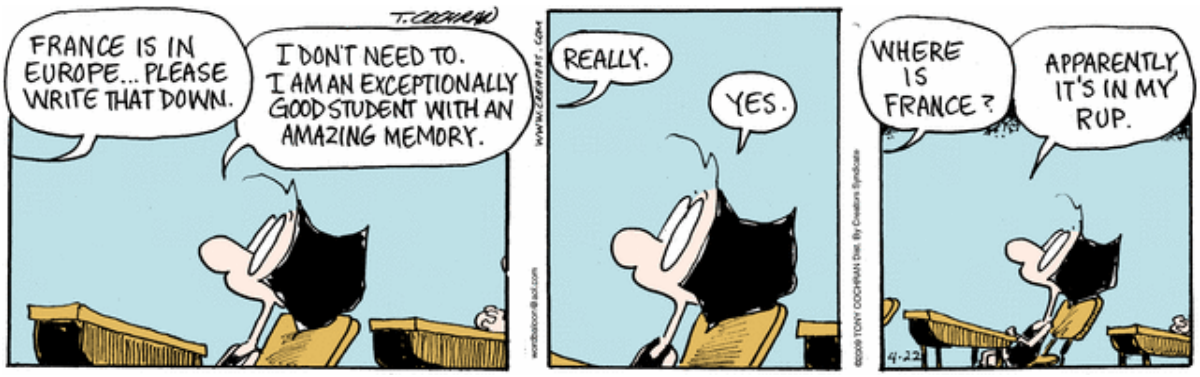
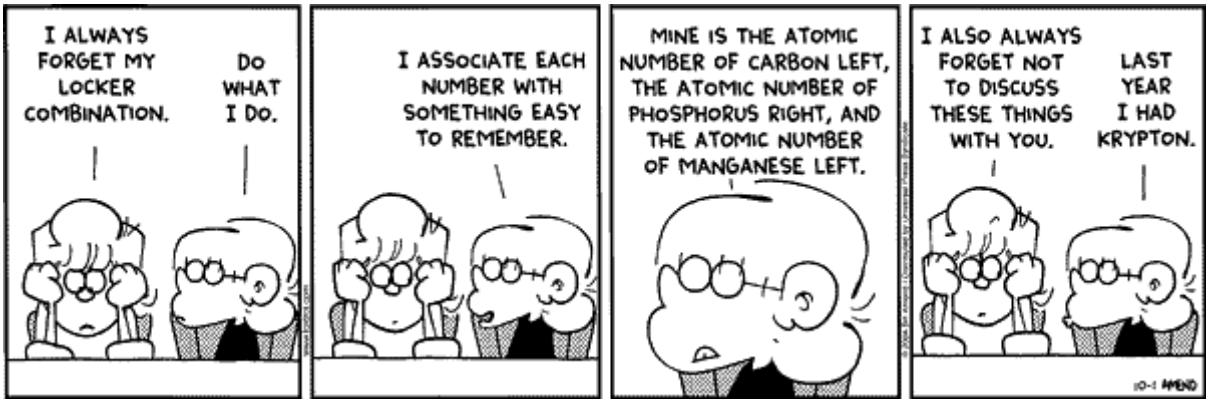
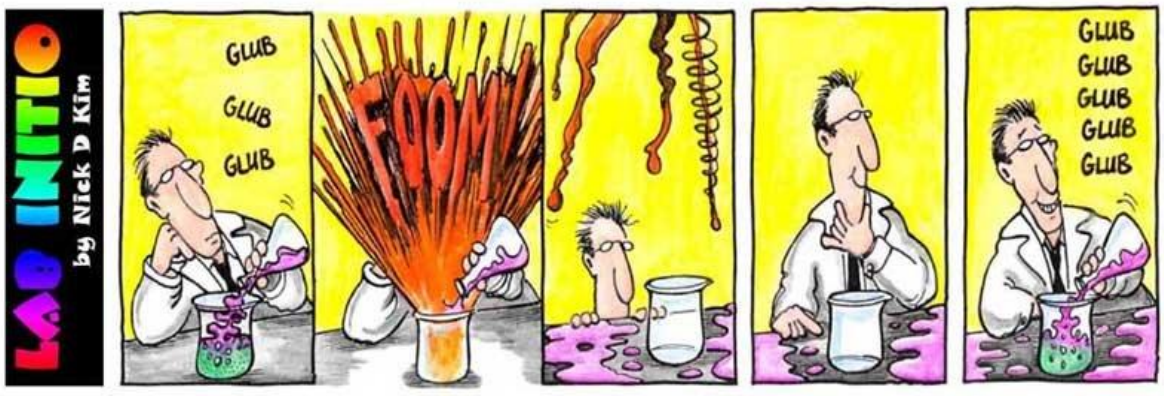
You may remove this page.

