Sample Diploma Question

3 sig digs

Numerical Response

4. If the pH of a sample of river water is 7.730, then the corresponding hydronium ion concentration, $[H_3O^+(aq)]$, of the sample, expressed in scientific notation, is $a.bc \times 10^{-d}$ mol/L. The values of ***a***, ***b***, ***c***, and ***d*** are

1 (***a***), 8 (***b***), 6 (***c***), and 8 (***d***).

(Record all **four digits** of your answer in the response boxes at the bottom of the screen.)

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

1.86 x 10 -8

Sample Diploma Question

Use the following information to answer question 7.

When carbon dioxide dissolves in blood it forms a weak acid called carbonic acid, which influences the pH of the blood. The rapid, shallow breathing that occurs during hyperventilation results in a decrease in carbon dioxide levels in the blood.

decrease

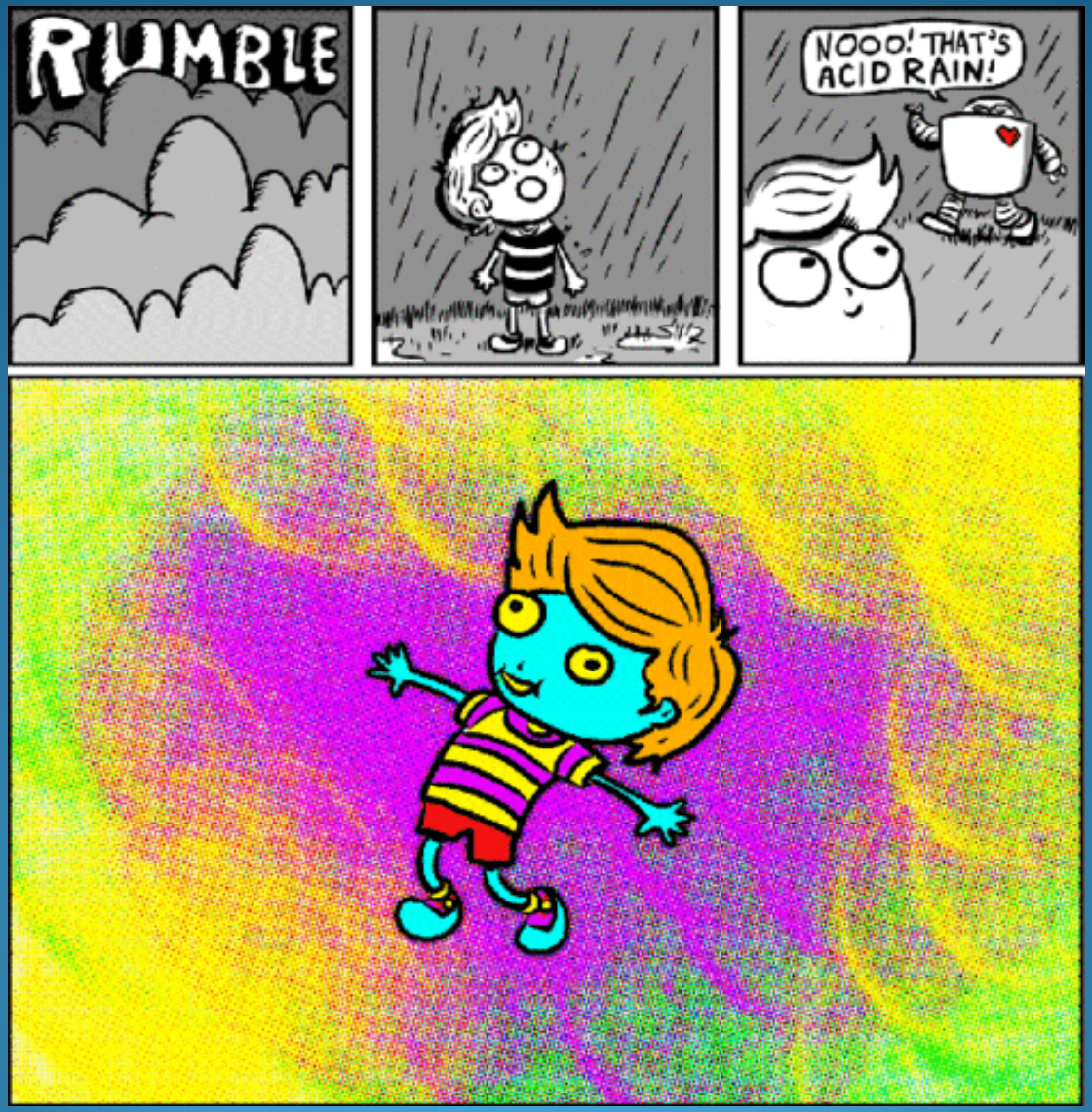
7. *Based on the information above, hyperventilation would cause the concentration of carbonic acid to* ___***i***___ *and the pH of the blood to* ___***ii***___ .

