Solutions Follow the Information Sheet.

CHEM 1423 - Final Exam – May 9, 2017

Name______________________________

If you wish to have your final exam and course grade posted on the Web site, please provide me with a four (4) digit number which will be the ID number for your grade.

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Four (4) digit number for posting

Please turn in:

1. Your Scantron with your name written in + bubbled answers. You don't have to bubble in your name.

2. This signature sheet. Please put your name on top. You are welcome to supply a 4 digit number of your choice if you would like your course results posted anonymously on the course web site.

You can keep the test (below) and use it to compare results with the answer key.

Conversions: 1 atm. = 760 torr

Constants: R = 0.082 L-atm/mol·K

R = 8.31 J/mol·K

R = 8.31×10^{-3} kJ/mol·K

$N_A = 6.02 \times 10^{23}$ mol^{-1}

F = 96,500 Coul/mol e^-

c = 3.00×10^8 m/s (speed of light)

Molar Masses: Given with each question: [M=xx]

PERIODIC TABLE OF THE ELEMENTS

Key: Atomic Number / Symbol / Atomic Mass (1 H 1.008)

Period	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
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 23.00	12 Mg 24.30											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 47.88	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 65.38	31 Ga 69.72	32 Ge 72.59	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	49 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	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 (222)
7	87 Fr (223)	88 Ra 226.0	103 Lr (260)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)									

Series														
Lanthanide series	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 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0
Actinide series	89 Ac 227.0	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	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)

Approved by the I.U.P.A.C. Council in Geneva, August 30, 1997

ELECTROCHEMISTRY INFORMATION

Table 1: Standard Reduction Potentials

Reduction Half-Reactions	E° (V)
$F_2 + 2\,e^- \rightarrow 2\,F^-$	+2.87
$Au^{3+} + 3\,e^- \rightarrow Au$	+1.50
$Cl_2 + 2\,e^- \rightarrow 2\,Cl^-$	+1.36
$Br_2 + 2\,e^- \rightarrow 2\,Br^-$	+1.07
$Hg^{2+} + 2\,e^- \rightarrow Hg$	+0.86
$Ag^+ + 1\,e^- \rightarrow Ag$	+0.80
$I_2 + 2\,e^- \rightarrow 2\,I^-$	+0.54
$Cu^{2+} + 2\,e^- \rightarrow Cu$	+0.34
$Sn^{2+} + 2\,e^- \rightarrow Sn$	-0.14
$Fe^{3+} + 3\,e^- \parallel Fe$	-0.04
$Ni^{2+} + 2\,e^- \rightarrow Ni$	-0.25
$Fe^{2+} + 2\,e^- \rightarrow Fe$	-0.44
$Zn^{2+} + 2\,e^- \rightarrow Zn$	-0.76
$Mn^{2+} + 2\,e^- \rightarrow Mn$	-1.18
$Al^{3+} + 3\,e^- \rightarrow Al$	-1.66
$Mg^{2+} + 2\,e^- \rightarrow Mg$	-2.37
$K^+ + 1\,e^- \rightarrow K$	-2.93
$Li^+ + 1\,e^- \rightarrow Li$	-3.05

Table 2: Some Reduction and Oxidation Potentials in Aqueous Solution

Reduction Potentials

$2\ H_2O + 2\ e^- \rightarrow H_2 + 2\ OH^-$	$E^o_{red} = -0.83$ V
$Al^{3+} + 3\ e^- \rightarrow Al$	$E^o_{red} = -1.66$ V
$Zn^{2+} + 2\ e^- \rightarrow Zn$	$E^o_{red} = -0.76$ V
$Mg^{2+} + 2\ e^- \,\|\, Mg$	$E^o_{red} = -2.37$ V
$Na^+ + 3\ e^- \,\|\, Na$	$E^o_{red} = -2.71$ V
$Fe^{2+} + 2\ e^- \,\|\, Fe$	$E^o_{red} = -0.44$ V

