This exam should have exactly 20 questions. Each question is equally weighted at 5 points each. You will enter your answer choices on the virtual bubblehseet after you have finished. Your score is based on what you submit on the virtual bubblesheet and not what is circled on the exam.

---

1. You have three gases: H_2, F_2, and Cl_2. To predict which one would have the highest van der Waals "b" value, you would compare:

a. their temperatures

b. their pressures

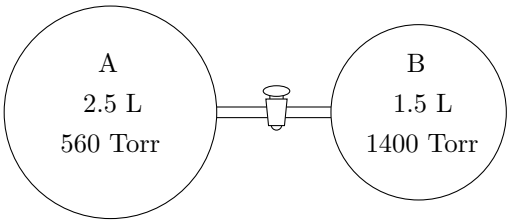
c. their intermolecular attractions

● d. their molar masses

Explanation: b scales with size which matches up with molar masses

---

2. (Part 1 of 2) There are two glass bulbs of gases A and B connected by a closed valve as depicted in the diagram along with the volumes and pressures in each bulb.



The valve is now opened and the gases completely mix. What is partial pressure of gas A in this mixture?

a. 300 Torr

b. 280 Torr

● c. 350 Torr

d. 420 Torr

e. 480 Torr

Explanation: Use Boyle's Law to get new pressures for each gas. Final volume is 2.5 + 1.5 = 4.0 L. Therefore, after opening the valve, 560(2.5/4) = 350 Torr A. 1400(1.5/4) = 525 Torr B.

---

3. (Part 2 of 2) What is the mole fraction of Gas A after the valve is opened?

a. 0.286

b. 0.500

c. 0.375

● d. 0.400

e. 0.425

Explanation: Use pressures in previous problem to get mole fraction via $X_A = P_A/P_{total}$. The numbers are 350/(350+525) = 0.400 mole fraction A.

---

4. Consider a Maxwell-Boltzmann distribution plot of gas velocities vs number of particles (the classic plot). Assuming all the gases listed are at the same temperature, which one will have the broadest distribution of velocities in a given container?

a. SF_6

b. Kr

● c. Ar

d. Xe

e. HBr

Explanation: The lightest gas will have the greatest range of velocities - the distribution is broader. The lightest gas listed is argon, Ar, at 40 g/mol.

---

5. Consider the following reaction to make water vapor (temperature is high enough that water is in gas state).

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$$

If 0.642 mol H_2 and 0.642 mol O_2 are allowed to react completely, what volume of water vapor would be produced if the temperature is 425 K and pressure is 1.22 bar?

a. 19.1 L

b. 17.8 L

c. 18.2 L

d. 37.2 L

●e. 18.6 L

Explanation: Hydrogen is limiting reactant and makes 0.640 mol water vapor. Now use IGL to get volume: $V = nRT/P = 0.642(0.08314)425/1.22 = 18.6$ L of water vapor. Note: If you want to use 0.08206 for R, you HAVE to convert bar into atm first so the pressure would be 1.204 atm.

---

6. Scooby the (helium) balloon dog has a volume of 5.28 L at 25.0 °C and 1.00 atm pressure. If Scooby is dropped into liquid nitrogen at −195.8 °C, what will Scooby's new volume be (still at 1 atm pressure)?

●a. 1.37 L

b. 2.14 L

c. 3.46 L

d. 0.68 L

e. 1.18 L

Explanation: Charles Law: $V_2 = V_1(T_2/T_1) = 5.28$ L$(77.35/298.15) = 1.37$ L.

---

7. A sample of 3 moles of AX_3 fully decomposes according to the equation:

$$AX_3(g) \longrightarrow A(g) + 3X(g)$$

If the resulting gases have a total pressure of 488 Torr, what is the partial pressure of X in the final system?

a. 325 torr

b. 244 torr

c. 122 torr

d. 293 torr

e. 390 torr

●f. 366 torr

Explanation: The products will form in 1/4 and 3/4 mole fractions of the total. Gas X is 3/4 of the total of 488 which is 366.

