

Adult Basic Education
Science

Science 3102

Simple Machines and Energy

Study Guide

Credit Value: 1

Text: *Nelson Physics 12: College Preparation; Hirsch, Alan J.; Nelson Thomson Canada; 2004.*

Science Courses [General College Profile]

Science 2100A
Science 2100B
Science 2100C
Science 3101
Science 3102
Science 3103
Science 3104
Science 3105
Science 3106

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To the Student

I. Introduction to Science 3102

Science 3102, *Simple Machines and Energy*, is the first of two Science courses in the General College Profile that covers concepts in the area of Physics. This course is a prerequisite to Science 3103, *Electricity*. While the course is available to all students, it is specifically designed for those who plan to pursue post-secondary education in the area of industrial trades.

In the first unit, *Science Skills*, you are introduced to the Workplace Hazardous Materials Information System (WHMIS). You then cover some of the basic mathematical skills (specifically; use of the metric system, scientific notation, and significant digits) that are needed throughout the remainder of this course and in Science 3103. The second unit, *Simple Machines*, introduces you to the various types of simple machines and explores how machines are useful in both domestic and industrial settings. In unit three, *Energy*, you learn about the various forms of energy and how energy is changed, or transformed, from one form to another. You explore thermal energy in more detail and learn how it is related to heat and temperature.

There are two labs (Core Labs) and two assignments that students are required to complete for this course. Your instructor may require you to complete additional lab activities and/or assignments.

The textbook that you will need for the course is *Nelson Physics 12: College Preparation*; Hirsch, Alan J.; Nelson Thomson Canada; 2004.

To the Student



II. Use of Study Guides

Before beginning this course, ensure you have the text and any other resources needed (*see the information in the Introduction to this course for specifics*).

As you work through the Study Guide, you will see that it is divided according to the Units listed in the Table of Contents. When you open a unit it will have the following components:

Reading for this Unit:

Here you will find the chapters, sections and pages of the text you will use to cover the material for this unit. Skim the sections of the textbook, look at the titles of the sections, scan the figures and read any material in the margins. Once you have this overview of the unit, you are ready to begin. Do not be intimidated by the content. You will work through the text, section by section, gaining knowledge and understanding of the material as you go.

<p>References and Notes</p> <p>This left hand column guides you through the material to read from the text. Read any highlighted notes that follow the reading instructions. The symbols   direct you to the questions that you should complete when finished a reading assignment..</p>	<p>Work to Submit</p> <p>You come across three (3) headings in this right hand column.</p> <p>Writing: This section comprises your notes for the unit. Here you will find either written questions or references to specific questions or problems from your text. You may want to write out each question followed by the answer. This material should be checked by your instructor before moving on to the next unit. Mathematical problems should have their solutions checked <u>as you go</u>.</p> <p>Laboratory: This section indicates if there is a Core Lab that should be completed for the unit. Let the instructor know in advance that you will be ready for the lab. A lab report should be submitted for each Core Lab. Your instructor will provide guidelines as to how s/he wants the report written.</p> <p>Assignment: This section indicates if there is an assignment that should be completed for the Unit. The information in the “References and Notes” column will indicate how you obtain the assignment. These assignments frequently relate the science content to technology, society and the environment.</p>
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To the Student

III. Recommended Evaluation

Written Notes	10%
Labs/Assignments	20%
Test(s)	20%
Final Exam (<i>entire course</i>)	<u>50%</u>
	100%

Unit 1 - Science Skills

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: *Nelson Physics 12: College Preparation*
Appendix A: Skills Handbook: pages 546 - 548
Appendix B: Safety Skills: pages 566 - 571
Appendix C: Reference: page 572
Study Guide
Assignment 1 “Introduction to WHMIS”: Appendix A
Assignment 2: “Science Skills”: Appendix B

References and Notes

Assignment 1 is found in Appendix A of this Study Guide. Read the material carefully and refer to pages 566 - 571 to help you do this assignment. [▶▶]

Assignment 2 is found in Appendix A of this Study Guide. Refer to pages 546 - 548 and 572 to help you do the assignment. [▶▶]

Note: *This unit is covered by completion of two assignments. You should pass both completed assignments in to your instructor for marking. While you **will not** be specifically tested on the material covered in the assignments, you will be expected to apply this knowledge in all future work.*

Work to Submit

Assignment 1:

1.1 Complete Assignment 1, “*Introduction to WHMIS*”.



Assignment 2:

1.2 Complete Assignment 2, “*Science Skills*”.


Unit 2 - Simple Machines

To fulfill the objectives of this unit, students should complete the following

Reading for this unit: *Nelson Physics 12: College Preparation*
Chapter 2, Section 2.1, pages 70 - 76.

References and Notes	Work to Submit
<p data-bbox="203 674 625 743"><i>Study pages 70 - 76. Then answer questions 2.1 - 2.13</i>  </p> <p data-bbox="203 856 625 1184">Note: You are studying only simple machines in this course. The other category of machines is compound machines, which are made up of two or more simple machines working together. Cars and dishwashers are examples of compound machines.</p> <p data-bbox="203 1415 625 1556">Note: Ask your instructor for a copy of the worksheet, Classes of Levers, to use when completing 2.6 (c).</p>	<p data-bbox="662 638 781 674">Writing:</p> <p data-bbox="662 716 1382 821">2.1 a) Define machine. b) List the five main functions of machines and give an example of a machine for each function.</p> <p data-bbox="662 863 1382 926">2.2 a) What are the two families of simple machines? b) List the ‘members’ of each family.</p> <p data-bbox="662 968 1349 1031">2.3 Define lever and give a practical example of a lever.</p> <p data-bbox="662 1073 1008 1115">2.4 What is a fulcrum?</p> <p data-bbox="662 1157 1382 1367">2.5 Define the following parts of a lever and give the symbol for each: i) effort force ii) load force iii) effort arm iv) load arm</p> <p data-bbox="662 1409 1349 1556">2.6 a) Describe the three classes of levers. b) Give an example to illustrate each. c) Complete the worksheet, <i>Classes of Levers</i>. (See the Note opposite.)</p> <p data-bbox="662 1598 1414 1745">2.7 a) What is a biomechanical system? b) Give an example of a biomechanical system that operates as a simple machine and describe how it works.</p>

Unit 2 - Simple Machines

References and Notes	Work to Submit
<p data-bbox="203 646 617 827"><i>Note: Ask your instructor for a copy of the student worksheet, Identifying the Components of Levers, to use for labelling the diagrams for question 2.9.</i></p> <p data-bbox="203 1016 634 1524"><i>Note: In the lab you will be measuring effort force (F_E) and load force (F_L). The unit used to measure force is the newton (N). You will also be asked to multiply force by distance. The unit for the product is the newton meter (N.m). You should also note that all measurements for distance are recorded in meters (m). If you have taken your measurements in centimeters (cm), you will need to convert to meters.</i></p> <p data-bbox="203 1570 634 1675"><i>Refer to Investigation 2.2, Forces on Levers, page 78, to do the laboratory. </i></p>	<p data-bbox="662 428 781 457">Writing:</p> <p data-bbox="662 499 1414 718">2.8 Describe the following types of simple machines that belong to the lever family and give an example of each: i) pulley ii) wheel and axle iii) gear</p> <p data-bbox="662 760 1414 831">2.9 Complete question 3 from the <i>Practice</i> on page 74. (See the <i>Note</i> opposite.)</p> <p data-bbox="662 873 1414 1087">2.10 Describe the following types of simple machines that belong to the inclined plane family and give an example of each: i) inclined plane ii) wedge iii) screw</p> <p data-bbox="662 1129 1170 1159">2.11 What is a compound machine?</p> <p data-bbox="662 1201 1414 1230">2.12 Complete question 6 from the <i>Practice</i> on page 76.</p> <p data-bbox="662 1272 1414 1344">2.13 Complete question 1 from the <i>Chapter 2.1 Questions</i> on page 77.</p> <p data-bbox="662 1499 829 1528">Laboratory:</p> <p data-bbox="662 1570 1414 1684">2.14 Complete Investigation 2.2. (See the <i>Note</i> opposite.) Pass your Lab Report in to your instructor for marking.</p>

Unit 2 - Simple Machines

References and Notes

Study pages 100 - 103. Then answer questions 2.15 - 2.16



Note: You likely use several simple and/or compound machines at home every day. These machines are referred to as **domestic** machines.

