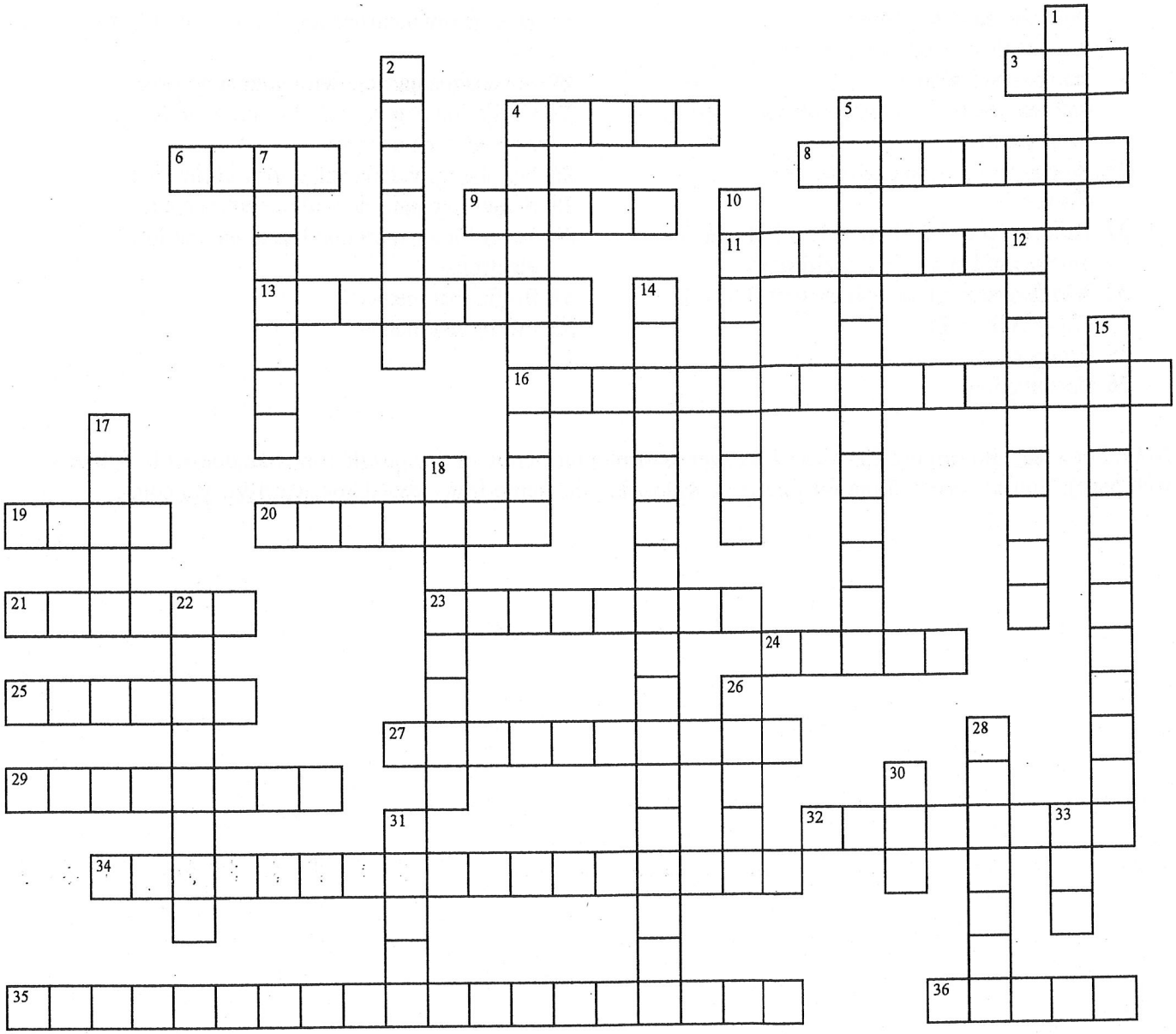
Chemistry Topics Review



ACROSS

3 Covalent compounds have a ___ MP and BP
4 Prefix that means 5
6 When oxygen forms an ion does it lose or gain electrons?
8 Type of bond between 2 metals
9 Type of bond when metal bonds nonmetal
11 Most reactive nonmetals
13 In an ionic bond, the atoms _____ electrons
16 "B" Groups
19 Ionic and metallic compounds both have a _____ MP and BP
20 Oxidation number of a magnesium ion (write number then charge)

DOWN

1 Type of bonding in NaCl
2 The atomic number is the same as the number of what subatomic particle?
4 Elements in the same group have similar _____
5 Which reaction type is represented by AB -> A + B
7 Term for atoms of the same element with different numbers of neutrons (and therefore different mass numbers)
10 Rusting is an example of a _____ change
12 Which reaction type is represented by A + B -> AB

21 Positive ion
23 Type of bond between two nonmetals
24 Type of bond where electrons are transferred from one atom to another
25 In a covalent bond electrons are _____ between two atoms
27 Only elements found uncombined in nature (least reactive)
29 Boiling water is an example of a _____ change
32 Things you end with in a chemical reaction (on the right side of the yield sign)
34 Which reaction type is represented by AB + CD -> AD + CB
35 Group 2A
36 Negative ion

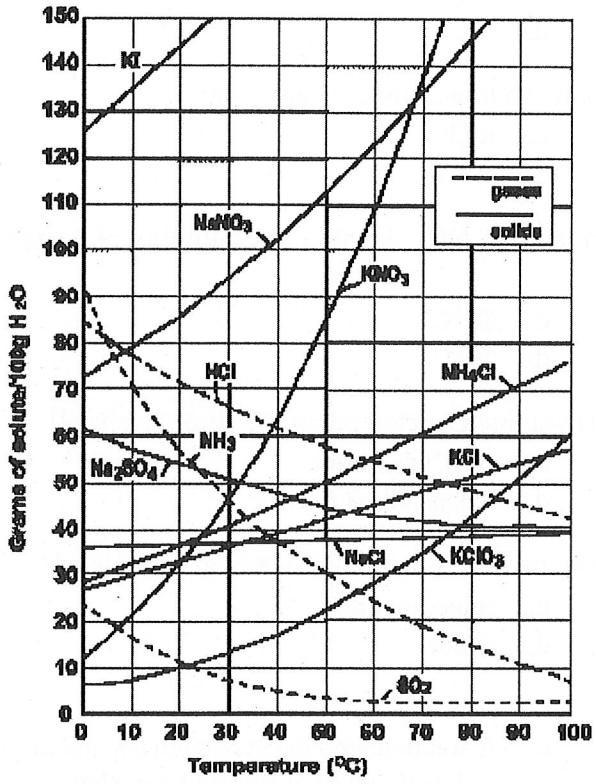
14 Which reaction type is represented by A + BC -> B + AC
15 Most reactive metals
17 How many neutrons are in an atom of Carbon-14?
18 Subatomic particle with almost no mass
22 Oxidation number of a bromine ion (write number then charge)
26 Number of valence electrons in fluorine
28 Subatomic particle with a neutral charge
30 Term for an atom that has gained or lost electrons
31 Prefix that means 4
33 Prefix that means 3

Name: _____ Class: _____ Date: _____ ID: A

Solubility Curves Quiz

Multiple Choice

Identify the choice that best completes the statement or answers the question.



____ 1. Which compound is least soluble at 10 Celsius?

a. KI
b. SO_2
c. $KClO_3$
d. Na_2SO_4

____ 2. What happens to the solubility of solids as temperature increase?

a. increases
b. decreases
c. stays the same
d. it depends on the compound

____ 3. How would you describe a solution of 20g of NH_4Cl in 100g of water at 70 Celsius?

a. unsaturated
b. saturated
c. supersaturated
d. concentrated

____ 4. What is the solubility of hydrochloric acid, HCl, at 40 Celsius in 100g of water?

a. 74g
b. 32g
c. 40g
d. 61g

____ 5. How would you describe a solution of 110g of sodium nitrate at 40 Celsius in 100g of water?
a. unsaturated
b. saturated
c. supersaturated
d. dilute

____ 6. What is the solubility (saturation point) of Potassium Chlorate at 20 Celsius in 100g of water
a. 33g
b. 10g
c. 65g
d. 52g

____ 7. Which substance's solubility is least responsive to a change in temperature?
a. KI
b. KNO_3
c. KCl
d. NaCl

____ 8. At what temperature is the solubility of ammonia, NH_3, equal to the solubility of potassium chlorate
a. 38 °C
b. 45 °C
c. 57 °C
d. 26 °C

____ 9. What happens to the solubility of gases as you increase temperature? (use the chart!)
a. decreases
b. increases
c. stays the same
d. it depends on the gas

____ 10. How would you describe a solution of 110g of KNO_3 in 100g of water at 60 Celsius?
a. unsaturated
b. saturated
c. supersaturated
d. dilute

____ 11. What is a supersaturated solution?
a. A solution with less than the maximum amount of solute dissolved at a given temperature
b. a solution with more than the maximum amount of solute dissolved at a given temperature
c. A solution with the maximum amount of solute dissolved at a given temperature
d. the same as a dilute solution

Solubility Curves Quiz
Answer Section

MULTIPLE CHOICE

1. ANS: C PTS: 1
2. ANS: A PTS: 1
3. ANS: A PTS: 1
4. ANS: D PTS: 1
5. ANS: C PTS: 1
6. ANS: B PTS: 1
7. ANS: D PTS: 1
8. ANS: C PTS: 1
9. ANS: A PTS: 1
10. ANS: B PTS: 1
11. ANS: B PTS: 1

Warmup Review: Gases and Heat

1. $C(s) + H_2O(g) + heat <-> CO(g) + H_2(g)$

   How would each of the following shift equilibrium?
   a. lower temp
   b. increase pressure
   c. remove hydrogen
   d. add water vapor
2. How much heat is needed to melt 15g of ice?
3. What is the mass of a sample of water that releases 10,000 J of heat as it cools down 10°C?
4. If A 25L sample of neon is collected at 44.0 °C. Assuming the pressure remains constant, what would be the volume of the neon at standard temperature?
5. What would the pressure in atm be of N_2 gas, if a 20g sample occupied a volume of 8.7L at a temperature of 45K?
6. How much stock 3M acid is needed to prepare 500ml of 0.5M HCl?

Ch.19 : Acids and Bases

Acids (**)**

-
-
-
- Examples:
- Usu. recognized by H in chemical formula
- React with

Bases (**)**

-
-
-
- Are electrolytes as aqueous solutions
-
- Usu. Recognized by OH in chemical formula
- Examples:

* Acids and bases react together to form (ionic compound)*

Sample Reaction:

Definition of Acids/Bases:

1. Arrhenius Acid/Base Definition

   - Says are hydrogen-containing compounds that when dissolved yield hydrogen ions (H^+) in aqueous solution.
   - Says dissolve in water to yield hydroxide (OH^-) in solution.

   This definition did not fully account for all acids and bases. Example: Sodium Carbonate (Na_2CO_3) is basic but does not contain hydroxide. A better definition was needed.

2. Bronsted-Lowery Acids and Bases

   Acid –

   Base –

$$\underset{\text{Ammonia}}{NH_3(aq)} + \underset{\text{Water}}{H_2O(l)} \rightleftharpoons \underset{\text{Ammonium ion}}{NH_4^+(aq)} + \underset{\text{Hydroxide ion}}{OH^-(aq)}$$

   A base that gains a Hydrogen ion forms

   An acid that loses a Hydrogen ion forms

   In the reactions above and below, label the acid, base, conjugate acid and conjugate base.

$$HCl(g) + H_2O(l) \rightleftharpoons H_3O^+(aq) + Cl^-(aq)$$

This reaction forms hydronium. Notice that water can act as a

Acid Strength vs. Concentration

- Some acids are known as Strong Acids (HCl), some are known as Weak Acids (HF).
- Concentration refers to the

Neutral Solutions:

$[H^+] = [OH^-]$ in a neutral solution. - Brackets represent concentration

Ion Product Constant for Water (K_w)

For an aqueous solution, the product of the hydrogen ion and hydroxide ion concentrations always equals a set value, K_w.

$$K_w = [H^+][OH^-] = 1 \times 10^{-14}$$

As acids or bases are added to the solution the H^+ and OH^- concentrations may change, but the product remains the same. If [H+] > [OH-], the solution is acidic, and vice versa.

