Chemistry 201
Quiz 2
May 3, 2005

Time: 65 minutes | **Chemistry 201 Quiz 2** | **May 3, 2005** Prof. *R. Sultan*

Name: KEY **Major:**_____

Student No: _____ **Signature:**_____

Circle your section:

Section **1**	Sultan
Section **2**	Al-Ghoul
Section **3**	Halaoui

TOTAL _____/100

Periodic charts and Table of atomic masses provided.
There are 20 questions.
There is no double penalty.

Useful information:

- Gas constant R = 0.08206 L atm/mol K

  = 8.314 J/mol K

- 1.00 atm = 760 mm Hg

- Avogadro's number $N_A = 6.023 \times 10^{23}$ mole^{-1}

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P_1 $T_1 = 336.6$

- The vapor pressure of ethanol is 400 mm Hg at 63.5°C. Its molar heat of vaporization is 39.3 kJ/mol. What is the vapor pressure of ethanol, in mm Hg, at 34.9°C? $T_2 = 308.0$

Clausius-Clapeyron: $\ln \frac{P_2}{P_1} = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

A. 1,510 mm Hg
(B) 107 mm Hg
C. 200 mm Hg
D. 0.0099 mm Hg
E. 4.61 mm Hg

$\ln \frac{P_2}{400} = \frac{39.3 \times 10^3}{8.314}\left(2.972 - 3.247\right) \times 10^{-3}$

$= -1.30$ $\quad \frac{P_2}{400} = 0.27 \Rightarrow \boxed{P_2 = 107\,mm}$

- How much energy (heat) is required to convert 52.0 g of ice at -10.0°C to steam at 100°C?
Given: 2.89 mol

specific heat of ice:	2.09 J/g•°C	ΔH_{fus} = 6.02 kJ/mol
specific heat of water:	4.18 J/g•°C	ΔH_{vap} = 40.7 kJ/mol
specific heat of steam:	1.84 J/g•°C	

$\Delta H_{total} = 52.0 \times 2.09\left[0-(-10)\right] + 2.89 \times 6.02 \times 10^3$
$+ 52.0 \times 4.18\left[100 - 0\right] + 40.7 \times 10^3 \times 2.89$

A. 2,570 kJ
B. 1,086 kJ
(C) 157.8 kJ
D. 40.2 kJ
E. 22,957 kJ

$= 1087 + 17398 + 21736 + 117623\ (J)$

$= 157.8 \times 10^3\,J = \boxed{157.8\,kJ}$

Take 10.0 g $\quad$ 0.312 mol $\quad$ 0.124 mol $\quad [n_{HBr} < n_{O_2}]$

- If equal masses of O_2 (g) and HBr (g) are in separate containers of equal volume and temperature, which one of the following statements is true?

✓ (A) The pressure in the O_2 container is greater than that in the HBr container.
X B. There are more HBr molecules than O_2 molecules.
x C. The average velocity of the O_2 molecules is less than that of the HBr molecules. No! higher
x D. The average kinetic energy of HBr molecules is greater than that of O_2 molecules. No. Same
x E. The pressures of both gases are the same.

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- What is the osmotic pressure of a solution that contains 13.7 g of propyl alcohol (C_3H_7OH) dissolved in enough water to make 500 mL of solution at 27°C?

60.10 g/mol

300.1 K

$$M_0 = \frac{13.7}{60.10 \times 0.500} = 0.456\ M$$

A. 0.014 atm
B. 0.037 atm
C. 0.456 atm
D. 0.01 atm
(E.) 11.2 atm

$$\Pi = M_0 RT = 0.456 \times 0.08206 \times 300.1 = \boxed{11.2\ atm}$$

- What is the molarity of a solution of 10.0 % by mass cadmium sulfate, $CdSO_4$ (molar mass = 208.46 g/mol)? The density of the solution is 1.10 g/mL.

Consider 100.0 g of solution

A. 0.048 M
B. 0.436 M
C. 0.479 M
(D.) 0.528 M
E. 22.9 M

$$m_{CdSO_4} = 10.0\ g \qquad n_{CdSO_4} = \frac{10.0}{208.46} = 0.0480\ mol$$

$$V_{sol} = \frac{m_{sol}}{d} = \frac{100.0}{1.10} = 90.9\ mL$$

$$M_0 = \frac{n_{CdSO_4}}{V_{sol}} = \frac{0.0480}{0.0909} = \boxed{0.528\ M}$$

- How many molecules of N_2 gas can be present in a 2.5 L flask at 50°C and 650 mmHg?

