Exercise walk-through

Kinetic Molecular Theory ▪ 3.5

eXercise

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

Method — 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).

Method — 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.

Method — Speed and molar mass

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

Method — 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.

Practice 2.1 ▪ 1 mark

What is proportional to the absolute temperature of a gas?

Solution 2.1

Method: Temperature and kinetic energy

Worked steps

The average kinetic energy of the particles B1.

Practice 2.2 ▪ 2 marks

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

Solution 2.2

Method: Speed and molar mass

Worked steps

He — it has a smaller molar mass, so at equal kinetic energy it moves faster M1 A1.

Practice 2.3 ▪ 1 mark

What happens to the Maxwell-Boltzmann curve when temperature rises?

Solution 2.3

Method: The Maxwell-Boltzmann distribution

Worked steps

The peak shifts to higher speed and the curve flattens/broadens B1.

Exam-style 3.1 ▪ 1 mark

According to kinetic molecular theory, collisions between ideal-gas particles are

A inelastic (energy lost)

B elastic (no energy lost)

C impossible

D always head-on

Solution 3.1

Method: The assumptions

A inelastic (energy lost)

B elastic (no energy lost) ✓

C impossible

D always head-on

Worked steps

B — elastic collisions.

Exam-style 3.2 ▪ 1 mark

Two gases, H_2 and O_2, are at the same temperature.
(a) Compare their average kinetic energies.
(b) Compare their average speeds, with a reason.

Solution 3.2

Method: Temperature and kinetic energy

Worked steps

(a) Equal — average kinetic energy depends only on temperature B1. (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 M1 A1.

Exam-style 3.3 ▪ 3 marks

Describe how the Maxwell-Boltzmann speed distribution changes when a gas is heated, and what stays the same.

Solution 3.3

Method: The Maxwell-Boltzmann distribution

Worked steps

Heating shifts the peak to a higher speed and lowers/broadens it (a wider spread with more fast molecules) M1 M1; the total area (number of molecules) stays the same A1.