Oxidation Potentials

$2\ H_2O \rightarrow O_2 + 4\ H^+ + 4\ e^-$	$E^o_{oxid} = -1.23$ V
$2\ I^- \rightarrow I_2 + 2\ e^-$	$E^o_{oxid} = -0.54$ V
$2\ Br^- \,\|\, Br_2 + 2\ e^-$	$E^o_{oxid} = -1.07$ V
$2\ F^- \rightarrow F_2 + 2\ e^-$	$E^o_{oxid} = -2.87$ V

Some Electrochemical Equations

F = 96,500 C/mol e^- (Coulombs per mole of electrons)

1 J = 1 CxV [i.e. 1 Joule = 1 Coulomb x Volt]

$\Delta G^o = -nFE^o$

$$E = E^o - \frac{0.0592}{n} \cdot \log(Q)$$

Q = i x t i.e. Charge (in Coul) = Current (in Amps = Coul/sec) x time (in sec)]

E = Q x V i.e. Energy (in J) = Charge (in Coulombs) x Voltage (in Volts)
(note: 1 Coulomb-Volt = 1 Joule)

Solutions

(60) **60 QUESTIONS (Mark the one correct answer to each question on your scantron)**

Each Question is worth 1 point. Your score will be converted to percent by: Score = XX/60 x 100 (where XX is the number of correct answers)

1. For the reaction, A + B → Products, the rate law is: $Rate = k\frac{[C]^2}{[B]}$ The units of the rate constant are:

   (A) s^{-1} (B) M^2s^{-1} (C) $M^{-2}s^{-1}$ (D) $M^{-1}s^{-1}$

2. The rate of the chemical reaction involving two substances, A and B, is measured. It is found that if the initial concentration of A used is tripled, keeping the B concentration the same, the rate increases by a factor of 9 (relative to the first experiment). If the concentrations of both A and B are doubled, the rate increases by a factor of 32 (relative to the first experiment). The rate law for this reaction is: Rate =

   (A) $k[A]^2[B]^2$ (B) $k[A][B]$ (C) $k[A]^2[B]^3$ (D) $k[A][B]^2$

3. Consider a reaction which is zeroth order; i.e. $d[A]/dt = -k[A]^0 = -k$. For this reaction, a plot of ____ vs. time is a straight line with a ____ slope.

   (A) $\ln([A]_t)$, negative (B) $[A]_t$, negative

   (C) $(A]_t$, positive (D) $1/[A]_t$, positive

4. The reaction, A → Products, is of order "n" with respect to [A]; i.e. Rate = $k[A]^n$. When the initial concentration of A is 0.20 M, the initial rate is 1.5 Ms^{-1}. When the initial concentration of A is 0.60 M, the initial rate is 40.5 Ms^{-1}. The order of this reaction, n, is:

   (A) -2 (B) +1 (C) +2 (D) +3

For #5 - #6: Consider a **second** order reaction, A → Products. The rate constant for this reaction is 0.02 $M^{-1}s^{-1}$. The initial concentration of A is 0.75 M

5. Approximately how long will it take for the reactant concentration to decrease to 0.20 M?

   (A) 45 s (B) 100 s (C) 180 s (D) 80 s

6. What will be the concentration of A 60 s after the start of the reaction?

   (A) 0.39 M (B) 0.23 M (C) 0.47 M (D) 0.56 M

7. For the reaction, $Sc^{3+}(aq) + 2\ Ni^{+}(aq) \rightarrow Sc^{+}(aq) + 2\ Ni^{2+}(aq)$, the reaction mechanism is:

$$2\,Ni^{+} \underset{}{\overset{K}{\rightleftarrows}} Ni + Ni^{2+} \quad \text{Fast equilibrium}$$

$$Ni + Sc^{3+} \xrightarrow{k} Ni^{2+} + Sc^{+} \quad \text{Slow step}$$

The overall rate equation for this reaction is:

(A) $Rate = k'\dfrac{[Ni^{2+}][Sc^{3+}]}{[Ni^{+}]^{2}}$ (B) $Rate = k'\dfrac{[Ni^{+}][Sc^{3+}]}{[Ni^{2+}]}$

