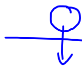
Thermal Physics

PE

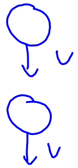
PE → KE

⇒ Ball gets faster + faster



PE = KE

But we know ball reaches terminal velocity



v $KE = \frac{1}{2}mv^2$

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where has the PE gone?

WD against air resistance

The Energy must have gone inside the ball → INTERNAL ENERGY

When this happens the body gets hot (increased temp)

it seems like these are connected

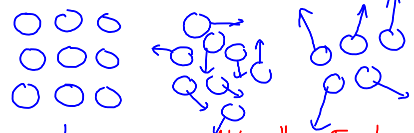
To understand this we need to model matter.

Particle model of matter

Matter is made of small particles. like rubber balls

using particles we can explain the states of matter

solid	liquid	Gas



regular arrangement

Force between atoms

particles roll around each other

free to move

We can use what we know about mechanics to model atomic behaviour.

Measurement of amount of matter

When dealing with particles we (e.g. apples) can use – number of particles
– mass

Since matter is made of particles we can also use the number of particles.

Mole 6×10^{23} molecules of matter

– Avagadros number

Molar mass mass of a mole

e.g. Carbon 12g
Hydrogen 1g

We can now understand what happens to the energy when we rub our hands
– using the particle model

The KE and PE of the atoms is increased

- Increased movement
- pulled apart

Note gas atoms have KE only

Internal Energy

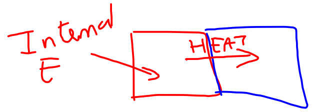
Total KE + PE of all the atoms of a body.

- To increase the internal energy we can either do work or transfer energy from a hot body.

Heat

Heat is transferred when a hot body is in thermal contact with a cold body

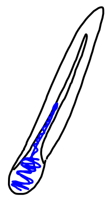
unit - Joule



Temperature

- How hot or cold a body is.

To measure Temp we need an observable physical quantity that changes with temp.

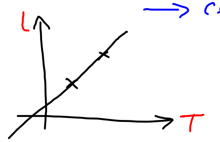


+ 2 fixed points

boiling + freezing water

100   0

→ celsius scale



Internal Energy

The total PE + KE of all the atoms of a body.

Temperature

How hot or cold a body is. Proportional to the average KE of the atoms.

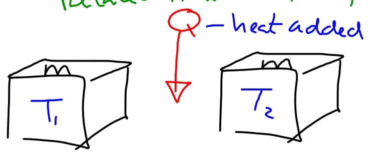
Heat

Is transferred when a hot body is in contact with a cold one.

Specific Heat Capacity c

The amount of heat required to raise the temp. of 1kg of a substance by 1°C.

Relates Heat and Temp.



$$c = \frac{Q}{m(T_2 - T_1)}$$

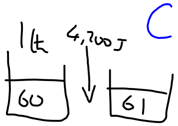
unit J/kg°C

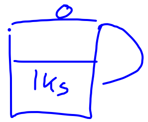
$$c = \frac{Q}{m\Delta T}$$

$$\Rightarrow \boxed{Q = mc\Delta T}$$

Example

$c_{water} = 4,200$ J/kg°C





$20°C \rightarrow 100°C$

$Q = 1 \times 4{,}200 \times 80$

Power of kettle = 1800 W

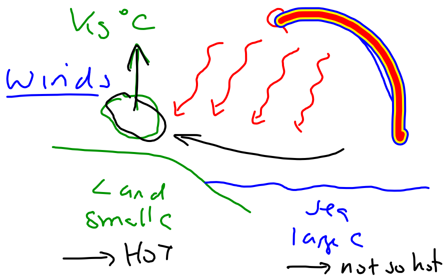
How long to heat water?

$P = \frac{Q}{t}$ $t = \frac{Q}{P}$

$t = \frac{4{,}200 \times 80}{1800}$

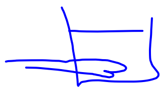
$t = 186.7\ s$

Note when water cools it will emit 4,200 J per kg °C



Measuring c

using an electrical heater

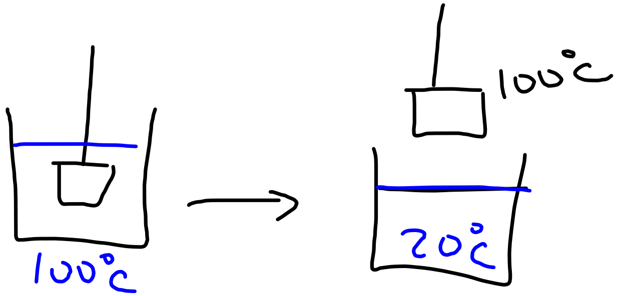


Power = P

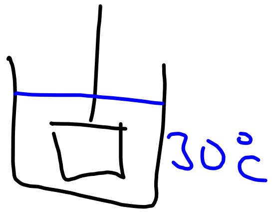
$\frac{Q}{t} = mc\frac{\Delta T}{t}$

$P = mc\frac{\Delta T}{t}$

method of mixtures



Heat from metal = Heat to water



$$m_m c_m \Delta T_m = m_w c_w \Delta T_w$$

$$m_m c_m (100-30) = m_w c_w (30-20)$$

Change of state

When matter changes state its temp. does not change