



SCIENCE OLYMPIAD
AT THE
UNIVERSITY OF FLORIDA

Northern Regional: January 19th, 2019

Chemistry Lab C Test

Name(s): _____

Team Name: _____

School Name: _____

Team Number: _____

Rank: _____

Score: _____



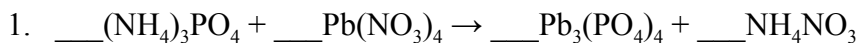
UFSO Chemistry Lab Test

Reminder: Do NOT write on this test itself (points will be deducted); please do all necessary work and place final answers on the Answer Sheet ONLY. Also, the point value is shown at the end of each question in parentheses, i.e. (1). Enjoy!

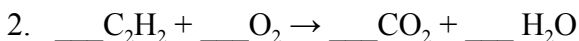
General Chemistry - Part 1 (51 points)

Balance the following chemical equations and identify the type of reaction. Write the sum of the coefficients of the empirical formula on your answer sheet on the indicated line.

(5 points each)



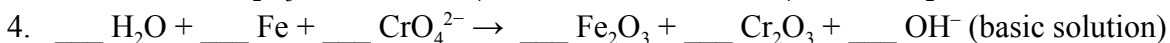
a. Type: $\underline{\hspace{5cm}}$



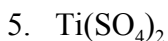
a. Type: $\underline{\hspace{5cm}}$

Balance the following Redox reactions in the indicated solutions. Write the sum of the coefficients of the empirical formula on your answer sheet on the indicated line.

(6 points each)



Name the following molecules. (1 point each)



Provide the molecular formulas for the following molecules. (1 point each)

10. Ammonium oxide

11. Silver acetate

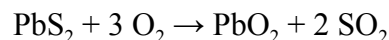
12. Nickel(III) sulfide

13. Zinc Fluoride

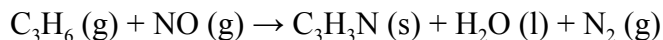
14. Neodymium bromide

Answer the following questions.

15. Write the balanced chemical formula for the following reaction (4): Lead(IV) sulfide reacts with oxygen gas to produce lead(IV) oxide and sulfur dioxide.

