CHEM 1032
Spring 2023
UNIT ASSESSMENT 1

SECTION: _____

NAME: Key

TUID: | | | | | | | | | |

Before the Unit Assessment begins, read the rest of this page, and follow the instructions.

!!! Do not turn this page until given the signal to begin !!!

Put away everything besides pencil(s) and a scientific calculator.

- Non-programmable (scientific) calculators are permitted. Graphing calculators **are not permitted** (such as these models: TI-83, TI-84, TI-89, Casio FX-9750).
- Any other electronic devices - including cell phones, smart phones, and smart watches - **are not permitted**. If you are not sure what is permitted, ask *before* the exam begins.

When you are told to begin work, open the booklet and read the directions.

A periodic table and other useful information can be found on the next page.

Grading. Each question is graded by your instructor using the scale below.

1 - Excellent
- The student demonstrates a deep understanding of concepts and problem-solving techniques.
- Calculations are clear and legibly written.
- Any mistakes are minor or careless errors that do not indicate a major conceptual misunderstanding.

0.5 - Fair
- The student demonstrates a partial understanding of concepts and techniques.
- Calculations are clear and legibly written but contain errors.
  - The student may have started out correctly but gone on a tangent or not finished the problem.
  - The student may have used pattern matching to answer a different, more familiar question instead.

0 - Unsatisfactory/Incomplete
- The student did not demonstrate an understanding of the problem or has minimal understanding.
- Calculations are unclear, missing, or incomplete.
  - The student may have written some appropriate formulas or diagrams, but nothing further.
  - The student may have done something entirely wrong.
  - The student may have written almost nothing or nothing at all.

Unit Assessment Time: 50 minutes.
It is to your advantage to answer every question.

!!! Do not turn this page until given the signal to begin !!!

Units:

amu	*atomic mass unit*
atm	*atmosphere*
g	*gram*
h	*hour*
J	*joule*
K	*kelvin*
mmHg	*unit of pressure*
M	*molarity*
K	*kelvin*
L	*liter*
mol	*mole*
s	*second*

Symbols:

H	*enthalpy*
ν	*frequency*
M	*molar mass*
mol	*mole*
P	*pressure*
t	*time*
T	*temperature*
V	*volume*

Constants:

N_A	*Avogadro's number*
R	*ideal gas constant*

SI (Metric) Prefixes:

c	*centi-*
d	*deci-*
k	*kilo-*
m	*milli-*

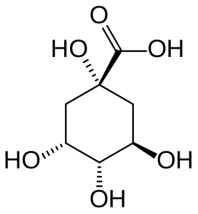
1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.008																		2 He 4.0026
3 Li 6.94	4 Be 9.0122												5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305												13 Al 26.982	14 Si 28.085	15 P 30.974	16 S 32.06	17 Cl 35.45	18 Ar 39.948
19 K 39.098	20 Ca 40.078(4)		21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845(2)	27 Co 58.933	28 Ni 58.693	29 Cu 63.546(3)	30 Zn 65.38(2)	31 Ga 69.723	32 Ge 72.630(8)	33 As 74.922	34 Se 78.971(8)	35 Br 79.904	36 Kr 83.798(2)
37 Rb 85.468	38 Sr 87.62		39 Y 88.906	40 Zr 91.224(2)	41 Nb 92.906(2)	42 Mo 95.95	43 Tc	44 Ru 101.07(2)	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(3)	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57-70 *	71 Lu 174.97	72 Hf 178.49(2)	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23(2)	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po	85 At	86 Rn
87 Fr	88 Ra	89-102 **	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [144.91]	62 Sm 150.36(2)	63 Eu 151.96	64 Gd 157.25(3)	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05
89 Ac [227.03]	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No

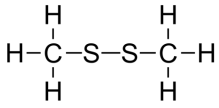
!!!! FOR CREDIT, BE CLEAR AND WRITE LEGIBLY !!!!

Coffee is an aqueous solution made by extracting molecules from ground coffee beans into water. This most commonly occurs using hot water, making a cup of coffee in a few minutes, or cold water, making a cup of coffee overnight.

