

# 9.1 Kinetic Theory of Temperature and Pressure

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

Total: 9 marks

**KEY WORDS** pressure 压强 • temperature 温度 • kinetic energy 动能  
• random motion 无规则运动 • heat 热量

## Objective

Build the skills to answer exam questions on **the kinetic theory of temperature and pressure**.

You must be able to:

- describe a gas as many particles in **random motion** 无规则运动 with negligible volume
- relate **absolute temperature** 绝对温度 to the average **kinetic energy** 动能 of the particles
- explain gas **pressure** 压强 as the result of particle collisions with the walls
- use  $\overline{KE} = \frac{3}{2}k_B T$

## 1 Worked examples

Study these first. Each one shows the method for a question type used later.

### ■ The kinetic-theory picture

A gas is a huge number of tiny particles in random motion, with negligible volume and no forces except during brief collisions.

### ■ Temperature and energy

$\overline{KE} = \frac{3}{2}k_B T$ , where  $k_B = 1.38 \times 10^{-23} \text{ J K}^{-1}$  and  $T$  is the **absolute** temperature (in kelvin). Doubling  $T$  doubles the average kinetic energy.

### ■ Pressure

Particles collide with the container walls; faster or more frequent collisions mean a larger force per unit area, i.e. a higher pressure.

## 2 Practice

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**2.1** State what causes the pressure a gas exerts on its container. [1]

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**2.2** The absolute temperature of a gas doubles. State what happens to the average kinetic energy of its particles. [1]

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**2.3** Find the average kinetic energy of a particle at  $T = 300 \text{ K}$  (take  $k_B = 1.38 \times 10^{-23} \text{ J K}^{-1}$ ). [2]

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## 3 Exam-style questions

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**3.1** The absolute temperature of a gas is a measure of the [1]

|   |   |
|---|---|
| A | B |
| C | D |

- A total volume
- B average kinetic energy of its particles
- C number of particles
- D pressure

**3.2** If the average kinetic energy of the gas particles triples, the absolute temperature [1]

|   |   |
|---|---|
| A | B |
| C | D |

- A stays the same
- B doubles
- C triples
- D falls to one third

**3.3** A gas in a sealed rigid container is heated from 300 K to 600 K.

(a) State the ratio of the new average kinetic energy to the old. [1]

(b) Explain, in terms of particle motion, why the pressure rises. [2]