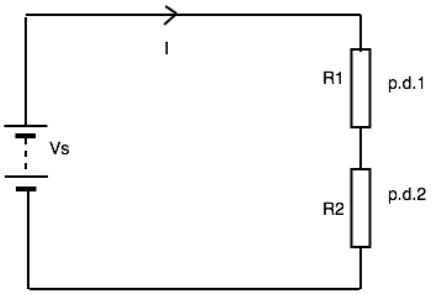
5.5 Potential dividers

Look at the following potential divider:



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

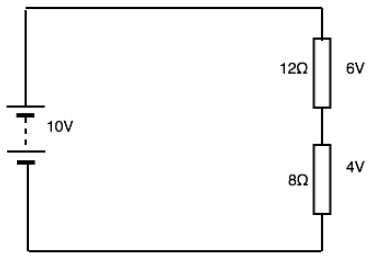
$$V_s = p.d._1 + p.d._2$$

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 $\frac{R_1}{R_2}$.
Lets look at an example:

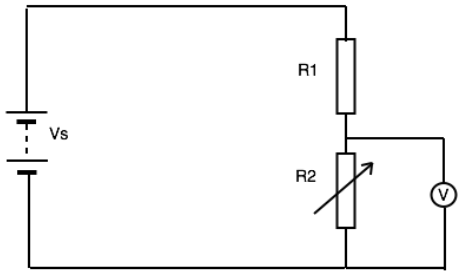


The ratio of 12Ω/8Ω is equal to the ratio 6V/4V. Additionally the voltage of the power supply (=10V) is equal to the sum of the p.d.s (6V + 4V).

(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.$_2$.

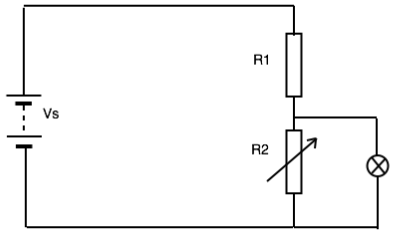
A potential divider circuit is useful when we want to have a variable voltage supply. Look at the following circuit:



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).

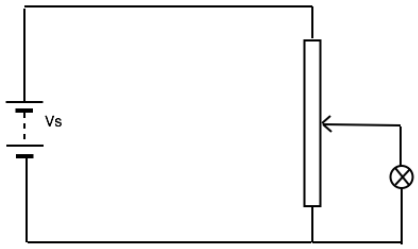
(3) What will the voltmeter indicate when R_2 is relatively large?

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.

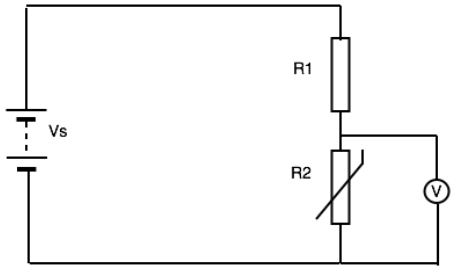
There is a special device designed to be used as a potential divider. This is called a rheostat or potentiometer. It has a sliding contact that changes the ratio of R_1 and R_2. The following circuit shows such a device:



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!