 Name: _____

Chem 111 10:10a section Final Exam

This exam is composed of 50 questions. Go initially through the exam and answer the questions you can answer *quickly*. Then go back and try the ones that are more challenging to you and/or that require calculations. Periodic table, solubility rules, and valuable constants are on the last page of the exam. Feel free to tear it off.

As discussed on the course syllabus, honesty and integrity are absolute essentials for this class. In fairness to others, dishonest behavior will be dealt with to the full extent of University regulations.

1. The average molecular speed in a sample of N_2 gas is 478 m/s at 303 K.
   The average molecular speed in a sample of CO_2 gas at the same temperature is:
   1) 304 m s^{-1} 2) 381 m s^{-1} 3) 478 m s^{-1} 4) 326 m s^{-1} 5) 600 m s^{-1}

2. A 1.28 mol sample of Ar gas is confined in a 31.5 liter container at 26.5 °C. If 1.28 mol of F_2 gas is added while doubling the volume and keeping the temperature constant, the average kinetic energy per molecule will:
   1) decrease 2) remain the same 3) increase
   4) not enough information 5) I don't have a clue

3. A sample of Cl_2 gas is confined in a 2.0 liter container at 50 °C. Then 2.5 mol of He is added, holding both the volume and temperature constant. The pressure will increase because:
   1) As the number of molecule-wall collisions increases, the force per collision increases.
   2) With more molecules per unit volume, the molecules hit the walls of the container more often.
   3) With more molecules in the container, the molecules have higher average speeds.
   4) With higher average speeds, on average the molecules hit the walls of the container with more force.
   5) None of the Above

 Name: _____

4. A 1.96 mol sample of CO_2 gas is confined in a 49.1 liter container at 32.3 °C. If the temperature of the gas sample is increased to 55.0 °C, holding the volume constant, the **pressure will increase** because:

   1) With higher average speeds, on average the molecules hit the walls of the container with more force.
   2) With lower average speeds, the molecules hit the walls of the container less often.
   3) As the average speed increases, the number of molecule-wall collisions decreases.
   4) None of the above

5. In our bodies, sugar is broken down with oxygen to produce water and carbon dioxide. How many moles of glucose ($C_6H_{12}O_6$) are required to react completely with 42.8 L of oxygen gas (O_2) according to the following reaction at 0 °C and 1 atm pressure? Note that the reaction may need balancing.

$$C_6H_{12}O_6\ (s) + O_2\ (g) \rightarrow CO_2\ (g) + H_2O\ (l)$$

   1) 6.0 mol 2) 0.250 mol 3) 0.319 mol 4) 0.637 mol 5) 7.13 mol

6. What is the total volume of gaseous products formed when 190 L of bromine trifluoride (BrF_3) react completely to form Br_2 and F_2? (All gases are at the same temperature and pressure, before and after.)

   1) 85 L 2) 190 L 3) 380 L 4) 320 L 5) 160 L

7. The temperature of the atmosphere on Mars can be as high as 27 °C at the equator at noon, and the atmospheric pressure is about 8.0 mm of Hg. If a spacecraft could collect 10.0 m^3 of this atmosphere, compress it to a small volume, and send it back to earth, about how many moles would the sample contain?

   1) 4.3 mol 2) 97 mol 3) 54 mol 4) 0.13 mol 5) 1.2 mol

 Name: _____

8. HNO_3 is (a table on page 1 provides a clue):

   1) a strong base 2) a weak base 3) a strong acid
   4) a weak acid 5) none of the above

9. The concentration of H^+ in table wine (pH 3.4) is:

   1) 3.40×10^{9} M 2) 3.40×10^{-9} M 3) 3.98×10^{4} M
   4) 3.98×10^{-4} M 5) 1.00×10^{-7} M

10. Reactions in water that produce gases tend to be:

    1) unfavorable 2) favorable 3) ugly
    4) endothermic 5) exothermic

11. Mixing $\mathbf{Na_2S}$ with $\mathbf{NH_4Cl}$ in water leads to precipitation of:

    1) a S^{2-} salt 2) a Na^+ salt 3) a Cl^- salt
    4) everything precipitates 5) no precipitation

12. You need to make an aqueous solution of 0.131 M ammonium sulfide for an experiment in lab, using a 250 mL volumetric flask. How much solid ammonium sulfide should you add?

