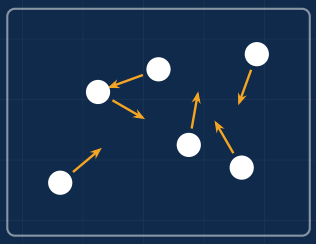
CAMBRIDGE IGCSE™ PHYSICS 0625 | TOPIC 2

FREE SAMPLE

Thermal Physics

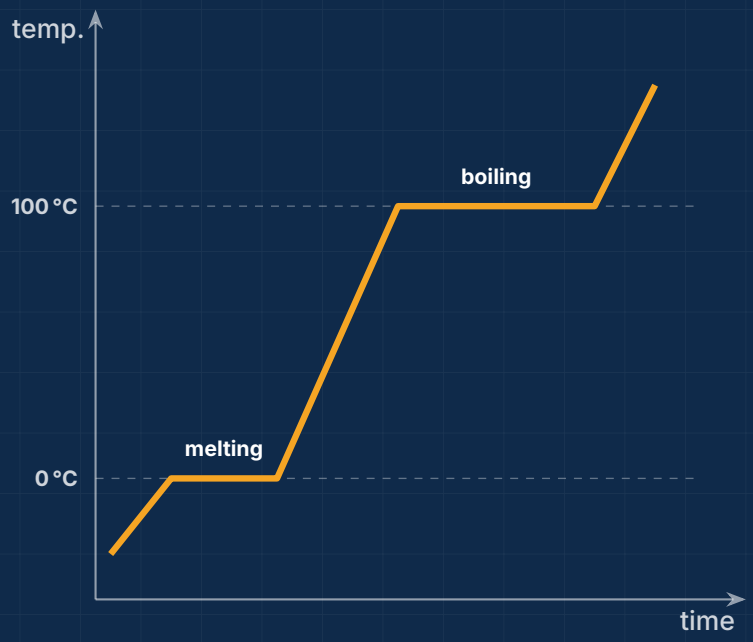
Free sample: knowledge organiser and Worksheet 1 with answers

Particle model | Gases & kelvin | Thermal expansion | Specific heat capacity | Changes of state | Conduction & convection | Radiation | Exam-style questions



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

$$T = \theta + 273$$



I Can't Do Physics

Physics that finally makes sense.

Free sample

Full pack: worksheets, exam paper, answers

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Knowledge organiser

States of matter and the particle model

	solid	liquid	gas
particles	close together, regular pattern	close together, irregular	far apart, random
motion	vibrate about fixed positions	move around each other	move randomly at high speed
shape, volume	fixed shape and volume	shape of container, fixed volume	no fixed shape or volume

melting: solid → liquid boiling, evaporation: liquid → gas condensation: gas → liquid
solidification (freezing): liquid → solid
SUPPLEMENT Solids: strong forces, small separation, fixed shape. Gases: very weak forces, large separation.

Temperature, pressure, Brownian motion

Higher temperature: particles move faster (SUPPLEMENT greater average kinetic energy).
Absolute zero = −273 °C = 0 K: least kinetic energy.
$T\,(\mathrm{K}) = \theta\,(^\circ\mathrm{C}) + 273$
Gas pressure: particles collide with the walls (SUPPLEMENT force per unit area).
Brownian motion: smoke specks move randomly because fast air molecules hit them.

Gases and thermal expansion

Fixed V, T up: faster particles hit the walls more often and harder, so p up.
Fixed T, V down: more collisions per second per unit area, so p up.
SUPPLEMENT pV = constant (fixed mass of gas at fixed T)
Expansion: gas > liquid > solid. Use: thermometer. Problems: bridge and rail gaps, sagging cables.

Specific heat capacity

Temperature rise: internal energy increases.
SUPPLEMENT $c = \Delta E/(m\Delta\theta)$ unit J/(kg °C): the energy needed per unit mass per unit temperature rise. Water: 4200 J/(kg °C).
SUPPLEMENT To measure c: heater of known power in an insulated block or beaker; measure m, time and temperature rise; $\Delta E = Pt$.

