

Adult Basic Education

Science

Science 3102

Simple Machines and Energy

Curriculum Guide

Prerequisites: None

Credit Value: 1

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 Instructor

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*, students are introduced to the Workplace Hazardous Materials Information System (WHMIS). They 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 students to the various types of simple machines and explores how machines are useful in both domestic and industrial settings. In unit 3, *Energy*, students learn about the various forms of energy and how energy is changed, or transformed, from one form to another. They 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. Instructors may add more labs and assignments if they wish.

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

To the Instructor

II. Curriculum Guides

Each new ABE Science course has a Curriculum Guide for the instructor and a Study Guide for the student. The Curriculum Guide includes the specific curriculum outcomes for the course. Suggestions for teaching, learning, and assessment are provided to support student achievement of the outcomes.

Each course is divided into units. Each unit comprises a **two-page layout of four columns** as illustrated in the figure below. In some cases the four-column spread continues to the next two-page layout.

Curriculum Guide Organization: The Two-Page, Four-Column Spread

Unit Number - Unit Title	Unit Number - Unit Title
Outcomes Specific curriculum outcomes for the unit.	Notes for Teaching and Learning Suggested activities, elaboration of outcomes, and background information.

Suggestions for Assessment	Resources
Suggestions for assessing students' achievement of outcomes.	Authorized and recommended resources that address outcomes.

To the Instructor

III. Study Guides

The Study Guide provides the student with the name of the text(s) required for the course and specifies the sections and pages that the student will need to refer to in order to complete the required work for the course. It guides the student through the course by assigning relevant reading and providing questions and/or assigning questions from the text or some other resource. Sometimes it also provides important points for students to note. (See the *To the Student* section of the Study Guide for a more detailed explanation of the use of the Study Guides.) The Study Guides are designed to give students some degree of independence in their work. Instructors should note, however, that there is much material in the Curriculum Guides in the *Notes for Teaching and Learning* and *Suggestions for Assessment* columns that is not included in the Study Guide and instructors will need to review this information and decide how to include it.

IV. Resources

Essential Resources

Nelson Physics 12: College Preparation; Hirsch, Alan J.; Nelson Thomson Canada; 2004. ISBN 0-17-626530-9

Nelson Physics 12: College Preparation Solutions Manual; Dick, Ricci, et al; Nelson Thomson Canada; 2004. ISBN 0-17-626972-X

Nelson Physics 12: College Preparation Teacher's Resource; Dick, Robinson, et al; Nelson Thomson Canada; 2004. ISBN 0-17-626532-5

Recommended Resources

Nelson Physics 12: College Preparation Workbook; Dick, Ricci, et al; Nelson Thomson Canada; 2004. ISBN 0-17-626531-7

Nelson Physics 12: College Preparation Computerized Assessment Bank; Brucker, McArdle, et al; ISBN 0-17-626535-X

To the Instructor

V. Recommended Evaluation

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

Simple Machines and Energy

Unit 1 - Science Skills

Outcomes

1.1 Describe the purpose and use of Workplace Hazardous Materials Information System (WHMIS).

1.1.1 Identify and differentiate each WHMIS hazard symbol.

1.1.2 Demonstrate WHMIS procedures for use, handling, and disposal of hazardous materials.

1.1.3 Locate specific information found on a Material Safety Data Sheet (MSDS).

Notes for Teaching and Learning

As an introduction to WHMIS, instructors should ask students:

What hazardous chemicals have you used either at home, school, or work?

Have you ever been injured or know of someone who has been injured by a hazardous chemical?

Why is knowledge and training in hazardous substances so important?

Instructors should show examples of items that contain a WHMIS label that may be found in the classroom or lab.

Instructors should distribute copies of MSDS sheets of some chemicals commonly used in the lab and discuss how they should be handled safely.

It is important for instructors to stress to students that an employer has responsibilities to ensure the safety of its employees. The employer must ensure that all equipment and materials (such as cleaning chemicals) are properly handled, stored and maintained and must teach employees how to store, handle, use, and dispose of any controlled material. Before they use an unknown substance, employees have the right to know what it is and the responsibility to find out how to use it.

