

NAME _____

**Chemistry 141
Final Exam
Fall, 2003**

Constants:

$$c = 2.998 \times 10^8 \text{ m sec}^{-1}$$

$$h = 6.626 \times 10^{-34} \text{ J sec}$$

$$T_0 = 273.2 \text{ K}$$

$$R = 0.08206 \text{ L atm mol}^{-1} \text{ K}^{-1}$$

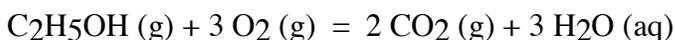
$$N_A = 6.023 \times 10^{23} \text{ mol}^{-1}$$

Part I. Short Answer. 3 points each.

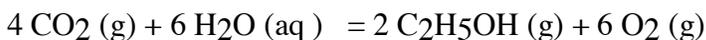
1. Place the following elements in order of increasing first ionization energy: Mg, Na, Rb, Cl.

lowest IE _____ highest IE

2. The standard molar enthalpy of combustion for ethanol, C₂H₅OH, is -1409 kilojoules.



What is the standard enthalpy change for the following process?



3. Name the following compounds:

a) Na₂CO₃ _____

b) FeSO₄ _____

4. Write the formula for the following compounds:

a) sodium nitrite _____

b) sodium permanganate _____

5. Classify the following compounds as strong or weak electrolytes

a) NaCl _____

b) HC₂H₃O₂ _____

c) NH₃ _____

6. What is the oxidation state of the bold element?

- a) CrO_4^{2-}
- b) BaS
- c) NH_3

7. When one mole of benzene is vaporized at a constant pressure of 1.00 atm and at its boiling point of 353.0 K, 30.79 kJ of energy (heat) is absorbed and the volume change is +28.90 L. What is ΔE for this process? (1 L-atm = 101.3 J)

- A. 30.79 kJ
- B. -89.87 kJ
- C. 25.80 kJ
- D. 133.71 kJ
- E. 27.86 kJ

8. Which of the following statements is true?

- A. Electrons are never found in an antibonding MO.
- B. All antibonding MOs are higher in energy than the atomic orbitals of which they are composed.
- C. Antibonding MOs have electron density mainly outside the space between the two nuclei.
- D. None of the above is true.
- E. Two of the above statements are true.

9. Place the following diatomic molecules in order of increasing polarity:

HF, Cl_2 , NO, HCl.

less polar _____ more polar

10. Sketch a plot of pressure vs. moles gas for an ideal gas (label the axes, including units).

11. Circle the correct answer for each of the following:

- a) the greatest electronegativity: Na, K, Cl
- b) would be likely to form a stable (+2) cation: Rb, K, Ca
- c) the greatest metallic character: P, Fe, Cs

For questions 12 - 14 refer to the phase diagram for CO₂.

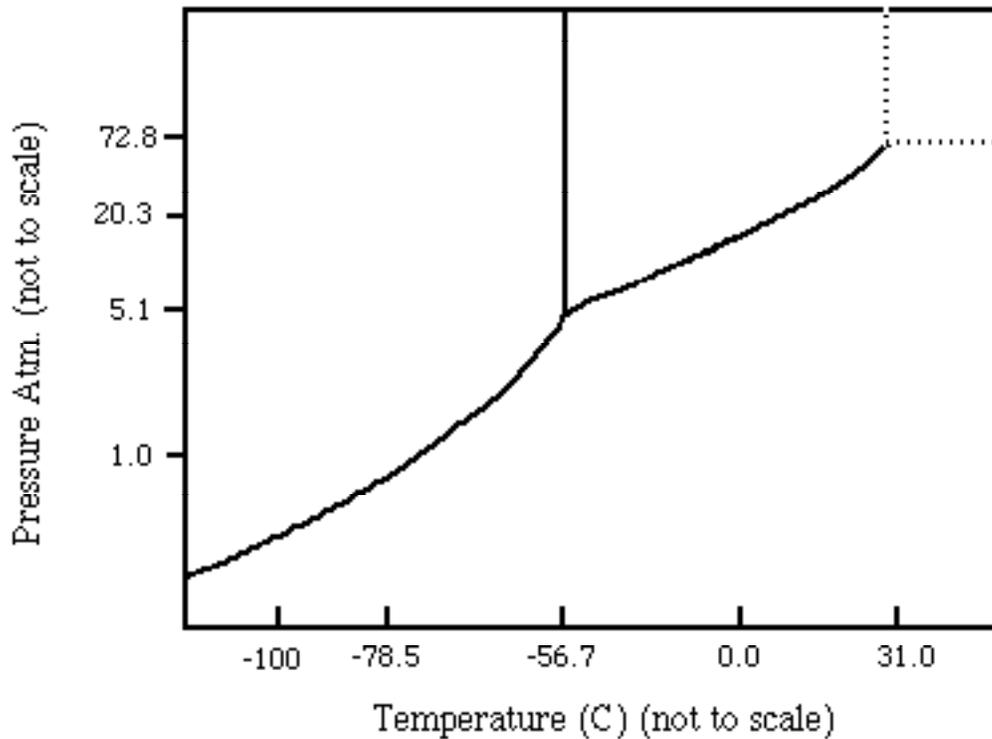
12. Label the four regions of the phase diagram with the appropriate phase (solid, liquid, gas, supercritical fluid).

