CHEM 200/202 Final Exam (A) December 13, 2014

CHEM _____ Lab Section Number: _____

Name (printed):_____
(Last) (First)

Signature:_____

This exam consists of 32 questions at 5 points each for a total of 160 points. Make sure that your test has all of the pages. *Please read each problem carefully*. There are no intentionally misleading questions; each problem should be taken at its face value. Please mark your answers ***on the Scantron sheet*** provided to you ***and on the actual exam***.

You will be given a periodic table and an exam information sheet to use during the exam. You may remove it from the exam make it more accessible. You may also use the designated Casio fx-300ms-plus calculator or equivalent non-programmable non-graphing scientific calculator during the exam. Use the back pages of the test as scratch paper. You are not allowed to use any devices capable of accessing the internet, textbooks, notes, or homemade reference sheets during the exam.

You may leave if you finish the exam early. Give the exam and the information sheet to your TA and leave quietly without disturbing other students. Before leaving, check that all your answers have been properly entered on the Scantron sheet and the exam and that your name is written on every page of the exam and on the Scantron sheet.

All cell phones and electronic devices must be turned off and put away. Please remove all hats and caps. Place your books and all papers out of sight under your seat. If the TA believes that you might be looking at your neighbor's paper, you will be asked to move to a new location.

Exam scores will be posted on Blackboard as soon as the grading is complete. Your test will be returned to you in the first lab meeting of next week. If you have any questions regarding the grading of your exam, please notify your TA.

The time available for the exam is 120 minutes. **Good luck!**

Name: _____ Lab Section #: _____

Please mark your answers on the scantron sheet using a #2 pencil and also mark your answers on the exam itself.

Mark Test From "A" on your scantron.

1. Which of the following is the correct formula for iron(II) nitrate?
   a) $Ir_2(NO_3)_2$
   b) $Fe(NO_3)_2$
   c) $Fe_2(NO_3)$
   d) $Fe_2(NO_3)_2$
   e) $[FeNO_3]^{2+}$

2. Which of the following is the correct name for the formula, Li_2SO_4?
   a) Lithium Sulfate
   b) Lithium Sulfide
   c) Lithium Sulfite
   d) Lithium di-Sulfide
   e) di-Lithium Sulfanade

3. Balance the equation below by inserting the following coefficients (in order presented).
   ___$Cu(NO_3)_2(aq)$ + ___$KOH(aq)$ → ___$Cu(OH)_2(s)$ + ___$KNO_3(aq)$
   a) 2, 2, 1, 2
   b) 1, 2, 1, 2
   c) 1, 1, 1, 2
   d) 1, 2, 2, 1
   e) 1, 2, 0, 1

4. Chromium(III) oxide reacts with hydrogen sulfide (H_2S) gas to form chromium(III) sulfide and water. Given an excess of $H_2S(g)$, determine how many moles of Cr_2O_3 were used in the reaction if 378 g of $Cr_2S_3(s)$ was produced and the reaction had an 80.0% yield.
   $$Cr_2O_3(s) + 3H_2S(g) \rightarrow Cr_2S_3(s) + 3H_2O(l)$$
   a) 1.51 mol
   b) 1.89 mol
   c) 2.36 mol
   d) 2.03 mol
   e) 7.05 mol

5. How many grams of NaH_2PO_4 are needed to react with 43.74 mL of 0.285 M NaOH?
   $$NaH_2PO_4(s) + 2NaOH(aq) \rightarrow Na_3PO_4(aq) + 2H_2O(l)$$
   a) 0.748 g
   b) 1.496 g
   c) 0.720 g
   d) 0.677 g
   e) 1.321 g

6. Identify the oxidizing and reducing agents in the following:

$$Sn(s) + 2H^+(aq) \rightarrow Sn^{2+}(aq) + H_2(g)$$

   a) Ox: Sn(*s*); Red: $H_2(g)$
   b) Ox: $H^+(aq)$; Red: Sn(*s*)
   c) Ox: $Sn^{2+}(aq)$; Red: $H^+(aq)$
   d) Ox: $H_2(g)$; Red: $Sn^{2+}(aq)$
   e) The oxidizing agent cannot be determined.