0.855 atm

A. 2.1×10^{-23} molecules
(B.) 4.9×10^{22} molecules
C. 3.1×10^{23} molecules
D. 3.6×10^{25} molecules
E. 0.081 molecules

$$PV = nRT \Rightarrow n_{N_2} = \frac{PV}{RT}$$

$$n_{N_2} = \frac{0.855 \times 2.5}{0.08206 \times 323.1} = 0.0806\ mol$$

$$N_{N_2} = N_A\, n_{N_2} = 6.023 \times 10^{23} \times 0.0806 = \boxed{4.9 \times 10^{22}\ molecules}$$

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46.07 g/mol

- What mass of ethanol, C_2H_5OH a nonelectrolyte, must be added to 10.0 L of water to give a solution that freezes at -10.0°C? Assume the density of water is 1.0 kg/L. K_f of water is 1.86°C/m.

$\Delta T = 10.0°$ $\quad m_o = \frac{n_{C_2H_5OH}}{m_{H_2O}}$

A. 85.7 kg
B. 24.8 kg
C. 5.38 kg
(D) 2.48 kg
E. 1.17 kg

$\Delta T = K_f m_o$

$m_o = \frac{\Delta T}{K_f} = \frac{10.0}{1.86}$

$= 5.38 \text{ mol/kg}$

$n_{C_2H_5OH} = m_o m_{H_2O}$

$= 5.38 \times 10.0$

$= 53.8 \text{ mol}$

$m_{C_2H_5OH} = M_{C_2H_5OH} n_{C_2H_5OH}$

$= 46.07 \times 53.8 = 2.48 \times 10^3 \text{ g}$

$= 2.48 \text{ kg}$

- The vapor pressure of water at 20°C is 17.5 mm Hg. What is the vapor pressure of water over a solution prepared from 2.00×10^2 g of sucrose ($C_{12}H_{22}O_{11}$) and 3.50×10^2 g water?

342.23 g/mol

$n_{suc.} = \frac{2.00 \times 10^2}{342.23} = 84 \text{ mol}$

$n_{H_2O} = \frac{3.50 \times 10^2}{18.02} = 19.4 \text{ mol}$

$\chi_{H_2O} = \frac{19.4}{19.4 + 0.584}$

$= 0.971$

A. 0.51 mm Hg
B. 16.0 mm Hg
(C) 17.0 mm Hg
D. 18.0 mm Hg
E. 19.4 mm Hg

$P_{H_2O} = P^\circ_{H_2O} \chi_{H_2O}$

$= 17.5 \times 0.971 = \boxed{17.0 \text{ mm Hg}}$

- Which of the following statements about the energetics of dissolution of NaCl in water is false? (Process 1 ≡ expansion of the solute; Process 2 ≡ expansion of the solvent; Process 3 ≡ mixing of the solute and the solvent particles). Given: $\Delta H_{soln} = +3$ kJ/mol.

✓ A. ΔH_1 and ΔH_2 are both positive.
✓ B. $\Delta H_{hydration} = \Delta H_2 + \Delta H_3$
✗ (C) $|\Delta H_3| > \Delta H_1 + \Delta H_2$ no! since $\Delta H_{soln} > 0$
✓ D. ΔH_3 for NaCl in H_2O is < 0, but ΔH_3 can generally be either positive or negative.
E. None of the above.

No

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- Which of the following relations emerging from the Kinetic Molecular Theory (KMT) of ideal gases is incorrect? (m = mass of a gas molecule; M = Molar mass; ε = average kinetic energy/molecule; N = number of gas molecules; n = number of moles)

✓ A. $P = \frac{1}{3}\frac{n}{V}M\overline{u^2}$

$PV = \frac{1}{3}Nm\overline{u^2} = \frac{1}{3}N_A n \frac{M}{N_A}\overline{u^2}$