The statement above is completed by the information in row

Row	*i*	*ii*
A.	increase	increase
B.	increase	decrease
C.	decrease	increase
D.	decrease	decrease

If acid decreases then pH would go up (more basic)

Acid Deposition



Curriculum

- Outline the chemical reactions (*e.g., combustion reactions*) that produce air pollutants (i.e., sulfur dioxide and nitrous oxides) that, when combined with water, ultimately result in acid deposition
- describe impacts on the biotic and abiotic components of the environment caused by acid deposition
- identify and explain how human activities and natural events contribute to acid deposition in the environment.
- research and plot on a map the distribution patterns of acid deposition as influenced by prevailing winds

Curriculum

- explain the mechanism and significance of biomagnification.
- explain, qualitatively, how buffers maintain a relatively constant pH when a small amount of acid or base is added to an aqueous system .
- explain the importance of maintaining a relatively constant pH in a living system
- explain what is meant by buffering capacity
- evaluate methods used to reduce the incidence of acid deposition and photochemical smog

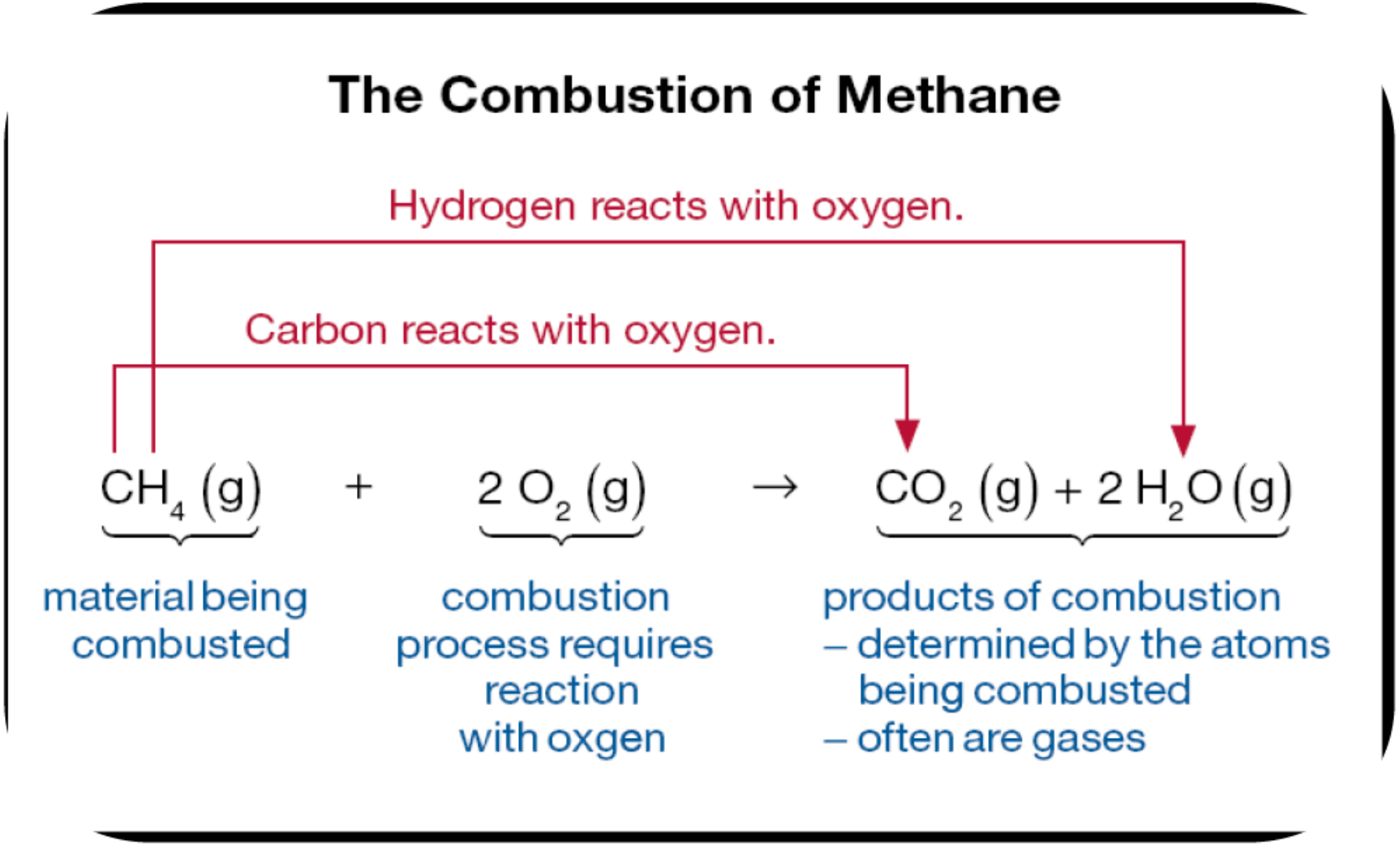
Combustion

- **Combustion reactions** involve the reaction between a fuel and oxygen
- Combustion reactions always create emissions which very depending on the type of fuel
- We will be looking at three types of combustion reactions:
  - Hydrocarbon combustion
  - Oxides of Sulphur
  - Oxides of nitrogen

Hydrocarbon Combustion

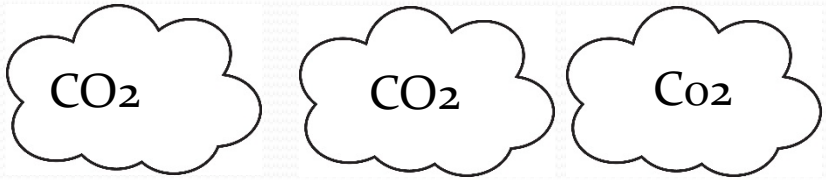
- $C_xH_y + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)}$
- The reactants are always a hydrocarbon (hydrogen and carbon) and oxygen
- The products are always carbon dioxide and water gases

Fossil Fuel Combustion



Problems with Combustion

- CO_2 is a greenhouse gas
- Greenhouse gases lead to global warming through the greenhouse effect



Greenhouse effect:

Ultravilot rays come from the sun and can pass through clouds of CO_2 and warm the earth.

But once they hit a something they become infrared rays that can not pass through clouds and continue to warm the earth in a cycle.

- $C_2H_{6\ (g)} + O_{2\ (g)} \rightarrow$

- Methane (CH_4) burns

Oxides of Sulfur (SO_x)

- The two most common way sulfurs are found in fuel include:
  - The element sulfur found in coal $S_8(s)$

    $S_8 + C + O_2 \rightarrow CO2 + \mathbf{SO_2}$ ← BAD!