    1) 2.23 g 2) 3.15 g 3) 1.24 g 4) 2.74 g 5) 9.11 g

13. Which of the following describes the compound $\mathbf{Ba(NO_3)_2}$?

    1) If the compound dissolved in water it would not conduct electricity.
    2) The compound is ionic.
    3) If the compound dissolved in water it would be a non-electrolyte.
    4) The compound is molecular.
    5) Both (1) and (2)

 Name: _____

14. Which reaction below is a redox reaction?

1) $NaOH\ (aq) + HNO_3\ (aq) \rightarrow NaNO_3\ (aq) + H_2O\ (l)$

2) $Na_2CO_3\ (aq) + 2\ HClO_4\ (aq) \rightarrow CO_2\ (g) + H_2O\ (l) + 2NaClO_4$

3) $CdCl_2\ (aq) + Na_2S\ (aq) \rightarrow CdS\ (s) + 2\ NaCl\ (aq)$

4) $Zn(OH)_2\ (s) + H_2SO_4\ (aq) \rightarrow ZnSO_4\ (aq) + 2\ H_2O\ (l)$

5) None of the above

15. The net ionic equation for the reaction of zinc sulfate and sodium hydroxide is:

1) $Zn^{2+}\ (aq) + 2\ OH^-\ (aq) \rightarrow Zn(OH)_2\ (s) + Na_2SO_4\ (aq)$

2) $ZnSO_4\ (aq) + 2\ NaOH\ (aq) \rightarrow Zn(OH)_2\ (aq) + Na_2SO_4\ (aq)$

3) $Zn^{2+}\ (aq) + 2\ OH^-\ (aq) \rightarrow Zn(OH)_2\ (aq)$

4) $Zn^{2+}\ (aq) + 2\ OH^-\ (aq) \rightarrow Zn(OH)_2\ (s)$

5) No *net* reaction occurs

16. In an exothermic process:

1) work is performed on the surroundings
2) heat is transferred to the surroundings
3) work is performed on the system
4) heat is transferred to the system

17. Change in internal energy is best described as:

1) ΔH 2) q 3) w 4) q+w 5) ΔG

18. A positive value of ΔE means that:

1. heat is tranferred to the surroundings
2. heat is transfered to the system
3. energy in the form of heat and/or work is transferred to the surroundings
4. energy in the form of heat and/or work is transferred to the system

 Name: _____

19. An automobile engine generates **2160** Joules of heat that must be carried away by the cooling system. The internal energy changes by **–2758** Joules in this process.

    How much work to push the pistons is available in this process ?

    1) 4918 J 2) 598 J 3) 2758 J 4) 2160 J 5) 4320 J

20. Given the standard molar enthalpies of formation shown at right, determine ΔH for the reaction:

Subst	ΔH_f° (kJ/mol)
C_3H_8 (g)	-104.70
CO_2 (g)	-393.51
H_20 (g)	-241.83
H_20 (l)	-285.83

C_3H_8 (g) + 5 O_2 → 3 CO_2 (g) + 4 H_20 (g)

1) –530.6 kJ mol^{-1} 2) +530.6 kJ mol^{-1}

3) –2043 kJ mol^{-1} 4) +2043 kJ mol^{-1}

5) not enough information to determine

21. Given the information above, what is the heat required to vaporize water at 298 K?

    1) –40.65 kJ mol^{-1} 2) 40.65 kJ mol^{-1} 3) 44.00 kJ mol^{-1}

    4) –44.00 kJ mol^{-1} 5) not enough information to determine

 Name: _____

22. A 45.5 g sample of copper at 99.8 °C is dropped into a beaker containing 152 g of water at 18.5 °C. When thermal equilibrium is reached, what is the final temperature of the copper? The specific heat capacities of water and copper are 4.184 and 0.385 J g^{-1} K^{-1}, respectively.

1) 25.3 °C 2) 12.5 °C 3) 37.0 °C 4) 90.1 °C 5) 20.7 °C

23. Given the following information:

N_2 (g) + $2O_2$ (g) → N_2O_4 (g) $\Delta H° = 9.2$ kJ

$2N_2O$ (g) → $2N_2$ (g) + O_2 (g) $\Delta H° = -164.2$ kJ

what is the standard enthalpy change for the reaction:

$2N_2O$(g) + $3O_2$ (g) → $2N_2O_4$ (g) $\Delta H° = ?$

1) –155 kJ mol^{-1} 2) –146 kJ mol^{-1} 3) 155 kJ mol^{-1}

4) 146 kJ mol^{-1} 5) not enough information to determine

24. Which of the following has the weakest bond?

1) HF 2) HCl 3) HBr 4) HI

25. Being careful to consider molecular orbital theory (or at least valence bond theory), which of the following has the shortest bond length?