$pH = -\log[H^+]$, $[H^+] = 10^{-pH}$	$pH + pOH = 14$	$PV = nRT$
$\frac{N_t}{N_0} = \left(\frac{1}{2}\right)^{t/t1/2}$	$ln\left(\frac{N_t}{N_0}\right) = -0.693\frac{t}{t_{1/2}}$	$log\left(\frac{N_t}{N_0}\right) = -0.301\frac{t}{t_{1/2}}$







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JBA 2022 – Chemistry Exam 3

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

Multiple choice questions are worth two points each.

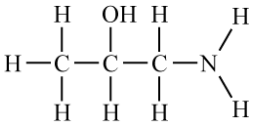
1. Which of these classes of compounds form most of the membranes for your cells?
   a. carbohydrates
   b. lipids (or fats)
   c. amino acids
   d. nucleic acids.

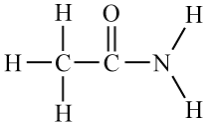
   Answer ___b____

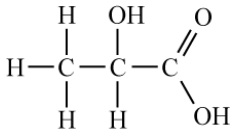
2. What key role do carbohydrates serve in the body?
   a. They form cell walls
   b. They encode genetic information
   c. They are sources of energy
   d. They serve no role in the body.

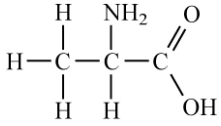
   Answer ___c____

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

   a. 

   c. 

   b. 

   d. 

   Answer ___d____

4. If acids are compounds that donate 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____

5. 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____

6. H_3O^+ is called the

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

   Answer ___d____

7. 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____

8. 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.
   c. two times *smaller* than the river hydronium ion concentration.
   d. one hundred times *smaller* than the river hydronium ion concentration.

   Answer ___b____

9. Uranium-238 decays by emission of an alpha particle. The other product of this decay is

   a. $^{234}_{92}U$ b. $^{234}_{91}Pa$ c. $^{234}_{88}Ra$ d. $^{234}_{90}Th$

   Answer ___d____

10. One difference between a chemical reaction and a nuclear reaction is that in a nuclear reaction

    a. only small amounts of energy are absorbed or emitted.
    b. only the valence electrons are involved.
    c. atoms retain their identity.
    d. atoms often change from one element to another.

    Answer ___d____

11. In our demo with the inverted flask and green water on Thursday, the primary reason the liquid moved into the flask was

    a. The pressure inside the flask increased compared to the pressure outside the flask.
    b. The pressure inside the flask decreased compared to the pressure outside the flask
    c. The combustion of the matches produced carbon dioxide.
    d. The temperature inside the flask increased during the demo.

    Answer ___b____

10. Thorium-234 undergoes beta decay as shown below. What is Q?

$$^{234}_{90}\text{Th} \rightarrow {}^{0}_{-1}\text{e} + \text{Q}$$

a. $^{234}_{91}$Pa b. $^{233}_{91}$Th c. $^{233}_{90}$Th d. $^{234}_{89}$Ac

Answer ___a____

11. After three half-lives, what fraction of the original radioactive isotope remains in a sample?

a. 1/4 b. 1/8 c. 1/16 d. none

Answer ___b____

12. The mass of a helium nucleus is slightly less than the sum of its parts (2 protons and 2 neutrons) because

a. the mass of protons and neutrons are not precisely known.
b. some of the mass is given to electrons.
c. the mass of a proton is larger than the mass of a neutron.
d. some of the mass is converted to binding energy.

