draw circuit diagrams with power sources (cell or battery), switches, lamps, resistors (fixed and variable), fuses, ammeters and voltmeters, bells, light-dependent resistors, thermistors and light-emitting diodes

Circuit Symbols

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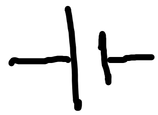
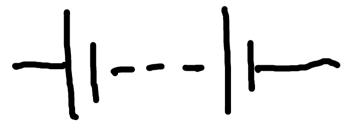
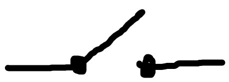
cell



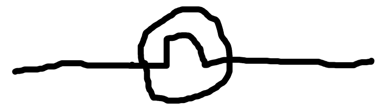
battery



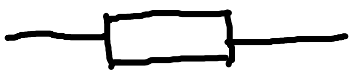
switch



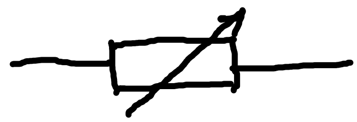
lamp



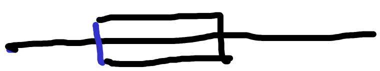
resistor (fixed)



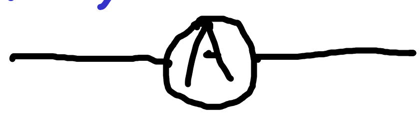
variable resistor



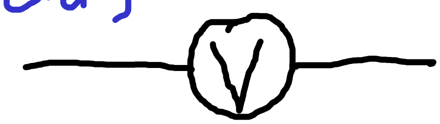
fuses



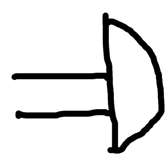
ammeters



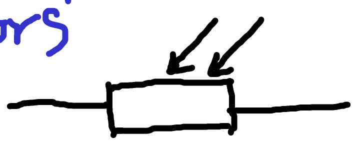
voltmeters



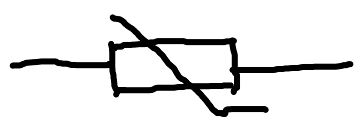
bells



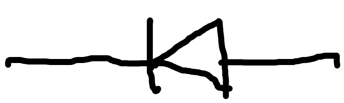
light-dependent resistors



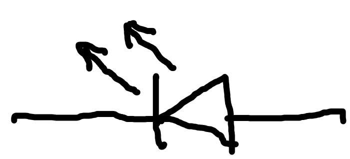
thermistors



diode



light-emitting diode



state that the current at every point in a series circuit is the same and apply the principle to new situations or to solve related problems

Current in Series Circuit

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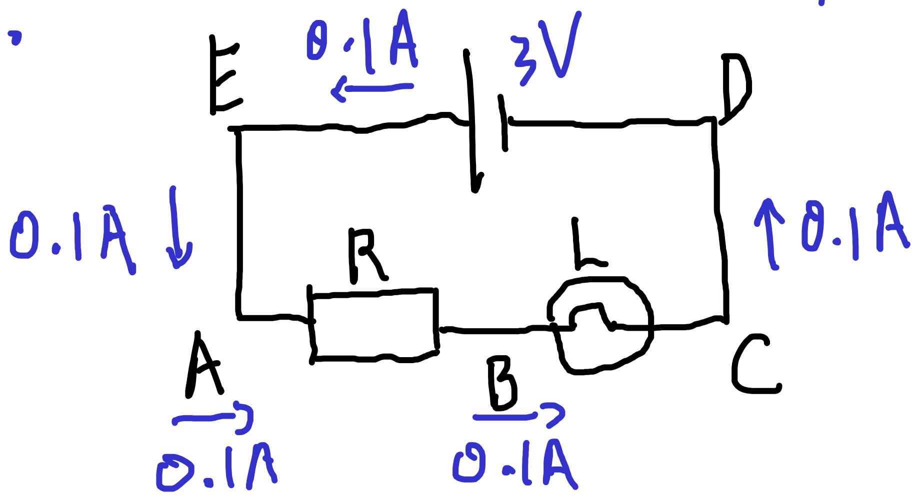
e.g. If all things in a circuit are connected one after another, they are in series.

