

Work done	Work done and power	Work done and deformation	Thermal energy and temperature	Thermal conduction	Convection	Radiation	Thermal insulators
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Key Words

Key Word	Definition
Energy	The ability to do work. Measured in joules.
Conductor	A material that transfers thermal energy quickly.
Insulator	A material that transfers thermal energy slowly.
Internal energy	The energy stored by the atoms and molecules that make up a substance.
Power	The rate at which energy is transferred, or at which work is done. Measured in watts.
Temperature	A measure of the average kinetic energy of the particles.
Conduction	Transfer of thermal energy through solids by the vibration of particles.
Convection	Transfer of thermal energy through fluids (liquids and gases), when hot particles rise.
Radiation	Transfer of thermal energy as a wave. It does not need particles so can occur in a vacuum.
Work done	The energy transferred when a force acts over a distance.

Misconceptions

Work done and power are not the same. Work done is the energy transferred, and power is how quickly it is transferred.

Insulators do not warm objects up. They slow down the transfer of thermal energy, keeping objects at the current temperature for longer.

Heat does not always rise. Warm particles will rise in a fluid because of the temperature difference but in conduction direction does not matter and heat radiation is given out in all direction.

Key questions

What is work done and how can an object be powerful?

How is thermal energy transferred via conduction, convection and radiation?

How can thermal energy transfer be reduced and what materials are best?

Work done

When a **force** is used to **move an object**, energy is transferred (because the object has moved) and we say that **work is done**.

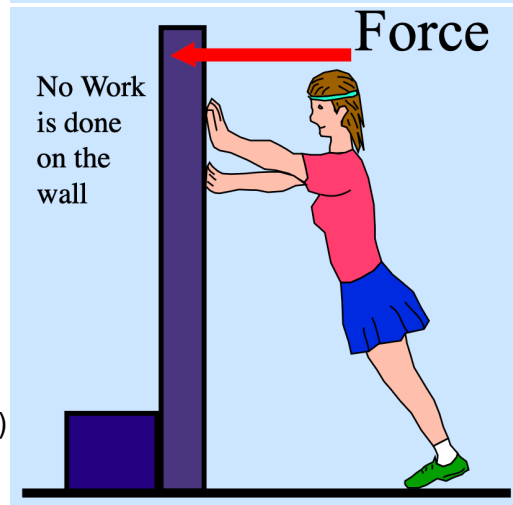
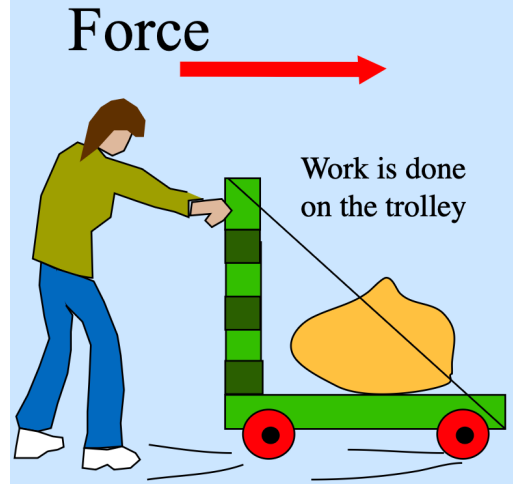
A force that causes movement **in the direction of the force** has done work. But a force applied to an object that **does NOT move**, means **no work is done** on the object. Zero movement = zero work.

Or, if a force is applied but the object does not move **in the direction of the force**, then once again, **NO work is done!**

Work done = Force x distance moved
(in the direction of the force)

- Work done in joules, J
- Force in newtons, N
- Distance moved in metres, m

Remember to use CFIFA when setting out calculations →



- Convert – do the units match the standard ones?
- Formula
- Insert numbers
- Fine tune (rearrange)
- Answer

Power

Power is the rate at which energy is transferred or the rate at which work is done.

Power is all about - **how quickly something transfers energy** or - how quickly something **does work**.

$$\text{Power} = \frac{\text{Energy transferred}}{\text{Time taken}}$$

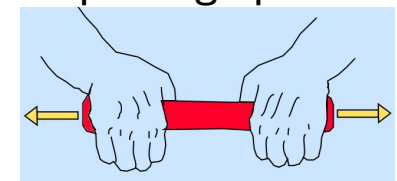
- Power in watts, W
- Energy transferred or work done in joules, J
- Time taken in seconds, s

Deformation

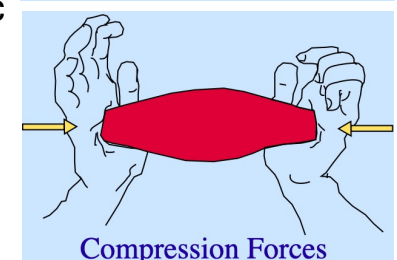
Tension and compression are examples of resultant forces which cause **change to the shape** of an object. The proper term for a "change of shape" is a **deformation**.