Students who have completed Science 3101 were introduced to WHMIS and may remember something about it. However, they are still required to complete the assignment in this unit.

Unit 1 - Science Skills

Suggestions for Assessment

Assignment 1, *Introduction to WHMIS*, should be evaluated and assigned a mark which will be used as part of the overall final mark for the course. Students will find the information to complete the assignment within the assignment itself. Additional information can be found in Appendix B of the text. The outcomes covered in the assignment should **not** be included on written tests, as students will be assessed formatively in the lab and summatively in the assignment.

Note: Both the assignment and the answer key are found in the Appendix of this document.

Resources

Nelson Physics 12: College Preparation, Appendix B, pages 566 - 568.

Assignment 1, Introduction to WHMIS, Appendix A.

Unit 1 - Science Skills

Outcomes

1.2 Display an understanding of the metric system and SI units.

1.2.1 Identify the fundamental units of mass, length, and volume.

1.2.2 Recognize common metric prefixes and abbreviations.

1.2.3 Convert one metric unit of measure to another.

1.3 Demonstrate the correct use of scientific notation.

1.3.1 Recognize scientific notation as given on a calculator's display.

1.3.2 Express a decimal numeral in scientific notation and vice versa.

1.3.3 Perform calculations using values expressed in scientific notation.

1.4 Demonstrate the correct use of significant digits.

1.4.1 Determine which digits in a measurement are significant.

1.4.2 Express the answer to any arithmetic operation in the correct number of significant digits.

Notes for Teaching and Learning

Students should already have a background knowledge of the metric system, scientific notation, and significant digits. However, these skills are imperative for successful completion of Science 3102 and 3103 and it should not be assumed that students have previously attained proficiency. Instructors must ensure that students have mastered these basic skills before moving on in this course, as these skills will also be required in subsequent Science courses.

Unit 1 - Science Skills

Suggestions for Assessment

Assignment 2, *Science Skills*, should be evaluated and assigned a mark which will be used as part of the overall mark for the course. Students will find the information to complete the assignment in Appendices A and C of the text. This assignment includes practice problems in the areas of scientific notation, significant digits, and metric conversion. The outcomes should **not** be specifically included on written tests, as students will be assessed formatively in their written work and summatively in the assignment.

Note: Both the assignment and the answer key are found in the Appendix of this document.

Instructors are encouraged to provide additional worksheets and/or assignments to students who require more practice.

Resources

Nelson Physics 12: College Preparation, Appendix A, pages 546 - 548.

Nelson Physics 12: College Preparation, Appendix C, pages 572 - 573.

Assignment 2, Science Skills, Appendix A.

Unit 2 - Simple Machines

Outcomes

2.1 Describe types of simple machines; i.e. the lever and the inclined plane; and modifications of them.

2.1.1 Define and identify the functions of a machine.

2.1.2 Identify the two families of machines; the lever and inclined plane.

2.1.3 Define lever and identify parts of a lever. Include:

- i) fulcrum
- ii) effort force
- iii) load force
- iv) effort arm
- v) load arm

2.1.4 Describe the three classes of levers.

2.1.5 Describe other simple machines included in the lever family of machines. Include

- i) pulley
- ii) wheel and axle
- iii) gears

2.1.6 Describe how biomechanical systems can be understood as simple machines.

Notes for Teaching and Learning

This unit is meant to give students an introduction to machines. It focuses on simple machines and introduces the concept of compound machines. The only calculations that students will perform are in the Core Lab.

Instructors should make it clear to students that machines can be used whenever a force is needed, whether the force is very small or very large.

Unit 2 - Simple Machines

Suggestions for Assessment

Students are directed to complete the worksheet, *Classes of Levers*, to help them understand the differences between first, second, and third class levers. The worksheet is LSM 2.1-1 and it should be photocopied and given to students for question 2.6 (c) in the Study Guide.