  - Hydrogen sulfide in **sour gas** $H_2S(s)$
    - $H_2S + O_2 \rightarrow H_2O + \mathbf{SO_2}$

Hydrogen Sulphide

- Natural gas, coal and oil often contain sulphur compounds

- Hydrogen sulphide, H_2S is toxic, it binds to hemoglobin

sour gas: natural gas that contains greater than 1% hydrogen sulfide

What happens when SO_2 forms with water?

It creates Acid rain (Acid deposition)!

Sulfurous acid

$$SO_2 + H_2O \rightarrow \mathbf{H_2SO_3}$$

... main cause of acid rain

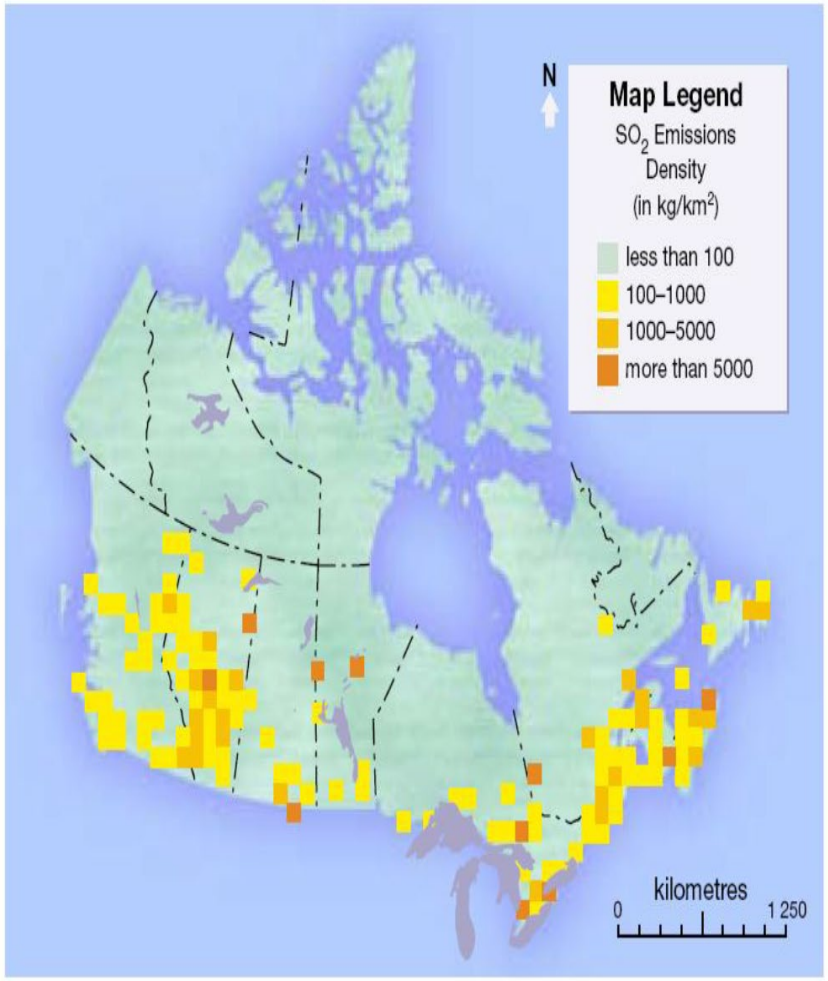
Acid Deposition

- The real danger of oxides of sulfur , oxides of nitrogen and carbon dioxide is their ability to make acids when combined with moisture in the air.

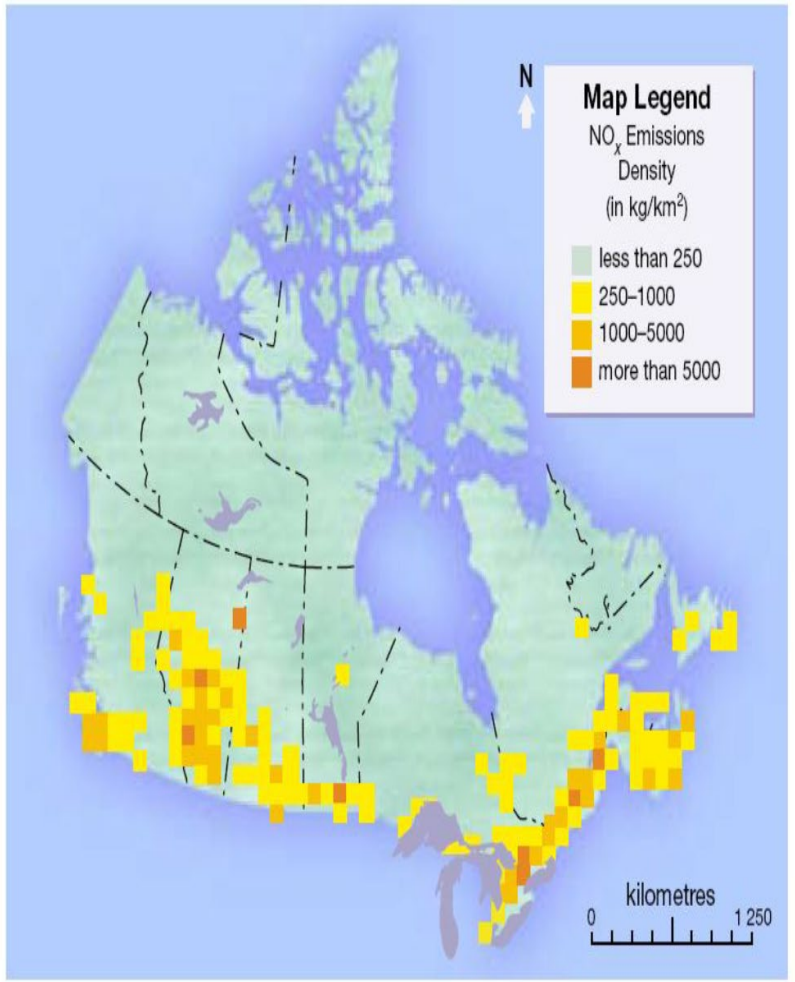
Flaring process: converts hydrogen sulfide into sulfur dioxide and sulfur trioxide