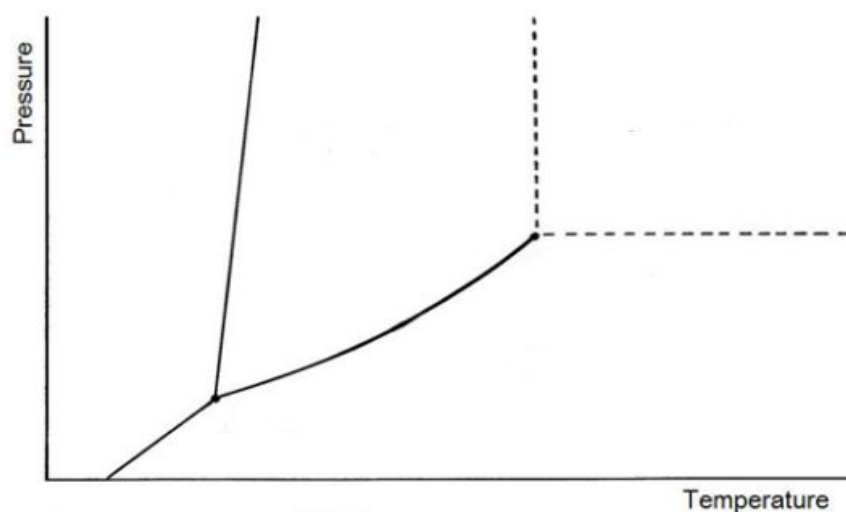


16. Balance the following reaction to use for the following questions: (5) (Tie-Breaker #4)



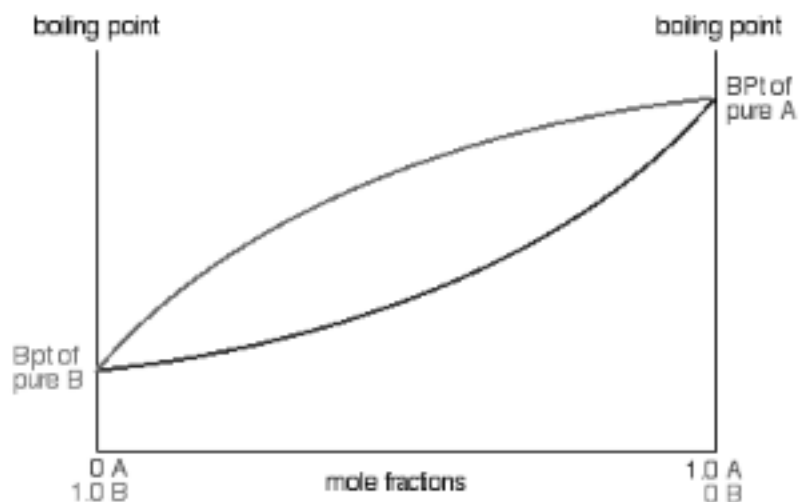
- Given 21.6 g of C_3H_6 and 21.6 g of NO , how many grams of $\text{C}_3\text{H}_3\text{N}$ can be produced? (2)
 - What is the limiting reactant of the reaction? (1)
 - Bill Nye performs the above reaction with the given amounts of reactants to produce 23.7 g of $\text{C}_3\text{H}_3\text{N}$. Calculate the percent yield of the reaction. (2)
17. List five examples of intrinsic properties and five examples of extrinsic properties. (5)

Physical Properties - Part 2 (57 points)

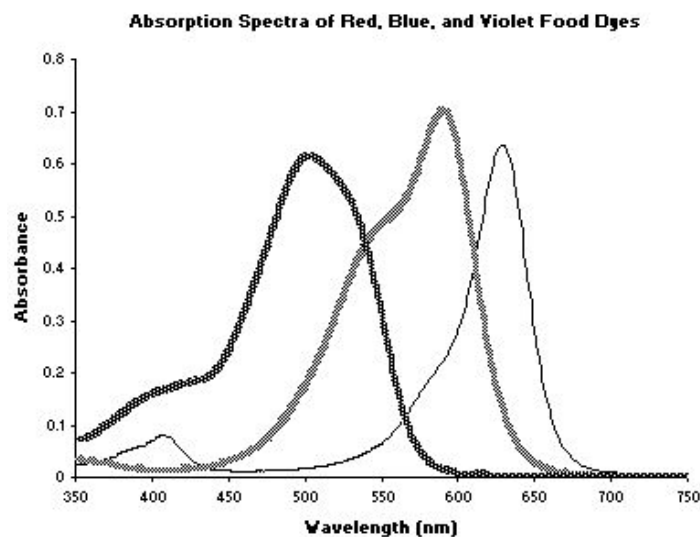


- Label the three states of matter in the phase diagram above. (3)
- Draw and label arrows in the phase diagram above to indicate the following processes: melting, freezing, sublimation, deposition, vaporization, and condensation. (6)
- What is a supercritical fluid? (2)
- Label the area of the phase diagram above where the substance would be a supercritical fluid AND label the critical point of the phase diagram. (2)
- What is the triple point of a substance? (1)
- Label the triple point of the substance on the phase diagram above. (1)
- Does the phase diagram above represent the substance water or carbon dioxide? How do you know? (5) (Tie-Breaker #1)

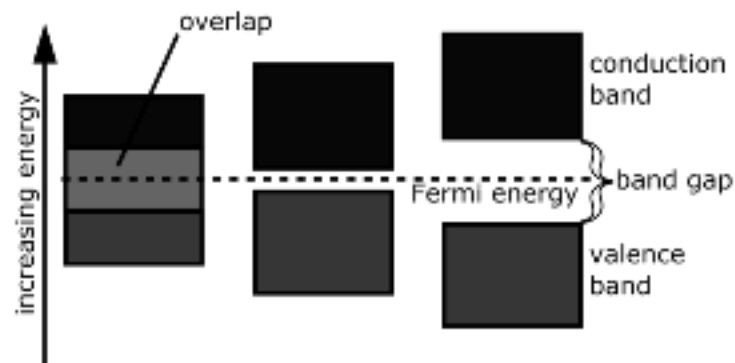
25. Label the curves in the multicomponent system diagram below to indicate which represents the vapour composition and which represents the liquid composition. (2)



26. Write the correct choices on the answer sheet: Adding a solute to a solution will (increase/decrease) the solution's freezing point and (increase/decrease) its boiling point. (2)
27. Explain the difference between ductility and malleability. (4)
28. Identify and describe the three main types of magnetism. (6) (Tie-Breaker #3)
29. Write out the electron configuration of Technetium. (1)
- Use the electron configuration of Technetium to describe its magnetic properties. (3)
30. For the absorption spectra of red, blue, and violet food dyes below, label which curve corresponds to each color dye. Use the letter R to indicate the red dye, B for the blue dye, and V for the violet dye. (3)