↳ $P = \frac{1}{3}\frac{n}{V}M\overline{u^2}$ ✓

✓ B. $P = \frac{2}{3}\frac{N}{V}\varepsilon$

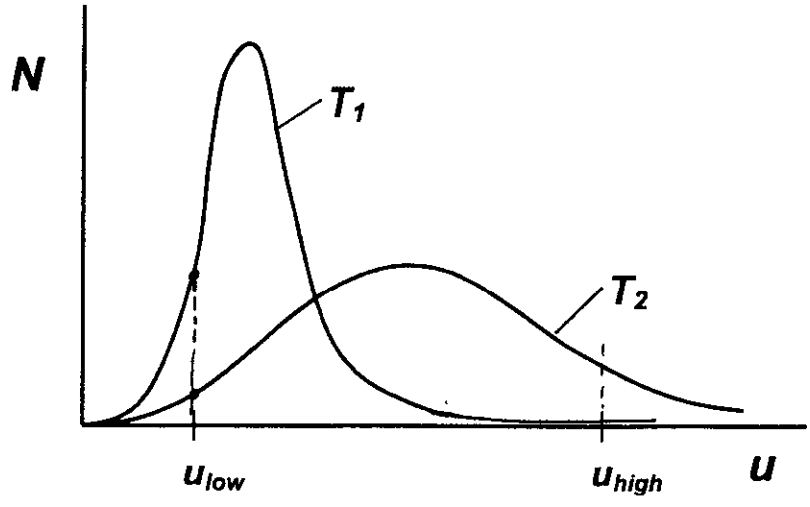
$PV = \frac{1}{3}N\underbrace{m\overline{u^2}\cdot\frac{1}{2}}_{\varepsilon}\times 2 \Rightarrow P = \frac{2}{3}\frac{N}{V}\varepsilon$

✓ C. $\overline{u^2} = \frac{3RT}{M}$

✗ (D) $\frac{1}{2}m\overline{u^2} = \frac{3}{2}RT$ $\qquad \frac{1}{2}m\overline{u^2} = \frac{3}{2}\left(\frac{R}{N_A}\right)T$ (R in numerator)

E. $\underbrace{\frac{1}{3}Nm\overline{u^2}}_{PV} = \underbrace{nRT}_{PV}$ ✓

- Consider the following diagram representing the distribution of molecular speeds:



Which of the following statements is true?

✗ A. $T_2 < T_1$
✗ B. The fraction of molecules with speed u_{high} is larger at T_1 than at T_2.
✗ C. The fraction of molecules with speed u_{low} is larger at T_2 than at T_1.
✗ D. The values of u_{mp} at T_1 and at T_2 are the same, since it is the value at which the maximum occurs. No!
(E) None of the above.

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- Which of the following is **not** an *atomic network* solid?

A. diamond Y
B. fullerene No (molecular)
C. graphite Y
D. solid Ar No (atomic but not network)
E. carbon nanotubes Y
X F. B and E
G B and D
X H. D and E

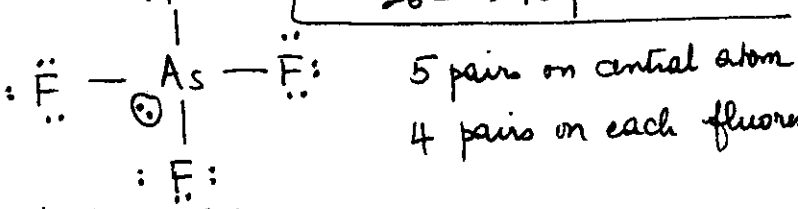
- Which of the following properties **does not suggest** the similarity in structure between the liquid and the gas phases?

✓ A. isotropy
✓ B. fluidity
✓ C. Brownian motion in liquids
D The molar volume of a liquid is generally only 4% larger than that of the solid. — Similarity between liquids & solids.
✓ E. Molecules in the liquid undergo constant thermal motion.

- In the ion AsF_4^-, the hybridization of the central atom (As) and that of the fluorine atoms are, respectively:

$5 + 4\times7 + 1 = 34$ valence e⁻s.

$34 - 8 = 26 \longrightarrow 13$ pairs



5 pairs on central atom → dsp^3
4 pairs on each fluorine → sp^3

A. dsp^3, sp^2
B dsp^3, sp^3
C. d^2sp^3, sp^3
D. sp^3, sp^3
E. dsp^3, dsp^3

- Which of the following *is not right* in a mixture of two liquids wherein the interactions are unfavorable?

✓ A. the vapor pressure is higher than predicted by Raoult's law.
✓ B. $\Delta H_{mix.} > 0$
No C The mixing is most likely to be between two non-polar liquids. rather polar & non-polar
✓ D. The attractions between the molecules in the pure liquids are stronger than those in the mixture.
✓ E. Interactions between the solute and the solvent molecules resemble those between carbon disulfide (CS_2) and acetone (CH_3COCH_3).

non-polar polar

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- Which of the following is **true** about a Van der Waals gas?

✓ (A) At high enough temperatures only positive deviations from ideality are observed.
✗ B. The *b* constant is a measure of the strength of the intermolecular forces.
✗ C. The smaller the gas molecules, the larger the deviation from ideality.
✗ D. The pressure exerted by the molecules is higher than P_{ideal}.
✗ E. The more the temperature is increased, the higher the deviation from ideality.
✗ F. The lower the value of the *a* constant, the stronger the intermolecular attractive forces.