Melting, boiling and evaporation

Melting and boiling: energy in, **no temperature change**. Water: melts at 0 °C, boils at 100 °C.
Evaporation: the more energetic particles escape from the surface, so the liquid **cools**.
SUPPLEMENT Faster when warmer, with a larger surface area or more air movement. Boiling: throughout the liquid, at one temperature. Evaporation: surface only, any temperature.

Transfer of thermal energy

	How it works	Examples
conduction	mainly in solids. SUPPLEMENT Vibrating particles pass energy on; metals also have free electrons, so conduct best; gases conduct poorly	copper pan base, plastic handle
convection	liquids and gases only: heated fluid expands, becomes less dense and rises; cooler, denser fluid sinks	radiator heating a room
radiation	infrared; emitted by all objects; needs no medium. Dull black: best emitter and absorber; shiny silver: worst (reflects). SUPPLEMENT Greater from a hotter or larger surface	the Sun heating the Earth; vacuum flask

SUPPLEMENT Constant temperature: energy is transferred away at the same rate as it is received. More greenhouse gases: less infrared escapes, so the Earth warms until a new balance is reached.

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The particle model of matter

WORKSHEET 1

CORE SUPPLEMENT

You will: describe the properties of solids, liquids and gases, name the changes of state, use the particle model to explain temperature, gas pressure and Brownian motion, and (Extended) link the properties of each state to the forces and distances between particles.

CORE all students SUPPLEMENT Extended (Supplement) students CHALLENGE stretch question

1 CORE Complete the table. Write **yes** or **no** in each space. [3]

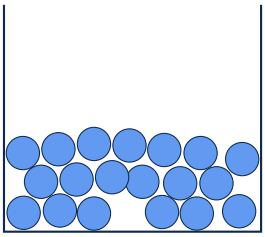
	fixed shape?	fixed volume?	easily compressed?
solid			
liquid			
gas			

2 CORE Name each change of state. [4]

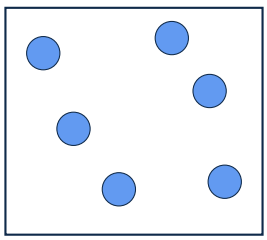
(a) solid → liquid _____ **(b)** liquid → gas (at the boiling point) _____

(c) gas → liquid _____ **(d)** liquid → solid _____

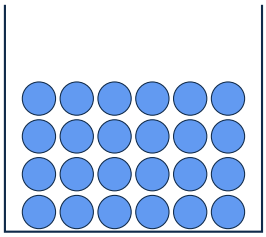
3 CORE The diagrams show the particles in a solid, a liquid and a gas, in a different order.



X



Y



Z

(a) Which diagram shows each state? solid _____ liquid _____ gas _____ [1]

(b) Describe the arrangement and the motion of the particles in a solid. [2]

(c) Describe the separation and the motion of the particles in a gas. [2]

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4 CORE This question is about temperature and the motion of particles.

(a) The temperature of a gas increases. State what happens to the motion of its particles. [1]

.....

(b) State the temperature of absolute zero in °C. [1]

temperature = _____

(c) Describe the particles of a substance at absolute zero. [1]

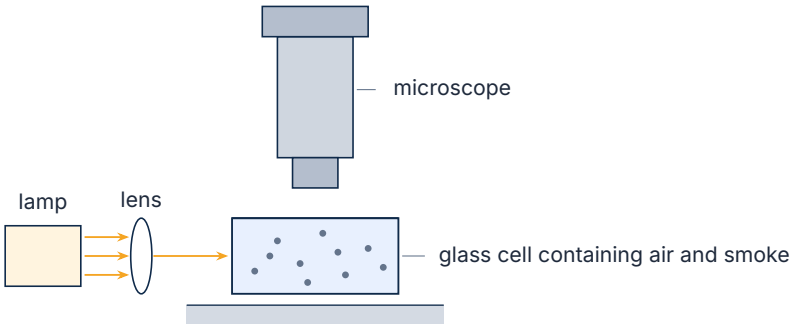
.....

