Chem 210 Jasperse Final Exam- Version 1

1. Which of the following liquids would have the highest vapor pressure, factoring in both the impact of the substance and the temperature?

   a. $C_5H_{13}OH$ at 25˚C
   b. $C_5H_{13}OH$ at 90˚C
   c. $FeCl_3$ at 25˚C
   d. $C_8H_{15}OH$ at 25˚C
   e. $C_8H_{15}OH$ at 90˚C

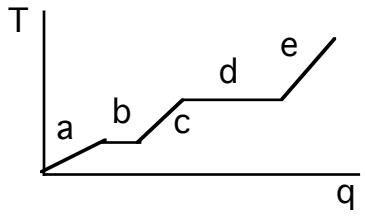
2. Which would have the highest melting point?

a. CO_2 b. H_2O c. NaCl d. CH_3Cl e. CH_3CH_2Br

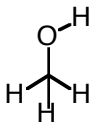
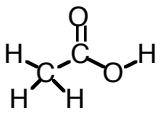
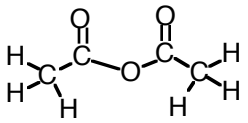
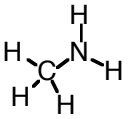
3. The heat of fusion for water is 6.0 kJ/mol, the specific heat for liquid water is 4.18 J/g-K, and the heat of vaporization for water is 40.7 kJ/mol. How many kJ of heat would it take to convert 36 g of solid ice (18 g/mol) from 0˚C to water vapor (at 100˚C final temperature)?

   a. 97 kJ b. 22.6 kJ c. 108 kJ d. 1.5×10^4 kJ

4. Region "d" on the heating curve shown (Temperature versus heat, "q") corresponds to:
   a. a pure gas increasing in temperature
   b. a liquid increasing in temperature
   c. a solid increasing in temperature
   d. a solid melting
   e. a liquid boiling



5. Which one of the following substances would <u>not</u> have hydrogen bonding as one of its intermolecular forces?

a. 
b. 
c. 
d. 

6. A 20 L container of argon gas originally at 1 atm and 27ºC has the pressure increased to 2.0 atm and the temperature raised to 127ºC. What is the final volume of the container?

   a. 188 L
   b. 53.3 L
   c. 13.3 L
   d. 47 L

7. What is the volume of 60 g of NO_2 (44 g/mol) at 1.2 atm and 30ºC?
   a. 3.1 L
   b. 28 L
   c. 47 L
   d. 2.0 L
   e. none of the above

8. How many L of CO_2 is produced by combustion of 45.0 g of C_5H_{12} (72.0 g/mol) at STP?

$$C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6\ H_2O$$

   a. 617 L
   b. 2.8 L
   c. 70 L
   d. 14 L
   e. none of the above.

9. Why does $CH_3CH_2NH_2$ dissolve readily in water but C_4H_{10} does not?

   a. Hydrogen bonding between $CH_3CH_2NH_2$ and water is strong. But interactions between C_4H_{10} and water are weaker than the water-water interactions that would need to be sacrificed in order to dissolve C_4H_{10}.
   b. C_4H_{10} has strong hydrogen bonding with water.
   c. $CH_3CH_2NH_2$ has only induced dipole forces (London forces)
   d. C_4H_{10} is much more polar than $CH_3CH_2NH_2$

10. Which relationship is <u>true</u> for solubility in water?

    a. C_6H_{14} > NaCl
    b. $C_{11}H_{23}NH_2 > C_3H_7NH_2$
    c. $CH_3OH > CHCl_3$
    d. $CH_3CCl_3 > CH_3CH_2OH$

11. Which of the following statements is <u>false</u>?
    a. When a solute is dissolved in water, the freezing point of water goes down
    b. A saturated solution contains dissolved solute in equilibrium with undissolved solid
    c. Dissolving a solid results in a decrease in entropy and will only occur if the dissolving is exothermic.
    d. Smaller gases have higher velocity at room temperature than do larger molecules.