Sample Problem:

[H+]	[OH-]	Acid/Base
H=1E-3 H=1E-7 H=1E-11 H=1E-14 H=1E-2 H=1E-12		
	OH=1E-12 OH=1E-4 OH=1E-7 OH=1E-3 OH=1E-14 OH=1E-6	
H=6E-2 H=4E-7		
	OH=2E-5	

1. How would you neutralize an acid?

2. What two things are produced when an acid and a base are mixed?

3. An unknown is slippery, with a bitter taste. Is it probably an acid or a base?

4. A chemical formula contains hydroxide (OH). Is it probably an acid or a base?

5. Give 3 examples of acids.

6. Give 2 examples of bases.

7. What is an electrolyte?

8. Is an acid a proton donor or proton acceptor?

9. As I add water to an acidic solution, am I decreasing the acid's strength or its concentration?

10. What is the pH of a neutral solution?

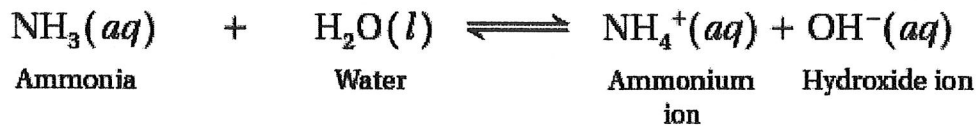
11. A solution has a pH of 13, is it an acid or a base?

12. A solution has a hydrogen-ion concentration of 1E-6. What is its hydroxide-ion concentration?

13. If a solution has [H+] = 1E-11 is it acidic or basic?

14. When dissolved in water a compound dissociates to form H+ ions. Is the unknown an acid or a base?

15. Label the acid, base, conjugate acid, and conjugate base below.



Introduction to Acids & Bases: A WebQuest

Directions: Visit the following websites to gather information about acids and bases.

1. http://www.visionlearning.com/library/module_viewer.php?c3=&mid=58&l=

The word acid comes from the Latin word _____ meaning _____.

Boyle stated that acids taste _____, are corrosive to _____, change the color of litmus to _____,and become less acidic when mixed with _____.

He described bases as feeling _____, changing litmus to the color _____, and becoming less basic when mixed with an _____.

About 200 years later, Arrhenius proposed that water can dissolve many compounds by separating them into their individual _____. He suggested that acids contain _____ and can dissolve in water to release _____.
Bases dissolve in water to release _____ ions into the solution.

2. http://www.chem4kids.com/files/react_acidbase.html

Every liquid has _____ & _____ traits. One exception might be _____. It is just water. However, the _____ ions and _____ ions cancel each other out.

3. http://chemistry.about.com/od/acidsbases/a/acidbaseformula.htm

Give the formula for the following acids:

Citric Acid-	_____	
Hydrochloric Acid-	_____	
Nitric Acid-	_____	
Sulfuric Acid-	_____	*(not on this website)*
Acetic Acid-	_____	

Give the formula for the following bases:

Sodium Hydroxide-	_____	
Sodium Bicarbonate-	_____	*(not on this website)*
Potassium Hydroxide-	_____	
Calcium Hydroxide-	_____	
Magnesium Hydroxide-	_____	
Barium Hydroxide-	_____	

4. http://chemistry.about.com/od/acidsbases/a/acidsbasesterms.htm

Scroll down to Properties of Acids.

Complete the following sentences for **Acids**

- Tastes _____
- Changes litmus from blue to _____.
- Solutions are _____ (conduct electricity).
- React with bases to form _____ + _____.
  Neutralization
- Create _____ gas when reacting with an active metal.
- Five (5) Common acids (scroll down):

Properties of **Bases**

- Tastes _____.
- Feels _____.
- Don't change the color of _____.
- Solutions are _____ (conduct electricity).
- React with acids to form _____ + _____.
  Neutralization
- Four (4) Common Bases:

5. http://chemistry.about.com/od/acidsbases/a/phtable.htm and
http://www.visionlearning.com/library/module_viewer.php?c3=&mid=58&l
Scroll down on the site above until you get to the pH scale :

DRAW a generalized pH scale below, showing

A. pH range of acids _____
B. pH of a neutral substance _____
C. pH of a basic (alkaline) substance _____

Use information from the sites above and list the following substances according to pH. The lowest pH should be listed first and the highest base listed last. HCl and NaOH are given as examples. More than one substance from the left may go on each line to the right! THE COMPOUNDS ON THE LEFT GET WRITTEN ON A LINE ON THE RIGHT BESIDE THE CORRECT pH NUMBER FOR THAT SUBSTANCE!

Substances:	Correct Acid-Base pH list
Pure water	1 HCl
Apples	2 _____
Ammonia	3 _____
Lime (Calcium Hydroxide)	4 _____
Milk	5 _____
HCl	6 _____
Vinegar	7 _____
Baking Soda	8 _____
NaOH	9 _____
Human Blood	10 _____
Lemon juice	11 _____
Battery Acid	12 _____
Milk of Magnesia	13 _____
Rain water	14 NaOH
Egg whites	
Drano	

*Some students get stuck. Ask a friend if you can't progress. Sometimes it is tricky knowing exactly where to click.

Alien Juice Bar Webquest Name_____

Period_____Date_____

Go to the following website and answer the questions about the 3 challenges:

http://sv2.berkeley.edu/showcase/flash/juicebar.html

Google Alien Juice Bar. Click the 1st Link.

Challenge 1- *click on it*

1. Cabbage juice acts much like pH paper, because it will change color when it contacts acis and bases. Cabbage juice is purple. Click "Start," you must put the cabbage juice in all 3 liquids. What color does the cabbage juice change to in...
   a. The water?_____
   b. The lemon juice?_____
   c. The window cleaner?_____

2. Now try to figure out which color means neutral, acid, or base by dragging the liquids to those labels. Click "check me" to see if you are correct. Once you are, write down which color does cabbage water turn in …
   a. An acid?_____
   b. A base?_____
   c. A neutral solution?_____

3. Now, click "Try More" and write down whether each of the following are neutral, an acid, or a base (pour cabbage juice in them, then separate them again):
   a. Distilled water_____
   b. Coffee_____
   c. Mouthwash_____
   d. Cough medicine_____
   e. Liquid Soap_____
   f. Orange juice_____
   g. Toothpaste juice_____
   h. Soda pop_____
   i. Tea_____

Challenge 2- *click continue, then main menu, then challenge 2*

1. What is the warning at the bottom of the sign?_____

2. You must pour each alien the type of drink that they request by dragging it to the cup. (Try not to kill anyone!!). When you finish, click continue.
    a. What is flying cabbage voted?_____

Challenge 3- *click main menu, then challenge 3*

1. Move the mouse over the green "What is pH?" button to answer the following:
    a. What pH is acidic?_____
    b. What pH is basic?_____
    c. What pH is neutral FOR THE PURPOSES OF THIS ACTIVITY?_____

2. In this challenge, first, pour cabbage juice into all of the drinks to reveal the pH. Then, change the pH to what the alien tells you to (acidic, basic, or neutral) by adding other juices to them. Once you finish each tray, write down what the alien says
    a. What does the first alien say when you make all the drinks acidic?

    _____

    b. What does the second alien say when you make all the drinks basic?

    _____

    c. What does the third alien say when you make all the drinks neutral?

    _____

3. How do you change an acidic drink to neutral?_____
4. How do you change a basic drink to neutral?_____
5. How do you change a neutral drink to acidic?_____
6. How do you change a acidic drink to basic?_____

Write Acid or Base for the following: Name_____

Slippery
Ph>7
Sour
Ph=7
Contains H
Proton Donor
Proton Acceptor
Bitter
pH<7
Contains OH
Lemon juice
Most foods
Soap
Cleaning Fluid
Coca-Cola
Turns Litmus Blue
Turns Litmus Red

How did Arrhenius define acids and bases?

How did Bronsted-Lowery?

Explain the difference between concentration and strength of an acid

What does Kw stand for? (The term, not the value)

3 acids have the following pH Values: 2, 4, 6. Which is the strongest acid?

What is an indicator?

What is neutralization? What 2 things are always formed by a neutralization?

In chemistry, what is the definition of a salt?

After proton transfer occurs, the acid forms a conjugate _____, and a base forms a conjugate _____.

PLACE THE FOLLOWING TERMS IN THE CORRECT COLUMN IN THE CHART BELOW:

pH=7 pH>7 pH<7 slippery bitter

sour electrolyte in water H in chemical formula OH in chemical formula

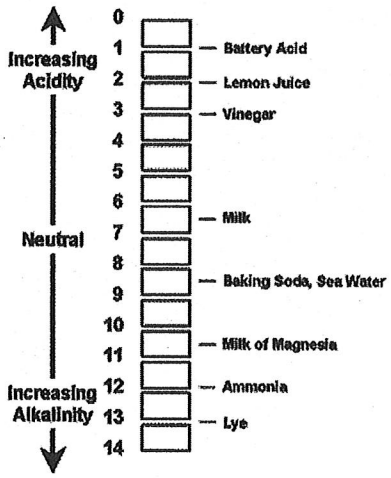
higher concentration of hydrogen ions higher concentration of hydroxide ions

soap/cleaners lemon juice/foods $Ca(OH)_2$ H_2SO_4 NaOH HCl

reacts w/ fats&oils reacts w/ metals&carbonates

Acid	Base

Neutral substances have a pH of ____. An example is _____.



What is the strongest acid listed?

What is the strongest base listed?

What is the weakest base listed?

What is the weakest acid listed?

Which is a stronger base, pH=8 or pH=10?

Which is a stronger acid, pH=2 or pH=5?

What should you add to a base to neutralize it?

Label the acid, base, salt, and water in the acid-base neutralization reactions below:

a. $NaOH + HCl \rightarrow NaCl + HOH$

b. $H_2SO_4 + 2\ NH_4OH \rightarrow + 2\ H_2O + (NH_4)_2SO_4$

Which of the 4 reaction types are acid-base neutralizations like the one above? _____

The products of an acid-base neutralization are always _____ and a _____.