Students are also directed in the Study Guide (question 2.8) to complete question 3 from the *Practice* on page 74.

LSM 2.1-2, *Identifying the Components of Levers*, should be photocopied and given to students for labelling to help them with this question.

Students may use the answer sheets provided on pages 39 - 40 in the *Workbook* when working on the *Try This Activity: Domestic Machines*.

Note: *Lab and Study Masters*, LSM's, and their solutions are found in the *Teacher's Resource*.

Resources

Nelson Physics 12: College Preparation, pages 68 - 80, 100 - 104.

LSM 2.1-1, Student Worksheet: Classes of Levers.

LSM 2.1-2, Student Worksheet: Identifying the Components of Levers.

Unit 2 - Simple Machines

Outcomes

2.1.7 Describe the simple machines included in the inclined plane family of machines. Include:

- i) inclined plane
- ii) wedge
- iii) screw

2.2 Investigate the relationship between force and distance for the load arm and effort arm of levers.

2.3 Identify applications of types of simple machines, including the lever, the inclined plane, and modifications of these.

Notes for Teaching and Learning

Outcome 2.2 is achieved by completion of **Core Lab #1: Investigation 2.2, Forces on Levers**. If possible, students should work in groups of two or more in the lab. There is an answer sheet in the *Workbook*, pages 29 - 30, which can be used by students as a Lab Report. Some of the data can be completed before starting the investigation. Students may need some guidance when trying to complete the table.

Although students likely have a wide variety of experiences with both domestic and industrial machines, they may not realize that many of the devices they have used in the past or use every day are either simple or compound machines.

Unit 2 - Simple Machines

Suggestions for Assessment

Instructors should review all the student answers to the questions in the *Study Guide* for this unit. Their written work should be assigned a mark to be used as part of the final evaluation for the course.

Instructors should also collect the student's lab report and assign a mark.

Note: An overall mark of 10% is recommended for the written work from the Study Guide, excluding lab reports and assignments. An overall mark of 20% is recommended for the labs and assignments.

Instructors may give a test on Unit 2 to cover the topic of simple machines. The mark obtained on the test would be used as part of the evaluation for the course.

Resources

Core Lab #1:

Nelson Physics 12: College Preparation, Investigation 2.2, Forces on Levers, pages 78 - 80.

Nelson Physics 12: College Preparation Workbook, Forces on Levers - Answer Sheet, pages 29 - 30.

Unit 3 - Energy

Outcomes

3.1 Describe various forms of energy.

3.1.1 Define energy.

3.1.2 Identify forms of energy.

Include:

- i) kinetic
- ii) chemical potential
- iii) gravitational potential
- iv) elastic potential
- v) electrical
- vi) radiant
- vii) sound
- viii) nuclear
- ix) thermal

3.2 Analyze energy transformations and energy-transforming technologies.

3.2.1 Define energy transformation and energy-transforming technology.

3.2.2 Describe, using energy-transformation equations, various energy transformations.

3.2.3 State the Law of Conservation of Energy.

Notes for Teaching and Learning

Students are introduced to forms of energy and energy transformations. Energy is defined as the capacity to do work. Students should also realize that the converse is true; when “work” is done, energy is transformed. Instructors should make sure that students understand that the meaning of the word work in the context of Physics is not the same as its meaning in everyday life.

Students are expected to know what the Law of Conservation of Energy states and realize that it applies to all energy transformations. However, they are not expected to be able to apply it to energy transformation equations.

Unit 3 - Energy

Suggestions for Assessment

Instructors should review all the student answers to the questions in the *Study Guide* for this unit. Their written work should be assigned a mark to be used as part of the final evaluation for the course.

LSM 3.1-1 can be used for review of some of the terms in this unit.

Resources

Nelson Physics 12: College Preparation, pages 128 - 131, 149 - 154.

LSM 3.1-1, Energy Forms and Transformations.