- Sulphur oxides (SO_X) and nitrogen oxides (NO_X) in the atmosphere cause acid rain

Sulfur Dioxide (SO_2) Emissions in Canada (2000)



Nitrogen Oxide (NO_x) Emissions in Canada (2000)



Nitrogen and CO_2 can also cause acid deposition

- $NO_2 + H_2O \rightarrow HNO_3$ Nitic acid
- $CO_2 + H_2O \rightarrow H_2CO_3$ Carbonic acid

Acid rain

- **Acid deposition** is when emissions combine with water to form acid rain
- Emissions that are from human sources are **anthropogenic**
- Acid rain is precipitation that falls with a pH of less than 5.6

Sources of SO_2
Natural
• hot springs • volcanic outgassing
Human-made
emissions from • coal-fired power plants • pulp and paper mills • refining crude oil • refining oil sands • refining metals and smelting • automobiles

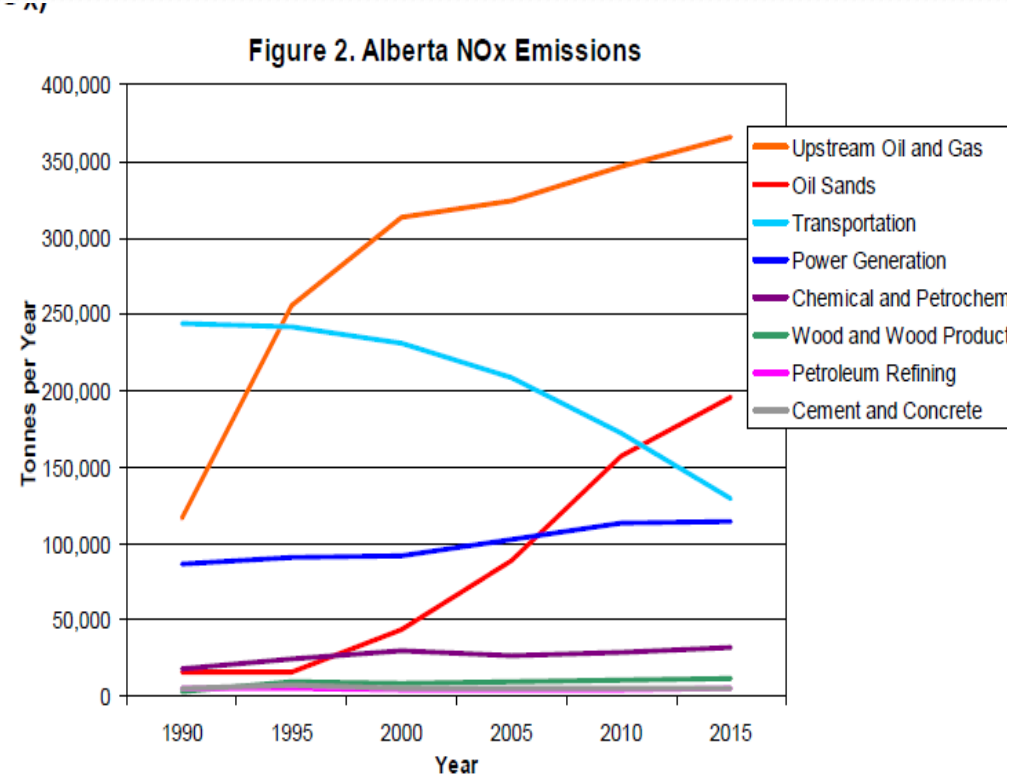
Negative effects of acid rain:

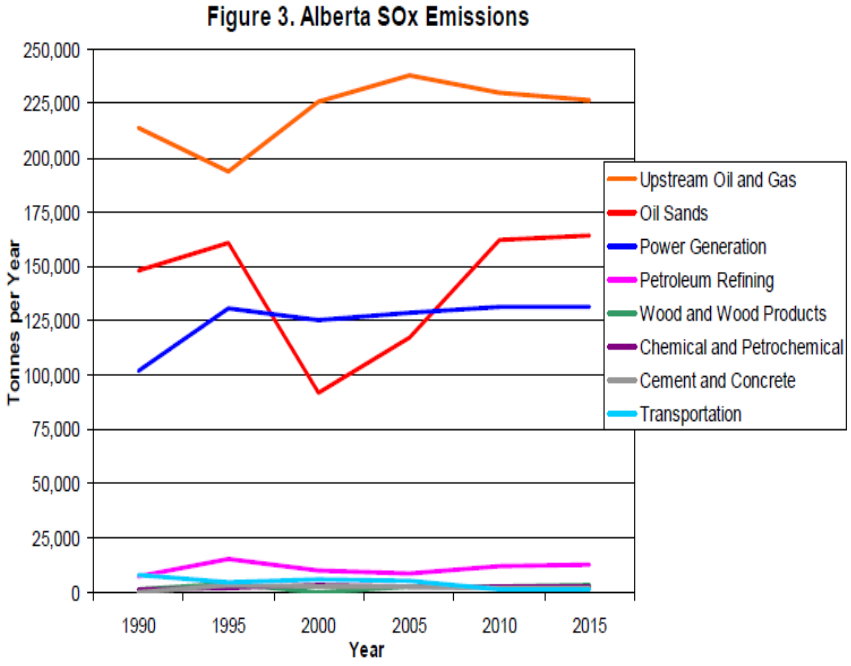
- Ecosystem: wildlife, streams ect
  - Low pH fish die in lakes/streams
- Aluminum leaching from soil (effects plats and soil pH)
  - May see dead trees
- Corrodes metal/ statues/ buildings / roads

