THE UNKNOWN

a. Use $P = I\Delta V$ to find the power.

$$P = I\Delta V$$

$$P = (0.50\ \text{A})(6.0\ \text{V})$$

$$= 3.0\ \text{W}$$

◀ *Substitute $I = 0.50$ A, $V = 6.0$ V.*

b. You learned that $P = \frac{E}{t}$. Solve for E to find the energy.

$$E = Pt$$

$$= (3.0\ \text{W})(5.0\ \text{min})$$

◀ *Substitute $P = 3.0$ W, $t = 5.0$ min.*

$$= (3.0\ \text{J/s})(5.0\ \text{min})\left(\frac{60\ \text{s}}{1\ \text{min}}\right)$$

$$= 9.0\times10^{2}\ \text{J}$$

3 EVALUATE THE ANSWER

- **Are the units correct?** Power is measured in watts, and energy is measured in joules.
- **Is the magnitude realistic?** With relatively low voltage and current, a few watts of power is reasonable.

Nora

12	Define a kilowatt-hour as a unit for measuring electrical energy and is equal to 1000 watts delivered continuously for 3600 s (or 1h)

The amount of electrical energy used by a device is its rate of energy consumption, in joules per second or watts (W), multiplied by the number of seconds the device is operated. Joules per second times seconds $\left(\frac{J}{s} \times s\right)$ equals the total amount of joules of energy. The joule, also defined as a watt-second, is a relatively small amount of energy, too small for commercial sales use. For this reason, electric companies measure energy sales in a unit of a large number of joules called a kilowatt-hour (kWh). A **kilowatt-hour** is equal to 1000 watts delivered continuously for 3600 s (1 h), or 3.6×10^6 J. Not many household devices other than hot-water heaters, stoves, clothes dryers, microwave ovens, heaters, and hair dryers require more than 1000 W of power.

If we use 1 kilowatt appliance for 1 hour then Electrical Energy Consumed is 1 KWh.

1 Unit = 1 KWh

1000 Watt × 60 min = 1000 Watt × 60 × 60 = 3600 × 1000 Joule

1 KWh = 3.6×10^6 Joule

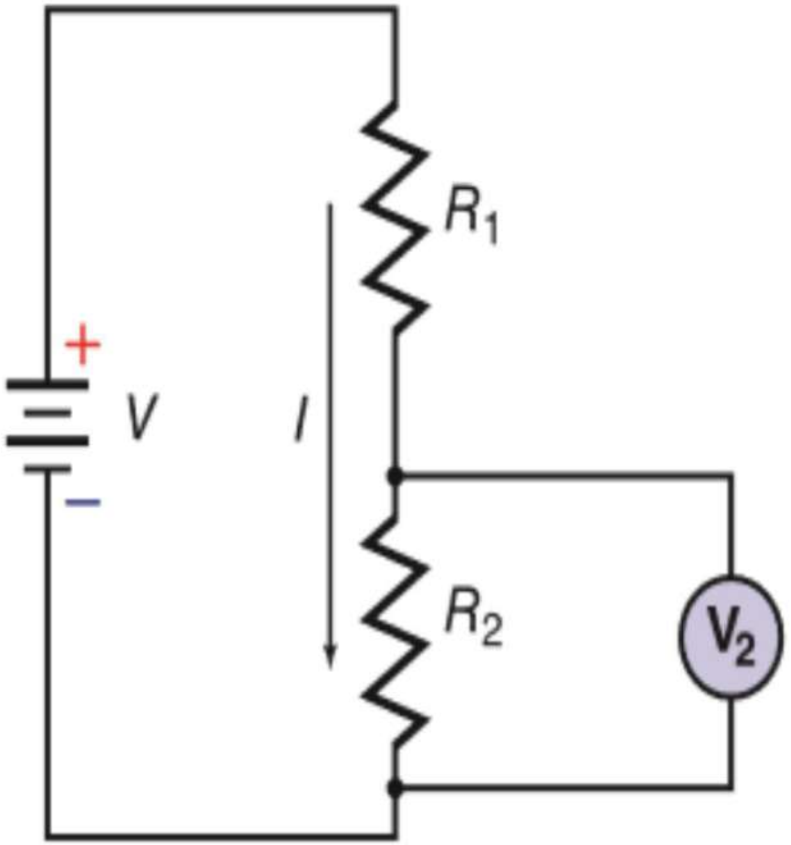
2350 Units × 0.25 = ______ AED

Nora

13 Use the voltage divider circuit as a series circuit to calculate resistances and voltage drop across the components

Page 108

$$\Delta V_2 = IR_2 = \left(\frac{\Delta V}{R_1 + R_2}\right)R_2 = \frac{\Delta V R_2}{R_1 + R_2}$$