Unit 3 - Energy

Outcomes

3.3 Describe the relationship between thermal energy, heat and temperature.

3.3.1 Define heat and temperature.

3.3.2 Distinguish between thermal energy, heat, and temperature.

3.4 Analyze methods of heat transfer.

3.4.1 Define and describe conduction, convection, and radiation.

Notes for Teaching and Learning

It needs to be made clear to students that although they probably have used the terms thermal energy and heat synonymously, they are not the same thing. Students have already been introduced to thermal energy earlier in this unit. Now they will examine it in more detail and learn to distinguish it from heat. They will also learn how both thermal energy and heat are related to temperature.

Students are required to complete **Core Lab #2: Effects of Heat Transfer**. If possible, students should work in groups of two or more in the lab. In Part I, students should explain that heat is transferred through the bimetallic strip by conduction and that heat causes the metals on the bimetallic strip to expand at different rates. Part II of the investigation is based on the *Try This Activity* on page 151 of the text. Explanations of the observations can be found on page 120 of the Solutions Manual. In Part III, when the hot-water flask is on top, nothing happens. When the cold-water flask is on top, a convection current is created since the cold water is heavier than the hot water and sinks pushing the hot water to the top flask.

Instructors may do all or parts of **Core Lab #2** as a demonstration and ask students to complete the Analysis.

Unit 3 - Energy

Suggestions for Assessment

It is suggested that students complete the Analysis portion of the lab as their lab report, using the sheets provided in Appendix B of the Study Guide. Instructors should collect the student's lab report and assign a mark that is used as part of the evaluation for the course.

Resources

Core Lab #2, *Effects of Heat Transfer*, Appendix B.

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? _____

Worksheet 1 continued

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



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 tem
- 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 A



Class B



Class C



Class D



Class E



Class F



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



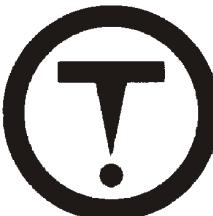
B



C



D1



D2



D3



E



F

_____ Poisonous Materials

_____ Compressed Gas

_____ Dangerously Reactive Materials

_____ Flammable and Combustible Materials

_____ Toxic Materials

_____ Oxidizing Materials

_____ Bio-Hazardous/Infectious Materials

_____ Corrosive Materials

Worksheet 3b: WHMIS Product Classification and Hazard Symbols - Quiz

Exercise

Complete Part I of the WHMIS Quiz by checking off situations that apply to you. Then complete Part II of the quiz by using the classes and symbols information provided earlier.

Part 1

Instructions: Please a check before all questions you would answer “yes” to.

Part II

Using your classes and symbols information, identify the appropriate WHMIS Class

WHMIS Class

<input type="checkbox"/> 1. Have you ever used rat poisoning?	_____
<input type="checkbox"/> 2. Have you ever used bleach?	_____
<input type="checkbox"/> 3. Have you ever used a propane barbecue?	_____
<input type="checkbox"/> 4. Have you ever used a Bunsen burner?	_____
<input type="checkbox"/> 5. Have you ever picked up an old battery?	_____
<input type="checkbox"/> 6. Have you ever filled your car up with gas?	_____
<input type="checkbox"/> 7. Have you ever painted with oil paints?	_____
<input type="checkbox"/> 8. Have you ever sat in your car while it was running?	_____
<input type="checkbox"/> 9. Have you ever touched raw chicken?	_____
<input type="checkbox"/> 10. Have you ever used nail polish remover?	_____
<input type="checkbox"/> 11. Have you ever changed a lantern mantle?	_____

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 may 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)?

* 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 APPARATUS SHOULD BE
WORN IN A FIRE INVOLVING THIS MATERIAL.
FLASH POINT(C), TAG CLOSED-CUP..... >42.
(CONCENTRATION)
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.
SEE SECTION II.

IRRITANCY OF MATERIAL.....

SLIGHT.

SENSITIZING CAPABILITY OF MATERIAL.....

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 from entering a watercourse.

