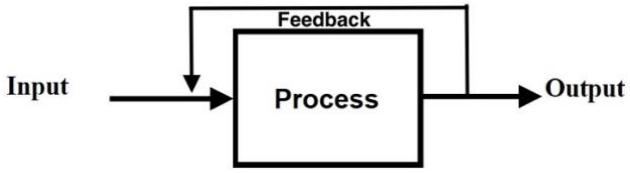
Design and Technology 7059/1

Topic on Electronics

1) An electronic system has;
- Input; for gathering information.
- Process; decide what to do with information
- Output; involves with switching device on/off.

2) Feedback – in a system with feedback, the output is fed back to the input, and depending on the outut, the input is adjusted so as to reach a steady-state.
- Open-loop control system;

- Closed-loop control system;



3) <u>Conductors and Insulators</u>
- <u>Electrical conductor</u>; material that allows electricity to flow through easily.
- <u>Electrical insulator</u>; material that electricity cannot follow though.
- <u>Semi-conductor</u>; electricity can flow through them, but with difficulty.

4) <u>Power Supply</u>
<u>4a) Mains power supply</u> has alternating current.
- **Advantages**; It is more cost-effective and easy to transmit large amounts of power over large distances.

4b) Most common source of power is the **battery**. Batteries have a positive and negative terminal and it has potential difference (concept linkage w/ Physics, topic of 'Current of Electricity).

- Potential difference is measured in volts (V)

- Batteries in series – add voltage of batteries together to get the total voltage/electromotive force of the source. (Concept linkage w/ Physics, topic of 'DC Circuits')
- Batteries in parallel – total voltage is same as of individual battery.
- **Advantage of Batteries;** portable, generally of lower power.
- **Safety;** Never short circuit a battery, never break open a battery due to presence of corrosive chemicals, never throw batteries into a fire due to explosive potential.

4c) Photovoltaic cells/ Solar panels – converts light energy into electricity using semi-conductors.

- Generally environmentally-friendly

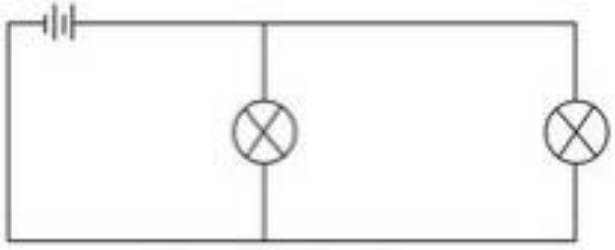
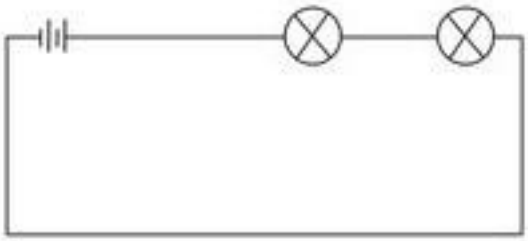
5) <u>Electric Current and Electrical Power</u>
   5a) **Electrical Current** is the rate of charge flow per unit time.
- Measured in Amperes (A)

5b) **Power** is the rate of energy change.

- Measured in Watts (W)
- $Power\ (P) = Current\ (I) \times\ Voltage\ (V)$

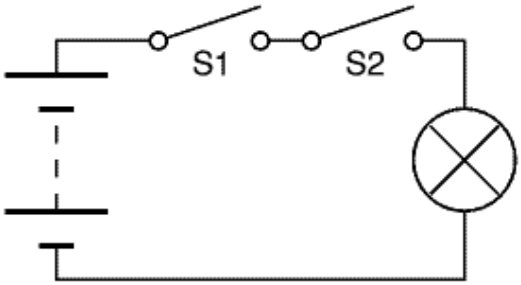
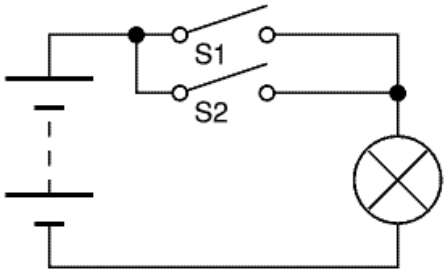
6) <u>Multimeter</u>
- To measure current, a Ammeter is used. It must be connected in series with the circuit.
- To measure voltage, a voltmeter is used. It must be connected parallel with the circuit.

