PHYSICS
FORM 5
ELECTRICAL QUANTITES

QUANTITY	SYMBOL	UNIT	SYMBOL
Current	I	Amperes	A
Voltage (P.D.)	V	Volts	V
Resistance	R	Ohm	Ω
Charge (electric)	Q	Coulomb	C
Power	P	Watt	W
Energy	E	Joule	J
Time	T	seconds	s

Quantity of a Charge, Q

$$Q = It$$

$$Quantity\ of\ charge = Current \times time$$

$$Coulomb = Ampere \times seconds$$

$$1\ Coulomb = 1\ Ampere \times 1\ second$$

Definition of a Coulomb – The coulomb is defined as the quantity of charge which flows in one second passed any point in a circuit in which there is a steady current of 1 ampere.

Since, $Q = It$, transposing to make I the subject,

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

$$Ampere = \frac{Coulomb}{time}$$

$$1\ Ampere = \frac{1\ Coulomb}{1\ second}$$

Definition of an Ampere – A current of one ampere is a flow of charge at a rate of 1 Coulomb per second.

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Voltage

The voltage or potential difference between the ends of a conductor is equal to the energy converted from electrical to other forms of energy per unit electric charge flowing through it.

$$Voltage = \frac{Energy}{Charge}$$

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

$$Volts = \frac{Joules}{Coulomb}$$

$$1\ Volt = \frac{1\ Joule}{1\ Coulomb}$$

1 volt is defined as the potential difference between the ends of a conductor if 1 Joule of electrical energy is converted to other forms of energy when one Coulomb of charge flows through it.

Resistance

Resistance is the ability of a substance to resist the flow of a current through it.

$$Resistance = \frac{Voltage}{Current}$$

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

$$Ohms = \frac{Volts}{Amperes}$$

$$1\ Ohm = \frac{1\ Volt}{1\ Ampere}$$

Definition of an Ohm – 1 Ohm is defined as the resistance of a conductor through which a current of 1 ampere flows when the potential difference of 1 volt is applies across its ends.

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Power

Power is defined as the rate of change of energy.

$$Power = \frac{Energy\ converted}{Time} \quad \text{——— 1}$$

$$P = \frac{E}{t}$$

$$Watt = \frac{Joule}{second}$$

$$Voltage = \frac{Energy}{Charge} \quad \text{——— 2}$$

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Ammeter

An ammeter is an electrical device that is used to measure the magnitude of current that flows through a circuit.

For the ammeter to measure current, the current must flow through the ammeter.

The ammeter should not change the value of the current. In order to do this the ammeter has an **exceedingly low resistance**.

The ammeter must therefore be connected in series also.

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Voltmeter

A voltmeter is an electrical device that is used to measure the potential difference (voltage) between the ends of a conductor.

Since the voltmeter measure voltage between the ends it must therefore be connected to both ends of the conductor. The voltmeter is therefore connected in parallel.

Since the voltmeter is connected in parallel it may be possible to form a short circuit. To prevent this from happening the voltmeter has an **exceedingly high resistance**.

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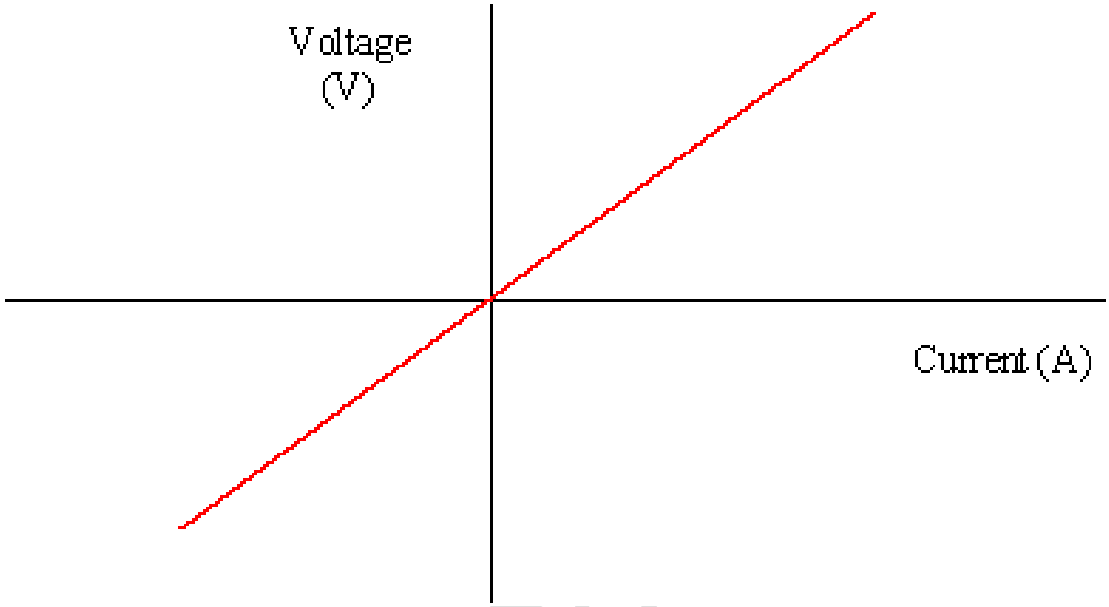
I-V Relationships

1. Metallic Conductor at Constant Temperature



The straight line passing through the origin means that current is directly proportional to voltage. As the voltage increases so too does the current. The same relationship exists even when there is a change in direction.

