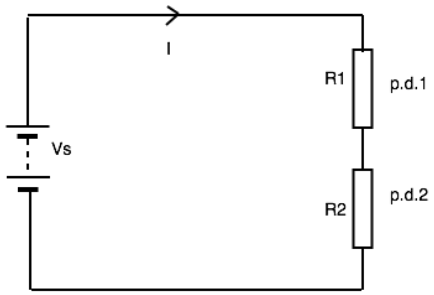
5.5 Potential dividers

Look at the following potential divider:

videos



V_s is the supply voltage and $p.d._1$ and $p.d._2$ are the potential differences dropped across two resistors R_1 and R_2. I is the current flowing. We know that:

$$V_s = p.d._1 + p.d._2$$

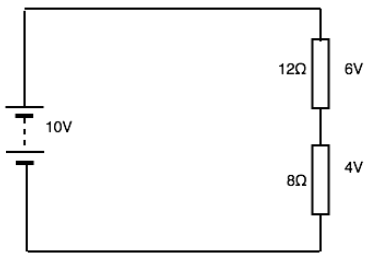
and:

$$p.d._1 = IR_1 \; and \; p.d._2 = IR_2$$

We can see that the supply voltage is divided up between the two resistors depending on their resistance. If one has a bigger resistance than the other, it will get a bigger proportion of the supply voltage. This is why this circuit is an example of a potential divider, because the resistors are dividing up the voltage (or potential).

It is all about ratios. The ratio $\frac{p.d._1}{p.d._2}$ is equal to the ratio $\frac{R_1}{R_2}$.

Let's look at an example:



8Ω as a fraction of the total resistance is equal to 4V as a fraction of the total potential difference.

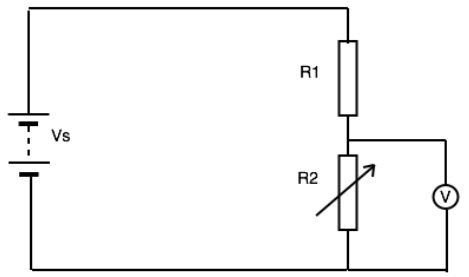
$$\frac{8\Omega}{(8\Omega + 12\Omega)} = \frac{4V}{(4V + 6V)}$$

$$\therefore \frac{8\Omega}{20\Omega} = \frac{4V}{10V}$$

(1) Write down a formula (using R_1, R_2 and V_s) to find $p.d._1$.

(2) Write down a formula (using R_1, R_2 and V_s) to find $p.d._2$.

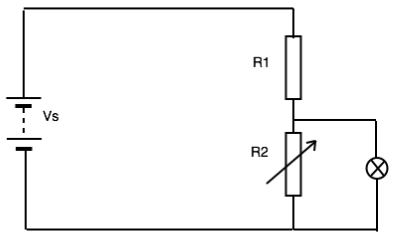
A potential divider circuit is useful when we want to have a variable voltage supply. Look at the following circuit:



R_2 is now a variable resistor. This means that the ratio of resistances is variable, and this will affect the p.d. across R_2 (measured with a voltmeter).

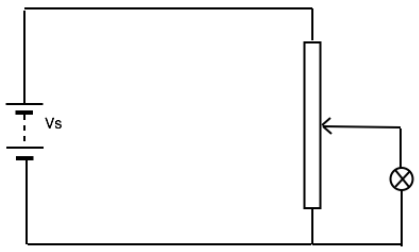
(3) What will the voltmeter indicate when R_2 is relatively large?

We can use this circuit to provide a variable voltage to another circuit by connecting across R_2.



We can adjust the brightness of the lamp using the variable resistor to change the p.d. across the lamp.

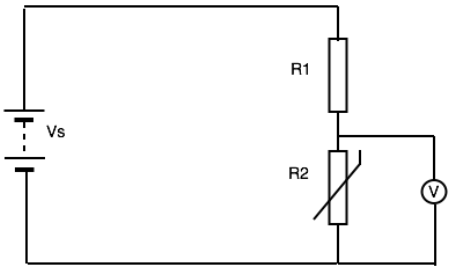
There is a special device designed to be used as a potential divider. This is called a rheostat or potentiometer. It has a sliding contact that changes the ratio of R_1 and R_2. The following circuit shows such a device:



The total resistance is a constant, but the slide contact means that a variable p.d. can be selected. When the slider is at the top the p.d. will be V_s. When the slider is at the bottom, the p.d. will be zero.

Sensor circuits

Potential dividers are often used in sensing circuits. A thermistor or LDR can be used in place of R_1 or R_2. There resistance changes depending on conditions, hence the p.d. across them. Look at the following example:



Here we have a thermistor in place as R_2.

(4) ✐ What will happen to the voltmeter reading as the temperature of the thermistor increases?

(5) ✐ How could you connect the voltmeter in the circuit so that it responds in the opposite sense as the temperature increases?

(6) ✐ Draw a circuit diagram to show how an LDR could be used as a light level meter. Hint: You may need to adapt you voltmeter!