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REFERENCE SHEET FOR CHEM 1 FINAL EXAMINATION
(Not all data on this sheet will be necessary for any given exam)

THIS EXAM HAS 12 PAGES (INCLUDING THE COVER)
MAKE SURE YOU HAVE THEM ALL

</div>

PERIODIC CHART OF THE ELEMENTS

Numbers in parenthesis are mass numbers of most stable or most common isotope.

Atomic weights corrected to conform to the 1963 values of the Commission on Atomic Weights.

The group designations used here are the former Chemical Abstract Service numbers.

*Lanthanide Series

‡Actinide Series

PHYSICAL CONSTANTS

$c = 2.998 \times 10^8$ m/s (speed of light)

$e = 1.602 \times 10^{-19}$ C (charge of one electron)

$m_e = 9.1094 \times 10^{-28}$ g (mass of one electron)

Gas Constant: $R = 8.3145$ J/(mol K) = 0.08206 L atm/(mol K)

1 atomic mass unit = 1.66×10^{-24} kg

Planck's Constant: $h = 6.62606876 \times 10^{-34}$ J s

Rydberg constant: $R_H = 1.10 \times 10^7$ m^{-1} = 2.18×10^{-18} J

1 cal = 4.184 J

Specific heat of water: 4.184 J/g°C

0.00°C = 273.15 K

1 atm = 760 mmHg

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YOU MAY TEAR THIS SHEET OFF AND USE IT FOR REFERENCE

PUT YOUR NAME ON THE THIRD PAGE, AND ALL FOLLOWING PAGES

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CHEM 1   FINAL EXAM   SPRING 04

NAME_____   DATE:

INSTRUCTOR (circle): Islam   Kazimierska   Zhao   Voloshchuk

SHOW ALL WORK   USE CORRECT UNITS AND SIGNIFICANT DIGITS
YOU MAY SHOW YOUR WORK ON THE BACK OF THE SHEET, BUT INDICATE
YOUR ANSWER ON THE FRONT

PERIODIC TABLE AND REFERENCE DATA MAY BE TORN OFF OF EXAM

24 QUESTIONS, 150 POINTS TOTAL (+2 EXTRA CREDIT AT END OF EXAM)

1. (12 points) Indicate whether each of the following statements is true or false:

   T   F
A. __ __A salt with a negative enthalpy of solvation can lower the temperature of
           a solution when it dissolves.
B. __ __A C-C single bond is generally shorter than a C=C double bond.
C. __ __A compound with an odd number of electrons cannot satisfy the octet rule.
D. __ __The Born-Haber cycle allows estimation of the lattice energy of
           an ionic compound.
E. __ __Two hydrogen iodide molecules can engage in hydrogen bonding.
G. __ __Osmosis can take place when two solutions of different concentration in
           the same solute are separated by a membrane, assuming that the membrane
           is permeable to water but not the solute.
H. __ __A nonpolar molecule will usually be insoluble in water.
I. __ __In a hydrogen atom, the energy of the electron does not depend on the
           azimuthal quantum number l.
J. __ __An ionic solid will not conduct electricity.
K. __ __The face centered cubic lattice structure represents a close-packed
           structure.
L. __ __Electronegativity represents the amount of energy released when a neutral,
           isolated atom in the gas phase acquires an additional electron.
M. __ __A precipitation reaction involves the formation of an insoluble product.

2. (6 points) Draw Lewis structures for the following molecules and ions.
       A. (2 points) ICN (C is the central atom)

       B. (2 points) PO_4^{3-}

       C. (2 points) HCO_2H (1 H is bonded to an oxygen, 1 H is bonded to carbon,
           and both oxygens are bonded to carbon)

NAME_____

3. (8 points) Name each of these compounds, and <u>circle</u> all forces that would be present in a pure sample of this substance:

        A. CCl_4 NAME:

        FORCES: Ionic bonding   Ion-dipole interactions

                       Dispersion interactions   Dipole-dipole interactions

                       Hydrogen-bonding interactions

        B. $Fe_2(O_2)_3$ NAME:

        FORCES: Ionic bonding   Ion-dipole interactions

                       Dispersion interactions   Dipole-dipole interactions

                       Hydrogen-bonding interactions

4. (8 points) For each of the following molecules, give the name of the molecular geometry, give an approximate value for the specified angle (in degrees), and indicate whether the molecule has a permanent dipole. If an angle is a little smaller than some value, you must specify "greater than" or "less than" the closest angle you can name.

