

KEEP YOUR WORK AND ANSWERS COVERED.

1. (30 pts) Indicate whether each statement is true (T) or false (F). Be certain T or F is clearly indicated.

- T For every substance, its $\Delta H_{\text{vap}}^{\circ}$ is greater than its $\Delta H_{\text{fus}}^{\circ}$.
- T At 10 atm, the boiling point of a liquid is higher than its normal boiling point.
- T CO_2 is the most used supercritical fluid worldwide.
- T Each H_2O molecule in ice uses two hydrogen bond donor interactions and two hydrogen bond acceptor interactions.
- F Neon atoms cannot have a temporary dipole.
- F Diamond is a two-dimensional network of sp^2 carbon atoms.
- T Every enthalpy of hydration is negative.
- F All soluble ionic compounds dissolve in water exothermically.
- F A chloride ion has a higher charge density than a fluoride ion.
- T Gases with a larger value of k_{H} have a greater solubility in water.

2. (8 pts) List the primary intermolecular forces for each of the following (pure) compounds. If more than one IF is operating for a compound, CIRCLE the strongest IF for that compound.

BrCN dipole-dipole, dispersion

Cl_3PO dipole-dipole, dispersion

- ** 3. (6 pts) Consider the following physical properties for benzene, C_6H_6 .

melting point = $5.5\text{ }^{\circ}\text{C}$ $\Delta H_{\text{fus}}^{\circ} = 9.87\text{ kJ}$ boiling point = $80.1\text{ }^{\circ}\text{C}$ $\Delta H_{\text{vap}}^{\circ} = 30.72\text{ kJ}$ c of solid = $1.5\text{ J}/(\text{g}\cdot^{\circ}\text{C})$ c of liquid = $1.8\text{ J}/(\text{g}\cdot^{\circ}\text{C})$

A 14.0 g sample of solid benzene at $-12.7\text{ }^{\circ}\text{C}$ was heated until finally reaching gas phase at its boiling point. Consider just part of this overall process: start with the solid at $-12.7\text{ }^{\circ}\text{C}$, and heat the sample until you have liquid at $5.5\text{ }^{\circ}\text{C}$. Circle the number of kJ's which would be required.

| | | | | | |
|------|------|------|-------------|------|------|
| 1.26 | 1.51 | 1.83 | <u>2.15</u> | 2.49 | 2.72 |
| 3.08 | 3.31 | 3.66 | 3.95 | 4.22 | 4.52 |

4. (6 pts) A solution of 5.78 mol% potassium carbonate has a density of 1.32 g/mL. Circle the mass% of the solute.

| | | | | | |
|-------|-------|-------|-------|-------|--------------|
| 21.6% | 23.7% | 26.0% | 28.1% | 30.8% | <u>32.0%</u> |
| 36.9% | 38.1% | 40.5% | 43.9% | 45.5% | 47.1% |

- ** 5. (5 pts) What chemical type of solid is formed by each of the following substances?

silicon dioxide covalent network
 gold metallic network

- ** 6. (6 pts) Consider $\text{CaCl}_2(\text{s})$ dissolving into water. Using enthalpies of formation, calculate $\Delta H_{\text{soln}}^\circ$ (in kJ) and enter it on the line at right. (Only the answer, and not the calculation, will be graded for this question.)

-81.35

7. (5 pts) A solution contains 0.562 g of tetraphosphorus trisulfide in 25.0 g benzene, C_6H_6 . Circle the freezing point (in $^\circ\text{C}$) of the solution. For C_6H_6 , $K_f = 5.07^\circ\text{C}/\text{m}$ and $\text{mp} = 5.49^\circ\text{C}$.

| | | | | | |
|------|------|------|------|------|-------------|
| 4.73 | 4.79 | 4.84 | 4.87 | 4.90 | <u>4.97</u> |
| 5.03 | 5.08 | 5.11 | 5.15 | 5.20 | 5.26 |

- ** 8. (7 pts) For each compound below in water, list the primary intermolecular forces which are operating between the compound and the water.

H_3CNH_2 hydrogen bonding, dipole-dipole, dispersion
 SiF_4 dipole-induced dipole, dispersion

9. (6 pts) Consider a closed, 50.0 L container of air with 55.0% RH at 30. °C (86 °F). If that volume of air cools down to 10. °C (50. °F), how much dew is present at equilibrium? Circle the answer in g.

- | | | | | | |
|-------|-------|--------------|-------|-------|-------|
| 0.168 | 0.209 | <u>0.364</u> | 0.470 | 0.508 | 0.661 |
| 0.727 | 0.813 | 0.954 | 1.05 | 1.13 | 1.22 |

10. (9 pts) Consider CH₄ and C₂H₆ (H₃CCH₃) for dissolving into water. Both are gases in their native phase. Of the two compounds, which has weaker total IFs with water and which has stronger total IFs with water?

weaker IFs CH₄ stronger IFs C₂H₆

Explain your answer. You must include which specific IFs are involved.
*each has dip-indip and disp with water
 these IFs are stronger with larger molecules OR more atoms
 OR more surface area
 ∴ C₂H₆ is stronger*

Of the two compounds, which is less opposed by entropy to dissolve and which is more opposed?

less opposed by S CH₄ more opposed by S C₂H₆

Explain your ranking.

*C₂H₆ is larger hydrocarbon
 ∴ more hydrophobic / more shunned by H₂O / or?*

11. (6 pts) Consider the following pure compounds.

H₃SiCl Cl₃PO BCl₃ H₂O ClF₃ CH₃CH₂F

Which has the strongest dispersion? Cl₃PO

Which has the weakest dispersion? H₂O

** 12. (6 pts) A solution contains 9.19 g water and 29.6 g CH₃OH. Circle the mole fraction of water in the solution.

- | | | | | | |
|-------|-------|--------------|-------|-------|-------|
| 0.317 | 0.330 | <u>0.356</u> | 0.378 | 0.391 | 0.419 |
| 0.436 | 0.450 | 0.477 | 0.496 | 0.511 | 0.532 |