(C) $Rate = k'\dfrac{[Ni^{+}]^{2}[Sc^{3+}]}{[Ni^{2+}]}$ (D) $Rate = k'[Ni][Sc^{3+}]$

8. The gas phase equilibrium, $2\ A(g) \leftrightharpoons 3\ B(g) + C(g)$. The equilibrium constant is $K_c = 1\text{x}10^{-4}$. If one puts an initial concentration of 2.0 M of A into a flask, what is the approximate concentration **of B** at equilibrium? [**NOTE**: You may assume that very little A reacts]

(A) 0.16 M (B) 0.19 M (C) 0.28 M (D) 0.06 M

9. Consider the gas phase equilibrium reaction, $2\ A(g) \leftrightharpoons B(g)$. If one initially fills a container with A at a concentration of 3.0 M, and then allows it to come to equilibrium, it is found that the equilibrium concentration of B is 1.2 M. Therefore, the value of the equilibrium constant, K_c is approximately:

(A) 3.3 (B) 2.0 (C) 0.67 (D) 0.37

10. The equilibrium constant for the reaction, $N_2(g) + O_2(g) \leftrightharpoons 2\ NO(g)$ is $1.7\text{x}10^{-3}$ (at 2300 K). What is the equilibrium constant for the reaction, $6\ NO(g) \leftrightharpoons 3\ N_2(g) + 3\ O_2(g)$?

(A) $4.9\text{x}10^{-9}$ (B) 8.4 (C) $1.7\text{x}10^{3}$ (D) $2.0\text{x}10^{8}$

For #11 - #13: Consider the gas phase equilibrium, $4NO_2(g) + O_2(g) \leftrightharpoons 2N_2O_5(g)$. This is an Exothermic reaction.

11. For the above reaction, if $O_2(g)$ is added to the mixture, then the ratio, $[NO_2]/[N_2O_5]$ will ____________ and K_c will ______________

(A) decrease, Increase (B) increase, decrease

(C) decrease, remain constant (D) increase, remain constant

12. For the above reaction, if Ne(g) is added to the mixture in a container at fixed **total pressure**, the ratio, $[NO_2]/[N_2O_5]$ will ___________ and

K_c will _____________

(A) decrease, Increase
(B) increase, decrease
(C) decrease, remain constant
(D) increase, remain constant

13. For the above reaction, if the temperature is **decreased**,

(A) the equilibrium will move to the left and K will decrease
(B) the equilibrium will move to the right and K will increase
(C) the equilibrium will move to the left and K will remain constant
(D) the equilibrium will move to the right and K will remain constant

14. The weight percent of Thalium in a sample of water is $3x10^{-11}$ % . Therefore, the concentration of Thalium, in parts per trillion (ppt) is:

(A) 0.30 ppt (B) $3x10^{-2}$ ppt (C) $3x10^{-4}$ ppt (D) 3.0 ppt

15. What is the molality of a solution prepared by adding 138 grams of Glycerol ($C_3H_8O_3$, M=92.) to 600 grams of water?

(A) 2.033 molal (B) 3.75 molal (C) 2.5 molal
(D) Determination of the molality requires the density of the soluton

16. The density of a solution prepared by adding 93 grams of Ethylene Glycol ($C_3H_6O_2$, M=62) to 400 grams of water is 1.30 g/mL. What is the approximate Molarity of this solution?

(A) 3.95 Molar (B) 3.75 Molar (C) 4.95 Molar (D) 3.45 Molar

17. Which of the following aqueous solutions has the **lowest boiling** point?

(A) 0.20 m K_3PO_4
(B) 0.30 m $Ca(NO_3)_2$
(C) 0.70 m $C_6H_{12}O_6$
(D) 0.32 m NaBr

18. When a sample of the strong electrolyte, aluminum nitrate, $Al(NO_3)_3$, is dissolved in 600 mL of aqueous solution, the osmotic pressure at 25 °C is 350 torr. Approximately how many moles of $Al(NO_3)_3$ are dissolved in the 600 mL?

