Electronics

Name _____ Date _____

By the end of this topic I can…

- describe the thermistor, LDR, strain gauge and piezo-electric transducer
- use $\Delta R/R = 2\Delta l/l$ for a strain gauge
- analyse a potential divider and a sensing circuit

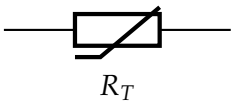
Electronic systems have three parts: a change in a physical property (temperature, pressure…) is picked up by a _____; the electrical signal goes to a _____; the processor gives an output voltage to drive an _____.

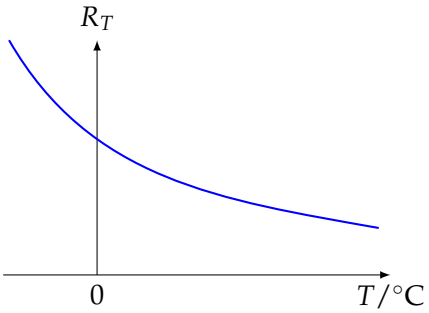
Sensors

Thermistor

A _____ is a component whose _____.

- _____ (negative temperature coefficient): resistance _____ as temperature rises. (A-level uses NTC only.)
- the relation is _____: the curve looks like an exponential _____
- **explanation**: at low temperature electrons are _____ to atoms; at high temperature they gain energy and break free, so there are more _____ to conduct (band theory)



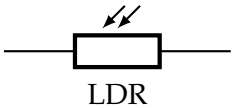


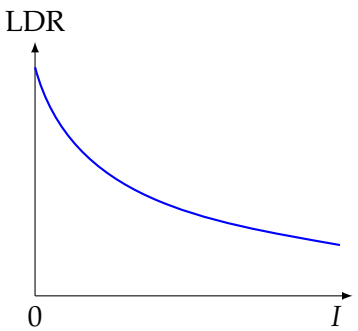
NTC thermistor.

Light-dependent resistor (LDR)

A _____ has a resistance that _____ as the light intensity _____.

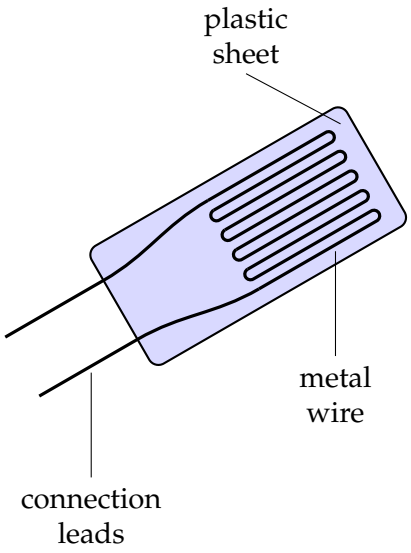
- the variation is _____
- light gives bound electrons enough energy to become _____: brighter light means more _____
- in the dark: $R \approx$ _____ Ω in bright light: $R \approx$ _____ Ω





LDR resistance falls as light intensity rises.

Strain gauge



A _____ is used to measure the width of a narrow _____. A long folded metal wire is sealed on a plastic sheet. As the crack widens the gauge is _____, the wire gets longer, and its _____ changes.

- resistance of a wire:

- if only the length changes (area constant): $\Delta R = \frac{\rho \Delta l}{A}$, so

- in fact the volume $V = Al$ stays constant, so as the wire gets longer it also gets _____. Both effects increase the resistance, giving an extra factor of two (for small strains):

Question 31.1 A strain gauge has resistance 120 Ω. As a crack widens the wire stretches by 0.10%. Find the new resistance.

Piezo-electric transducer

A _____ transforms _____ energy into _____ energy, or vice versa.

- when the material is _____, a p.d. is produced across it. A p.d. applied across it makes it _____.

- **generating sound**: an _____ voltage makes the material vibrate at the same frequency, giving compressions and rarefactions of air: _____ and _____

- **detecting sound**: pressure variations produce an _____ voltage across the device: _____

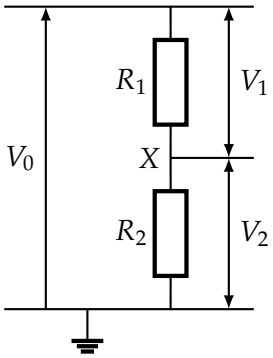
- **mechanism**: the material contains _____ (dipoles). When compressed they rearrange, so the

_____ varies and a small p.d. appears.



microphone loudspeaker

Processors: the potential divider



Sensors such as the thermistor and LDR only change their _____, but output devices are driven by _____. A _____ turns a change in resistance into a change in voltage.

A _____ is two _____ connected across a fixed voltage supply.

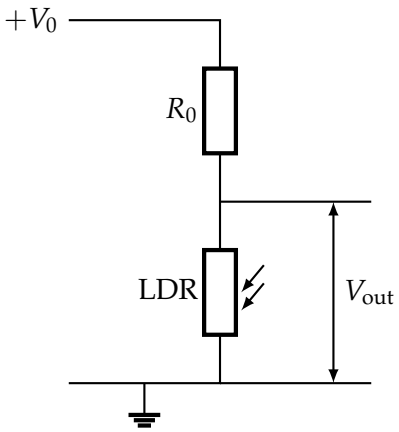
- V_0 = _____, and the _____ I flows through both, so

- the voltage is shared in proportion to the _____:

- if R_1 increases (R_2 fixed): V_1 _____ and V_2 _____. If R_1 decreases: V_1 _____ and V_2 _____.

- potential is measured relative to a reference point called _____ (or ground), defined as _____. In the diagram the potential at X equals V_2.

Question 31.2 A potential divider has $R_1 = 2.0\ \text{k}\Omega$ and $R_2 = 6.0\ \text{k}\Omega$ across a 12 V supply. Find V_1 and V_2.



Example 31.1 For the sensing circuit shown, suggest how the output voltage changes as the light level increases.

Question 31.3 In the example, $R_0 = 8.0\ \text{k}\Omega$, the LDR has 12 kΩ and $V_0 = +15$ V. Find V_{out}.

Question 31.4 Design a sensing circuit that produces a greater output voltage as the temperature of the sensor rises. Explain how it works.