

CHEM 1032
PRACTICE
UNIT ASSESSMENT 1

SECTION: _____

NAME:	Key								
TUID:	<input type="text"/>								

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

Symbols:

H	<i>enthalpy</i>
v	<i>frequency</i>
M	<i>molar mass</i>
mol	<i>mole</i>
P	<i>pressure</i>
t	<i>time</i>
T	<i>temperature</i>
V	<i>volume</i>

Constants:

N_A	<i>Avogadro's number</i>
R	<i>ideal gas constant</i>

SI (Metric) Prefixes:

c	<i>centi-</i>
d	<i>deci-</i>
k	<i>kilo-</i>
m	<i>milli-</i>

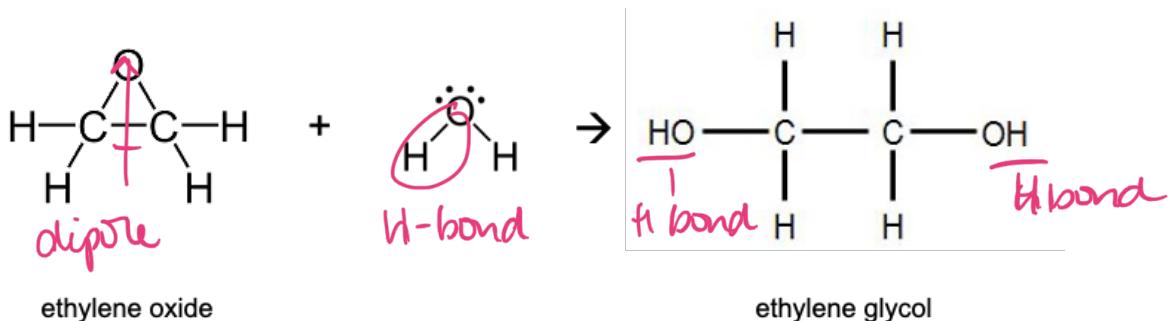
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
H 1.008																He 4.0026		
Li 6.94	Be 9.0122															Ne 20.180		
Na 22.990	Mg 24.305															Ar 36.948		
Sc 44.956	Ti 47.897	V 50.942	Cr 51.996	Mn 54.938	Fe 55.845(2)	Co 58.933	Ni 58.693	Cu 63.546(3)	Zn 65.38(2)	Ga 69.723	Ge 72.630(8)	As 74.922	Se 78.971(8)	Br 79.934	Kr 83.798(2)			
Rb 85.468	Sr 87.62		Y 88.906	Zr 91.224(2)	Nb 92.906(2)	Mo 95.95	Tc 101.07(2)	Ru 102.91	Rh 106.42	Pd 107.87	Ag 112.41	Cd 114.82	In 118.71	Sn 121.76	Sb 127.90(3)	Te 126.90	Xe 131.28	
Cs 132.91	Ba 137.33	* 57-70	Lu 71	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	At 85	
Fr 87	Ra 88	* 89-102	Lr 103	Rf 104	Db 105	Sg 106	Bh 107	Hs 108	Mt 109	Ds 110	Rg 111	Cn 112	Nh 113	Fl 114	Mc 115	Lv 116	Ts 117	Og 118

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

Ethylene Glycol ($(\text{CH}_2\text{OH})_2$ – 62.07 g/mol) is a liquid used in a series of real-world applications, like

- as a starting product in the synthesis of polymers.
- in ball point pens to help thicken the ink.
- to act as an antifreeze in cars.

The synthesis of the ethylene glycol can occur according to the reaction below...



Part I – Multiple Choice Questions (1 pt each)

Excellent Answer = 1 pt

Fair Answer = 0.5 pts

Unsatisfactory Answer = 0 pts

C

1. Which molecule in the reaction above would you expect to have the highest viscosity?

- A. ethylene oxide
- B. water
- C. ethylene glycol
- D. All three molecules have similar viscosity

has H-bonding and mass is greater than H_2O .

