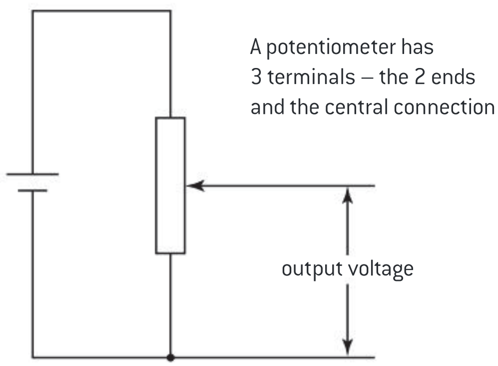
Potential divider circuits and sensors

POTENTIAL DIVIDER CIRCUIT

The example on the right is an example of a circuit involving a **potential divider**. It is so called because the two resistors 'divide up' the potential difference of the battery. You can calculate the 'share' taken by one resistor from the ratio of the resistances but this approach does not work unless the voltmeter's resistance is also considered. An ammeter's internal resistance also needs to be considered. One of the most common mistakes when solving problems involving electrical circuits is to assume the current or potential difference remains constant after a change to the circuit. After a change, the only way to ensure your calculations are correct is to start again.

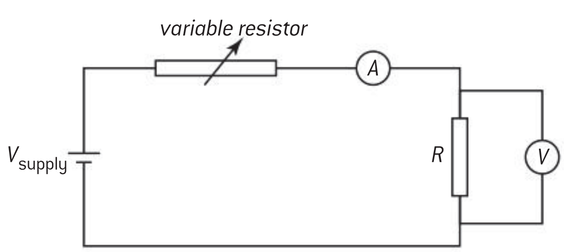
A variable potential divider (a **potentiometer**) is often the best way to produce a variable power supply. When designing the potential divider, the smallest resistor that is going to be connected needs to be taken into account: the potentiometer's resistance should be significantly smaller.



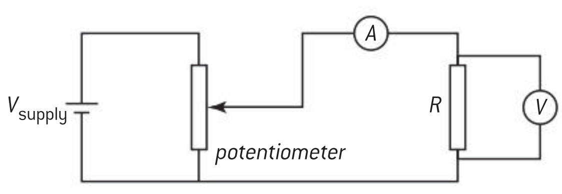
In order to measure the *V–I* characteristics of an unknown resistor *R*, the two circuits (*A* and *B*) below are constructed. Both will both provide a range of readings for the potential difference, *V*, across and current, *I*, through *R*. Providing that *R* >> the resistance of the potentiometer, this circuit (circuit B) is preferred because the range of readings is greater.

- Circuit *B* allows the potential difference across *R* (and hence the current through *R*) to be reduced down to zero. Circuit *A* will not go below the minimum value achieved when the variable resistor is at its maximum value.
- Circuit *B* allows the potential difference across *R* (and hence the current through *R*) to be increased up to the maximum value V_{supply} that can be supplied by the power supply in regular intervals. The range of values obtainable by Circuit *A* depends on a maximum of resistance of the variable resistor.

Circuit *A* – variable resistor



Circuit *B* – potentiometer

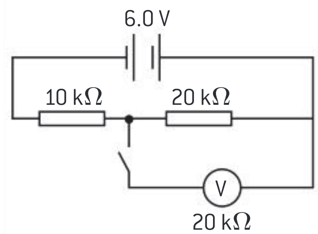


EXAMPLE

In the circuit below the voltmeter has a resistance of 20 kΩ. Calculate:

(a) the pd across the 20 kΩ resistor with the switch open

(b) the reading on the voltmeter with the switch closed.



(a) pd $= \frac{20}{(20 + 10)} \times 6.0 = 4.0$ V

(b) resistance of 20 kΩ resistor and voltmeter combination, *R*, given by:

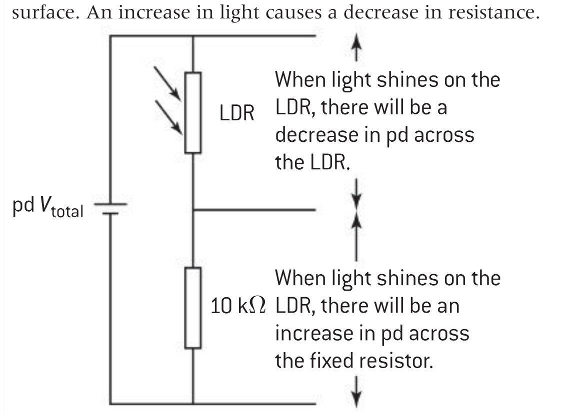
$$\frac{1}{R} = \frac{1}{20} + \frac{1}{20} \text{ k}\Omega^{-1}$$

$\therefore R = 10$ kΩ

$\therefore$ pd $= \frac{10}{(10 + 10)} \times 6.0 = 3.0$ V

SENSORS

A **light-dependent resistor** (**LDR**), is a device whose resistance depends on the amount of light shining on its surface. An increase in light causes a decrease in resistance.



A **thermistor** is a resistor whose value of resistance depends on its temperature. Most are semi-conducting devices that have a **negative temperature coefficient** (**NTC**). This means that an increase in temperature causes a decrease in resistance. Both of these devices can be used in potential divider circuits to create sensor circuits. The output potential difference of a **sensor circuit** depends on an external factor.