Warmup - pH + pOH

Name _____

Determine pH

1. $[H^+] = 1E-3$
2. $[H^+] = 1E-14$
3. $[H^+] = 1E-7$
4. $[H^+] = 1E-10$

Determine pOH

5. $[OH^-] = 1E-8$
6. $[OH^-] = 1E-2$
7. $[OH^-] = 1E-12$

Determine pH

8. $[OH^-] = 1E-13$
9. $[OH^-] = 1E-2$
10. $[OH^-] = 1 \times 10^{-6}$
11. $[H^+] = 10^{-11}$

Determine pOH

12. $[H^+] = 1E-5$
13. $[OH^-] = 1E-12$
14. $[H^+] = 1E-14$
15. $[H^+] = 1E-7$

Determine $[H^+]$

16. pH = 3
17. pH = 11
18. pH = 7

Determine $[OH^-]$

19. pOH = 2
20. pOH = 14
21. pOH = 8

Determine $[H^+]$

22. pOH = 13
23. pOH = 2
24. pH = 6
25. pOH = 9

Determine $[OH^-]$

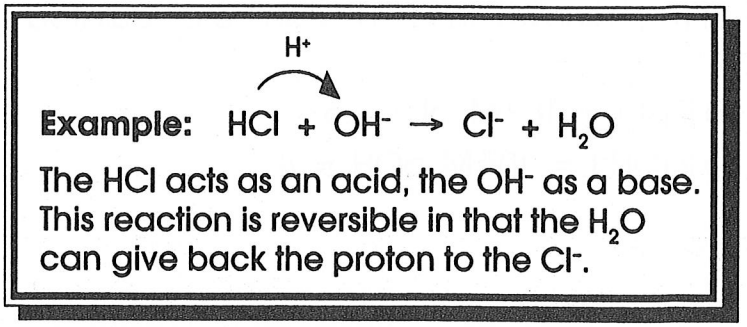
26. pH = 4
27. pOH = 6
28. pH = 12

29. In a solution, $[H^+] = 1e-4$. What is $[OH^-]$?
30. In a solution, $[OH^-] = 1e-2$. What is $[H^+]$?
31. The pH of a solution is 6. What is its pOH?
32. The pOH of a solution is 12. what is its pH?
33. A solution has a pH = 4. Is it acidic or basic?
34. A solution has a pOH = 2. Is it acidic or basic?
35. What is an indicator?
36. Is an acid a proton (H^+) Donor or a proton (H^+) Acceptor?

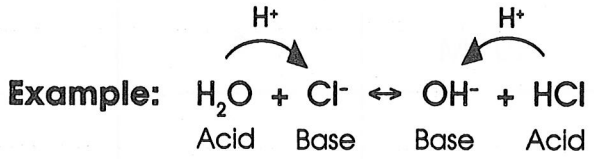
BRONSTED-LOWRY ACIDS AND BASES

Name _____

According to Bronsted-Lowry theory, an acid is a proton (H^+) donor, and a base is a proton acceptor.



Label the Bronsted-Lowry acids and bases in the following reactions and show the direction of proton transfer.



1. $H_2O + H_2O \leftrightarrow H_3O^+ + OH^-$

2. $H_2SO_4 + OH^- \leftrightarrow HSO_4^- + H_2O$

3. $HSO_4^- + H_2O \leftrightarrow SO_4^{-2} + H_3O^+$

4. $OH^- + H_3O^+ \leftrightarrow H_2O + H_2O$

5. $NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$

pH AND pOH

Name _____

The pH of a solution indicates how acidic or basic that solution is.

pH range of 0 - 7 acidic
7 neutral
7-14 basic

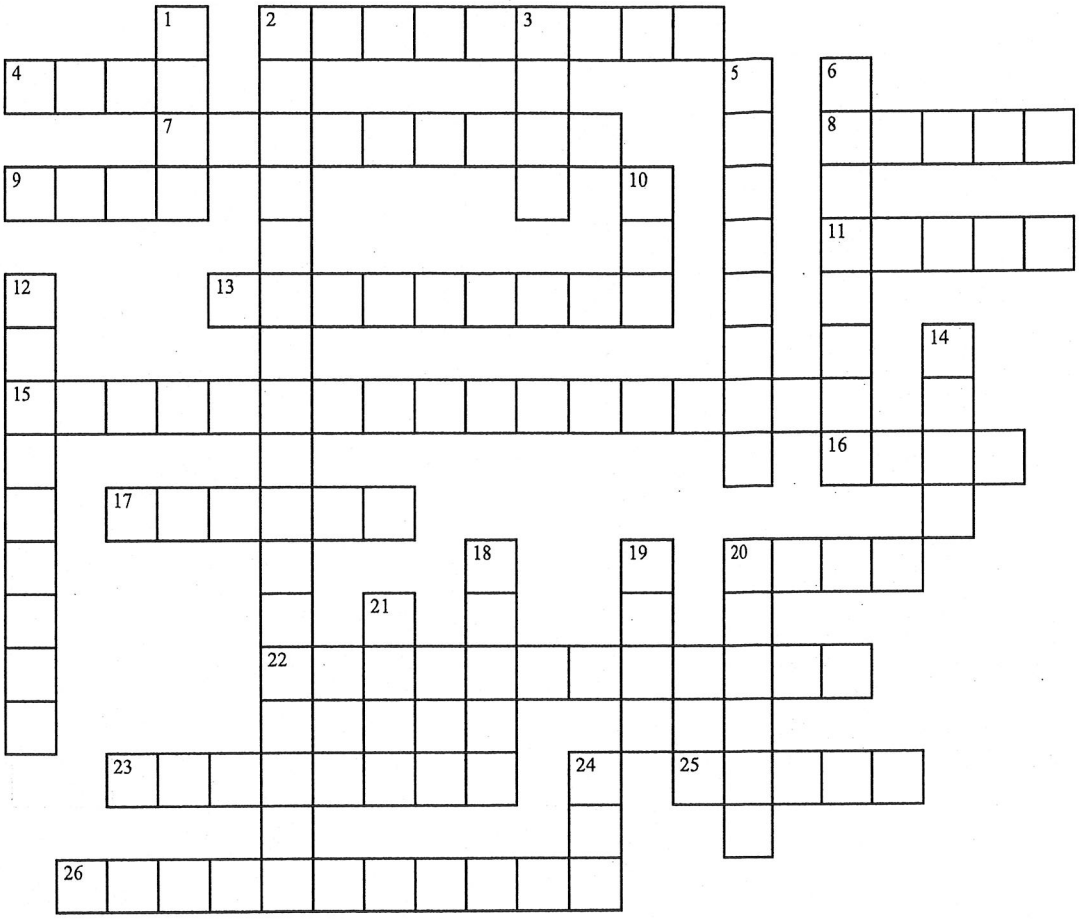
Since $[H^+]\ [OH^-] = 10^{-14}$ at 25° C, if $[H^+]$ is known, the $[OH^-]$ can be calculated and vice versa.

$pH = -\log [H^+]$ So if $[H^+] = 10^{-6}$ M, pH = 6.
$pOH = -\log [OH^-]$ So if $[OH^-] = 10^{-8}$ M, pOH = 8.
Together, pH + pOH = 14.

Complete the following chart.

	$[H^+]$	pH	$[OH^-]$	pOH	Acidic or Basic
1.	10^{-5} M	5	10^{-9} M	9	Acidic
2.		7			
3.			10^{-4} M		
4.	10^{-2} M				
5.				11	
6.		12			
7.			10^{-5} M		
8.	10^{-11} M				
9.				13	
10.		6			

Chemistry Acid Base Equilibrium Review Crossword



ACROSS

2 Solution with the maximum amount of solute dissolved
4 Bases have a pH ____ than 7
7 Type of reaction: A + B -> AB
8 In the reaction H2 + N2 -> NH3, adding N2 would shift equilibrium to the _____
9 When you raise the pressure, equilibrium shift towards the side with _____ gas
11 Bronsted-Lowery defined an acid as a proton _____
13 Things you start with in a chemical reaction
15 Acid base neutralization is always this type of reaction
16 How acids taste
17 Which is a stronger base, pH of 11 or 12?
20 Slippery
22 Acids and bases both conduct electricity in solution, so we call them _____
23 Bronsted-Lowery defined a base as a proton _____
25 PH of a neutral substance
26 Solution with less than the maximum amount of solute dissolved

DOWN

1 Acids have a pH ____ than 7
2 Type of reaction: A + BC -> B + AC
3 Food
5 Acids have more _____ ions
6 Things you end with in a chemical reaction
10 When determining equilibrium based on pressure, you must county up to moles of ____ on each side of the equation
12 Bases has more _____ ions
14 Bases turn litmus paper _____
18 Example of a neutral substance
19 Acid base neutralization always produces water and a _____
20 How bases taste
21 In the reaction H2 + N2 -> NH3, removing H2 would shift equilibrium to the _____
24 Acids turn litmus paper _____

Note: For a fee, you can use Crossword Weaver to print a nice copy of this puzzle (one that doesn't look like a web page). You can check it out for free by downloading the demo from www.CrosswordWeaver.com .

Name: _____ Class: _____ Date: _____ ID: B

Equilibrium, Acid Base

Multiple Choice

Identify the choice that best completes the statement or answers the question.

____ 1. At equilibrium, what is the rate of production of reactants compared with the rate of production of products?
a. lower
b. higher
c. the same
d. much higher

____ 2. Consider the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$. What is the effect of decreasing the volume on the contained gases?
a. The reaction shifts toward the product gas.
b. The system reacts by increasing the number of gas molecules.
c. The pressure on the gases decreases momentarily.
d. Ammonia is consumed in the reaction.

____ 3. What happens to a reaction at equilibrium when more reactant is added to the system?
a. The reaction makes more reactants.
b. The answer cannot be determined.
c. The reaction makes more products.
d. The reaction is unchanged.

____ 4. In an endothermic reaction at equilibrium, what is the effect of raising the temperature?
a. The reaction makes more products.
b. The answer cannot be determined.
c. The reaction makes more reactants.
d. The reaction is unchanged.

____ 5. In a reaction (at equilibrium) that makes more moles of gas than it consumes, what is the effect of increasing the pressure?
a. The reaction is unchanged.
b. The answer cannot be determined.
c. The reaction makes more reactants.
d. The reaction makes more products.

____ 6. Which of the changes listed below would shift the following reaction to the right?
$4HCl(g) + O_2(g) \rightleftharpoons 2Cl_2(g) + 2H_2O(g)$
a. decrease of pressure
b. addition of Cl_2
c. increase of pressure
d. removal of O_2

____ 7. What is the effect of adding more water to the following equilibrium reaction?
$CO_2 + H_2O \rightleftharpoons H_2CO_3$
a. There is no effect.
b. CO_2 concentration increases.
c. The equilibrium is pushed in the direction of reactants.
d. More H_2CO_3 is produced.

____ 8. The K_{eq} of a reaction is 4×10^{-7}. At equilibrium, the ____.
a. rate of the forward reaction is much greater than the rate of the reverse reaction
b. reactants are favored
c. products are favored
d. reactants and products are present in equal amounts

____ 9. What is the equilibrium constant for the following reaction?
$C + O_2 \rightleftharpoons CO_2$

a. $\frac{[C]^2[O_2]^2}{[CO_2]^2}$

b. $\frac{[CO_2]}{[C][O_2]}$

c. $\frac{[CO_2]^2}{[C]^2[O_2]^2}$

d. $\frac{[C][O_2]}{[CO_2]}$

____ 10. Which of the following is a property of an acid?
a. sour taste
b. nonelectrolyte
c. strong color
d. unreactive

____ 11. What is a property of a base?
a. watery feel
b. bitter taste
c. strong color
d. unreactive

____ 12. In the reaction $CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$, the carbonate ion is acting as a(n) ____.
a. Brønsted-Lowry acid
b. Brønsted-Lowry base
c. Arrhenius base
d. Arrhenius acid

____ 13. In a neutral solution, the $[H^+]$ is ____.
a. zero
b. $10^{-14}M$
c. equal to $[OH^-]$
d. $1 \times 10^7 M$

____ 14. What is the best description for a solution with a hydroxide-ion concentration of $1 \times 10^{-4}M$?
a. neutral
b. acidic
c. basic
d. The answer cannot be determined.

____ 15. Which type of solution is one with a pH of 8?
a. basic
b. acidic
c. neutral
d. The type varies, depending on the solution.