(A) $1.1x10^{-2}$ mol (B) $2.8x10^{-3}$ mol (C) $7.9x10^{-3}$ mol (D) $3.9x10^{-3}$ mol

19. The normal boiling point of pure CCl_4(l) is 77.0 °C and the boiling point elevation constant is 5.0 °C/m. When 80. grams of an unknown compound is placed in 750 grams of CCl_4, the boiling point of the solution is 80.5 °C. The Molar Mass of the unknown compound is approximately:

(A) 86 g/mol (B) 69 g/mol (C) 152 g/mol (D) 114 g/mol

20. A 300. L sample of nitric acid (HNO_3, M=63) has a **pOH** of 11.5. Approximately how many grams of nitric acid are contained in the sample?

(A) 60. grams (B) 0.20 grams (C) 0.62 grams (D) 23. grams

21. Which of the following aqueous solutions is/are basic (pH > 7)?

(i) Potassium Lactate (KLac)
(ii) Sodium Nitrate ($NaNO_3$)
(iii) Pyridinium Bromide (PyrHBr)
(iv) Sodium Propanoate (NaProp)

(A) i & iv (B) ii & iii (C) i & ii & iv (D) iv only

22. The pH of a 0.10 M solution of hydrocyanic acid, HCN, is 5.10. Therefore, the acid dissociation constant, K_a, for this acid is:

(A) 6.8×10^{-12} (B) 7.9×10^{-5} (C) 6.3×10^{-10} (D) 4.8×10^{-7}

23. For the weak acid, Hypobromous acid, HBrO, the acid ionization constant is 2.0×10^{-9}. What is the approximate pH of a 0.05 M solution of this acid?

(A) 9.0 (B) 5.0 (C) 3.4 (D) 4.6

24. The weak base, aniline (Anil), has a base equilibrium constant, $K_b = 4.3 \times 10^{-10}$. What is the pH of a 0.05 M aqueous solution of anilinium chloride (AnilHCl)?

(A) 11.0 (B) 8.7 (C) 5.3 (D) 3.0

25. If added to 2 L of 0.40 M HNO_3, which of the following would form a buffer?

(1) 0.6 mol of potassium lactate (KLac)
(2) 0.6 mol of sodium carbonate (Na_2CO_3)
(3) 1.2 mol of sodium acetate (NaAc)
(4) 1.2 mol of ammonium bromide (NH_4Br)

(A) 1 & 2 & 3 (B) 2 & 3 & 4 (C) 3 only (D) 2 & 3

For #26 - #30: Consider Carbonic acid, H_2CO_3, which is a diprotic acid with acid dissociation constants, $Ka' = 4.2 \times 10^{-7}$ and $Ka'' = 4.8 \times 10^{-11}$.

26. What is the approximate pH of a 0.05 M solution of sodium carbonate, Na_2CO_3 ?

(A) 5.8 (B) 11.5 (C) 10.2 (D) 8.2

27. What is the approximate pH of a solution containing 0.25 M K_2CO_3 and 0.40 M $NaHCO_3$?

(A) 10.5 (B) 9.4 (C) 10.1 (D) 6.6

28. What is the approximate pH of a solution prepared by adding 0.70 mol of HNO_3 to 4 L of 0.40 M Na_2CO_3?

(A) 10.4 (B) 10.2 (C) 5.5 (D) 10.7

29. What is the approximate pH of a solution prepared by adding 2.40 mol of NaOH to 5 L of 0.40 M H_2CO_3 ?

(A) 5.9 (B) 10.9 (C) 9.0 (D) 9.7

30. What is the approximate ratio of concentrations, $[H_2CO_3]/[HCO_3^-]$, of a buffer solution with pH = 6.80?

(A) 2.7 (B) 1.5 (C) 0.4 (D) 0.7

31. 600 mL of 0.40 M NaOH(aq) is needed to completely neutralize a sample of aqueous H_3PO_4(aq). Approximately how many grams of H_3PO_4 (M=98 g/mol) were in the sample?

