9
~~10~~ pages
2.5 hours

NAME: ANSWERS pg 1

# BLUEVALE COLLEGIATE INSTITUTE SCH4UI PRACTICE EXAM

Friday, January 27, 2012, 8:30am-11:00am

1. You may use a(n) i) non-programmable calculator, ii) exam aid sheet (8.5 x 11 double sided, must be handed in with exam), iii) periodic table provided.
2. No other electronic devices are permitted.
3. Keep your eyes on your own exam, looking at others' exams may result in a mark of ZERO!

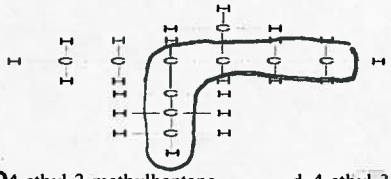
| | | |
|---|---|---|
| **PART A: Multiple Choice # (1-50)** | | **50 marks** |
| **PART B: Quicks # (51-70)** | | **20 marks** |
| **PART C: Calculations # (71-80)** | | **80 marks** |
| **Total:** | | **150 marks** |

**Part A: Multiple Choice.** Identify the letter of the choice that best completes the statement or answers the question. Transfer your answer on to the scantron card provided.

E **1. Name $CH_3CH(OH)CH_3$.**
a. iso-ethanol
b. tertiary-propanol
c. butanol
d. propanol
(e.) 2-propanol

C **2. Which organic compound is saturated?**
a. ethylcyclopentane
b. 2-methyl-3-ethylpentyne
(c.) 1,1-dimethylhexane
d. cyclohexane
e. 1,3,5-trimethyl-2-octene

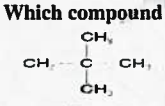
A **3. Name the following compound.**



(a.) 4-ethyl-3-methylheptane
b. 4-methyl-3-propylhexane
c. 3-propyl-4-methylhexane
d. 4-ethyl-3-methylhexene
e. 3-ethyl-4-propylheptane

C **4. Which feature do all aromatic hydrocarbons have?**
a. an amine groupd. an aldehyde group
b. halogens e. all double bonds in a ring
(c.) a benzene ring structure

D **5. Which compound is a structural isomer of the compound shown below?**



a. propane
b. butane
c. methane
(d.) pentane
e. hexane

C 6. **Which statement describes an oxidation reaction in organic chemistry?**
a. The product has fewer carbon-oxygen bonds than the reactant.
b. The product has one methyl group more than the reactant.
(c.) The product has more carbon-oxygen bonds than the reactant.
d. The product has more carbon-hydrogen bonds than the reactant.
e. Ring structures usually form.

C **7. What forms when water reacts with an alkene?**
a. an ester
b. an acid
(c.) an alcohol
d. an amine
e. a ketone

B **8. Which of the following statements is <u>false</u>?**
a. Different compounds with the same molecular formula are called isomers.
(b.) The most common intermolecular force for organic molecules is hydrogen bonding.
c. The carbon atoms of organic compounds may join together in long chains or rings.
d. In an electron-dot formula, four dots between a pair of atoms represents a double bond.

e. Alkanes, alkenes, and alkynes are all aliphatic hydrocarbons.

C **9. Considering the same number of carbons, which molecule would have the highest boiling point?**

a. alkane
b. aromatic
(c.) alcohol
d. amine
e. ether

amide > acid > alcohol > ketone ~ aldehyde > amine > ester > ether > alkane

B **10. Which of the following statements is false?**

a. In general, as the number of carbon atoms increases, we observe an increase in boiling points.
(b.) In the alkane class, branched chain isomers have higher boiling points than their straight-chain isomers.
c. Molecules of straight-chain alkanes are tetrahedral at each carbon.
d. As dispersion forces are the only type of intermolecular force between alkane molecules, alkanes would not be miscible with water.
e. Because of the weak intermolecular forces, alkanes have low densities compared to water.

B **11. An electron has the following set of quantum numbers:**

$n = 3, l = 1, m_l = 1, m_s = +\frac{1}{2}$.

