Sample Diploma Question

Use the following information to answer question 1.

An Equation for a Chemical Reaction Associated with Acid Deposition

$$HNO_2(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + NO_2^-(aq)$$

1. In the chemical reaction represented by the equation above, the proton donors are

A. $HNO_2(aq)$ and $H_2O(l)$

B. $HNO_2(aq)$ and $H_3O^+(aq)$

~~**C.** $NO_2^-(aq)$ and $H_2O(l)$~~

~~**D.** $NO_2^-(aq)$ and $H_3O^+(aq)$~~

Donor: who is giving an H+

Sample Diploma Question

Go to page 12 of data booklet!

acid

2. Which of the following descriptions applies to vinegar, a solution of $CH_3COOH(aq)$?

A. $CH_3COOH(aq)$ ~~is a weak base that~~ partially ionizes in water to form $CH_3CO^+(aq)$ and $OH^-(aq)$ ions.

B. $CH_3COOH(aq)$ is a weak acid that partially ionizes in water to form $CH_3COO^-(aq)$ and $H_3O^+(aq)$ ions.

C. $CH_3COOH(aq)$ ~~is a strong base~~ that completely ionizes in water to form $CH_3CO^+(aq)$ and $OH^-(aq)$ ions.

D. $CH_3COOH(aq)$ is a strong acid that completely ionizes in water to form $CH_3COO^-(aq)$ and $H_3O^+(aq)$ ions.

Sample Diploma Question

Use the following information to answer question 4.

Equal volumes of four different colourless household solutions are placed into numbered beakers.

Beaker		
1	Lye solution, NaOH(aq)	base
2	Salt solution, NaCl(aq)	Ionic
3	Sugar solution, $C_{12}H_{22}O_{11}(aq)$	molecular
4	Vinegar solution, $CH_3COOH(aq)$	acid

4. The solution above that would **not** conduct electricity is

A. lye
B. salt
C. sugar
D. vinegar

Sample Diploma Question

Use the following information to answer question 5.

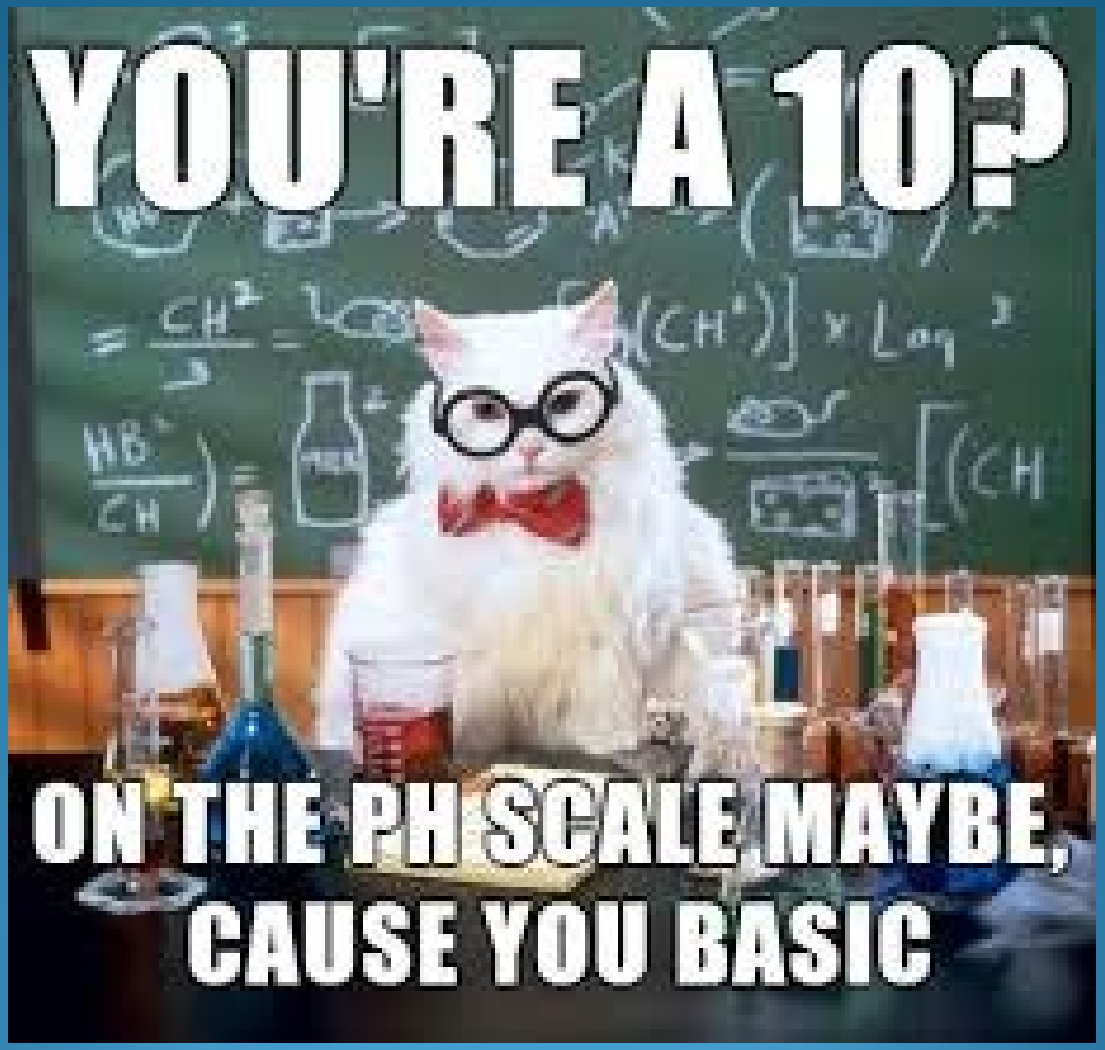
A 0.10 mol/L solution of benzoic acid, $C_6H_5COOH(aq)$, and a 0.10 mol/L solution of hydrochloric acid, HCl(aq), are tested with conductivity meters and pH meters.

