

Chemistry 120 - Exam 3
Fall 2001

T Take the multiple choice portion of the exam with you as you leave.

T Turn in Part II of the exam along with the Scan-Tron answer sheet to me.
Make certain your name and exam number, found on page 6, are on the Scan-Tron sheet.

Part I: Multiple Choice Questions - Enter the correct answer on the Scan-Tron sheet. Each question is worth 3 points.

$$R = 0.0821 \text{ L-atm/mol-K} = 8.314 \text{ J/mol-K}$$

- Which statement is not consistent with the kinetic theory of gases?
 - The forces of attraction between gas molecules are very weak or negligible.
 - A gas is mostly empty space.
 - Gas molecules gain kinetic energy when they collide with one another.
 - The average kinetic energy of the molecules in a gas is proportional to the absolute temperature of the gas.
 - Gas molecules move in a straight lines colliding with one another and the walls of the container.
- At 23°C and 325 mmHg, an unknown pure gas has a density of 0.493 g/L. Which of the following gases could be the unknown gas?
(At. Wts.: N = 14.0; O = 16.0; Ne = 20.2; C = 12.0; H = 1.00; F = 19.0)
 - N₂O
 - Ne
 - C₂H₆
 - CO
 - F₂
- What is the partial pressure of dinitrogen, N₂, in a container that contains 2.0 mole O₂, 3.0 mole N₂ and 1.0 mole CO₂ when the total pressure of the mixture is 900. mmHg?
(At. Wts.: N = 14.0; O = 16.0; C = 12.0)
 - 450 mmHg
 - 150 mmHg
 - 200 mmHg
 - 600 mmHg
 - 300 mmHg
- A 1.00 L bulb contains a sample of O₂ at 25°C and 1.00 atm pressure. A second 1.00 L bulb contains a sample of CH₄ at 25°C and 1.00 atm pressure/ What is the ratio of the average velocity of O₂ molecules to that of CO₂ molecules?
(At. Wts: C = 12.0; O = 16.0; H = 1.00)
avg V_{CO₂} : avg V_{O₂}
 - 1 : 1.38
 - 1 : 1.17
 - 1 : 0.727

d. 1 : 0.853
e. 1 : 1

5. Which quantum number describes the orientation in space of an orbital?
- n
 - l
 - m_l
 - m_s
 - all of the above
6. How many orbitals are in a subshell designated with an azimuthal quantum number of 4?
- 1
 - 3
 - 5
 - 7
 - 9
7. Which of the following sets of quantum numbers is not permissible?
- $n = 1; l = 0; m_l = 0; m_s = +\frac{1}{2}$
 - $n = 4; l = 2; m_l = 1; m_s = +\frac{1}{2}$
 - $n = 3; l = 3; m_l = 3; m_s = \frac{1}{2}$
 - $n = 2; l = 1; m_l = 1; m_s = \frac{1}{2}$
 - $n = 2; l = 0; m_l = 0; m_s = +\frac{1}{2}$
8. What is the maximum number of orbitals in the fourth principle shell?
- 8
 - 9
 - 16
 - 4
 - 18
9. The element whose neutral atom in the ground state has six half-filled orbitals is:
- Ga
 - Cr
 - Ba
 - Sc
 - Se
10. Which of the following ground state electronic configurations is incorrect?
- Na $1s^2 2s^2 2p^6 3s^1$
 - Fe^{2+} $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$
 - Ti^{2+} $[Ar]3d^2$
 - Se^{2+} $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$
 - Ga $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^1$
11. Which of the following elements has the largest first ionization potential?
- Na
 - F
 - S
 - Al
 - P
12. Which of the following sequences arranged elements in order of decreasing atom radius (decreasing from left to right)?
- Mg, Si, S, O, F
 - F, O, S, Mg, Si
 - S, Si, Mg, F, O
 - Si, S, F, O, Mg
 - Mg, Si, F, O, S