- Consider an effusion apparatus constituted of two compartments of equal volumes separated by a thin wall pierced with a very tiny orifice. In a first experiment, the left compartment is filled with ammonia gas (NH_3) at 1.75 atm. In a second experiment, the left compartment is filled with hydrogen chloride gas (HCl) at 2.56 atm. Predict the ratio of the rates of effusion $Rate_{NH3}/Rate_{HCl}$.

A. 3.13
B. 2.14
C. 1.46
(D) 1.00
E. 0.467

$$\frac{Rate\ NH_3}{Rate\ HCl} = \frac{P_{NH_3}}{P_{HCl}}\sqrt{\frac{M_{HCl}}{M_{NH_3}}}$$

$$= \frac{1.75}{2.56} \times \sqrt{\frac{36.46}{17.03}} = 1.00$$

- Which of the following statements is **incorrect?**

✗ (A) In a spontaneous process, the entropy of the system can only increase. [that of the universe...]
✓ B. The number of microstates for arranging 7 particles, 5 in one compartment and 2 in another compartment is equal to 21.
✓ C. If for a given process, $\Delta S_{univ.} < 0$, then the reverse process is spontaneous.
✓ D The arrangement for 7 particles, 4 in one compartment and 3 in the other is more probable than the arrangement in B.
E. A and D No! A only

- Which of the following statements is correct?

✗ A. Cells bathed in a hypertonic solution experience ~~crenation~~ plasmolysis and thus swell. but they shrink
✗ B. Cells bathed in a hypotonic solution ~~experience hemolysis~~ and thus shrink. but they swell
✗ C. Osmosis takes place spontaneously from the solution compartment into the pure solvent through a semi-permeable membrane. the opposite
✓ (D) Osmotic pressure is equivalent to the pressure we need to apply to stop the flow of solvent into the solution through the semi-permeable membrane.
✗ E. Osmometry is the performance of osmotic pressure measurements. Not only → determination of molar mass of solute

$$\Omega = \frac{7!}{5!\,2!} = \frac{7\times6\times\cancel{5\times4\times3\times2}}{\cancel{(5\times4\times3\times2)}\,(2)} = 21$$

$$\Omega = \frac{7!}{4!\,3!} = \frac{7\times6\times5\times\cancel{4\times3\times2}}{\cancel{(4\times3\times2)}\times(3\times2)} = 35$$

more microstates ⇓ more probable

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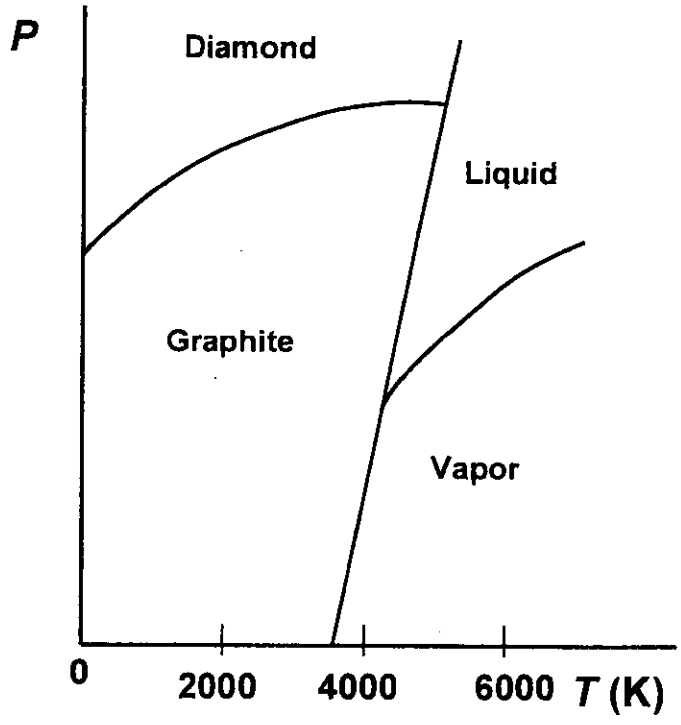
- Consider the following phase diagram for carbon:



Which of the following statements is **incorrect?**

✓ A. Carbon has two triple points.
✓ B. At one of the two triple points, two solid phases are in equilibrium with each other and with the liquid phase.
✓ C. At one of the two triple points, one solid phase, the liquid and the vapor are at equilibrium.
✓ D. If at room temperature, graphite is subject to very high pressure, it is converted to diamond.
X (E.) Graphite is denser than diamond.
F. None of the above. No