1) B_2 2) C_2 3) N_2 4) O_2 5) F_2

 Name: _____

26. The central CO bond in the molecule $CH_3–CO–CH_3$ is best described as a:

1) single bond
2) double bond
3) triple bond
4) ionic bond
5) the molecule doesn't exist

27. Draw the Lewis structure for **CO^{2-}**. What is the bond order of the CO bond?

1) single 2) double 3) triple

28. Draw the Lewis structure for **$XeOF_4$** (Xe is the central atom). What is the hybridization on **Xe**?

1) sp^3d^3 2) sp^3d^2 3) sp^3d 4) sp^3 5) sp^2

29. The molecule **$XeOF_4$** is:

1) polar 2) nonpolar 3) can't tell

30. A molecule has sp^3d^2 hybridization with one lone pair. The **electron pair geometry** of this molecule is:

1) tetrahedral 2) octahedral 3) linear
4) square pyramidal 5) trigonal bipyramidal

 Name: _____

31. Using molecular orbital theory, what is the bond order in the anion $\mathbf{F_2^-}$?

1) 0.5 2) 1.0 3) 1.5 4) 2 5) 0

32. Consider the unbalanced equation:

$S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + I^-(aq)$

In the balanced equation, the coefficient in front of $S_2O_3^{2-}(aq)$ is:

1) 1 2) 2 3) 3 4) 4 5) 6

33. Considering that same reaction

$S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + I^-(aq)$

An oxidizing agent in this reaction is:

1) $S_2O_3^{2-}$ 2) I_2 3) neither

34. Which radiation below has the shortest wavelength?

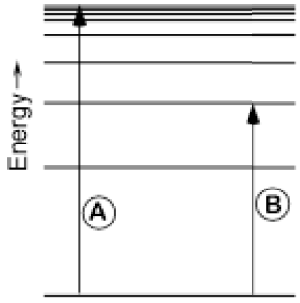
1) blue light (6.8×10^{14} Hz)
2) green light (6.0×10^{14} Hz)
3) red light (4.5×10^{14} Hz)
4) microwaves (2.4×10^{9} Hz)
5) x-rays (5.0×10^{18} Hz)

 Name: _____

35. What is the wavelength of visible light with frequency 5.00×10^{14} Hz?

1) 600 nm 2) 300 nm 3) 500 nm 4) 162 nm 5) 280 nm

36. Consider the diagram at right. The transition labeled A is ***best*** described as :



1) emission 2) absorption
3) ionization 4) electron capture

37. The principle quantum number n specifies:

1) orbital orientation 2) subshell orbital shape
3) transition probability 4) orbital karma
5) energy and distance from nucleus

38. The correct spectroscopic notation for the sulfur ion S^{2-} is:

1) $1s^2 2s^2 2p^6 3s^2 3p^2$ 2) $1s^2 2s^2 2p^6 3s^2 3p^3$
3) $1s^2 2s^2 2p^6 3s^2 3p^4$ 4) $1s^2 2s^2 2p^6 3s^2 3p^5$
5) $1s^2 2s^2 2p^6 3s^2 3p^6$

39. Which of the following elements has the greatest difference between the first and second ionization energies?

1) Na 2) Si 3) P 4) Mg 5) Cl

40. Which list below is in order of increasing electron affinity?

1) Si < P < S < Cl 2) Ne < F < O < N
3) F < Cl < Br < I 4) Be < Mg < Ca < Sr
5) none of the above

 Name: _____

41. Which list below is in order of increasing ionization energy?

1) Cl < S < P < Si
2) Ne < F < O < N
3) F < Cl < Br < I
4) Sr < Ca < Mg < Be
5) none of the above

42. Which molecule below does not exist?

1) BeF_2 2) CaF_3 3) MgO 4) KCl 5) $BeCl_2$

43. The molecule HF can be thought of as having both ionic and covalent character. Given that statement, which of the following is likely to best describe the charge on each atom?