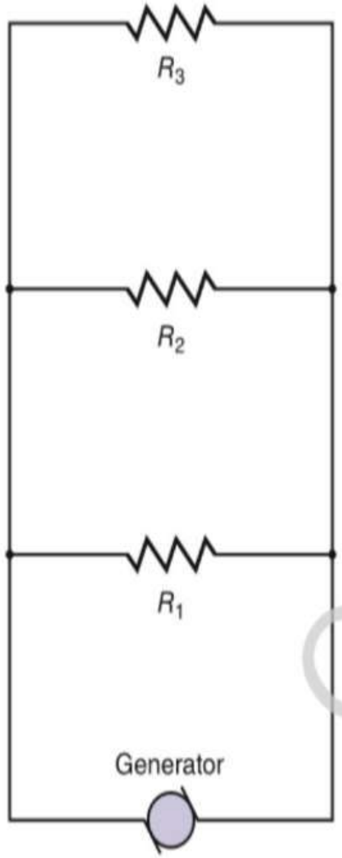


Nora

14	Explain the characteristics of a parallel circuit

Characteristics of a parallel circuit.

1. Each device joins the same two spots. As a result, each gadget has the same voltage.
2. The circuit's total current is split between the parallel branches. Each branch's current is proportional to the inverse of its resistance.
3. The sum of the currents in the parallel branches equals the total current in the circuit.
4. The overall resistance of the circuit decreases as the number of branches grows.



Nora

15 | Calculate the equivalent resistance of a parallel circuit

Page 113

EQUIVALENT RESISTANCE FOR RESISTORS IN PARALLEL
The reciprocal of the equivalent resistance is equal to the sum of the reciprocals of the individual resistances.

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

EQUIVALENT RESISTANCE AND CURRENT IN A PARALLEL CIRCUIT Three resistors, 60.0 Ω, 30.0 Ω, and 20.0 Ω, are connected in parallel across a 90.0 V battery.

EXAMPLE 3

a. Find the current through each branch of the circuit.

b. Find the equivalent resistance of the circuit.

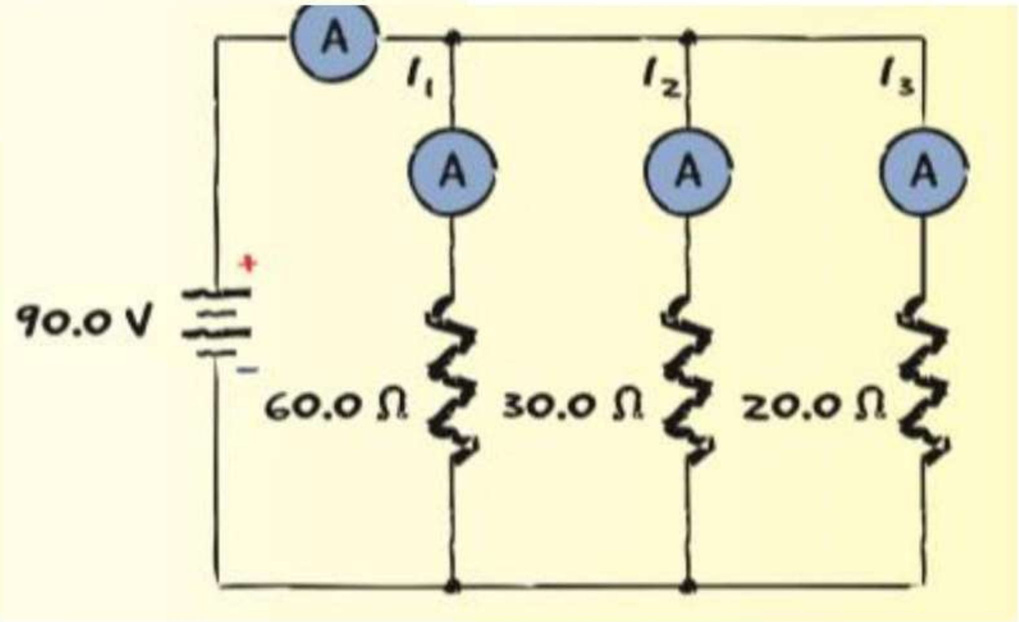
c. Find the current through the battery.