31. Label the following types of material in the band gap diagram below. (3)



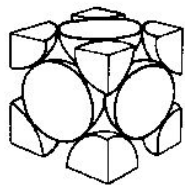
32. What does the band gap in the above diagram represent? (2)

Multiple Choice (1 point each)

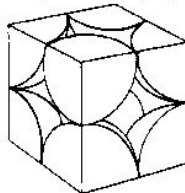
33. Which of the following is the strongest intermolecular force?

- Ionic bond
- Van der waals forces
- Dipole-Dipole forces
- Hydrogen bond

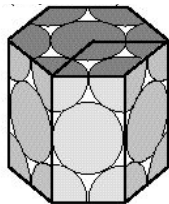
34. Which of the following shows a unit cell of Body Centered Cubic structure?



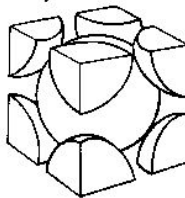
a.



b.



c.



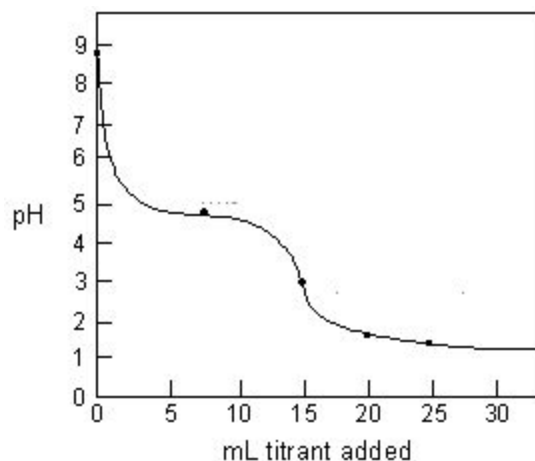
d.

35. Which of the following describes standard temperature and pressure conditions (STP)?
- 0°F; 1 atm
 - 0°C; 101.325 kPa
 - 298 K; 101.325 kPa
 - 273 K; 100 kPa
36. Determine the molality of an aqueous solution with a boiling point differing from that of pure water by 8.6°C. (The K_b of water = 0.512 °C · kg/mol)
- 17.3 mol/kg
 - 5.9 mol/kg
 - 14.8 mol/kg
 - 16.8 mol/kg
37. Which of the following is solid at STP conditions?
- Hg
 - Cl
 - Br
 - I
38. Which of the following is an extrinsic property?
- Freezing point
 - Mass
 - Color
 - Specific Heat Capacity
39. Which of the following elements is least electronegative?
- Br
 - Fe
 - F
 - O
40. At what temperature is water most dense?
- 3°C
 - 0°C
 - 2°C
 - 4°C
41. What is the most common oxidation number of oxygen in most compounds?
- 1
 - 2
 - 3
 - 4

42. What is the atomic packing factor of a face centered cubic structure?
- .52
 - .68
 - .74
 - .89
43. What is a coordination number?
- The number of electrons an atom will gain or lose in an ionic bond
 - The number of atoms directly surrounding a central atom
 - The number of atoms in a unit cell
 - The length of a bond between two atoms

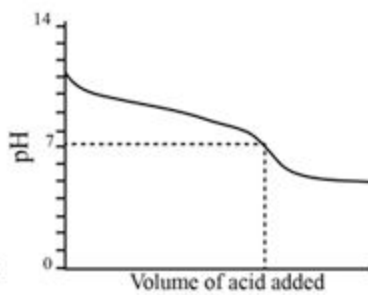
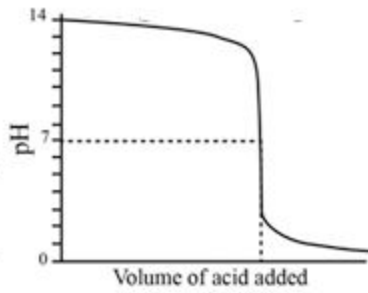
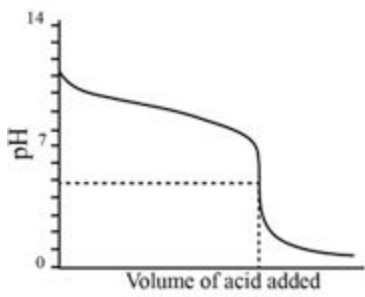
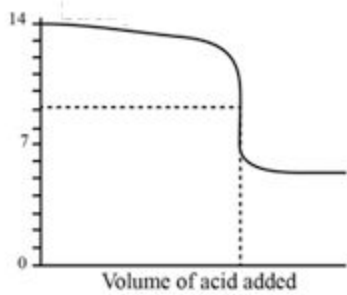
Acid/Base Equilibrium - Part 3 (43 points)