---

8. The average speed of a gas at 350 K is 360 m/s. What will the speed be of that gas when heated up to 896 K ?

a. 600 m/s

●b. 576 m/s

c. 922 m/s

d. 540 m/s

e. 720 m/s

Explanation: Use the following ratio: $\frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}}$, so $\frac{v_2}{360} = \sqrt{\frac{896}{350}} = 1.6 \quad v_2 = 360(1.6) = 576$

---

9. You have three gas samples. Rank them from lowest v_{rms} to highest v_{rms} (slowest to fastest).

a. Ar at 600 < He at 600 < He at 300

●b. Ar at 600 < He at 300 < He at 600

c. He at 300 < Ar at 600 < He at 600

d. He at 600 < Ar at 600 < He at 300

e. He at 300 < He at 600 < Ar at 600

f. He at 600 < He at 300 < Ar at 600

Explanation: smaller molecules go faster... higher T molecules go faster

---

10. What is the molar mass of $C_{14}H_8F_2$?

a. 218.1 g/mol

b. 195.2 g/mol

c. 226.2 g/mol

d. 232.3 g/mol

●e. 214.2 g/mol

Explanation: Multiply the molar mass of carbon by 14 carbon atoms (12.01 g/mol × 18) Repeat with 1.008 g/mol × 8 hydrogen and 19.00 g/mol × 2 fluorine)

---

11. What mass of NaOH is required to produce 185 g $Ni(OH)_2$ according to the following reaction? (answer to nearest whole number)

$$NiCl_2(s) + 2NaOH(aq) \longrightarrow Ni(OH)_2(aq) + 2NaCl(aq)$$

a. 60 g NaOH

b. 160 g NaOH

c. 96 g NaOH

●d. 120 g NaOH

e. 147 g NaOH

Explanation: 92.7 g/mol is MWt for $Ni(OH)_2$. So 139/92.7 = 1.50 mol. To go with that you'll need 1.5(2/1) = 3 mol of NaOH. 3(40) = 120 g

---

12. Properly balance the following chemical equation:

$$Na_3PO_4 + Pb(NO_3)_2 \longrightarrow NaNO_3 + Pb_3(PO_4)_2$$

What is the sum of the coefficients after balancing?

●a. 13

b. 11

c. 9

d. 8

e. 15

Explanation: The coefficients are as follows:

$$2Na_3PO_4 + 3Pb(NO_3)_2 \longrightarrow 6NaNO_3 + Pb_3(PO_4)_2$$

Therefore, when summing them: 2 + 3 + 6 + 1 = 13

---

13. If you have 3 moles of Mg and 3 moles of oxygen gas placed in a closed container, what is in the container after the reaction has run to completion?

$$2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$$

●a. O_2 and MgO

b. Mg and MgO

c. MgO only

d. Mg, O_2, and MgO

Explanation: Mg is limiting. It all reacts and makes 3 mol of MgO. This rxn only uses 1.5 mol of the oxygen, so it is leftover. Therefore both MgO and O_2 are leftover.

---

14. You have two balloons filled with helium gas. Balloon X is at 300 K. Balloon Y is at a different temperature. If the rate of effusion in Balloon Y is twice that as in Balloon X, what is the temperature of Balloon Y?

a. 75 K

●b. 1200 K

c. 150 K

d. 600 K

e. 300 K

Explanation: If the rate is 2× higher for higher T, then the temperature will be 2^2 or 4× the temperature. 4(300) = 1200 K.

---

15. After finishing a whole 2.1 L bottle of Diet Coke, you leave the bottle sitting on the counter for a while and then put the lid back on, sealing it shut. How many moles of gas are in the bottle if the temperature is 25 °C and the pressure is 1.0 atm?

a. 0.12 mol

b. 0.00085 mol

c. 22 mol

d. 0.094 mol

●e. 0.086 mol

f. 0.019 mol

Explanation: $n = PV/RT$ = 2.1(1)/0.08206/298.15 = 0.086 mol