        A. KrF_2 MOLECULAR SHAPE:_____

                                  F-Kr-F BOND ANGLE:_____
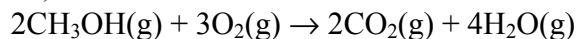
                                  PERMANENT DIPOLE? Y / N

        B. CH_2S MOLECULAR SHAPE:_____

                                    H-C-S BOND ANGLE:_____

                                  PERMANENT DIPOLE? Y / N

NAME_____

5. (13 points) Consider the reaction:

$$2CH_3OH(g) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(g)$$

A. (5 points) Use the following bond enthalpies to calculate the heat of reaction. As always, you must show your work to receive credit.

	Average bond enthalpy (kJ/mol)		Average bond enthalpy (kJ/mol)
C-H	413	C-C	348
C-O	358	C=O	799
O-O	146	O-H	463
O=O	495		

B. (5 points) Use the following heats of formation to calculate the heat of reaction. As always, you must show your work to receive credit.

	ΔH_f^o kJ/mol
$H_2O(g)$	-241.82
$CH_3OH(g)$	-201.2
$CO_2(g)$	-393.5

C. (3 points) State which value you believe should be more accurate, and explain why. No more than 4 sentences should be necessary. Do not mention significant figures in your answer.

NAME_____

6. (9 points) Consider a 0.750 molal solution of glucose (a nonvolatile compound, $C_6H_{12}O_6$) in water. Use the following information to answer the questions below.

Molal freezing point depression constant of water: 1.86°C/molal
Molal boiling point elevation constant of water: 0.51°C/molal
Vapor pressure of pure water at 25.0°C: 23.76 torr

      A. (3 points) What is the boiling point for this solution?

      B. (3 points) What is the freezing point for this solution?

      C. (3 points) What is the vapor pressure of this solution at 25.0°C?

7. (6 points) Use the following data to calculate the energy required to convert 10.0 g of liquid water at 100.0°C to steam at 115.0°C under a constant 1 atm pressure.
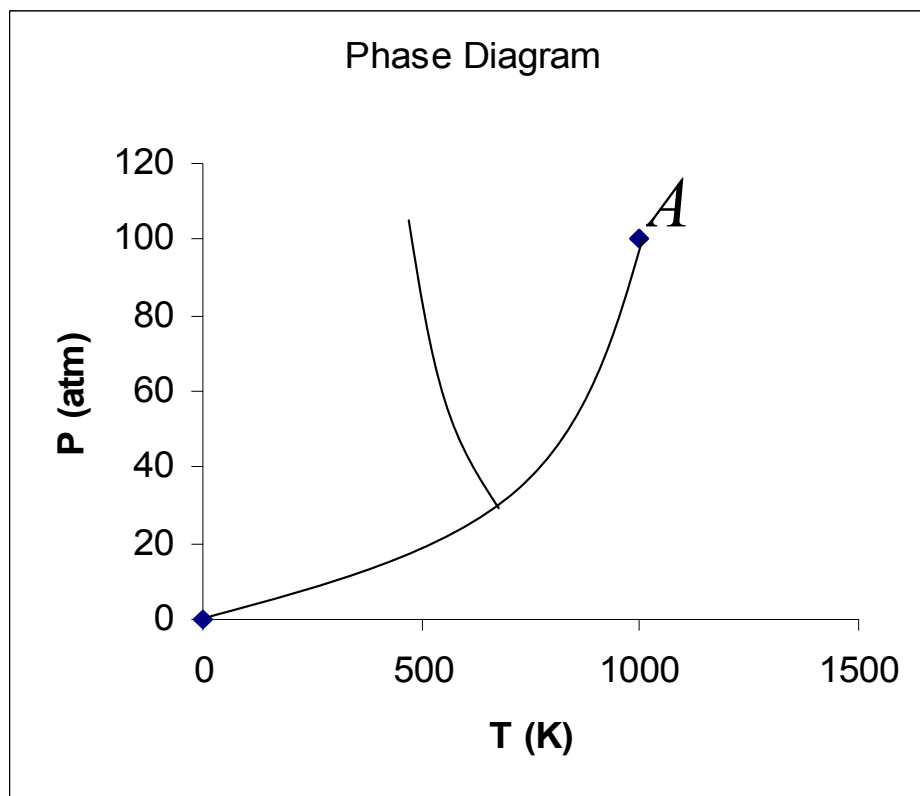Specific heat of liquid water: 4.184 J/(g K)
Specific heat of water vapor: 1.841 J/(g K)
Heat of vaporization for water: 40.67 kJ/mol