____ 16. Which of these solutions is the most basic?
a. $[H^+] = 1 \times 10^{-11}M$
b. $[H^+] = 1 \times 10^{-2}M$
c. $[OH^-] = 1 \times 10^{-4}M$
d. $[OH^-] = 1 \times 10^{-13}M$

____ 17. What characterizes a strong acid or base?
a. ionic bonding
b. presence of a hydroxide or hydrogen ion
c. complete ionization in water
d. polar covalent bonding

____ 18. A $0.12M$ solution of an acid that ionizes only slightly in solution would be termed ____.
a. strong and dilute
b. concentrated and strong
c. dilute and weak
d. concentrated and weak

Equilibrium, Acid Base

Multiple Choice

Identify the choice that best completes the statement or answers the question.

____ 1. At equilibrium, what is the rate of production of reactants compared with the rate of production of products?
a. much higher
b. higher
c. the same
d. lower

____ 2. Consider the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$. What is the effect of decreasing the volume on the contained gases?
a. The reaction shifts toward the product gas.
b. The system reacts by increasing the number of gas molecules.
c. The pressure on the gases decreases momentarily.
d. Ammonia is consumed in the reaction.

____ 3. What happens to a reaction at equilibrium when more reactant is added to the system?
a. The reaction makes more products.
b. The reaction makes more reactants.
c. The reaction is unchanged.
d. The answer cannot be determined.

____ 4. In an endothermic reaction at equilibrium, what is the effect of raising the temperature?
a. The reaction makes more products.
b. The reaction makes more reactants.
c. The reaction is unchanged.
d. The answer cannot be determined.

____ 5. In a reaction (at equilibrium) that makes more moles of gas than it consumes, what is the effect of increasing the pressure?
a. The reaction makes more products.
b. The reaction makes more reactants.
c. The reaction is unchanged.
d. The answer cannot be determined.

____ 6. Which of the changes listed below would shift the following reaction to the right?
$4HCl(g) + O_2(g) \rightleftharpoons 2Cl_2(g) + 2H_2O(g)$
a. addition of Cl_2
b. removal of O_2
c. increase of pressure
d. decrease of pressure

____ 7. What is the effect of adding more water to the following equilibrium reaction?
$CO_2 + H_2O \rightleftharpoons H_2CO_3$
a. More H_2CO_3 is produced.
b. CO_2 concentration increases.
c. The equilibrium is pushed in the direction of reactants.
d. There is no effect.

____ 8. The K_{eq} of a reaction is 4×10^{-7}. At equilibrium, the ____.
a. reactants are favored
b. products are favored
c. reactants and products are present in equal amounts
d. rate of the forward reaction is much greater than the rate of the reverse reaction

____ 9. What is the equilibrium constant for the following reaction?
$C + O_2 \rightleftharpoons CO_2$

a. $\frac{[C][O_2]}{[CO_2]}$

b. $\frac{[CO_2]}{[C][O_2]}$

c. $\frac{[C]^2[O_2]^2}{[CO_2]^2}$

d. $\frac{[CO_2]^2}{[C]^2[O_2]^2}$

____ 10. Which of the following is a property of an acid?
a. sour taste
b. nonelectrolyte
c. strong color
d. unreactive

____ 11. What is a property of a base?
a. bitter taste
b. watery feel
c. strong color
d. unreactive

____ 12. In the reaction $CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$, the carbonate ion is acting as a(n) ____.
a. Arrhenius base
b. Arrhenius acid
c. Brønsted-Lowry base
d. Brønsted-Lowry acid

____ 13. In a neutral solution, the $[H^+]$ is ____.
a. $10^{-14} M$
b. zero
c. $1 \times 10^7 M$
d. equal to $[OH^-]$

____ 14. What is the best description for a solution with a hydroxide-ion concentration of $1 \times 10^{-4} M$?
a. acidic
b. basic
c. neutral
d. The answer cannot be determined.

____ 15. Which type of solution is one with a pH of 8?
a. acidic
b. basic
c. neutral
d. The type varies, depending on the solution.

____ 16. Which of these solutions is the most basic?
a. $[H^+] = 1 \times 10^{-2} M$
b. $[OH^-] = 1 \times 10^{-4} M$
c. $[H^+] = 1 \times 10^{-11} M$
d. $[OH^-] = 1 \times 10^{-13} M$

____ 17. What characterizes a strong acid or base?
a. polar covalent bonding
b. complete ionization in water
c. ionic bonding
d. presence of a hydroxide or hydrogen ion

____ 18. A $0.12M$ solution of an acid that ionizes only slightly in solution would be termed ____.
a. concentrated and weak
b. strong and dilute
c. dilute and weak
d. concentrated and strong

Nuclear Decay Review

NAME_____

Write the equations for the following processes:

1) The alpha decay of radon-198

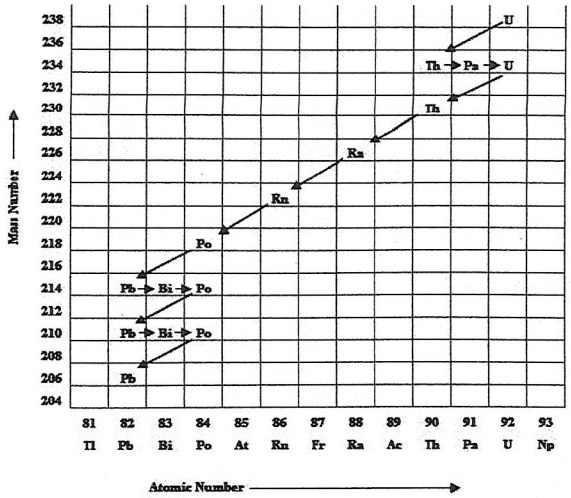
2) The beta decay of uranium -237

3) The alpha and gamma decay of carbon-14

Which type of radiation is most penetrating?

What type of radiation could metal foil block?

What is needed to block gamma radiation?



As Uranium decays from Th to Ra, what type of decay is occurring?

As Uranium decays from Bi to Po, what type of decay is occurring?

When on the graph are gamma rays being emitted?

When beta decay occurs, the atomic number increases by one. Explain what process causes this to happen. Include the basic equation that illustrates this process.

What is the mass of an alpha particle?

What is the charge of an alpha particle?

What is the charge of a beta particle?

What is the mass of a gamma ray?

How could you control the rate of nuclear decay?

$$^{222}_{88}Ra \longrightarrow {}^{4}_{2}He + {}^{218}_{86}Rn$$

What type of decay is shown above?

$$^{14}_{6}C \longrightarrow {}^{14}_{7}N + {}^{0}_{-1}e + {}^{0}_{0}\bar{\nu}$$

What type of decay is shown above?

During gamma decay, which of the following change:
Atomic Number (yes) (no)
Mass Number (yes) (no)

During alpha decay which of the following change:
Atomic Number (yes) (no)
Mass Number (yes) (no)

During beta decay which of the following change:
Atomic Number (yes) (no)
Mass Number (yes) (no)

PERIODIC TABLE PUZZLE

Name _____

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I																	
	F														G	H	
													B				A
C								E				J					

		D															

Place the letter of each of the above elements next to its description below.

1. An alkali metal ____
2. An alkaline earth metal ____
3. An inactive gas ____
4. An active nonmetal ____
5. A semi-metal ____
6. An inner transition element ____
7. Its most common oxidation state is -2. ____
8. A metal with more than one oxidation state ____
9. Metal with an oxidation number of +3 ____
10. Has oxidation numbers of +1 and -1 ____

NUCLEAR DECAY

Name _____

Predict the products of the following nuclear reactions.

1. $^{42}K \rightarrow {}^{0}_{-1}e +$ _____

   This is _____

2. $^{239}Pu \rightarrow {}^{4}_{2}He +$ _____

   This is _____

3. $^{235}_{92}U \rightarrow$ _____ $+ {}^{231}_{90}Th$

   This is _____

4. $^{1}_{1}H + {}^{3}_{1}H \rightarrow$ _____

   This is _____

5. $^{6}_{3}Li + {}^{1}_{0}n \rightarrow {}^{4}_{2}He +$ _____

6. $^{27}_{13}Al + {}^{4}_{2}He \rightarrow {}^{30}_{15}P +$ _____

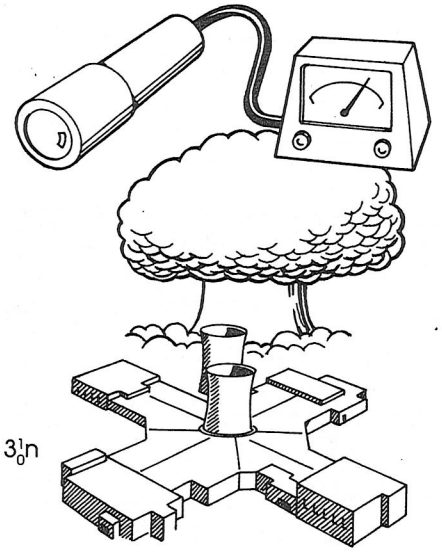
7. $^{9}_{4}Be + {}^{1}_{1}H \rightarrow$ _____ $+ {}^{4}_{2}He$

8. $^{37}K \rightarrow {}^{0}_{+1}e +$ _____

9. _____ $+ {}^{1}_{0}n \rightarrow {}^{142}_{56}Ba + {}^{91}_{36}Kr + 3{}^{1}_{0}n$

   This is _____

10. $^{238}_{92}U + {}^{4}_{2}He \rightarrow$ _____ $+ {}^{1}_{0}n$



Name: _____ Class: _____ Date: _____ ID: A

Nuclear Chemistry Quiz

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. An unstable nucleus ____.
a. increases its nuclear mass by fission
b. increases its half-life
c. emits energy when it decays
d. expels all of its protons

____ 2. The charge on a gamma ray is ____.
a. +2
b. +1
c. 0
d. –2

____ 3. What particle is emitted in alpha radiation?
a. electron
b. photon
c. helium nucleus
d. hydrogen nucleus

____ 4. A beta particle is a(n) ____.
a. photon
b. electron
c. helium nucleus
d. hydrogen nucleus

____ 5. What is the change in atomic mass when an atom emits a beta particle?
a. decreases by 2
b. decreases by 1
c. remains the same
d. increases by 1

____ 6. The least penetrating form of radiation is ____.
a. beta radiation
b. gamma radiation
c. alpha radiation
d. X rays

____ 7. What is the change in atomic number when an atom emits a beta particle?
a. decreases by 2
b. decreases by 1
c. increases by 2
d. increases by 1

____ 8. What is the change in atomic number caused by the emission of gamma radiation?
a. decreases by 2
b. decreases by 1
c. remains the same
d. increases by 1

____ 9. Which symbol is used for an alpha particle?
a. ${}_{1}^{2}\mathrm{He}$
b. ${}_{2}^{2}\mathrm{He}$
c. ${}_{1}^{4}\mathrm{He}$
d. ${}_{2}^{4}\mathrm{He}$

____ 10. What symbol is used for beta radiation?
a. ${}_{0}^{0}\mathrm{e}$
b. ${}_{-1}^{0}\mathrm{e}$
c. ${}_{0}^{-1}\mathrm{e}$
d. ${}_{-1}^{-1}\mathrm{e}$

____ 11. Which of the following materials is necessary to stop a beta particle?
a. three feet of concrete
b. three inches of lead
c. thin pieces of wood
d. single sheet of paper

____ 12. Which of the following materials is most effective for stopping gamma radiation?
a. several cm of lead
b. one cm of water
c. single sheet of aluminum foil
d. single sheet of paper

____ 13. A neutron breaks down to form _____.
a. an alpha particle
b. two protons
c. a proton and an electron
d. a helium nucleus

____ 14. If an isotope decays by the process of beta emission, ____.
a. the mass number changes
b. the atomic number changes
c. protons are given off
d. the number of neutrons remains the same

____ 15. What particle is needed to complete this nuclear reaction?
$^{222}_{86}Rn \rightarrow {}^{218}_{84}Po + $ _____
a. $^{4}_{2}He$
b. $^{0}_{-1}e$
c. $^{1}_{1}H$
d. $^{1}_{0}n$

____ 16. What particle does argon-39 (atomic number 18) emit when it decays to potassium-39 (atomic number 19)?
a. neutron
b. electron
c. proton
d. alpha particle

____ 17. What particle is needed to complete the following nuclear equation?
$^{56}_{25}Mn \rightarrow$ ____ + $^{0}_{-1}e$
a. $^{56}_{27}Co$
b. $^{27}_{25}Mn$
c. $^{56}_{26}Fe$
d. $^{58}_{24}Cr$

____ 18. What particle is needed to complete the following equation?
$^{14}_{7}N +$ ____ $\rightarrow {}^{14}_{6}C + {}^{1}_{1}H$
a. $^{1}_{0}n$
b. $^{0}_{-1}e$
c. $^{4}_{2}He$
d. $^{0}_{+1}e$

____ 19. To what element does polonium-208 (atomic number 84) decay when it emits an alpha particle?
a. $^{210}_{82}Pb$
b. $^{210}_{82}Po$
c. $^{204}_{82}Pb$
d. $^{214}_{86}Rn$

____ 20. What is the approximate half-life of uranium-238?
a. hundreds of years
b. thousands of years
c. millions of years
d. billions of years

____ 21. What happens in a chain reaction?
a. Products that start a new reaction are released.
b. Reactants that have two parts split.
c. Products that are radioactive are lost.
d. Radioactive reactants are deposited on control rods.

