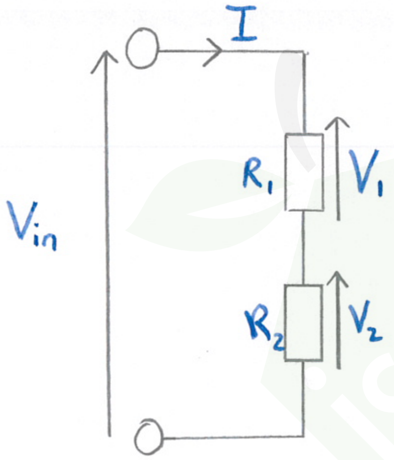
Worked Solutions

Potential Divider

Exercise 1: Two resistors, of resistances R_1 and R_2, are connected in series. A potential V_{in} is applied across this combination of resistors. Find:

a) the potential difference across each resistor.

b) the resistance of a single resistor which could be used to replace this set of two resistors without changing the current flowing through this circuit.



Arrows denoting potential differences go from low to high potential.

Current I flows through both resistors i.e. $I_1 = I_2 = I$

From Kirchhoff's Voltage Law, going clockwise.

$$V_{in} - V_1 - V_2 = 0$$

$$V_{in} = V_1 + V_2 \qquad (1)$$

For resistors

$$V_1 = IR_1 \qquad (2)$$

$$V_2 = IR_2 \qquad (3)$$

Substituting (2) & (3) into (1)

$$V_{in} = IR_1 + IR_2 = I(R_1 + R_2)$$

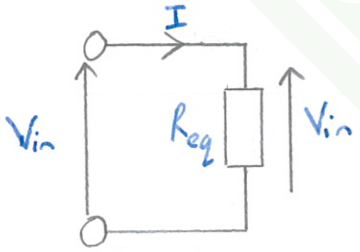
$$I = \frac{V_{in}}{(R_1+R_2)} \qquad (4)$$

Substituting (4) into (2) & (3)

$$V_1 = \frac{V_{in} R_1}{(R_1+R_2)}$$

$$V_2 = \frac{V_{in} R_2}{(R_1+R_2)}$$

Equivalent Resistance for resistors in series



$$V_{in} = I R_{eq}$$

but from above equivalent circuit

$$V_{in} = I(R_1 + R_2)$$

$$\Rightarrow R_{eq} = R_1 + R_2$$