	H	**F**
1)	+1.0	–1.0
2)	+0.7	–0.7
3)	0.0	0.0
4)	-0.7	+0.7
5)	-1.0	+1.0

44. What is the most common charge of ions formed from **Sr**?

1) +1 2) +2 3) -1 4) -2 5) -3

45. What is the formula of the compound formed between the ions $\mathbf{Co^{3+}}$ and $\mathbf{O^{2-}}$?

1) CoO 2) Co_2O 3) Co_2O_3 4) Co_3O_2 5) CoO_2

46. What is the molar mass of **nitrogen dioxide**?

1) 62 g/mol 2) 32 g/mol 3) 44 g/mol 4) 16 g/mol 5) 46 g/mol

 Name: _____

47. A sample of citric acid, $\mathbf{C_6H_8O_7}$, contains 0.153 mol of the compound. What is the mass of this sample, in grams?

1) 3.02 g 2) 13.7 g 3) 29.4 g 4) 0.0730 g 5) 20.2 g

48. What is the (mass) percent composition of **H** in citric acid, $\mathbf{C_6H_8O_7}$?

1) 6.87% 2) 4.20% 3) 38.1% 4) 30.6% 5) 6.00%

49. Ethylene glycol, $C_2H_6O_2$, is an ingredient in automobile antifreeze. Its density is 1.11 g/cm^3 at 20°C. If you need exactly 1000 mL of ethylene glycol, what mass of the compound, in grams, is required?

1) 901 g 2) 90.1 g 3) 111g 4) 1110 g 5) 1000 g

50. The correct designator for this course is:

1) Econ 3.33 2) Chem 363 3) Chem 111 4) Sports 1 5) SOM 555

 Name: _____

$PV = nRT$ $\quad K.E. = \frac{1}{2}mu^2$ $\quad E = h\nu = \frac{hc}{\lambda}$

$1\ mL = 1\ cm^3$

$1\ atm = 760\ mm\ Hg$

$\Delta H_{vap}(H_2O) = 40.65\ kJ\ mol^{-1}$

$\Delta H_{fus}(H_2O) = 6.00\ kJ\ mol^{-1}$

$\Delta E = q + w = \Delta H - P\Delta V$

$h = 6.626x10^{-34}\ J\ s$

$c = 2.998x10^{8}\ m\ s^{-1}$

$N = 6.022x10^{23}\ mol^{-1}$

$R = 0.0820\ L\ atm\ K^{-1}\ mol^{-1}$

$R = 8.314\ J\ K^{-1}\ mol^{-1}$

Solubility Rules for some ionic compounds in water

Soluble Ionic Compounds

1. All sodium (Na^+), potassium (K^+), and ammonium (NH_4^+) salts are SOLUBLE.
2. All nitrate (NO_3^-), acetate ($CH_3CO_2^-$), chlorate (ClO_3^-), and perchlorate (ClO_4^-) salts are SOLUBLE.
3. All chloride (Cl^-), bromide (Br^-), and iodide (I^-) salts are SOLUBLE -- EXCEPT those also containing: lead, silver, or mercury (I) (Pb^{2+},Ag^+, Hg_2^{2+}) which are NOT soluble.
4. All sulfate (SO_4^{2-}) salts are SOLUBLE - - EXCEPT those also containing: calcium, silver, mercury (I), strontium, barium, or lead (Ca^{2+}, Ag^+, Hg_2^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}) which are NOT soluble.

Not Soluble Ionic Compounds

5. Hydroxide (OH^-) and oxide (O^{2-}) compounds are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or barium (Na^+, K^+, Ba^{2+}) which are soluble.
6. Sulfide (S^{2-}) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, ammonium, or barium (Na^+, K^+, $NH4^+$, Ba^{2+}) which are soluble.
7. Carbonate (CO_3^{2-}) and phosphate (PO_4^{3-}) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or ammonium (Na^+, K^+, NH_4^+), which are soluble.

PERIODIC TABLE OF THE ELEMENTS

1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	8A
1 H 1.008																	2 He 4.003
3 Li 6.939	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
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
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
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 (99)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 181.0	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 (222)
87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Unq (261)	105 Unp (262)	106 Unh (263)	107 Uns (262)	108 Uno (265)	109 Une (266)									