HANDLING PROCEDURES AND EQUIPMENT.....
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 worker 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 1
Introduction to WHMIS

Answer Key

Answer Key for Worksheet 1: WHMIS - An Introduction Quiz

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 in the background notes.) **Students should mention items such as the employer needed to use proper workplace labels, provide workers with training in WHMIS, have MSDSs available to the worker, have competent supervisors, and so on.**

2. (a) WHMIS stands for: **Workplace Hazardous Materials Information System**

(b) What is WHMIS? **A national information system which provides information about any materials that pose a risk or hazard in the workplace.**

(c) What does WHMIS require suppliers, employers and workers to do? **It requires suppliers, employers and workers to use the system to identify and handle hazardous materials safely.**

3. Do WHMIS laws differ across Canada? **The law does not differ.**

4. What is a hazardous material? **A hazardous material is any substance that can cause illness, disease or death to unprotected people.**

5. What are the three main parts of WHMIS? **Labels, Material Safety Data Sheets (MSDSs), and worker education.**

6. Hazards identified in the WHMIS system can come from: (Place a mark by those that are right.) **(All except c) reading and g) seeing**

| | |
|--|--|
| a. <input type="checkbox"/> fire | e. <input type="checkbox"/> inhalation |
| b. <input type="checkbox"/> skin contact | f. <input type="checkbox"/> ingestion |
| c. <input type="checkbox"/> reading | g. <input type="checkbox"/> seeing |
| d. <input type="checkbox"/> explosion | |

7. How bad a hazard is usually depends on one or more of the following: (Mark the answers that you think are correct.) **(The following should be checked a, d, e, f, and g)**

| | |
|---|---|
| a. <input type="checkbox"/> the amount of material | e. <input type="checkbox"/> how great the pressure is |
| b. <input type="checkbox"/> the month of the year | f. <input type="checkbox"/> how easily the material burns or explodes |
| c. <input type="checkbox"/> the manufacturer | g. <input type="checkbox"/> how concentrated the material is |
| d. <input type="checkbox"/> how toxic the material is | h. <input type="checkbox"/> your elevations |

Answer Key for Worksheet 2: WHMIS - Responsibilities and Labels Quiz

1. Who are the three main WHMIS participants? **Suppliers, employers and workers**

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

E a) provide training on how to use WHMIS
ME b) learn how to use WHMIS
E c) provide training on procedures for the safe use, storage and handling of the hazardous materials on site
ME d) learn how and follow procedures for the safe use, storage and handling of the hazardous materials on site
ME e) recognize special color, number or letter codes on pumps, pipes and vessels carrying hazardous materials
E f) develop emergency procedures and supply training to follow tem
E 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 | b | check materials as they arrive from suppliers |
| b. | Make sure materials are labeled | c | keep MSDSs handy on site |
| c. | Provide information | d | provide step-by-step training on the use, handling, storage or disposal of hazardous materials |
| d. | Develop procedures | e | explain how to do things at a safety or staff meeting |
| e. | Train workers | c | place WHMIS posters on the job board for easy reference |
| | | e | show and practice what to do in an emergency |
| | | a | post a list of all hazardous materials on the site |

Answer Key for Worksheet 3a: Match the WHMIS Symbols



A



B

D1 Poisonous Materials



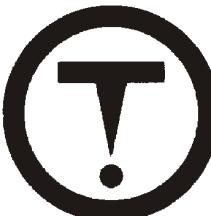
C



D1

A Compressed Gas

F Dangerously Reactive Materials



D2



D3

D2 Toxic Materials

C Oxidizing Materials



E.



F

D3 Bio-Hazardous/Infectious Materials

E Corrosive Materials

Answer Key for Worksheet 3b: WHMIS Product Classification and Hazard Symbols Quiz

Exercise

Complete Part I of the WHMIS Quiz by checking off situations that apply to you. Then complete Part II of the quiz by using the classes and symbols information provided earlier.

