

Name: _____
Chemistry 120, Section A
Final Exam, December 15, 2004

General Instructions: Read each question carefully and express your answers in the expected format, using proper English grammar, punctuation, and spelling. Show *all* of your work for *all* calculation problems and include units on answers where appropriate. Express your answers in the correct number of significant figures. To speed calculations, round all atomic weights to one decimal place.

Part A. Definitions (2 points each). Define each term or differentiate between the pairs of terms.

1. hydrophobic –
2. isotonic –
3. colligative properties –
4. semipermeable membrane –
5. colloid vs. suspension –

Part B Short answer

6. An aqueous antifreeze solution is 25.0% ethylene glycol ($C_2H_6O_2$) by mass. The density of this solution is 1.02 g/mL. Calculate the molarity, molality and mole fraction of the ethylene glycol. (10 points)

7. Which solvent, water or carbon tetrachloride, would you use to dissolve each of the following compounds? (5 points)
- CO_2
 - $\text{HC}_2\text{H}_3\text{O}_2$
 - NH_4NO_3
 - $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
 - $$\begin{array}{c} \text{O} \\ || \\ \text{CH}_3\text{CCH}_3 \end{array}$$
8. The vapor pressure of a solution containing 53.6-g glycerol ($\text{C}_3\text{H}_8\text{O}_3$) in 133.7 g ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) is 113 mm Hg at 40°C . Calculate the vapor pressure of pure ethanol at 40°C assuming that glycerol is a nonvolatile, nondissociating compound (which is true). (5 points)
9. A 0.350-g sample of a large biomolecule was dissolved in 15.0 g of chloroform (CHCl_3), and the freezing point depression was determined to be 0.240°C . Calculate the molar mass of the biomolecule (K_f for chloroform is $4.70^\circ\text{C}\cdot\text{kg}/\text{mol}$). (5 points)
10. The melting point of 250 mL of water changes by 0.47°C when 25.0 g of an ionic compound (molar mass determined in a separate experiment to be 125.0 g/mol) is added. How many ions does this molecule dissociate into? (5 points)

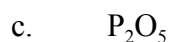
11. Explain the reverse osmosis purification of water. (5 points)

Part C Comprehensive short answer

12. A piece of unknown solid weighing 23.925 g was placed into a graduated cylinder containing 4.52 mL water at 25.0°C. The water level rose to 9.65 mL. Calculate the density of the solid (3 points). Express the answer in the correct number of significant figures (1 point) and *SI* units (1 point).

13. Convert 12.5 μg to kg (1 point), showing your work in dimensional analysis (3 points) and expressing your answer in correct scientific notation (1 point).

14. Name the following compounds, using the appropriate system. (5 points)



15. What is the formula unit for the following interactions? (5 points)
- Ca²⁺ and F⁻
 - Barium and sulfur
 - Fe²⁺ and nitrate
 - Ammonium and carbonate
 - Zinc and bromine
16. Balance the following reactions, or indicate they are balanced as written. (3.5 points)
- Ca(OH)₂ + H₃PO₄ ÷ H₂O + Ca₃(PO₄)₂
 - H₂ + N₂ ÷ NH₃
17. Given the balanced equation: Mg + I₂ ÷ MgI₂, calculate the limiting reagent and theoretical yield if 25 g each reactant are combined, and the reaction allowed to go to completion. (10 points)

18. Convert the following names and formulas of acids and bases. (5 points)

NH₃ _____

_____ lithium hydroxide

H₂SO₄ _____

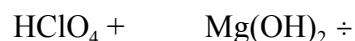
_____ carbonic acid

_____ hydrobromic acid

19. Balance the following redox reaction, which occurs in acidic solution. (5 points)



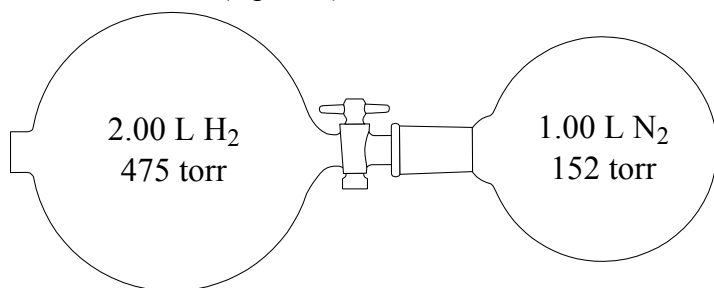
20. Predict the products of the following acid-base reaction and write the balanced molecular reaction, the complete ionic reaction and the net ionic reaction. (10 points)



