Name _____

SSN _____

CHEM 121a Exam 3 Fall 1998

This exam consists of 8 true-false questions (each worth 2 pts), 20 multiple choice questions (each worth 3 pts), and 3 short problems (each worth 8 pts). There are a total of 100 possible points.

True-False

If the statement is true, do nothing. If the statement is false, write a replacement for the underlined word, phrase, or number to make the statement true.

1. A property that is <u>independent</u> of the pathway is called a state function. _____
2. The first law of thermodynamics is the same as the law of conservation of <u>mass</u>. _____
3. In a(n) <u>exothermic</u> process, heat is absorbed from the surroundings. _____
4. Phosphorus has a <u>smaller</u> atomic radius than antimony. _____
5. The atomic radius of F is <u>larger</u> than the ionic radius of F^-. _____
6. <u>Valence</u> electrons are found in the outermost principal quantum level of an atom. _____
7. The <u>wavelength</u> is the distance between two consecutive peaks or troughs in a wave. _____
8. <u>Electron affinity</u> is the energy required to remove an electron from a gaseous atom or ion. _____

Multiple Choice

Please print your name and the "Test Color" on your Scantron sheet. Carefully mark the appropriate answer to each question on the Scantron sheet, and show any work in the space provided. Please hand in <u>both</u> the Exam and the Scantron sheet.

1. A gas absorbs 0.0 J of heat and then performs 15.2 J of work. The change in internal energy of the gas is

   a. −24.8 J
   b. 14.8 J
   c. 55.2 J
   d. −15.2 J
   e. 4.18 J

2. One mole of an ideal gas is expanded from a volume of 1.00 liter to a volume of 10.00 liters against a constant external pressure of 1.00 atm. How much work (in joules) is performed on the surroundings? (T = 300 K; 1 L atm = 101.3 J)

   a. 456 J
   b. 912 J
   c. 2740 J
   d. 2870 J
   e. 5478 J

3. Which statement is true of a process in which one mole of a gas is expanded from state A to state B?

   a. When the gas expands from state A to state B, the surroundings are doing work on the system.
   b. The amount of work done in the process must be the same, regardless of the path.
   c. It is not possible to have more than one path for a change of state.
   d. The final volume of the gas will depend on the path taken.
   e. The amount of heat released in the process will depend on the path taken.

4. Which of the following is true?

   a. When a gas is compressed, w is negative.
   b. Temperature is an extensive property.
   c. Hess's law is a notable exception to the first law of thermodynamics.
   d. The melting of ice is an exothermic process.
   e. The change in enthalpy is the same as heat at constant pressure.

5. You have a 28.2-g sample of a metal heated to 95.2 °C. You drop it in a calorimeter with 100. g of water at 25.1 °C. The final temperature of the water is 31.0 °C. Assuming no heat loss to the surroundings nor the calorimeter, calculate the heat capacity of the metal. The specific heat capacity of water is 4.18 J/(g °C).

   a. 0.325 J/g°C
   b. 0.981 J/g°C
   c. 1.12 J/g°C
   d. 1.36 J/g°C
   e. 4.18 J/g°C

6. Consider the reaction:

   $H_2(g) + 1/2\ O_2(g) \rightarrow H_2O(l) \qquad \Delta H° = -286\ kJ$

   Which of the following is true?

   a. The reaction is exothermic.
   b. The reaction is endothermic.
   c. The enthalpy of the products is less than that of the reactants.
   d. Heat is absorbed by the system.
   e. Both "the reaction is exothermic" and "the enthalpy of the products is less than that of the reactants" are true.

7. Consider the reaction:

$C_2H_5OH(l) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + H_2O(l) \qquad \Delta H° = -1.37 \times 10^3$ kJ

When a 15.1-g sample of ethyl alcohol (molar mass = 46.1 g/mol) is burned, how much energy is released as heat?

a. 0.449 kJ
b. 2.25×10^3 kJ
c. 4.49×10^2 kJ
d. 1.02×10^3 kJ
e. 196 kJ

8. What is the minimum wavelength of a photon of light that can excite an electron in the hydrogen atom from the n = 1 to the n = 8 energy level?

a. 92.7 nm
b. 122 nm
c. 40.1 nm
d. 60.4 nm
e. 300. nm

9. What is the energy of a photon of blue light that has a frequency of 6.7×10^{14} Hz?

a. 6.7×10^{14} J
b. 4.4×10^{-19} J
c. 1.5×10^5 J
d. 1.01×10^{48} J
e. 5.8×10^{-19} J

10. In Bohr's atomic theory, when an electron moves from one energy level to another energy level more distant from the nucleus

a. energy is emitted.
b. energy is absorbed.
c. no change in energy occurs.
d. light is emitted.
e. not enough information is given.

