

## Chem 108: Class/ Lab

Week 13

Pick a vial and a plastic dropper  
Using the vial number, sign-in on the Lab roster

Pick up **HANDOUTS**

- 1) Fluid Exchange Form & Post Lab (Handout)
- 2) Acid-Bases: pH (Handout)

## Chem 108: Class/ Lab

Week 13: 2019f

Do Today:

- 1) Fluid Exchange (Handout)  
*Due Next Lab*

- 2) Acid-Base: pH (Handout)

*Data completed & signed before leaving Lab*

Follow Instructions

<http://chemconnections.org/general/chem120/fluid-ex.108.html>

## Chem 108: Class/ Lab

Week 13

TODAY:

Fluid Exchange (Handout)

3) You have been assigned a geographical location for your Global Residence. Check the *Global Homelands Map*, which follows, for your location and if necessary move to your place of residence.

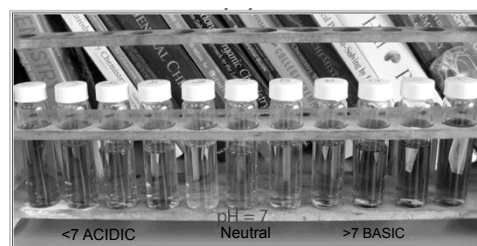
<http://chemconnections.org/general/chem120/fluid-ex.108.html>

Global Homelands Map  
(Print of Lab)



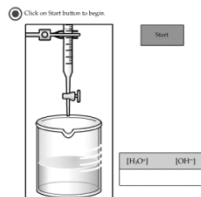
Wait for Dr. R's instructions on exchanging fluids, keeping records, and using the handout provided.

## Acid-Base Indicators



## Water as an Acid and a Base

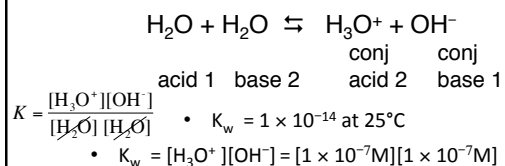
### Self-ionization



<http://chemconnections.org/general/movies/KwActivity.swf>

## Pure Water is an Acid and a Base

It is amphoteric. (It can behave either as an acid or a base).




**NOTE: only concentrations [mol/L] are used in the calculation; liquids (l) and solids (s) are not included**


<https://phet.colorado.edu/en/simulation/ph-scale-basics>

## The pH Scale

pH: the negative logarithm of the hydrogen ion concentration.



Beer's pH ~ 4



Quantitative, logarithmic, numeric scale based on testing the electric current of aqueous solutions & relating it to the equilibrium concentration of the hydrogen ion,  $[H^+_{(aq)}] = [H_3O^+_{(aq)}]$

**pH = -log[H<sup>+</sup>]**

0	10 <sup>0</sup>	1
1	10 <sup>-1</sup>	0.1
2	10 <sup>-2</sup>	0.01
3	10 <sup>-3</sup>	0.001
4	10 <sup>-4</sup>	0.0001
5	10 <sup>-5</sup>	0.00001
6	10 <sup>-6</sup>	0.000001
7	10 <sup>-7</sup>	0.0000001
8	10 <sup>-8</sup>	0.00000001
9	10 <sup>-9</sup>	0.000000001
10	10 <sup>-10</sup>	0.0000000001
11	10 <sup>-11</sup>	0.00000000001
12	10 <sup>-12</sup>	0.000000000001
13	10 <sup>-13</sup>	0.0000000000001
14	10 <sup>-14</sup>	0.00000000000001

Introduced in 1909 by Søren Sørensen, Danish brewer/chemist, as a convenient way of expressing acidity..... Providing much improved quality control in brewing.