7) Circuits

Parralel	Series
 Parallel Circuit	 Series Circuit
If resistance of the different paths in a parallel circuit is the same, current flow will be split equally amongst the separate paths. If resistance of the different paths in a parallel circuit are different, current flow will be higher in the path of lowest resistance.	Current is the same at any point in a circuit. (Physics-based explanation; At any point in the circuit, the same amount of charges flow through it. Hence, current flow is the same at any point in a parallel circuit.)
The potential difference of each path in the parallel circuit is equal to the electromotive force of the source.	The total potential difference of all the components is equivalent to the electromotive force of the source.

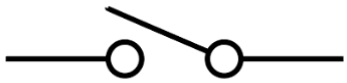
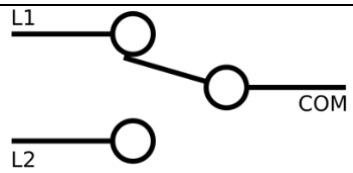
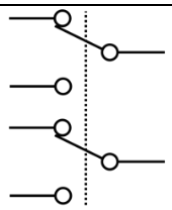
8) Switches

- Switches are used to make or break a circuit.

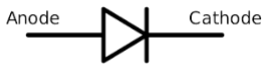
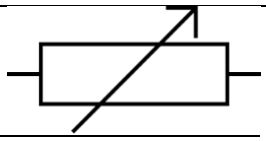
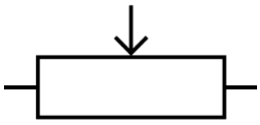
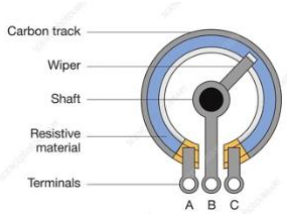
Connecting switches in series	Connecting switches in parallel
	
All switches must be closed before current will flow.	Current will flow when any switch is closed.
May be used for safety reasons. E.g ovens only work when door is closed and main switch is on.	May be used for ease of operation. E.g. buses; pressing of any switch alerts the driver.

8b) Types of switches

Type	Symbol	Application

SPST (Single-pole, single-throw)		Two contacts. Simple on-and-off switch.
SPDT (Single-pole, double throw)		Three contacts. Can operate two parts of a circuit.
DPDT (Double-pole, double throw)		Six contacts. A pair of on-on switches which operate in a synchronized fashion. Can operate two different circuits at once.

8c) Diode, Potentiometer, Capacitors

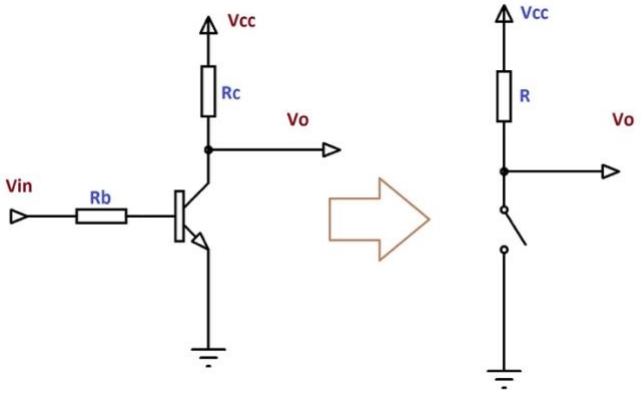
Diode		Controls flow of current. Allows current to flow in one direction only.
Variable resistor		Used to control current.
Potentiometer	 	Can work as a variable resistor or as a voltage divider. To use as a variable resistor, only two pins are used. To use as a potential divider, all three pins are used.
Capacitors		Stores electrical charge. When connected to a battery, current flows into it, causing it to 'light up'. The amount of charge a capacitor can store is called capacitance. The higher the capacitance, the more charge it can store.

9) Transistors

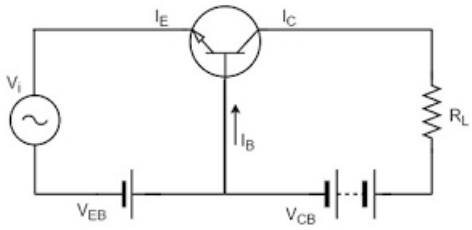
- NPN Transistors are semiconductor devices used to amplify and switch electronic signals and power. It acts as a automatic switch and transistor amplifier.
- There are 3 terminals for connection to an external circuit.
- The base controls the current that flows between the collector and the emmiter.
- When no current flows through the base of the transistor, the transistor is 'switched off'.
- When a small current flows into the base, the transistor

; Switches 'on', allowing a current to flow from the collector to the emmiter.

; Amplifies the input current to a higher-output circuit.



- Diagram above represents the usage of transistors as a switch.

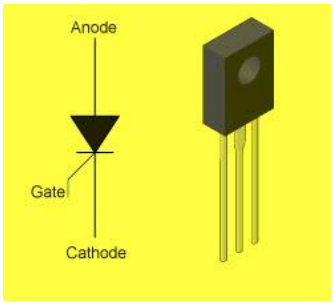


- Diagram above represents the usage of transistors as an amplifier.

