1 Cognitive reasoning for the chemical sciences 2.4

1. **Set 1:** Please answer the questions.

   (a) For an ideal gas. If T is constant and one doubles mass, what happens to v_{rms}?

   (b) Which has greater kinetic energy, one mole of the ideal gas N_2 or one mole of the ideal gas He? (If they have equal kinetic energy please say so.)

   (c) For the van der Waals equation, if $b > 0$ and $a = 0$, what happens to pV/nRT?

   (d) For effusion. If one doubles the molar density, keeping T constant, what happens to the rate of effusion?

   (e) For effusion. If we double the radius of the molecules, what happens to the rate of effusion?

2. **Set 2:** State a procedure which allows the carrying out of the posed problem.

   (a) Given: the volume, the pressure, the temperature, and the number of grams of a flask of ideal gas. Find the molar mass.

   (b) Given: the volume, v_{rms}, number of moles, and pressure of a flask of ideal gas. Find: the molar mass of the gas.

   (c) Given: the density of the ideal gas O_2, the volume, temperature and pressure of a flask. Find the number of O_2 molecules.

   (d) Given: the value of the van der Waals a and b constant for the molecules C_4H_8 decide **approximate** values for $C_{12}H_{24}$.

3. **Set 3:** State answers to the following questions:

   (a) The volume of a gas increases by 1%, the number of moles increases by 2%, the presuure increases by 3% and the temperature remains unchange. Is this gas an ideal gas?

   (b) Given: Two van der Waals gases. They have the same b value but different a values. At a given p and T, does one mole of the one with a bigger a value occupy more or less volume than a mole of the other gas?

   (c) Gas effuses from a flask into a vacuum. Given: The initial rate of gas effusion. The molar density of gas molecules increases by x%, find the decrease in temperature required so that no change in effusion rate occurs.

   (d) Given: Two van der Waals gases. They have different a values and b values from each other. In the limit of very high pressure and assuming constant temperature, how many of these four constants control which of these gases has gfreater molar density? Please state reason.

(e) The volume of a gas increases by 1%, the number of moles increases by 2%, the presuure increases by 3% and the temperature remains unchange. Assuming the gas is a van der Waals can you deduce $a > 0$, $b > 0$ or that both a and b are > 0? State your reasoning.

4. Set 4: Please answer the following questions.

   (a) In an ideal gas if one doubles V, keeping all other variables but T constant what change is there in T?

   (b) If one doubles the mass, keeping all other variables constant, what happens to the rate of effusion?

   (c) If one increase the volume of a sphere by a factor of eight, what happens to the surface area of a sphere?

   (d) If one increases the volume of a cube by a factor of eight (retaining the cubic shape in the process), what happens to the surface area of the cube?

   (e) If one increases KE of a baseball by a factor of 2 what happens to the momentum of the baseball?

   (f) If we increase the velocity by a factor of 2, keeping n constant, what happens to pV?

   (g) Assume in a van der Waals gas the a term dominates. Comparing the van der Waals gas to an ideal gas with the same number of moles, volume and at the same temperature, is p greater or smaller?

   (h) Assume in a van der Waals gas the b term dominates. Comparing the van der Waals gas to an ideal gas with the same number of moles, volume and at the same temperature, is p greater or smaller?

   (i) In a van der Waals gas $\frac{pV}{nrT}$ is less than one. Does the attractive a or the repulsive b term dominate?