**In which orbital is this electron found?**

a. 3*s*
(b.) 3*p*
c. 3*d*
d. 3*f*
e. 4*p*

E **12. Which set of quantum numbers is not possible?**

a. $n = 3, l = 0, m_l = 0, m_s = \frac{1}{2}$
b. $n = 5, l = 3, m_l = 2, m_s = \frac{1}{2}$
c. $n = 4, l = 3, m_l = -1, m_s = -\frac{1}{2}$
d. $n = 5, l = 3, m_l = -3, m_s = -\frac{1}{2}$
(e.) $n = 4, l = 4, m_l = 2, m_s = -\frac{1}{2}$

A **13. What did Heisenberg contribute to the quantum mechanical model of the atom?**

(a.) Uncertainty principle
b. Hund's rule
c. Aufbau principle
d. Wave equation

D **14. What did Schrodinger contribute to the quantum mechanical model of the atom?**

a. Uncertainty principle
b. Hund's rule
c. Aufbau principle
(d.) Wave equation

A **15. Which electron configuration represents a reactive non-metallic element?**

(a.) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$
b. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$
c. $1s^2\ 2s^2\ 2p^6\ 3s^2$
d. $1s^2\ 2s^2\ 2p^5\ 3s^2\ 3p^6$
e. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

E **16. What is the maximum number of electrons in $n = 3$?**

a. 2
b. 3
c. 6
(d.) 18
e. 9

$2n^2$

D **17. Which sublevel, when full, corresponds to the lanthanide series of elements?**

a. 3*d*
b. 3*f*
c. 4*d*
(d.) 4*f*
e. 5*f*

F **18. Which element has the highest electron affinity?**

a. Li
b. N
c. O
(d.) F
e. Ni

B **19. Which pair of atoms and/or ions is isoelectric?**

a. $O^{2-}$ and $Cl^-$
(b.) $Ca^{2+}$ and $Cl^-$
c. $F^-$ and $N^{2-}$
d. $Li^+$ and $Na^+$
e. $K^+$ and Kr

B **20. Which element has the lowest first ionization energy?**

a. Ca
(b.) Cs
c. Br
d. O
e. Ba

D **21. A 20.0 g sample of aluminum is cooled 7.5°C. The specific heat capacity of aluminum is 0.900 J/g•°C. What is the energy change for this sample?**

a. 140 kJ
b. −140 kJ
e. − 1.4 kJ
d. 140 J
(d.) −140 J

cooled → Q = −ve

$Q = mc\Delta T$
$= (20.0\text{g})(0.900\text{J/g°C})(-7.5\text{°C})$
$= -135\text{J} \doteq -140\text{J}$

B **22. Which statement describes an exothermic reaction?**
a. The energy absorbed in bond breaking is more than the energy released in bond formation.
(b.) The energy absorbed in bond breaking is less than the energy released in bond formation.
c. The system absorbs energy.
d. The surroundings cool down.
e. The potential energy of the reactants is less than the potential energy of the products.

C **23. Which statement does not describe an endothermic reaction?**
a. The surroundings cool down.
b. $\Delta H^{o}_{rxn}$ is positive.
(c.) Heat is released by the system.
d. Heat is absorbed by the system.
e. The potential energy of the products is greater than the potential energy of the reactants.

A **24. Which expression does not represent the rate of the following reaction?**

$$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$$

(a.) $\frac{\Delta[Mg]}{\Delta t}$ b. $\frac{\Delta[H_2]}{\Delta t}$ c. $-\frac{1}{2}\left(\frac{\Delta[HCl]}{\Delta t}\right)$ d. $\frac{\Delta[MgCl_2]}{\Delta t}$

would have to be $-\frac{\Delta[Mg]}{\Delta t}$

C **25. In the following reaction, what is equal to the rate of production of NO gas?**

$$4NH_{3(g)} + 5O_{2(g)} \rightarrow 4NO_{(g)} + 6H_2O_{(g)}$$

$RLF = \frac{CRLF}{KR}$

$\frac{\Delta[NO]}{\Delta t} = -\frac{4}{5}\frac{\Delta[O_2]}{\Delta t}$

a. the rate of production of $NH_3$ gas
b. one third the rate of production of water
(c.) four fifths the rate of disappearance of $O_2$ gas
d. one quarter the rate of disappearance of $NH_3$ gas
e. six times the production of water vapour