KNOWN

$R_1 = 60.0\ \Omega$
$R_2 = 30.0\ \Omega$
$R_3 = 20.0\ \Omega$
$\Delta V = 90.0\text{ V}$

UNKNOWN

$I_1 = ?$ $I = ?$
$I_2 = ?$ $R = ?$
$I_3 = ?$



Nora

2 SOLVE FOR THE UNKNOWN

a. Because the voltage across each resistor is the same, use $I = \frac{\Delta V}{R}$ for each branch.

$$I_1 = \frac{\Delta V}{R_1} = \frac{90.0\ \text{V}}{60.0\ \Omega} = 1.50\ \text{A}$$

$$I_2 = \frac{\Delta V}{R_2} = \frac{90.0\ \text{V}}{30.0\ \Omega} = 3.00\ \text{A}$$

$$I_3 = \frac{\Delta V}{R_3} = \frac{90.0\ \text{V}}{20.0\ \Omega} = 4.50\ \text{A}$$

b. Use the equivalent resistance equation for parallel circuits.

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

$$= \frac{1}{60.0\ \Omega} + \frac{1}{30.0\ \Omega} + \frac{1}{20.0\ \Omega}$$

$$= 0.100\ \Omega^{-1}$$

$$R = 10.0\ \Omega$$

c. Use $I = \frac{\Delta V}{R}$ to find the total current.

$$I = \frac{\Delta V}{R} = \frac{90.0\ \text{V}}{10.0\ \Omega} = 9.00\ \text{A}$$

3 EVALUATE THE ANSWER

- **Are the units correct?** Current is measured in amps; resistance is measured in ohms.
- **Is the magnitude realistic?** The equivalent resistance is less than the resistance of any single resistor. The currents through the resistors are inversely proportional to the resistance. The current for the circuit (I) equals the sum of the currents found for each resistor ($I_1 + I_2 + I_3$).

Nora

16	Describe the forces that occur when like or unlike poles of two permanent magnets are brought close together (in terms of the interaction between the magnetic fields and the orientation of the magnetic field lines).

Like poles repel.

Unlike poles attract.

Figure 2 Like poles of two magnets repel each other (top), while unlike poles attract each other (bottom).

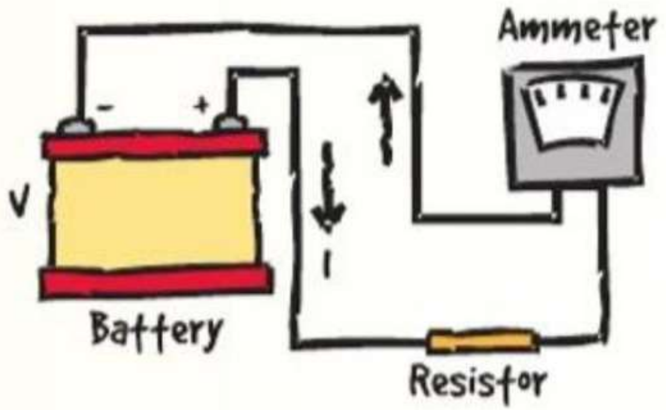
17	Determine the magnitude of the current in terms of the rate of flow of electric charge [I=q/t]. State Ohm's law and apply it to simple circuits [ΔV=I.R].

EXAMPLE 2

CURRENT THROUGH A RESISTOR A 30.0 V battery is connected to a 10.0-Ω resistor. What is the current in the circuit?

1 ANALYZE AND SKETCH THE PROBLEM

- Draw a circuit containing a battery, an ammeter, and a resistor.
- Show the direction of the conventional current.



KNOWN	UNKNOWN
$\Delta V = 30.0\ V$	$I = ?$
$R = 10.0\ \Omega$	

2 SOLVE FOR THE UNKNOWN

Use $I = \frac{\Delta V}{R}$ to determine the current.