A

2. Compounds are considered hygroscopic if they absorb water from the air. Using intermolecular forces hypothesize if ethylene glycol is hygroscopic. *Both have H bond like dissolves like*

- A. Ethylene glycol is hygroscopic, the IMF between ethylene glycol and water are similar.
- B. Ethylene glycol is not hygroscopic, the IMF between ethylene glycol and water are too different.
- C. Ethylene glycol is hygroscopic, the dispersion forces will pull in water from the air.
- D. Ethylene glycol is not hygroscopic, the dispersion forces will repel water.

H Bond is Strongest in both.

C

3. Some pen inks are made from ethylene glycol and alcohol. Assuming an ideal solution, what is the vapor pressure of a solution that contains 52.3 g of ethylene glycol dissolved in 500.0 g of methanol (CH_3OH)? The vapor pressure of pure methanol is 97.68 mmHg at 20 °C.

- A. 0.05 mmHg
- B. 0.949 mmHg
- C. 92.69 mmHg
- D. 102.67 mmHg

$$500.0 \text{ g methanol} \left| \frac{1 \text{ mol}}{32.01 \text{ g}} \right. = 15.62 \text{ mol}$$

$$52.3 \text{ g EG} \left| \frac{1 \text{ mol}}{62.07 \text{ g EG}} \right. = 0.843 \text{ mol}$$

$$P_{\text{vap}} = X_{\text{solvent}} P^{\circ}_{\text{solvent}}$$

$$P_{\text{vap}} = 0.949(97.68 \text{ mmHg})$$

$$P_{\text{vap}} = 92.69 \text{ mmHg}$$

$$\frac{15.62 \text{ mol}}{15.62 + 0.843} = 0.949 X_{\text{solvent}}$$

D 4. The normal boiling point of ethylene glycol is 197 °C and the enthalpy of vaporization is 65.6 kJ/mol. If an ethylene glycol sample is observed to boil in a lab apparatus at 105 °C, what is true?

- A. The temperature is slightly higher in the apparatus.
- B. The temperature is significantly higher in the apparatus.
- C. The pressure is slightly lower in the apparatus.
- D. The pressure is significantly lower in the apparatus.

normal BP 1 atm 197 °C
↓
new BP ↓
condition Large T 105 °C
gap, so
large P gap

D 5. Ethylene glycol is used in the synthesis of many compounds, where it needs to be mixed with other reagents. Which compound would you expect to be immiscible in ethylene glycol?

- X A. Ethanol – CH₃CH₂OH. → H bonding
- B. Methyl amine – CH₃NH₂. → H bonding
- C. Acetic Acid – CH₃COOH. → H bonding
- D. Butane – CH₃CH₂CH₂CH₃. → Dispersion