Note: This is the end of Unit 2. See your instructor to find out if there is any other work that you need to do for the unit or if you are required to do a test on the unit.

Work to Submit



Writing:

- 2.15 Complete the *Try This Activity*, Domestic Machines, page 101.
- 2.16 Give 2 examples of large compound machines used in industries such as mining or construction and describe the function of each.

Unit 3 - Energy



To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: *Nelson Physics 12: College Preparation*
Chapter 3, Section 3.1, pages 128 - 131;
Section 3.6, pages 149 - 152.



References and Notes	Work to Submit
<p data-bbox="203 747 618 821"><i>Study pages 128 - 131. Then answer questions 3.1 - 3.6</i>  </p> <p data-bbox="203 1268 631 1373">Note: Carefully study <i>Sample Problem 1</i> on page 130 before you do questions 3.5 - 3.6.</p>	<p data-bbox="662 716 781 747">Writing:</p> <p data-bbox="662 789 954 821">3.1 Define energy.</p> <p data-bbox="662 863 1341 936">3.2 List and briefly describe the various forms of energy.</p> <p data-bbox="662 978 1312 1010">3.3 Complete <i>Practice</i> question 2 on page 129.</p> <p data-bbox="662 1052 1341 1157">3.4 a) What is energy transformation? b) What is meant by energy-transformation technology?</p> <p data-bbox="662 1199 1312 1230">3.5 Complete <i>Practice</i> question 3 on page 130.</p> <p data-bbox="662 1272 1373 1346">3.6 Complete questions 1, 2, and 3 from <i>Section 3.1 Questions</i> on page 131.</p>

Unit 3 - Energy

References and Notes

Study pages 149 - 151. Then answer questions 3.7 - 3.13  

Note: Carefully study Figure 1 (a) and (b) before you do question 3.10.

The lab activity, *Effects of Heat Transfer*, is found in Appendix B of the Study Guide.  

Note: See your instructor to find out what is expected for your Lab Report. The lab report should be passed in to your instructor for marking.

Work to Submit

Writing:



- 3.7 a) What is **thermal energy**?
b) On what three factors does thermal energy depend?
- 3.8 Define **heat**.
- 3.9 Define **temperature**.
- 3.10 Complete Practice questions 1 and 2 on page 150.
- 3.11 What are the three methods of transferring heat from a warmer body to a cooler body?
- 3.12 Describe each of the three methods of heat transfer and give an example of each.
- 3.13 Complete Practice questions 4, 7, and 9 on page 152.

Laboratory:

- 3.14 Complete all parts of the lab activity, *Effects of Heat Transfer*.

Unit 3 - Energy

References and Notes

Study page 152. Then answer questions 3.17 - 3.18  

Note: This is the end of Unit 3. See your instructor to find out if there is any other work that you need to do for the unit.

Work to Submit

Writing:

- 3.15 What does the **Law of Conservation of Energy** state?
- 3.16 What type of energy is often produced as “waste energy” in the operation of most machines?

Appendix A

Assignment 1
Introduction to WHMIS

Instructions:

Read the material carefully and answer the questions in the worksheets found at the end of each section. Pass in the worksheets **ONLY** to your instructor for marking.

Section 1

WHMIS: An Introduction

Case Study

On his third day of a part-time job, a 19-year-old was pouring a drum of highly flammable chemical into small containers. Highly flammable means that the chemical can start a serious fire if not handled properly. There were no warning labels on the drums that held the chemical. A spark from static electricity made the chemical explode. The young worker suffered burns to 95% of his body. He died the next day.

WHMIS (pronounced “wimis”) stands for Workplace Hazardous Materials Information System. It is a Canada-wide information system set up to protect all Canadian workers and employers. A hazardous material is any substance that can cause illness, disease or death to unprotected people. Sometimes hazardous materials are called “hazardous products”, “controlled products” or “dangerous goods”.

WHMIS provides vital information about any materials that pose a risk or hazard in the workplace. This information is necessary to protect the health and safety of everyone in the work place.

The WHMIS information system is based on a law in Canada that came into effect in October, 1988. It states that everyone has a right to know about the hazardous substances that are being used in their workplace. It requires suppliers, employers, and workers to use the system to identify and handle hazardous materials safely. WHMIS rules apply in every province and territory of Canada.

People who do not follow the laws on hazardous materials can be charged with an offense and, if convicted, can be fined or jailed.

Why is it needed?

In our daily lives there are hundreds of materials and chemicals which have been developed to make our work easier and to allow us to make better products. In this process, there are substances that are used or produced that can be dangerous to people if handled improperly. WHMIS lets us know which materials are dangerous, and how we can protect ourselves when we handle them.

The danger of hazardous materials can come from explosion, fire, skin contact, inhalation or ingestion. How bad the danger is will usually depend on one or more of the following:

- the amount of pressure there is (gases);
- how easily the material burns or explodes;
- the amount of material there is;
- how toxic it is;
- how it enters the body; and
- its concentration.

Who developed WHMIS?

Once the need for a national information system was recognized, WHMIS was developed by joint committees of employers, unions and governments.

What problems does WHMIS try to solve?

- unlabelled chemicals in workplaces;
- lack of awareness by employers about the identity and hazards of the chemical they are using;
- inadequate information provided by suppliers to employers and workers, about the hazards of the chemical they are using; and
- differences between provinces and territories in the way hazardous materials are handled.

The three main parts of WHMIS

WHMIS has three main parts to help identify and handle hazardous materials safely:

1. **Labels:** They are applied to the containers with materials inside. The labels supply vital warning information.
2. **Material Safety Data Sheets (MSDS):** Sheets of information stored separately from the material. These sheets give details for handling emergencies, clean-ups, and controls for the safe use of the hazardous materials. The law requires the employer to have a MSDS available for every hazardous material in the workplace.

3. **Worker Education:** Employers must provide instruction to each worker on how to use WHMIS, what hazardous materials are on site, and how to handle them properly.

Employee Responsibility

Workers have the responsibility to use the system to protect themselves from hazardous materials by:

- recognizing labels;
- checking the hazards; and
- following recommended procedures.

Employer and supplier responsibilities will be discussed in other activities.

Exemptions of Products from WHMIS

Some products are already covered by other legislation. These have been partially exempt from having to follow WHMIS requirements for labels and MSDS's. Employers must still follow WHMIS laws for these products by educating workers in the safe handling of the products and by using labels when the contents are transferred. These products include consumer products, cosmetics and drugs, explosives, pesticides and radioactive substances.