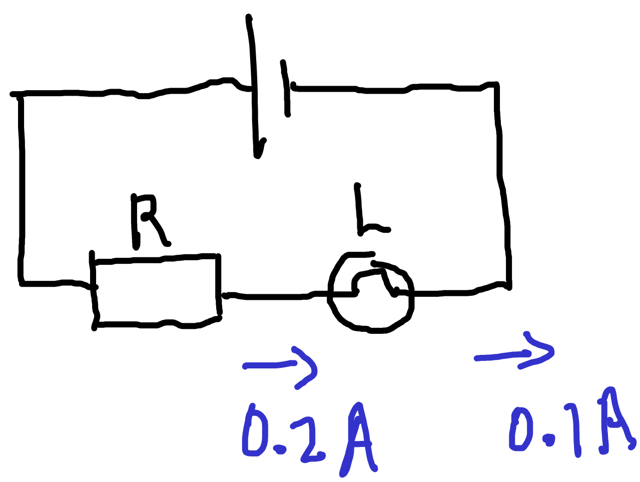


Then current at any point - A, B, C, ... - must be the same.

What if they are not?

e.g. like this -

0.2A goes into lamp L and 0.1A comes out



Then 0.1C must accumulate in L every 1s.

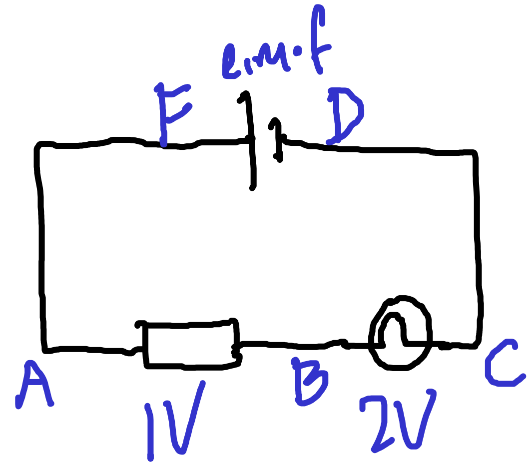
- never been observed.

state that the sum of the potential differences in a series circuit is equal to the potential difference across the whole circuit and apply the principle to new situations or to solve related problems

p.d. in series

Dr K M Hock

e.g.



How much work is done to bring 1C of charge from
(i) A to B
(ii) B to C
(iii) C to D
(iv) D to F ?

Answers. Using $V = \frac{W}{Q} \rightarrow W = QV$,

(i) 1J (ii) 2J (iii) 0J (iv) 0J

e.g. What is the p.d. across AC?

Ans. Since p.d. is work for 1C, can just add: p.d. AC = p.d. AB + p.d. BC

= 1V + 2V = 3V

e.g. What is the e.m.f. of the cell?

Ans. Since all work is done by the cell, so e.m.f. = sum of p.d.'s of all parts of circuit (in series)

$(V = V_1 + V_2)$ = 1V + 2V = 3V.

state that the current from the source is the sum of the currents in the separate branches of a parallel circuit and apply the principle to new situations or to solve related problems

