APES Chemistry Review

Basics

→ Neutrons, protons, and electrons are the components of atoms, which combine to form molecules.

→ The basic unit of all chemical compounds, whether natural or man-made, is the molecule.

Abbreviations

C ≡ carbon	S ≡ sulfur	U ≡ uranium	Cl_2 ≡ chlorine
O_2 ≡ oxygen	N_2 ≡ nitrogen	H_2 ≡ hydrogen	P ≡ phosphorus
NO_2^{-1} ≡ nitrite	NO_3^{-1} ≡ nitrate	SO_4^{-2} ≡ sulfate	NH_3 ≡ ammonia

NO_x ≡ oxides of nitrogen or nitrogen oxides (NO, NO_2)

SO_x ≡ oxides of sulfur or sulfur oxides (SO_2, SO_3)

VOC ≡ volatile organic compounds (compounds containing carbon which readily evaporate, ex. methane, benzene)

PAN ≡ peroxyacyl nitrates

pH

→ pH is the negative log of the hydrogen ion concentration (sometimes called the potential of hydrogen ion).

→ Mathematically it is represented by the equation: $pH = -\log[H^+]$ or $pH = -\log[H_3O^+]$

→ $[H^+]$ is the molarity (# of moles per liter) of H^+ ions

→ $[H^+]$ and $[H_3O^+]$ are essentially the same. H_3O^+ is called the hydronium ion, it results when H^+ are in water.

→ Low pH corresponds to being more acidic. High pH corresponds to being more basic.

→ The opposite of acidic is basic.

→ The range of pH is from 0 to 14.

pH=1 ∴ $[H^+]=1 \times 10^{-1}$ moles/liter (very acidic)	pH=4 ∴ $[H^+]=1 \times 10^{-4}$ moles/liter (acidic)
pH=6 ∴ $[H^+]=1 \times 10^{-6}$ moles/liter (slightly acidic)	pH=7 ∴ $[H^+]=1 \times 10^{-7}$ moles/liter (neutral)
pH=8 ∴ $[H^+]=1 \times 10^{-8}$ moles/liter (slightly basic)	pH = 13 ∴ $[H^+]=1 \times 10^{-13}$ moles/liter (very basic)

Nuclear Fission

→ Nuclear fission (splitting atoms) is the source of energy in today's nuclear power plants. The reactions used are chain reactions, in which one neutron initiates the reaction of millions of Uranium nuclei.

1 U-235 + 1 n → 1 Kr-92 + 1 Ba-141 + 3 n + energy (the 3 neutrons (n) initiate further reactions)

3 U-235 + 3 n → 3 Kr-92 + 3 Ba-141 + 9 n + energy (the 9 neutrons initiate further reactions)

9 U-235 + 9 n → 9 Kr-92 + 9 Ba-141 + 27 n + energy (the 27 neutrons initiate further reactions)

This continues until there are millions of neutrons being produced and millions of times more energy, as well.

→ A moderator and control rods are used to absorb neutrons to prevent the chain reaction from getting out of control which would result in a meltdown.

Air Pollution in the Troposphere

→ All fossil fuels contain large amounts of carbon (from the molecules of decomposed lifeforms). The combustion of fossil fuels (reaction with oxygen) produces carbon dioxide and carbon monoxide:

$$C + O_2 \rightarrow CO_2$$ (the #1 man-made greenhouse gas)

$$2C + O_2 \rightarrow 2CO$$ (incomplete combustion)

→ Coal may also contain sulfur which reacts during combustion:

$$S + O_2 \rightarrow SO_2$$

→ During combustion, the nitrogen that composes 80% of the air in the troposphere reacts:

$$N_2 + O_2 \rightarrow 2NO$$

→ The reactions above all show the formation of primary air pollutants

→ Primary air pollutants undergo reactions in the atmosphere to form secondary air pollutants.

Photochemical Smog

$$2NO + O_2 \rightarrow 2NO_2$$ (causes brownish haze)

$$NO_2 + \text{UV light} \rightarrow NO + O$$ followed by:

$$O + O_2 \rightarrow O_3$$ (O_3 is ozone and is very hazardous to plants, animals, and materials in the troposphere)

$$\text{hydrocarbons} + O_2 + NO_2 \rightarrow \text{PANs}$$ (peroxyacyl nitrates cause burning eyes and damage vegetation)

Acid Precipitation

$$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$$ (HNO_3 is nitric acid and causes acid precipitation)

$$2SO_2 + O_2 \rightarrow 2SO_3$$ followed by:

$$SO_3 + H_2O \rightarrow H_2SO_4$$

→ Acid deposition can be neutralized by the addition of lime ($CaCO_3$) which is a base (a base will neutralize an acid)

Air Pollution in the Stratosphere

The reaction that is supposed to happen, which protects the Earth from UV light

$$2O_3 + \text{UV light} \rightarrow 3O_2$$

The destruction of ozone by CFCs

$$CCl_3F + \text{UV light} \rightarrow CCl_2F + Cl$$ (CCl_3F is a CFC) followed by:

$$Cl + O_3 \rightarrow ClO + O_2$$ followed by:

$$ClO + O \rightarrow Cl + O_2$$ followed by:

$$Cl + O_3 \rightarrow ClO + O_2$$ (same as first step above) followed by:

$$ClO + O \rightarrow Cl + O_2$$ (same as second step above) followed by:

(these reactions are repeated thousands of times to destroy thousands of ozone molecules)