Some products are covered by other laws and are completely exempt from WHMIS. These include wood and products of wood, tobacco and products made of tobacco, hazardous wastes and manufactured articles.

Worksheet 1: WHMIS: An Introduction - Quiz

Questions

1. What should have been done on the work site to prevent the 19-year old worker from losing his life? (Refer to the Case Study at the beginning.)

2. (a) WHMIS stands for: _____

- (b) What is WHMIS? _____

- (c) What does WHMIS require suppliers, employers and workers to do?

3. Do WHMIS laws differ across Canada? _____

4. What is a hazardous material? _____

5. What are the three main parts of WHMIS? _____

6. Hazards identified in the WHMIS system can come from: (Place a mark by those that are right.)

- | | |
|-----------------------|---------------------|
| a. _____ fire | e. _____ inhalation |
| b. _____ skin contact | f. _____ ingestion |
| c. _____ reading | g. _____ seeing |
| d. _____ explosion | |

7. How bad a hazard is usually depends on one or more of the following: (Mark the answers that you think are correct.)

- | | |
|------------------------------------|--|
| a. _____ the amount of material | e. _____ how great the pressure is |
| b. _____ the month of the year | f. _____ how easily the material burns or explodes |
| c. _____ the manufacturer | g. _____ how concentrated the material is |
| d. _____ how toxic the material is | h. _____ your elevations |

Section 2

WHMIS: Responsibilities and Labels

Responsibilities

The responsibility for safely handling hazardous materials is shared by three parties:

- the employer
- the worker
- the supplier

The Employer

- The employer must tell you what hazardous materials you may come into contact with on the site.
- He/she must make sure that all hazardous materials on the job site are marked or labeled properly in accordance with WHMIS rules.
- Employers must have safe procedures for the use, handling, storage and disposal of hazardous materials that are in use on the site. They must also have procedures for handling emergencies involving hazardous materials.
- The employer is required to provide you, the worker, with training on:
 - how to use WHMIS labels and Material Safety Data Sheets. You must also be told where MSDS's are kept. Workers should have easy access to Material Safety Data Sheets either through the use of posters, computers or binders containing the sheets.
 - procedures for the safe use, storage, handling and disposal of the hazardous materials on the work site.
 - procedures to follow in case of an emergency involving the hazardous materials.
 - the codes that are used and that are specific to the work site. Those codes may be colors, letters or numbers. As the codes may change from one work site to another, the employer must make sure that the employee is trained for his particular work site. Pipes, pumps, large containers, or vessels that carry hazardous materials should all be marked with these codes.
- The employer is responsible for supplying and replacing all safety equipment related to hazardous materials and substances.

The Worker

You have responsibility to:

- receive information and be informed about hazardous materials on the work site;
- learn how to use WHMIS;
- follow recommended procedures to protect yourself and others; and
- inform your employer of hazards and/or damaged and missing labels.

The Supplier

The suppliers must provide labels and the information on the Material Safety Data Sheets. The information on labels and MSDS's are the foundation for the safe handling on hazardous materials.

Labels

The Workplace Hazardous Materials Information Systems has labels that are used to identify hazardous materials. The purpose of the labels is to alert workers to main hazards of products and provide procedures for working with them, as well as to direct workers to the second part of the information system, the Material Safety Data Sheet.

There are three main types of WHMIS labels:

- **Supplier Labels** which are placed on the container by the manufacturer or distributor. The materials are then shipped to the workplace;
- **Workplace Labels** which are placed on hazardous materials when needed on the job site. When any hazardous material is taken out of its supplier container and put into another container, workplace labels must be applied to the new container; and
- **Other means of identification** in the workplace: pipes, tubes, pumps or vessels may be used to transport hazardous materials from one place to another. Since each work site may be different, the employer has to develop ways of warning the worker that there are hazardous materials present. Sometimes coloured flags or tapes are attached or the containers are coloured. As each employer has developed his/her own system for warning employees, it is necessary that the employee be trained to recognize this "other means of identification" used by the employer.

Supplier Labels

When hazardous materials enter the workplace, the supplier label is the first warning sign that hazardous materials are present. The label may be placed on the container of hazardous materials by the supplier before shipping, or the supplier label may be included with the shipment and placed on the containers by the receiver when the shipment arrives at the workplace. The supplier label has a special “hatch” border to draw attention to it. The label will signal that hazardous materials are present.

Suppliers must provide supplier labels on containers of products sold or imported into the workplace.

The supplier label provides these 7 types of information:

product identifier	the name of the hazardous material
supplier identifier	the name and address of the supplier
MSDS statement	a statement indicating that a Material Safety Data Sheet for that material is available in the workplace
hazard symbols	one or more of 8 WHMIS hazard symbols relevant to the hazardous material
risk phrase	a brief description of the hazard and the effects of exposure on the body
precautionary measures	brief instructions for the safe use of materials
first aid measures	how to treat persons who have been exposed to the material.

There is no specific rule for the size, shape or color of the label, but it must contrast with the background color of the container. In other words, a yellow label is not allowed on a yellow drum or a blue label on a blue bottle, and so forth.

A problem arises when the container with the hazardous material is small. It is difficult to fit a label with all of the above information on a small bottle. When the container is less than 100 milliliters, or one third of a can of pop, only the following information is required on the supplier label:

- product identifier
- supplier identifier
- a statement making reference to a MSDS
- hazard symbols showing the dangers associated with the material

Sample Supplier Label

METHANOL
DANGER
POISON
FLAMMABLE
VAPOUR HARMFUL
MAY CAUSE BLINDNESS IF SWALLOWED

Keep away from heat, sparks and flame. No smoking. Container must be grounded when being emptied. Vapour may travel long distance. Avoid contact with eyes and skin. Do not inhale vapours or mist. Do not take internally. Harmful if absorbed through the skin.

FIRST AID: In case of contact, immediately flush eyes and skin with plenty of water for at least 15 minutes.

If swallowed, induce vomiting by sticking finger down throat, or by giving soapy water to drink. Repeat until vomit is clear.

If affected by vapour, move to fresh air.

If breathing has stopped, apply artificial respiration.

GET MEDICAL ATTENTION IMMEDIATELY.

PRECAUTIONS: Wear chemical-goggles and resistant gloves. Wash thoroughly after handling. Use with enough ventilation to keep below TLV. Keep container closed. Never use pressure to empty container.

**SEE MATERIAL SAFETY DATA SHEET FOR PRODUCT
VOIR FICHE SIGALÉTIQUE**

ABC Company
Anytown, Ontario Telephone 123-4567

MÉTHANOL
DANGER
POISON
INFLAMMABLE
VAPEURS NOCIVES
PEUT PROVOQUER LA CÉCITÉ, SI AVALÉ

Garder loin de la chaleur, des étincelles et des flammes. Ne pas fumer. Brancher le contenant à une prise de terre avant de le vider de son contenu. Les vapeurs peuvent s'étendre sur de longues distances. Éviter tout contact avec les yeux et la peau. Ne pas respirer les vapeurs. Ne pas absorber. Nocif si absorbé par la peau.

PREMIERS SOINS: En cas de contact avec les yeux ou la peau, laver à grande eau pendant au moins 15 minutes. Si avalé, provoquer le vomissement en introduisant un doigt dans la gorge ou en faisant absorber de l'eau savonneuse à la victime. Répétez jusqu'à cessation du vomissement.

Sortir au grand air, si indisposé par les vapeurs.

Si la respiration est interrompue, recourir à la respiration artificielle.