Wind Patterns and Acid Deposition

Two main factors affect the amount of acid precipitation

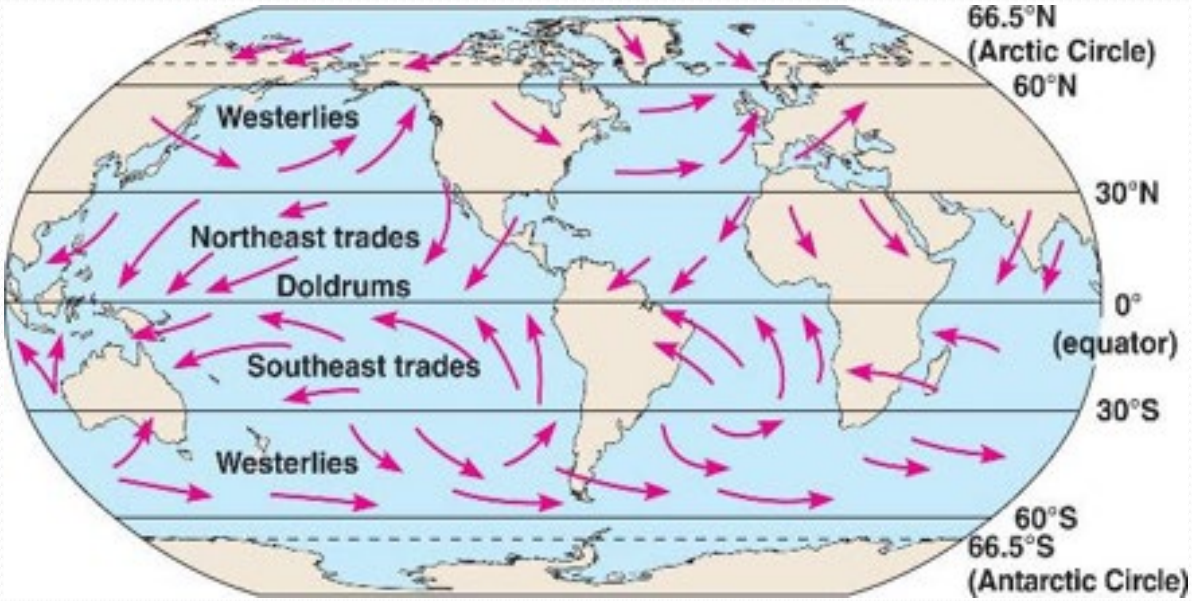
1. The amount of NOx and SOx emissions locally





2) The prevailing wind patterns, which can deliver acid precipitation from other regions.

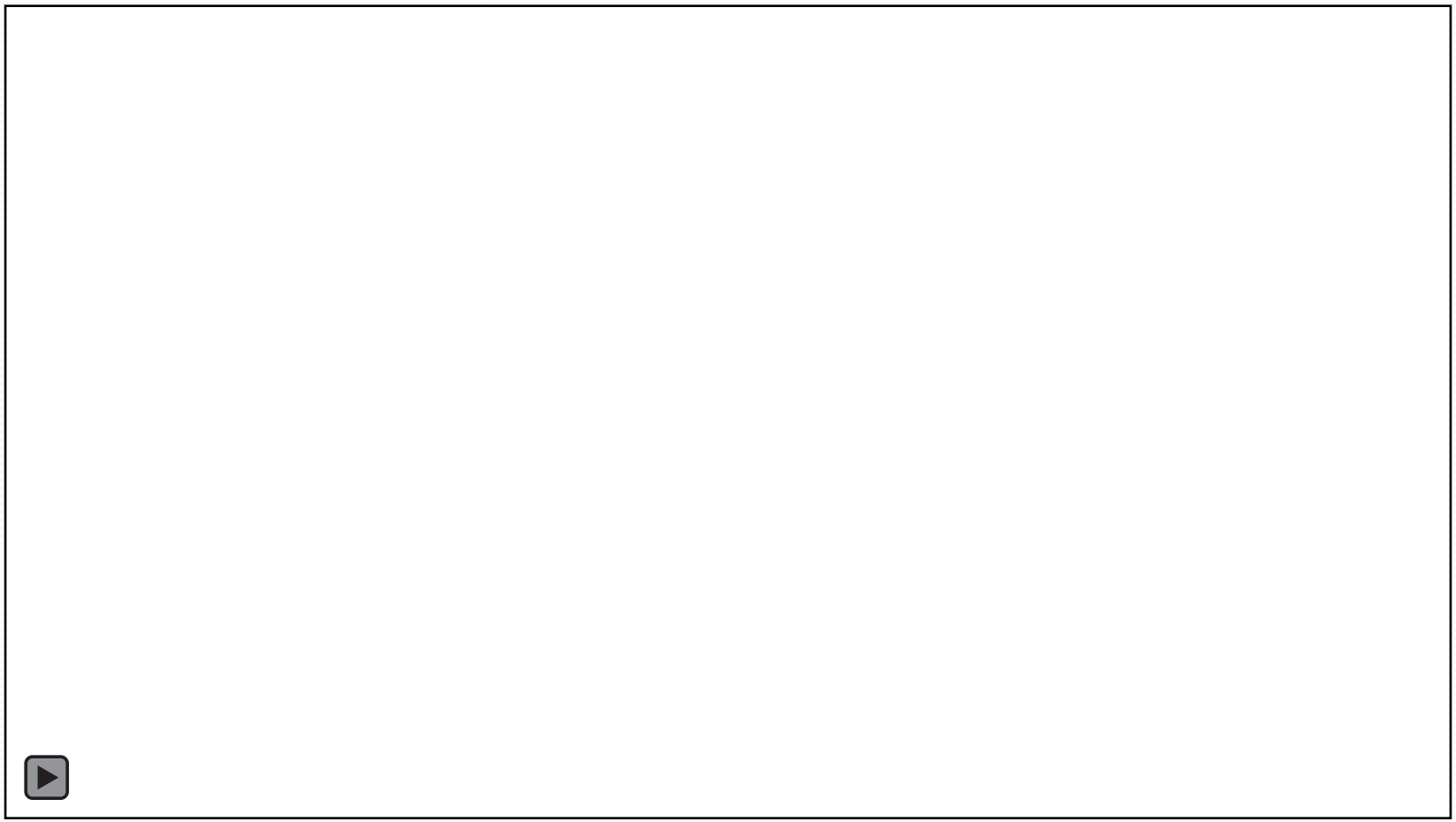
- Wind patterns like the jet stream tend to push acid clouds toward the northern Ontario and northern Quebec