E **26. In the following reaction, butane is consumed at the rate of 0.0333 mol/(L•s). Determine the rate at which $CO_2$ is produced.**

$$C_4H_{10(g)} + \frac{13}{2}O_{2(g)} \rightarrow 4CO_{2(g)} + 5H_2O_{(g)}$$

$RLF = \frac{CRLF}{KR}$ $\frac{\Delta[CO_2]}{\Delta t} = \frac{4}{1}\frac{\Delta[C_4H_{10}]}{\Delta t} = 4[0.0333] = 0.133$

a. 0.008 25 mol/(L•s) b. 0.0165 mol/(L•s) c. 0.0333 mol/(L•s) d. 0.0667 mol/(L•s) (e.) 0.133 mol/(L•s)

D **27. Which statement about the factors that affect reaction rates is false?**
a. Decreasing the concentrations of the reacting particles decreases the chance of collision.
b. A collision with poor orientation requires a higher activation energy than a collision with optimum orientation.
c. Increasing the pressure in a gaseous reaction increases the chance of collision.
(d.) A reaction occurs every time particles of the reactants collide.
e. Increasing the temperature increases the reaction rate.

A **28. Given the following reaction mechanism, what is the equation for the overall reaction?**
$2A \rightarrow B + 2C$ (slow)
$B + C \rightarrow D + E$ (fast)
$C + D \rightarrow E + F$ (fast)
(a.) $2A \rightarrow 2E + F$ b. $2A + B + 2C \rightarrow D + 2E + F$ c. $2A + 2C \rightarrow 2E + F$ d. $2A + C \rightarrow 2E + F$

A **29. Which quantity does not increase when the temperature of a reaction system is raised?**
(a.) activation energy b. # of collisions c. # of effective collisions d. average kinetic energy of the particles

C **30. Which statement about the instantaneous rate of a reaction is not correct?**
a. The higher the rate, the greater is the slope of a line on a concentration-time graph.
b. The instantaneous rate is the slope of the tangent to a line on a concentration-time graph.
(c.) The instantaneous rate is the slope of the secant to a line on a concentration-time graph.
d. The instantaneous rate decreases over time.

C **31. A reaction quotient is calculated to be $3.2 \times 10^{-5}$. The equilibrium constant for the same reaction is $5.4 \times 10^{-5}$. Which statement is correct?**

Qc

$K_c > Q_c$ $\frac{[products]}{[reactants]}$ need more products →

a. The system is at equilibrium.
b. The concentrations of the products are greater than their concentrations at equilibrium.
(c.) The system will attain equilibrium by moving to the right.
d. The system will attain equilibrium by moving to the left.

A **32. What will happen if the pH of the following equilibrium system is increased?** i.e. made more basic ↑ $[OH^-]$

$$H^+_{(aq)} + 2CrO_4^{2-}{}_{(aq)} \Leftrightarrow Cr_2O_7^{2-}{}_{(aq)} + OH^-_{(aq)}\uparrow$$

yellow orange

(a.) The solution will turn yellow.
b. The solution will turn a darker orange.
c. The concentration of $H^+_{(aq)}$ will decrease.
d. All hydroxide ion will be used up.
e. The concentration of $OH^-_{(aq)}$ will increase.

ANSWERS pg. 4

A **33. Use Le Châtelier's principle to predict what will happen if $CoCl_4^{2-}$ is added to the following equilibrium system.** $Co(H_2O)_6^{2+}{}_{(aq)} + 4Cl^-{}_{(aq)} \Leftrightarrow CoCl_4^{2-}{}_{(aq)} + 6H_2O_{(l)}$
pink ← purple/blue
(a.) The solution will become more pink. c. The concentration of chloride will decreace.
b. The solution will become more purple. d. The pH of the system will increase.

