D.C. Circuits

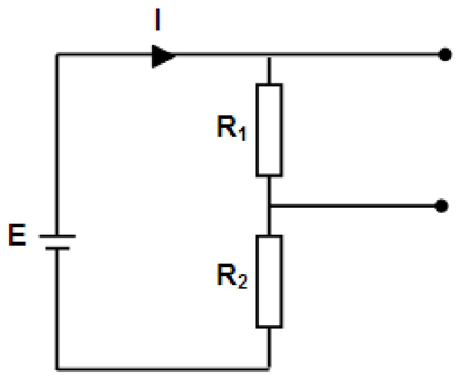
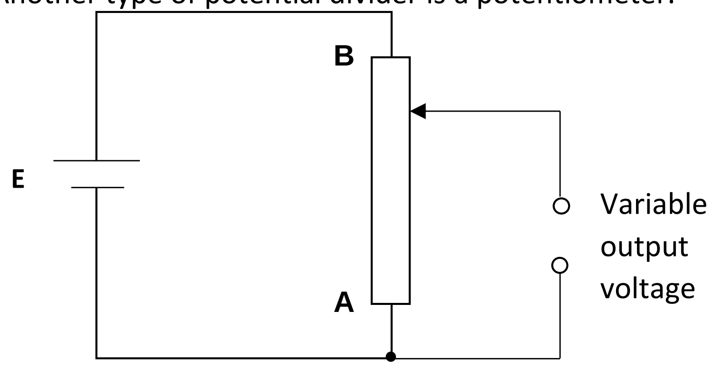
Resistors in Series

$$R_{total} = R_1 + R_2 + R_3$$

Resistors in Parallel

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

Potential Divider Principle

Two resistors are connected <u>in series</u> with a source of e.m.f.  $V_1 = \left(\frac{R_1}{R_1+R_2}\right) E$ $V_2 = \left(\frac{R_2}{R_1+R_2}\right) E$	Another type of potential divider is a potentiometer.  **A potentiometer used as a potential divider** A variable direct voltage may be obtained from a fixed supply voltage. Moving the sliding contact from A to B in the circuit shown above increases the output from zero to E.

Light Dependent Resistor (LDR)

A LDR is a resistor whose resistance <u>decreases</u> as light intensity falling on it <u>increases</u>. (Light falling on the LDR releases more charge carriers to conduct current.)

A thermistor (or thermally sensitive resistor) is a resistor whose resistance R_t changes greatly with <u>temperature</u>.

Thermistor

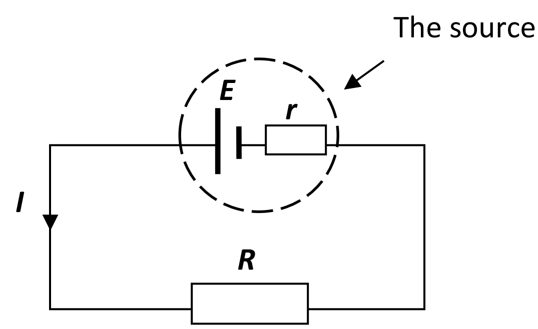
Commonly used thermistors have a *negative* temperature coefficient, i.e. resistance R_t <u>decreases</u> as temperature <u>increases</u>.

Electromotive force (e.m.f.), *E*, is the amount of energy transferred per unit charge from some other form of energy into electrical energy when charge is moved round a complete circuit.

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

Internal Resistance and Terminal potential diference

As shown in the diagram below, internal resistance is normally denoted as ***r*** and in a circuit it is denoted as a resistor that is in series with the source, and directly connected to the negative terminal. ***R*** is normally the external resistance (the load that is connected to the source, which is indicated by the dotted line circle.) While ***E*** is the e.m.f. of the source.



e.m.f. = p.d. across internal resistor + p.d. across external resistor

$E = v + V$

$E = Ir + IR$

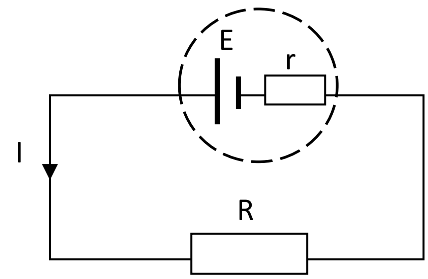
$IR = E - Ir$

The quantity of (***E – Ir***) therefore indicates the amount of voltage that reaches the external components of a circuit and is known as the **terminal p.d.**

<u>Perspective of power</u>

Power generated by source = Sum of power dissipated in other components.