NAME_____

8. (6 points) Use the phase diagram below to answer the following questions:

Phase Diagram

A.(2 point) What is the name of the point labeled A? _____

B. (2 point) What states of matter are present at T=300 K and P=50 atm?

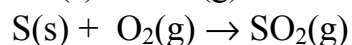C. (2 point) What phase transitions are possible at P=1 atmosphere?

9. (6 points) Consider the following reaction:
$$2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g)$$
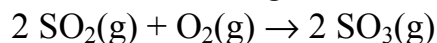
A. (4 points) Use the information below to calculate the heat of reaction
for the above reaction:

$2\ S(s) + 3\ O_2(g) \rightarrow 2\ SO_3(g)$ $\Delta H = -790$ kJ/mol
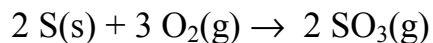
$S(s) + O_2(g) \rightarrow SO_2(g)$ $\Delta H = -297$ kJ/mol

B. (2 points) Use the result of part A to calculate the heat evolved or consumed
by the reaction of 1.0 g $SO_2(g)$ with excess oxygen. State in words
whether the heat is evolved or consumed.

NAME_____

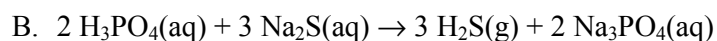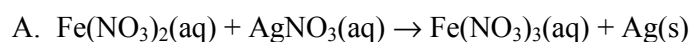10. (6 points) Balance each of the following equations. Write your answer on the lines, and specify "1" rather than leaving the space blank. <u>Blank spaces will be counted incorrect.</u>

    A. __$C_6H_{12}O_6(s)$ + __$O_2(g)$ → __$H_2O(g)$ + __$CO_2(g)$

    B. __$Fe_2O_3(s)$ + __$Al(s)$ → __$Fe(s)$ + __$Al_2O_3(s)$
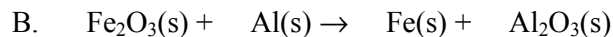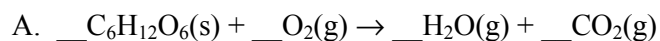
11. (6 points) Write the net ionic equation for each of the following reactions.

    A. $Fe(NO_3)_2(aq)$ + $AgNO_3(aq)$ → $Fe(NO_3)_3(aq)$ + $Ag(s)$

    B. $2 H_3PO_4(aq)$ + $3 Na_2S(aq)$ → $3 H_2S(g)$ + $2 Na_3PO_4(aq)$

12. (4 points) Give the values of the angles indicated below. If an angle is a little smaller than some value, you must specify "greater than" or "less than" the closest angle you can name.
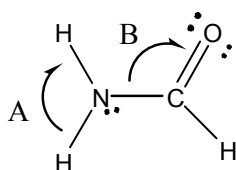
    Angle A (H-N-H):   Angle B (N-C-O):

13. (2 points) A primitive cubic lattice is taken to have 1 site per unit cell. How many lattice sites are assigned to a single unit cell of a body-centered cubic lattice, if the counting is done the same way?

14. (6 points) Write the electronic configuration of each of the following atoms or ions. You may use condensed notation.