C **34. If the equation in question 33 had a $K_c$ of 0.1, the reaction vessel would appear** $K_c < 1$ favours reactants
a. colourless b. blue (c.) pink d. purple/blue

C **35. What will happen to the following equilibrium if an inert gas is added while the volume remains constant?**
$2IBr_{(g)} \Leftrightarrow I_{2(g)} + Br_{2(g)}$
a. The concentration of IBr will increase. (c.) There will be no change to the equilibrium system.
b. The concentration of $I_2$ will increase. d. The concentration of $Br_2$ will decrease.

D **36. If the equation in question 35 has the pressure increased, what will happen to the equilibrium?**
a. The concentration of IBr will increase. c. The concentration of $I_2$ will increase.
b. The concentration of $Br_2$ will decrease. (d.) There will be no change to the equilibrium system. equal amount of gas moles on both sides

A **37. What is the relationship between the ion product and the solubility product constant when a precipitate forms?**
(a.) $Q_{sp} > K_{sp}$ b., $Q_{sp} \leq K_{sp}$ c., $Q_{sp} < K_{sp}$ d., $Q_{sp} = K_{sp}$

C **38. What is the conjugate acid of $H_2PO_4^-{}_{(aq)}$?** bases gain $H^+$
a. $H_3O^+{}_{(aq)}$ b. $OH^-{}_{(aq)}$ (c.) $H_3PO_{4(aq)}$ d. $HPO_4^{2-}{}_{(aq)}$

WHOOPS!!
**39. What is the conjugate acid of $H_2PO_4^-{}_{(aq)}$?**
a. $H_3O^+{}_{(aq)}$ b. $OH^-{}_{(aq)}$ c. $H_3PO_{4(aq)}$ d. $HPO_4^{2-}{}_{(aq)}$

A **40. What is the Brønstead-Lowry definition of a base?**
(a.) a substance that accepts protons c. a substance that dissolves in water to form $H^+$ ions
b. a substance that donates protons d. a substance that dissolves in water to form $OH^-$ ions

C **41. What is the oxidation number of P in $PO_3^{3-}$?**
a. −6 (c.) +3
b. −3 d. +6
e. +5
$P + 3(-2) = -3$
$P = +3$

B **42. How does the oxidation number of Bi change when $BiO_3^-$ reacts to form $Bi(OH)_3$?**
a. decreases by 3 c. no change
(b.) decreases by 2 d. increase by 1
e. increases by 4
$Bi + 3(-2) = -1$ $Bi = +5$
$Bi + 3(-2) + 3(+1) = 0$ $Bi = +3$

A **43. Using the following reaction, identify the OXIDIZING agent.** is reduced
$5\,VO^{2+} + MnO_4^- + H_2O \rightarrow 5\,VO_2^+ + Mn^{2+} + 2\,H^+$
(a.) Mn b. O c. V d. H e. not a redox reaction
$Mn^{+7} + 5e^- \rightarrow Mn^{2+}$

B **44. Which substance is the strongest oxidizing agent?** most easily reduced
a. Fe +0.44 c. $Cu^{2+}$ +0.34
(b.) $Br_2$ +1.23 d. $Zn^{2+}$ −0.76
e. $H_2$ 0

D **45. What does the double line || represent in galvanic cell notation?**
a. change in phase c. separation of electrodes
b. the anode (d.) salt bridge
e. electrolyte

B **46. Electrons leave the cathode of a battery and return through the anode.**
a. true (b.) false $e^-$ flow from anode to cathode

B **47. In a galvanic cell, oxidation occurs at the cathode.**
a. true (b.) false DR. I.O. from CROATIA

A **48. Corrosion will occur in aluminum faster than in iron because aluminum is higher on the activity series.**
(a.) true b. false

A **49. The oxidation number of an element increases as the element is oxidized**
(a.) true b. false

