AP PHYSICS 2 • EXERCISE SHEET

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 $\overline{KE} = \frac{3}{2}k_BT$

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

$\overline{KE} = \frac{3}{2}k_BT$, where $k_B = 1.38 \times 10^{-23}$ 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

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

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

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

3 Exam-style questions

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

- **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** 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]

Solutions

2.1 the collisions of the gas particles with the container walls.

2.2 it also doubles ($\overline{KE} \propto T$).

2.3 $\overline{KE} = \frac{3}{2}k_BT = \frac{3}{2}(1.38 \times 10^{-23})(300) = 6.2 \times 10^{-21}$ J.

3.1 B.

3.2 C.

3.3 (a) 2 : 1. (b) higher temperature means faster particles, which hit the walls harder and more often, raising the pressure.