OBTENIR DES SOINS MÉDICAUX IMMÉDIATS.

PRÉCAUTIONS: Porter des lunettes protectrices (pour produits chimiques) et des gants résistants. Se laver minutieusement après usage. Utiliser dans un endroit bien aéré, afin de maintenir un niveau de vapeurs tolérable. Garder le contenant fermé. Ne jamais user de pression en vidant le récipient.

Workplace Labels

These labels must be placed on both hazardous materials produced in the workplace and on hazardous materials moved out of its original container into a new container. The workplace label is supplied by the employer and contains less information than the supplier label. It does not need to show a hazard symbol, and it is required to give only three of the seven kinds of information:

- product identifier - name of the products
- precautionary measures - how to handle it safely; and
- a statement telling the reader that a Material Safety Data Sheet is available for the material.

There are no specific requirements for the color, size or shape of the workplace label, and it has no special border.

Sample Workplace Label

Toluene Sulphonic Acid 70%, Liquid
Wear protective gloves, apron, goggles and face shield
USE IN WELL VENTILATED AREA
Refer to Material Safety Data Sheet

Worksheet 2: WHMIS: Responsibilities and Labels - Quiz

1. Who are the three main WHMIS participants?

2. Mark the employer's responsibilities with an "E" and the worker's responsibilities with a "ME".

- a) provide training on how to use WHMIS
- b) learn how to use WHMIS
- c) provide training on procedures for the safe use, storage and handling of the hazardous materials on site
- d) learn how and follow procedures for the safe use, storage and handling of the hazardous materials on site
- e) recognize special color, number or letter codes on pumps, pipes and vessels carrying hazardous materials
- f) develop emergency procedures and supply training to follow them
- g) clearly mark or label pumps, pipes and vessels carrying hazardous materials

3. Write the letter of the employer's responsibility in the blank that best matches the way in which employers can meet the requirement.

	Employer's Responsibilities		Ways employers can meet the requirements...
a.	Identify all hazardous materials on site		check materials as they arrive from suppliers
b.	Make sure materials are labeled		keep MSDS's handy on site
c.	Provide information		provide step-by-step training on the use, handling, storage or disposal of hazardous materials
d.	Develop procedures		explain how to do things at a safety or staff meeting
e.	Train workers		place WHMIS posters on the job board for easy reference
			show and practice what to do in an emergency
			post a list of all hazardous materials on the site

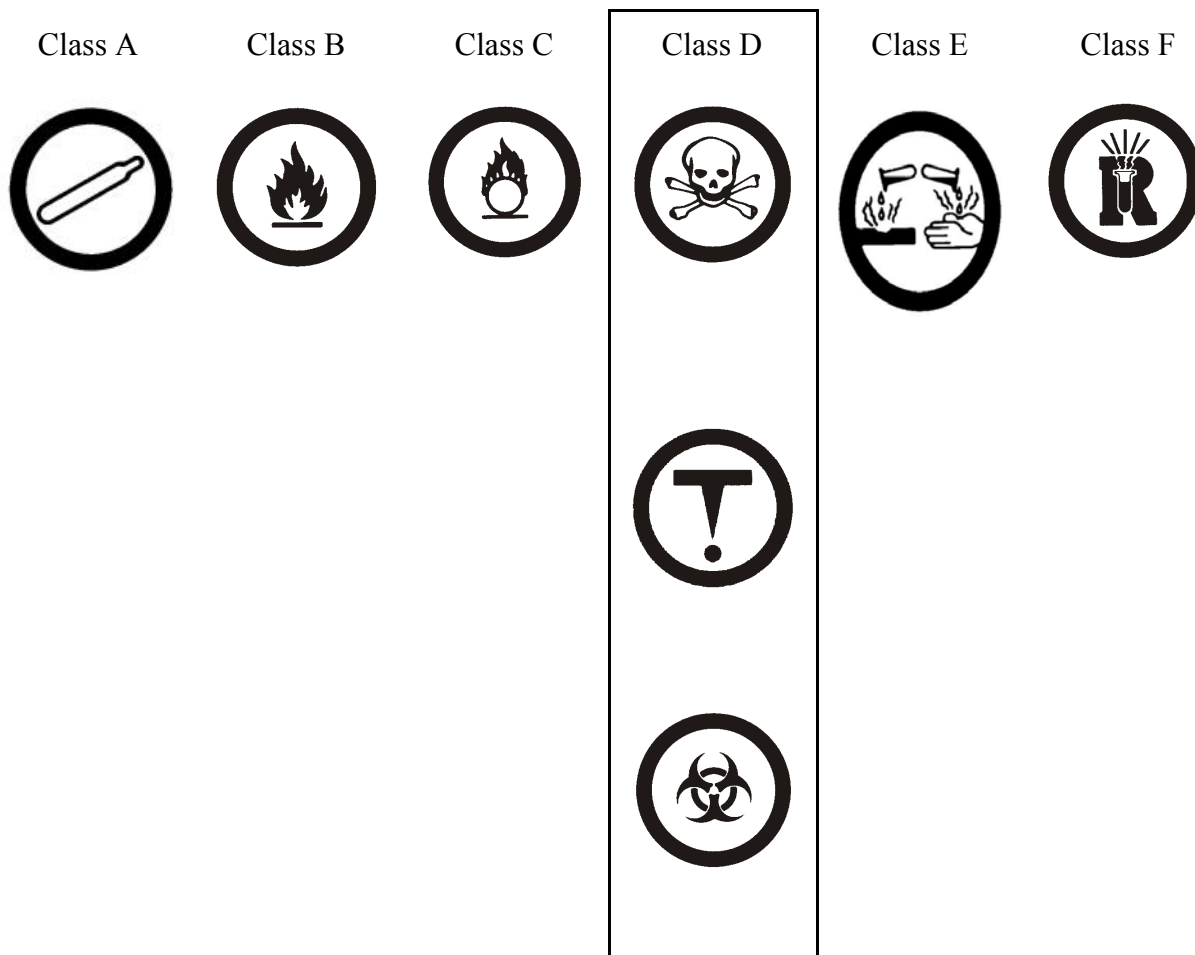
Section 3

WHMIS: Product Classification and Hazard Symbols

On the supplier label introduced in the last activity, there is a picture or symbol which shows the type of hazard the material presents in the container. In total, there are eight different symbols used to indicate type of hazard of the material in the container.

These eight symbols are organized into 6 different classes of hazardous materials. The classes are lettered A through F. Class D, which is poisonous and infectious materials, has 3 divisions for different types of poisons. Each of these divisions has a symbol.

- Class A - Compressed gas
- Class B - Flammable and combustible material
- Class C - Oxidizing material
- Class D - Poisonous and infectious materials
 - Division 1 - Materials causing immediate and serious toxic effects
 - Division 2 - Materials causing other toxic effects
 - Division 3 - Bio-hazardous infectious material
- Class E - Corrosive material
- Class F - Dangerous reactive material



Class B, flammable and combustible material, is also divided into subclasses or divisions. Unlike Class D, however, it does not have symbols for each of its divisions.

Class B subclasses or divisions are:

- Division 1 - flammable gas
- Division 2 - flammable liquid (flash point below 37.82°C)
- Division 3 - combustible liquid (flash point greater than 37.82°C)
- Division 4 - flammable solid (can be ignited by heat or friction)
- Division 5 - flammable aerosol (small drops of a liquid suspended in air)
- Division 6 - reactive flammable material (flammable in air)

What is a flashpoint?

