Relative atomic mass (A_r) is the weighted average mass of all isotopes of an element, relative to $\frac{1}{12}$ of the mass of a carbon-12 atom.

Relative atomic mass can be calculated using this equation:

$$\text{relative atomic mass } (A_r) = \frac{\sum(\text{isotope mass} \times \text{isotope abundance})}{\text{total abundance}}$$

For example, boron has two isotopes. Approximately 20% of boron atoms are the ^{10}B isotope and 80% of boron atoms are the ^{11}B isotope.

$$\text{relative atomic mass of boron} = \frac{(10 \times 20) + (11 \times 80)}{100} = 10.8$$

The relative atomic mass of each element is usually given to one decimal place and is shown on the periodic table.

10.8
B
boron
5

Relative molecular mass (M_r) is the average mass of a molecule, relative to $\frac{1}{12}$ of the mass of a carbon-12 atom.

Relative molecular mass can be calculated using this equation:

$$\text{relative molecular mass } (M_r) = \sum(A_r \times \text{number of each atom})$$

For example, a molecule of methane, CH_4, consists of one carbon atom and four hydrogen atoms,

relative molecular mass of methane = $(12.0 \times 1) + (1.0 \times 4) = 16.0$

The term **relative formula mass** is used when referring to **ionic compounds** because they do not form molecules. Ionic compounds form giant ionic lattices consisting of a repeating formula unit.

Astronomy

artificial

asteroid

atmosphere

big bang theory

circular orbit

comet

cosmic microwave background (CMB)

distance

dwarf planet

earth

evidence

evolution

expanding

force

frequency

galaxy

gravity

life cycle

main sequence star

mass

moon

natural

nebula

orbit

orbital speed

planet

radiation

radius

red giant

red-shift

satellite

solar system

space

stable orbit

star

steady state theory

sun

surface

telescope

thermal expansion

universe

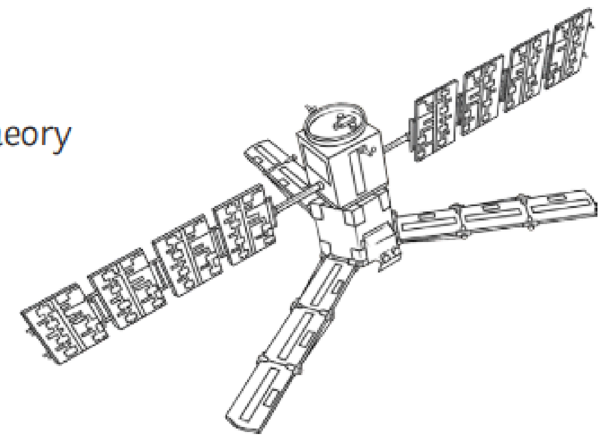
velocity

wave

wavelength

weight

white dwarf



Boldon School

INNOVATE: FOCUS: ACHIEVE

Study to Succeed

KNOW MORE DO MORE REMEMBER MORE

Energy adds up

The **law of conservation of energy** states that energy cannot be created or destroyed, only transferred.

total energy before = total energy after

Transferring energy

Light, sound, and electricity are ways of transferring energy between different stores.

Energy and temperature

- **Thermometers** measure temperature in degrees **Celsius (°C)**.
- Temperature measures the *average* energy.
- **Thermal energy** measures the total energy.

A warm bath has more thermal energy than a heated kettle, even though the kettle has a higher temperature.

Heating solids, liquids, and gases

- As we heat things the particles gain more **kinetic energy**, and vibrate more or faster.
- The energy needed to heat an object depends on the mass, material and temperature rise.

Equilibrium

Equilibrium is when objects have the same thermal energy.

Energy and power

Renewable resources

Renewable resources produce greenhouse gases when built, not when used, and will not run out.

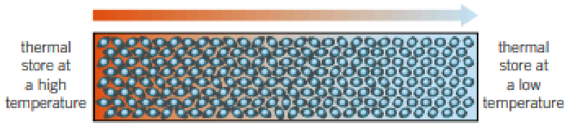
For example, wind, tidal, wave, hydroelectric, geothermal, biomass, and solar powers.

Particles

Thermal energy can be **transferred** by **conduction, convection** or **radiation.**

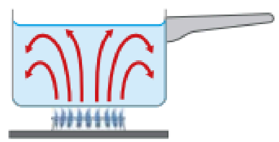
Conduction

- Particles collide into others when they vibrate.
- Occurs in solids.



Convection

- Occurs in liquids or gases.
- The part in contact with the heat source gets hotter. The particles move faster, causing them to become further apart, and a decrease in density.
- The hot part then rises, and cooler, denser parts fall and take its place at the bottom.
- They now heat, so the cycle continues. We call this a **convection current**.



Energy and power

Power is the rate of energy transfer – how much energy is transferred each second.

Energy bills

- Energy bills are measured in 1 **kilowatt** per hour (kWh).

  For example, a 2kW device uses 4kWh.
- A bill covers the cost of the fuel used at the power station, the power station, staff, and infrastructure.
- To convert kWh this to joules, convert the time to seconds.

  For example, 2000J/s × 7200s = 14400000J

Reducing bills

- Use fewer appliances or more efficient ones.
- Insulated houses lose less thermal energy so don't need to use as much power.

Work energy and machines

Work done (J) = force (N) × distance (m)

Simple machines like **levers** and **gears** can make it easier to do work but you still get the energy out that you put in.

Radiation

- **Infrared radiation** transfers energy without particles – it is a wave.
- All objects emit radiation.
- The amount depends on their temperature and the surface (colour and rough/smooth).
- Radiation can be **absorbed** or **reflected**.

Non-renewable resources

Non-renewable resources include the **fossil fuels** coal, oil, and gas. These were formed millions of years ago from fossilised remains.

These are non-renewable because you cannot reuse them, and they will eventually run out.

Coal, oil, or gas are used to run **thermal power stations**.

Fossil fuels are burned to heat water, which produces steam.

The steam turns a turbine, which spins a generator.

The current created is sent to our offices, factories, and homes down long cables.

These fossil fuels produce **greenhouse gases**, such as carbon dioxide.

Food and fuels

- There is energy in the **chemical stores** associated with food and fuel.
- Energy is measured in **joules (J)**.
- You need different amounts of energy for different activities.

The energy in food varies.
For example:
- *apple – 200kJ per 100g*
- *chips – 1000kJ per 100g*

The energy used when we do things varies too.
For example:
- sitting – 6kJ per minute
- running – 60kJ per minute