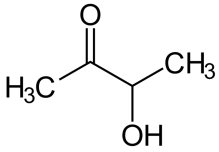
In addition to the caffeine molecules we all know and love, some of the other common molecules in coffee are shown below…



Quinic Acid
192.17 g/mol



Dimethyl disulfide
94.19 g/mol



Acetoin
88.11 g/mol

Part I – Multiple Choice Questions (1 pt each)

Excellent Answer = 1 pt *Fair Answer = 0.5 pts* *Unsatisfactory Answer = 0 pts*

A 1. All of the molecules above have dispersion forces. The best reason to explain this is…

A. all of the molecules contain electrons, which are constantly moving.
B. all of the molecules contain electronegative elements, which attract electrons.
C. all of the molecules contain hydrogen atoms, which like to give up electrons.
D. Not all molecules above have dispersion forces.

C 2. Which molecule above would you expect to have the lowest surface tension?

A. Quinic acid
B. Acetoin
C. Dimethyl disulfide
D. All three molecules have similar surface tension

½ credit →

D 3. When sucrose ($C_{12}H_{22}O_{11}$) is added to a cup of coffee, the enthalpy of mixing (ΔH_{mix}) is…

A. endothermic, IMF are broken between the sucrose molecules.
B. endothermic, IMF are formed between the sucrose molecules.
C. exothermic, IMF are broken between the sucrose and water molecules.
D. exothermic, IMF are formed between the sucrose and water molecules.

½ credit →

C 4. A pure 25.5 g sample of quinic acid requires 9142 J of heat to vaporize at 25 °C. Determine the ΔH_{vap} at this temperature.

A. 0.36 kJ/mol
B. 14.3 kJ/mol
C. 68.9 kJ/mol
D. 358 kJ/mol

$25.5\,g \left| \frac{1\,mol}{192.17\,g} \right. = 0.1327\,mol$

$9142/1000 = 9.142\,kJ$

$\frac{9.142\,kJ}{0.1327\,mol} = 68.9\,kJ/mol$

200.0 mL → 200.0 g | 1 mol / 18.01 g = 11.1 mol

C 5. If we assume a 200.0 mL cup of coffee has 0.100 mol of dimethyl disulfide and 0.200 mol of acetoin, what would be the vapor pressure of the solution at 20.0 °C? Remember coffee is an aqueous solution; assume a density of 1.00 g/mL.

½ credit →

A. 0.46 mmHg
B. 16.22 mmHg
C. 17.08 mmHg
D. 17.54 mmHg

$\frac{11.1 \text{ mol}}{11.1 + 0.1 + 0.2} = (0.9737)(17.54 \text{ mmHg}) = 17.08 \text{ mmHg}$

Part II – Open Answer Questions – *See Page 1 for full grading details*

Excellent Answer = 1 pt *Fair Answer = 0.5 pts* *Unsatisfactory Answer = 0 pts*

6. Acetoin has an enthalpy of vaporization of 48.7 kJ/mol. If the substance has a vapor pressure of 1.74 mmHg at 20 °C, what is the vapor pressure at 75 °C?

Show your work here…..

$\ln\left(\frac{P_2}{1.74 \text{ mmHg}}\right) = \frac{48.7 \text{ kJ/mol} \cdot 1000 \text{ J/kJ}}{8.314 \text{ J/mol·K}}\left(\frac{1}{293} - \frac{1}{348}\right)$

$\ln\left(\frac{P_2}{1.74 \text{ mmHg}}\right) = 5857 \text{ K}\ (0.000539 \text{ K}^{-1})$

$\ln\left(\frac{P_2}{1.74 \text{ mmHg}}\right) = 3.159$ $\frac{P_2}{1.74 \text{ mmHg}} = 23.55$ $P_2 = 40.97 \text{ mmHg}$