When a liquid evaporates it gives off a vapor. The vapor combines with air to form a mixture. If enough vapor is present and mixed with air, the mixture can be ignited. A flashpoint is the lower temperature at which a liquid gives off enough vapor to form a mixture that can produce a flame.

Colour Coding and Symbols

Sometimes the symbols are colour coded into three main groups: red for fire, blue for poison and yellow for “change”. Symbols in red would be Class B: flammable and combustible material; symbols in blue would be Classes D and E; symbols in yellow would be those belonging to Classes A, C and F.

Exemptions

Some products such as pesticides, certain consumer products and explosives do not require the distinctive WHMIS label because they are already covered by other labeling laws. WHMIS requires employers to provide training to workers. If those products are transferred to small containers, WHMIS requires that workplace labels be applied.

Worksheet 3a: Match the WHMIS Symbols

Match the symbol with the description on the right.



A



B

_____ Poisonous Materials

_____ Compressed Gas



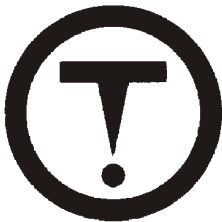
C



D1

_____ Dangerously Reactive Materials

_____ Flammable and Combustible Materials



D2



D3

_____ Toxic Materials

_____ Oxidizing Materials



E



F

_____ Bio-Hazardous/Infectious Materials

_____ Corrosive Materials

Section 4

WHMIS: Material Safety Data Sheets (MSDS)

Material Safety Data Sheets (MSDS)

The Material Safety Data Sheet is a very important technical document. There is a MSDS for every hazardous material on site.

Federal law requires that a supplier provide a MSDS for each controlled product. Newfoundland and Labrador law requires the employer to have a MSDS available for every hazardous material in the workplace. The MSDS must be readily accessible to all workers, worker representatives and members of the occupational health committee.

Every MSDS must be current (up to a maximum of 3 years is allowed between updates). The MSDS must be revised within 90 days after new hazard information becomes known about the material.

The MSDS has 9 main sections containing information which the employer should be aware of. None of these section should be left blank, but their order may vary.

1. **Product Identification and Use:** the product name, identification number and use, as well as information on how to contact the supplier and manufacturer.
2. **Hazardous Ingredient:** the identify of the ingredients, their concentrations and estimates of immediate and severe health effects.
3. **Physical Data:** a physical description of the product.
4. **Fire and Explosion Data:** information on the ability of the product to catch fire or explode, and the means of extinguishing a fire.
5. **Reactivity Data:** the ability of the product to react dangerously.
6. **Toxicological Properties:** information on how materials enter the body and what the short and long-term health effects are.
7. **Preventative Measures:** information on control measures including ventilation, personal protective equipment (gloves, respirators, etc.) and work procedures.
8. **First Aid Measures:** information on immediate treatment in case of contact with the product.
9. **Preparation Information:** information on who prepared the MSDS and when.

The MSDS contain more information than the required 9 sections. For example, some MSDS's will include information about how to safely transport the product. This will be listed under "TDG" or "Transportation of Dangerous Goods".

Exemptions

Some companies do not want to disclose information on the MSDS because they would be giving away trade secrets. Some cleaners and soaps are examples of this. Those companies submit a request to a committee that approves or turns down the company's request. Other situations arise where consumer products fall under other laws; when this occurs, the MSDS does not have to have all parts completed.

Worksheet 4a: WHMIS Material Safety Data Sheets (MSDS's)

1. How many sections must be provided on a MSDS? _____

2. What is the title of the section of the MSDS that tells who to contact if you have questions about the products?

3. Which section of the MSDS lists the special protective measures you can take to avoid harmful contact with the products?

4. How often must a MSDS be updated?

Worksheet 4b: Using Material Safety Data Sheets

The following pages contain questions about a product you may be familiar with, WD40. Refer to the MSDS sheet for the product to answer the following questions.

WD40

1. What is the telephone number of the supplier? _____

Under what section of the MSDS did you find this information?

2. What problems can occur if you get WD40 in your eyes?

Under what section of the MSDS did you find this information?

3. What should you do if you get WD40 in your eyes?

What could you have done to prevent it from happening?

4. What engineering controls may be needed for this products?

5. Are the ingredients of this product carcinogenic (cancer causing)?

* * * * *

* M S D S *

* *

* Canadian Centre for Occupational Health and Safety *
* * * * * Issue : 2000-1 (February, 2000) *

*** IDENTIFICATION ***

MSDS RECORD NUMBER : 1671684
PRODUCT NAME(S) : 3958-1020 WD40 FULL PALLET 3.785L & SPRAY
PRODUCT IDENTIFICATION : MATERIAL SAFETY DATA SHEET : 00002589
DATE OF MSDS : 1996-07-11
CURRENCY NOTE : This MSDS was provided to CCOHS in electronic form on
1998-04-27

*** MANUFACTURER INFORMATION ***

MANUFACTURER : K-G PACKAGING
ADDRESS : 8001 Keele Street
Post Office Box 89
Concord Ontario
Canada L4K 1B2
EMERGENCY TELEPHONE NO.: 613-996-6666 (24 HRS) (CANUTEC)

*** MATERIAL SAFETY DATA ***

MATERIAL SAFETY DATA SHEET : 00002589

K-G PACKAGING
8001 KEELE STREET P.O. BOX 89
CONCORD, ONTARIO CANADA L4K 1B2
CANUTEC EMERGENCY #:1-613-996-6666(24HR)

Product: 3958-1020 WD40 FULL PALLET 3.785L & SPRAY

SECTION 01: MANUFACTURER INFORMATION

MANUFACTURER.....K-G PACKAGING
8001 KEELE STREET P.O. BOX 89
CONCORD, ONTARIO
CANADA
L4K 1B2
CANUTEC EMERGENCY #:1-613-996-6666(24HR)
PRODUCT NAME..... 3958-1020 WD40 FULL PALLET 3.785L & SPRAY
CHEMICAL FAMILY..... ORGANIC MIXTURE.
TRADE NAMES & SYNONYMS..... SAME AS PRODUCT NAME.
PRODUCT USES..... LUBRICANT/PENETRANT.
CHEMICAL FORMULA..... NOT APPLICABLE.
MOLECULAR WEIGHT..... NOT APPLICABLE.
T.D.G. CLASSIFICATION..... NOT REGULATED.
WHMIS CLASSIFICATION..... B3.
NFCC SECTION 4.1..... CLASS II.
NFPA CODE 30B..... CLASS II.
HMIS RATING FLAMMABILITY..... 2 MODERATE HAZARD.
HMIS RATING HEALTH..... 1 SLIGHT HAZARD.
HMIS RATING REACTIVITY..... 0 MINIMAL HAZARD.