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

$$= \frac{30.0\ V}{10.0\ \Omega}$$ ◄ Substitute

$$= 3.00\ A$$

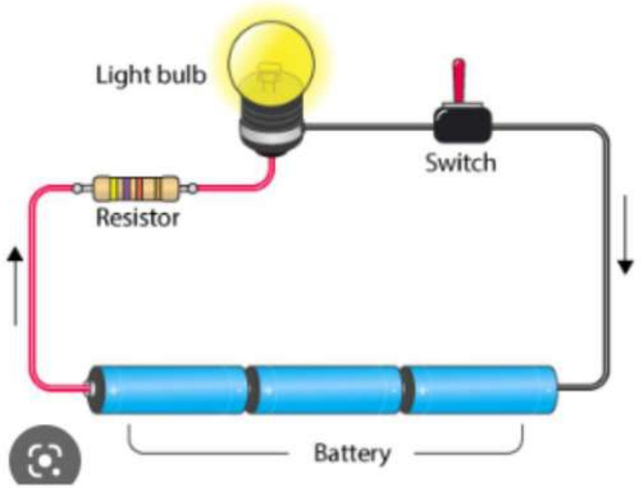
3 EVALUATE THE ANSWER

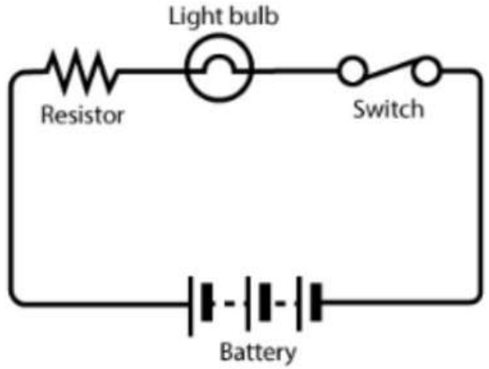
- **Are the units correct?** Current is measured in amperes.
- **Is the magnitude realistic?** There is a fairly large potential difference

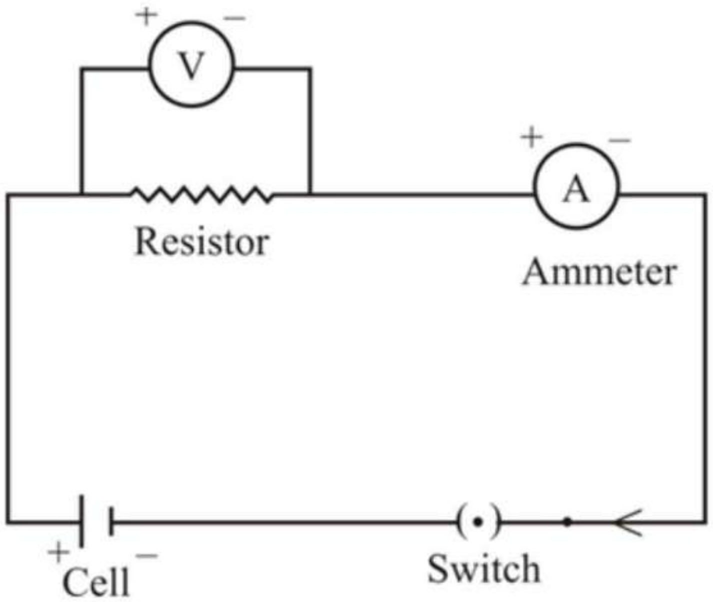
Nora

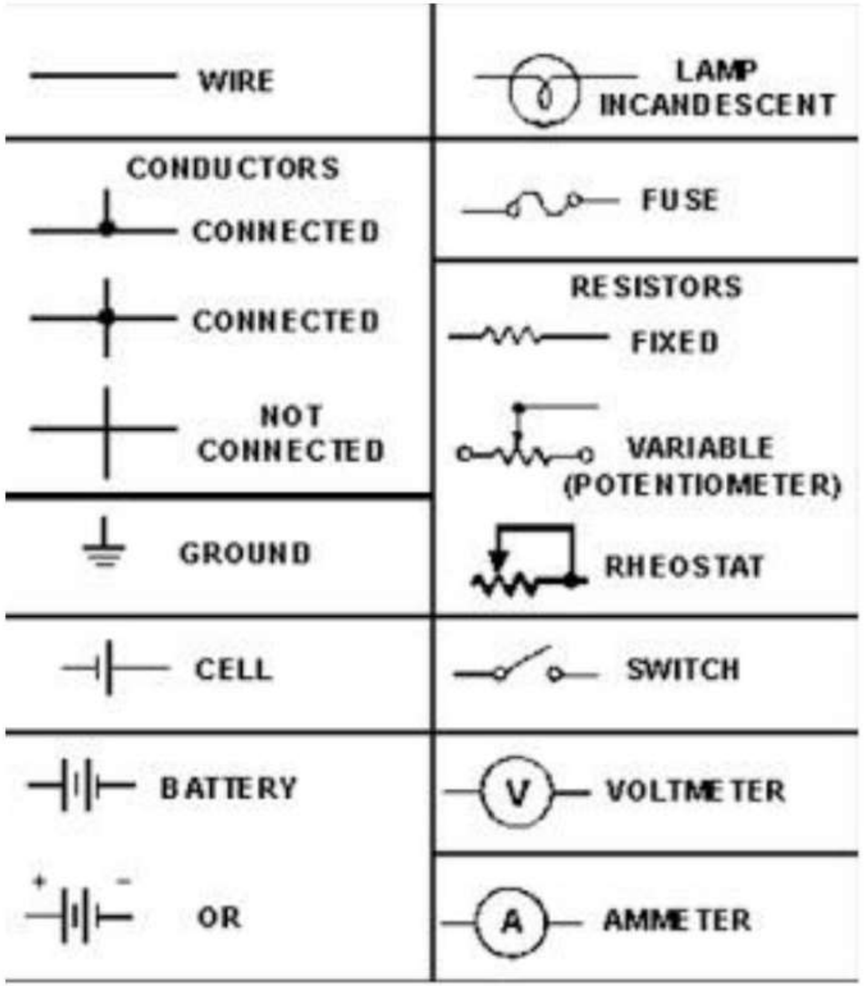
18	Draw schematic circuit diagrams with different components along with ammeters and voltmeters correctly connected to measure current and voltage

