Chemistry Lab

Acids and Bases, Aqueous Solutions

Captains Tryouts Division C

John P. Stevens High School

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Score: ___/95

<u>Multiple Choice:</u>

1. Which of the following is not a characteristic of an acid? (1)
   a. Corrosive
   b. Turns red litmus paper blue
   c. Tastes sour
   d. Conducts Electricity

2. In the following reaction, what does water act as? $H_2O + H_2O \rightarrow H_3O^+ + OH^-$ (1)
   a. An Arrhenius acid
   b. A Brønsted-Lowry base
   c. A Lewis acid
   d. All of the above

3. What is the pH of a 0.05 M hydrosulfuric acid given its $K_a = 1.0 * 10^{-7}$? (1)
   a. 3.0
   b. 4.0
   c. 4.4
   d. 5.7

4. Which of the following reactions will not result in a precipitate? (1)
   a. $Pb(NO_3)_2 + 2NaI \rightarrow PbI_2 + 2NaNO_3$
   b. $NaF + AgCl \rightarrow NaCl + AgF$
   c. $Na_2CO_3 + SrCl_2 \rightarrow 2Nacl + SrCO_3$
   d. $MgSO_4 + BaCl_2 \rightarrow MgCl_2 + BaSO_4$

5. Fill in the following table below: (2)

Model	Acids	Bases
Arrhenius		
Bronsted-Lowry		
Lewis		

6. What volume of a 0.20 M sulfurous acid is needed to neutralize 150 mL of 1.70 M sodium hydroxide? (2)

a. 640 mL
b. 1280 mL
c. 520 mL
d. 870 mL

7. If in an aluminum hydroxide solution the $[Al^{3+}] = 2.4*10^{-2}$ and $[OH^-] = 8*10^{-3}$, which of the following best describes the solution? (K_{sp} of $Al(OH)_3$ is $1.8 * 10^{-5}$) (2)
   a. Unsaturated
   b. Concentrated
   c. Saturated
   d. Supersaturated

8. A precipitate will form if: (1)
   a. Ion product is less than the solubility product
   b. There is an excess of one reactant
   c. $Q > K_{sp}$
   d. K_{sp} is positive

9. Which of the following is the strongest base? (1)
   a. NO_3^-
   b. H_2CO_3
   c. NH_3
   d. LiOH

10. How many grams of NaCl are dissolved in 2.5 liters of a 0.7 M NaCl solution? (1)
    a. 72 g
    b. 217 g
    c. 35 g
    d. 102 g

11. Which of the following mixtures is a colloid? (Select all that apply) (3)
    a. Milk
    b. Muddy water
    c. Jelly
    d. Oil paint
    e. Dressing
    f. Whipped Cream

12. What is the molar mass of a covalent compound given that when 120 g of it is placed in 0.4 kg of water, the new freezing point is -5.84 °C? (2)
    a. 84 g
    b. 53 g
    c. 19 g
    d. 151 g

13. The [OH⁻] at the half-equivalence point in a titration was found to be $1.6 * 10^{-10}$. What is the value of K_a for this acid? (2)
    a. 1.8
    b. 4.2
    c. 8.0
    d. 6.7

14. The K_{sp} of PbI_2 is $1.4 * 10^{-8}$. What is its molar solubility? (1)
    a. $1.5 * 10^{-3}$ M
    b. $1.1 * 10^{-4}$ M
    c. $2.5 * 10^{-2}$ M
    d. $0.7 * 10^{-8}$ M

15. Which of the following would not increase the solubility of silver chloride? (1)
    a. Increasing the temperature
    b. Adding sodium chloride to the solution
    c. Agitation of the solution
    d. Grinding the solute into smaller sized particles

16. Mixing equal volumes of which of the following pairs of solutions would give an acidic solution? (2)
    a. 1.2 M barium hydroxide and 1.2 M nitric acid
    b. Carbonic acid with a pH of 5 and ammonia with a pH of 10
    c. An acid with a pH of 4.6 and a base with a pOH of 1.5
    d. 0.7 M cesium hydroxide and 0.5 M sulfuric acid

17. A solution with a concentration of 0.34 M is measured to have an absorbance of 0.57. Another solution of the same chemical has an absorbance of 0.23 when measured under the same conditions. What is its concentration? (2)
    a. 0.14 M
    b. 0.84 M
    c. 0.045 M

d. 1.3 M

18. Which of the following laws describe the relation between pressure and dissolved gas?(1)
    a. Charles' Law
    b. Raoult's Law
    c. Henry's Law
    d. Dulong–Petit Law