SECTION 02: HAZARDOUS INGREDIENTS

% SPECIES	CAS / TLV	LD/50, ROUTE, SPECIES	LC/50, ROUTE,
STODDARD SOLVENT			
10-30	8052-41-3 100 ppm	5g/kg ORAL-RAT	5g/m3 INHAL-RAT
PETROLEUM BASE OIL			
5-10	64742-65-0 5 mg/m3	NOT AVAILABLE	NOT AVAILABLE
MINERAL SPIRITS			
60-100	64742-47-8 NOT AVAILABLE	>5000 mg/kg ORAL - RAT	1400 ppm/4H INHAL - RAT

SECTION 03: PHYSICAL DATA

PHYSICAL STATE..... LIQUID.
 BOILING POINT (DEG C)(CONC)..... >149.
 VAPOUR PRESSURE(PSIG)-AEROSOL..... NOT AVAILABLE.
 @ 20 C
 VAPOUR DENSITY (AIR=1)..... GREATER THAN 1.
 (BY WEIGHT)
 SOLUBILITY IN WATER..... NEGLIGIBLE.
 APPEARANCE..... LIGHT AMBER.
 ODOR..... CHARACTERISTIC.
 ODOR THRESHOLD..... NOT AVAILABLE.
 SPECIFIC GRAVITY (LIQUID)..... 0.78-0.82.
 PERCENT VOLATILE (BY WEIGHT)..... 72-75.
 EVAPORATION RATE..... LESS THAN 1.
 n-BUTYL ACETATE = 1
 PH..... NOT APPLICABLE.
 FREEZING POINT: (C)..... NOT AVAILABLE.
 COEFFICIENT OF WATER\OIL..... NOT AVAILABLE.
 DIST.

SECTION 04: FIRE & EXPLOSION DATA

FLAMMABILITY..... COMBUSTIBLE.
 IF YES, UNDER WHICH..... EXCESSIVE HEAT, SPARKS AND OPEN FLAME.
 CONDITIONS ?
 EXTINGUISHING MEDIA..... CARBON DIOXIDE, DRY CHEMICAL, FOAM.
 SPECIAL PROCEDURES..... WATER FROM FOGGING NOZZLES MAY BE USED TO
 COOL CLOSED CONTAINERS TO PREVENT BUILD-UP
 IF EXPOSED TO EXTREME TEMPERATURES.FULL
 PROTECTIVE EQUIPMENT INCLUDING SELF
 CONTAINED BREATHING APPARTATUS SHOULD BE
 WORN IN A FIRE INVOLVING THIS MATERIAL.
 FLASH POINT(C),TAG CLOSED-CUP..... >42.
 (CONCENTRA TE)
 AUTO IGNITION TEMPERATURE (C)..... NOT AVAILABLE.
 LOWER FLAMMABLE LIMIT..... 1.
 (% BY VOLUME)
 UPPER FLAMMABLE LIMIT..... 6.
 (% BY VOLUME)
 HAZARDOUS COMBUSTION
 PRODUCTS..... HYDROCARBON FUMES AND SMOKE. CARBON
 MONOXIDE WHERE COMBUSTION IS INCOMPLETE.
 EXPLOSION DATA
 SENSITIVITY TO STATIC..... NOT APPLICABLE.
 DISCHARGE
 SENSITIVITY TO IMPACT..... NOT APPLICABLE.

SECTION 05: REACTIVITY DATA

CHEMICAL STABILITY:
YES..... UNDER NORMAL CONDITIONS.
NO, WHICH CONDITIONS?..... NOT APPLICABLE.
COMPATABILITY WITH OTHER
SUBSTANCES :
NO, WHICH ONES?..... STRONG OXIDIZING AGENTS.
HAZARDOUS PRODUCTS OF
DECOMPOSITION..... HYDROCARBON FUMES AND SMOKE. CARBON
MONOXIDE WHERE COMBUSTION IS INCOMPLETE.
REACTIVITY CONDITIONS?..... NOT APPLICABLE.

SECTION 06: TOXICOLOGICAL PROPERTIES

ROUTE OF ENTRY:
SKIN CONTACT..... MAY CAUSE IRRITATION.
SKIN ABSORPTION..... NO DATA AVAILABLE FOR THIS PRODUCT
MIXTURE.
EYE CONTACT..... MAY CAUSE IRRITATION.
INHALATION..... INHALATION OF SOLVENTS MAY CAUSE
IRRITATION.
INHALATION, CHRONIC..... UNKNOWN.
INGESTION..... MAY CAUSE HEADACHE, NAUSEA, VOMITING AND
WEAKNESS.
EFFECTS OF ACUTE EXPOSURE..... DIZZINESS, NAUSEA. IRRITATION TO SKIN &
EYES.
EFFECTS OF CHRONIC EXPOSURE..... SOLVENTS MAY CAUSE DEFATTING DERMATITIS.
EXPOSURE LIMIT OF MATERIAL..... SEE SECTION II.
IRRITANCY OF MATERIAL..... SLIGHT.
SENSITIZING CAPABILITY OF..... UNKNOWN.
MATERIAL
CARCINOGENICITY OF MATERIAL..... THE INGREDIENTS OF THIS PRODUCT ARE NOT
LISTED AS CARCINOGENS BY NTP, (NATIONAL
TOXICOLOGY PROGRAM), NOT REGULATED AS
CARCINOGENS BY OSHA, (OCCUPATIONAL SAFETY
AND HEALTH ADMINISTRATION), AND HAVE NOT
BEEN EVALUATED BY IARC, (INTERNATIONAL
AGENCY FOR RESEARCH ON CANCER), NOR BY
ACGIH (AMERICAN CONFERENCE OF GOVERNMENTAL
INDUSTRIAL HYGIENISTS).
REPRODUCTIVE EFFECTS..... NO INFORMATION IS AVAILABLE AND NO ADVERSE
REPRODUCTIVE EFFECTS ARE ANTICIPATED.
TERATOGENICITY..... NO INFORMATION IS AVAILABLE AND NO ADVERSE
TERATOGENIC EFFECTS ARE ANTICIPATED.
MUTAGENICITY..... NO INFORMATION IS AVAILABLE AND NO ADVERSE
MUTAGENIC EFFECTS ARE ANTICIPATED.
SYNERGISTIC MATERIALS..... NONE KNOWN.

SECTION 07: PREVENTIVE MEASURES

GLOVES/ TYPE..... WEAR CHEMICAL RESISTANT GLOVES.
RESPIRATORY/TYPE..... IF USED INDOORS ON A CONTINUOUS BASIS, USE
OF A CARTRIDGE TYPE RESPIRATOR
NIOSH/MSHATC 23C OR EQUIVALENT) IS
RECOMMENDED.
EYE/TYPE..... SAFETY GLASSES.
FOOTWEAR/TYPE..... RUBBER SAFETY BOOTS.
OTHER/TYPE..... NOT REQUIRED.
ENGINEERING CONTROLS..... VENTILATION - LOCAL (MECHANICAL IF USED INDOORS
ON A CONTINUOUS BASIS).
LEAK/SPILL..... REMOVE ALL SOURCES OF IGNITION. USE AN INERT
ABSORBENT MATERIAL, AND NON-SPARKING TOOLS.
AVOID BREATHING FUMES. VENTILATE AREA. PREVENT

HANDLING PROCEDURES AND EQUIPMENT..... FROM ENTERING A WATERCOURSE.
STORE IN A COOL, WELL VENTILATED AREA NOT TO EXCEED 50 DEG C.
WASTE DISPOSAL..... DO NOT PUNCTURE OR INCINERATE CONTAINERS, EVEN WHEN EMPTY.DISPOSE OF IN ACCORDANCE WITH LOCAL, PROVINCIAL AND FEDERAL REGULATIONS.
STORAGE NEEDS..... KEEP AWAY FROM HEAT, SPARKS, AND OPEN FLAMES.

