* It's ok to register during class (for lab tomorrow)

Today: continue with Ch.10, start ch.11 November 18th

Tomorrow: last lab, expt 12, pre-lab only - we are not doing expt 12 from lab manual

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An unknown gas has a density of 1.72 g/L at 25°C & 1.0 atm. What is its density at 75°C & 5.0 atm?

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

$$n = \frac{m}{mm}$$

	①	②
p	1.0 atm	5.0 atm
mm	—	—
d	1.72 g/L	?
T	298 K	348 K

$$\frac{d_2 P_1}{d_1 T_1} = \frac{P_2}{T_2}$$

$$\hookrightarrow d_2 = \boxed{7.36\ g/L}$$

The anesthetic nitrous oxide (N_2O) is 74% by mass N_2O & the rest O_2. What is the partial pressure of N_2O in a cylinder with a total pressure of 5.2 atm?

$$P_{N_2O} = X_{N_2O} * P_{TOT}$$

$$P_{O_2} = X_{O_2} * P_{TOT}$$

$$P_{TOT} = P_{N_2O} + P_{O_2}$$

74 g N_2O ÷ 44 g/mol = 1.68 mol N_2O

26 g O_2 ÷ 32 g/mol = 0.813 mol O_2

$$X_{N_2O} = \frac{n_{N_2O}}{n_{total}} = \frac{1.68}{(1.68+0.813)} = 0.67$$

$$X_{O_2} = 0.33$$

*have to add up to 1!

$$= 0.67 * 5.2\ atm = \boxed{3.51\ atm}$$

$$= 0.33 * 5.2\ atm = \boxed{1.69}$$

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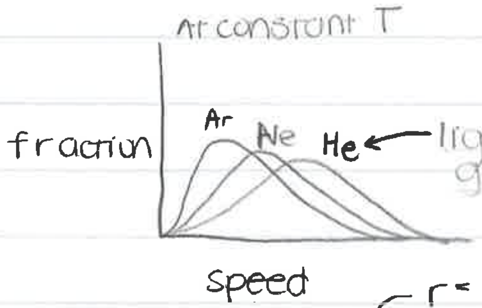
$$E_k = \frac{1}{2}m\overset{\text{speed}(v)}{u}^2 = \frac{3RT}{2N_A}$$

$E_k \propto T$

$E_k \propto mu^2$



← lightest molecule has greatest speed!

$r = 8.314\ J/mol \cdot K$

$1J = 1kg \cdot m^2/s^2$

$r = \frac{8.314\ kgm^2}{s^2\ mol\ K}$

$$mu^2 = \frac{3RT}{N_A} \longrightarrow u^2 = \frac{3RT}{\underbrace{mN_A}_{g/mol}}$$

whatever "T" is!

*What is the speed (avg) of O_2 @ 298K?

↳ mm = 32g/mol
= 0.032kg/mol

$$u^2 = \frac{3 \cdot 8.314\,kgm^2 \cdot 298K \cdot mol}{s^2\,mol\,K \cdot \underbrace{0.032kg}_{MM_{O_2}}}$$

$u^2 = 2.32 \times 10^5\ m^2/s^2$

$$\boxed{u = 482\ m/s}$$

$$mu^2 = \frac{3RT}{N_A} \Rightarrow u^2 = \frac{3RT}{MM}$$

↳ @ constant temperature:

$u_1^2 \propto \frac{1}{mm_1}$, $u_2^2 \propto \frac{1}{mm_2}$

$$\frac{u_1^2}{u_2^2} = \frac{mm_2}{mm_1}$$

$$\boxed{\frac{u_{fast}}{u_{slow}} = \sqrt{\frac{MM_{heavy}}{MM_{light}}}}$$

← graham's law: effusion & diffusion

How much faster does CH_4 (MM = 16g/mol) effuse/diffuse than SO_3 (MM = 80 g/mol)?

