Worksheet 16.1

Chapter 16: Environmental chemistry – glossary

Acid deposition  The process by which acidic particles, gases and precipitation leave the atmosphere.

Acid rain  Rain with a pH of less than 5.6.

Activated sludge process  The activated-sludge process is a biological method of secondary water treatment in which bacteria oxidize organic material under aerobic conditions.

Aerobic  A process which requires oxygen.

Aerobic decomposition  Decay of organic matter in the presence of oxygen.

Air pollutant  A substance present in sufficient concentration in the air to produce a harmful effect on humans or other animals, vegetation or materials.

Aldehydes  A homologous series of compounds with the general formula, RCHO, with the carbonyl group (C = O) at the end of the molecule. They are present as secondary pollutants in photochemical smog.

Algal bloom  A rapid growth of algae on the surface of freshwaters caused by an excessive supply of nutrients. Light and oxygen levels are reduced in the water below.

Alkaline scrubbing  A post-combustion method of removing sulfur dioxide from combustion products. An alkaline mixture is sprayed downwards into the exhaust gases.

Anaerobic decomposition  Decay of organic matter in the absence of oxygen.

Anthropogenic sources  Sources derived from human activities.

Biodegradable  A substance which can be broken down by natural biological processes; for example, the activities of decomposer organisms.

Biological oxygen demand (BOD)  The amount of oxygen needed to decompose organic matter in a specified time (five days) at a specified temperature (20°C). The BOD is calculated by keeping a sample of water with a known amount of oxygen for five days at 20°C. The oxygen content is then measured again after this time. A high BOD value indicates the presence of a large amount of organic matter. Unpolluted water has a very low BOD value.

Bond order  A measure of the degree of bonding between two atoms relative to that of a normal single bond. For example the bond order in O₂ is 2, and 1.5 in ozone (O₃).

Buffer  An aqueous solution, consisting of a weak acid and its conjugate base, which resists a change in pH when small amounts of either hydroxide ions (from a base) or hydrogen ions (from an acid) are added.

Cation-exchange capacity  This is the number of moles of single charged positive ions which can be held in 1 kg of soil. The CEC is an indicator of soil fertility.
Catalytic converter  A device fitted to modern car exhaust systems which converts carbon monoxide, nitrogen monoxide and unburnt hydrocarbons into carbon dioxide and nitrogen.

Chlorination  The addition of chlorine to water in order to kill harmful bacteria.

Common ion effect  The common ion effect is an application of Le Chatelier’s principle. According to Le Chatelier’s principle the equilibrium will respond so as to counteract the effect of the added common ion. This means that the equilibria will shift so that the concentration of a common ion in solution is decreased. This decreases the solubility of the slightly soluble salts.

Diffusion  The spontaneous movement of gas or liquid particles from a region of high concentration to regions of low concentration.

Dioxins  Toxic chemicals formed during the high temperature combustion of chloro-organic matter. They remain in the environment and contain chlorine atoms bonded to benzene rings.

Electrostatic precipitation  A method of removing very fine particles suspended in a gas by electrostatic charging and subsequent precipitation onto a collector in a strong electric field.

Eutrophication  This occurs when nutrients, especially phosphates and nitrates, are added to water, which promote excessive algae growth. As the algae die and decompose, high levels of organic matter and the decomposing organisms deplete the water of available oxygen, causing the death of other organisms, such as fish.

Fertilizers  A group of chemicals that supply plants with the nutrients they need for growth.

Flocculation  The process of aggregating suspended solids in water into larger insoluble clumps.

Fluidized-bed combustion  A post-combustion method of removing sulfur dioxide from combustion products in which coal is mixed with powdered limestone. Calcium carbonate breaks up under the high temperature conditions to form calcium oxide and carbon dioxide. The calcium oxide reacts with sulfur dioxide to form the solid calcium sulfate.

Fossil fuel  Non-renewable fuels, such as coal, oil and natural gas, formed underground over geological periods of time from the decaying remains of plants and animals.

Free radical  A species with one or more unpaired electrons, often produced in photochemical reactions. They are reactive intermediates in atmospheric chemistry.

Global warming  The increase in the temperature of the Earth’s atmosphere since the Industrial Revolution. It is believed to be a consequence of rising levels of greenhouse gases, especially carbon dioxide.

Greenhouse effect  A heating effect occurring in the atmosphere because of the presence of gases that absorb infrared radiation which has been radiated from the Earth’s surface.

Greenhouse factor  A measure of the ability of a gas to absorb infrared radiation compared to carbon dioxide, CO₂.

