

- Instructions:**
1. Put your **name** and **section number** on both **page 1** and the **answer key**. Do **not detach the answer key** from the back of the exam.
 2. **Closed notes, closed book**. You are not to use any reference materials during the exam. A **periodic table** is attached. Calculators are allowed.
 3. The exam consists of two parts. A multiple choice section and a fill in the blanks, calculations section. You must **show work on calculations for credit**.
 4. When you are **finished**, **place the exam** in your **section's envelope**. You are then free to leave.

Good Luck!!!

Place answers to questions 1 - 30 on the answer key attached to your exam. Answers to questions 31, 32 and 33 are to be answered directly on the exam page. Questions 1 - 25 are worth 3 pts. each, 26 - 30 are worth 2 pts. each and 31 - 33 are worth 5 pts. each.

1. Which of the following statements concerning intermolecular forces are correct?
 1. Dispersion forces exist in all molecular solids.
 2. Dispersion forces increase as the number of electrons increases.
 3. Dipole-dipole attractions occur in nonpolar molecules if they have polar bonds.
 4. Hydrogen bonding only occurs for molecules containing OH bonds.

a) 1 only b) 1 and 2 c) 4 only d) 1, 2, and 4 e) 2 and 3
2. Which one of the following substances will exhibit dipole-dipole intermolecular forces?

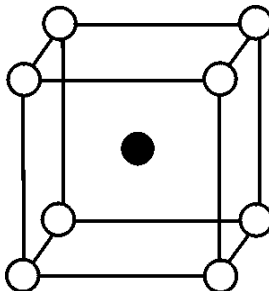
a) Kr b) N₂ c) CO₂ d) CCl₄ e) CO
3. Which one of the following molecules will have the lowest boiling point?

a) NH₃ b) CH₃Cl c) CH₄ d) NH₂Cl e) CHCl₃
4. Which intermolecular forces are present in CH₃F(s)?
 1. dispersion
 2. dipole-dipole
 3. hydrogen bonding

a) 1 only b) 2 only c) 3 only d) 1 and 2 e) 1, 2, and 3
5. Which intermolecular force or bond is responsible for the density of H₂O(s) being less than that of H₂O(l)?

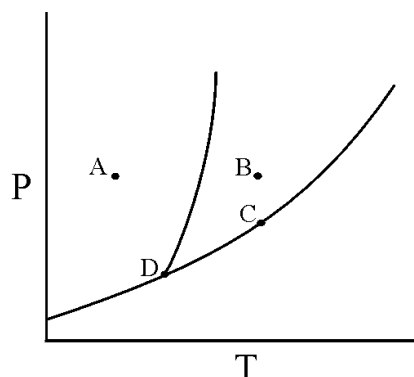
a) hydrogen bonding b) dispersion forces c) covalent bonding d) ionic bonding
e) dipole/induced dipole forces

6. Arrange KCl, CH₃CH₂OH, C₃H₈, and He in order of increasing boiling point.
- a) C₃H₈ < He < CH₃CH₂OH < KCl b) C₃H₈ < He < KCl < CH₃CH₂OH
 c) He < KCl < C₃H₈ < CH₃CH₂OH d) He < C₃H₈ < CH₃CH₂OH < KCl
 e) KCl < He < C₃H₈ < CH₃CH₂OH
7. High surface tension in liquids is an indication of
- a) strong adhesive forces. b) no adhesive forces. c) strong intermolecular forces.
 d) strong intramolecular bonds. e) π -bonding.
8. Which of the following are valid reasons why vegetable oil has a greater viscosity than diethyl ether, CH₃OCH₃?
1. Oil molecules are not held together by hydrogen bonds.
 2. Oil molecules have long chains that become entangled.
 3. Intermolecular forces are greater for the larger oil molecules.
- a) 1 only b) 2 only c) 3 only d) 1 and 3 e) 2 and 3
9. An atom located on a corner lattice point in a cubic unit cell is shared equally between _____ unit cells.
- a) 2 b) 4 c) 6 d) 8 e) 10
10. Which equation represents the number of atoms in a face-centered cubic unit cell?
- a) # atoms = $\frac{1}{8}(8)$ b) # atoms = $\frac{1}{4}(8)$ c) # atoms = $1 + \frac{1}{8}(8)$
 d) # atoms = $\frac{1}{2}(6) + \frac{1}{8}(8)$ e) # atoms = $1 + \frac{1}{2}(6) + \frac{1}{8}(8)$
11. In the unit cell below, element X is within the cell and element Y is at the corners. What is the formula for this compound?



- a) XY
 b) XY₂
 c) XY₄
 d) XY₈
 e) X₂Y

12. Which of the following statements concerning the phase diagram below are correct?



1. Moving from point A to B results in a phase transition from solid to liquid.
2. Point D lies at the critical point.
3. At point C, liquid and gas phases coexist at equilibrium.

a) 1 only b) 2 only c) 3 only d) 1 and 3 e) 2 and 3

13. Ideally, colligative properties depend only on

- a) the identity of the solute in a solution.
- b) the number of solute particles per solvent molecule in a solution.
- c) the temperature of a solution.
- d) the charge of the ions dissolved in solution.
- e) the gas pressure above the surface of a solution.

14. What is the definition of molality?

- a) moles of solute per liter of solution
- b) grams of solute per kg of solution
- c) grams of solute per kg of solvent
- d) moles of solute per kg of solvent
- e) moles of solute per liter of solvent

15. To prepare approximately 1 liter of a solution that is 4.75% by mass NaCl, one should

- a) dissolve 4.75 g NaCl in water up to a total volume of 1.00 L.
- b) dissolve 47.5 g NaCl in 1.00×10^3 g water.
- c) dissolve 47.5 g NaCl in 952.5 g water.
- d) dissolve 952.5 g NaCl in 47.5 g water.
- e) dissolve 46.5 g NaCl in 1.00 kg water.