↳ $\frac{u_{CH_4}}{u_{SO_3}} = \sqrt{\frac{80}{16}} = 2.24$

↳ $\frac{u_{CH_4}}{u_{SO_3}} = 2.24 \longrightarrow u_{CH_4} = 2.24 * u_{SO_3}$

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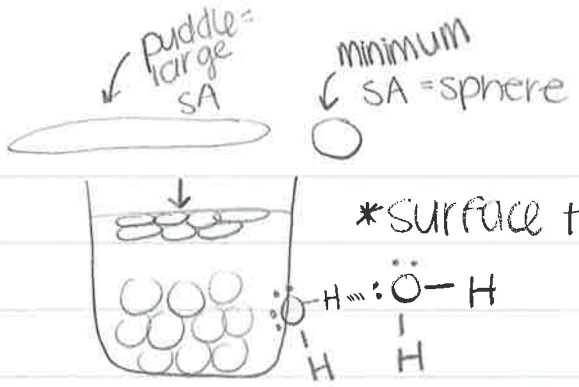
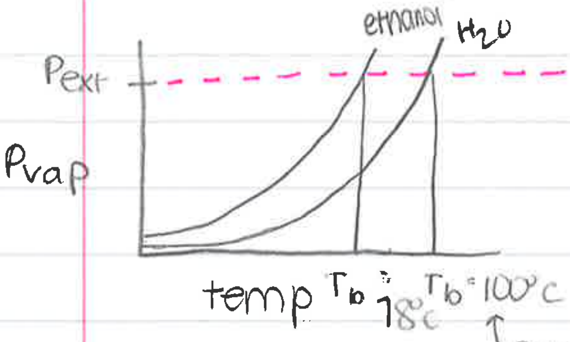
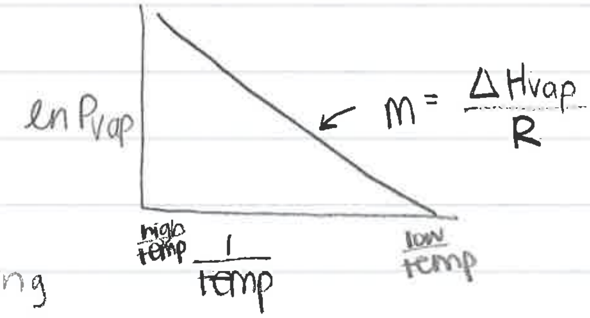


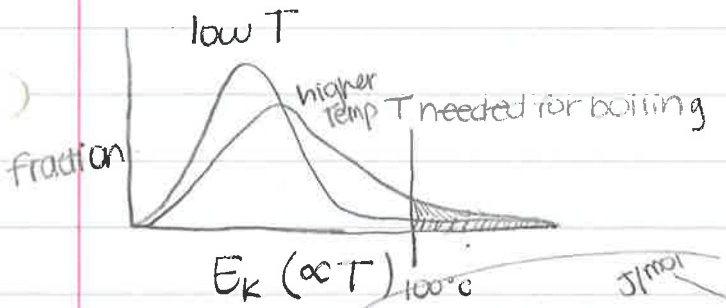
*surface tension



↑ stronger IMF's

CH_2Cl_2 bp = 50°C





$$y = mx + b$$

$$\ln(P_{vap}) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T}\right) + b$$

J/mol

$$\left[\ln\left(\frac{P_{vap\,1}}{P_{vap\,2}}\right) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)\right]$$

↑ 8.314 J/mol·K

* Clausius-Clapeyron

~95%

drive towards disorder

Enthalpy & Entropy: two driving forces for reactions

$\Delta H < 0$ exothermic (enthalpy-favored)

$\Delta H > 0$ endothermic (enthalpy not fav)

} → does it take energy or does it give off energy?