____ 22. Controlled nuclear chain reactions ____.
a. take place in nuclear reactors
b. are always fusion reactions
c. never produce radioactive by-products
d. are characteristic of atomic bombs

____ 23. A reaction in which small nuclei combine to form a heavier nucleus is called ____.
a. fission
b. a chemical reaction
c. background radiation
d. fusion

____ 24. Nuclear fusion ____.
a. takes place in the sun
b. occurs at low temperatures
c. can be controlled in the laboratory
d. is used in medicine

____ 25. Radiation therapy is used to ____.
a. study reaction mechanisms
b. detect elements
c. treat cancer
d. initiate neutron activation analysis

____ 26. What is the change in atomic mass when an atom emits gamma radiation?
a. decreases by 2
b. decreases by 1
c. remains the same
d. increases by 1

____ 27. What is the change in the atomic number when an atom emits an alpha particle?
a. decreases by 2
b. decreases by 1
c. increases by 1
d. increases by 2

____ 28. Which of the following materials is necessary to stop an alpha particle?
a. three feet of concrete
b. three inches of lead
c. single sheet of aluminum foil
d. single sheet of paper

____ 29. What is the change in atomic mass number when an atom emits an alpha particle?
a. decreases by 2
b. decreases by 4
c. increases by 2
d. increases by 4

____ 30. When radium-226 (atomic number 88) decays by emitting an alpha particle, it becomes ____.
a. polonium-222
b. polonium-224
c. radium-222
d. radon-222

____ 31. A reaction that results in the combining of smaller atomic nuclei is ____.
a. chemical
b. fission
c. fusion
d. ionization

Half-Life Problems

1. An isotope of cesium (cesium-137) has a half-life of 30 years. If 1.0 mg of cesium-137 disintegrates over a period of 90 years, how many mg of cesium-137 would remain?

2. A 2.5 gram sample of an isotope of strontium-90 was formed in a 1960 explosion of an atomic bomb at Johnson Island in the Pacific Test Site. The half-life of strontium-90 is 28 years. In what year will only 0.625 grams of this strontium-90 remain?

3. Actinium-226 has a half-life of 29 hours. If 100 mg of actinium-226 disintegrates over a period of 58 hours, how many mg of actinium-226 will remain?

4. The half-life of isotope X is 2.0 years. How many years would it take for a 4.0 mg sample of X to decay and have only 0.50 mg of it remain?

5. After 3 half-lives have passed, 0.375 grams of Bismuth-218remain. How big was the original sample?

6. The half-life of a radioactive element is 30 seconds. In what period of time would the activity of the sample be reduced to one-sixteenth of the original activity?

7. The half-life of francium is 3 minutes. After 18 minutes, what fraction of the original sample remains?

HALF-LIFE OF RADIOACTIVE ISOTOPES

Name _____

1. How much of a 100.0 g sample of ^{198}Au is left after 8.10 days if its half-life is 2.70 days?

_____

2. A 50.0 g sample of ^{16}N decays to 12.5 g in 14.4 seconds. What is its half-life?

_____

3. The half-life of ^{42}K is 12.4 hours. How much of a 75$\bar{0}$ g sample is left after 62.0 hours?

_____

4. What is the half-life of ^{99}Tc if a 50$\bar{0}$ g sample decays to 62.5 g in 639,000 years?

_____

5. The half-life of ^{232}Th is 1.4×10^{10} years. If there are 25.0 g of the sample left after 2.8×10^{10} years, how many grams were in the original sample?

_____

6. There are 5.0 g of ^{131}I left after 40.35 days. How many grams were in the original sample if its half-life is 8.07 days?

_____

PS Quiz: Nuclear Chemistry

Name _____

Explain the difference between fission and fusion:

Give 2 problems with nuclear energy:

$^{4}_{2}He$: What types of particle is that?

$^{0}_{-1}e$: What type of particle is that?

Which type of radiation is the most penetrating?

Which type is least penetrating?

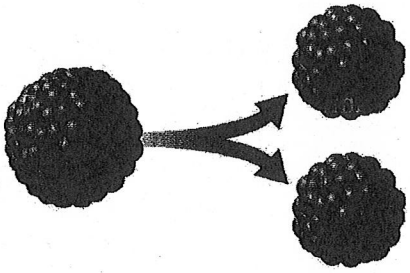
Which 2 types could you stop with metal foil?

In which type of decay does just the atomic number of the atom change?

In which type does the atomic number and mass number change?

Label the diagrams below fission or fusion:

_____



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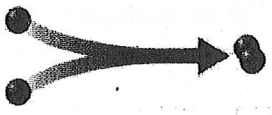


Which equation below represents beta decay? Also, it has a mistake... correct it

Which represents alpha decay? (Careful!) Also, it has a mistake... correct it.

Which equation below represents fusion.

(1) $^{3}_{1}H + ^{1}_{1}H \rightarrow ^{4}_{2}He$

(2) $^{40}_{18}Ar + ^{1}_{1}H \rightarrow ^{40}_{19}K + ^{1}_{0}n$

(3) $^{234}_{91}Pa \rightarrow ^{234}_{92}U + ^{0}_{1}e$

(4) $^{226}_{88}Ra \rightarrow ^{226}_{86}Rn + ^{4}_{2}He$

$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{142}_{56}Ba + ^{91}_{36}Kr + 3\,^{1}_{0}n$

What does the above equation represent?

What is the mass of an alpha particle?

What is the charge of an alpha particle?

Goal 5.04

According to Bronsted-Lowery:

Acids are proton _____

Bases are proton _____

According to Arrhenius:

Acids dissociate in water to form _____ ions

Bases dissociate in water to form _____ ions

Identify the following properties as belonging to an acid or a base:

Sour

Slippery

pH<7

pH>7

electrolytes in water

bitter

pH=7

Know how to solve acid Molarity and Dilution problems!

How many liters of stock 2M HNO_3 are needed in order to prepare 50L of 0.1M solution?

What is the molarity of 80g of HCl dissolved in 20L of solution?

What is the molarity of 5 mol of $HC_2H_3O_2$ dissolved in 10L of water?

Molarity is used to measure _____. Remember Acid Strength is not the same as its concentration. Watering down an acid reduces its _____. Its _____ (weak vs. strong acid or base) is purely based on how well that acid dissociates in water.

A graph of pH vs. concentration would appear _____ in shape.

Indicator	pH Range	Acid	Base
Pentamethoxy red	1.2-2.3	red-violet	colorless
Methyl yellow	2.9-4.0	red	yellow
Bromcresol green	4.0-5.6	yellow	blue
Chlorphenol red	5.4-6.8	yellow	red
Rosolic acid	6.8-8.0	yellow	red
Phenolphthalein	8.0-10.0	colorless	red
Nile blue	10.1-11.1	blue	red
Tropeolin O	11.0-13.0	yellow	orange-brown

Using the chart above:

What indicator would you use in order to titrate a basic solution to a pH of 4?

What would be the best indicator to use to neutralize a solution?

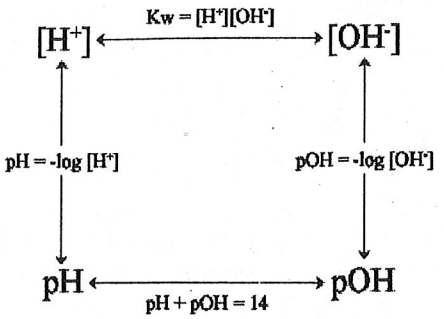
If [H+] = 1E-6, what is [OH-]?

If [H+] = 1E-3, what is the pH? Is it an acid or a base?

If [OH-]= 1E-10, what is the pOH? Is the substance an acid or a base?

If [OH-] = 1E-5, what is the pH? Is it an acid or a base?

If [H+]= 0.0001, what is the pOH? Is it an acid or a base?



If the hydrogen ion concentration is 1E-2, what is the pOH? Is it an acid or a base?

Identify the acid, base, conjugate acid, and conjugate base below:

$HBr + H_2O \rightarrow H_3O^+ + Br^-$

$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

Acid Base Titration Problem

1. What is the molarity of a hydrochloric acid solution, 30.0 mL of which is just neutralized by 48.0 mL of 0.100 M NaOH?

Equilibrium:

Explain how each of the following would affect the chemical equilibrium of the following reaction: $C(s) + H_2O(g) + \text{heat} \leftrightarrow CO(g) + H_2(g)$

a. removing hydrogen
b. adding water vapor
c. lowering the temperature
d. increasing the pressure
e. decreasing the pressure
f. adding carbon monoxide
g. removing carbon

The reaction $N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$ produces the fertilizer ammonia. At equilibrium, a 1L flask contains 0.15 mol H_2, 0.25 mol N_2, and 0.10 mol NH_3.

a. Write the equilibrium expression:
b. Calculate the K_{eq} for this reaction:
c. Tell if reactants or products are favored at equilibrium:

Half-Life Practice Problems

1.) What is the half-life of a 100.0 g sample of nitrogen-16 that decays to 12.5 grams in 21.6 seconds?

2.) All isotopes of technetium are radioactive, but they have widely varying half-lives. If an 800.0 gram sample of technetium-99 decays to 100.0 g of technetium-99 in 639,000 years, what is its half-life?

3.) A 208 g sample of sodium-24 decays to 13.0 g of sodium-24 within 60.0 hours. What is the half-life of this radioactive isotope?

4.) If the half-life of iodine-131 is 8.10 days, how long will it take a 50.00 g sample to decay to 6.25 g?

5.) The half-life of hafnium-156 is 0.025 seconds. How long will it take a 560 g sample to decay to one-fourth of its original mass?

6.) Chromium-48 has a short half-life of 21.6 hours. How long will it take 360.00 g of chromium-48 to decay to 11.25 g?