12. What is the rate law for the reaction A + 2B + C → products:

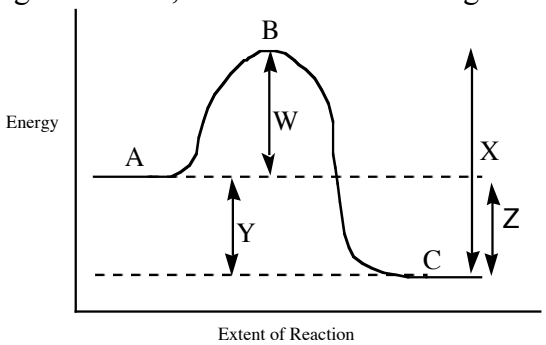
Initial [A]	Initial [B]	Initial [C]	rate
0.25	0.25	0.25	3.0
2.5	0.25	0.25	30.0
0.25	0.50	0.25	6.0
0.25	0.25	0.75	27.0

    a. rate = $k[A][B][C]^2$
    b. rate = $k[A][B]$
    c. rate = $k[A][B]^2[C]^3$
    d. rate = $k[A][B]^2[C]$

13. Substance X has a half life of 20 days. If a sample is originally 12 g, how much will be left after 80 days?

    a. 0.75 g
    b. 1.5 g
    c. 0.45 g
    d. 3.0 g
    e. none of the above

14. For the reaction diagram shown, which of the following statements is <u>true</u>?



a. Line W represents the ΔH for the forward reaction; point B represents the transition state
b. Line W represents the activation energy for the forward reaction; point B represents the transition state
c. Line Y represents the activation energy for the forward reaction; point C represents the transition state
d. Line X represents the ΔH for the forward reaction; point B represents the transition state

15. Given the mechanism shown, what would be the rate law?

A + B → C + D	fast
C + B → F + G	slow
G + H → I + J	fast

a. rate = k[A][B]
b. rate = $k[A][B]^2$
c. rate = $k[A][B]^2[C]$
d. rate = $k[A][B]^2[C][G][H]$
e. none of the above

16. Which expression represents K correctly for the following reaction?

$$C(s) + O_2(g) + 5H_2(g) \rightleftharpoons C_2H_6(g) + 2H_2O(g)$$

a. $[O_2][H_2]^5/[C_2H_6][H_2O]$
b. $[C_2H_6][H_2O]^2/[O_2][H_2]^5$
c. $[C_2H_6][H_2O]\ /[C][O_2][H_2]^5$
d. $[C_2H_6](2[H_2O])^2/[CO](5[H_2])^5$

17. Calculate K for the following reaction if the equilibrium concentrations of B, C, and D are as shown.

$$A(s) + 2B(g) \rightleftharpoons 3C(g) + D(g) \quad K = ??$$

Equilibrium Concentrations (M): .50 M .20 M .40 M

a) 0.0128
b) 1.0×10^{-2}
c) 25
d) 63

18. When 5 mol of A and 3 mol of B are placed in a container and allowed to come to equilibrium, the resulting mixture is found to contain 1 mol of B. What are the amounts of A, C, and D at equilibrium?

$$A(g) + 2B(g) \rightleftharpoons 3C(g) + D(g)$$

Initial:	5.0 mol	3.0 mol	0 mol	0.00 mol
Equilibrium:		1.0 mol		

a. 1.0 mol A, 3.0 mol C, 1.0 mol D
b. 4.0 mol A, 3.0 mol C, 1.0 mol D
c. 1.0 mol A, 6.0 mol C, 1.0 mol D
d. 3.0 mol A, 2.0 mol C, 2.0 mol D
e. 4.0 mol A, 3.0 mol C, 4.0 mol D

19. What is the equilibrium concentration of C if [A] = 0.40 M and [B] = 0.15 M at equilibrium?

$$A(g) + 2B(g) \rightleftharpoons 2C(g) \qquad K = 2.56 \times 10^{-3}$$

a. 3.2×10^{-2} M
b. 8.0×10^{-4} M
c. 0.20 M
d. 0.10 M
e. 4.8×10^{-3} M

20. 0.80 mol of A and 0.80 mol of B are placed in a 1.00 L flask and allowed to reach equilibrium. (There is no C at first.) After reaching equilibrium, the flask is found to contain 0.64 mol of C. What is the value of K for this reaction?

