Chemistry

When faced with the question: *what is chemistry?* you might give an answer like - the study of chemicals. When faced with another question like: *what are chemicals?* you probably would answer with - things that are found in bottles in the lab. Fact is, practically everything in and around you is one or more chemical substances. We use the term **matter** to represent all chemical substances.

- **Matter** is anything that has mass and takes up space**.**

You probably already recognize that everything around you, living and nonliving, is composed of matter. You and everything surrounding you is matter - your books, pens, paper, what you drink, the food you eat, the air you breathe, even your friends, and your pets - all these things are matter.

Since you and your surroundings are matter, it might be helpful to think about things that are not matter. You might begin by thinking about things like forces. Gravitational force is not matter. Why not? The answer is that gravity doesn't take up space and it doesn't have mass. Likewise, electricity is not matter even though it is caused by the flow of matter called electrons. What are some other "things" that are non-matter?

- **Chemistry** is the study of matter, its properties, and the changes or chemical reactions that matter can undergo.

Rusting of metal (oxidation of iron) is one example of a relatively slow chemical reaction that unfortunately occurs all around us. It costs a fortune because rusting destroys our automobiles over time. Another example of oxidation is the burning of a wax candle. Burning is another example of oxidation called combustion. Can you describe at least three other examples of oxidation reactions that occur around your home, or that you might rely on nearly every day of your life?

An example of a much quicker reaction is the reaction that occurs between vinegar, CH_3COOH (aq), and baking soda, $NaHCO_3$ (s). This reaction releases carbon dioxide gas, and causes the formation of bubbles.

There are two major branches of chemistry: pure chemistry and applied chemistry.

- **Pure chemistry** deals with describing known substances and discovering new compounds.
- **Applied chemistry** is the search for uses for chemical substances.

There is no shortage of work! New chemicals are discovered or produced every day. The composition and properties of each new substance is researched and documented. It can take years of teamwork to understand the basic properties of a single substance.

Modern society places demands on science and technology to solve problems. Many of the technologies and conveniences that you are accustomed to are the result of interaction between **chemists** who discover new materials and their properties, and **technologists** who adapt them to meet your needs. There is a close link between chemistry, technological innovation, and the needs of society. The study of chemistry also has implications for the environment - both good and bad.

As an example, consider the combustion of fuels. We all need heat to keep our homes warm. Most of us rely on wood, oil, propane, or electricity that was generated from the burning of fuel. We use fuel to drive our cars, busses, ferries, transport trucks, and airplanes. Most of us consider the use of fuel as good, but there are consequences to the environment (such as acid precipitation, pollution, and global warming which is considered as bad).

There is no doubt that chemistry is all around us!

SAFETY

Throughout the years, many chemists have learned lab safety lessons the hard way. Their experiences have given rise to procedures designed to promote the safety of those who have followed them into the lab. It is your responsibility and that of the professionals at your school to ensure that proper safety procedures are followed when you complete lab activities.

As a student of chemistry, it is essential that you have a clear understanding of all of the activities that you will be carrying out, including potential dangers. It is also important that you know what to do in case of an accident. We will do a special safety lab and watch some videos to demonstrate the safety rules. You will also fill out a safety contract.

Safety Warnings and Labels and Hazardous Household Products Symbols

As you complete the activities for this lesson you should look for products around your home and find labels with safety symbols similar to the one shown below. These are known as **HHPS** which stands for **Hazardous Household Products Symbols**. There are four HHPS which are used as warnings to home consumers. The Bleach container below shows an example of one of these four symbols.

Department of Transport (DOT) Symbols

Similar systems exist for materials in the transportation industry. For example, you may have seen special placards (similar to the one shown below) on trucks and boats that carry flammable liquids.

Workplace Hazardous Materials Information System (WHMIS)

Chemicals in laboratories are also labeled, but use a different labeling system. **WHMIS** (Workplace Hazardous Materials Information System) is one of many information systems designed to warn people of the hazards associated with chemical substances in the workplace.

