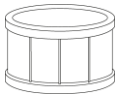
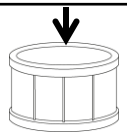
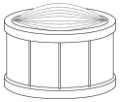
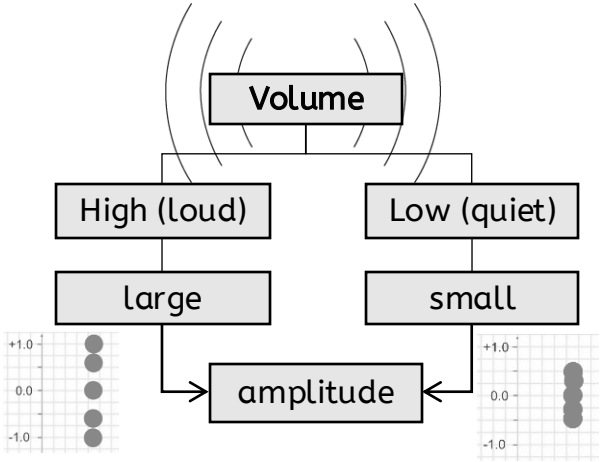
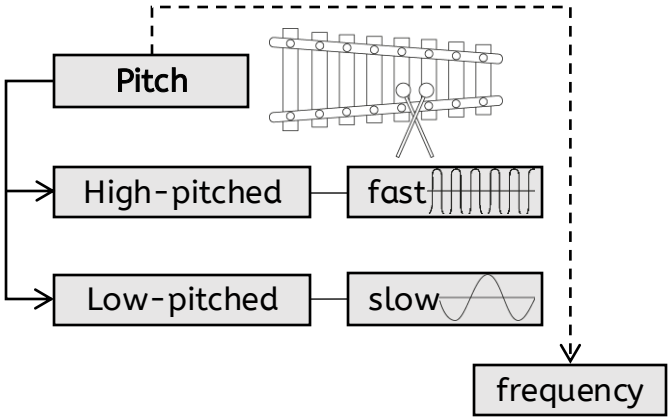
Sound and light

Describing sound

Sources of sound

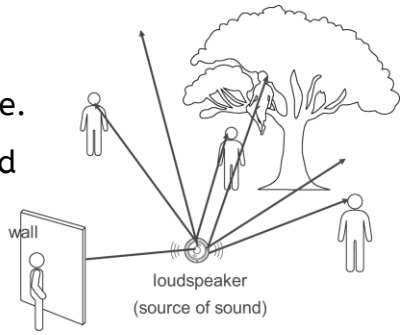
		
No sound	**Force** exerted	**Vibrating** matter





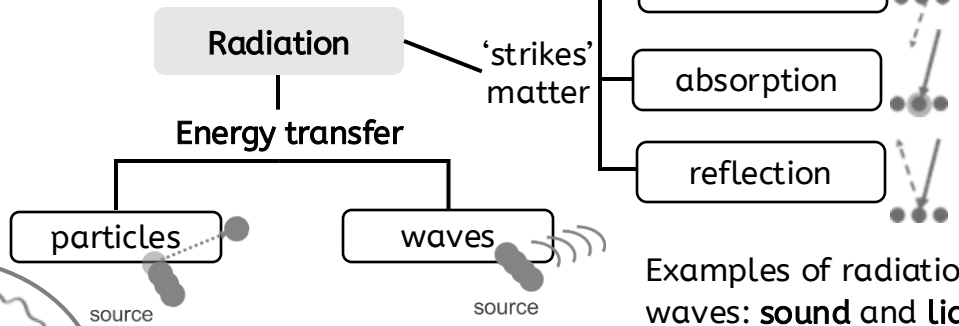
Vibrations travel through matter

- Travel in **all directions** from a source.
- Can be observed by **detectors** placed at a distance.
- If blocked, a **shadow region** occurs.
- Fastest in solids, slowest in gases.



- Gas ✓
- Liquid ✓
- Solid ✓
- Vacuum ×

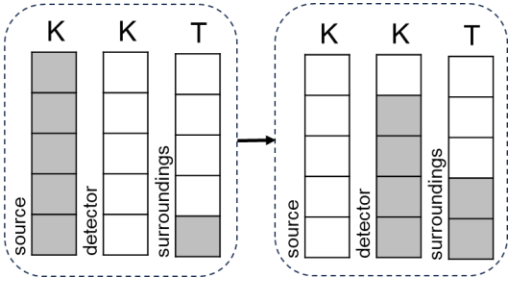
Radiation



Examples of radiation by waves: **sound** and **light**.

Energy transfer

- As vibrations travel, the energy store of the source decreases.
- The energy store of the matter increases.
- The kinetic store of any detector increases.
- By the **mechanical** pathway.



- The thermal store of the surroundings also increases.