Part 1

Instructions: Please a check before all questions you'd answer "yes" to. **Answers will vary.**

Part II

Using your classes and symbols information, identify the appropriate WHMIS Class

WHMIS Class

| | |
|--|---------------|
| 1. Have you ever used rat poisoning? | D |
| 2. Have you ever used bleach? | D or E |
| 3. Have you ever used a propane barbecue? | B |
| 4. Have you ever used a Bunsen burner? | B |
| 5. Have you ever picked up an old battery? | E |
| 6. Have you ever filled your car up with gas? | B |
| 7. Have you ever painted with oil paints? | B or D |
| 8. Have you ever sat in your car while it was running? | D |
| 9. Have you ever touched raw chicken? | D |
| 10. Have you ever used nail polish remover? | B or D |
| 11. Have you ever changed a lantern mantle? | F |

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

1. How many sections must be provided on a MSDS? **9 sections**
2. What is the title of the section of the MSDS that tells who to contact if you have questions about the products? **product identification and use**
3. Which section of the MSDS lists the special protective measures you can take to avoid harmful contact with the products? **preventative measures**
4. How often must a MSDS be updated? **every three years or 90 days after a new hazard information becomes known**

Answer Key for Worksheet 4b: Using Material Safety Data Sheets

WD40

1. What is the telephone number of the supplier? Under what section of the MSDS did you find this information?

Look up Product Identification to find the contact information. The emergency number is (613) 996-6666.

2. What problems can occur if you get WD40 in your eyes? Under what section of the MSDS did you find this information?

Look in Toxicological Properties. WD40 may cause eye irritation.

3. What should you do if you get WD40 in your eyes? What could you have done to prevent it from happening?

Flush eyes immediately with plenty of water for at least 15 minutes. Then get medical attention. You could have worn safety glasses when using this product.

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

Proper ventilation if used frequently indoors.

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

No, the ingredients are not listed as carcinogens.

Answer Key for Worksheet 5: Control of Hazardous Materials

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

inhalation, ingestion, and absorption

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

Acute effects occur immediately or shortly after exposure. Immediate death can sometimes result. Chronic effects show up years later. By that time the worker may have had many exposures.

3. What is sensitization?

Sensitization is when the body reacts strongly to defend against exposure. A low level of exposure will cause a strong reaction.

4. What is a control measure?

Something that prevents workers from becoming ill or being injured.

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

First, at the source: eliminate the hazardous material or substitute a less hazardous material.

Second, in the pathway: barriers can be used to keep a hazard away.

Third, at the worker level: workers can use personal protective equipment to keep exposure to hazardous materials below the allowable exposure limit.