7. A sample of methane (CH_4) is placed in a 10.0 L container at 25.0°C and 725 torr. The gas sample is then moved to a 7.50 L container at 25.0°C. What is the gas pressure in the second container?
   a) 1.19 atm
   b) 0.723 atm
   c) 797 torr
   d) 967 torr
   e) 544 torr

8. The density of a noble gas is 2.71 g/L at 3.00 atm and 0°C. Identify the gas.
   a) He
   b) Ar
   c) I
   d) Kr
   e) Ne

9. A 2.00 L sample of an unknown gas effuses from a container in 11.1 minutes. An equal volume of H_2*(g)* in the same apparatus under the same conditions effuses in 2.42 minutes. What is the molar mass of the unknown gas?
   a) 84.2 g/mol
   b) 0.19 g/mol
   c) 42.4 g/mol
   d) 10.4 g/mol
   e) 24.8 g/mol

10. A calorimeter is filled with 28.3 g of radiator coolant, ethylene glycol ($HOCH_2CH_2OH$) at 20.1°C. A 15.2 g block of aluminum at 86.2°C is placed into the calorimeter. Assuming the heat capacity of the calorimeter is negligible, what will be the final temperature for the coolant liquid and aluminum block? (*c* of ethylene glycol = 2.42 J/g•K, *c* of aluminum = 0.900 J/g•K)
    a) -184°C
    b) 31.1°C
    c) 3.48°C
    d) 59.2°C
    e) 24.8°C

11. You desire to use a laser to break O-H bonds on molecules. An O-H bond has a bond energy of 467 kJ/mol. Listed below are some lasers, *which is the least expensive laser*, that provides enough energy to be able to break O-H bonds?
    a) 157 nm ($35,000)
    b) 250 nm ($10,000)
    c) 405 nm ($5,000)
    d) 488 nm ($2,500)
    e) None of these lasers have enough energy.

12. A hydrogen atom has its electron in the excited, n = 3, energy level. When the electron falls from the excited level to the ground level the atom emits a photon of light. What is the wavelength of the emitted photon?
    a) 3282 nm
    b) 97.56 nm
    c) 820.6 nm
    d) 136.8 nm
    e) 102.6 nm

13. Select the correct electron configuration for Te ($Z = 52$).
    a) [Kr]$5s^2 5p^6 4d^8$
    b) [Kr]$5s^2 5d^{10} 5p^4$
    c) [Kr]$5s^2 4d^{10} 5p^6$
    d) [Kr]$5s^2 4f^{14}$
    e) [Kr]$5s^2 4d^{10} 5p^4$

14. When comparing the successive ionization energies of an element, an unusually big increase in ionization energy is seen when
    a) the first valence electron is removed.
    b) the second valence electron is removed.
    c) the eighth electron is removed.
    d) the first core electron is removed.
    e) the last valence electron is removed.

15. What is the correct order of decreasing size of the following ions?
    a) $P^{3-} > Cl^- > K^+ > Ca^{2+}$
    b) $Ca^{2+} > K^+ > Cl^- > P^{3-}$
    c) $K^+ > Cl^- > Ca^{2+} > P^{3-}$
    d) $K^+ > Cl^- > P^{3-} > Ca^{2+}$
    e) None of these choices is correct.

16. What differentiates a network covalent solid (e.g. diamond) from a normal covalent solid (e.g. graphite)?
    a) The intermolecular forces in a network covalent solid consist only of hydrogen bonds.
    b) A network covalent solid consists of covalent bonds between all atoms throughout the entire solid.
    c) Network covalent solids have lower melting points than comparable covalent solids.
    d) The strength of both covalent solids and network covalent solids are equivalent.
    e) All the above statements are true.