Sound and light

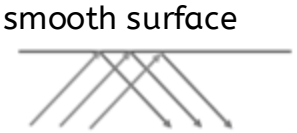
Vibrations get less with distance

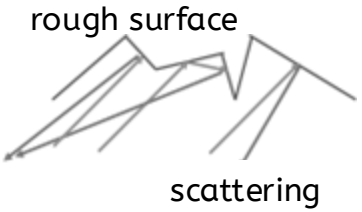
best absorbers

softer | thicker

- Energy **spreads out** among more particles.
- Each **particle absorbs** some energy, not passing it all on.
- If **all energy** is absorbed, a shadow region occurs.

Reflections



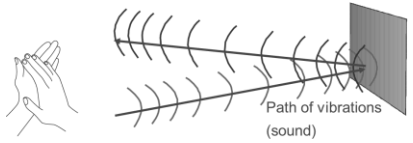


Surfaces

- Smooth surfaces can build **noise**.
- Rough surfaces scatter sound so that it spreads out and quietens.
- Noise can be made worse by many reflections interacting, and better by using rough surfaces.

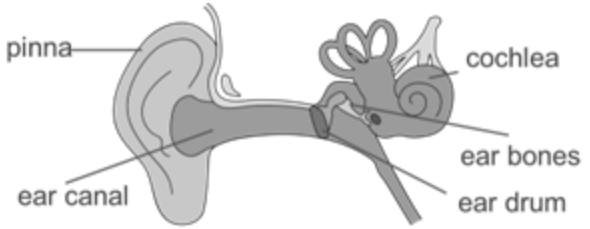
Echoes

- A reflected sound is an echo.
- Some animals use echoes.



Hearing

The ear



Sound in the ear

- The function:
  - **transfer energy** to the nervous system, as much as possible
  - from the vibrations in the air
  - to the inner ear,
  - so that the brain can perceive and interpret it.
- Energy transfer from the tiny hairs in the cochlea to the nerves is by the **electrical** pathway.

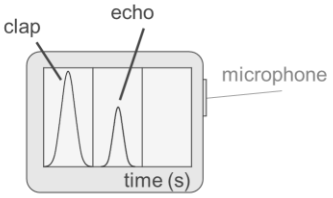
Differences in hearing

- The **audible range** of human hearing is from about 20 Hz to 20 000 Hz.
- Above this is **ultrasound** and below this is **infrasound**.
- Different animals have different ranges of hearing.
- Exposure to loud sounds and ageing can contribute to hearing differences, e.g. deafness.

Sound and light

Using technology to improve data quality

Measuring short times

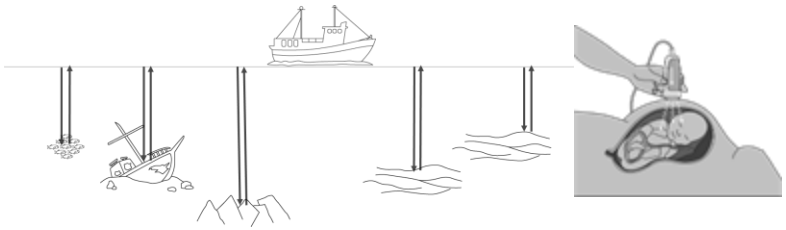


- **Digital** clock reduces systematic error (no scale).
- **Datalogging** equipment:
  - reduces difficulty observing quiet sounds e.g. echoes
  - reduces difficulty judging when sound arrives (measures directly)
  - reduces reflex action delays
  - allows 'zoom in' on time scale.

Using scientific knowledge

Echolocation

- Finding an object



Acoustic imaging

- Deep in the sea
- Inside living organisms (foetal scan)
- Inside solid objects

We have more information, of better quality, with much less risk.

Hearing technology examples

- Hearing aids
- Hearing implants
- Hearing loops

Reduce the chance of hearing damage by wearing ear protection and reducing volume of sounds.

Observing by measurement

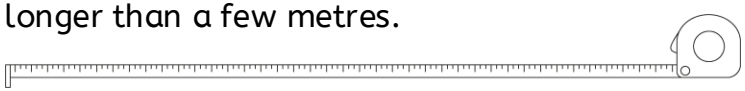
Quantities: and their units

Base quantities: length (m), mass (kg), time (s), temperature (K).

Derived quantities include force (N), **frequency (Hz)**, **loudness (dB)**.

Measuring instruments

- Include rulers, balances, clocks and thermometers.
- Measuring tapes are used to measure distances longer than a few metres.



Unit prefixes

- Standard prefixes change a number by multiples of 1 000, e.g. one *kilo*metre is equal to 1 000 metres.
- The prefix ***milli***- uses a multiple of 0.001, it means one thousandth:
  - one **millisecond** is one thousandth of a second (1 ms is easier to use than 0.001 s).
- A non-standard but common prefix is ***centi***-, to mean one hundredth.
  - one centimetre is one hundredth of one metre (1 cm is easier to use than 0.001 m).