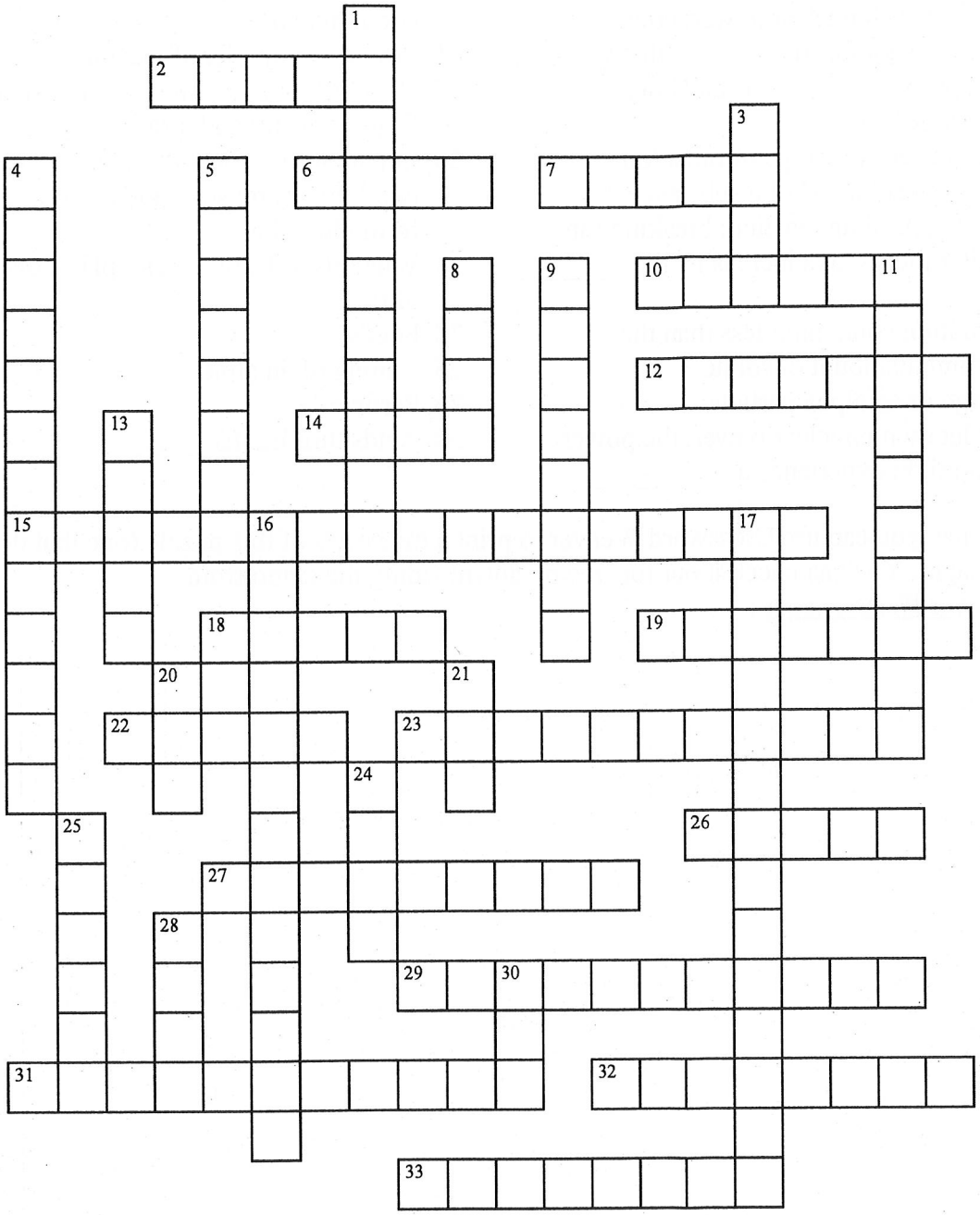
7.) Potassium-42 has a half-life of 12.4 hours. How much of an 848 g sample of potassium-42 will be left after 62.0 hours?

8.) Carbon-14 has a half-life of 5730 years. How much of a 144 g sample of carbon-14 will remain after 1.719×10^4 years?

9.) If the half-life of uranium-235 is 7.04×10^8 years and 12.5 g of uranium-235 remain after 2.82×10^9 years, how much of the radioactive isotope was in the original sample?

10) What fraction of a radioisotope would remain after 5 half-lives have passed?

PS Chem Topics Crossword 2



ACROSS

2 Indicator of chemical change that is visible when something rusts. A change in _____

6 PH<7

7 Most penetrating type fo radiation

10 Which is a sronger base, pH of eleven or twelve?

12 Splitting of an atom

14 PH>7

15 A + BC -> B + AC

DOWN

1 Indicator of a chemical change: two liquids mix and form a solid _____

3 Slippery

4 AB -> A + B

5 Type of change where the composition of the material does not change, and no new compounds are formed.

8 Bases turn litmus _____

9 Things you end with (right hand side) in a chemical reaction

18 PH of a neutral substance, like water
19 Mass of an alpha particle _____ _____ (include unit)
22 Problem with nuclear power: creates dangerous radioactive _____ that we must put in metal barrels and bury.
23 Beaker gets cold
26 Least penetrating type of radiation
27 Used to test the pH of a substance
29 Way to spead up reaction: breaking into smaller pieces, aka increasing the _____ _____
31 A solution containing less than the maximum amount of solute
32 Charge of an alpha particle
33 Problem with nuclear power: the power plant might experience a _____

11 Energy is released
13 Which conducts electricity when dissolved in water (in solution), ionic or covalent compounds?
16 Probability model of the atom, in use today
17 Occurs when you mix an acid and a base, forming water and a salt
20 Indicator of a chemical change, you mix two liquids and see bubbles, indicating the formation of a ____
21 Which is a stronger acid, pH of one or pH of two?
24 Foods
25 Joining of an atom
28 Particle: $^{0}_{-1}e$
30 Acids turn litmus _____

Chemistry Test: Acids & Bases, Equilbrium, Nuclear Chemistry

1. Given the equilibrium system:

$$2\,A(g) + B(g) + 10\text{ kcal} \leftrightarrow C(g)$$

Which conditions would yield the most product?
A) high temperature and high pressure
B) high temperature and low pressure
C) low temperature and low pressure
D) low temperature and high pressure

2. Given the reaction at STP and at equilibrium:

$$H_2(g) + Cl_2(g) \leftrightarrow 2\,HCl(g)$$

Which change will result in an increase in the concentration of $Cl_2(g)$?
A) increasing the concentration of HCl(g)
B) increasing the concentration of $H_2(g)$
C) decreasing the concentration of HCl(g)
D) decreasing the pressure of the system

3. Which compound will conduct an electric current when dissolved in water?
A) $C_{12}H_{22}O_{11}$
B) NaOH
C) C_2H_5OH
D) $C_6H_{12}O_6$

4. Water containing dissolved electrolyte conducts electricity because the solution contains mobile
A) electrons
B) atoms
C) ions
D) molecules

5. Which of the following particles has the greatest mass?
A) an alpha particle
B) a proton
C) a beta particle
D) an electron

6. Given the reaction at equilibrium:

$$N_2(g) + 3\,H_2(g) \leftrightarrow 2\,NH_3(g) + 22\text{ kcal}$$

Which stress would cause the equilibrium to shift to the left?
A) increasing the temperature
B) increasing the pressure
C) adding $H_2(g)$ to the system
D) adding $N_2(g)$ to the system

7. Which equation represents alpha decay?
A) $^{222}_{86}Rn \rightarrow {}^{218}_{84}Po + X$
B) $^{116}_{49}In \rightarrow {}^{116}_{50}Sn + X$
C) $^{38}_{19}K \rightarrow {}^{38}_{18}Ar + X$
D) $^{234}_{90}Th \rightarrow {}^{234}_{91}Pa + X$

8. As an atom of a radioactive isotope emits an alpha particle, the mass number of the atom
A) decreases
B) increases
C) remains the same

9. Which reaction has a K_{eq} represented by the equilibrium expression below?

$$K_{eq} = \frac{[A]^2\,[B]}{[C]^3}$$

A) $2\,A + B \leftrightarrow 3\,C$
B) $3\,C \leftrightarrow 2\,A + B$
C) $A^2 + B \leftrightarrow C^3$
D) $C^3 \leftrightarrow A^2 + B$

10. Given the reaction at equilibrium:

$$2\,SO_2(g) + O_2(g) \leftrightarrow 2\,SO_3(g)$$

As the pressure is increased at constant temperature, the number of moles of $SO_3(g)$ produced will
A) decrease
B) increase
C) remain the same

11. Which of the following is the best conductor of electricity?
A) NaCl(s)
B) NaCl(aq)
C) $C_6H_{12}O_6(aq)$
D) $C_6H_{12}O_6(s)$

12. Which factors must be equal in a reversible chemical reaction at equilibrium?
A) the activation energies of the forward and reverse reactions
B) the rates of reaction of the forward and reverse reactions
C) the concentrations of the reactants and products
D) the potential energies of the reactants and products

13. Given the equation:

$$H_2(g) + I_2(g) \leftrightarrow 2\,HI(g)$$

Which statement is always true when this reaction has reached chemical equilibrium?
A) $[H_2] \times [I_2] > [HI]$
B) $[H_2] \times [I_2] < [HI]$
C) $[H_2]$, $[I_2]$, and [HI] are all equal.
D) $[H_2]$, $[I_2]$, and [HI] remain constant.

14. Given the reaction at equilibrium:

$$2\ SO_2(g) + O_2(g) \leftrightarrow 2\ SO_3(g)$$

Which is the correct equilibrium constant expression for the reaction?

A) $K_{eq} = \dfrac{[SO_3]}{[SO_2][O_2]}$

B) $K_{eq} = \dfrac{[SO_3]^2}{[SO_2]^2 + [O_2]}$

C) $K_{eq} = \dfrac{[2SO_3]}{[2SO_2] + [O_2]}$

D) $K_{eq} = \dfrac{[SO_3]^2}{[SO_2]^2[O_2]}$

15. Given the equilibrium reaction at constant pressure:

$$2\ HBr(g) + 17.4\ kcal \leftrightarrow H_2(g) + Br_2(g)$$

When the temperature is increased, the equilibrium will shift to the

A) left, and the concentration of HBr(g) will increase
B) right, and the concentration of HBr(g) will decrease
C) right, and the concentration of HBr(g) will increase
D) left, and the concentration of HBr(g) will decrease

16. An uncontrolled chain reaction takes place during the

A) fusion of light nuclei into heavier nuclei
B) production of energy by the Earth's Sun
C) explosion of an atomic bomb
D) operation of a fission nuclear reactor

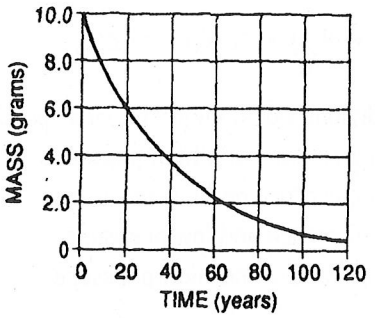
17. Given the nuclear reaction:

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{138}_{56}Ba + {}^{95}_{36}Kr + 3\,{}^{1}_{0}n + \text{energy}$$

This equation can best be described as

A) endothermic
B) natural decay
C) fission
D) fusion

18. The graph below represents the decay curve of a radioactive isotope. The half-life of this isotope is

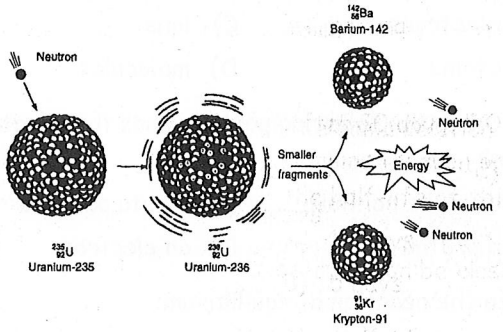


A) 30 years
B) 8 years
C) 45 years
D) 60 years

19. Which statement explains why nuclear waste materials may pose a problem?

A) They frequently have short half-lives and remain radioactive for brief periods of time.
B) They frequently have short half-lives and remain radioactive for extended periods of time.
C) They frequently have long half-lives and remain radioactive for brief periods of time.
D) They frequently have long half-lives and remain radioactive for extended periods of time.