$H_2O(l) \rightarrow H_2O(g)$ Entropy: gases have more disorder

↳ gases >> liquids > solids

Does the rxn increase disorder? YES, → entropy favored

NO, → entropy not favored

→ signs are opposite for entropy

↳ $H_2O(l) \rightarrow H_2O(g)$ $\Delta S^\circ_{vap} = +109$ J/mol·K ← entropy favored

Chapter 11-12 Day 1 (Sections 9.11, 9.12 and 11.1 – 11.4)   18 November 2019

1. Which member of each pair has the highest predicted absolute entropy?

$Cl_2(g)$ or $Br_2(l)$ $Br_2(g)$ or $Ba(s)$ $Cl_2(g)$ or $Cu(s)$

2a. Use the table of absolute entropies in Appendix B, pages A-9 through A-13 to calculate ΔS° for the reaction shown. Do it like we did with ΔH°.

$2\ S(s) + 3\ O_2(g) \rightarrow 2\ SO_3(g)\quad \Delta S^o = ?$

2b. Count the moles of reactant gases and product gases. Do the products have more or less total entropy? Is the sign of ΔS° consistent?

$2\ S(s) + 3\ O_2(g) \rightarrow 2\ SO_3(g)$

3. Sketch a heating curve for water (see notes). Label the regions I, II, III, IV, and V like we did in class. Which value would you need for each region? (Values given are for water.)

___ Region I	A. ΔH_{fus} = 6.01 kJ/mol
___ Region II	B. ΔH_{vap} = 40.67 kJ/mol
___ Region III	C. $C_{m,\ H2O(s)}$ = 36.7 J/mol deg
___ Region IV	D. $C_{m,\ H2O(l)}$ = 75.4 J/mol deg
___ Region V	E. $C_{m,\ H2O(g)}$ = 33.6 J/mol deg

3b. What regions from the picture in Question 4 (I, II, III, IV, V) would you need to calculate the heat transferred when H_2O is…

A. Raised in temperature from -10 °C to +50 °C
Circle the regions: I II III IV V

B. Lowered in temperature from 90 °C to 50 °C
Circle the regions: I II III IV V

C. Lowered in temperature from 10 °C to -30 °C
Circle the regions: I II III IV V

D. Raised in temperature from -10 °C to +110 °C
Circle the regions: I II III IV V

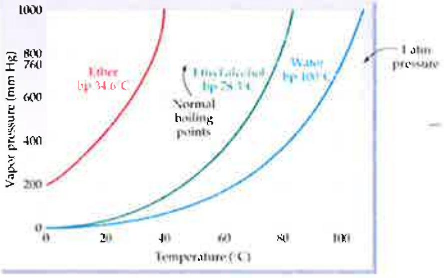
E. Raised in temperature from -10 °C to -5 °C
Circle the regions: I II III IV V

3c. Which of the above situations (in Question 5) is exothermic? A B C D E

3d. How much heat is required to warm 52 g ice at -25 °C to water vapor at 120 °C?

4. Use the Clausius-Clapyron equation (page 427) to estimate ΔH_{vap} for bromine, given that bromine has a vapor pressure of 400 mmHg at 41.0 °C and a normal boiling point of 331.9 K. Hint: What is P_{vap} at the normal boiling point?

3a. Which liquid …
… always has the highest vapor pressure temperature?
… has the highest boiling point?



… has the strongest intermolecular forces?

… would evaporate the fastest in an open container?

3b. Estimate the boiling point of water if the external pressure is 400 mmHg?

3c. At what temperature at 1 atm one substance entirely a gas and the other two are still liquids?

Preparing for the final exam. Go to our Chm 203 course website and scroll down past the old exams and right before the pictures.

Now try these problems from the book:

Sections 9.11 and 9.12 Entropy and free energy, Problems 9.42, 9.126, 9.130, Chapter 9 practice test 15.

Section 11.1. (Properties of Liquids) Problems 22, 24.

Section 11.2. (Evaporation, vapor pressure, boiling point) Problems 1, 2, 26 – 36 (even)

Section 11.3. (Phase changes) Problems 3, 4

Section 11.4. (Energy changes) Problem 5, 6, 38 – 50 (even),

Practice test Questions 1 – 7.