Page 95









Nora

19	Explain the characteristics of a series circuit.

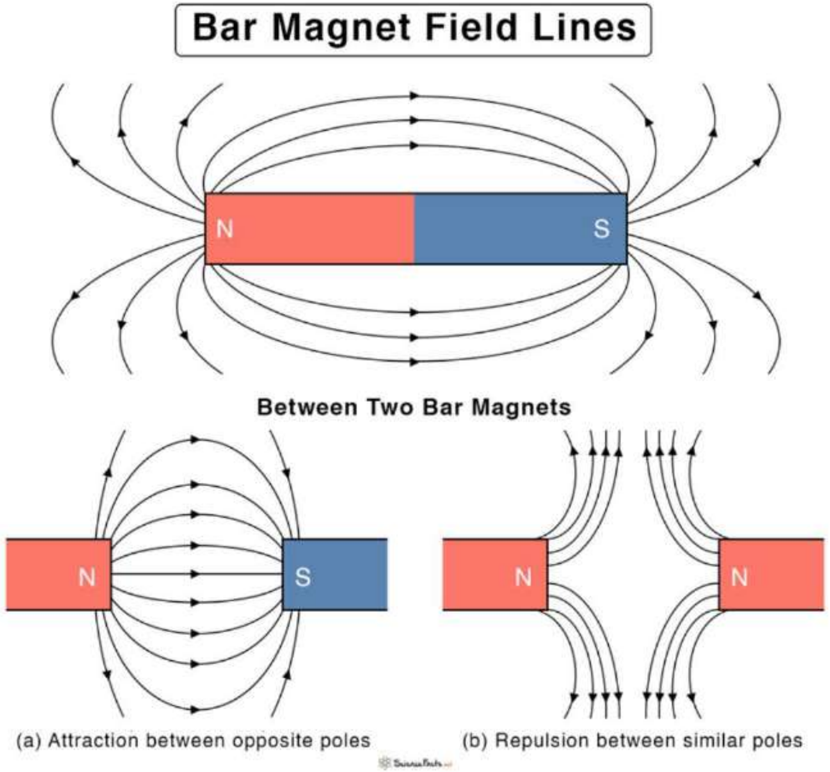
Page 107-108

Characteristics of Series Circuits

- Only one path (electron has no choices, must go through all components)
- If one goes out, they all go out
- Voltage adds $V_T = V_1 + V_2 + V_3 + \ldots.$
- Current is constant $I_T = I_1 = I_2 = I_3 = \ldots.$
- Resistance adds $R_T = R_1 + R_2 + R_3 + \ldots.$
- Power adds $P_T = P_1 + P_2 + P_3 + \ldots.$

Nora

20	Describe the properties of magnets. Describe the characteristics of magnetic fields and sketch the field lines around a permanent magnet.



General Properties of Magnets

1. Magnets have polarity – north and south poles.
2. Like poles repel, opposite poles attract
3. Some metals can be permanently magnetized, and some ores in the earth are already magnetized – magnetite and lodestones are naturally occurring magnets.
4. Some metals can be turned into temporary magnets (polarized) by being brought near another magnet. This is magnetizing by induction.
5. Magnets cannot be broken or separated into separate north and south poles. If you break a magnet, you simply get two smaller magnets. North and south cannot exist independently.

Nora