5. Which of the following rows identifies the acid solution with the highest conductivity and the acid solution with the highest hydronium ion concentration, $[H_3O^+(aq)]$?

Row	Highest Conductivity	Highest $[H_3O^+(aq)]$
A.	HCl(aq)	HCl(aq)
B.	HCl(aq)	$C_6H_5COOH(aq)$
C.	$C_6H_5COOH(aq)$	HCl(aq)
D.	$C_6H_5COOH(aq)$	$C_6H_5COOH(aq)$

HCl strongest acid as per pg. 12 of data book therefore, highest H3O+

pH



Curriculum

- describe the relationship between pH and hydronium ion concentration
- calculate pH from hydronium ion concentration and hydronium ion concentration from pH
- calculate the concentration of strong monoprotic acids and strong monoprotic bases from empirical data

WHMIS review

	**Exploding bomb** (for explosion or reactivity hazards)		**Flame** (for fire hazards)		**Flame over circle** (for oxidizing hazards)
	**Gas cylinder** (for gases under pressure)		**Corrosion** (for corrosive damage to metals, as well as skin, eyes)		**Skull and Crossbones** (can cause death or toxicity with short exposure to small amounts)
	**Health hazard** (may cause or suspected of causing serious health effects)		**Exclamation mark** (may cause less serious health effects or damage the ozone layer*)		**Environment*** (may cause damage to the aquatic environment)
	**Biohazardous Infectious Materials** (for organisms or toxins that can cause diseases in people or animals)				

* The GHS system also defines an Environmental hazards group. This group (and its classes) was not adopted in WHMIS 2015. However, you may see the environmental classes listed on labels and Safety Data Sheets (SDSs). Including information about environmental hazards is allowed by WHMIS 2015.

Water

- Water is a molecular substance
- Does water conduct electricity?
- No!

- Scientists infer that pure water can self ionize to form ions shown below:

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

Water

- On average about 2 water molecules out of every billion are ionized
- Since so few ionize, very little electric current is conducted
- Chemists have determined that the concentration of hydronium ions in pure water is about 1.0 x 10^{-7} mol/L
- The ionization of water contains the same amount of hydroxide ions

$$[H_3O^+(aq)] = [OH^-(aq)] = 1.0 \times 10^{-7}\ mol/L$$

pH

- Scientists found that the concentration of hydronium ions ranged from about 10 mol/L for a strong acid to about 1.0 x 10^{-15} mol/L for a strong base.
- This huge of a range and negative powers of 10 is not very nice to work with so Danish biochemist Søren Sørenson suggested a system of base 10 logarithms