$$2A(g) + 1B(g) \rightleftharpoons 2C(g)$$

Initial:	0.80	0.80	0
Change:			
Equilibrium:			0.64

a) 11
b) 4.0
c) 33
d) 6.1

21. Given: $2A(g) \rightleftharpoons 1B(g) + 2C(g)$ $\Delta H^\circ = -69$ kJ $K = 1 \times 10^{-6}$

If the above reactants and products are contained in a closed vessel and the reaction system is at equilibrium, the number of moles of B can be <u>increased</u> by

a. removing some C from the system.
b. removing some A from the system.
c. decreasing the size/volume of the reaction vessel.
d. increasing the temperature of the reaction system.

22. What is the final concentration of C at equilibrium if the initial [A] concentration is 0.70M?

$2A(g) \rightleftharpoons 1B(g) + 2C(g)$ $\quad K = 2.2 \times 10^{-8}$

Initial: 0.70 0

Equilibrium:

a. 7.7×10^{-7}
b. 1.6×10^{-3}
c. 3.1×10^{-3}
d. 6.2×10^{-4}
e. none of the above

23. Calculate the pH of a solution that is 2.3×10^{-4} M in HNO_3.

a. 1.32
b. 3.64
c. 3.43
d. 11.36
e. none of the above

24. What is the $[OH^-]$ concentration of a solution with pH=9.18?

a. 5.6×10^{-10} M
b. 4.6×10^{-6} M
c. 1.51×10^{-5} M
d. 4.8×10^{-4} M
e. none of the above

25. Calculate the pH of 0.20 M weak acid HA, $K_a = 1.5 \times 10^{-8}$.

a. 3.29
b. 4.26
c. 6.59
d. 10.71
e. none of the above

26. An 0.60 M solution of weak acid HZ has a pH of 4.28. What is the value of K_a for HZ?

a. 5.2×10^{-3}
b. 4.6×10^{-9}
c. 2.8×10^{-5}
d. 1.9×10^{-12}
e. none of the above

27. Which function as <u>bases</u> in the following equilibrium?

$$CH_3OH(l) + H_2PO_2^-(aq) + \rightleftharpoons H_3PO_2(aq) + CH_3O^-(aq)$$

a. $H_2PO_2^-$ and CH_3O^-
b. $H_2PO_2^-$ and CH_3OH
c. H_3PO_2 and CH_3O^-
d. CH_3OH and H_3PO_2

28. Which of the following statements is true relative to NaBr, KN_3, NH_4NO_3, and $CrBr_3$.

a. NH_4NO_3 would give an acidic solutions; NaBr and KN_3 would give neutral solutions
b. NaBr and $CrBr_3$ would give neutral solutions; and KN_3 would give a basic solution
c. NH_4NO_3, and $CrBr_3$ would give acidic solutions; NaBr and KN_3 would give basic solutions
d. NH_4NO_3, and $CrBr_3$ would give acidic solutions and KN_3 would give a basic solution

29. For the reaction shown, which of the following statements would be <u>false</u>?

$$HA(aq) + B^-(aq) \rightleftharpoons HB(aq) + A^-(aq) \qquad K = 2.5 \times 10^{-5}$$

a) The equilibrium is reactant favored
b) B^- anion is the weakest base present
c) A^- anion is the strongest base present
d) HA is the strongest acid present
e) The solution will contain more HA than HB at equilibrium

30. Which of the following would give a <u>basic</u> solution when dissolved in water?

a. HNO_2
b. Na_2CO_3
c. NaCl
d. $CrCl_3$

31. When the following chemicals are mixed, each in 1 liter of water, which would give an acidic pH at the end?

a) 1 mole of NaCN and 1 mole of HCl
b) 1 mole of HCN and 1 mole of NaOH
c) 1 mole of HCl and 1 mole of NaOH
d) 1.5 mole of KOH and 1 mole of HCl

32. K_a for weak acid HZ is 2.8×10^{-5}. The pH of a buffer prepared by combining 50.0 mL of 1.00 M NaZ and 22.0 mL 1.00 M HZ is
a) 4.19
b) 4.55
c) 4.91
d) 5.14
e) none of the above

