Unit 13 · Ideal Gas

WORKSHEET

Full marks 32

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 32

1 Key words [4]

Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

absolute zero	**Avogadro's law**	**Avogadro's number**	**Boltzmann's constant**	**gas constant**
ideal gas	**latent heat**	**mole**	**rms speed**	**viscosity**

A gas whose molecules have no forces between them and take up no volume is an _____. It obeys $PV = nRT$, where R is the universal _____. The amount of substance that holds 6.02×10^{23} particles is one _____, and that number is _____. Equal volumes of all gases at the same temperature and pressure hold equal numbers of molecules: this is _____. The square root of the mean of the squares of the molecules' speeds is the _____. R divided by Avogadro's number is _____. The lowest possible temperature, where the lines of P against θ of every gas meet, is _____.

2 True or false [2]

Write True or False after each sentence. Correct the false ones. Each carries 0.5 mark.

i. At the same temperature, the molecules of every gas have the same average kinetic energy. ☐

ii. Doubling the Celsius temperature of a gas at constant pressure doubles its volume. ☐

iii. The rms speed of a gas's molecules is proportional to its absolute temperature. ☐

iv. The pressure of a gas comes from its molecules striking the walls of the container. ☐

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. The SI unit of the universal gas constant R is: [1]

a. J/K **b.** J/(mol K)
c. J/(kg K) **d.** $N/(m^2 K)$

ii. Which is NOT an assumption of the kinetic model of an ideal gas? [1]

a. the molecules are in constant random motion
b. the collisions are perfectly elastic
c. there are no forces between molecules except in collisions
d. the molecules attract each other strongly

iii. The volume of 2 moles of an ideal gas at NTP is: [1]

a. 11.2 L **b.** 22.4 L
c. 44.8 L **d.** 2 L

iv. A gas is kept at constant volume. Its pressure is doubled when it is heated from 27 °C to: [1]

a. 54 °C **b.** 300 °C

c. 327 °C **d.** 600 °C

v. The average kinetic energy of a molecule of an ideal gas depends only on: [1]

a. its mass **b.** the pressure

c. the absolute temperature **d.** the volume of the container

4 Short answers [7]

Write short answers to the following questions.

a. Why does a real gas behave most like an ideal gas at low pressure and high temperature? [2]

b. A tightly closed balloon left in the sun swells and may burst. Explain using the kinetic model. [2]

c. A 10 L cylinder holds oxygen at 2.0×10^5 Pa and 27 °C. Find the number of moles of oxygen in it and its mass. (R = 8.31 J/(mol K); molar mass of oxygen 32 g/mol) [3]

5 Long answer [4]

Write a long answer to the following question.

A cubical box of side l holds N molecules of a gas, each of mass m. Using the kinetic model, show that the pressure of the gas is $P = \frac{1}{3}\rho crms^2$.

6 Numerical problems [7]

Solve the following problems. Show your working. R = 8.31 J/(mol K); $k_B = 1.38 \times 10^{-23}$ J/K.

a. Find, for nitrogen at 27 °C, i. the rms speed of its molecules and ii. the average kinetic energy of one molecule. (Molar mass of nitrogen 28 g/mol) [4]

Answer: _____

b. A hospital oxygen cylinder of volume 20 L holds oxygen at 1.5×10^7 Pa and 15 °C. Find the mass of oxygen in it. (Molar mass of oxygen 32 g/mol) [3]

Answer: _____

7 Think [3]

Nitrogen molecules in a room move at about 500 m/s. Yet when someone opens a bottle of perfume in a corner, it takes many seconds for the smell to reach the other side. Why?

8 Activity: A balloon on a bottle

(not marked)

Stretch a balloon over the mouth of an empty glass bottle. Stand the bottle in a bowl of hot water, then in a bowl of ice-cold water. Watch the balloon, and read the temperature of each bowl.

The bottle stands in	Temperature of the water (°C)	Temperature (K)	What the balloon does
Room air			
Hot water			
Ice-cold water			

What happens to the air in the bottle in each case? Explain with the kinetic model.