You may remove this page.

$pH = -\log[H^+]$, $[H^+] = 10^{-pH}$	$M_cV_c = M_dV_d$
$pH + pOH = 14$	$N_A = 6.02 \times 10^{23}\ mol^{-1}$

Periodic Table of the Elements

1 IA 1A	2 IIA 2A	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 (VIII 8)	9 VIII 8	10 (VIII 8)	11 IB 1B	12 IIB 2B	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A
1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [280]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]

Lanthanide Series	57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.243	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967
Actinide Series	89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]

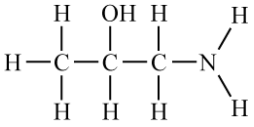
Please write legibly! If I can't read it, I can't grade it!

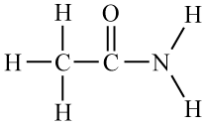
JBA 2017 – Chemistry Exam 3

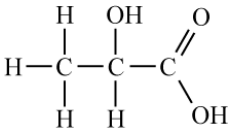
Name:_____ Score:_____/100 = _____/80

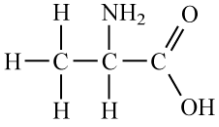
Multiple choice questions are worth two points each.

1. Amino acids are compounds that contain **both** amine and carboxylic acid groups. Which compound is an amino acid?

a. 

c. 

b. 

d. 

Answer ___d____

2. If acids are compounds that release protons (H^+), how is it that SO_x and NO_x cause acid rain?

   a. They react with hydrogen gas in the atmosphere to produce acids.
   b. There is not sufficient evidence to indicate that these compounds actually do cause acid rain.
   c. They react with water to form acids.
   d. They react with ammonia to form acids.

Answer ___c____

3. The compound CH_3NH_2 reacts with water to form $CH_3NH_3^+$ and OH^-. In this reaction, CH_3NH_2 is acting as a(n)

   a. salt
   b. base
   c. acid
   d. solvent

Answer ___b____

4. H_3O^+ is called the

   a. hydroxide ion
   b. hydrogen ion
   c. hydrate ion
   d. hydronium ion

Answer ___d____

5. If the concentration of a dilute solution of nitric acid (HNO_3) is 0.00010 M, what is the pH of that solution?

   a. 14.0
   b. 7.0
   c. 4.0
   d. 5.0

Answer ___c____

6. The pH of a sample of water from a river is 6.0. A sample of wastewater from a food processing plant has a pH of 4.0. The concentration of hydronium ion in the wastewater is

   a. two times *larger* than the river hydronium ion concentration.
   b. one hundred times *larger* than the river hydronium ion concentration. Answer ___b____
   c. two times *smaller* than the river hydronium ion concentration.
   d. one hundred times *smaller* than the river hydronium ion concentration.

7. The primary structure of a protein is determined by

   a. the intertwining of protein molecules.
   b. the order of amino acids in the protein.
   c. the hydrogen bonding that gives the protein three-dimensional shape. Answer ___b____
   d. the amino acid composition.

8. All of the following examples are classified as potential energy except

   a. energy in chemical bonds.
   b. energy of a moving object.
   c. energy in nuclear particles. Answer ___b____
   d. energy stored by position.

9. There are only four amine-containing bases that comprise DNA. Which of the following bases is not found in DNA (but is found in RNA)? (Hint check your powerpoint notes)

   a. adenine
   b. guanine.
   c. cytosine. Answer ___d____
   d. uracil.

10. What volume of 2.00 M HCl is required to prepare 100 mL of 0.200 M HCl?

   a. 0.11 mL
   b. 1.0 mL
   c. 10 mL Answer ___c____
   d. 100 mL

11. Match the term with its definition. (10 points)

__E__ pH	A. a concentration term expressed in moles per liter
__F__ solvent	B. a water insoluble compound containing at least one carbon-carbon multiple bond
__A__ molarity	C. an substance that donates 2 protons (H^+)
__C__ diprotic acid	D. a compound with the formula $C_n(H_2O)_n$.
__B__ unsaturated fat	E. $-\log[H^+]$
__D__ carbohydrate	F. the substance in which a solute is dissolved
__I__ state function	G. the species that forms when an acid has donated its proton
__G__ conjugate base	H. a water insoluble compound with no carbon-carbon multiple bonds
__J__ enzyme	I. a thermodynamic concept that does not depend on pathway (or mechanism).
__H__ saturated fat	J. a biochemical catalyst

12. Write reactions for the following: (2 points each)

a. The dissociation of nitric acid (HNO_3, a strong acid)

$$HNO_3 \rightarrow H^+ + NO_3^-$$

b. The dissociation of calcium hydroxide ($Ca(OH)_2$, a strong base)

$$Ca(OH)_2 \rightarrow Ca^{2+} + 2OH^-$$

c. The reaction of hydrochloric acid (HCl) with potassium hydroxide (KOH).

$$HCl + NaOH \rightarrow NaCl + H_2O$$

Please write legibly! If I can't read it, I can't grade it!