33. Consider a solution that contains 0.50 moles of HN_3 and 0.50 moles of NaN_3 in 1.0 L of water. If 0.15 mol of HNO_3 is added to this buffer solution, the pH of the solution will get slightly _____. The pH does not change more drastically because the HNO_3 reacts with the _____ present in the buffer solution.

a) higher, NaN_3
b) higher, HN_3
c) lower, NaN_3
d) lower, HN_3

34. When placed in 1 L of water, which of the following combinations would give a buffer solution? (Remember, in some cases they might react with each other…)

1) 0.5 mol HF and 0.5 mol NaF
2) 1 mol HCl and 0.5 mol NaF
3) 0.5 mol HCl and 1.0 mol NaF
4) 0.5 mol HCl and 1.0 mol NaOH

a) 1 only
b) 1 and 2 only
c) 1 and 3 only
d) 3 and 4 only
e) all would give buffer solutions

35. What is the pH when 40 mL of 1.0 M HCl is added to 80 mL of 0.5 M NaZ? (HZ has $K_a = 2.6 \times 10^{-6}$)

a) 2.94×10^{-3}
b) 4.59
c) 7.00
d) 3.03
e) none of the above

36. An initial pH of 3.5 and an equivalence point at pH 9.1 correspond to a titration curve for a

a) strong acid to which strong base is added
b) strong base to which strong acid is added
c) weak acid to which strong base is added
d) weak base to which strong acid is added

37. What is the molarity of an HCl solution if 28 mL of this solution required 41 mL of 0.63 M NaOH to reach the equivalence point?

a) 0.92 M
b) 0.43 M
c) 0.48 M
d) 1.3 x 10-4 M
e) none of the above

38. Suppose calcium sulfate has solubility of 2.5 x 10^{-4} mol/L when added to distilled water. Which of the following statements would be **false**?

a) The solubility would **increase** at pH = 2 because the acid would react with the sulfate anion and pull the equilibrium to the right
b) The solubility of the calcium sulfate would **decrease** if $Ca(NO_3)_2$ was added to the solution
c) The solubility of the calcium sulfate would **decrease** if Na_2SO_4 was added to the solution
d) The solubility would **decrease** if the temperature was raised from room temperature to 80ºC

39. The solubility of MX_2 is 9.1 x 10^{-7} mol/L. What is the K_{sp} of MX_2?

a) 9.1 X 10^{-9}
b) 8.3 X 10^{-17}
c) 3.0 X 10^{-18}
d) 3.0 X 10^{-10}
e) none of the above

40. What is the solubility (in moles/L) of CuBr in a solution that also contains 0.020 M $CuNO_3$ (the latter is fully soluble). (K_{sp} CuBr = 5.4 x 10^{-9})

a) 5.3 x 10^{-9}
b) 7.3 X 10^{-5}
c) 1.8 X 10^{-7}
d) 2.7 X 10^{-7}
e) none of the above

41. Under which conditions is a reaction sure to be **reactant-favored**?

a) the reaction is **endothermic** and its ΔS is **negative**
b) the reaction is **endothermic** and its ΔS is **positive**
c) the reaction is **exothermic** and its ΔS is **negative**
d) the reaction is **exothermic** and its ΔS is **positive**

42. Which one of the following reactions would have a positive value for ΔS°?

a) $C_6H_{12}(g) + 9O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$
b) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
c) $H_2O(l) \rightarrow H_2O(s)$
d) $BaCO_3(s) \rightarrow BaO(s) + CO_2(g)$
e) none of the above

43. Calculate ΔS° (at 25°C in J/K) for the following reaction, given the standard entropies shown (in J/mol-K):

	2A(g) +	B(g) →	3C(l) +	3D (g)
Standard entropies:	187	186	78	131

a) +120
b) +59
c) +67
d) -59

44. Consider the following reaction at 25˚C.

$A(g) + B(g) \rightarrow C(s) + D(g)$ $\Delta H^\circ = -48$ kJ/mol $\Delta S^\circ = -222$ J/mol•K

What is the value of ΔG° for this reaction, in kJ, at 73˚C, and would it be product-favored at 73˚C?

a) -4.0×10^4 kJ and reactant favored
b) 28.8 kJ and reactant favored
c) 131 kJ and reactant favored
d) -91 kJ and product favored