13. Indicate the approximate temperature and nature of each phase change that will occur as you heat a sample of CO₂ from -100 to 40 °C at a constant pressure of 20.3 atm. .

14. Label on the figure and define the critical and triple points.

critical point

triple point



Phase Diagram for CO₂

Part II. Short Problems. **8 points each.**

13. How much heat (in joules) is required to convert a 100 cm^3 block of solid CO_2 into gaseous CO_2 ($\Delta H_{\text{sub}} = 24.2 \text{ kJ/mole}$, density = 1.56 g/cm^3)?

14. Draw a molecular orbital diagram for the molecule NO, nitrogen oxide. Using the diagram answer the following questions.

(i) What is the highest energy molecular orbital to which an electron or electrons have been assigned? _____

(ii) How many net sigma (σ) bonds are there? _____

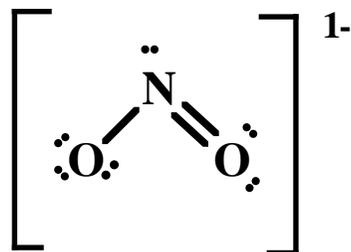
(iii) How many net pi (π) bonds? _____

(iv) What is the N-O bond order? _____

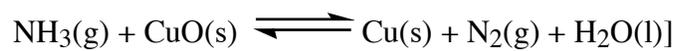
(v) Is the molecule diamagnetic or paramagnetic? _____

(vi) If the molecule is oxidized to the nitrosonium ion, NO^+ , the N-O bond is (longer)(shorter) _____ and it is (stronger)(weaker) _____ than in NO.

15. Propose a hybridization and bonding scheme that will explain the geometry and bond character of the NO_2^- anion given the following lewis structure.



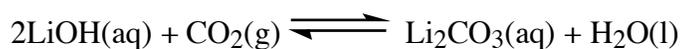
16. Balance the following redox reaction.



17. A compound containing carbon, nitrogen, and hydrogen is combusted completely with excess oxygen to produce 138 g of NO_2 , 28.0 g of CO_2 , and 90.0 g of H_2O . What is the empirical formula of the compound?

Part III. Longer Problems. **12 points each.**

19. A solution of LiOH can be used as an air purifier to remove CO₂ from space vehicles and submarines according to the following reaction:



How many moles of Li₂CO₃ will be produced if 20.2 liters of air at 22.3 °C, 1.24 atm. pressure, and containing 5.06% CO₂ is bubbled through 10.0 liters of a 0.0100 M LiOH solution?

20. For each of the following molecules; a) draw a reasonable lewis dot structure, b) describe the molecular geometry and polarity, and c) give the hybridization on the central atom.

a) AsH₃

b) XeF₂

c) SO_2 (S is central atom)

21. The molar heat of combustion of methane (CH_4) is -760.1 kJ/mole . How many liters of methane at STP must be combusted with excess O_2 to heat 1.13 liters of water from 25 to 100 $^\circ\text{C}$? The specific heat of water is $4.18 \text{ J/g } ^\circ\text{C}$ and the density is 1.00 g/cm^3