5 CORE A sealed metal can contains air. Explain, in terms of particles, how the air exerts a pressure on the inside walls of the can. [2]

.....

.....

6 CORE A student looks at smoke in air through a microscope. A bright lamp lights the smoke from the side.



(a) Describe what the student sees through the microscope. [2]

.....

.....

(b) Explain what causes this motion. [2]

.....

.....

(c) State why this observation is evidence for the kinetic particle model of matter. [1]

.....

Exam tip In a gas the particles are **far apart** and move **randomly at high speed**. In a solid they are **close together** in a **regular** pattern and **vibrate about fixed positions**. Do not say that particles in a solid "do not move".

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7 SUPPLEMENT Use ideas about the forces and the distances between particles to explain why

(a) a solid has a fixed shape, [2]

.....

.....

(b) a gas has no fixed volume and is easy to compress. [2]

.....

.....

8 SUPPLEMENT Gas particles in a container collide with the walls.

(a) Explain, in terms of force and area, how these collisions produce a pressure. [2]

.....

.....

(b) The total force of the gas on one wall of area 0.040 m^2 is 4000 N. Calculate the pressure of the gas on the wall. [2]

.....

pressure = _____

9 SUPPLEMENT This question is about the motion of smoke particles in air.

(a) A student writes: *"The bright specks that I can see moving are air molecules."* Explain why the student is wrong. Use the words *molecules* and *microscopic particles* correctly. [1]

.....

(b) CHALLENGE A smoke particle has a much greater mass than an air molecule. Explain how collisions with air molecules can still move it in random directions. [2]

.....

.....

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Answers: Worksheet 1

Mark codes: B1 independent mark C1 method mark, implied by a correct final answer A1 correct answer with unit. Accept answers that round correctly; allow error carried forward from earlier parts.

Worksheet 1 – The particle model of matter

1 Solid: yes, yes, no B1
Liquid: no, yes, no B1
Gas: no, no, yes B1

2 **(a)** melting B1 **(b)** boiling B1
(c) condensation B1 **(d)** solidification (freezing) B1

3 **(a)** solid **Z**, liquid **X**, gas **Y** B1
(b) Close together in a regular pattern (lattice) B1; vibrate about fixed positions. B1
(c) Far apart (large spaces between them) B1; move randomly (in all directions) at high speed. B1

4 **(a)** They move faster (they have more kinetic energy). B1
(b) **−273 °C** B1
(c) They have the least possible kinetic energy (they move as little as possible). B1

5 The air particles move randomly at high speed and collide with the walls B1; each collision exerts a force on the wall, and together these collisions produce a pressure. B1

6 **(a)** Bright specks (of smoke) B1; moving in a random, jerky, zigzag way. B1
(b) The smoke particles are hit by air molecules B1; the molecules move fast and randomly, so the collisions are random (more hits on one side at any instant). B1
(c) It shows that the (invisible) air molecules are moving randomly, as the model says. B1

7 **(a)** Strong forces between the particles B1; hold them in fixed positions, close together, so they cannot move past each other. B1
(b) The forces between gas particles are very weak (negligible), so the particles move freely and spread out to fill any container B1; there are large distances between the particles, so they can be pushed closer together. B1

8 **(a)** Each particle that hits the wall exerts a force on it B1; pressure is the total force of these collisions per unit area of the wall. B1
(b) $p = F/A = 4000 \div 0.040$ C1 = **100 000 Pa** (1.0×10^5 Pa) A1

9 **(a)** Air molecules are far too small to be seen with a microscope; the specks are smoke particles. B1
(b) The air molecules move at very high speed B1; at each instant the smoke particle is hit by many more molecules on one side than the other, giving it a random unbalanced push. B1

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Get the full pack

You have just used Worksheet 1. The full Thermal Physics pack contains:

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- **Worksheet 2:** Gases and thermal expansion
- **Worksheet 3:** Specific heat and changes of state
- **Worksheet 4:** Thermal energy transfer
- **Multiple-choice practice:** 10 Paper 1/2-style questions
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