Logarithms

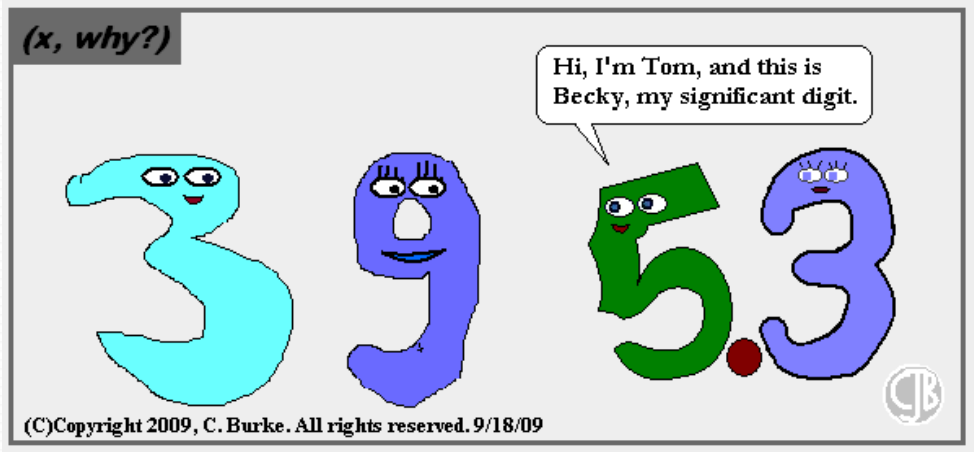
- A base 10 logarithm of a number is the power to which you raise 10 to equal that number

- The formula for finding pH is:

$$pH = -\log [H_3O^+(aq)]$$

Significant Digits and pH

- For pH values, the only numbers that are significant are the numbers to the right of the decimal point
- A pH of 8.29 has_____ significant digits
- A pH of 3 has _____significant digits



Example

- Calculate the pH of a solution where the hydronium concentration is 3.8×10^{-3} mol/L

$$pH = -\log [H_3O^+(aq)]$$

- pH= -log (3.8×10^{-3})= 2.42

Example

- Calculate the pH of a 4.42×10^{-13} mol/L solution of drain cleaner.

$$pH = -\log [H_3O^+(aq)]$$

- pH= $-\log(4.42 \times 10^{-13}) = 12.3545$ → 12.355 rounded

Board Question

- Find the pH of a solution with a hydronium ion concentration of 4.422×10^{-4} mol/L.

$$pH = -\log [H_3O^+(aq)]$$

- $-\log(4.422 \times 10^{-4}) = 3.35438 = 3.35$ (rounded)

Can pH be less than zero?

- Calculate the pH of a 10 mol/L solution of HCl(aq)

$$pH = -\log [H_3O^+(aq)]$$

- -log(10) = -1

pH Scale

Each number you go up it is increasing the concentration by **10 times**

- What has a greater hydronium ion concentration? And by how much more?
- pH of 5 vs. pH of 6
- pH of 9 vs. pH of 4

5 is a stronger acid that 6 therefore 5 has a greater hydronium concentration 10x more

4 is a stronger acid that 9 therefore 4 therefore (10x10x10x10x10 = 100 000x more

- As pH increases what happens to hydronium ion (H_3O^+) concentration?
- Decreases

Calculating Concentration from pH and pOH

OMG ITS JIGSAW!!!

- The pH of beaker one was 2.4, the pH of beaker 2 is 7. How do we find the hydronium concentration of both of the beakers?

$$[H_3O^+(aq)] = 10^{-pH}$$

$10^{-2.4} = 0.003981071 = 4.0 \times 10^{-3}$ (rounded)

$10^{-7} = 0.0000001 = 1 \times 10^{-7}$

Example

- Calculate the hydronium ion concentration of a 200mL of solution with a pH of 11.50 at 25°C

$$[H_3O^+(aq)] = 10^{-pH}$$

- $10^{-11.50}$ = 3.16 x 10 -12

Board Question

- Find the hydronium concentration of a vinegar solution with a pH of 3.4

$$[H_3O^+(aq)] = 10^{-pH}$$