<http://www.chemconnections.org/general/chem108/Acids-Bases%20Guide.html>

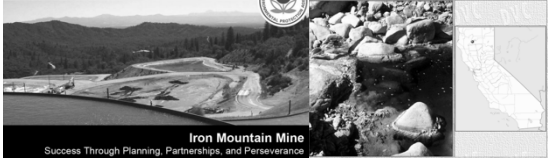
## The pH Scale

- $pH \approx -\log[H^+] \approx -\log[H_3O^+]$
- pH in water ranges from 0 to 14.
- $K_w = 1.00 \times 10^{-14} = [H^+] [OH^-]$
- $pK_w = 14.00 = pH + pOH$
- As pH rises, pOH falls (sum = 14.00).
- There are no theoretical limits on the values of pH or pOH. (e.g. pH of 2.0 M HCl is -0.301)

<https://phet.colorado.edu/en/simulation/ph-scale-basics>

## The pH Scale

**Abandoned Mine Lands Case Study**




**Iron Mountain Mine**  
Success Through Planning, Partnerships, and Perseverance

The drainage water from the Iron Mountain Mine is the most acidic water on Earth; some samples collected in 1990 and 1991 have been measured to have a pH value of -3.6, which is the lowest pH observed globally in a natural environment.

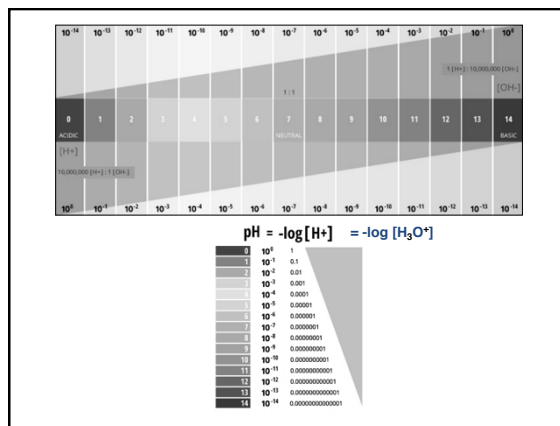
## Indicators

### Natural Indicators



## Acid-Base Indicators

Indicator	pH range for color change														
	0	2	4	6	8	10	12	14							
Methyl violet	Yellow														Violet
Thymol blue	Red		Yellow			Yellow									Blue
Methyl orange			Red			Yellow									
Methyl red			Red			Yellow									
Bromthymol blue					Yellow										Blue
Phenolphthalein								Colorless							Pink
Alizarin yellow R										Yellow					Red



**The Relations Among  $[H_3O^+]$ , pH,  $[OH^-]$ , and pOH**

	$[H_3O^+]$	pH	$[OH^-]$	pOH
BASIC	$1.0 \times 10^{-15}$	15.00	$1.0 \times 10^1$	-1.00
	$1.0 \times 10^{-14}$	14.00	$1.0 \times 10^0$	0.00
	$1.0 \times 10^{-13}$	13.00	$1.0 \times 10^{-1}$	1.00
	$1.0 \times 10^{-12}$	12.00	$1.0 \times 10^{-2}$	2.00
	$1.0 \times 10^{-11}$	11.00	$1.0 \times 10^{-3}$	3.00
	$1.0 \times 10^{-10}$	10.00	$1.0 \times 10^{-4}$	4.00
NEUTRAL	$1.0 \times 10^{-8}$	8.00	$1.0 \times 10^{-6}$	6.00
	$1.0 \times 10^{-7}$	7.00	$1.0 \times 10^{-7}$	7.00
ACIDIC	$1.0 \times 10^{-6}$	6.00	$1.0 \times 10^{-8}$	8.00
	$1.0 \times 10^{-5}$	5.00	$1.0 \times 10^{-9}$	9.00
	$1.0 \times 10^{-4}$	4.00	$1.0 \times 10^{-10}$	10.00
	$1.0 \times 10^{-3}$	3.00	$1.0 \times 10^{-11}$	11.00
	$1.0 \times 10^{-2}$	2.00	$1.0 \times 10^{-12}$	12.00
	$1.0 \times 10^{-1}$	1.00	$1.0 \times 10^{-13}$	13.00
	$1.0 \times 10^0$	0.00	$1.0 \times 10^{-14}$	14.00
	$1.0 \times 10^1$	-1.00	$1.0 \times 10^{-15}$	15.00