Hence, in the similar circuit,

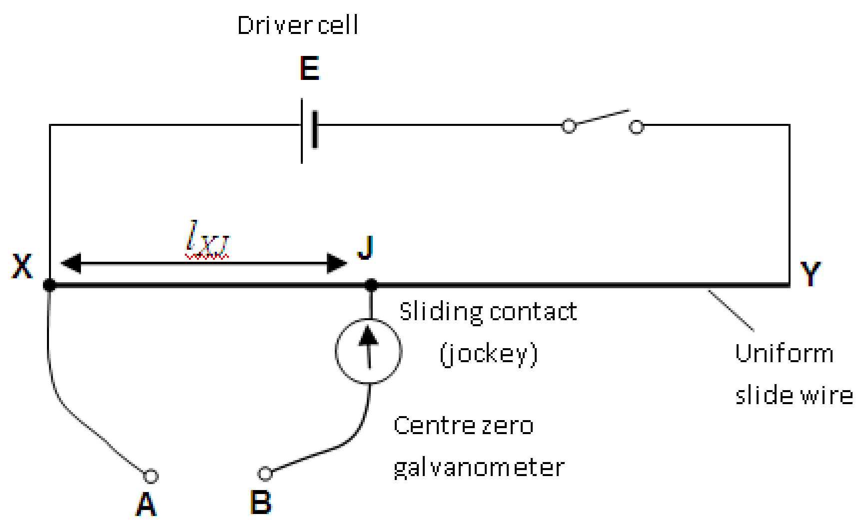


$$P_{source} = p + P$$

$$IE = Iv + IV = I^2r + I^2R$$

where: p is the power dissipated due to internal resistance and P is the power dissipated due to external load. v is the potential difference across r and V is the potential difference across R.

Use of Potentiometer as a means of comparing potential differences



If the wire is of uniform cross-sectional area and resistivity, the <u>potential gradient *k*</u> ("potential difference per unit length") along the wire is uniform and given by:

$$k = \frac{V_{XY}}{l_{XY}} \quad \text{where } l_{XY} \text{ : length of slide wire}$$

The potential difference, V_{XJ} across a certain length *l* of the wire is directly proportional to the length *l*, i.e.,

$$V_{XJ} = kl_{XJ}$$

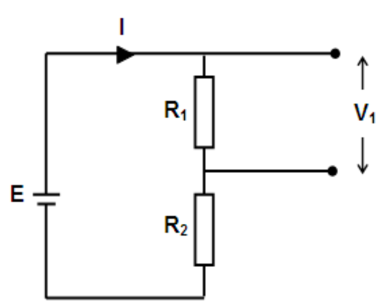
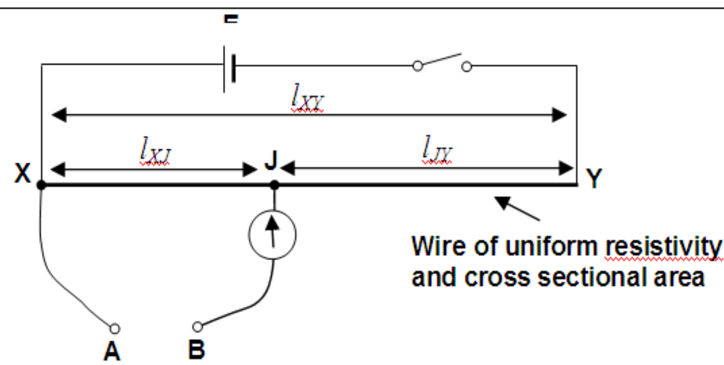
To find the value of V_{AB} :

$$\text{Since} \quad V_{AB} = V_{XJ} = kl_{XJ} \quad \text{and} \quad k = \frac{V_{XY}}{l_{XY}},$$

$$V_{AB} = \frac{V_{XY}}{l_{XY}} l_{XJ}$$

$$V_{AB} = \left(\frac{l_{XJ}}{l_{XY}}\right) V_{XY}$$

where $V_{XY} = E$ *if the driver cell has **no** internal resistance.*

CIRCUIT		
RESISTIVE MATERIAL	Resistors: R_1 and R_2	Resistive Wire of Length l_{XY} (Actual Resistance between XJ and JY depends on the length l_{XJ} and l_{JY} respectively.)
OUTPUT VOLTAGE	$V_1 = \left(\frac{R_1}{R_1 + R_2}\right) E$	$V_{AB} = \frac{l_{XZ}}{l_{XY}} E = \frac{l_{XZ}}{l_{XJ} + l_{JY}} E$