

Thermal Physics

IGCSE Physics ■ Topic 2

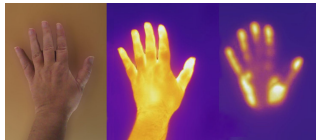
IGCSE Physics



Thermal Physics

What we will cover

- 1 States of matter
- 2 The kinetic particle model
- 3 Specific heat capacity
- 4 Changes of state
- 5 Conduction convection radiation
- 6 Recap



1

States and the particle model

States of matter

solid 固体

regular; vibrate
about fixed positions

liquid 液体

close; can slide – take
the container's shape

gas 气体

far apart, fast;
fill the container

Temperature and the particle model

All matter is moving **particles** 粒子.

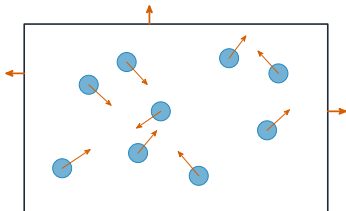
Temperature 温度 measures the **average kinetic energy** of the particles.

Lowest possible: **absolute zero** 绝对零度,
 -273°C .

$$T(\text{K}) = \theta(^{\circ}\text{C}) + 273.$$



Gas pressure and Boyle's law



gas particles hit the walls — each hit is a tiny force.
Pressure = force per unit area

particle hits make the pressure

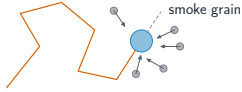
Fixed mass, constant temperature:

$$pV = \text{constant}.$$

$$200 \text{ cm}^3 \text{ at } 100 \text{ kPa} \rightarrow 50 \text{ cm}^3$$

$$p_2 = \frac{100 \times 200}{50} = 400 \text{ kPa}$$

Brownian motion



fast, invisible air particles hit the smoke grain from random directions, so it moves in a jerky, random path

Smoke specks move in a **jerky, random** path – pushed by fast, invisible air particles.

Brownian motion 布朗运动 is strong evidence for the particle model.

2 Heating

Thermal expansion and heat capacity



cool: a gap is left for expansion



hot: the rails expand and the gap closes

Heated matter expands (gases most).

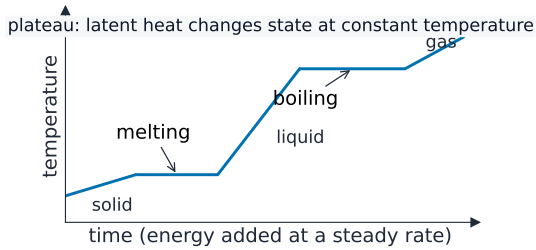
Specific heat capacity 比热容:

$$c = \frac{\Delta E}{m \Delta \theta}$$

2.0 kg **water**, 20 → 70°C, $c = 4200$

$$\Delta E = mc \Delta \theta = 420 \text{ kJ}$$

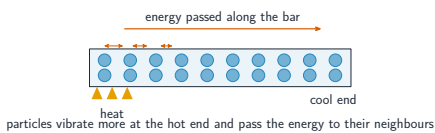
Changes of state



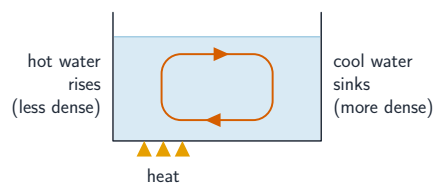
- **melting** 熔化/**boiling** 沸腾
– temperature **stays flat** while the state changes
- **evaporation** 蒸发 – fastest particles leave the surface, so the liquid **cools**

3 Thermal transfer

Conduction and convection



conduction 热传导: *particles pass energy*



convection 对流: *hot fluid rises*

Metals conduct well (free **electrons** 自由电子); convection needs a moving fluid, so not in solids.

Radiation



Thermal radiation 热辐射 is **infrared** 红外线 – it needs **no material** and crosses space.

Dull black surfaces are good **emitters and absorbers**; shiny white ones reflect.

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Recap

Topic 2 – key takeaways

1 Particles

temperature = average kinetic energy

2 Gas law

$pV = \text{constant}$ at constant temperature

3 Heating

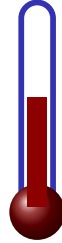
$\Delta E = mc\Delta\theta$; state changes stay flat

4 Transfer

conduction, convection, radiation

Check yourself

- 1 Convert 25°C to kelvin.
- 2 Halve a gas's volume – what happens to its pressure?
- 3 Why does evaporation cool a liquid?
- 4 Which surface is the best emitter of infrared?



Answers 1. 298 K 2. it doubles 3. the fastest particles leave 4. dull black