Biotic and Abiotic

- **Abiotic factors** are non living parts of an ecosystem
  - Ex. Soil, rocks, bodies of water
- **Biotic factors** are living parts of an ecosystem
  - Ex. Plants, animals, insects
- Acid deposition affects both of these factors and decreases **biodiversity**

Biodiversity 4 min



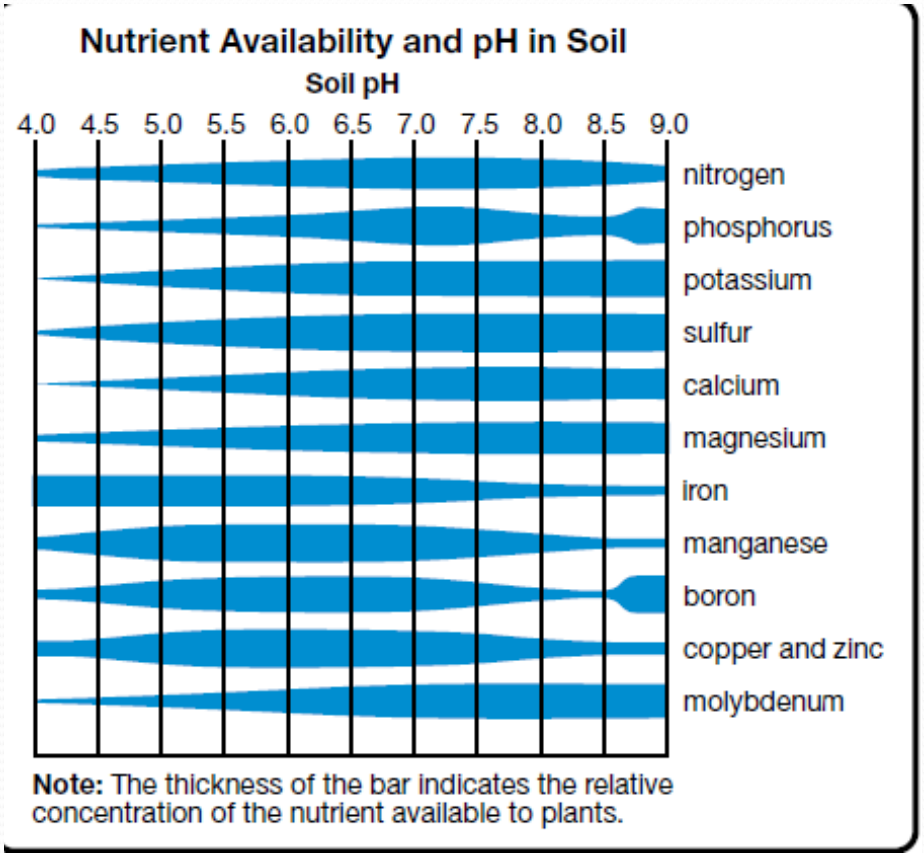
Optimal Soil pH

pH less than 5.6 (acid rain) what will grow? What won't grow?

Plant	Soil pH for Optimal Growth
alfalfa	6.5 to 7.0
barley	6.3 to 6.5
blueberries	4.5
canola	5.5 to 8.3
clover	5.8 to 6.2
corn	5.8 to 6.2
oats	5.8 to 6.2
pasture grass	5.5 to 6.2
sugar beets	6.5 to 8.0
potatoes	5.2 to 8.0
wheat	5.5 to 6.5

Chemical Absorption and pH

- Acid deposition can lead to a problem in plants ability to absorb nutrients through their roots



