version: 229 Exam 1 - F22 - McCord - ch301

last name ______________ first name ______________ signature ______________________

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.20	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (267)	105 Db (268)	106 Sg (269)	107 Bh (270)	108 Hs (270)	109 Mt (278)	110 Ds (281)	111 Rg (282)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (290)	116 Lv (293)	117 Ts (294)	118 Og (294)

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (266)

constants

$R = 0.08206$ L atm/mol K

$R = 0.08314$ L bar/mol K

$R = 62.36$ L Torr/mol K

$R = 8.314$ L kPa/mol K

$R = 8.314$ J/mol K

$N_A = 6.022 \times 10^{23}$ /mol

conversions

1 atm = 760 torr

1 atm = 14.7 psi

1 atm = 101325 Pa

1 atm = 1.01325 bar

1 bar = 10^5 Pa

°F = °C(1.8) + 32

K = °C + 273.15

conversions

1 in = 2.54 cm

1 ft = 12 in

1 yd = 3 ft

1 mi = 5280 ft

1 lb = 453.6 g

1 ton = 2000 lbs

1 tonne = 1000 kg

1 gal = 3.785 L

1 gal = 231 in^3

1 gal = 128 fl oz

1 fl oz = 29.57 mL

1 Troy oz = 31.104 g

water data

$C_{s,ice} = 2.09$ J/g °C

$C_{s,water} = 4.184$ J/g °C

$C_{s,steam} = 2.03$ J/g °C

$\rho_{water} = 1.00$ g/mL

$\rho_{ice} = 0.9167$ g/mL

$\rho_{seawater} = 1.024$ g/mL

$\Delta H_{fus} = 334$ J/g

$\Delta H_{vap} = 2260$ J/g

$K_w = 1.0 \times 10^{-14}$

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

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

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

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

●f. Ar at 600 < He at 300 < He at 600

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

---

2. 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. Kr

●b. Ar

c. Xe

d. SF_6

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.

---

3. 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. 18.6 L

b. 18.2 L

c. 17.8 L

d. 19.1 L

e. 37.2 L

Explanation: Hydrogen is limiting reactant and makes 0.642 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.

---

4. A balloon was filled with 1 L of nitrogen gas and 1 L of helium, and over the next two days the balloon shrinks as the gas molecules inside escape through pores in the balloon wall. Which best describes the mole fraction of nitrogen in the balloon two days later?

●a. $X_{N_2} > 0.5$

b. $X_{N_2} = 0.5$

c. $X_{N_2} < 0.5$

d. You need to know the temperature to be able to answer this question.

Explanation: helium is much smaller than nitrogen which means it will effuse much faster which means the helium leaves the balloon faster, leaving behind a larger mole fraction of nitrogren, therefore the mole fraction of N_2 is greater than 0.5 now.

---

5. 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. 390 torr

●b. 366 torr

c. 293 torr

d. 244 torr

e. 122 torr

f. 325 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.

---

6. Cyclopentanol burns according to the following equation:

$$C_5H_9OH + 7O_2 \longrightarrow 5CO_2 + 5H_2O$$

Now we react 3.16 mols of C_5H_9OH with 20.3 mol of oxygen. Assuming the reaction goes to completion, how many moles of H_2O are produced ?

a. 18.6 mol

b. 12.5 mol

●c. 14.5 mol

d. 20.4 mol

e. 15.8 mol

Explanation: You can run 3.16 mol of rxn with 3.16 mol of cyclopentanol (1:1). You can run 2.90 mol of rxn with 20.3 mol oxygen (1:7). The oxygen is limiting then. Take the 2.90 mol rxn and multiply by 5 mol water per rxn and get 14.5 mol water.

---

7. 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. 720 m/s

b. 600 m/s

c. 540 m/s

●d. 576 m/s

e. 922 m/s

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

---

8. 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 pressures

b. their intermolecular attractions

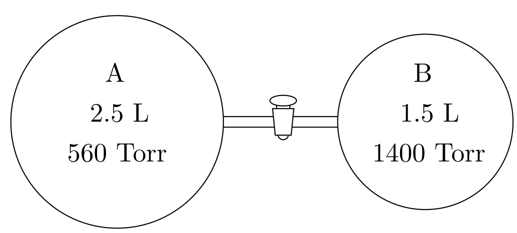
●c. their molar masses

d. their temperatures

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

---

9. (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. 480 Torr

b. 420 Torr

●c. 350 Torr

d. 280 Torr

e. 300 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.

---

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

a. 0.500

●b. 0.400

c. 0.375

d. 0.425

e. 0.286

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.

---

11. 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. 0.094 mol

b. 0.12 mol

●c. 0.086 mol

d. 22 mol

e. 0.019 mol

f. 0.00085 mol

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

---

12. 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. MgO only

b. Mg and MgO

●c. O_2 and MgO

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.

---

13. A gold coin weighs 1.00 Troy ounces. If 1 Troy ounce is equal to 31.104 grams, how many atoms of gold are in the gold coin?

a. 1.87×10^{25} Au atoms

b. 1.94×10^{22} Au atoms

c. 9.32×10^{25} Au atoms

●d. 9.51×10^{22} Au atoms

Explanation: 31.104 g Au / 196.97 g/mol = 0.1579 mol $\times 6.022 \times 10^{23} = 9.51 \times 10^{22}$ atoms of Au.

---

14. What mass of NaOH is required to produce 139 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. 120 g NaOH

c. 96 g NaOH

d. 160 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

---

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

●a. 214.2 g/mol

b. 226.2 g/mol

c. 232.3 g/mol

d. 195.2 g/mol

e. 218.1 g/mol

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

---

16. 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. 0.68 L

c. 2.14 L

d. 3.46 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.

---

17. Comparing a substance in its gas phase at 1 atm to its liquid phase at 1 atm, which best describes the relationship of the liquid density (ρ_{liq}) to the gas density (ρ_{gas})?

a. ρ_{liq} is 1000× greater than ρ_{gas}

b. ρ_{liq} is 10× greater than ρ_{gas}

c. ρ_{liq} is 10^6× greater than ρ_{gas}

d. ρ_{liq} is 100× greater than ρ_{gas}

Explanation: it's 1000× for liquid vs gas densities... solids too for that matter

---

18. 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. 12

b. 15

c. 13

d. 9

e. 11

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: $2 + 3 + 6 + 1 = 12$

---

19. 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. 300 K

b. 1200 K

c. 600 K

d. 150 K

e. 75 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.

---

20. A 4.10 gram sample of gas was collected in a 1.50 L container at 295 K and 600 Torr. Which of these molecules listed below could be the identity of the gas sample?

a. Kr

b. Cl_2

c. O_2

d. C_3H_8

e. H_2

f. Ar

Explanation: Get moles via IGL: $n = PV/RT = 600(1.5)/(62.36(295)) = 0.0489$ mol. MWt = mass/mol $= 4.10/0.0489 = 83.8$ g/mol which is Kr.

After you are finished and have all your answers circled, go to the front of the room and then use the QR code there to pull up the virtual answer page. Enter the appropriate info plus all your answers - click the SUBMIT button. Make sure you get the confirmation screen and show it to the TA or proctor. After that, turn in your exam and scratch paper. You're free to leave after that.

https://mccord.cm.utexas.edu/neon