45. For the following reaction, under which temperature circumstances (**in °C**) will it be **product-favored**?

$A(g) + B(g) \rightarrow C(s) + D(g)$ $\Delta H^\circ = -76$ kJ/mol, $\Delta S^\circ = -210$ J/K-mol

a) It will be product-favored at temperatures below 362 °C
b) It will be product-favored at temperatures below 89 °C
c) It will be product-favored at all temperatures
d) It will be product-favored at temperatures above 43 °C
e) It will be product-favored at temperatures below 316 °C

46. What is the oxidation number of Cl in $HClO_3$?

a. +3
b. +4
c. +5
d. +7
e. none of the above

47. After balancing the following redox reaction, what is the coefficient for H_2O?

$$H_2CrO_4 + Fe \rightarrow Cr_2O_3 + Fe_2O_3 + H_2O$$

a. 1
b. 2
c. 5
d. 8
e. none of the above

48. Which substance is the oxidizing agent in the following reaction?

$$3Mg + 2FeBr_3 \rightarrow 3MgBr_2 + 2Fe$$

a. Fe°
b. Mg^{2+}
c. Fe^{3+}
d. Mg°
e. none of the above

49. Given the following reduction potentials, what would be the E° for a cell for a product–favored reaction involving the chemicals shown?

$Cl_2 + 2e^- \rightarrow 2Cl^-$ E° = +1.32 V
$Cr^{3+} + 3e^- \rightarrow Cr$ E° = –0.74 V

a. 2.1V
b. 4.9 V
c. 0.58 V
d. 1.72 V
e. none of the above

50. Balance the reaction and determine E° for the following unbalanced reaction?

$Al + Co^{2+} \rightarrow Al^{3+} + Co$ $\Delta G° = -799$ kJ

a. +0.275 V
b. +0.490 V
c. +1.38 V
d. +2.55 V
e. none of the above

51. Which transformation could take place at the anode of an electrochemical cell?

a. Mn^{2+} to Mn
b. H_2O to O_2
c. H_2SO_4 to $H_2S_2O_3$
d. Br_2 to Br^-
e. none of the above

52. Calculate the value of E° for the reaction shown, given the standard reduction potentials:

Reduction Potentials
$Br_2 \rightarrow 2Br^-$ E°= +1.08 V
$Zn^{2+} \rightarrow Zn$ E°= -0.76 V

Overall Reaction
$Zn + Br_2 \rightarrow ZnBr_2$ E° = ??

a. 0.38 V
b. –0.38 V
c. 0.68 V
d. 1.84 V

53. The value of E° for the following reaction is 1.52 V. What is the value of E_{cell} with the concentrations shown?

$2Al + 3Sn^{2+} \rightarrow 3Sn + 2Al^{3+}$ E° = 1.52
0.1 M 0.9 M

a. 1.40
b. 1.55
c. 1.49
d. 0.80

54. Given the following reduction potentials, which species would react with Cu^{2+}?

$Br_2 + 2e^- \rightarrow 2Br^-$	$E^\circ = +1.08$ V
$Cu^{2+} + 2e^- \rightarrow Cu$	$E^\circ = +0.34$ V
$Ni^{2+} + 2e^- \rightarrow Ni$	$E^\circ = -0.13$ V
$Cd^{2+} + 2e^- \rightarrow Cd$	$E^\circ = -0.40$ V
$Al^{3+} + 3e^- \rightarrow Al$	$E^\circ = -1.66$ V

a. Br^- only
b. Cd and Al only
c. $Cd^{2+} + Al^{3+}$ only
d. Ni, Cd and Al

55. Molten $PbCl_2$ is subjected to electrolysis in order to form elemental lead and chlorine. Which of the following is <u>false</u>?

a. Elemental lead metal is formed and deposited at the <u>cathode</u>
b. Elemental chlorine gas is formed at the <u>cathode</u> and bubbles away
c. Electrons flow from the anode to the cathode
d. none of the above

56. How many grams of Zn metal (65.4 g/mol) will be produced by passing a current of 6.6 amps through a solution of ZnI_2 for 45 minutes.