H Bonding in EG
Like dissolves like

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

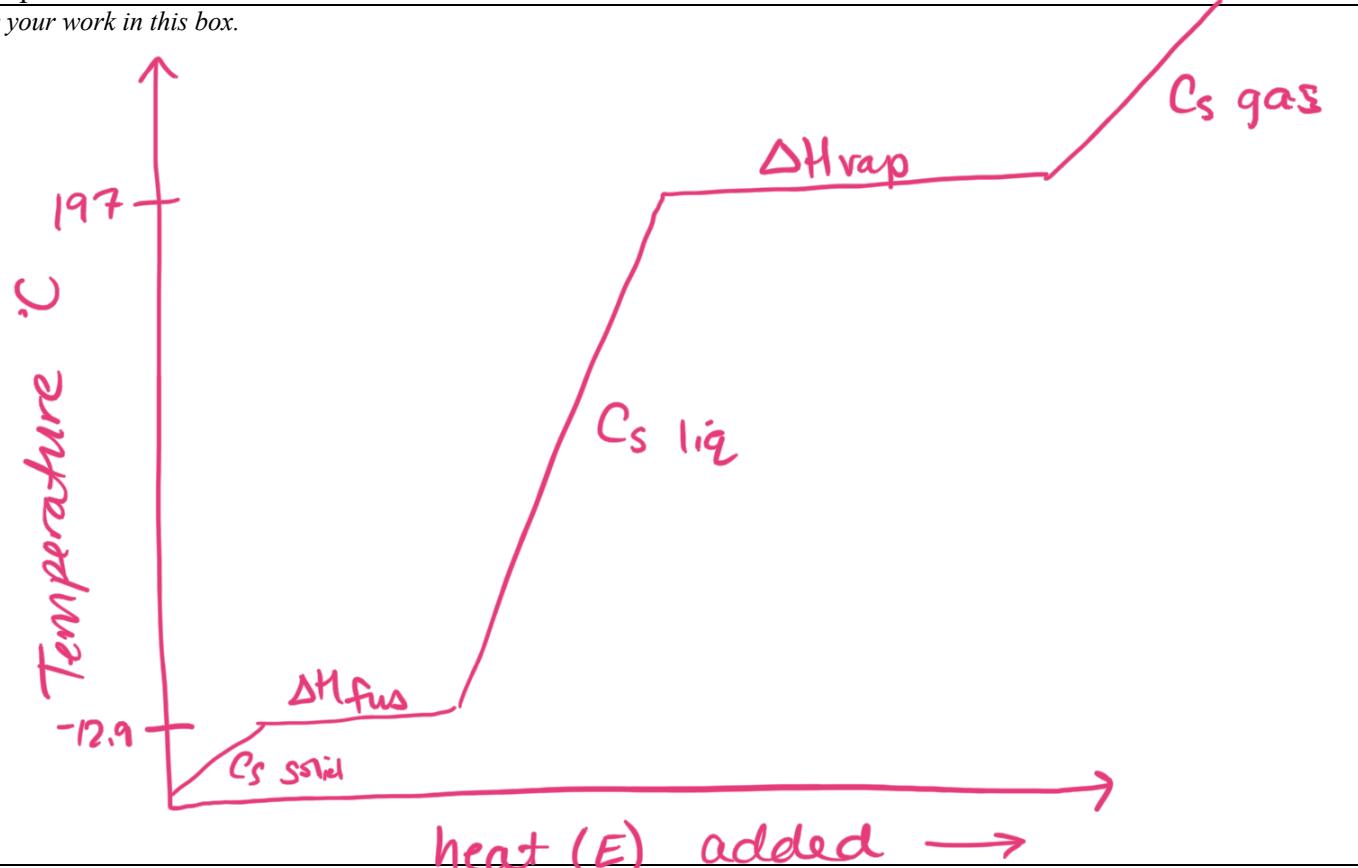
Excellent Answer = 1 pt

Fair Answer = 0.5 pts

Unsatisfactory Answer = 0 pts

6. The heating curve of pure ethylene glycol is an important tool for industrial chemists working with the compound. Sketch the curve below incorporating the boiling point (197 °C), freezing point (-12.9 °C), enthalpy of fusion (9.9 kJ/mol), and the enthalpy of vaporization (65.6 kJ/mol) into your plot. Be sure to label all components in detail.

Show your work in this box.



7. Ethylene glycol mixed with water is used as antifreeze in cars. Write the components that contribute to the enthalpy of solution, label the sign (+ or -) for each. Hypothesize the sign for the enthalpy of solution, explain your answer.

Show your work in this box.

$$\Delta H_{\text{soln}} = \Delta H_{\text{solute}} + \Delta H_{\text{solvent}} + \Delta H_{\text{mix}}$$

(+) (+) (-)

A reasonable argument can be made for (\leftarrow) ξ (+) for ΔH_{soln} , must discuss pulling apart IMF and new IMF forming.

- g solute* *g solvent* *FP*
8. Determine the mass of ethylene glycol present in 100.0 g of water if the antifreeze works until $-15.0\text{ }^{\circ}\text{C}$.

Show your work in this box.