Currents in Parallel

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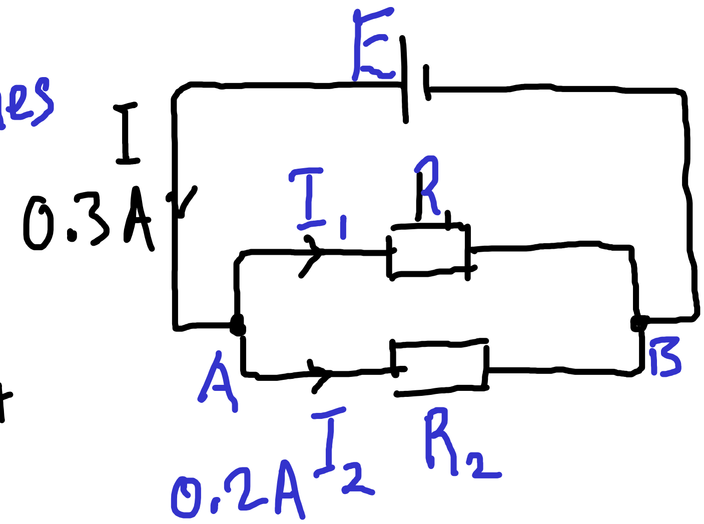
e.g. The circuit branches into 2 wires at A and joins back at B.



If I_2 is 0.2A, what is I_1?

Ans. 0.3C goes to A every 1s.
0.2C goes from A to R_2 every 1s.

Since charges do not collect at A
0.3 − 0.2 = 0.1 C must go from A to R_1 in 1s.

∴ current $I_1 = I - I_2 = 0.1A$.

Current from the source (e.g. cell)
= Sum of currents in separate branches of a parallel circuit

e.g.
$I = I_1 + I_2$

state that the potential difference across the separate branches of a parallel circuit is the same and apply the principle to new situations or to solve related problems

p.d. in parallel

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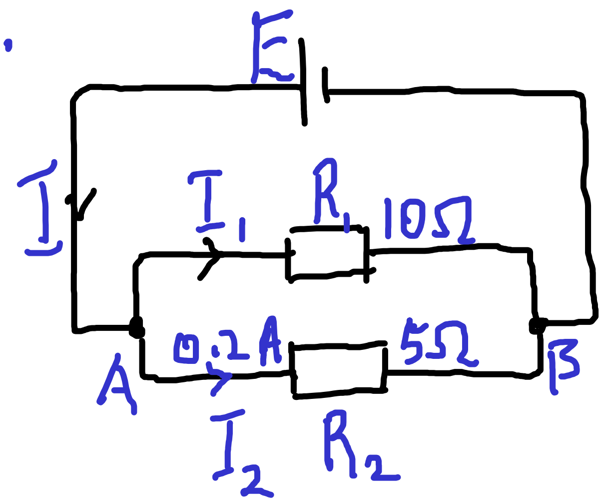
e.g.



Find

(i) p.d. across AB
(ii) I_1
(iii) I
(iv) E (e.m.f.)

Answers.

(i) ($V = IR$) p.d. AB = p.d. across R_2
$= 0.2 \times 5 = 1V.$

(ii) ($I = \frac{V}{R}$) p.d. across R_1 = p.d. AB
In R_1, $I_1 = \frac{1V}{10\Omega} = 0.1A$

(iii) $I = I_1 + I_2 = 0.1 + 0.2 = 0.3A$

(iv) E = p.d. AB $= 1V$

p.d. across separate branches of parallel circuit is the SAME. (e.g. R_1, R_2 above) recall and apply the relevant relationships, including R = V/I and those for current, potential differences and resistors in series and in parallel circuits, in calculations involving a whole circuit