10) Thyristor.

- An electronic component w/ 3 leads; anode (+), cathode (-), and gate.
- Output remains switched on once triggered until manually reset.
- The gate controls the current that flows btwn/ the anode and the cathode.
- When no current flows into the gate, the thyristor is 'off'.

- When a small current flows into the gate, the thyristor switches 'on', allowing a current to flow between the anode and cathode.
- Once triggered, it remains on even w/ no current flowing through the gate.



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11) Resistor

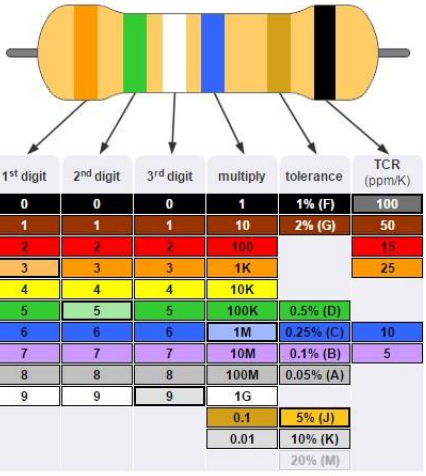
- Resistors restrict current flow in a circuit.
- It is used to protect components from damage due to excessive currents in the circuit.
- Resistors have no polarity. [Can be connect either-way around].
- Resistance is measured using Ohms / Ω

Resistors are colour-coded w/ colour bands to show their values.

; The first band gives the first digit and the second band gives the second digit.

; Third band is the multiplier

; Fourth band shows the tolerance of the resistor.



	1st digit	2nd digit	3rd digit	multiply	tolerance	TCR (ppm/K)
Black	0	0	0	1	1% (F)	100
Brown	1	1	1	10	2% (G)	50
Red	2	2	2	100		15
Orange	3	3	3	1K		25
Yellow	4	4	4	10K		
Green	5	5	5	100K	0.5% (D)	
Blue	6	6	6	1M	0.25% (C)	10
Violet	7	7	7	10M	0.1% (B)	5
Gray	8	8	8	100M	0.05% (A)	
White	9	9	9	1G		
Gold				0.1	5% (J)	
Silver				0.01	10% (K)	
None					20% (M)	

12) Connecting of Resistors

Connecting resistors in series; $R = R1 + R2 + R3$ …

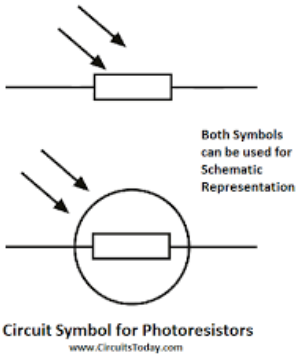
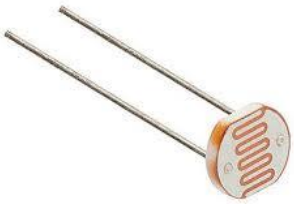
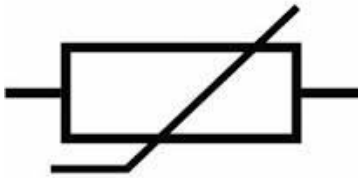
Connecting resistors in parallel; $\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$ …

13) Ohms Law

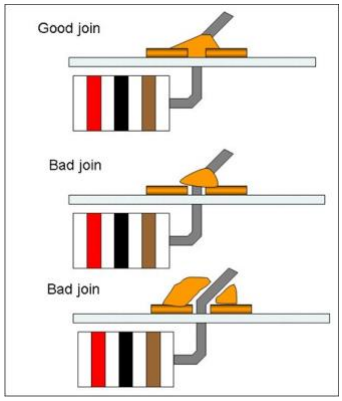
Ohm's Law is the relationship between voltage, current, and resistance.