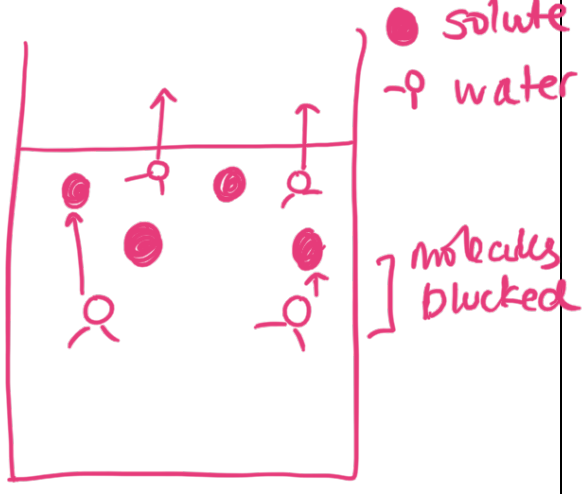
$e^?$ $e^?$

WRITE THE VAPOR PRESSURE HERE → 40.97 mmHg

7. Would you expect coffee to have a lower or higher boiling point than pure water? Explain and support with a drawing what is occurring on a molecular level in the coffee.

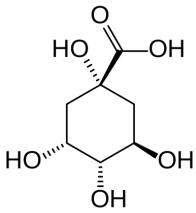
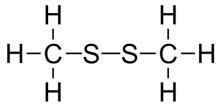
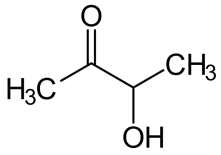
Explain your answer here…..

Coffee is a solution, consisting of water as solvent and all of the other molecules as solute. The presence of the solute prevents evaporation of water molecules. More energy is required to evaporate the water molecules



CIRCLE AN ANSWER → *LOWER BP* *or* *HIGHER BP*

8. The melting points of the three molecules of interest are -85, 15, 168 °C. Assign the melting to points to the three molecules and explain your answer.

		
Melting Point… 168°C	*Melting Point…* -85°C	*Melting Point…* 15°C

Explain your assignments here....

The boiling points can be assigned based on IMF. Dimethyl disulfide is nonpolar so only has dispersion, acetoin has OH so it will have hydrogen bonding, Quinic acid will have the highest because it has many OH groups, so stronger H bonding.

9. Coffee beans are made of polar and nonpolar compounds. When made, about 90% of the polar molecules make it into the cup of coffee you drink, while only 10% of the nonpolar molecules do. First, explain this observation using intermolecular forces and then explain why hot coffee brews faster than cold coffee.

Explain your answer here…

Coffee is made of water (solvent) and the molecules extracted from the beans. Since water is polar it will form IMF with other polar molecules, like dissolves like. Nonpolar molecules are less likely to be extracted because the attractions are much weaker. As the temp is increased the KE of the system increases, meaning there is more molecular movement. This movement enhances mixing, which increases the speed of dissolution.

10. Sparkling coffee is iced coffee which contains dissolved CO_2. If the concentration of CO_2 in the liquid is 0.167 M before the can is opened, what is the pressure of CO_2 in the can? Would you characterize the solution as unsaturated, saturated, or super saturated? Why?

Show your work here…

$S_{gas} = k_H P_{gas}$

$0.167\ M = (0.037\ M/atm)(P_{gas})$

$4.5\ atm = P_{gas}$

Circle one..

Unsaturated	*Saturated*	*Supersaturated*

Explain…

There is $CO_{2(g)}$ above the liquid increasing the amount of dissolved CO_2 above the normal solubility

END OF EXAM
!!! DON'T FORGET TO CHECK YOUR WORK !!!!

Useful information:

$1\ atm = 760\ mmHg = 101.3\ kPa$ $\qquad R = 8.314 \frac{J}{mol \cdot K} == 0.08206 \frac{L \cdot atm}{mol \cdot K}$

0 ºC = 273 K

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

$S_{gas} = k_H P_{gas}$ $\qquad X_{solvent} + iX_{solute} = 1$ $\qquad P_{solution} = X_{solvent} P^o_{solvent}$

$\Delta T_f = (i)(m)(K_f)$ $\qquad \Delta T_b = (i)(m)(K_b)$

$K_f\ H_2O = 1.84\ °C/m$ $\qquad K_b\ H_2O = 0.512\ °C/m$

H_2O normal boiling point: 100 °C
H_2O normal freezing point: 0 °C
H_2O vapor pressure at room temp (20 °C): 17.54 mmHg

CO_2 k_H at 20 °C is 0.037 M/atm

USE THIS PAGE FOR SCRAP. IT WILL NOT BE GRADED.

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