Circuit Calculations

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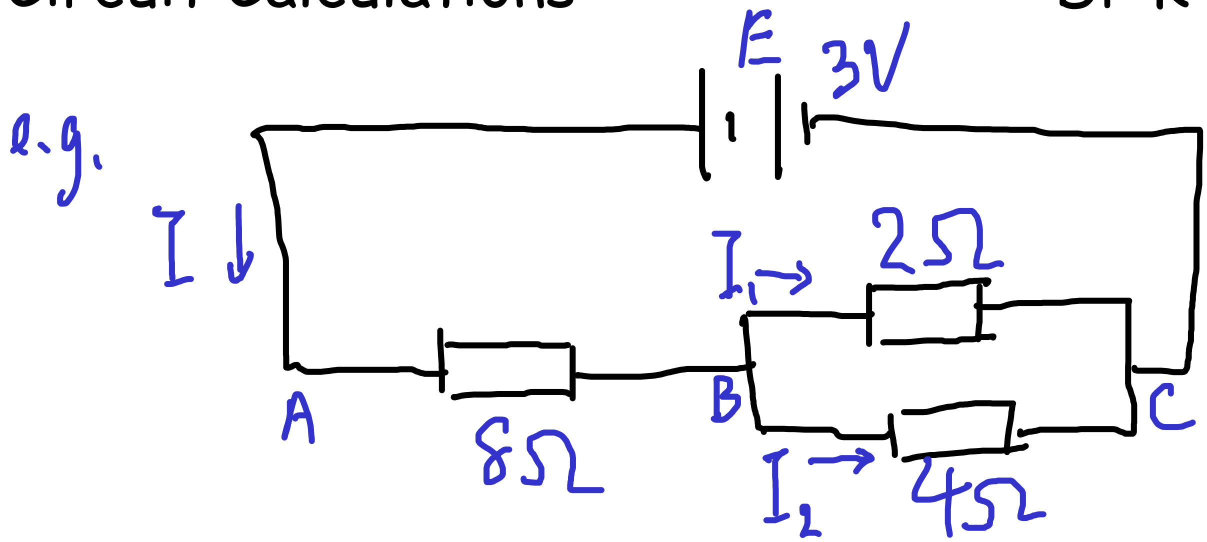
e.g.



Find (i) effective resistance between B, C

(ii) " " " A, C

(iii) I

(iv) p.d. across AB

(v) p.d. across BC

(vi) I_1 (vii) I_2

Answers. (i) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R} = \frac{1}{2} + \frac{1}{4} = \frac{3}{4} \rightarrow R = \frac{4}{3}\,\Omega$

(ii) $R = R_1 + R_2 = 8 + \frac{4}{3} = 9\frac{1}{3}\,\Omega$

(iii) $I = \frac{V}{R} = \frac{3}{9\frac{1}{3}} = \frac{9}{28}$ A

(iv) $V = IR = \frac{9}{28} \times 8 = \frac{18}{7}$ V

(v) $(V = V_1 + V_2)$ p.d. BC = e.m.f. − p.d. AB $= 3 - \frac{18}{7} = \frac{3}{7}$ V

(vi) $I_1 = \frac{V}{R_1} = \frac{3/7}{2} = \frac{3}{14}$ A (vii) $I_2 = I - I_1 =$ ____

describe the action of a variable potential divider (potentiometer)

Potential Divider

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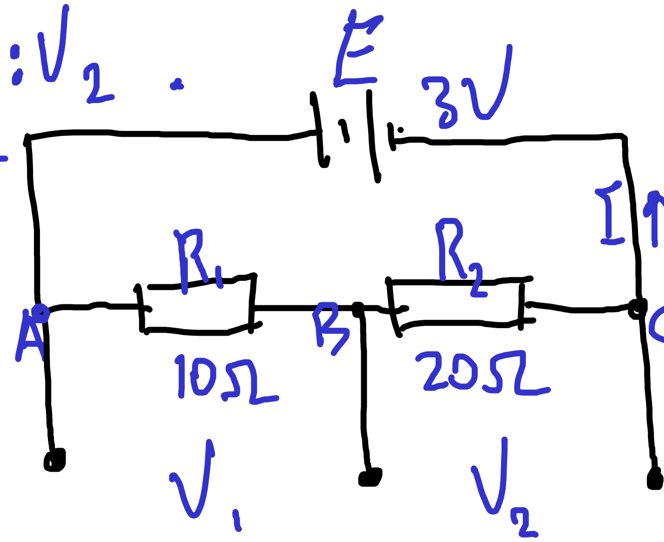
e.g. (i) Find the ratio $V_1 : V_2$.
(ii) Then find V_1, V_2