19. Which of the following pairs are not miscible? (1)
    a. CH_3CN and $(CH_3CH_2)_2NH$
    b. $CH_3CH_2OCH_2CH_3$ and CCl_2F_2
    c. C_5H_{12} and C_6H_{14}
    d. CCl_4 and H_2O

20. What is the molarity of a $Ca(NO_3)_2$ solution if it is 6.5% $Ca(NO_3)_2$ by mass and has a density of 1.19 g/ml? (2)
    a. 1.27 M
    b. 0.47 M
    c. 0.11 M
    d. 0.73 M

Free Response:

Show your work whenever needed. Circle your answer.

1. Create the equilibrium expression of a solution of NH_3 (3)

2. You performed two titrations to the endpoint. Calculate the molarity of the two following analytes given the data below: (4)

   a.

KOH	55 mL	0.6 M
HI	30 mL	? M

   b.

$Ca(OH)_2$	95 mL	? M
HCl	35 mL	1.6 M

3. A solution contains 1.5 M HF and 0.85 M F. Given the K_a of HF is 6.46 x 10^{-4} , calculate the pH. (5)

4. Calculate the percent dissociation of 0.05 M (theoretical acid) HA, given $K_a = 1.5*10^{-9}$ (5)

5. Calculate the K_{sp} for the individual salts given molar solubility of Ag_2S: $9.2 * 10^{-23}$ (4)

6. How much water would you need to add to 150 mL of a 7.25 M KCl solution to make a 2.00 M solution? (3)

7. Describe briefly how to perform a titration. Be sure to use proper word choice. (5 points)

8. A solution consists of 7.25 g of carbon tetrachloride mixed with 215.0 g water. Calculate the molality, molarity, mass percent, and mole fraction. (4 points)

9. Calculate the pH of a buffer that is made from 0.52 M hydrocyanic acid (HCN) and 0.45 M cyanide (CN^-). Assume the K_a of HCN is $6.2*10^{-10}$ (5 points)

10. 40.9 grams of sulfuric acid were added into 365 mL water. Calculate the change in freezing point. (K_f water = 1.86 °C kg*mol^{-1}, density of water = 0.994 g/mL) (3)

11. Order the following acids in terms of increasing acidity and explain your reasoning: $HSeO_4$, $HAsO_3$, $HBrO_4$, H_3AsO_4 (5)

12. Describe how a buffer functions, state an example, and write its respective dissociation reaction. (5)

13. Determine the Lewis acid and base in the following reaction. (2 points) Draw the Lewis structure for each reactant and product. (3 points) Reaction: $BF_3 + NH_3 \rightarrow NH_3BF_3$

14. The table below shows the relationship between the absorbance of a solution and its concentration at some constant path length.

Concentration	Absorbance
0.225 M	0.072
0.527 M	0.168
0.923 M	0.458
1.433 M	0.682

a. If the molar absorptivity constant for the solution is 0.30 L mol⁻¹cm⁻¹, what is the path length? (1 point)

b. What is the absorbance when the concentration is 0.432 M and the path length is doubled? (1 point)

c. Calculate the transmittance of the solution from part b. (1 point)

d. If the intensity of the light entering the detector for the solution from part b is 0.42 W/m², what is the intensity of the incident light on the sample? (1 point)

15. Calculate the pH of 3.5 M $H_2C_6H_6O_6$ in an aqueous solution. $K_{a1} = 7.9*10^{-5}$ and $K_{a2} = 1.6*10^{-12}$ (5)

Periodic Table of the Elements
amu to 4 significant figures

1 / 1A	2 / 2A	3 / 3B	4 / 4B	5 / 5B	6 / 6B	7 / 7B	8 / 8B	9 / 8B	10 / 8B	11 / 1B	12 / 2B	13 / 3A	14 / 4A	15 / 5A	16 / 6A	17 / 7A	18 / 8A
1 H 1.008																	2 He 4.003
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
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 47.88	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 65.39	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 (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
55 Cs 132.9	56 Ba 137.3	57 La 138.9	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)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (281)	111 Rg (272)	112 Cn (285)	113 (Uut) (284)	114 Fl (289)	115 (Uup) (288)	116 Lv (293)	117 (Uus) (294)	118 (Uuo) (294)

Lanthanide Series

58 Ce 140.1	59 Pr 140.9	60 Nd 142.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0

Actinide Series

90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	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)	103 Lr (262)