13. Complete the following table: (10 points)

Compound	Molarity	pH	pOH	Acidic, Basic or Neutral?
H_2SO_4	0.012 M	1.62	12.38	Acidic
KOH	0.0035 M	11.54	2.46	Basic

14. You dissolved 38.0 g of glucose ($C_6H_{12}O_6$) in 0.750 L. What is its molarity? (8 points)

$$38.0\text{ g } C_6H_{12}O_6 \times \frac{1\text{ mol } C_6H_{12}O_6}{180.16\text{ g } C_6H_{12}O_6} = 0.211\text{ mol } C_6H_{12}O_6$$

$$\frac{0.211\text{ mol } C_6H_{12}O_6}{0.750\text{ L}} = 0.281\text{ M } C_6H_{12}O_6$$

15. In a beaker, you mix 35.0 mL of 0.100 M HNO_3 and 30.0 mL of 0.200 M NaOH (8 points)
(NOTE there was a typo on the original exam so only part a was graded)

a. Write the balanced reaction that you would expect to occur. (2 points)

$$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$$

b. When the reaction is complete, will the resulting solution be acidic, basic, or neutral? Explain your decision. (6 points)

We have

$$0.035\text{ L } HNO_3 \times \frac{0.100\text{ mol } HNO_3}{1\text{ L}} = 0.0035\text{ mol } HNO_3$$

and

$$0.030\text{ L NaOH} \times \frac{0.200\text{ mol NaOH}}{1\text{ L}} = 0.0060\text{ mol NaOH}$$

Since we have more moles of NaOH than HNO_3 and since the stoichiometry is 1 mol HNO_3 per 1 mol NaOH, HNO_3 must be the limiting reactant. Therefore, NaOH will remain and since NaOH is a strong base, the solution will be basic.

16. What is the purpose of a catalyst in a chemical reaction? How do enzymes accomplish this purpose? (8 points)

Catalysts increase the rate of a reaction without themselves being consumed in the reaction. They accomplish this by providing an alternate mechanism with a lower activation energy. Enzymes accomplish this by holding molecules in a specific position to allow the reaction to occur.

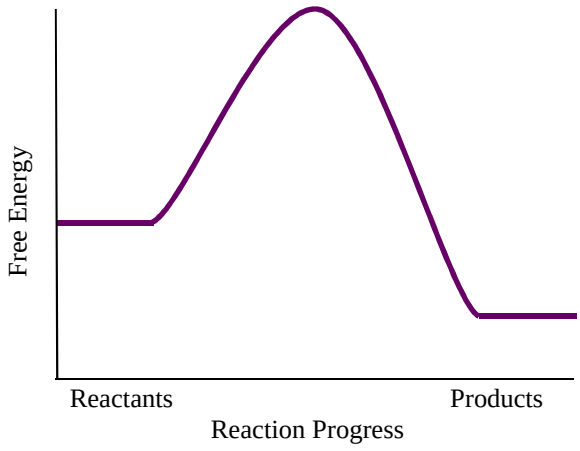
17. In the copper lab, we used 15 mL of 3.0 M sodium hydroxide solution to begin the alloy formation. How many grams of NaOH are present in 15 mL of 3.0 M NaOH? (8 points)

$$0.015 \text{ L NaOH} \times \frac{3.0 \text{ mol NaOH}}{1 \text{ L}_6} = 0.045 \text{ mol NaOH}$$

$$0.045 \text{ mol NaOH} \times \frac{40.00 \text{ g NaOH}}{1 \text{ mol NaOH}_6} = 1.8 \text{ g NaOH}$$

18. Draw a reaction coordinate diagram below for a spontaneous (favorable) process. Label the axes and describe how information related to the tendency and rate of the reaction can be extracted from such a diagram. (10 points)

Your diagram for the spontaneous and slow reaction should bear some resemblance to the picture below and meet the following requirements: 1) the axes must be labeled, 2) the free energy for the reactants must be higher than the free energy of the products so that ΔG is negative (spontaneous), 3) the size of the activation barrier (hill) must be present, and relatively large to indicate a slow reaction. Your discussion should point out these items and how the tendency is determined by the relative energies of the reactants and products and the rate is determined by the activation energy.



19. Hydrochloric acid (HCl) is classified as a strong acid, while acetic acid (CH_3COOH) is classified as a weak acid. Explain what these terms mean. If you could examine a solution of HCl and a separate solution of acetic acid on a molecular level, what would you expect to see in each? (8 points)

Strong acids dissociate completely, while weak acids do not. In a solution of HCl, we would expect to find only H^+ and Cl^-, but no "HCl".In a solution of CH_3COOH, we would expect to find H^+, CH_3COO^-, but also a significant amount of CH_3COOH. A diagram may be useful.

20. Ammonia gas can be created by heating ammonium chloride and calcium hydroxide. Calcium chloride and water are also produced as products. You conduct an experiment where 25.0 mL of 5.89 M ammonium chloride solution is slowly added to 33.0 grams of solid calcium hydroxide while the mixture is heated.

a. Balance reaction for this process. (2 points)

$$2\,NH_4Cl(aq) + 1\,Ca(OH)_2(s) \rightarrow 2\,NH_3(g) + 1\,CaCl_2(s) + 2\,H_2O(l)$$

b. How many moles of ammonium chloride are introduced to the reaction? (3 points)

$$0.025\ L\ NH_4Cl \times \frac{5.89\ mol\ NH_4Cl}{1\ L_6} = 0.1473\ mol\ NH_4Cl$$

c. How many moles of calcium chloride are introduced to the reaction? (3 points)

$$33.0\ g\ Ca(OH)_2 \times \frac{1\ mol\ Ca(OH)_2}{74.09\ g\ Ca(OH)_{26}} = 0.445\ mol\ Ca(OH)_2$$

d. What mass of ammonia is formed? (4 points)

If NH_4Cl is limiting reactant:

$$0.1473\ mol\ NH_4Cl \times \frac{2\ mol\ NH_3}{2\ mol\ NH_4Cl} \times \frac{17.03\ g\ NH_3}{1\ mol\ NH_{36}} = 2.51\ g\ NH_3$$

If $Ca(OH)_2$ is limiting reactant:

$$0.445\ mol\ Ca(OH)_2 \times \frac{2\ mol\ NH_3}{1\ mol\ Ca(OH)_2} \times \frac{17.03\ g\ NH_3}{1\ mol\ NH_{36}} = 15.16\ g\ NH_3$$

So, ammonium chloride is the limiting reactant and 2.51 g of ammonia is formed.