**The pH Values of Some Familiar Aqueous Solutions**  
(TODAY'S LAB EXPERIMENT)

$H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$

$[H_3O^+][OH^-] = K_w$

**Th pH Values of Some Familiar Aqueous Solutions**

- 14 1 M NaOH (14.0)
- 13 Lye (13.0)
- 12 Household ammonia
- 11 Milk of magnesia (10)
- 10 Detergent solution (~10)
- 9
- 8 Sea water (7.0-8.3)
- 7.4 Blood (7.4)
- 7 NEUTRAL
- 6.4 Milk (6.4)
- 6 Urine (4.8-7.5)
- 5.6 Unpolluted rain water (5.6)
- 4
- 3.5 Beer (4.0-4.5)
- 3 Vinegar (2.4-3.4)
- 2.2-2.4 Lemon juice (2.2-2.4)
- 1.0-3.0 Stomach acid (1.0-3.0)
- 1
- 0 1 M HCl (0.0)

**Chem 108: Class/ Lab**  
Week 13

1) Fluid Exchange  
(Handout) *Due Next Lab*

TODAY:  
2) Acid-Base: pH (Handout)  
*Data table completed & signed before leaving Lab*

*Due Next Week:*  
*Fully Completed Handout plus On-line Questions*  
<http://chemconnections.org/general/chem108/Acids-Bases%20Guide.html>

**Acid-Base Strengths**  
pH [indicator paper & pH meter]

<https://phet.colorado.edu/en/simulation/ph-scale>

**Strong Acid:**

**Strong Base:**

**Weak Acid:**

**Weak Base:**

<http://www.chemconnections.org/general/chem108/Acids-Bases%20Guide.html>

**pH = -log[H<sup>+</sup>]**

	Red Litmus	Blue Litmus	Solution pH	pH Meter	Description
A	red	red	1	1.0	acid
B	blue	blue	13	13.0	base
C	red	blue	7	7.0	neutral
D	red	blue	7	7.0	neutral
E	red	blue	7	7.0	neutral
F	red	blue	7	7.0	neutral
G	red	blue	7	7.0	neutral
H	red	blue	7	7.0	neutral
I	red	blue	7	7.0	neutral
J	red	blue	7	7.0	neutral
K	red	blue	7	7.0	neutral
L	red	blue	7	7.0	neutral
M	red	blue	7	7.0	neutral
N	red	blue	7	7.0	neutral
O	red	blue	7	7.0	neutral
P	red	blue	7	7.0	neutral
Q	red	blue	7	7.0	neutral

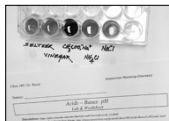
**Lab pH: pH Meter**

	Red Litmus	Blue Litmus	Solution pH	pH Meter	Description
A	red	red	1	1.0	acid
B	blue	blue	13	13.0	base
C	red	blue	7	7.0	Neutral (H <sub>2</sub> O in H <sub>2</sub> O; acid & base)
D					6.4
E					10.1
F					4.7
G					8.4
H					12.0
I					6.1
J					7.0
K					10.9
L					12.2
M					3.8
N	red	red	6	7	6.4
O	blue	blue	7	7	7.3
P	red	red	1	2	1.9
Q	red	blue	7	7	7.0

## Chem 108: Class/ Lab

Week 13

- 1) Fluid Exchange  
(Handout) *Due Next Lab*



**TODAY:**

- 2) Acid-Base: pH (Handout)

*Show Dr. R your well plate with test solutions and indicator, and your completed data table, which corresponds to the wells; to be signed before leaving Lab*

**Due Next Week:**

**Fully Completed Handout plus On-line Questions**

<http://chemconnections.org/general/chem108/Acids-Bases%20Guide.html>