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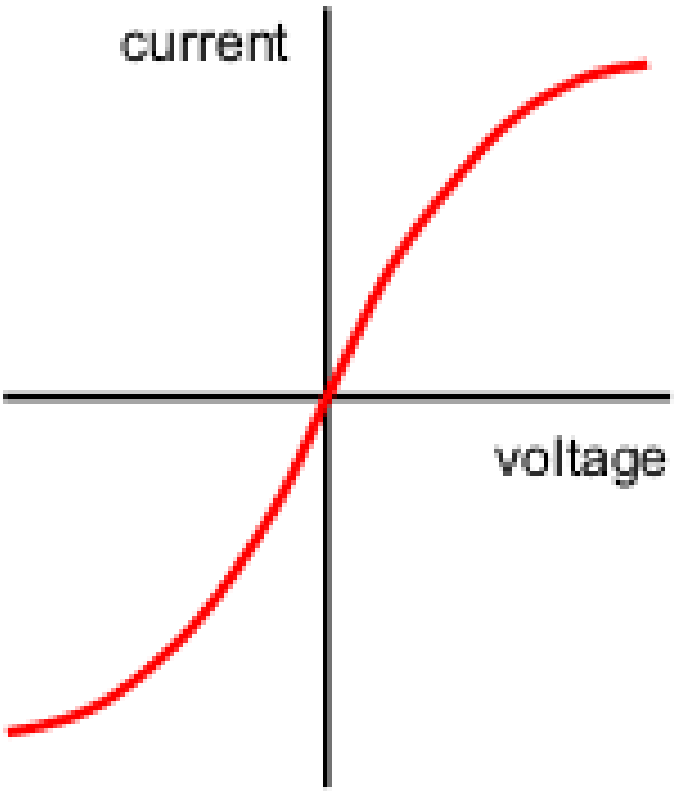
2. Filament Lamp



Initially with the filament lamp, as the voltage increases, the current increases proportionately. Filament lamps usually have high resistance therefore when a current flows through, heat is generated. The increase in temperature, increases the resistance of the filament lamp. This means that for the same increase in voltage the subsequent increase in current is less.

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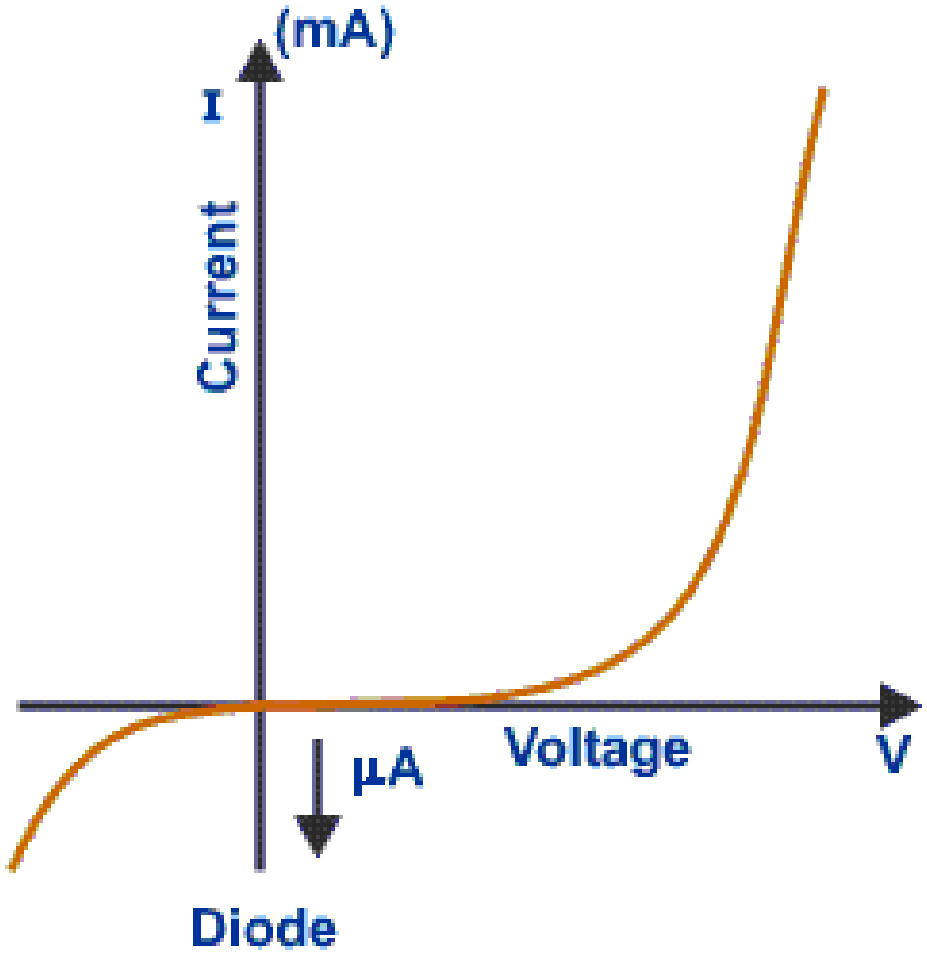
3. Semi-Conductor Diode



A semi-conductor diode, is an electrical device that allows current to flow in only one direction. From the graph it is seen that as the voltage increases the current remains initially zero. After a certain minimum voltage has been reached only then will the current begin to flow. The relationship afterwards between current and voltage is linear.

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4. Copper Sulphate ($CuSO_4$) Using Copper Electrodes

In the electrolysis of copper sulphate solution using copper electrodes, a certain minimum voltage is required before current begins to flow. After this minimum voltage is achieved the I-V relationship is linear.