AP CHEMISTRY • EXERCISE SHEET

3.5 Kinetic Molecular Theory

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS kinetic molecular theory 分子运动论 • maxwell-boltzmann 麦克斯韦 • solute 溶质 • solution 溶液

Objective

Build the skills to answer exam questions on the **kinetic molecular theory** of gases.

You must be able to:

- state the assumptions of the **kinetic molecular theory** 分子运动论
- link **temperature** to average kinetic energy
- read a **Maxwell-Boltzmann** 麦克斯韦-玻尔兹曼 speed distribution

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

The assumptions

An ideal gas is modelled as: many tiny particles in constant random motion; negligible volume; no forces between them; and **elastic** collisions (no energy lost).

Temperature and kinetic energy

The **average kinetic energy** of the particles is proportional to the **absolute temperature**:

$$KE_{\text{avg}} = \tfrac{3}{2} k_B T.$$

Doubling T (in kelvin) doubles the average kinetic energy.

Speed and molar mass

At the same temperature, **lighter** molecules move **faster** (same KE means smaller mass $\Rightarrow$ larger speed). So H_2 moves faster than O_2 at the same T.

The Maxwell-Boltzmann distribution

The curve shows the spread of molecular speeds. Higher temperature shifts the peak **right** and **flattens** it (a wider spread, more fast molecules). The area under the curve is the total number of molecules.

2 Practice

Now apply the methods above.

2.1 What is proportional to the absolute temperature of a gas? [1]

2.2 At the same temperature, which moves faster: He or Ar? Give a reason. [2]

2.3 What happens to the Maxwell-Boltzmann curve when temperature rises? [1]

3 Exam-style questions

3.1 According to kinetic molecular theory, collisions between ideal-gas particles are [1]

- **A** inelastic (energy lost)
- **B** elastic (no energy lost)
- **C** impossible
- **D** always head-on

3.2 Two gases, H_2 and O_2, are at the same temperature.

(a) Compare their average kinetic energies. [1]

(b) Compare their average speeds, with a reason. [2]

3.3 Describe how the Maxwell-Boltzmann speed distribution changes when a gas is

heated, and what stays the same. [3]

Solutions

2.1 The average kinetic energy of the particles.

2.2 He — it has a smaller molar mass, so at equal kinetic energy it moves faster.

2.3 The peak shifts to higher speed and the curve flattens/broadens.

3.1 B — elastic collisions.

3.2 (a) Equal — average kinetic energy depends only on temperature. (b) H_2 is faster; it has a smaller mass, so for the same $KE = \frac{1}{2}mv^2$ it has a larger v.

3.3 Heating shifts the peak to a higher speed and lowers/broadens it (a wider spread with more fast molecules); the total area (number of molecules) stays the same.