B **50. Reduction refers to the loss of electrons.**
a. true (b.) false

ANSWERS pg. 5



**Part B: Quicks:** Complete the following Quicks in the space provided. (20)

51. The IUPAC name of $H_3C - O - CH_2CH_3$ is methoxyethane
52. Ketones are reduced to produce 2° alcohols
53. Aldehydes are oxidized to produce carboxylic acids
54. The IUPAC name of the smallest possible carboxylic acid methanoic acid
55. The name of the product formed from the condensation of propanoic acid and N-ethylbutanamine
N-ethyl-N-butylpropanamide $CH_3CH_2C(=O)OH + H-N(-CH_2CH_3)(-CH_2CH_2CH_2CH_3)$
56. What is another correct name for methylethanoate? methyl acetate
57. Write the electron configuration for $Cl^-$ $1s^2 2s^2 2p^6 3s^2 3p^6$
58. Write the principle level distribution for $Ag^+$ [Kr] $4d^{10}$ $5s^2$ fill $4d^9$ to $4d^{10}$
59. What ion or atom has the principle level distribution [Ar] $4s^2$, charge = $4^+$? $Cr^{4+}$
60. When thermochemical equations are added to find ΔH of an unknown reaction is using Hess's Law
61. If the temperature of 50 g of water increased by 7°C, $Q_{gained}$ = 1464.4J
62. Reactions that make up steps in a reaction mechanism are called elementary steps
63. A catalyst (lowers **ΔH** OR lowers **activation energy** circle one _____
64. The units for the rate constant, k of a third order overall reaction is $L^2 \cdot mol^{-2} \cdot s^{-1}$
65. In an exothermic reaction the equation for ΔH with respect to $E_a$ forward and $E_a$ reverse is $\Delta H_{rxn} = E_{a\,forward} - E_{a\,reverse}$
66. What will you observe when $Q_{sp} > K_{sp}$ precipitate
67. What is the $[OH^-]$ in 1.0M $CH_2O_2H$, $K_a = 1.8 \times 10^{-4}$, pH = 3.1? $1.26 \times 10^{-11}$ M
68. The conjugate acid of $H_2PO_4^-$ (base) is $H_3PO_4$
69. Calculate $K_b$ when $K_a = 1.8 \times 10^{-6}$ $5.56 \times 10^{-9}$ $K_b = \frac{K_w}{K_a}$ $K_b = \frac{1.0 \times 10^{-14}}{1.8 \times 10^{-6}}$
70. The charge of Cr in $Cr_2O_7^{2-}$ is +6

61. $q = mc\Delta T$
$= (50g)(4.184 J/g°C)(+7°C)$

67. $pOH = 14 - pH$
$= 14 - 3.1$
$= 10.9$
$[OH^-] = 10^{-pOH}$
$= 10^{-10.9}$
$= 1.26 \times 10^{-11}$

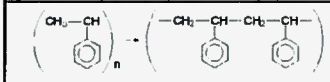
70. $2Cr + 7(-2) = -2$
$2Cr = 12$
$Cr = +6$

ANSWERS pg. 6

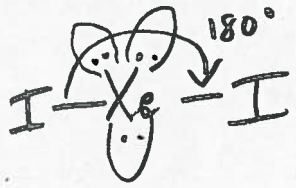
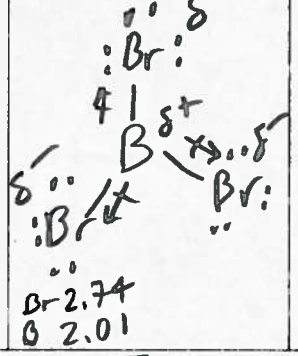
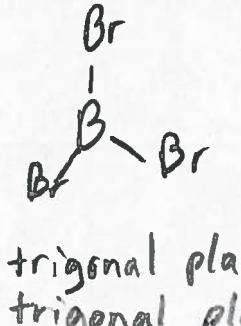


**Part C: Short Answer.** Complete the following questions in the space provided (80)
**Make sure to include FULL solutions to receive FULL marks **