13. The bright-line emission spectrum of the hydrogen atom is the result of:
- Changes in kinetic energy of atoms from higher potential energy to lower PE.
 - Electronic transitions from lower potential energy levels to higher PE levels.
 - Higher PE atoms colliding with lower PE atoms.
 - Electronic transitions from higher potential energy levels to lower PE levels.
 - Electronic transfers between atoms.
14. Which of the following statements is *false*?
- In the Bohr model of the hydrogen atom, both the location and the potential energy of the electron are known exactly and simultaneously.
 - Each line in the bright-line emission spectrum of an element represents the potential energy of a principal shell or subshell.
 - The Heisenberg Uncertainty Principle says that it is not possible to know both the exact location and exact energy of an electron simultaneously.
 - The Pauli principle states that every electron in an atom always has its own unique set of four quantum numbers.
 - The shorter the wave length of light the greater is its energy.
15. The valence electrons possessed by an atom of a main-group element...
- ...are held closest to the nucleus.
 - ...are those in orbitals of highest l value.
 - ...are those in the highest principle shell of an atom.
 - ...are those with unpaired spins.
 - ...are those involved in transitions to shells of lower energy.
16. The stable monatomic ion most likely to be formed by phosphorus would be:
- | | |
|-------------|-------------|
| a. P^{3-} | d. P^{3+} |
| b. P^{2-} | e. P^{2+} |
| c. P^1 | |
17. Based on the valence electrons possessed by elements, all of the following formulas are correct except:
- | | |
|-------------|------------|
| a. MgO | d. CaS |
| b. BeF_2 | e. Na_2N |
| c. $AlBr_3$ | |
18. In which of the following lists do the ions not appear in the order of increasing ionic radius?
- | | |
|-------------------------------|--------------------------|
| a. $Li^+ < Na^+ < K^+$ | d. $S^{2-} < Cl^- < K^+$ |
| b. $Al^{3+} < Mg^{2+} < Na^+$ | e. $Cl^- < Br^- < I^-$ |
| c. $Na^+ < F^- < O^{2-}$ | |
19. Which of the following pairs of elements when combined with one another would be expected to form compounds that exist as molecules (molecular compounds)?
- | | | | | |
|---------------|-----------------|------------|-------------|-------------|
| 1. Ca and O | 2. N and F | 3. S and K | 4. I and Cl | 5. Mg and S |
| a. 2, 3 and 4 | d. 4 only | | | |
| b. 1, 3 and 5 | e. 1 and 5 only | | | |

c. 2 and 4 only

20. Which of the following is not a property of ionic compounds:
- If soluble in water will form solutions that conduct electricity.
 - Solids at room temperature.
 - Exist as crystalline species with usually high melting temperatures.
 - Are composed of an equal number of positive and negative ions.
 - When melted, the melts are electrically conductive.
21. The most polar covalent bond of those shown below is:
- H-I
 - H-I
 - Cl-Cl
 - H-Cl
 - I-Br
22. What would be the most likely formula for a compound formed between sulfur, S, and chlorine, Cl.
- SCl
 - SCl₂
 - S₂Cl
 - S₃Cl₂
 - S₂Cl₃
23. Which sequence list the elements in order of increasing electronegativity?
- N < Ga < P < Cs < Ca
 - Cs < Ga < Ca < N < P
 - N < P < Ca < Cs < Ga
 - Ga < Cs < N < P < Ca
 - Cs < Ca < Ga < P < N
24. Chemical reactions between nonmetals and nonmetals primarily involve
- interactions between protons.
 - interactions between protons and electrons.
 - interactions between protons, neutrons and electrons.
 - the transfer of electrons.
 - the sharing of electrons.
25. The big holiday near the end of November that usually involves turkey but really should involve pizza is:
- Pizza day
 - November day
 - Brittany Spear's birthday (okay, turkey is more appropriate for this one).
 - Thanksgiving day
 - July 4th

Part II: Worked out problems, etc. Show all work and USE UNITS.

1. The following equation represents the complete combustion of C_5H_6 :



- (a) Comparing all volumes at the same temperature and pressure, what is the maximum volume of CO_2 that can be obtained from 22.0 L of C_5H_6 and 125 L of O_2 ? (4 pts)

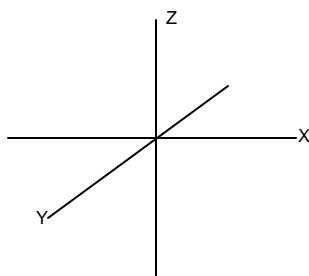
volume of CO_2 = _____

- (b) If 25.0 L of C_5H_6 and 175 L of O_2 are combined and allowed to react completely, which reactant would be in excess and by how many liters? (4 pts)

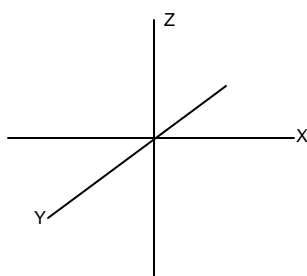
species = _____

volume in excess = _____

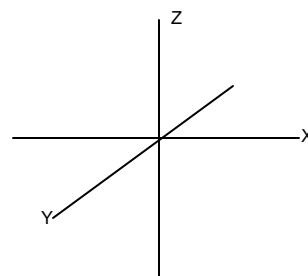
2. Sketch the requested orbitals on the axes: (3 pts)



3s



$2p_x$



any d-orbital

3. Why do the radii of the atoms in the second period get smaller as you move from left to right across the period? (4 pts)

4. (a) Use Lewis dot symbols, arrows, etc., to show how sodium and oxygen combine to form an ionic compound. Be very clear in your description/diagram. (4 pts)

(b) Use Lewis dot symbols, arrows, etc., to show how C and H can combine to form methane, CH₄, a covalent compound. Be very clear in your description/diagram. (3 pts)

5. Use abbreviated ground state electronic configurations to show why these three Group VIA elements, O, S, Se, have similar chemical properties. (3 pts)