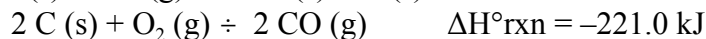
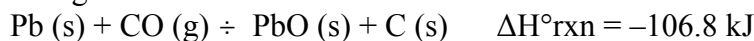
21. 25.00 mL of an acid of unknown strength required 19.21 mL of 0.1818 N NaOH to reach the equivalence point using phenolphthalein as an indicator. What is the normality? (3 points)

22. A compressed gas cylinder, at 13.7 MPa and 23°C, is in a room where fire increased the temperature to 450°C. What is the new pressure? (4 points)

23. Consider the flasks in the following diagram. What are the final partial pressures of H₂ and N₂ after the stopcock between the two flasks is opened, assuming the final volume is 3.00 L? (3 points)



24. Given the following:



What is the enthalpy change for the formation of PbO (s) from lead metal and oxygen gas? (4 points)

Part D. Multiple choice (2 points each) Place the *capital* letter of the *best* answer in the blank to the left of the answer.

_____ 25. In the molecule C₂H₄ the valence orbitals of the carbon atoms are

- A. not hybridized.
- B. sp hybridized.
- C. sp² hybridized.
- D. sp³ hybridized.
- E. dsp hybridized.

_____ 26. Atoms which are sp hybridized form _____ pi bond(s).

- A. 0
- B. 1
- C. 2
- D. 3
- E. 4

_____ 27. An atom has the following set of quantum numbers: n=3, l = 1, m_l = 0, m_s = +½. Which element is this?

- A. C
- B. Ge
- C. Mg
- D. Sc
- E. Si

_____ 28. In which of the following groups of substances would London dispersion forces be the *only* significant factors in determining boiling points?

- I. Cl₂ II. HF III. Ne
IV. KNO₂ V. CCl₄

- A. I, III, V
- B. I, II, III
- C. II, IV
- D. II, V
- E. III, IV, V

- _____ 29. Which of the following frequencies corresponds to light with the *highest* energy?
- A. $3.00 \times 10^{13} \text{ s}^{-1}$
 - B. $4.12 \times 10^5 \text{ s}^{-1}$
 - C. $8.50 \times 10^{20} \text{ s}^{-1}$
 - D. $9.12 \times 10^{12} \text{ s}^{-1}$
 - E. $3.20 \times 10^9 \text{ s}^{-1}$
- _____ 30. Hydrogen bonding can occur between which pairs of molecules?
- A. CH_4 and H_2O
 - B. H_2O and HCl
 - C. CH_4 and CH_2O
 - D. H_2O and NH_3
 - E. more than one of the above
- _____ 31. In a face-centered cubic lattice, an atom lying at the corner of a unit cell is shared equally by how many unit cells?
- A. 1
 - B. 2
 - C. 4
 - D. 8
 - E. 16
- _____ 32. The process of condensation happens when which of the following occurs?
- A. A solid becomes a liquid.
 - B. A liquid becomes a solid.
 - C. A liquid becomes a gas.
 - D. A gas becomes a liquid.
 - E. A solid becomes a gas.
- _____ 33. The formal charge of sulfur in sulfate is
- A. -2
 - B. +4
 - C. +6
 - D. +7
 - E. +8
- _____ 34. Brass is considered to be a(n) _____.
- A. interstitial alloy
 - B. ionic solid
 - C. molecular solid
 - D. substitutional alloy
 - E. more than one of these

- _____ 35. Which of the following statements about quantum numbers are incorrectly paired?
- A. $n = 0$... spherical shape
 - B. $l = 2$... spherical shape
 - C. $n = 1$... $l = 1$
 - D. $l = 1$... 3 possible shapes
 - E. $n = 1$... $l = 0$
- _____ 36. The element with the *largest* size is expected to be
- A. B
 - B. Li
 - C. O
 - D. W
 - E. Xe
- _____ 37. The *most polar* of the following bonds is
- A. C-H
 - B. N-H
 - C. O-H
 - D. S-H
 - E. none are polar
- _____ 38. The correct Lewis dot structure for a central atom with four bonding pairs and a lone pair is
- A. pyramidal
 - B. square pyramidal
 - C. tetrahedral
 - D. trigonal bipyramidal
 - E. octahedral
- _____ 39. The chemical species with electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$ is
- A. Ar
 - B. Cl^-
 - C. Ge
 - D. Sc^+
 - E. Sr