WHMIS uses a set of symbols to indicate the potential hazards posed by chemicals used in the workplace and in educational institutions. You have to become familiar with the symbols and their meanings even though you may not encounter all the classes of hazardous substances listed below as you complete activities at your school.

Compressed Gases

- danger of an explosion because gas is under pressure
- examples: natural gas, propane

Flammable and Combustible Materials

- danger of fire or explosion when exposed to heat, sparks, flame or friction or upon contact with water
- examples: white phosphorus, butane, acetone (cleaner/solvent)

Oxidizing Materials

- danger of fire or explosion in presence of flammable or combustible materials; may cause burns on contact with skin
- examples: peroxides, chlorates, acids containing oxygen

Materials Causing Immediate and Serious Toxic Effects

- danger of fatality if inhaled, swallowed, or absorbed through skin; may burn skin or eyes
- examples: methanol (gas line antifreeze), ethylene glycol (engine coolant), cyanides, sulfuric acid (battery acid)

Materials Causing Other Toxic Effects

- danger of poisoning; prolonged exposure may lead to death or permanent disability; danger of irritation; may cause cancer, birth defects or sterility
- examples: asbestos (in some insulating tiles and floor tiles), toluene (paint stripper), benzene, barium ions, lead (e.g. car batteries)

Biohazardous Infectious Materials

- danger of contraction of a disease
- examples: medical waste, blood, bacterial specimens

Corrosive Materials

- danger of severe skin or eye irritation on contact; causes severe tissue damage; may be harmful if inhaled; may react with metals and release harmful gases
- examples: sulfuric acid, hydrochloric acid (brick layer's acid), sodium hydroxide (lye, fiber separator in paper mills)

Dangerously Reactive Materials

- danger of release of toxic or flammable gas upon contact with water; may explode as a result of disturbance, friction, increase in temperature; may react rapidly release large amounts of heat
- examples: sodium metal, trinitrotoluene (TNT), certain cyanides (gold refining)

Materials Safety Data Sheet

In addition to the WHMIS symbols, each package of chemicals purchased in a school laboratory comes with a **MSDS** (**M**aterials **S**afety **D**ata **S**heet) which lists nine categories or sections of information. The images below show a typical MSDS . Look over this MSDS sheet (shown in two parts) and identify the nine categories (sections) of information.

The nine categories are:

1.

2.

3.

4.

5.

6.

7.

8.

9.

Science Kit & Boreal Laboratories

777 East Park Drive
Tonawanda, N.Y. 14150-6784
(716)874-4000

859 Vansickle Hwy
St. Catharines, Ontario L2S 3T4

815 Flora Lane
San Luis Obispo, CA 93405-6010

MATERIAL SAFETY DATA SHEET

MSDS No. PP 140
Effective Date February 18, 2000

SECTION I NAME

Product	PHENOLPHTHALEIN, POWDER
Chemical Synonyms	3,3-Bis(para-hyroxyphenyl)phthalide
Formula	$C_{20}H_{14}O_4$
Unit Size	up to 2.5 Kg.
C.A.S. No.	77-09-8

24 HOUR EMERGENCY ASSISTANCE

CHEMTREC
800-424-9300
Day 716-226-6177

Health	1
Fire	1
Reactivity	1

NFPA HAZARD RATING / HMIS *

LEAST	SLIGHT	MODERATE	HIGH	EXTREME
0	1	2	3	4

SECTION II INGREDIENTS OF MIXTURES

Principal Component(s)	%	TLV Units
Phenolphthalein, powder	100%	None established.
CAUTION! MAY BE HARMFUL IF SWALLOWED.		

SECTION III PHYSICAL DATA

Melting Point (°F)	259-263°C (498°-505°F)	Specific Gravity (H_2O = 1)	1.277 (32°C/4°C)
Boiling Point (°F)	Decomposes.	Percent Volatile by Volume (%)	N/A
Vapor Pressure (mm Hg)	Negligible as solid.	Evaporation Rate (=1)	N/A
Vapor Density (Air=1)	N/A		
Solubility in Water	0.004% at 25°C.		
Appearance & Odor	White powder; no odor.		