a. 6.0 g
b. 0.111 g
c. 3.3 g
d. 6.6 g
e. none of the above

57. What particles are produced in the following reaction? $^{238}U + {}^{16}O \rightarrow {}^{140}Ba + {}^{110}Ru +$ _

a. 2 neutrons
b. 4 neutrons
c. 1 alpha particle
d. 2 alpha particles
e. 4 alpha particles

58. Fact: ^{14}O is unstable and radioactive. Is its n/p ratio too high or too low? In that case, which process could lead to stability? (Make sure that both parts of the answer are correct.)

a. Its n/p ratio is <u>too low</u>. It could attain stability by <u>electron capture or positron emission</u>.
b. Its n/p ratio is <u>too low</u>. It could attain stability by <u>beta emission</u>.
c. Its n/p ratio is <u>too high</u>. It could attain stability by <u>electron capture</u>.
d. Its n/p ratio is <u>too high</u>. It could attain stability by <u>beta emission</u>.
e. Its n/p ratio is <u>too high</u>. It could attain stability by <u>positron emission</u>.

59. What is the missing product from this reaction: $^{28}Al \rightarrow {}^{28}Si + \_\_\_\_\_$

a. alpha particle
b. beta ray
c. positron
d. gamma ray
e. neutron

60. The half–life for radioactive element Z is 6 hours. If there is originally 50 g of sample Z, how much will be left after 15 hours?

a. 8.8 g
b. 11 g
c. 24 g
d. 16 g
e. none of the above

Chem 210 Final Exam Answers Practive Version 1

Test1 Answers	Test2 Answers	Test3 Answers	Test4 Answers
1. B	16. B	31. A	46. C
2. C	17. A	32. C	47. B
3. C	18. B	33. C	48. C
4. E	19. E	34. C	49. A
5. C	20. C	35. D	50. C
6. C	21. A	36. C	51. B
7. B	22. C	37. A	52. D
8. C	23. B	38. D	53. C
9. A	24. C	39. C	54. D
10. C	25. B	40. D	55. B
11. C	26. B	41. A	56. A
12. A	27. A	42. D	57. C
13. A	28. D	43. C	58. A
14. B	29. D	44. B	59. B
15. B	30. B	45. B	60. A

Chem 210 Jasperse Final Exam- Key Equations, Constants and Formulas

Test 1

PV=nRT	R=0.0821 L•atm/mol•K	1 atm = 760 mm Hg	K=273 + ºC
1 mol = 22.4 L (at STP)			
Formulas for First Order Reactions:	$kt = \ln([A_o]/[A_t])$	$kt_{1/2} = 0.693$	

Tests 2 and 3

$[H^+][HO^-] = 1.00 \times 10^{-14}$	$pH = -\log[H^+]$	pZ= -logZ General definition for p of anything
pH + pOH = 14	$[H^+] = 10^{-pH}$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Quadratic Equation
For weak acids alone in water:	$[H^+] = \sqrt{K_a x[WA]}$	$K_a = [H^+]^2/[HA]_{init}$
For weak bases alone in water:	$[OH^-] = \sqrt{K_b x[WB]}$	$K_b = [OH^-]^2/[Base]_{init}$
For conjugate acid/base pair:	$K_aK_b = 1.00 \times 10^{-14}$	
$pH = pK_a + \log[base]/[acid]$ For Buffer		
$\Delta G^\circ = G^\circ$ (products) - G° (reactants)	$\Delta S^\circ = S^\circ$ (products) – S° (reactants)	$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ (T in Kelvin)

Test 4

$E^\circ_{cell} = E^\circ_{reduction} + E^\circ_{oxidation}$	$\Delta G^\circ = -96.5nE^\circ_{cell}$
$E_{cell} = E^\circ - [0.0592/n]\log Q$	$\log K = nE^\circ/0.0592$
Mol e^- = [A • time (sec)/96,500]	time (sec)= mol e • 96,500/current (in A)
$t = (t_{1/2}/0.693) \ln(A_o/A_t)$	$\ln(A_o/A_t) = 0.693 \cdot t/t_{1/2}$
$E = \Delta mc^2$ (m in kg, E in J, c = $3x10^8$ m/s)	