17. Determine the enthalpy of reaction ($\Delta H°_{rxn}$) for the reaction below:

$$2\ N{\equiv}O(g) + Cl_2(g) \rightarrow 2\ O{=}N{-}Cl(g)$$

Bond Energy	N-O	N=O	N≡O	Cl-Cl	N-Cl	O-Cl	O=O
$\Delta H°$ (kJ/mol)	201	607	631	243	200	203	498

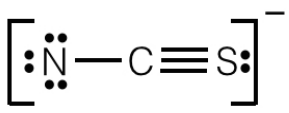
    a) -109 kJ
    b) 67 kJ
    c) -740 kJ
    d) 134 kJ
    e) -43 kJ

18. Of the bonds listed below, which is the most polar bond?
    a) Al-B
    b) Al-C
    c) Al-N
    d) Al-Sb
    e) Al-Si

19. Which statement below best describes the electronegativity of an atom?
    a) It is the magnitude of the negative charge of an anion.
    b) It is the energy required to remove an electron from an atom.
    c) It is the relative ease with which an atom can become polarized.
    d) It is the relative ability for a bonded atom to attract shared electrons
    e) It is a measure of the delocalization of the electron cloud around an individual atom.

20. Which statement below best describes the location of the electrons involved in metallic bonding?
    a) The electrons are delocalized evenly, everywhere, between all the atoms in the substance.
    b) The electrons have a higher probability of being found directly between adjacent nuclei.
    c) The electrons form a straight line bridging the adjacent nuclei.
    d) The electrons are removed from one atom and found exclusive around the adjacent atom.
    e) The electrons are on the far sides of the nuclei, which touch to form a covalent bond.

21. Thiocyanate has three resonance structures, below is the form which *contributes the least* to the resonance hybrid. What is the formal charge of the nitrogen in the resonance form below?
    a) -3
    b) -2
    c) 0
    d) +1
    e) +3

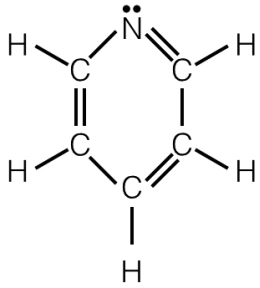


22. Which of the molecules listed below is polar?
    a) CO_2
    b) NH_3
    c) CF_4
    d) SO_4^{2-}
    e) C_2H_2

23. Which of the following molecules does not have a tetrahedral *electron group arrangement*?
    a) PF_3
    b) NH_4^+
    c) SO_4^{2-}
    d) IF_4^+
    e) H_2O

24. What is the *molecular shape* of a molecule of BrF_5?
    a) Octahedral
    b) Trigonal bipyramidal
    c) Seesaw
    d) Square planar
    e) Square pyramidal

25. Pyridine (C_5H_5N) is widely used as a starting chemical for the synthesis of many pharmaceutical compounds; its structure can be seen to the right. What is the hybridization of both the carbon and nitrogen atoms in the pyridine molecule?
    a) Carbons: sp^2 Nitrogen: sp^2
    b) Carbons: sp^3 Nitrogen: sp^2
    c) Carbons: sp Nitrogen: sp^3
    d) Carbons: sp Nitrogen: sp
    e) Carbons: sp^2 Nitrogen: sp



26. Determine the change in enthalpy when 33.83 g of pure H_2O is cooled from 117°C to 32.4°C.
    a) -19.9 kJ
    b) -5.26 kJ
    c) -8.52 kJ
    d) -85.0 kJ
    e) -96.3 kJ

	kJ/mol
$\Delta H°_{fus}$	6.07
$\Delta H°_{vap}$	40.7

	J/mol•°C
$C_{H20(g)}$	33.1
$C_{H20(l)}$	75.4
$C_{H20(s)}$	37.6

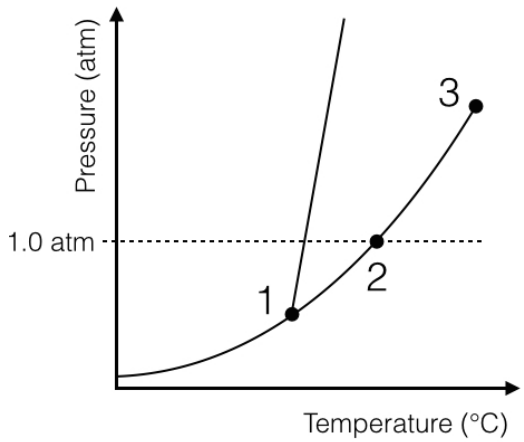
27. Water boils more easily (at lower temperatures) at higher altitudes than it does at sea level. Which factor below best explains why this happens?
    a) This is a colligative property of water.
    b) Temperatures cannot be properly measured at higher altitudes.
    c) The vapor pressure of water increases at higher altitudes.
    d) There is a lower atmospheric pressure at higher altitudes.
    e) The liquid water and water vapor are in a dynamic equilibrium.