44. Label the following equivalence point and midpoint of the titration curve below. (2)



45. What is the Henderson-Hasselbach equation? (1)
46. Explain the difference between the equivalence point and end point of a titration. (4)
47. What is the K_a Value of strong acids? (1)
48. Increasing the number of oxygen in an oxoacid (increases/decreases) the strength of the acid. (1)
49. Explain why HF is a weak base, unlike HCl, HBr, and HI. (2) (Tie-Breaker #2)
50. Vitamin C is a common name for what acid? (1)
51. Phenolphthalein is a common pH indicator characterized by a color change from _____ to _____ when placed in an acidic solution. (1)
52. Define the three types of acids and bases. (6)
53. True or False: $(CH_3)_3B$ is a Lewis acid but not a Bronsted-Lowry acid. (1)

Identify the titration curves as strong acid- strong base, strong base- weak acid, weak base- strong acid, or weak acid- weak base. (The analyte is stated first, followed by the titrant) (1 point each)



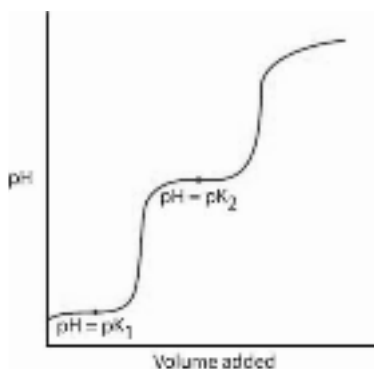
Determine if each of the following salts would produce a basic, acidic, or neutral solution in water. (1 point each)

58. NaNO_3
59. $(\text{NH}_4)_2\text{SO}_4$
60. CH_3COONa
61. KCl
62. RbCN
63. NaHCO_3
64. AlCl_3
65. Barium Chloride
66. Sodium Phosphate
67. Calcium Acetate
68. Ammonium Chloride

Multiple Choice (1 point each)

69. What is the hydroxide concentration in a solution with a pH of 2.4?
 - a. $6.72 \times 10^{-12} \text{ M}$
 - b. $3.98 \times 10^{-11} \text{ M}$
 - c. $3.98 \times 10^{-3} \text{ M}$
 - d. $5.03 \times 10^{-2} \text{ M}$
70. Which of the following is a strong acid?
 - a. NaOH
 - b. HClO_3
 - c. $\text{H}_2\text{C}_2\text{O}_4$
 - d. H_3PO_4
71. The overall dissociation constant of oxalic acid is 3.78×10^{-6} . Given that the second dissociation constant, K_2 , is 6.40×10^{-5} , what is the value of K_1 ?
 - a. 2.01×10^{-6}
 - b. 8.34×10^{-3}
 - c. 6.31×10^{-4}
 - d. 5.91×10^{-2}

72. How many hydrogen ions can be donated by the acid in the titration curve shown below?



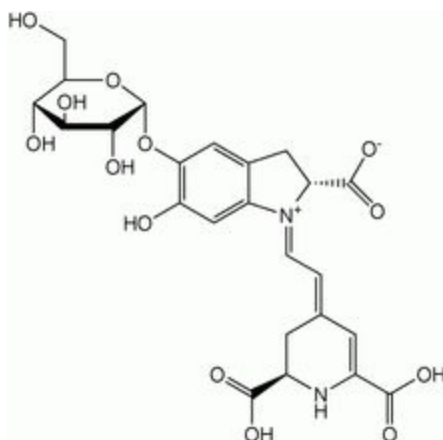
- 1
 - 2
 - 3
 - 4
73. What is the pH of a 0.015-M aqueous solution of MgOH?
- 12.48
 - 4.38
 - 12.18
 - 1.52
74. Which of the following is the strongest acid?
- HClO ($K_a = 3.0 \times 10^{-8}$)
 - HCHO₂ ($K_a = 1.8 \times 10^{-4}$)
 - HF ($K_a = 6.8 \times 10^{-4}$)
 - HOAc ($K_a = 1.8 \times 10^{-5}$)
75. What is the % ionization of hypochlorous acid in a 0.015-M aqueous solution of HClO at 25°C? (K_a of HClO = 3.0×10^{-8})
- 0.14
 - 28
 - .0014
 - 0.027
76. Ammonium is a...
- Strong base
 - Polyprotic acid
 - Weak base
 - Weak acid

