Chapter 18 Tutorial

Thermodynamics-II

Chapter 18 : Thermal Properties of Matter

Question 1:

Helium gas with a volume of 2.60 L, under a pressure of 0.180 atm, and at a temperature of

41.0°C is warmed until both pressure and volume are doubled.

(a) What is the final temperature?
(b) How many grams of helium are there? The molar mass of helium is 4.00 g/mol.

Question 2:

Calculate the mean free path of air molecules at a pressure of 3.50×10^{-13} atm and a temperature of 300 K. Model the air molecules as spheres of radius 2×10^{-10} m.

Question 3:

Consider an ideal gas at 27°C and 1.00 atm pressure. To get some idea how close these molecules are to each other, on the average, imagine them to be uniformly spaced, with each molecule at the center of a small cube.

(a) What is the length of an edge of each cube if adjacent cubes touch but do not overlap?
(b) How does this distance compare with the diameter of a typical molecule?
(c) How does their separation compare with the spacing of atoms in solids, which typically are about 0.3 nm apart?

Question 4:

For a gas of nitrogen molecules (N_2) what must the temperature be if 94.7% of all the molecules have speeds less than. (The molar mass of N_2 is 28 g/mol)

(a) 1500 m/s
(b) 1000 m/s
(c) 500 m/s

Table for v/v_{rms}

Table 18.2 Fractions of Molecules in an Ideal Gas with Speeds Less than Various Multiples of v/v_{rms}

v/v_{rms}	Fraction
0.20	0.011
0.40	0.077
0.60	0.218
0.80	0.411
1.00	0.608
1.20	0.771
1.40	0.882
1.60	0.947
1.80	0.979
2.00	0.993

Question 5:

Prove that *f(v)* is maximum for $\epsilon = kT$. Equation for *f(v)* is given below.

$$f(v) = \frac{8\pi}{m}\left(\frac{m}{2\pi kT}\right)^{\frac{3}{2}}\epsilon exp^{\frac{-\epsilon}{kT}}$$

Use result of question and obtain equation $v_{mp} = \sqrt{\frac{2kT}{m}}$.

Question 6:

Calculate the specific heat at constant volume of water vapor, assuming the nonlinear triatomic molecule has three translational and three rotational degrees of freedom and that vibrational motion does not contribute. The molar mass of water is 18 g/mol.