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. 0.000000000768 _____

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

15. 0.0000000605 _____

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. 0.00000000578 _____

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

28. 0.000000000439 _____

29. 0.000802 _____

30. 24,000 _____

31. 646,000,000,000 _____

32. 0.00000679 _____

33. 630,000 _____

34. 7,000,000,000 _____

35. 0.00000000007 _____

36. 0.0000000000285 _____

37. 0.0000000077 _____

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. 3.0×10^{-2} _____

2. 0.00456 _____

13. 9.82×10^{-3} _____

3. 123,453 _____

14. 0.0473 _____

4. 172 _____

15. 650.502 _____

5. 0.000984 _____

16. 3.03×10^{-1} _____

6. 0.502 _____

17. 2.04×10^5 _____

7. 3.100×10^5 _____

18. 1.29 _____

8. 1.14×10^4 _____

19. 0.00565 _____

9. 107.2 _____

20. 1362205.2 _____

10. 0.0000455 _____

21. 4.5×10^3 _____

11. 2205.2 _____

22. 1.0×10^{-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 | |

Assignment 2

Science Skills

Answer Key

Part I - Scientific Notation

Rewrite each number in scientific notation

1. 50,000 5×10^4

2. 60,000,000 6×10^7

3. 0.000009 9×10^{-6}

4. 0.0004 4×10^{-4}

5. 461,000 4.61×10^5

6. 0.000000004 4×10^{-10}

7. 0.0000000607 6.07×10^{-8}

8. 0.00000027 2.7×10^{-7}

9. 51,200,000,000 5.12×10^{10}

10. 150,000,000 1.5×10^8

11. 210,000,000,000 2.1×10^{11}

12. 0.00009 9×10^{-5}

13. 0.000000000768 7.68×10^{-11}

14. 4,900,000,000,000 4.9×10^{12}

15. 0.0000000605 6.05×10^{-9}

16. 1,080,000,000 1.08×10^9

17. 0.00000000009 9×10^{-12}

18. 6,340,000 6.34×10^6

19. 0.000000336 3.36×10^{-8}

20. 0.000037 3.7×10^{-5}

21. 36,300,000,000 3.63×10^{10}

22. 780,000,000 7.8×10^8

23. 0.00000062 6.2×10^{-7}

24. 5,200,000 5.2×10^6

25. 36,600,000 3.66×10^7

26. 0.00000000578 5.78×10^{-9}

27. 5,000,000,000,000 5×10^{12}

28. 0.00000000439 4.39×10^{-10}

29. 0.000802 8.02×10^{-4}

30. 24,000 2.4×10^4

31. 646,000,000,000 6.46×10^{11}

32. 0.00000679 6.79×10^{-6}

33. 630,000 6.3×10^5

34. 7,000,000,000 7×10^9

35. 0.0000000007 7×10^{-11}

36. 0.0000000000285 2.85×10^{-12}

37. 0.000000077 7.7×10^{-9}

38. 46,000 4.6×10^4

Rewrite each number in decimal notation.

1. 7×10^7 70,000,000

2. 5×10^{-4} 0.0005

3. 8×10^{-5} 0.00008

4. 2×10^6 2,000,000

5. 9.77×10^4 97,700

6. 2.1×10^{-12} 0.000000000021

7. 8×10^8 800,000,000

8. 2.03×10^{-9} 0.0000000203

9. 4.3×10^{-7} 0.00000043

10. 8.13×10^9 8,130,000,000

11. 2.6×10^{-6} 0.0000026

12. 8.4×10^{12} 8,400,000,000,000

13. 1.93×10^{10} 19,300,000,000

14. 9.48×10^5 948,000

15. 8.27×10^{-8} 0.0000000827

16. 2×10^{-10} 0.0000000002

17. 4.33×10^{11} 433,000,000,000

18. 9.52×10^{-11} 0.000000000952

19. 5.23×10^{-6} 0.00000523

20. 6.1×10^{-11} 0.00000000061

21. 1.38×10^6 1,380,000

22. 1.3×10^9 1,300,000,000

23. 5.73×10^{-5} 0.0000573

24. 5×10^{11} 500,000,000,000

25. 7.53×10^{-4} 0.000753

26. 2.8×10^{12} 2,800,000,000,000

27. 1.1×10^{-8} 0.000000101

28. 7×10^4 70000

29. 8.34×10^{-10} 0.00000000834

30. 9.94×10^7 99,400,000

31. 6.12×10^{-12} 0.000000000612

32. 1.1×10^5 110,000

33. 7.82×10^{-7} 0.000000782

34. 7.1×10^{10} 71,000,000,000

35. 4×10^4 40,000

36. 5.6×10^{-9} 0.000000056

Part II - Significant Digits

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

| | |
|---------------------------------|------------------------------------|
| 1. 3427 <u>4</u> | 12. 3.0×10^{-2} <u>2</u> |
| 2. 0.00456 <u>3</u> | 13. 9.82×10^{-3} <u>3</u> |
| 3. 123,453 <u>6</u> | 14. 0.0473 <u>3</u> |
| 4. 172 <u>3</u> | 15. 650.502 <u>6</u> |
| 5. 0.000984 <u>3</u> | 16. 3.03×10^{-1} <u>3</u> |
| 6. 0.502 <u>3</u> | 17. 2.04×10^5 <u>3</u> |
| 7. 3.100×10^5 <u>4</u> | 18. 1.29 <u>3</u> |
| 8. 1.14×10^4 <u>3</u> | 19. 0.00565 <u>3</u> |
| 9. 107.2 <u>4</u> | 20. 1362205.2 <u>8</u> |
| 10. 0.0000455 <u>3</u> | 21. 4.5×10^3 <u>2</u> |
| 11. 2205.2 <u>5</u> | 22. 1.0×10^{-3} <u>2</u> |

Round each of the following to 3 significant figures.