Lab Activity - Part 4 (49 points)



One day at the office, Dwight Schrute decided he needed to organize and clean the kitchen to improve efficiency. Unfortunately, he realized that the labels had been removed from everything in the kitchen, including the cleaning supplies! Dwight immediately recognized this situation as the work of Jim Halpert, the office prankster. But Dwight doesn't hesitate, for he instantly knows how to easily identify which solution is which.

What Dwight realizes is that with beets from his farm, he can extract a natural pH indicator, Betanin (pictured below), which can be used to help identify the substances.



Luckily, Dwight manages to identify all of the substances except two, which he has narrowed down to being either Lye (Drain Cleaner) or an aqueous solution of baking soda. Using the beet juice and other provided materials, determine the identities of mystery solutions A and B and answer the following questions.

Materials

You have been provided with 10 mL of both Mystery Solutions A and B, along with gloves which MUST be worn at all times, and the beet juice to use as an indicator.

Procedure

Add the beet juice using a pipette (which you should have brought to the competition) into mystery solution A one drop at a time. Record the color change that occurs. Do the same with mystery solution B.

Analysis

The natural indicator, Betanin, found within the beet juice has a working pH range of approximately 10.8 to 11.2. During this pH range, as the indicator is in a solution that is increasing in pH, the indicator will cause a change in color from red to yellow. The concentration of lye that has been provided as either mystery solution A or B has a pH of approximately 14. Meanwhile, the baking soda solution that has been provided has a pH of approximately 9.5.

Use this information to fill in the following table on your answer sheet and answer the related questions.

	Color Change (5 points each)	pH (>11 or <11) (5 points each)	Identity of Solution (10 points each)
Solution A			
Solution B			

77. What is the scientific name for lye? (2)
78. Calculate the pH of a 3.2-M solution of lye. (2)
79. Write the net ionic equation of the dissociation of lye into water. (4)
80. What is molecular formula of baking soda (sodium bicarbonate)? (1)

Reference

Periodic Table of the Elements

1

18

1 H Hydrogen 1.01	2 He Helium 4.00
----------------------------	---------------------------

Key to Symbols
 Fe naturally occurring elements on Earth
 Te synthetic elements on Earth
 () Atomic mass values listed in parentheses are those of the element's most stable or most common isotopes.
 * The systematic names and symbols for elements greater than 112 will be used until the approval of trivial names by IUPAC.
 † Estimated from currently available IUPAC data.

3 Li Lithium 6.94	4 Be Beryllium 9.01	5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (97.91)	44 Ru Ruthenium 101.07
55 Cs Cesium 132.91	56 Ba Barium 137.33	57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (144.91)	62 Sm Samarium 150.36
87 Fr Francium (223.02)	88 Ra Radium (226.03)	89 Ac Actinium (227.03)	104 Rf Rutherfordium (261.11)	105 Db Dubnium (262.11)	106 Sg Seaborgium (263.12)	107 Bh Bohrium (262.12)	108 Hs Hassium (265)†
			109 Mt Meitnerium (266)†	110 Ds Darmstadtium (271)†	111 Rg Roentgenium (272)†	112 Cn Copernicium (285)†	113 Uut Ununtrium (286)†
			114 Uuq Ununquadium (289)†	115 Uup Ununpentium (289)†	116 Uuh Ununhexium (289)†	117 Uus Ununseptium (289)†	118 Uuo Ununoctium (293)†

58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (144.91)	62 Sm Samarium 150.36	63 Eu Europium 151.97	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97
90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237.05)	94 Pu Plutonium 244.06	95 Am Americium (243.06)	96 Cm Curium (247.07)	97 Bk Berkelium (247.07)	98 Cf Californium (251.08)	99 Es Einsteinium (252.08)	100 Fm Fermium (257.10)	101 Md Mendelevium (258.10)	102 No Nobelium (259.10)	103 Lr Lawrencium (262.11)

f - Block

s - Block

d - Block

p - Block