Antifreeze freezes at -15.0°C , this is 15 below normal 0°C ,

$$\Delta T_f = 15.0 \text{ } ^\circ\text{C}$$

$$\Delta T_f = i m K_f$$

$$15.0^{\circ}\text{C} = (1)(m)(1.84^{\circ}\text{C}/m)$$

$$m = 8.15 \text{ m}$$

$$\text{Molarity} = \frac{\text{moles solute}}{\text{kg solvent}}$$

$$8.15 \text{ m} = \frac{x \text{ moles}}{0.100 \text{ kg}}$$

$$0.815 \text{ moles} \times 62.07 \frac{\text{g}}{\text{mole}} = 50.6 \text{ g}$$

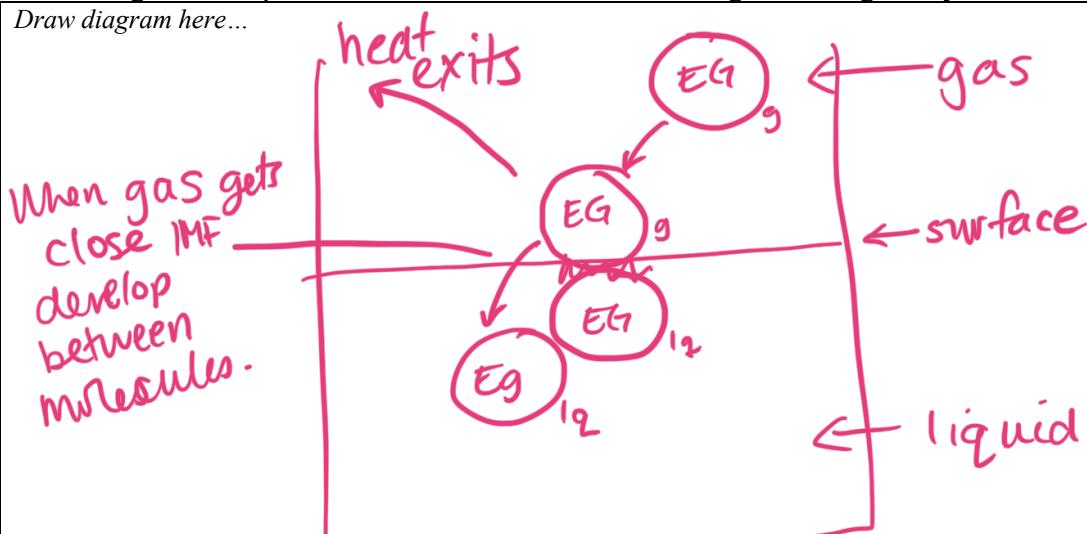
ANSWER IN THIS BOX →

Write mass of Ethylene Glycol here.

50.6 g

9. CLEARLY draw a diagram which shows the changes on the molecular level of ethylene glycol transitioning from a gas to a liquid. Indicate whether heat is entering or exiting the system.

Draw diagram here....



10. Sodium chloride (NaCl) can be added to solvents to increase conductivity. A 1931 research paper found that 36.09 g NaCl can dissolve in 100 g of water but only 7.09 g NaCl can dissolve in 100 g of ethylene glycol. Using intermolecular forces, explain why this is observed.

There are two reasonable answers...

Explain here...

(A) EG is less polar than H_2O ... in some orientation dipole cancels. So the ion-dipole force is not as strong, whereas H_2O has a strong dipole.

(B) EG has stronger IMF with itself... two OH groups, so more energy is required to separate the solvent vs H_2O .

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

Useful information:

$$1 \text{ atm} = 760 \text{ mmHg} = 101.3 \text{ kPa}$$

$$R = 8.314 \frac{J}{\text{mol} \cdot K} = 0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot K}$$

$$0^\circ\text{C} = 273 \text{ K}$$

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

$$S_{\text{gas}} = k_{\text{H}} P_{\text{gas}}$$

$$X_{\text{solvent}} + iX_{\text{solute}} = 1$$

$$P_{\text{solution}} = X_{\text{solvent}} P_{\text{solvent}}^{\circ}$$

$$\Delta T_f = (i)(m)(K_f)$$

$$\Delta T_b = (i)(m)(K_b)$$

$$K_f \text{ H}_2\text{O} = 1.84 \text{ } ^\circ\text{C/m}$$

$$K_b \text{ H}_2\text{O} = 0.512 \text{ } ^\circ\text{C/m}$$

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

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