Answer ___d____

13. Match the term with its definition. (12 points)

__E__ pH	A. a concentration term expressed in moles per liter
__H__ alpha particle	B. a compound that can behave both as an acid and as a base
__A__ molarity	C. a solution with pH > 7
__B__ amphiprotic	D. the force that holds the nucleons together in an atom's nucleus
__J__ critical mass	E. $-\log[H^+]$
__D__ binding energy	F. the substance in which a solute is dissolved
__L__ unsaturated fat	G. building blocks of proteins
__I__ primary structure	H. a helium nucleus emitted in nuclear reaction
__C__ basic	I. the order of amino acids in a protein
__G__ amino acid	J. the minimum amount of an isotope necessary to sustain a chain reaction.
__K__ acidic	K. a solution with $[H^+] > 1 \times 10^{-7}$ M
__F__ solvent	L. a water insoluble compound with no carbon-carbon multiple bonds

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

14. 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 nitric acid (HNO_3) with calcium hydroxide ($Ca(OH)_2$).

$$HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + 2H_2O$$

15. Complete the following table: (10 points)

Compound	Molarity	pH	pOH	Acidic, Basic or Neutral?
H_2SO_4	0.012 M	$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$ So, $[H^+] = 2(0.012) =$ 0.024 M, **pH =1.62**	12.38	Acidic
KOH	0.0035 M	11.54	$KOH \rightarrow K^+ + OH^-$ $[OH^-] = 0.0035$ M **pOH = 2.46**	Basic

16. Write the nuclear equation for the decay of Po-210 if it undergoes 2 consecutive alpha decay followed by a beta decay followed by another alpha decay? (10 points)

$$^{210}_{84}Po \rightarrow 3\,^{4}_{2}He + {}^{0}_{-1}e + {}^{198}_{79}Au$$

17. In a beaker, you mix 35.0 mL of 0.100 M HNO_3 and 30.0 mL of 0.200 M NaOH.

    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. (*hint: figure out which reactant is in excess*) (8 points)

We have

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

and

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

The stoichiometry requires 1 mole HNO_3 for every mole of NaOH. Therefore, we need:

$$0.0035\ mol\ HNO_3 \times \frac{1\ mol\ NaOH}{1\ mol\ HNO_3} = 0.0035\ mol\ NaOH$$

Since we need 0.0035 mol NaOH and we only have 00060 mol, the HNO_3 will run out and we will have some NaOH remaining. Since the base is left over, the solution will be **basic.**

18. In a carbon-14 dating experiment, a fossil was found to have 3.13% of its natural abundance of carbon-14 (in other words, if it originally would have contained 100 g ^{14}C, it now only contains 3.13g ^{14}C), If the half-life of ^{14}C is 5730 years, how old is the fossil? (10 points)

$$\ln\left(\frac{N_t}{N_0}\right) = -0.693\frac{t}{t_{1/2}}$$

$$\ln\left(\frac{3.13}{100}\right) = -0.693\frac{t}{5730y}$$

$$-3.464 = -0.693\frac{t}{5730y}$$

$$t = 5730y\frac{-3.464}{-0.693} = \mathbf{28,600\ years\ old}$$

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? (10 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. Nucleic acids are the building blocks of DNA.
    a. Every nucleic acid in DNA has three components. What are they? (3 points)

A sugar, a phosphate group and a nitrogen containing base

    b. Why types of intermolecular forces hold DNA strands together to form a double helix? (3 points)

Hydrogen bonding interactions

    c. In DNA, adenine and thymine are complementary bases, as are cytosine and guanine. If a segment of a single strand of DNA has the sequence, -ATTCGTAA-, what would the complementary sequence be? (4 points)

Since A is complementary to T and C is complementary to G, the sequence would be:
-TAAGCATT-