Sometimes the deformation is temporary, e.g. when we stretch a spring or an elastic band and then release it, it goes back to its original length; we call this deformation, an **elastic deformation**. But if the deformation is permanent such as when we stretch a piece of blu-tac, then we call this deformation, an **inelastic deformation**.

Force extending or pulling apart



Tension Forces



Compression Forces

Force squashing or pushing together

Thermal energy and temperature

When we know the **temperature** of something we know how hot it is, *not* how much **thermal energy** is in it. Temperature measures average energy in **degrees Celsius (°C)**.

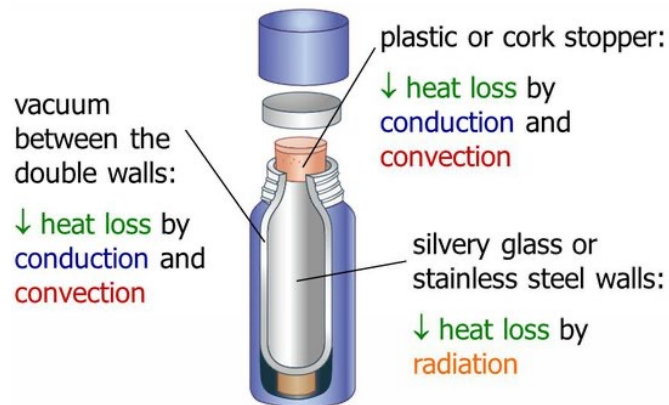
Thermal energy measures total energy in **joules (J)**. The amount of **thermal energy** in something depends upon

- how hot it is (its temperature)
- the material it is made from
- its mass.

Thermal insulators

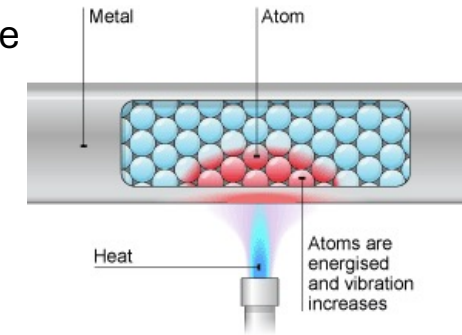
Insulation materials have a low thermal conductivity, meaning they are poor conductors of heat. This slows down the rate of heat transfer.

Different insulating methods can be used to reduce energy transfer



Conduction

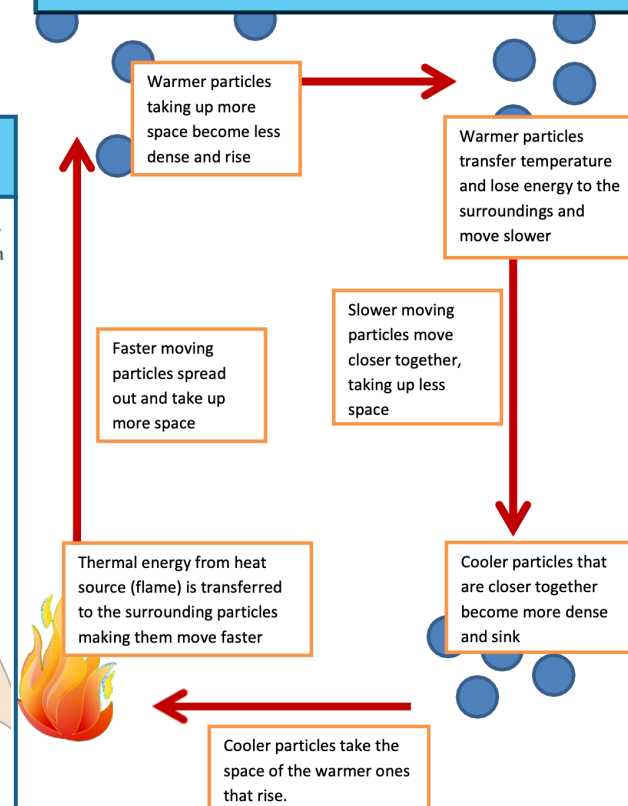
Conduction is the transfer of thermal energy by the progressive vibration of particles and, in metals, by the movement of free electrons. It relies on the closeness of particles; therefore conduction **only occurs in solids**, not in liquids or gases.



Convection

Convection is the transfer of thermal energy when particles of a heated fluid (a liquid or a gas) rise. It relies on the fluid movement of particles, so **it does not occur in a solid**.

Convection current



Radiation

Radiation is the transfer of thermal energy as a wave, an electromagnetic wave. This makes transfer of thermal energy by radiation incredibly fast (as fast as light) and because radiation travels as an electromagnetic wave it doesn't need particles and so thermal transfer by radiation can occur across a **vacuum**.