**71.** Complete the following table. [ /10]

| Reaction | Type of reaction | Class of organic product |
|---|---|---|
| $CH_3CH_2OH + HCl \rightarrow CH_3CH_2Cl + H_2O$ | substitution halogenation | alkyl halide (chloroethane) |
| $CH_3CHOHCH_3 \xrightarrow[heat]{H_2SO_4} CH_2{=}CHCH_3 + H_2O$ | dehydration/ elimination | alkene (propene) |
| $CH_3CH_2CH_2{-}C(=O){-}OH + NaOH \rightarrow CH_3CH_2CH_2{-}C(=O){-}ONa + H_2O$ | neutralization/ basic hydrolysis | salt of ester (sodium butanoate) |
| $CH_3CH_2{-}C(=O){-}NHCH_3 + H_2O \xrightarrow[heat]{H_2SO_4} CH_3CH_2{-}C(=O){-}OH + H_2NCH_3$ | hydrolysis | carboxylic acid (propanoic acid) amine (methanamine) |
|  | addition polymerization | polymer |

**72. Complete the following table by drawing Lewis Structures for the following molecules: [ /10]**

| Molecule | Noble Gas e⁻ (0.5) | Valence e⁻ (0.5) | # of bonds (0.5) | # of lone e⁻ (0.5) | Lewis diagram *(Indicate co-ordinate covalent bonds, or resonance structures, where appropriate)* (1) | 3-D Diagram *(draw 3-D and include bond angles and name of the general and specific name of the shape)* (2) |
|---|---|---|---|---|---|---|
| $XeI_2$ | 1 Xe × 8e⁻ = 8 2 I × 8e⁻ = 16 × 24e⁻ 1 Xe × 10e⁻ 2 I × 8e⁻ 26e⁻ | 1 Xe × 8e⁻ 2 I × 7e⁻ 22e⁻ | 26−22 / 2 = 2 | Ve⁻ − Be⁻ = 22 − 4 = 18e⁻ | δ⁻ δ⁺ δ⁻ I — Xe — I Xe 2.6 I 2.21 0.39 |  General: trigonal bipyramidal Specific: linear NON-POLAR MOLECULE |
| $BBr_3$ | 1 B × 6e⁻ 3 Br × 8e⁻ 30e⁻ | 1 Br × 3e⁻ 3 Br × 7e⁻ 24e⁻ | 30−24 / 2 = 3 | 24 − 6 = 18 |  Br 2.74 O 2.01 0.73 |  General: trigonal planar Specific: trigonal planar NON-POLAR MOLECULE |

ANSWERS pg. 7

**73. The experimental data in the table below were collected for the following decomposition of $SO_2Cl_{2(g)}$. What is the rate law for this reaction? [ /10]**

$SO_2Cl_{2(g)} \rightarrow SO_{2(g)} + Cl_{2(g)}$

| Trial | Initial concentration of $SO_2Cl_{2(g)}$ (mol/L) | Initial reaction rate [mol/(L•s)] |
|---|---|---|
| 1 | 0.100 | $2.2 \times 10^{-6}$ |
| 2 | 0.200 | $4.4 \times 10^{-6}$ |
| 3 | 0.300 | $6.6 \times 10^{-6}$ |

✓ $r = k[SO_2Cl_2]^m$

✓ $\frac{rate\,2}{rate\,1} = \frac{[SO_2Cl_2]_2^m}{[SO_2Cl_2]_1^m}$

$\frac{4.4\times10^{-6}}{2.2\times10^{-6}} = \frac{0.200^m}{0.100^m}$

$2^1 = 2^m$

✓ $m = 1$

✓ trial 1

✓ $k = \frac{r}{[SO_2Cl_2]^1}$

$= \frac{2.2\times10^{-6}\ mol/(L\cdot s)}{0.100\ mol/L}$

✓ $= 2.2\times10^{-5}\ s^{-1}$

✓ ∴ the rate law is $r = 2.2\times10^{-5}\ s^{-1}[SO_2Cl_2]^1$

**74.** a) The initial concentration of morphine (a base), $C_{17}H_{19}NO_3$, in a solution is $3.6 \times 10^{-3}$ mol/L. The pOH of the solution is 4.53. Calculate $K_b$ for morphine. [ /8]