28. Below are a list of substances which can be dissolved in water. Which substance is *not* properly matched with the *principle intermolecular interaction* that it would have with water molecules in the solution?
    a) Fe^{2+}: Ion-induced dipole
    b) Cl_2: Dipole-induced dipole
    c) CH_3OH: Hydrogen bonding
    d) HCl: Dipole-dipole
    e) CH_4: Dispersion

29. Polonium (Po) is one of the few elements that adopts a *simple cubic unit cell* geometry for its crystal structure. If the density of the polonium crystal is 9.20 g/cm^3 what is the atomic radius of a polonium atom?
    a) 670 pm
    b) 335 pm
    c) 118 pm
    d) 145 pm
    e) 167 pm

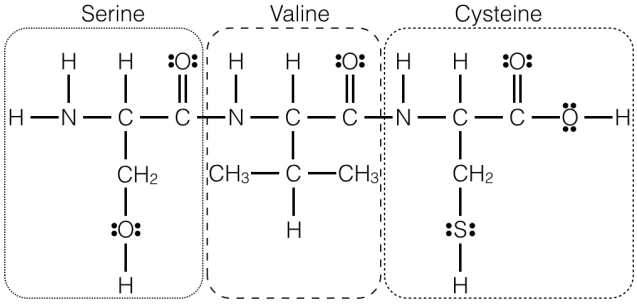
30. Which is the correct arrangement (from fewest to most) for the relative number of atoms per unit cell for the simple cubic (SC), face-centered cubic (FCC), and body-centered cubic (BCC) unit cells?
    a) SC < BCC < FCC
    b) SC < FCC < BCC
    c) BCC < SC < FCC
    d) SC = BCC < FCC
    e) BCC < FCC = SC

31. For the phase diagram to the right, which option below has the correct assignments for the points 1, 2, and 3?
    a) 1: boiling point at 1 atm; 2: melting point at 1 atm; 3: critical point
    b) 1: vapor point; 2: critical point; 3: melting point at 10 atm
    c) 1: triple point; 2: melting point at 1 atm; 3: critical point
    d) 1: boiling point at 1 atm; 2: critical point; 3: triple point
    e) 1: critical point; 2: boiling point at 1 atm; 3: triple point



32. Which liquid will have the *lowest* surface tension?
    a) Hexane ($CH_3(CH_2)_4CH_3$)
    b) Formaldehyde (CH_2O)
    c) Liquid nitrogen (N_2)
    d) Liquid gallium (Ga)
    e) Water (H_2O)

33. The figure below represents a molecule made of three amino acids (indicated by boxes). Which of the amino acids would be the most likely to interact with the nonpolar tail of a phospholipid (e.g. be embedded in the interior of a cell membrane)?



    a) Serine only.
    b) Valine only.
    c) Cysteine only.
    d) Both serine and cysteine.
    e) Both valine and cysteine.

34. When considering the heats of solution, which individual step in the process is <u>*always*</u> exothermic?
    a) ΔH_{solute}: the separation of solute molecules from each other.
    b) $\Delta H_{solvent}$: the separation of solvent molecules from each other.
    c) ΔH_{mix}: the mixing of solute molecules with solvent molecules to form a solution.
    d) Both ΔH_{solute} and $\Delta H_{solvent}$ are exothermic.
    e) All steps in the process are exothermic.

35. There are four colligative properties whose magnitudes are directly influenced by the number of particles in the solution. Which of the items listed below is not a colligative property?
    a) Reduced viscosity.
    b) Boiling point elevation.
    c) Osmotic pressure.
    d) Lowered vapor pressure.
    e) Freezing point depression.