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	Greater than 256°C.	Flammable Limits in Air % by Volume N/A	Lower	Upper
Extinguisher Media	Carbon dioxide; dry chemical; water spray; foam; sand.			

SPECIAL FIREFIGHTING PROCEDURES

If possible, isolate container in an open-air or well-ventilated area. Flood with a large volume of water. In fire conditions, wear a NIOSH/MSHA-approved self-contained breathing apparatus with a full facepiece operated in the pressure demand or other positive pressure mode.

UNUSUAL FIRE AND EXPLOSION HAZARDS

Fire or excessive heat may produce hazardous decomposition products; can react vigorously with oxidizing materials. Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.

D.O.T.	NON-REGULATED.

Approved by U.S. Department of Labor "essentially similar" to form OSHA-20

SECTION V — HEALTH HAZARD DATA

PF 140

Threshold Limited Value

None established. (ACGIH 1992-93).

Effects of Overexposure

Target organs: None known. **INGESTION:** Cathartic, very active even in small amounts (30-100 mg). May cause purging, collapse and fall of blood pressure. **EYES:** May cause irritation. **SKIN:** May be absorbed via moist or oily surfaces. May cause rash that can become ulcerous. **INHALATION:** May cause irritation of mucous membranes in the nose and throat. May cause coughing and sneezing.

Emergency and First Aid Procedures

INGESTION: If swallowed, if conscious, give several glasses of water to drink. Induce vomiting and call physician. Never give anything by mouth to an unconscious person. **EYES:** Flush thoroughly with water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention. **SKIN:** Flush with water, then wash with mild soap and water. **INHALATION:** Remove to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

SECTION VI — REACTIVITY DATA

Stability			Conditions to Avoid
	Unstable		Protect from light, excessive temperatures and heat.
	Stable	X	

Incompatibility (Materials to Avoid): Strong oxidizers.

Hazardous Decomposition Products: Thermal decomposition or burning may produce carbon monoxide and/or carbon dioxide.

Hazardous Polymerization		Conditions to Avoid
May Occur	Will Not Occur	Not applicable.
	X	

SECTION VII — SPILL OR LEAK PROCEDURES

Steps to be taken in case material is released or spilled

Recover for use if not contaminated. Carefully sweep up, avoid making dust, and place in a suitable container for disposal. Wash spill area with soap and water.

Waste Disposal Method

Discharge, treatment, or disposal may be subject to Federal, State or Local laws. These disposal guidelines are intended for the disposal of catalog-size quantities only.

Dispose of in an approved incinerator or contract with a licensed waste disposal service.

SECTION VIII — SPECIAL PROTECTION INFORMATION

Respiration Protection (Specify Type): None required in normal laboratory handling. If dusty conditions prevail, work in fume hood or wear a NIOSH/MSHA-approved respirator.

Ventilation				
Local Exhaust	Yes.	Special	No.	
Mechanical (General)	If dusty.	Other	No.	

Protective Gloves	Rubber - if needed.	Eye Protection	Chemical safety glasses.

Other Protective Equipment: Goggles, smock, apron, eye wash station, proper gloves, ventilation hood.

SECTION IX — SPECIAL PRECAUTIONS

Precautions to be Taken in Handling & Storing

Keep container tightly closed when not in use.

Store in a cool, dry place away from fire hazards and strong oxidizing materials. Avoid contact with skin and eyes. Wash thoroughly after handling.

Other Precautions

Read label on container before using. Do not wear contact lenses when working with chemicals.

Avoid breathing dust. Use with adequate ventilation. Remove and wash contaminated clothing.

For laboratory use only. Not for drug, food or household use. Keep out of reach of children.

Revision No. 6	Date 2/18/00	Approved Michael Raszeja	Chemical Safety Coordinator MR