| Concentration | $C_{17}H_{19}NO_{3(aq)}$ | + $H_2O_{(l)}$ ⇔ | $C_{17}H_{20}NO_3^+{}_{(aq)}$ | + $OH^-{}_{(aq)}$ |
|---|---|---|---|---|
| Initial (mol/L) | $3.6\times10^{-3}$ | — | 0 | 0 |
| Change | $-x$ | — | $+x$ | $+x$ |
| Equilibrium (mol/L) | $3.6\times10^{-3}-x$ | — | $x$ | $x$ |

✓ $\approx 3.57\times10^{-3}$ $\doteq 2.95\times10^{-5}$ $\doteq 2.95\times10^{-5}$ M

✓ $[OH^-] = 10^{-pOH}$

$= 10^{-4.53}$

✓ $= 2.95\times10^{-5}$ M

✓ $K_b = \frac{[C_{17}H_{20}NO_3^+][OH^-]}{[C_{17}H_{19}NO_3]}$

$= \frac{[2.95\times10^{-5}][2.95\times10^{-5}]}{[3.57\times10^{-3}]}$

✓ $\doteq 2.44\times10^{-7}$

∴ the $K_b$ for morphine is $2.44\times10^{-7}$

b) Calculate the percent ionization of morphine. [ /2]

✓ % ionization $= \frac{[OH^-]}{[C_{17}H_{19}NO_3]} \times 100$

$= \frac{2.95\times10^{-5}}{3.6\times10^{-3}} \times 100$

✓ $= 0.82\%$

∴ the % ionization of morphine is 0.82%

ANSWERS pg 8.

**75.** 300.0 mL of 0.00325 mol/L barium chloride is added to an equal volume of 0.00400 mol/L sodium sulfate. What is the concentration of barium ions after the precipitation of barium sulfate ($K_{sp} = 1.50 \times 10^{-9}$) is complete? [ /10]

$[Ba^{2+}] = [BaCl_2] \times \frac{V_i}{V_f}$

$= [0.00325] \times \frac{300.0\,ml}{600.0}$

$= 0.001625M$

$[SO_4^{2-}] = [Na_2SO_4] \times \frac{V_i}{V_F}$

$= [0.00400] \times \frac{300.0ml}{600.0ml}$

$= 0.002M$

| Concentration | $BaSO_4(s)$ ⇌ | $Ba^{2+}(aq)$ + | $SO_4^{2-}(aq)$ |
|---|---|---|---|
| Initial (mol/L) | — | 0.001625 | 0.002 |
| Change | — | $-x$ | $-x$ |
| Equilibrium (mol/L) | — | $0.001625 - x$ | $0.002 - x$ |
| | | $\simeq 0.001625M$ | $\simeq 0.002M$ |

approx: $\frac{[Ba^{2+}]}{K_{sp}} \geq 500$?

$= \frac{[0.001625]}{1.50 \times 10^{-9}}$

$= 1.1 \times 10^6$

So $[]_i - x \simeq []_i$

∴ the $[Ba^{2+}(aq)]$ is 0.001625 M

**76. a)** Calculate the pH at equivalence when 20 mL of 0.20 mol/L $NH_{3(aq)}$ is titrated against 0.20 mol/L $HCl_{(aq)}$. $K_b$ for ammonia, $NH_3$, is $1.8 \times 10^{-5}$ [ /15]