(A) 70.6 g (B) 7.8 g (C) 23.5 g

(D) Cannot be determined without the volume of the H_3PO_4 sample

32. Consider the slightly soluble salt, AB_3 . The solubility product constant for AB_3 is $K_{sp} = 6.0\times10^{-23}$. What is the solubility of AB_3 in a solution containing 0.05 M NaB(aq) (which is a strong electrolyte)?

(A) 1.8×10^{-20} M (B) 7.4×10^{-12} M (C) 4.8×10^{-19} M (D) 1.2×10^{-21} M

33. The enthalpy of vaporization of toluene is 39.2 kJ/mol and the normal boiling point is 111 °C.. What is the entropy change of the **system** when **2 (two) moles** of toluene gas condenses at 111 °C?

(A) -204 J/K (B) -102 J/K (C) -706 J/K (D) +102 J/K

34. The enthalpy of vaporization of liquid benzene, $C_6H_6(l)$, is +30.7 kJ/mol. What is the entropy change of the **surroundings** for the condensation of 0.50 mol of benzene gas at the boiling point, 80 °C?

(A) -43.5. J/K (B) -87 J/K (C) +87. J/K (D) +43.5 J/K

35. For the reaction, $CH_3OH(g) \rightleftarrows CO(g) + 2H_2(g)$, ΔH° = +91 kJ and ΔS° = +221 J/K. What is the entropy change of the **surroundings**, ΔS_{surr}, for the related reaction, $2CO(g) + 4H_2(g) \rightleftarrows 2CH_3OH(g)$, at 25 °C?

(A) +611 J/K (B) -442 J/K (C) -611 J/K (D) +442 J/K

36. For the hypothetical reaction, $A \rightleftharpoons B$, ΔS^o = -70 J/K (independent of temperature). The equilibrium constant for the reaction at 150 °C is 2.0×10^{-3}. What is the enthalpy change, ΔH^o for this reaction?

(A) +51.5 kJ (B) -7.8 kJ (C) -37.3 kJ (D) -51.5 kJ

37. The reaction, $A \rightarrow B$, is **exergonic** at 25 °C and the entropy change is -20 J/K. What can be concluded about the enthalpy change for this reaction?

(A) $\Delta H < -18$ kJ (B) $\Delta H > +6$ kJ (C) $\Delta H < -6$ kJ
(D) No conclusion can be made about ΔH

38. The equilibrium constant for the reaction, $4\ N_2O_5 \rightleftharpoons 4\ N_2(g) + 10\ O_2(g)$, is 5.8×10^{82} at 25 °C. What is the approximate value of the Gibbs Free Energy of Formation of $N_2O_5(g)$?

(A) +120. kJ/mol (B) +240. kJ/mol (C) -120 kJ/mol
(D) Insufficient data is given to determine $\Delta G_f^0(N_2O_5)$

For #39 - #40: The Enthalpy of Vaporization of Cl_2(liq) is 10.2 kJ/mol. The Entropy of Vaporization of Cl_2(liq) is 42.9 J/mol-K.

39. The Entropy change of the universe, ΔS_{univ}, when **3 (three)** moles of Cl_2(liq) **vaporizes** to Cl_2(gas) at -60 °C is approximately:

(A) +5.0 J/mol-K (B) -15.0 J/mol-K (C) -5.0 J/mol-K
(D) None of the above

40. The Gibbs Energy Change, ΔG^o, when **3 (three)** moles of Cl_2(gas) **condenses** to Cl_2(liq) at -60 °C is approximately:

(A) +1.8 kJ/mol (B) +3.2 kJ/mol (C) -1.0 kJ/mol (D) -3.2 kJ/mol

41. Regarding the reaction, $Br_2O_5(s) + 5\ CO(g) \rightarrow Br_2(l) + 5\ CO_2(g)$, which of the following statements is/are true?