SECTION 08: FIRST AID MEASURES

EMERGENCY FIRST AID PROCEDURE..... IN CASE OF EYE CONTACT, FLUSH IMMEDIATELY WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES AND GET MEDICAL ATTENTION. FOR SKIN, WASH THOROUGHLY WITH SOAP AND WATER. IF AFFECTED BY INHALATION OF VAPOUR OR SPRAY MIST, REMOVE TO FRESH AIR. IF SWALLOWED; DO NOT INDUCE VOMITING, GET MEDICAL ATTENTION.

SECTION 09: ADDITIONAL INFORMATION

NOTICE FROM CCL INDUSTRIES INC..... THE INFORMATION ON THIS MATERIAL SAFETY DATA SHEET IS PROVIDED BY CCL INDUSTRIES INC. FREE OF CHARGE. WHILE BELIEVED TO BE RELIABLE, IT IS INTENDED FOR USE BY SKILLED PERSONS AT THEIR OWN RISK. CCL INDUSTRIES INC. ASSUMES NO RESPONSIBILITY FOR EVENTS RESULTING OR DAMAGES INCURRED FROM ITS USE. THE INFORMATION ON THIS MATERIAL SAFETY DATA SHEET RELATES ONLY TO THE SPECIFIC MATERIAL DESIGNATED HEREIN AND DOES NOT RELATE TO USE IN COMBINATION WITH ANY OTHER MATERIAL OR IN ANY PROCESS.
DATED..... 071196

Reminder

MSDS's must be readily available to all works at all times.

Did you really understand the MSDS?

Here are some questions the worker should be able to answer.

1. Can this product harm your health? Do you know the symptoms that may warn you of over-exposure?
2. Do you know the first aid measures needed in case of an over-exposure?
3. Can this product burn or explode?
4. Does your work site need any control measures such as special ventilation?
5. Does this product require special handling precautions?
6. Do you need any personal protective equipment?
7. Do you need to be careful when mixing this product with other chemicals? Which ones?
8. Does this product require any special storage conditions?
9. Do you know what to do in case of a fire or explosion?
10. Do you know what to do in case of a spill or leak?
11. Do you know where the emergency response equipment is and how to use it?

If the worker cannot answer any of these questions, he/she must talk to his/her employer, supervisor or safety officer before using the product.

Section 5

WHMIS: Control of Hazardous Materials

When hazardous materials are on the work site, it is necessary to control them, so the health and safety of the workers is protected.

There are three routes that toxic substances may take to enter your body: inhalation, ingestion and absorption. Hazardous materials enter the body may have acute and chronic effects, or a combination of both effects.

- **acute effect:** occur immediately or shortly after exposure; immediate death sometimes results.
- **chronic effects:** show up years later. The worker, by this time, may have had many exposures. The period between the exposure to the hazardous material and the illness of the work is referred to as the latency period.

Sometimes the body reacts strongly to defend against exposure. This is called sensitization. Examples of sensitization include rashes and asthma-like reactions such as wheezing and coughing. Sensitization is acquired over a period of exposures, but once sensitization occurs, low level exposure to the material will cause a strong reaction. Avoid exposure to the material is the only solution to sensitization.

A hazard control measure is something that is used to prevent workers from injury or from becoming ill. A control measure may involve the way something is done or where it is done. If you want to open a can, you can use a can opener, not a hammer. If you do not want to get pain on furniture, you cover the furniture. These are examples of control measures.

On the work site there are many different ways in which control measures are used. If a control measure is to be of benefit, it must meet the following requirements:

- **It must adequately control the hazard.** If the hazard is lethal there should be no contact. The level of the hazard must be reduced, so there is no danger for the worker.
- **The control measure must create no new hazards.** For example, the cover on the furniture to protect it from paint should be arranged so no one can trip on it.
- **You must be able to do your job without unnecessary discomfort or stress.** Protective clothing should fit properly. It should not be too big or too small.

- **Every worker who comes into contact with the hazard must be protected by the control measure.** If a lab technician uses gloves, shouldn't the nurse (who takes the sample) do so as well?
- **The hazard must be eliminated from the surrounding community as well as in the workplace.** If a substance is harmful, why remove it from the work site and release it into the community?

Types of Control

There are three basic ways in which hazardous material can be controlled:

- **at the source:** The hazardous material can be eliminated or substituted with a less hazardous substance or material; for example, brake linings that do not contain asbestos can replace those that do.
- **in the pathway:** Barriers can be used to keep hazards away. For example, ventilation can be used to remove fumes or to dilute the concentration of the hazardous substance by mixing it with fresh air. Chemicals that react when mixed can be stored far away from each other.
- **at the worker level:** Personal protective equipment can be used and workers can be removed or rotated from hazard areas to keep exposure to dangerous chemicals below allowable limits.

As a worker involved in health and safety, you should always be aware of the effects of hazardous materials on you, your coworkers and the community. Your practices at work should prevent harm from coming to anyone. This involves knowing what is harmful. WHMIS is one important tool used to recognize hazards present in the workplace and to learn how to deal with them safely.

Worksheet 5: Control of Hazardous Materials

1. What are the three ways chemicals can enter your body? _____

2. What are the two effects that hazardous materials may have on your body? Explain what each type is. _____

3. What is sensitization? _____

4. What is a control measure? _____

5. What are three methods by which a hazardous material can be controlled? _____

Assignment 2

Science Skills

Part I - Scientific Notation

Rewrite each number in scientific notation

1. 50,000 _____

2. 60,000,000 _____

3. 0.000009 _____

4. 0.0004 _____

5. 461,000 _____

6. 0.0000000004 _____

7. 0.0000000607 _____

8. 0.00000027 _____

9. 51,200,000,000 _____

10. 150,000,000 _____

11. 210,000,000,000 _____

12. 0.00009 _____

13. 0.0000000000768 _____

14. 4,900,000,000,000 _____

15. 0.00000000605 _____

16. 1,080,000,000 _____

17. 0.000000000009 _____

18. 6,340,000 _____

19. 0.0000000336 _____

20. 0.000037 _____

21. 36,300,000,000 _____

22. 780,000,000 _____

23. 0.00000062 _____

24. 5,200,000 _____

25. 36,600,000 _____

26. 0.0000000578 _____

27. 5,000,000,000,000 _____

28. 0.00000000439 _____

29. 0.000802 _____

30. 24,000 _____

31. 646,000,000,000 _____

32. 0.00000679 _____

33. 630,000 _____

34. 7,000,000,000 _____

35. 0.0000000007 _____

36. 0.0000000000285 _____

37. 0.000000077 _____

38. 46,000 _____

Rewrite each number in decimal notation.