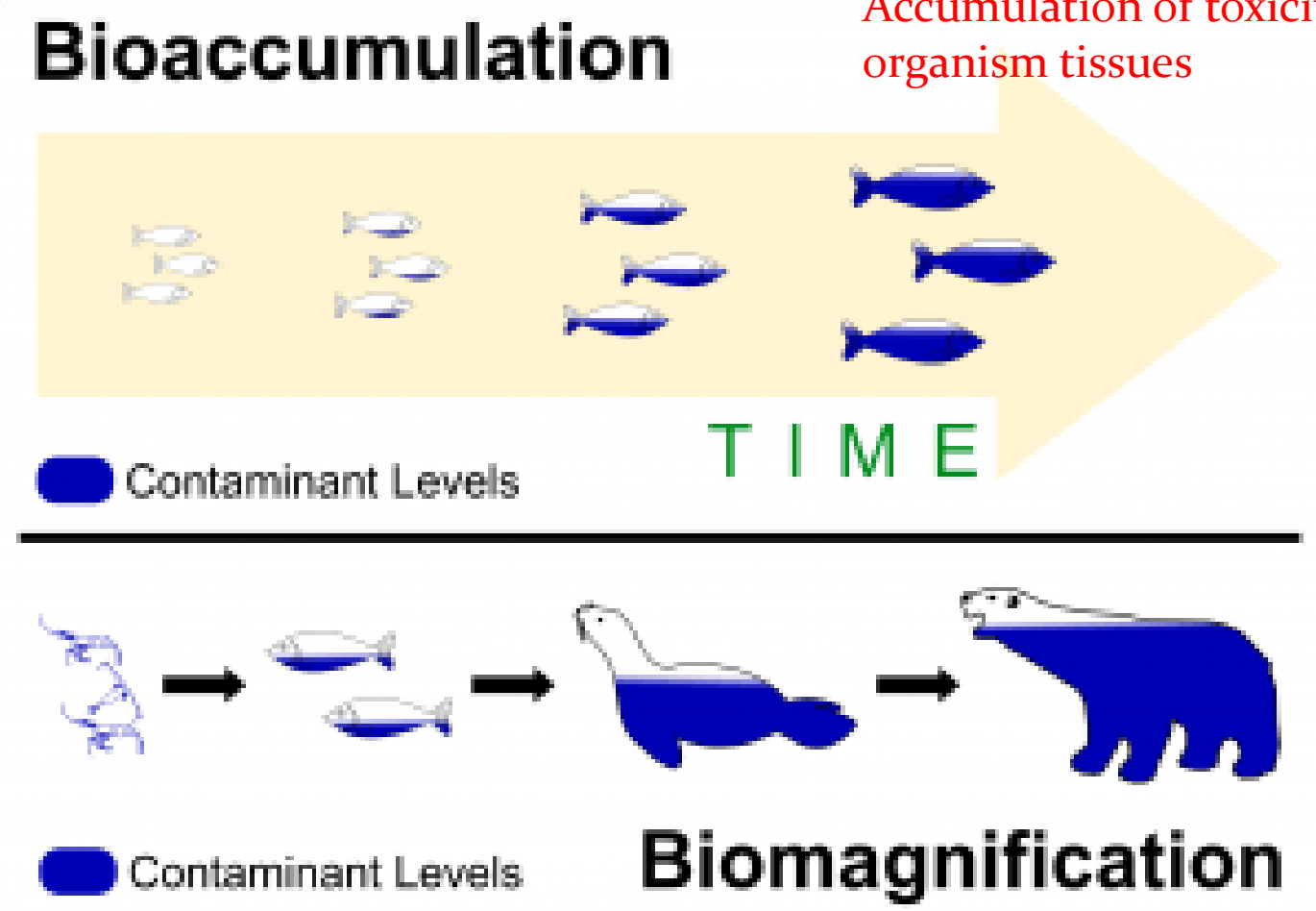
Leaching

- **Leaching** is taking a solid and turning it into a liquid that can enter soil and water systems
- Normally aluminum in soil is found as $Al(OH)_3(s)$ which is not very soluble
- When acid is added to the soil it reacts with the $Al(OH)_3(s)$ and causes aluminum ions to build up in the soil
- This can lead to:
  - Decreased root growth.
  - Prevents absorption of calcium.
  - Reduce decomposing soil bacteria.

Mercury

- Mercury is found in solid form in very small amounts of soil
- When it mixes with acid is can create Hg^{2+} which can enter water
- Mercury cannot be removed from living systems so it continues to build up
- The leads to **biomagnification** which is seeing pollutants at higher levels, higher in the food chain

Accumulation of toxicity in organism tissues



Increase in toxicity higher in the food chain

What is the *difference* between **bioaccumulation** and **biomagnification**?

- **Bioaccumulation** refers to the accumulation of a toxic chemical **in the** tissue of a particular organism.

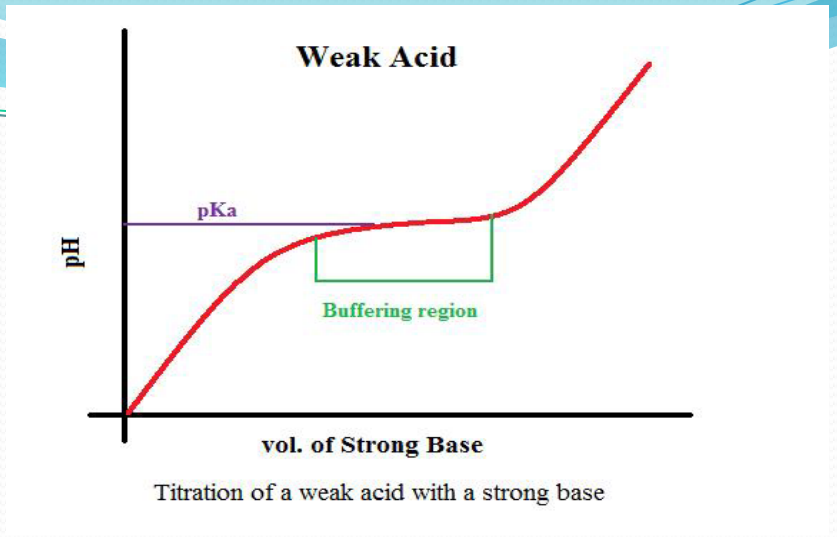
- **Biomagnification** refers to the increased concentration of a toxic chemical the higher an animal is on the food chain