(1) Br_2O_5 is the reducing agent
(2) Br_2 is oxidized
(3) CO is oxidized
(4) Br_2O_5 is reduced

(A) 1 & 2 (B) 3 & 4 (C) 2 & 3 & 4 (D) 1 & 2 & 4

42. For the electrochemical cell given by $Al|Al^{3+}||Cu^{2+}|Cu$, which of the following statements is/are correct?

(1) The cathode reaction is $Cu \rightarrow Cu^{2+} + 2e^-$
(2) Electrons flow from the Al electrode to the Cu electrode through an external circuit
(3) The anode reaction is $Al \rightarrow Al^{3+} + 3e^-$
(4) If the half-cells are separated by a K_2SO_4 salt bridge, SO_4^{2-} ions flow towards the Cu electrode

(A) 2 & 3 (B) 1 & 3 & 4 (C) 1 & 2 & 3 (D) 1 & 4

For #43 - #50: Use Table 1 (Standard Reduction Potentials) as needed.

43. Which of the following reactions are **reactant** favored?

(1) $Cl^- | Cl_2 || Hg^{2+} | Hg$ (2) $I^- | I_2 || Ag^+ | Ag$
(3) $Fe | Fe^{2+} || Ni^{2+} | Ni$ (4) $Ag | Ag^+ || Cu^{2+} | Cu$

(A) 2 & 3 (B) 1 & & 3 & 4 (C) 3 only (D) 1 & 4

44. For the electrochemical cell given by $Hg|Hg^{2+}||Be^{2+}|Be$, the cell potential is $E^o_{cell} = -2.71$ V. What is the **reduction potential** of Be^{2+}?

(A) -1.85 V (B) +3.57 V (C) -3.57 V (D) +1.85 V

.45. For the redox reaction given by $Fe|Fe^{3+}||Cu^{2+}|Cu$, the cell potential is: E^o_{cell} = +0.38 V. What is the equilibrium constant, K, for this reaction?

(A) $6.9\times10^{+12}$ (B) $3.3\times10^{+38}$ (C) $5.3\times10^{+16}$ (D) 3.1×10^{-39}

46. What is the standard Gibbs Free Energy change for the electrochemical reaction, $Ni^{2+} + 2\,I^- \rightarrow Ni + I_2$?

(A) -56 kJ (B) +56 kJ (C) +152 kJ (D) +76 kJ

47. Consider the following electrochemical cell reaction (values in parentheses indicate Molar Concentrations): $Al(s)|Al^{3+}(1.50\ M)||Mn^{2+}(0.002\ M)|Mn(s)$. Under standard conditions, the cell potential is E^o_{cell} = +0.48 V.

What is the approximate cell potential, E_{cell}, at the concentrations shown in the reaction?

(A) -0.40 V (B) +0.56 V (C) +0.73 V (D) +0.40 V

48. Consider a concentration cell, containing 0.10 M H^+ in the reference compartment (the cathode) and a solution containing H^+ in the sample cell (the anode) with pH = 3.50. (**Note: n = 1 for this cell**)

In cell notation, this can be written as: $H_2(g)|H^+(pH=3.50)||H^+(0.10\ M)|H_2(g)$. The cell potential, E_{cell} is approximately:

(A) +0.15 V (B) +0.34 V (C) -0.15 V (D) -0.21 V

49. The concentration of Arsenic [As, M=74.9] in drinking water was determined using a concentration cell with 0.40 M Arsenic(III) nitrate, $As(NO_3)_3$, in the reference cell (the cathode) and a sample of water with an unknown concentration of As^{3+}(xx) in the sample cell (the anode).
In cell notation, this can be written as: $As(s)|As^{3+}(xx)||As^{3+}(0.40\ M)|As(s)$.

The cell potential in the above concentration cell was measured to be +0.115 V. Therefore, the concentration of Arsenic in the sample, in **micrograms per Liter (μg/L)** is approximately:

(A) 280 μg/L (B) 3,900 μg/L (C) 45 μg/L (D) 111 μg/L

50. The solubility product of Li_3PO_4 is $K_{sp} = 3.2 \times 10^{-9}$. A Saturated solution of Li_3PO_4 is placed in the sample compartment (anode) of an electrochemical cell and a standard 2.00 M solution of LiCl (a strong electrolyte) is placed in the reference compartment (cathode). In cell notation, this can be written as:
$Li(s) \mid Li^+$(Saturated Solution) $\| Li^+(2.00\ M) \mid Li(s)$.