Formula; $V = IR, where\ V = Voltage, I = Current, and\ R = Resistance$

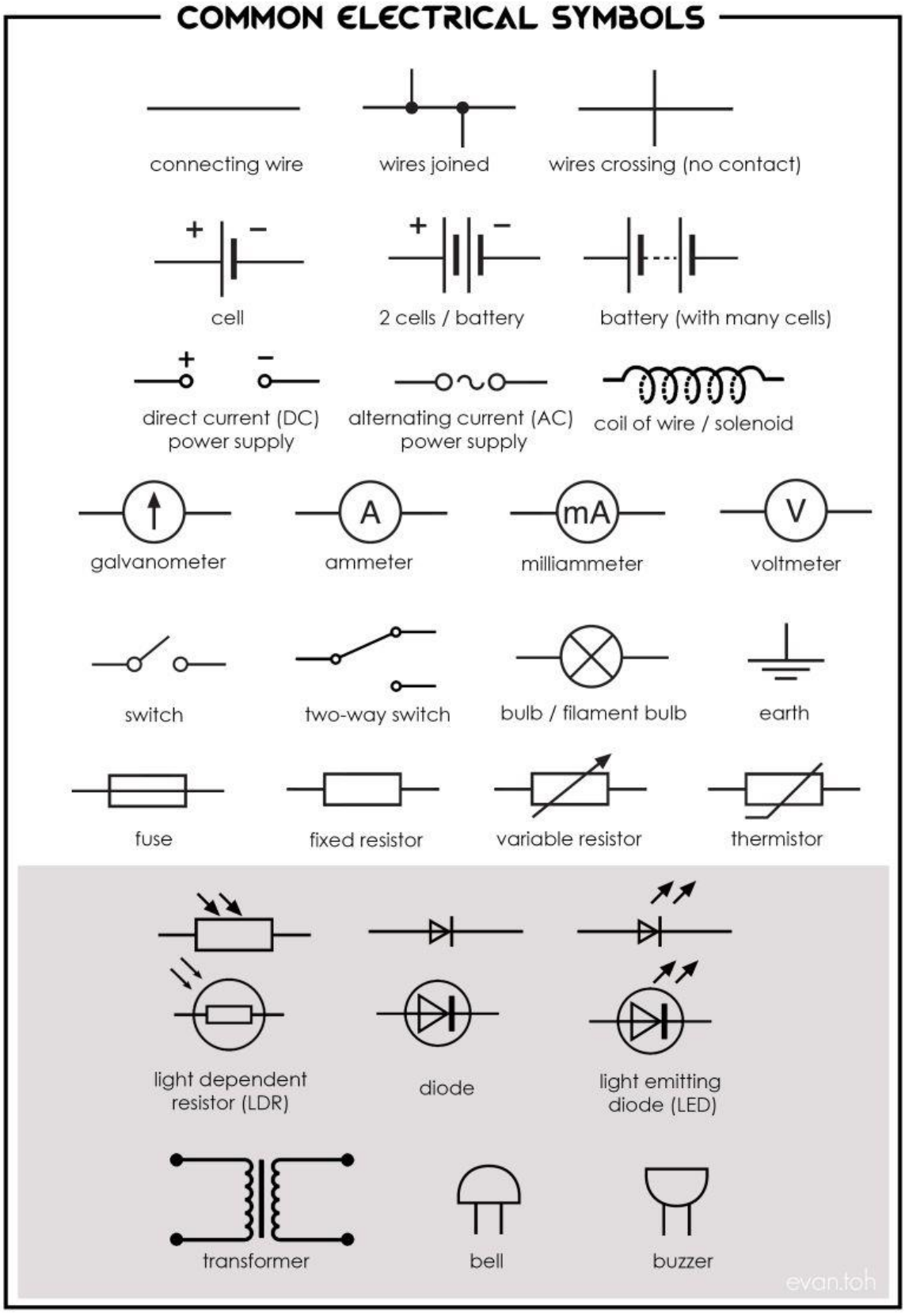
14) Input Devices [Sensors]

Name	Schematic Representation	Pictorial Representation	Function of Component
Light Dependent Resistor (LDR)			Transducer converts brightness to resistance. Resistance of LDR changes w/ light intensity.
Thermistor			A thermal resistor that changes resistance w/ temperature. Converts temperature to resistance

15) Soldering



Component within Electronics	Relation with Physics by topic
4b – Battery, Potential Difference, EMF	Current of Electricity
5 – Electrical Current and Power, Formula P=VI	Current of Electricity, Practical Electricity
6 - Usage of ammeter and voltmeter	Current of Electricity
7- Circuits	DC Circuit
13 – Ohms Law, formula V = I R	Current of Electricity
12 – Connecting of Resistors	Current of Electricity


COMMON ELECTRICAL SYMBOLS
connecting wire
wires joined
wires crossing (no contact)
+
−
cell
2 cells / battery
battery (with many cells)
direct current (DC) power supply
alternating current (AC) power supply
coil of wire / solenoid
galvanometer
A
ammeter
mA
milliammeter
V
voltmeter
switch
two-way switch
bulb / filament bulb
earth
fuse
fixed resistor
variable resistor
thermistor
light dependent resistor (LDR)
diode
light emitting diode (LED)
transformer
bell
buzzer
evan.toh