11. Which of the following statements about quantum theory is incorrect?

a. The energy and position of an electron cannot be determined simultaneously.
b. Lower energy orbitals are filled with electrons before higher energy orbitals.
c. When filling orbitals of equal energy, two electrons will occupy the same orbital before filling a new orbital.
d. No two electrons can have the same four quantum numbers.
e. The principal quantum number is represented by the letter n.

12. How many electrons can be contained in all of the orbitals with n = 4, l = 3, m_l = 0?

a. 2
b. 8
c. 10
d. 18
e. 32

13. What is the electron configuration of calcium?

a. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
b. $1s^2 2s^2 2p^6 2d^{10}$
c. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2$
d. $1s^2 2s^3 2p^6 3s^3 3p^3 4s^2$
e. $1s^2 2s^3 2p^5 3s^4 3p^5 4s^1$

14. The electron configuration for Cu is

a. $[Ar]4s^2 3d^9$
b. $[Kr]4s^2 3d^9$
c. $[Ar]4s^1 3d^{10}$
d. $[Ar]4s^2 4d^9$
e. $[Ar]3s^1 3d^{10}$

15. The electron configuration of Cr^{3+} is

a. $[Ar]4s^2 3d^1$
b. $[Ar]4s^1 3d^2$
c. $[Ar]3d^3$
d. $[Ar]4s^2 3d^4$
e. $[Kr]4s^2 3d^5$

16. All halogens have the following number of valence electrons:

a. 2
b. 3
c. 5
d. 7
e. 9

17. Germanium has _____ in its 4p orbitals.

a. 1 electron
b. 2 electrons
c. 3 electrons
d. 4 electrons
e. 5 electrons

18. The first ionization energy of Mg is 735 kJ/mol. The second ionization energy is

a. 735 kJ/mol
b. less than 735 kJ/mol
c. greater than 735 kJ/mol
d. not possible for Mg
e. more information is needed to answer this question

19. List the following atoms in order of increasing first ionization energy: Li, Na, C, O, F.

a. Li < Na < C < O < F
b. Na < Li < C < O < F
c. F < O < C < Li < Na
d. Na < Li < F < O < C
e. Na < Li < C < F < O

20. Researchers in Germany recently formed a new synthetic element with atomic number 109. Which of the following elements would have chemical properties most similar to this new element?

a. W
b. Rn
c. Ir
d. Lr
e. U

Written Problems

Write out the solutions to the written problems. Please <u>show</u> all of your work.

1. Several models of atomic orbitals (wood, computer generated) were demonstrated in class. Draw and completely label the s, p_x, d_{xy}, and $d_{x^2-y^2}$ orbitals. Please be sure to label all drawn axes appropriately. (Assume these are radial probabilities, ψ^2, so no shading is required.) (8 pts)

2. At 25 °C, the following heats of reaction are known:.

$2\ ClF + O_2 \rightarrow Cl_2O + F_2O$ $\Delta H =$ _____ kJ
$2\ ClF_3 + 2\ O_2 \rightarrow Cl_2O + 3\ F_2O$ $\Delta H = 341.4$ kJ
$2\ F_2 + O_2 \rightarrow 2\ F_2O$ $\Delta H = -$____ kJ

At the same temperature, calculate ΔH for the reaction: (8 pts)

$ClF + F_2 \rightarrow ClF_3$

3. For the reaction: $AgI(s) + 1/2\ Br_2(g) \rightarrow AgBr(s) + 1/2\ I_2(s)$ $\Delta H° = -54.0$ kJ

$\Delta H°_f$ for AgBr(s) = −_00.4 kJ./mol
$\Delta H°_f$ for $Br_2(g)$ = 30.9 kJ./mol

At the same temperature, calculate $\Delta H°_f$ for AgI(s): (8 pts)

Useful Information

$\Delta E = q + w$ $w = -P\Delta V$ $\nu = c/\lambda$ $E = h\nu$ $\Delta H = s*m*\Delta T$

$$\Delta E = -2.178 \times 10^{-18}\ J \left(\frac{1}{n_{final}^2} - \frac{1}{n_{initial}^2}\right)$$

$h = 6.626 \times 10^{-34}$ J s $c = 2.9979 \times 10^8$ m/s

True-False	(16)	_____
Multiple Choice	(60)	_____
Written Problems	(24)	_____
Exam 3 Total	(100)	_____