20. The diagram below represents a nuclear reaction in which a neutron bombards a heavy nucleus.



Which type of reaction does the diagram illustrate?

A) fission
B) fusion
C) alpha decay
D) beta decay

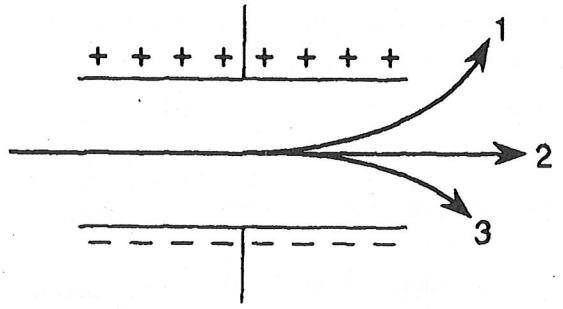
21. Which nuclear equation represents a fusion reaction?

A) $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$
B) $^{1}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He$
C) $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{92}_{36}Kr + {}^{141}_{56}Ba + 3\,{}^{1}_{0}n$
D) $^{238}_{92}U + {}^{1}_{0}n \rightarrow {}^{239}_{93}Np + {}^{0}_{-1}e$

22. Which list of particles is in order of increasing mass?

A) electron → proton → alpha particle
B) proton → electron → alpha particle
C) alpha particle → electron → proton
D) proton →alpha particle → electron

23. A mixture of emanations from radioactive atoms is passed through electrically charged plates, as shown in the diagram below.



The nuclear emanations 1, 2, and 3 are called, respectively,

A) gamma, alpha, and beta
B) beta, gamma, and alpha
C) gamma, beta, and alpha
D) alpha, beta, and gamma

24. Which of these types of nuclear radiation has the greatest penetrating power?

A) neutron
B) gamma
C) alpha
D) beta

25. After 30 days, 5.0 grams of a radioactive isotope remains from an original 40.-gram sample. What is the half-life of this element?

A) 15 days
B) 10 days
C) 20 days
D) 5 days

26. The half-life of a radioactive isotope is 20.0 minutes. What is the total amount of a 1.00-gram sample of this isotope remaining after 1.00 hour?

A) 0.500 g
B) 0.125 g
C) 0.250 g
D) 0.333 g

27. An original sample of a radioisotope had a mass of 10 grams. After 2 days, 5 grams of the radioisotope remains unchanged. What is the half-life of this radioisotope?

A) 1 day
B) 2 days
C) 5 days
D) 4 days

28. A radioactive element has a half-life of 2 days. Which fraction represents the amount of an original sample of this element remaining after 6 days?

A) $\frac{1}{8}$
B) $\frac{1}{2}$
C) $\frac{1}{3}$
D) $\frac{1}{4}$

29. In the reaction:

$$^{238}_{92}U + ^{1}_{0}n \rightarrow ^{239}_{93}Np + X$$

The species represented by X is

A) $^{4}_{2}He$
B) $^{0}_{-1}e$
C) $^{1}_{1}H$
D) $^{1}_{0}n$

30. As HCl(g) is added to water, the pH of the water solution

A) decreases
B) increases
C) remains the same

31. Which relationship is present in a solution that has a pH of 7?

A) $[H^+] > [OH^-]$
B) $[H^+] + [OH^-] = 7$
C) $[H^+] = [OH^-]$
D) $[H^+] < [OH^-]$

32. As an acidic solution is added to a basic solution, the pH of the basic solution

A) decreases
B) increases
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33. Which substance can be classified as an Arrhenius acid?

A) NaCl
B) LiOH
C) HCl
D) KOH

34. A solution of a base differs from a solution of an acid in that the solution of a base

A) is able to cause an indicator color change
B) has a greater $[OH^-]$
C) is able to conduct electricity
D) has a greater $[H_3O^+]$

35. Which substance is classified as an Arrhenius base?

A) $LiNO_3$
B) $KHCO_3$
C) HCl
D) NaOH

36. According to the Arrhenius theory, a substance that is classified as an acid will always yield

A) $I^-(aq)$ C) $F^-(aq)$

B) $K^+(aq)$ D) $H^+(aq)$

37. Given the reaction at equilibrium:

$$NH_4^+ + OH^- \leftrightarrow H_2O + NH_3$$

Which species is the proton donor in the forward reaction?

A) NH_4^+ C) OH^-

B) NH_3 D) H_2O

38. Given the reaction:

$$HCl(g) + H_2O(\ell) \rightarrow H_3O^+(aq) + Cl^-(aq)$$

Which reactant acted as a Brönsted-Lowry acid?

A) $H_2O(\ell)$, because it accepted protons

B) $HCl(g)$, because it reacted with chloride ions

C) $HCl(g)$, because it donated protons

D) $H_2O(\ell)$, because it produced hydronium ions

39. Given the reaction:

$$NH_3 + HCl \rightarrow NH_4Cl$$

In this reaction ammonia molecules (NH_3) act as a base because they

A) donate hydroxide ions (OH^-)

B) accept hydrogen ions (H^+)

C) accept hydroxide ions (OH^-)

D) donate hydrogen ions (H^+)

40. Which chemical equation represents the reaction of an Arrhenius acid and an Arrhenius base?

A) $C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(\ell)$

B) $Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

C) $HC_2H_3O_2(aq) + NaOH(aq) \rightarrow NaC_2H_3O_2(aq) + H_2O(\ell)$

D) $BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2\ NaCl(aq)$

41. The pH of 0.001M HCl is

A) 1 C) 3

B) 2 D) 4

42. Which pH value indicates the most basic solution?

A) 7 C) 3

B) 8 D) 11

43. Given the reaction at equilibrium:

$$A(g) + B(g) + \text{heat} \leftrightarrow C(g) + D(g)$$

The equilibrium will shift to the right when the

A) concentration of $C(g)$ is increased

B) temperature is increased

C) pressure is decreased

D) concentration of $A(g)$ is decreased

44. What is the hydroxide ion concentration of a solution with a pH of 4?

A) 1×10^{-10} C) 1×10^{-4}

B) 1×10^{-14} D) 1×10^{-7}

45. Given the following solutions:

Solution *A*: pH of 10
Solution *B*: pH of 7
Solution *C*: pH of 5

Which list has the solutions placed in order of increasing H^+ concentration?

A) *C, A, B* C) *C, B, A*

B) *B, A, C* D) *A, B, C*

46. What is the hydrogen ion concentration of a solution at 298 K whose hydroxide ion concentration is 1×10^{-8}?

A) 1×10^{-7} C) 1×10^{-6}

B) 1×10^{-8} D) 1×10^{-14}

47. For a given system at equilibrium, lowering the temperature will always

A) favor the endothermic reaction

B) increase the rate of reaction

C) favor the exothermic reaction

D) increase the concentration of products

48. What is the K_w of water at 1 atm and 298 K?

A) 1.0×10^{-7} C) 1.0×10^{7}

B) 1.0×10^{14} D) 1.0×10^{-14}

49. If a solution has a hydrogen ion concentration of 1×10^{-9} M, the solution is

A) acidic and has a pH of 9

B) acidic and has a pH of 5

C) basic and has a pH of 5

D) basic and has a pH of 9

50. According to the Arrhenius theory, when a base is dissolved in water it produces a solution containing only one kind of negative ion. What is the name of this negative ion?
A) hydroxide ion
B) hydride ion
C) hydrogen sulfate ion
D) hydrogen carbonate ion

51. When the pH of a solution is 8, what is the OH^- ion concentration in moles per liter?
A) 1×10^{-8} C) 1×10^{-7}
B) 1×10^{-14} D) 1×10^{-6}

52. What is the OH^- ion concentration of an aqueous solution with a pH of 5?
A) 1×10^{-7} M C) 1×10^{-5} M
B) 1×10^{-9} M D) 1×10^{-14} M

53. What is the pH of a 0.01 M solution of KOH?
A) 1 C) 12
B) 2 D) 13

54. As an aqueous solution becomes more acidic, the hydroxide ion concentration
A) decreases C) remains the same
B) increases

55. Which concentration indicates a basic solution at 298 K?
A) $[H_3O^+] > 1.0 \times 10^{-7}$ C) $[OH^-] = 1.0 \times 10^{-7}$
B) $[OH^-] > 1.0 \times 10^{-7}$ D) $[H_3O^+] = 1.0 \times 10^{-7}$

56. Given the equilibrium constant for water:

$$K_w = [H^+][OH^-] = 1 \times 10^{-14} \text{ at } 298 \text{ K}$$

As the $[H^+]$ increases, the $[OH^-]$
A) decreases C) remains the same
B) increases

57. An aqueous solution with a pH of 4 would have a hydroxide ion concentration of
A) 1×10^{-4} mol/L C) 1×10^{-10} mol/L
B) 1×10^{-7} mol/L D) 1×10^{-14} mol/L

58. What is the H^+ ion concentration of an aqueous solution that has a pH of 11?
A) 11×10^{-1} mol/L C) 1.0×10^{-3} mol/L
B) 3.0×10^{-1} mol/L D) 1.0×10^{-11} mol/L

59. A student tested a 0.1 M aqueous solution and made the following observations:

- conducts electricity
- turns blue litmus to red
- reacts with Zn(s) to produce gas bubbles

Which compound could be the solute in this solution?
A) LiOH C) CH_4
B) HBr D) LiBr

60. A solution has a hydroxide ion concentration of 1×10^{-5} M. What is the hydrogen ion concentration of the solution?
A) 1×10^{-9} M C) 1×10^{-1} M
B) 1×10^{-14} M D) 1×10^{-5} M

61. What is the pH of a solution with a hydroxide ion concentration of 0.001 mole per liter?
A) 1 C) 3
B) 7 D) 11

62. Which aqueous solution would turn blue litmus red?
A) HCl(aq) C) NaOH(aq)
B) NaCl(aq) D) K_2CO_3(aq)

63. If 25. milliliters of 0.80 M HCl is used to completely neutralize 40. milliliters of NaOH solution, what is the molarity of the base?
A) 0.050 M C) 50. M
B) 5.0 M D) 0.50 M

64. Which equation represents a neutralization reaction?
A) $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$
B) $NaOH + HCl \rightarrow NaCl + H_2O$
C) $2\ Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$
D) $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

65. Which products are formed when an acid reacts with a base?
A) an alcohol and carbon dioxide
B) a salt and water
C) a soap and glycerine
D) an ester and water

66. An alpha particle has the same composition as a
A) beryllium nucleus C) hydrogen nucleus
B) deuterium nucleus D) helium nucleus

67. Given the nuclear equation:

$$^{1}_{1}H + X \rightarrow {}^{6}_{3}Li + {}^{4}_{2}He$$

The particle represented by X is

A) $^{9}_{4}Be$

B) $^{10}_{6}C$

C) $^{9}_{4}Li$

D) $^{10}_{5}Be$

Chemistry Test: Acids & Bases, Equilbrium, Nuclear Chemistry

1. Given the equilibrium system:

$$2\,A(g) + B(g) + 10\text{ kcal} \leftrightarrow C(g)$$

Which conditions would yield the most product?
A) low temperature and high pressure
B) high temperature and high pressure
C) low temperature and low pressure
D) high temperature and low pressure