Greenhouse gases  Molecules that contribute to the greenhouse effect and global warming by absorbing infrared energy radiated from the Earth’s surface.
Haemoglobin  A quaternary protein composed of four polypeptide chains combined with a heme group. It can bond and transport oxygen molecules from the lungs to body tissues. Carbon monoxide is toxic as it bonds to the same sites as oxygen.

Half-life (of a radioactive sample)  The time for the radioactivity emitted by a sample of a radioactive isotope to fall to half its original value.

Halogenated organic gases  Halogenalkanes which deplete the ozone layer in the stratosphere. They are also greenhouse gases. The most well known are chlorofluorocarbons (CFCs).

Heavy metals  Heavy metals are toxic and metals, such as cadmium, lead and mercury, which have relatively high relative atomic masses.

Herbicide  A substance which kills plants.

Heterogeneous catalyst  Heterogeneous catalysis occurs when the catalyst and the reactants are in different phases (or states).

High-level radioactive waste  Radioactive waste of high-radioactivity, which needs to be shielded during transport and handling. It is cased in ceramic or glass and then packed in metal containers before being buried deep in granite rock, in remote places that are geologically stable.

Humus  A brown or black organic substance consisting of partially or wholly decayed vegetable or animal matter that provides nutrients for plants and increases the ability of soil to retain water.

Homogenous catalysis  Heterogeneous catalysis occurs when the catalyst and the reactants are in the same phase (or states).

Homolytic fission  The breaking of a covalent bond in which one electron from the bond is left on each fragment. It leads to the formation of two free radicals. It occurs, for example, in the mechanism for ozone depletion.

Hydrofluorocarbons  Hydrofluorocarbons (HFCs) are compounds containing carbon, hydrogen, and fluorine. They are used as replacement to CFCs as the absence of chlorine atoms means that they do not directly affect stratospheric ozone. They are, however, greenhouse gases as they absorb infrared radiation.

Infrared radiation  Electromagnetic radiation with a typical wavelength of $10^{-4}$ m between the visible and microwave regions of the electromagnetic spectrum.

Initiation  The first elementary step in a free radical reaction. It involves the homolytic cleavage of a bond, typically by ultraviolet radiation or high temperature, to generate free radicals. For example:

$$\text{CCl}_2\text{F}_2 \rightarrow \text{CClF}_2 \cdot + \text{Cl} \cdot$$

Incineration  A method of waste disposal in which the waste is burned at high temperatures. Incineration converts the waste to non-burnable ash of decreased volumes that can be safely disposed. Incomplete combustion can produce carbon monoxide gas, gaseous dioxins, and/or other harmful substances.
Intermediate  A chemical species that is neither a reactant nor a product but is formed and consumed during a chemical reaction. The chlorine oxide free radical ClO•, for example, is an intermediate formed when ozone decomposes in the presence of CFCs: Cl• + O₃ → ClO• + O₂.

Ion exchange  The exchange of ions of the same charge between an aqueous solution and a solid (in the form of a resin) in contact with it.

Low-level radioactive waste  Radioactive waste which, because of its low radioactivity, does not require shielding during normal transport or handling.

Nitrosamines  A group of organic compounds which contain the N–N = O functional group. Some nitrosamines are powerful carcinogens.

Non-renewable resources  Natural resources that cannot be replaced naturally within the same time scale as that at which they are removed from the environment. Fossil fuels are an example.

Osmosis  This is the movement of water from a dilute to a concentrated solution by passing through a semi-permeable membrane.

Osmotic pressure  This is the pressure that, when applied to a solution, prevents the entry of water across a semi-permeable membrane.

Ozone  A colourless and toxic gas with the chemical formula O₃. It has an angular structure with a bond order of 1.5. Ozone is produced in the lower atmosphere by the action of ultraviolet radiation on nitrogen dioxide, to produce oxygen atoms which can then react with oxygen molecules to give ozone. It is also produced in the stratosphere by the action of ultraviolet radiation on oxygen O₂ molecules, to produce oxygen atoms. These oxygen atoms then react with oxygen molecules to form ozone.

Ozone depletion  The decrease of ozone concentrations in the ozone layer in the stratosphere by the action of chlorine atoms produced from chlorofluorocarbons (CFCs).

Ozone layer  A layer of ozone in the stratosphere (between 15–30 km) which prevents harmful ultraviolet radiation from reaching the Earth’s surface.

Particulates  Particulates are solid particles or droplets in the air in the form of haze, smoke or dust, which remain suspended in the air or atmosphere for extended periods.