What will be the cell voltage, E_{cell} ?

(A) -0.052 V (B) +0.136 V (C) +0.052 V (D) +0.068 V

For #51 - #52: Use Table 2 (Some Reduction and Oxidation Potentials in Aqueous Solution) near the top of the test.

51. If aqueous Zn(II) Fluoride, $ZnF_2(aq)$ is placed in an electrolysis cell, and a voltage is applied, what will be the principal products of the electrolysis?

(A) Zn , F_2
(B) F_2 , H_2 , OH^-
(C) H_2 , OH^- , O_2 , H^+
(D) Zn , O_2 , H^+

52. If aqueous Aluminum Iodide, $AlI_3(aq)$ is placed in an electrolysis cell, and a voltage is applied, what will be the principal products of the electrolysis?

(A) Al , I_2
(B) I_2 , H_2 , OH^-
(C) H_2 , OH^- , O_2 , H^+
(D) Al , O_2 , H (C)

53. A current of 0.80 Amps (Coul/sec) is passed through a solution of Aluminum Nitrate, $Al(NO_3)_3(aq)$, for 7. hours. Approximately what mass of solid Aluminum, Al(s) [M=27], will be deposited at the cathode?

(A) 1.9 g (B) 1.3 g (C) 16.9 g (D) 5.6 g

54. Approximately how much energy (in kJ) is needed to plate out 90. grams of Sn(s) [M=118.7] by electrolysis from a solution containing $Sn(NO_3)_2(aq)$? Assume that the voltage is 9. Volts.

(A) 660 kJ (B) 2,050 kJ (C) 330 kJ (D) 1,320 kJ

55. The type of nuclides with the highest number of stable isotopes have a(n) ______ number of protons and ______number of neutrons

(A) even , odd (B) odd , even (C) even , even (D) odd , odd

56. What nuclide will undergo positron emission to form Ar-38 ?

(A) Ca-42 (B) Cl-38 (C) Cl-40 (D) K-38

57. Which of the following is a likely decay path for Ne-19. Stable isotopes in this range typically have N/Z = 1.0.

(A) ${}^{19}_{10}Ne \rightarrow {}^{0}_{-1}e + {}^{19}_{11}Na$ (B) ${}^{19}_{10}Ne \rightarrow {}^{4}_{2}He + {}^{15}_{8}O$

(C) ${}^{19}_{10}Ne \rightarrow {}^{0}_{+1}e + {}^{19}_{9}F$ (D) ${}^{19}_{10}Ne \rightarrow {}^{1}_{1}H + {}^{18}_{9}F$

58. Californium-252 (Cf-252) combines with an alpha particle to form a neutron and a new element. The new element is:

(A) Md-255 (B) Cm-249 (C) Md-256 (D) Fm-255

The last 2 questions are on the following page

59. Typical values of N/Z for stable nuclei rise with increasing atomic numbers because:

(A) More neutrons are required to form attractive interactions with the protons

(C) More long-range neutron-neutron attractions are required to counter the increasing short-range proton-proton repulsions

(B) Increased numbers of neutrons shield the short range proton-proton repulsions

(D) More short-range neutron-neutron attractions are required to counter the increasing long-range proton-proton repulsions.

60. Use the Molar Masses below to calculate the approximate Binding Energy per Nucleon (Eb/N) of Kr-92.

$m({}_1^1H) = 1.008$ g/mol , $m({}_0^1n) = 1.009$ g/mol , $m({}_{36}^{92}Kr) = 91.926$ g/mol

(A) 4.7×10^8 kJ/mol

(B) 8.5×10^8 kJ/mol

(C) 8.5×10^{11} kJ/mol

(D) 7.8×10^{10} kJ/mol