Ways to reduce impact

- The material that acid rain falls on can help prevent further damage in bodies of water
- Limestone ($CaCO_3(s)$) is a material that can do this:

- $CO_3^{2-} + H_3O^+ \rightarrow H_2O + HCO_3^-$
- Base acid

Buffering



Titration of a weak acid with a strong base

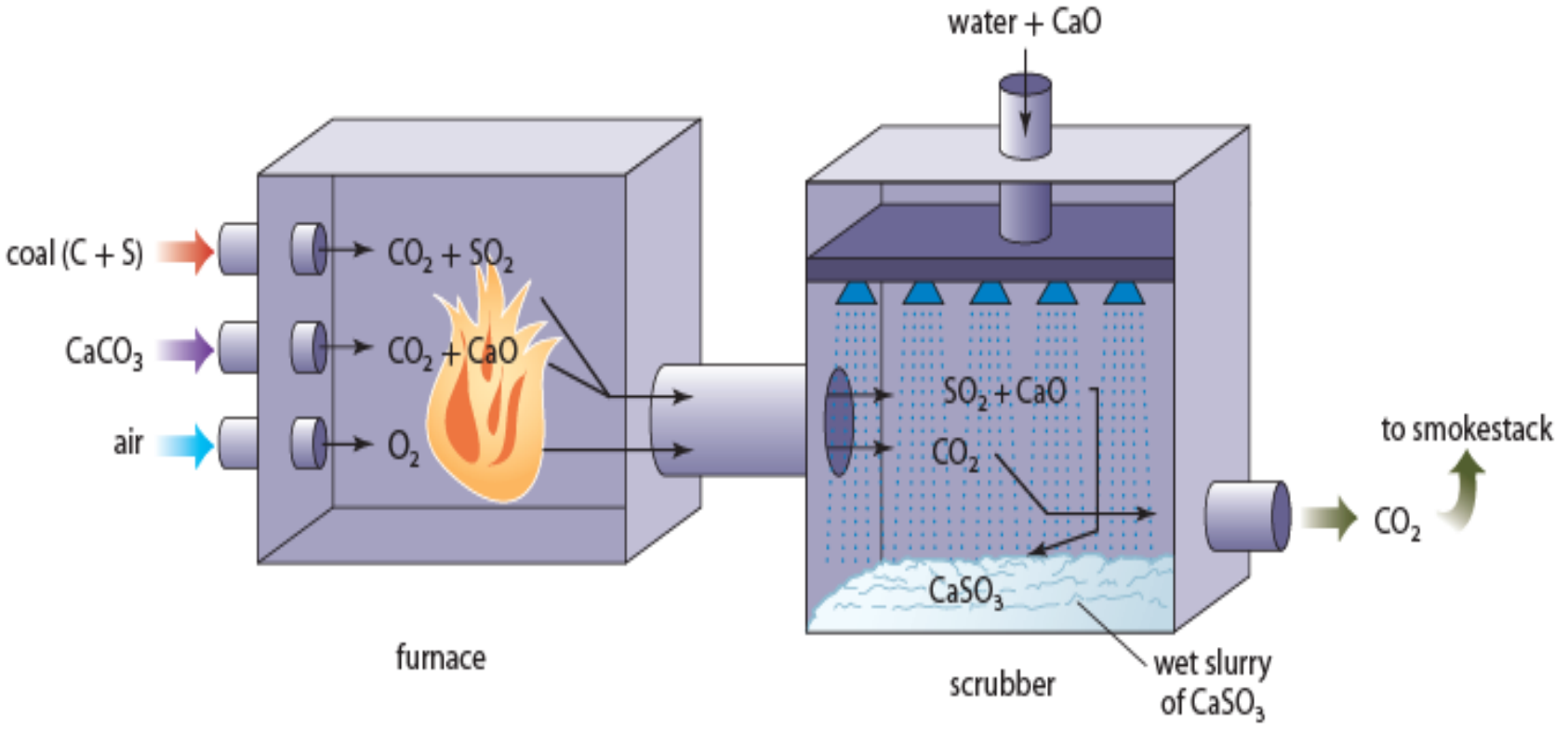
- **Buffering** is the resistance to change in pH
- Buffers are made of weak acid/base conjugate pairs
  - Ex. HF / F- & HCO_3^- / CO_3^{2-}
- This is done by removing hydronium from a sample
- Once a buffer is used up, it has reached its **buffering capacity**

Buffer demonstration 2 0 for avid

- https://www.youtube.com/watch?v=P-R-Cqvb5yo

Reducing Acid Deposition

Scrubbers


water + CaO
coal (C + S)
$CaCO_3$
air
$CO_2 + SO_2$
$CO_2 + CaO$
O_2
$SO_2 + CaO$
CO_2
$CaSO_3$
to smokestack
CO_2
furnace
scrubber
wet slurry of $CaSO_3$

NO_X

- Nitrogen is the most abundant gas in our atmosphere
- At high temperatures is can react to form two different compounds

Production of NO_x Compounds

$N_2(g) + O_2(g) \rightarrow 2\ NO(g)$

$2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$

- The most common cause of these reactions are from high temperature combustion processes
- Cars are a main source of NO_x

Photochemical Smog

- **Photochemical smog** is a brownish haze that appears over cities
- Photochemical smog is caused by NO_2
- It can irritate the eyes, nose and throat and be dangerous to people with lung issues like asthma (respiratory issues)

Ground level Ozone

- Ozone in the atmosphere is good and helps protect against damaging UV radiation
- Ozone near the ground is bad and contributes to something called **volatile organic compounds**
- When NO_x mixes with ozone near the ground it makes these volatile organic compounds which can be irritants to the respiratory system.

Catalytic Converters (4 min)