36. How many grams of NaCl must you add to 225 g of pure water to increase its boiling point to 102°C? Water's boiling point elevation constant (K_b) is 0.512 °C/*m*.
    a) You cannot increase boiling points by adding NaCl to water.
    b) 44.8 g
    c) 0.879 g
    d) 51.4 g
    e) 4.45 g

Solubility Rules

Soluble Ionic Compounds	
Solubility Rules:	**Exceptions:**
All compounds of Group 1A (1) ions Li^+, Na^+, K^+, etc, and ammonium ion NH_4^+ are soluble	
All common nitrates (NO_3^-) are soluble All common acetates (CH_3COO^-) are soluble Most perchlorates (ClO_4^-) are soluble	
All common chlorides (Cl^-) are soluble All common bromides (Br^-) are soluble All common iodides (I^-) are soluble	Ag^+, Pb^{2+}, Cu^+, Hg_2^{2+}
All common sulfates (SO_4^{2-}) are soluble	Ca^{2+}, Sr^{2+}, Ba^{2+}, Ag^+, Pb^{2+}
Insoluble Ionic Compounds	
Insolubility Rules:	**Exceptions:**
All common metal hydroxides (OH^-) are insoluble	Group 1A (1) ions - Li^+, Na^+, K^+, Rb^+ , etc The larger Group 2A (2) ions beginning with Ca^{2+}
All common carbonates (CO_3^{2-}) are insoluble All common phosphates (PO_4^{3-}) are insoluble	Group 1A (1) ions NH_4^+ ammonium ion
All common sulfides (S^{2-}) are insoluble	Group 1A (1) ions Group 2A (2) ions

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CHEM 200 Exam/Quiz Information Sheet – Fall 2013

Physical Quantities

atomic mass unit (amu) = 1.66056×10^{-27} kg

Avogadro's number = 6.022×10^{23}

universal gas constant (R) = 8.314 J/K·mol = 0.08206 L·atm/K·mol

absolute zero = -273.15 °C = 0 K

specific heat capacity of water ($c$$H_2O$) = 4.184 J/g·K

speed of light (c) = 3.000×10^8 m/s

Planck's constant (h) = 6.626×10^{-34} J·s

Conversion Factors

1 angstrom (Å) = 10^{-10} m

1 atm = 1.01325×10^5 Pa = 1.01325 bar = 760 Torr

1 calorie = 4.184 J

1 joule = 1 kg·m^2/s^2

Equations

$PV = nRT$

$P_A = X_A \cdot P_{total}$

$$d = \frac{(\text{molar mass}) \times P}{RT}$$

$$u_{rms} = \sqrt{\frac{3RT}{\text{molar mass}}}$$

$\Delta E = q + w$

$\Delta H_{rxn} = \Sigma \Delta H°_f(\text{products}) - \Sigma \Delta H°_f(\text{reactants})$

heat capacity = $q/\Delta T$

specific heat capacity (c) = $q/(\text{mass} \times \Delta T)$

speed of light (c) = $\nu \times \lambda$

$$E_{photon} = h\nu = \frac{hc}{\lambda}$$

$$E_{electron} = -2.18 \times 10^{-18} \text{ J} \left(\frac{Z^2}{n^2}\right)$$

$$\lambda = \frac{h}{mu}$$

$$\frac{1}{\lambda} = 1.096776 \times 10^7 \text{ m}^{-1} \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right), \text{ where } n_2 > n_1$$

Periodic Table of the Elements

	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.008																		2 He 4.003
2	3 Li 6.941	4 Be 9.012												5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31												13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08		21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62		39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc [98]	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	48 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57-70 *	71 Lu 175.0	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po [209]	85 At [210]	86 Rn [220]
7	87 Fr [223]	88 Ra [226]	89-102 **	103 Lr [262]	104 Rf [261]	105 Db [262]	106 Sg [266]	107 Bh [264]	108 Hs [277]	109 Mt [268]									

Metals | Non Metals

* Lanthanoids	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm [145]	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0
** Actinoids	89 Ac [227]	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]