5c, d, f, g

pHooey!

ChemCatalyst:

Q: What do you think pH really represents?
Q: How does the concentration of the solutions relate to pH?

Substance	pH
0.1 M HCl	1
0.01 M HCl	2
0.001 M HCl	3
water	7
0.01 M NaOH	12
0.1 M NaOH	13
1.0 M NaOH	14

Notes:

- How/why do Acids & Bases conduct electricity?
  - acids & bases conduct electricity, therefore there must be ions in them
  - dissociation: breaking up into ions (charged atoms)
  - Acids can dissociate:
    $HCl \rightarrow H^+ + Cl^-$ * H^+ ions are in acids
  - Bases can also dissociate:
    $NaOH \rightarrow Na^+ + OH^-$ * OH^- ions are in bases
  - these charged atoms from acids & bases conduct
- What is the Arrhenius definition of acids & bases?
  - Acid: any substance that adds hydrogen ions (H^+) to the solution
  - Base: any substance that adds hydroxide ions (OH^-) to the solution
- How does the concentration of ions relate to pH?
  - pH value for acids is directly related to the $[H^+]$
    - pH values 0-6 are acidic
  - pH value for bases is directly related to the $[OH^-]$
    - pH values 8-14 are basic
  - pH 7 = neutral (no H^+ or OH^-; or equal amounts)

Student Worksheet

pHooey!

Name: _____

Period: _____ Date: _____

Purpose: You will explore the relationship between pH, pOH, [H+], and [OH-].

Part I: Discovering the math behind pH

Directions: The following data table contains some of the data you collected in the first lesson. Additional information, the concentration of H+, has been included. Complete the following table:

Substance	Acidic or Basic?	pH	[H+] (in decimal)	[H+] (in scientific notation)
1 M HCl	acidic	0	1.0M	1.0×10^{0} M
Stomach acid (0.1 M HCl)	Acidic	1	0.1 M	1.0×10^{-1} M
Clear Soda	acidic	3	0.001 M	1.0×10^{-3} M
Rain Water	Acidic	6	0.000001 M	1.0×10^{-6} M
Distilled Water	Neutral	7	0.0000001M	1.0×10^{-7} M
Alcohol	Neutral	7	0.0000001M	1.0×10^{-7} M
Salt Water	Neutral	7	0.0000001 M	1.0×10^{-7} M
Washing Soda	Basic	8	0.00000001 M	1.0×10^{-8} M
Ammonia	Basic	10	0.0000000001 M	1.0×10^{-10} M
Drain Cleaner (0.1 M NaOH)	Basic	13	0.0000000000001M	1.0×10^{-13} M
1 M NaOH	Basic	14	0.00000000000001M	1.0×10^{-14} M

Answer the following questions:

1. If you know the concentration of [H+] of a solution in decimal form, explain how you can figure out its pH. # of decimal places after the decimal point
2. If you know the concentration of [H+] of a solution in scientific notation, explain how you can determine its pH. # in the power of ten
3. As the value of the pH increases, what happens to the concentration of H+?

   decreases
4. As the value of the pH decreases, what happens to the concentration of H+?

   increases
5. Solution A has a pH of 5. Solution B has a pH of 9.
   a) What is the [H+] of both solutions? pH5 = 1.0×10^{-5} M pH9 = 1.0×10^{-9} M
   b) Identify the solutions as acidic or basic. acidic ; basic
   c) Which solution has the greatest concentration of H+? How many times greater is the concentration? Solution A by 10^{4}

Part II: Looking at OH-

Procedure: Imagine the following table contains results of a series of dilutions of HCl and NaOH. Additional information about the solutions (the pOH) is included. Complete the table.

Well	pH	[H+]	[OH-]	pOH
A	1	1.0×10^{-1} M	1.0×10^{-13} M	13
B	2	1.0×10^{-2} M	1.0×10^{-12} M	12
C	3	1.0×10^{-3} M	1.0×10^{-11} M	11
D	4	1.0×10^{-4} M	1.0×10^{-10} M	10
E	5	1.0×10^{-5} M	1.0×10^{-9} M	9
F	6	1.0×10^{-6} M	1.0×10^{-8} M	8
G	7	1.0×10^{-7} M	1.0×10^{-7} M	7
H	7	1.0×10^{-7} M	1.0×10^{-7} M	7
I	7	1.0×10^{-7} M	1.0×10^{-7} M	7
R	7	1.0×10^{-7} M	1.0×10^{-7} M	7
Q	7	1.0×10^{-7} M	1.0×10^{-7} M	7
P	7	1.0×10^{-7} M	1.0×10^{-7} M	7
O	8	1.0×10^{-8} M	1.0×10^{-6} M	6
N	9	1.0×10^{-9} M	1.0×10^{-5} M	5
M	10	1.0×10^{-10} M	1.0×10^{-4} M	4
L	11	1.0×10^{-11} M	1.0×10^{-3}	3
K	12	1.0×10^{-12} M	1.0×10^{-2} M	2
J	13	1.0×10^{-13} M	1.0×10^{-1} M	1

HCl

OH

Answer the following questions:

1. What does [OH-] stand for?

2. What can you say about the concentration of OH- in solutions with high acidity?

   low

3. How is the value of the pH related to the value of the pOH for each concentration?

   they add up to 14

4. If you know the value of the pH, how can you determine the value of the pOH for that same solution?

   pOH = 14 - pH

5. If you know the value of the pOH for a solution, how can you figure out the value of the pH for that solution?

   pH = 14 - pOH

Making Sense:
How are pH and pOH related to each other mathematically?

If you finish early:
How are [H+] and [OH-] related to each other mathematically?

Making Sense Notes:

• What is the mathematical relationship for pH ∶ pOH?	• when the pH of a substance increases by a value of 1 (ex: from pH 2 to pH 3), the # of H^+ (hydrogen ions) decreases by a power of ten - ex: pH = 2 $[H^+] = 0.01 M$ pH = 3 $[H^+] = 0.001 M$ • **pH + pOH = 14** • pH is identical to the negative value of the exponents $pH = -\log[H^+]$ $pOH = -\log[OH^-]$ $[H^+] = 1.0 \times 10^{-4} M$ = pH = 4 *pH is always a positive #!
• How do you calculate pH?	• ex: what is the pH of a solution w/ a $[H^+]$ of $3.40 \times 10^{-4} M$? $pH = -\log[H^+]$ $= -\log(3.40 \times 10^{-4})$ **pH = 3.47** • ex: what is the pH of a solution w/ a $[OH^-]$ of $2.65 \times 10^{-6} M$? $pOH = -\log[OH^-]$ $= -\log(2.65 \times 10^{-6})$ $pOH = 5.58$ $pH + pOH = 14$ $pH = 14 - pOH$ $= 14 - 5.58$ **pH = 8.42**

Check-In:

Q: What is the pH of a solution w/ $[OH^-] = 1.0 \times 10^{-12} M$?

pH = 2