    A. Co^{2+}:

    B. Ni:

    C. Si:

NAME_____

15. (6 points) Answer each of the following:

    A. Arrange the following atoms in order of <u>increasing</u> electronegativity:
        Si S O Na

    B. Arrange the following species in order of <u>increasing</u> radius:
        F O^{2-} Li

    C. Arrange the following species in order of <u>increasing</u> ionization potential (if an ion is specified, use the ionization potential of the ion, not the parent atom): F^- Ne Na^+

16. (3 points) You are conducting an experiment on the photoelectric effect, and observe that, at a certain frequency and intensity of light, no current flows. According to <u>classical</u> physics, what should you do to make current flow between the electrodes? Answer in no more than 3 sentences.

17. (6 points) A sample of gas occupies a volume of 200.0 mL at 50.0°C and 3.0 atm. What will its volume be at 30.0°C and 1.0 atm?

NAME_____

18. (6 points) The radio station 92.1 FM broadcasts at a frequency of 9.21×10^7 Hz (92.1 MHz). Calculate the wavelength of the broadcast, and the energy of one photon.

19. (4 points) Write the products of the following reactions. If no reaction takes place, indicate "N.R."
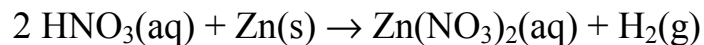
    A. $Ag(s) + AuNO_3(aq) \rightarrow$

    B. $HNO_3(aq) + NaHCO_3(aq) \rightarrow$
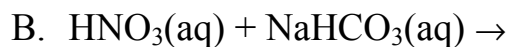
20. (3 points) Give the number of protons, neutrons and electrons in $^{24}_{12}Mg^{2+}$:

    Protons: Neutrons: Electrons:

NAME:_____

21. (6 points) What volume of 0.250 M HNO_3(aq) is required to completely react with 10.0 g of zinc metal according to the equation:

$$2\ HNO_3(aq) + Zn(s) \rightarrow Zn(NO_3)_2(aq) + H_2(g)$$

22. (6 points) A chemist wants to know the concentration of a solution of H_2SO_4 in water. She performs a titration against a 0.1005 M solution of sodium hydroxide. It is found that 37.35 mL of the NaOH solution are required to neutralize a 10.00 mL sample of the acid. What is the concentration of the acid?

NAME_____

23. (6 points) Sodium azide, $NaN_3(s)$, reacts with chlorine gas according to the equation:

$$2 \; NaN_3(s) + Cl_2(g) \rightarrow 2 \; NaCl(s) + 3 \; N_2(g)$$
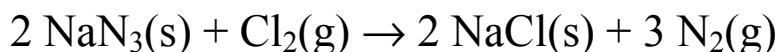
If 50.0 g of $NaN_3(s)$ is placed in a 125.0 L tank pressurized with 4.00×10^2 torr of $Cl_2(g)$ at 25.0°C, calculate the <u>partial pressure of nitrogen and chlorine</u> after the reaction goes to completion and <u>calculate the total pressure</u> in the tank. Assume that chlorine is the only gas is present in the tank before the start of the reaction, that the temperature remains constant during reaction, and that the volume of the solid materials may be neglected.

NAME_____

24. (6 points) Chlorine gas is hazardous to human health. The U.S. Office of Occupational Safety and Health Administration (OSHA) sets the maximum safe level of chlorine gas in air at 1 ppm.

A researcher stores a 25 mL vial of $Cl_2(g)$ at 2 atm of pressure in a room that measures 4.0 m x 3.0 m x 3.0 m. Both the room and the vial are kept at 25.0^oC. In a "worst case" scenario, the vial breaks and releases the gas, and a lack of ventilation keeps the gas confined to the room. If the density of air is 0.00118 g/cm^3, estimate the concentration of Cl_2 in the air, and state whether this worst case scenario would violate OSHA regulations. (Note: Whether it would or would not, hazardous gases should always be stored under safe, well-ventilated conditions.)

EXTRA CREDIT:
(1 point): Supercritical CO_2 (CO_2 that has been heated past its critical point) is sometimes used as a solvent. Is it a polar or a nonpolar solvent?

(1 point): Name the inventor of dynamite:

DON'T FORGET: As indicated in the syllabus, there is assigned reading for Chem 2 that you must do BEFORE the first class.

CONGRATULATIONS ON FINISHING CHEM 1, AND HAVE A GOOD SUMMER!