2. Given the reaction at STP and at equilibrium:

$$H_2(g) + Cl_2(g) \leftrightarrow 2\,HCl(g)$$

Which change will result in an increase in the concentration of $Cl_2(g)$?
A) increasing the concentration of HCl(g)
B) decreasing the pressure of the system
C) decreasing the concentration of HCl(g)
D) increasing the concentration of $H_2(g)$

3. Which compound will conduct an electric current when dissolved in water?
A) $C_{12}H_{22}O_{11}$
B) NaOH
C) C_2H_5OH
D) $C_6H_{12}O_6$

4. Water containing dissolved electrolyte conducts electricity because the solution contains mobile
A) atoms
B) ions
C) molecules
D) electrons

5. Which of the following particles has the greatest mass?
A) an alpha particle
B) an electron
C) a proton
D) a beta particle

6. Given the reaction at equilibrium:

$$N_2(g) + 3\,H_2(g) \leftrightarrow 2\,NH_3(g) + 22\text{ kcal}$$

Which stress would cause the equilibrium to shift to the left?
A) adding $H_2(g)$ to the system
B) increasing the pressure
C) adding $N_2(g)$ to the system
D) increasing the temperature

7. Which equation represents alpha decay?
A) $^{38}_{19}K \rightarrow {}^{38}_{18}Ar + X$
B) $^{234}_{90}Th \rightarrow {}^{234}_{91}Pa + X$
C) $^{116}_{49}In \rightarrow {}^{116}_{50}Sn + X$
D) $^{222}_{86}Rn \rightarrow {}^{218}_{84}Po + X$

8. As an atom of a radioactive isotope emits an alpha particle, the mass number of the atom
A) decreases
B) increases
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9. Which reaction has a K_{eq} represented by the equilibrium expression below?

$$K_{eq} = \frac{[A]^2[B]}{[C]^3}$$

A) $3\,C \leftrightarrow 2\,A + B$
B) $A^2 + B \leftrightarrow C^3$
C) $C^3 \leftrightarrow A^2 + B$
D) $2\,A + B \leftrightarrow 3\,C$

10. Given the reaction at equilibrium:

$$2\,SO_2(g) + O_2(g) \leftrightarrow 2\,SO_3(g)$$

As the pressure is increased at constant temperature, the number of moles of $SO_3(g)$ produced will
A) decrease
B) increase
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A) NaCl(s)
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14. Given the reaction at equilibrium:

$$2\ SO_2(g) + O_2(g) \leftrightarrow 2\ SO_3(g)$$

Which is the correct equilibrium constant expression for the reaction?

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B) $K_{eq} = \dfrac{[SO_3]^2}{[SO_2]^2 + [O_2]}$

C) $K_{eq} = \dfrac{[SO_3]}{[SO_2][O_2]}$

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When the temperature is increased, the equilibrium will shift to the

A) left, and the concentration of HBr(g) will increase

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A) production of energy by the Earth's Sun

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$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{138}_{56}Ba + {}^{95}_{36}Kr + 3\,{}^{1}_{0}n + \text{energy}$$

This equation can best be described as

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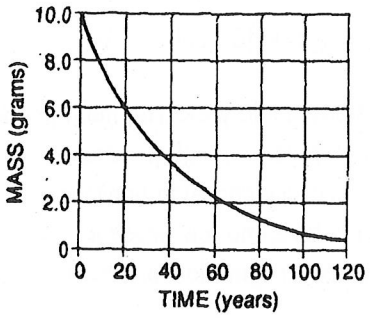

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B) 30 years

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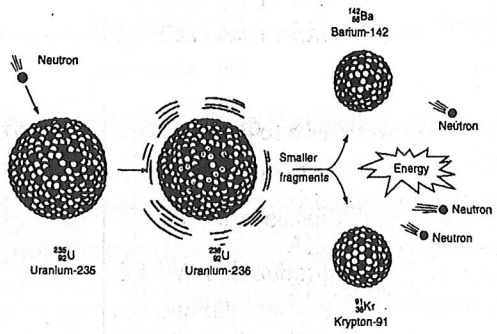

Which type of reaction does the diagram illustrate?

A) fusion

B) fission

C) beta decay

D) alpha decay

21. Which nuclear equation represents a fusion reaction?

A) $^{238}_{92}U + {}^{1}_{0}n \rightarrow {}^{239}_{93}Np + {}^{0}_{-1}e$

B) $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$

C) $^{1}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He$

D) $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{92}_{36}Kr + {}^{141}_{56}Ba + 3\,{}^{1}_{0}n$

22. Which list of particles is in order of increasing mass?

A) electron → proton → alpha particle
B) proton → electron → alpha particle
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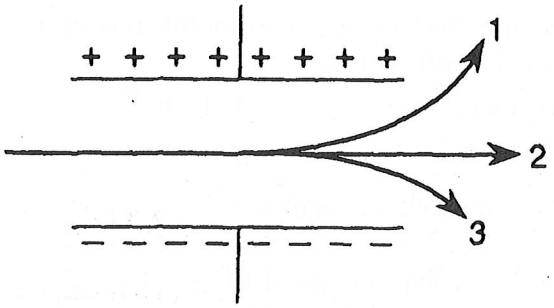

The nuclear emanations 1, 2, and 3 are called, respectively,

A) alpha, beta, and gamma
B) gamma, alpha, and beta
C) gamma, beta, and alpha
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B) beta
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B) 0.333 g
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D) 0.125 g

27. An original sample of a radioisotope had a mass of 10 grams. After 2 days, 5 grams of the radioisotope remains unchanged. What is the half-life of this radioisotope?

A) 1 day
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C) 5 days
D) 4 days

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B) $^{0}_{-1}e$
C) $^{1}_{1}H$
D) $^{4}_{2}He$

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$$NH_3 + HCl \rightarrow NH_4Cl$$

In this reaction ammonia molecules (NH_3) act as a base because they

A) accept hydroxide ions (OH^-)

B) accept hydrogen ions (H^+)

C) donate hydroxide ions (OH^-)

D) donate hydrogen ions (H^+)

40. Which chemical equation represents the reaction of an Arrhenius acid and an Arrhenius base?

A) $Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

B) $HC_2H_3O_2(aq) + NaOH(aq) \rightarrow NaC_2H_3O_2(aq) + H_2O(\ell)$

C) $C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(\ell)$

D) $BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2\ NaCl(aq)$

41. The pH of 0.001M HCl is

A) 1 C) 3

B) 2 D) 4

42. Which pH value indicates the most basic solution?

A) 7 C) 3

B) 8 D) 11

43. Given the reaction at equilibrium:

$$A(g) + B(g) + \text{heat} \leftrightarrow C(g) + D(g)$$

The equilibrium will shift to the right when the

A) pressure is decreased

B) concentration of $A(g)$ is decreased

C) temperature is increased

D) concentration of $C(g)$ is increased

44. What is the hydroxide ion concentration of a solution with a pH of 4?

A) 1×10^{-14} C) 1×10^{-10}

B) 1×10^{-4} D) 1×10^{-7}

45. Given the following solutions:

Solution *A*: pH of 10
Solution *B*: pH of 7
Solution *C*: pH of 5

Which list has the solutions placed in order of increasing H^+ concentration?

A) *A, B, C* C) *C, B, A*

B) *C, A, B* D) *B, A, C*

46. What is the hydrogen ion concentration of a solution at 298 K whose hydroxide ion concentration is 1×10^{-8}?

A) 1×10^{-7} C) 1×10^{-8}

B) 1×10^{-14} D) 1×10^{-6}

47. For a given system at equilibrium, lowering the temperature will always

A) favor the exothermic reaction

B) increase the concentration of products

C) increase the rate of reaction

D) favor the endothermic reaction

48. What is the K_w of water at 1 atm and 298 K?

A) 1.0×10^{7} C) 1.0×10^{-7}

B) 1.0×10^{-14} D) 1.0×10^{14}

49. If a solution has a hydrogen ion concentration of 1×10^{-9} M, the solution is

A) basic and has a pH of 9

B) acidic and has a pH of 5

C) basic and has a pH of 5

D) acidic and has a pH of 9

50. According to the Arrhenius theory, when a base is dissolved in water it produces a solution containing only one kind of negative ion. What is the name of this negative ion?
A) hydrogen sulfate ion
B) hydride ion
C) hydroxide ion
D) hydrogen carbonate ion

51. When the pH of a solution is 8, what is the OH^- ion concentration in moles per liter?
A) 1×10^{-7} C) 1×10^{-8}
B) 1×10^{-14} D) 1×10^{-6}

52. What is the OH^- ion concentration of an aqueous solution with a pH of 5?
A) 1×10^{-9} M C) 1×10^{-5} M
B) 1×10^{-14} M D) 1×10^{-7} M

53. What is the pH of a 0.01 M solution of KOH?
A) 1 C) 12
B) 2 D) 13

54. As an aqueous solution becomes more acidic, the hydroxide ion concentration
A) decreases C) remains the same
B) increases

55. Which concentration indicates a basic solution at 298 K?
A) $[H_3O^+] = 1.0 \times 10^{-7}$ C) $[OH^-] = 1.0 \times 10^{-7}$
B) $[OH^-] > 1.0 \times 10^{-7}$ D) $[H_3O^+] > 1.0 \times 10^{-7}$

56. Given the equilibrium constant for water:

$$K_w = [H^+][OH^-] = 1 \times 10^{-14} \text{ at } 298 \text{ K}$$

As the $[H^+]$ increases, the $[OH^-]$
A) decreases C) remains the same
B) increases

57. An aqueous solution with a pH of 4 would have a hydroxide ion concentration of
A) 1×10^{-10} mol/L C) 1×10^{-14} mol/L
B) 1×10^{-7} mol/L D) 1×10^{-4} mol/L

58. What is the H^+ ion concentration of an aqueous solution that has a pH of 11?
A) 1.0×10^{-3} mol/L C) 1.0×10^{-11} mol/L
B) 3.0×10^{-1} mol/L D) 11×10^{-1} mol/L

59. A student tested a 0.1 M aqueous solution and made the following observations:

- conducts electricity
- turns blue litmus to red
- reacts with Zn(s) to produce gas bubbles

Which compound could be the solute in this solution?
A) HBr C) LiOH
B) CH_4 D) LiBr

60. A solution has a hydroxide ion concentration of 1×10^{-5} M. What is the hydrogen ion concentration of the solution?
A) 1×10^{-1} M C) 1×10^{-5} M
B) 1×10^{-14} M D) 1×10^{-9} M

61. What is the pH of a solution with a hydroxide ion concentration of 0.001 mole per liter?
A) 1 C) 3
B) 7 D) 11

62. Which aqueous solution would turn blue litmus red?
A) NaCl(aq) C) K_2CO_3(aq)
B) NaOH(aq) D) HCl(aq)

63. If 25. milliliters of 0.80 M HCl is used to completely neutralize 40. milliliters of NaOH solution, what is the molarity of the base?
A) 0.050 M C) 0.50 M
B) 5.0 M D) 50. M

64. Which equation represents a neutralization reaction?
A) $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$
B) $NaOH + HCl \rightarrow NaCl + H_2O$
C) $2\ Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$
D) $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

65. Which products are formed when an acid reacts with a base?
A) a salt and water
B) a soap and glycerine
C) an ester and water
D) an alcohol and carbon dioxide

66. An alpha particle has the same composition as a
A) hydrogen nucleus C) deuterium nucleus
B) helium nucleus D) beryllium nucleus

67. Given the nuclear equation:

$$^{1}_{1}H + X \rightarrow {}^{6}_{3}Li + {}^{4}_{2}He$$

The particle represented by X is

A) $^{9}_{4}Li$

B) $^{10}_{6}C$

C) $^{10}_{5}Be$

D) $^{9}_{4}Be$