PAN (peroxyacetyl nitrate)  Peroxyacetyl nitrate is an important by-product in photochemical smog. PAN is a secondary pollutant which has a serious effect on health. It causes eye watering and respiratory problems.

Phase  A physically or chemically distinct part of a chemical equilibrium. A phase is homogenous throughout and is separated from other phases by a phase boundary.

Photochemical smog  A form of local atmospheric pollution found in large cities in which oxides of nitrogen and unburnt hydrocarbons react in the presence of light to produce a number of harmful products including ozone and PAN.
Pollution  The addition to an environment of a substance or an agent (such as heat) by human activity, at a rate greater than that at which it can be made harmless by the environment, and which has an appreciable effect on the organisms within it.

Polycyclic aromatic hydrocarbons (PAHs)  Also known as poly-aromatic hydrocarbons, they consist of hydrocarbons with fused benzene rings. They occur in oil, coal and tar deposits, and are produced as by-products of incomplete combustion. They have been identified as carcinogenic.

Polychlorinated biphenyls (PCBs)  A family of very toxic chemical compounds consisting of two benzene rings with chlorine atoms replacing two or more hydrogen atoms. They cause skin diseases and are suspected of causing birth defects and cancer.

Primary air pollution  Primary pollutants enter the atmosphere directly from their source.

Primary water treatment  The first stage of water treatment in which screens, sedimentation tanks, filters and skimming apparatus, and chlorination are used to remove substances that float or settle. Bacteria remove about 30% of biological oxygen demand (BOD).

Radioactive decay  The decay of a radioactive nucleus to form the nucleus of another element by alpha, beta or gamma decay.

Refrigerant  A substance, to cool something by absorbing heat from it. Refrigerants are usually substances that evaporate quickly. In the process of evaporation they draw heat from surrounding substances.

Renewable resources  Natural resources that are used at a rate equal to or less than can be replaced naturally. Wood and food crops are examples.

Reverse osmosis  This occurs when a pressure of 70 atm. (the osmotic pressure) is applied to the more concentrated salt solution. Water passes through the semi-permeable membrane and leaves the dissolved salts behind.

Secondary air pollution  Secondary pollutants are formed when primary pollutants react with each other or with other compounds present in the atmosphere.

Secondary water treatment  This involves the use of bacteria to remove dissolved organic matter from wastewater. The bacteria oxidize the organic material.

Semi-permeable membrane  A membrane which allows the solvent but not the dissolved solutes to pass.

Smog  Any haziness in the atmosphere caused by air pollutants. Photochemical smog is produced through the effect of ultraviolet light on the products of internal combustion engines. It may contain ozone and is damaging to the human respiratory system and eyes.

Smoke  Tiny particles of unburnt carbon suspended in air.

Soil  A mixture of mineral particles and organic material that covers the land and in which plants grow.

Soil organic matter (SOM)  This includes undecayed plant and animal tissues, their partial decomposition products and the soil biomass.
**Soil nutrient**  A substance plants need for growth.

**Stratosphere**  The layer of the atmosphere between 15 and 30 km above the troposphere.

**Sunscreen**  A chemical that protects the skin from harmful ultraviolet radiation from the sun.

**Salinization**  This occurs when soils are continually irrigated. The dissolved salts are left behind after the water evaporates. Plants cannot grow in salty soil.

**Temperature/thermal inversion**  This occurs when cold dense air is near the ground, and with a layer of warmer and therefore lighter air above it. Geographical conditions, such as surrounding high mountains and a windlessness, help create these conditions which trap the pollutants close to the ground.

**Tertiary water treatment**  This removes dissolved ionic pollutants, such as heavy metals, nitrates and phosphates. Heavy metals may be removed by ion exchange resins or precipitated as sulfides. Nitrates can be reduced to nitrogen gas by denitrifying bacteria under anaerobic conditions and phosphates may be precipitated.

**Thermal pollution**  Occurs when heated water passes into a body of water, causing a rise in temperature that endangers aquatic life by decreasing the solubility of dissolved oxygen and increasing the rate of metabolism.

**Troposphere**  The layer of the atmosphere closest to the ground and extending upwards (15–30 km) to the stratosphere.

**Ultraviolet radiation**  Electromagnetic radiation with a typical wavelength of $10^{-8}$ m.

**Volatile organic compound (VOC)**  Air pollutants formed by the evaporation of solvents or hydrocarbon fuels (man-made) or emitted by plants (biological). They are important precursors in the formation of photochemical smog.

**Wet deposition**  The process by which particles, gases and precipitation leave the atmosphere. It includes rain, fog and snow.