ans. (i) $V_1 = IR_1$

$V_2 = IR_2$

$$\frac{V_1}{V_2} = \frac{R_1}{R_2}$$

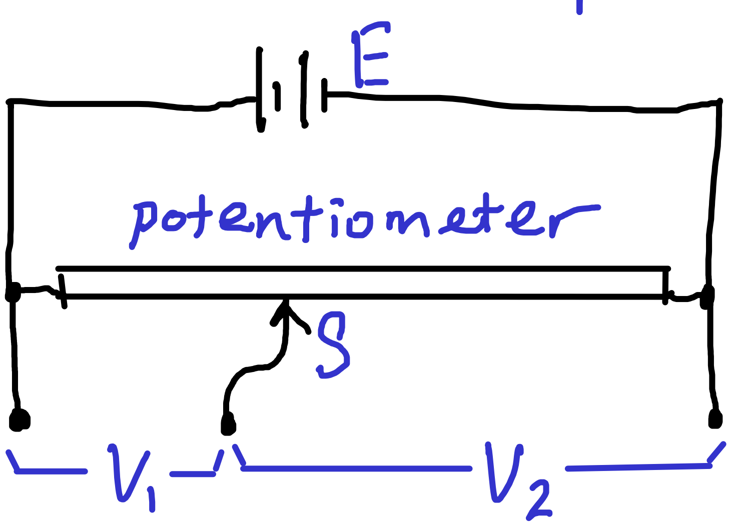
$\therefore V_1 : V_2 = R_1 : R_2 = 10 : 20 = 1 : 2$

(ii) p.d. across AC = 3V = $V_1 + V_2$

So 3V is divided in the ratio 1 : 2

$\therefore V_1 = 1V$, $V_2 = 2V$

Two resistors in series can divide a p.d. in the ratio $R_1 : R_2$.



e.g. using a variable resistor like this, can adjust V_1 by sliding contact S.

describe the action of thermistors and light-dependent resistors and explain their use as input transducers in potential dividers

Thermistor and LDR

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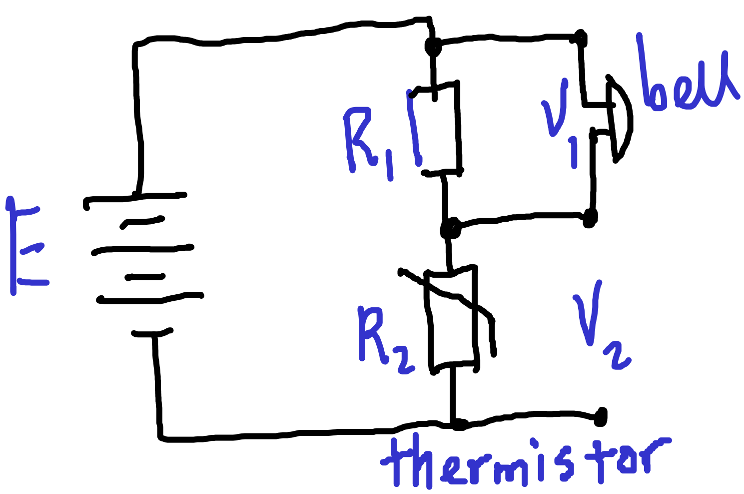
Source E divided in the ratio $V_1 : V_2 = R_1 : R_2$

e.g. fire alarm



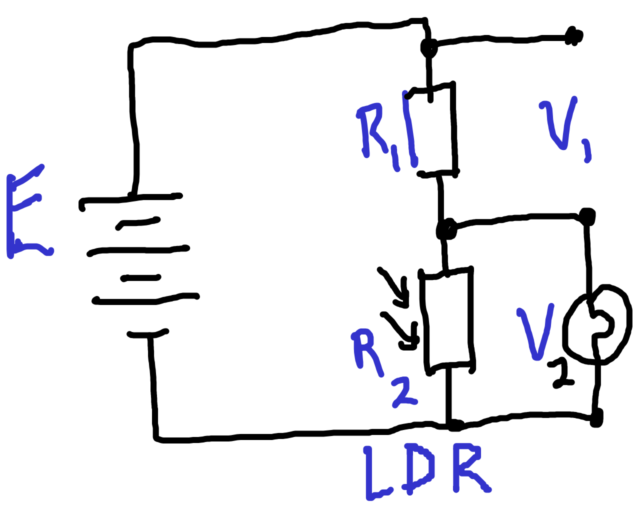
When hot, $R_2 \downarrow$

So $V_2 \downarrow$

and $V_1 \uparrow$

Then bell rings.