16. Which of the following liquids are likely to be miscible with water: 1-propanol, carbon tetrachloride, cyclohexane, and formic acid (HCO_2H)?

- a) 1- propanol and cyclohexane
- b) carbon tetrachloride and cyclohexane
- c) cyclohexane and formic acid
- d) carbon tetrachloride and formic acid
- e) 1-propanol and formic acid

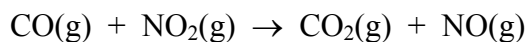
17. Which of the following statements concerning the attraction between ions and polar solvent molecules are correct?
1. The larger the ion charge, the greater the attraction.
 2. The attractive force increases as ionic radii increases.
 3. The greater the dipole (of the solvent molecule), the greater the attraction.
- a) 1 only b) 2 only c) 3 only d) 1 and 3 e) 1, 2, and 3
18. Which of the following actions will increase the equilibrium concentration of a gas in water?
1. increasing the temperature of the water
 2. increasing the volume water
 3. increasing the pressure of the gas above the liquid
- a) 1 only b) 2 only c) 3 only d) 1 and 3 e) 1, 2, and 3
19. Which of the following aqueous solutions should have the lowest freezing point?
- a) pure H₂O b) 1 *m* CaBr₂ c) 1 *m* NH₃ d) 1 *m* NaNO₃ e) 1 *m* C₆H₁₂O₆
20. Which of the following is an example of osmotic pressure?
- a) salting icy roads b) salting meats for preservation c) pressurizing soda with carbon dioxide
d) mixing water and ethylene glycol in anti-freeze e) distilling alcohol
21. Rate constants usually
- a) decrease with time. b) increase with time. c) decrease with temperature.
d) increase with temperature. e) are independent of time and temperature.
22. What determines the exponents in a rate law?
1. experimentation
 2. coefficients in the balanced equation
 3. concentrations of the reactants
- a) 1 only b) 2 only c) 3 only d) 1 and 2 e) 2 and 3
23. Which of the statements concerning relative rates of reaction is correct for the decomposition of dinitrogen pentaoxide?
- $$2 \text{N}_2\text{O}_5(\text{g}) \rightarrow 4 \text{NO}_2(\text{g}) + \text{O}_2(\text{g})$$
- a) The rate of disappearance of N₂O₅ is ½ the rate of appearance of O₂.
b) The rate of appearance of NO₂ is ¼ the rate of appearance of O₂.
c) The rate of disappearance of N₂O₅ is ½ the rate of appearance of NO₂.
d) The rate of appearance of NO₂ equals the rate of appearance of O₂.
e) The rate of disappearance of N₂O₅ equals the rate of appearance of NO₂.

24. Given the initial rate data for the reaction $A + B \rightarrow C$, determine the rate expression for the reaction.

$[A], M$	$[B], M$	$\frac{\Delta[C]}{\Delta t} \text{ (initial) } M/s$
0.10	0.20	4.20×10^{-4}
0.10	0.40	1.68×10^{-3}
0.20	0.40	3.36×10^{-3}

- a) $\frac{\Delta[C]}{\Delta t} = 0.105[A][B]^2$ b) $\frac{\Delta[C]}{\Delta t} = 0.0210[A][B]^2$
 c) $\frac{\Delta[C]}{\Delta t} = 0.0210[A]^2[B]$ d) $\frac{\Delta[C]}{\Delta t} = 0.105[A][B]$
 e) $\frac{\Delta[C]}{\Delta t} = 0.105[A]^2[B]$

25. What is the overall order of the reaction



if it proceeds via the following rate expression?

$$\frac{\Delta[CO_2]}{\Delta t} = k[CO][NO_2]$$

- a) zero-order b) first-order c) second-order d) third-order e) fourth-order

Be sure to place the answer to each of the following in the blank spaces provided on the answer page attached to the end of the exam

26. A solution in which there is more dissolved solute than in a saturated solution is known as a(n) _____ solution.

27. For a crystalline solid, the smallest repeating structure is referred to as the _____.

28. In capillary action, the attraction of water molecules to the surface of glass is referred to as a(n) _____ force, whereas the attraction to other water molecules is referred to as a(n) _____ force.

29. _____ is a measure of the degree to which the electron cloud surrounding an atom or molecule can be distorted in an electric field.

30. An example of a covalent network crystal is _____.

Do the following problems directly on this page in the space given. Place your answer in the blank spot provided. You must show your work to receive credit.

31. A solution made by dissolving 0.500 g of an unknown molecular compound in 673 g of water freezes at $-0.046\text{ }^{\circ}\text{C}$. Calculate the MW of the unknown compound. [$K_f(\text{H}_2\text{O}) = 1.86\text{ }^{\circ}\text{C/m}$]

MW = _____ g/mol

32. Lithium metal has a body-centered cubic structure with the length of an edge of the unit cell equal to $3.51 \times 10^{-8}\text{ cm}$. Calculate the density of lithium metal. [$\text{AW}(\text{Li}) = 6.941\text{ g/mol}$; Avogadro's Number = 6.022×10^{23}]

Density of Li = _____ g/cm^3

33. The solubility of N_2 in blood at $37\text{ }^{\circ}\text{C}$ and at a partial pressure of 0.80 atm is $5.6 \times 10^{-4}\text{ mol/L}$. Calculate the concentration of N_2 in the blood of a diver breathing compressed gas with a partial pressure of N_2 equal to 4.8 atm.

Molarity N_2 = _____ mol/L