1. 7×10^7 _____

2. 5×10^{-4} _____

3. 8×10^{-5} _____

4. 2×10^6 _____

5. 9.77×10^4 _____

6. 2.1×10^{-12} _____

7. 8×10^8 _____

8. 2.03×10^{-9} _____

9. 4.3×10^{-7} _____

10. 8.13×10^9 _____

11. 2.6×10^{-6} _____

12. 8.4×10^{12} _____

13. 1.93×10^{10} _____

14. 9.48×10^5 _____

15. 8.27×10^{-8} _____

16. 2×10^{-10} _____

17. 4.33×10^{11} _____

18. 9.52×10^{-11} _____

19. 5.23×10^{-6} _____

20. 6.1×10^{-11} _____

21. 1.38×10^6 _____

22. 1.3×10^9 _____

23. 5.73×10^{-5} _____

24. 5×10^{11} _____

25. 7.53×10^{-4} _____

26. 2.8×10^{12} _____

27. 1.1×10^{-8} _____

28. 7×10^4 _____

29. 8.34×10^{-10} _____

30. 9.94×10^7 _____

31. 6.12×10^{-12} _____

32. 1.1×10^5 _____

33. 7.82×10^{-7} _____

34. 7.1×10^{10} _____

35. 4×10^4 _____

36. 5.6×10^{-9} _____

Part II - Significant Digits

Determine the number of significant digits in each of the following:

- | | |
|-------------------------------|----------------------------------|
| 1. 3427 _____ | 12. 30.0×10^{-2} _____ |
| 2. 0.00456 _____ | 13. 0.982×10^{-3} _____ |
| 3. 123,453 _____ | 14. 0.0473 _____ |
| 4. 172 _____ | 15. 650.502 _____ |
| 5. 0.000984 _____ | 16. 3.03×10^{-1} _____ |
| 6. 0.502 _____ | 17. 20.4×10^5 _____ |
| 7. 3100.0×10^2 _____ | 18. 1.29 _____ |
| 8. 0.0114×10^4 _____ | 19. 0.00565 _____ |
| 9. 107.2 _____ | 20. 1362205.2 _____ |
| 10. 0.0000455 _____ | 21. 450.0×10^3 _____ |
| 11. 2205.2 _____ | 22. 1000×10^{-3} _____ |

Round each of the following to 3 significant digits.

- | | |
|---------------------------------|----------------------------------|
| 1. 77.0653 _____ | 6. 707.5 _____ |
| 2. 6,300,178.2 _____ | 7. 2,300.2 _____ |
| 3. 0.00023350 _____ | 8. 0.0003350 _____ |
| 4. 10.2030 _____ | 9. 10.26730 _____ |
| 5. 2.895×10^{21} _____ | 10. 18.95×10^{21} _____ |

Part III - Calculations

Calculate the following. Give the answer in correct scientific notation and correct significant digits.

1. $(4.53 \times 10^5) + (2.2 \times 10^6)$

5. $(9.10 \times 10^3) + 2.2 \times 10^6$

2. $1913.0 - (4.6 \times 10^3)$

6. $1113.0 - (14.6 \times 10^2)$

3. $(2.34 \times 10^{24}) + (1.92 \times 10^{23})$

7. $(6.18 \times 10^{-45}) + (4.72 \times 10^{-44})$

4. $(2.130 \times 10^3) - (6.6 \times 10^2)$

8. $(4.25 \times 10^{-3}) - (1.6 \times 10^{-2})$

Calculate the following. Give the answer in correct scientific notation and correct significant digits.

1. $3.95 \times 10^2 / 1.5 \times 10^6$

5. $1.05 \times 10^{-26} / 4.2 \times 10^{56}$

2. $(3.5 \times 10^2)(6.45 \times 10^{10})$

6. $(2.5 \times 10^9)(6.45 \times 10^4)$

3. $4.44 \times 10^7 / 2.25 \times 10^5$

7. $6.022 \times 10^{23} / 3.011 \times 10^{-56}$

4. $(4.50 \times 10^{-12})(3.67 \times 10^{-12})$

8. $(6.88 \times 10^2)(3.45 \times 10^{-10})$

Part IV - Metric System

1. What is the metric unit for linear measurement? _____
2. What is the metric unit for volume measurement? _____
3. What is the metric unit for mass measurement? _____
4. Explain the difference between mass and weight.

5. Convert between metric units as indicated:

- | | |
|--------------------------|------------------------------------|
| a. 1.25 mm = _____ cm | n. 0.06 km = _____ cm |
| b. 4.56 cm = _____ mm | o. 4330 dg = _____ hg |
| c. 75.96 m = _____ mm | p. 75 dam = _____ hm |
| d. 0.0026 km = _____ mm | q. 0.76 dL = _____ daL |
| e. 0.0012 km = _____ m | r. 1.3×10^3 g = _____ dag |
| f. 7.25 m = _____ cm | s. 6.5 mm = _____ μ m |
| g. 98.26 mg = _____ g | t. 3.0 Mg = _____ kg |
| h. 0.082 cm = _____ m | u. 3250 μ m = _____ cm |
| i. 21.76 dL = _____ daL | v. 5.4×10^6 L = _____ ML |
| j. 43.7 hL = _____ dL | |
| k. 2.0155 daL = _____ hL | |
| l. 6.44 kg = _____ dg | |
| m. 2.087 hg = _____ kg | |

Appendix B

Effects of Heat Transfer

Introduction:

Heat can be transferred by conduction, convection and radiation. When matter is heated the particles gain thermal energy. Particles with greater thermal energy move faster, and when they collide, they move farther apart. This causes the material being heated to expand. Conversely, when matter is cooled, it loses thermal energy. Particles with less thermal energy move slower, collide less frequently, and move closer together. This causes the material being cooled to contract.

If the matter gaining thermal energy is a solid, the particles do not have the ability to move around. When the particles with increased thermal energy collide and move farther apart, the solid will undergo linear expansion.

If the matter gaining thermal energy is a fluid (a gas or a liquid), the particles have the ability to move around. When the particles with increased thermal energy collide and move farther apart, the fluid becomes less dense (lighter) and the particles rise. They are replaced by cooler particles from a neighbouring region of greater density. The continuous cycling of particles establishes convection currents.

Part I

Materials

- bimetallic strip
- bunsen burner (or other heat source)

Procedure



Follow strict safety procedures whenever an open flame is used.

1. Light the bunsen burner and hold the tip of the bimetallic strip in the flame. Observe what happens to the metals
2. Before it cools, hold the bimetallic strip under cold water. Observe what happens.

Analysis

- a) Describe what happens to the bimetallic strip in step 1. Explain what happened by applying the concept of conduction and expansion.
- b) Describe what happens to the bimetallic strip in step 2. Explain what happened by applying the concept of conduction.

Part II

Materials

- convection box
- touch paper (or paper towel)
- radiometer
- heat lamp
- candle

Procedure



Follow strict safety procedures whenever an open flame is used.

Steps 1 - 2 should be carried out in a fume hood.

1. Light the candle under one of the chimneys in the convection box.
2. Place the lit touch paper, or rolled up paper towel, over the other chimney. Observe what happens to the smoke.
3. Place the radiometer in strong sunlight or under a heat lamp. Observe what happens.

Analysis

- a) Describe what happens to the smoke in Step. Explain what happened by applying the concept of convection.
- b) Describe what happens in the radiometer in Step 3. Explain what happened by applying the concepts of radiation and convection.

Part III

Materials

- 2 Erlenmeyer flasks (125ml or 250ml), or 2 jars of equal size and shape
- hot and cold tap water
- plastic tub or tray
- red food colouring
- small piece of heavy paper (or plastic)

Procedure

1. Place the flasks in a waterproof container (plastic tub or container), or in a sink. Fill the flasks to overflowing, one flask with cold water and the other with hot water. Add several drops of red food colouring to the hot water.
2. Place the heavy paper on top of the flask of hot water and, holding the paper in place, carefully invert the flask.
3. Carefully place the flask of hot water on top of the flask of cold water so that their rims match exactly.
4. Carefully remove the piece of paper from between the two flasks and observe any mixing.
5. Repeat steps 2 - 4 with the flask containing the hot water on the bottom. Observe any mixing.

Analysis

- a) Describe the mixing that occurred when the hot water flask was on top of the cold water flask. Explain what happened.
- b) Describe the mixing that occurred when the cold water flask was on top of the hot water flask. Explain what happened.
- c) Account for the difference between observations a) and b).