e.g. Street light



Light Dependent Resistor

When dark, $R_2 \uparrow$

So $V_2 \uparrow$

Then lamp on.

Thermistor and LDR 2

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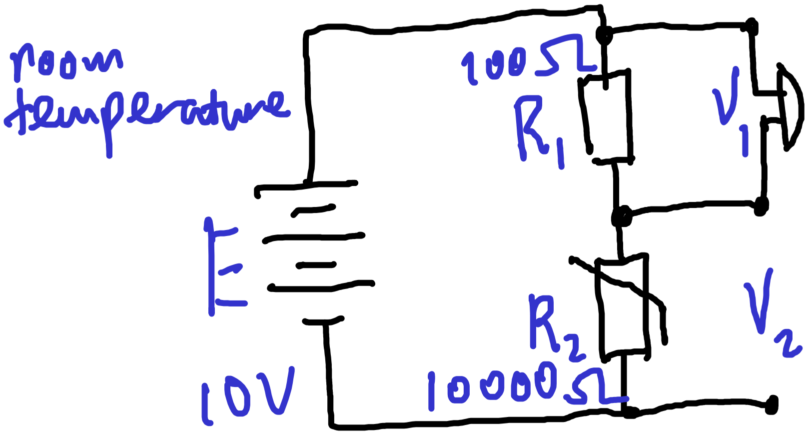
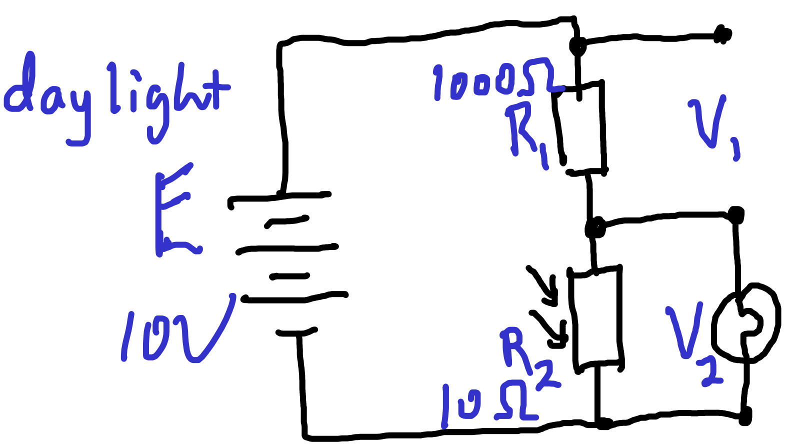
e.g. fire alarm. In a fire, R_2 drops to 1Ω. Find the voltage V_1 on the bell (i) before and (ii) after the fire.



(i) $R_1 : R_2 = 1 : 100$. $V_1 = \frac{1}{100+1} \times 10 \approx 0.1V$

(ii) $R_1 : R_2 = 100 : 1$. $V_1 = \frac{100}{100+1} \times 10 \approx 9.9V$

e.g. Street light. At night, R_2 increases to 100 000 Ω. Find voltage V_2 on the lamp (i) in the morning and (ii) at night.



(i) $R_1 : R_2 = 100 : 1$. $V_2 = \frac{1}{100+1} \times 10 \approx 0.1V$.

(ii) $R_1 : R_2 = 1 : 100$. $V_2 = \frac{100}{100+1} \times 10 \approx 9.9V$.