weak base → salt will be acidic; strong acid

$NH_3(aq) + HCl(aq) \rightarrow NH_4^+(aq) + Cl^-(aq)$

$n_{NH_3} = CV$

$= (0.20)(0.02)$

$= 0.004\,mol$

$\frac{1\,mol\,NH_3}{0.004} = \frac{1\,mol\,HCl}{x}$

$x = 0.004\,mol\,HCl$

$V = \frac{n}{c}$

$= \frac{0.004mol}{0.20\,M}$

$= 0.02L$

$\frac{1\,mol\,NH_3}{0.004} = \frac{1\,mol\,NH_4^+}{x}$

$x = 0.004\,mol\,NH_4^+$

$C = \frac{n}{V}$

$= \frac{0.004mol}{0.04L}$

$= 0.1M$

| Concentration (mol/L) | $NH_4^+(aq)$ + | $H_2O(l)$ ⇌ | $NH_3(aq)$ + | $H_3O^+(aq)$ |
|---|---|---|---|---|
| Initial | 0.1 | — | 0 | 0 |
| Change | $-x$ | — | $+x$ | $+x$ |
| Equilibrium | $0.1 - x$ | — | $x$ | $x$ |

$K_a = \frac{K_w}{K_b}$

$= \frac{1.0 \times 10^{-14}}{1.8 \times 10^{-5}}$

$= 5.55 \times 10^{-10}$

approx: $\frac{[NH_4^+]}{K_a} \geq 500$

$\frac{0.1}{5.55 \times 10^{-10}}$

$\doteq 1.8 \times 10^8$

$\simeq 0.1$

So $[]_i \simeq []_{eq'm}$

$K_a = \frac{[NH_3][H_3O^+]}{[NH_4^+]}$

$5.55 \times 10^{-10} = \frac{[x][x]}{[0.1]}$

$x^2 = 5.55 \times 10^{-11}$

$x \doteq 7.45 \times 10^{-6} M$

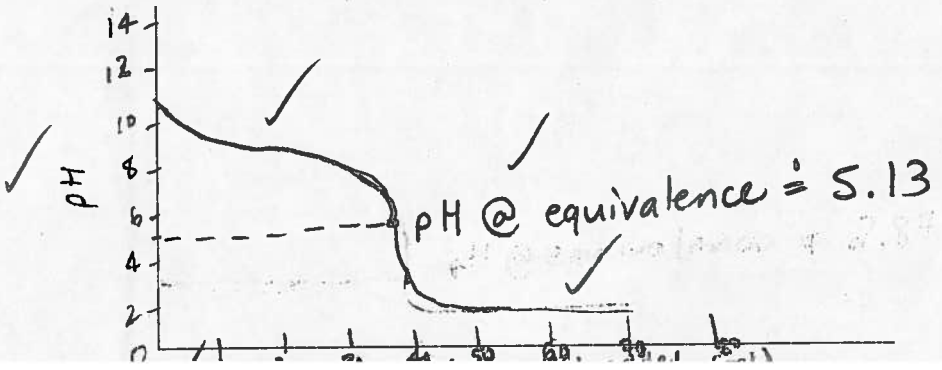
$pH = -\log[H_3O^+]$

$= -\log[7.45 \times 10^{-6}]$

$\doteq 5.13$

∴ the pH is 5.13 @ equivalence

**b) Draw a fully labeled titration curve for the titration in part a) [ /5]**



78. **The cell potential for the following galvanic cell is given.**

$$Zn_{(s)} \,|\, Zn^{2+}_{(aq)} \,||\, Pd^{2+}_{(aq)} \,|\, Pd_{(s)} \quad E^{\circ}_{cell} = 1.750\ V$$
$$Zn^{2+}_{(aq)} + 2e^{-} \rightarrow Zn_{(s)} \quad E^{\circ}_{cell} = -0.762\ V$$

**a) Determine the standard reduction potential for the following half reaction.** [ /3]

$$Pd^{2+}_{(aq)} + 2e^{-} \rightarrow Pd_{(s)}$$

$E^{\circ}_{cell} = E_{cathode} - E_{anode}$

$E_{cathode} = E^{\circ}_{cell} + E_{anode}$

$= 1.750 + (-0.762)$

$= 0.988\ V$

∴ the standard reduction potential for the cathode is $+0.988\ V$

**b) Draw a fully labeled diagram of this galvanic cell with a salt bridge of $NaNO_{3(aq)}$.** [ /7]