1. 77.0653 **77.1**
2. 6,300,178.2 **6.30 \times 10^6**
3. 0.00023350 **2.34 \times 10^{-4}**
4. 10.2030 **10.2**
5. 2.895×10^{21} **2.90 \times 10^{21}**
6. 707.5 **7.08 \times 10^2**
7. 2,300.2 **2.30 \times 10^3**
8. 0.0003350 **3.35 \times 10^{-4}**
9. 10.26730 **10.3**
10. 18.95×10^{21} **1.90 \times 10^{22}**

Part III - Calculations

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

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

2.7 $\times 10^7$

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

2.2 $\times 10^6$

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

-2.7 $\times 10^3$

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

-3.47 $\times 10^2$

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

2.53 $\times 10^{24}$

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

5.34 $\times 10^{-44}$

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

1.5 $\times 10^3$

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

-1.2 $\times 10^{-2}$

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

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

2.6 × 10⁻⁴

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

2.5 × 10⁻⁸³

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

2.3 × 10¹³

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

1.6 × 10¹⁴

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

1.97 × 10²

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

2.000 × 10⁷⁹

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

1.65 × 10⁻²³

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

2.37 × 10⁻⁷

Part IV - Metric System

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

Mass is the amount of matter in an object while weight is the force that results from the action of gravity on matter.

5. Convert between metric units as indicated:

- a. $1.25 \text{ mm} = \underline{\text{0.125}} \text{ cm}$
- b. $4.56 \text{ cm} = \underline{\text{45.6}} \text{ mm}$
- c. $75.96 \text{ m} = \underline{\text{75960}} \text{ mm}$
- d. $0.0026 \text{ km} = \underline{\text{2600}} \text{ mm}$
- e. $0.0012 \text{ km} = \underline{\text{1.2}} \text{ m}$
- f. $7.25 \text{ m} = \underline{\text{725}} \text{ cm}$
- g. $98.26 \text{ mg} = \underline{\text{0.09826}} \text{ g}$
- h. $0.082 \text{ cm} = \underline{\text{0.00082}} \text{ m}$
- i. $21.76 \text{ dL} = \underline{\text{0.2176}} \text{ daL}$
- j. $43.7 \text{ hL} = \underline{\text{43700}} \text{ dL}$
- k. $2.0155 \text{ daL} = \underline{\text{0.20155}} \text{ hL}$
- l. $6.44 \text{ kg} = \underline{\text{64400}} \text{ dg}$
- m. $2.087 \text{ hg} = \underline{\text{0.2087}} \text{ kg}$
- n. $06 \text{ km} = \underline{\text{6000}} \text{ cm}$
- o. $4330 \text{ dg} = \underline{\text{4.330}} \text{ hg}$
- p. $75 \text{ dam} = \underline{\text{7.5}} \text{ hm}$
- q. $0.76 \text{ dL} = \underline{\text{0.0076}} \text{ daL}$
- r. $1.3 \times 10^3 \text{ g} = \underline{\text{1.3}} \times \underline{\text{10}^2} \text{ dag}$
- s. $6.5 \text{ mm} = \underline{\text{0.0065}} \text{ } \mu\text{m}$
- t. $3.0 \text{ Mg} = \underline{\text{3000}} \text{ kg}$
- u. $3250 \text{ } \mu\text{m} = \underline{\text{0.3250}} \text{ cm}$
- v. $5.4 \times 10^6 \text{ L} = \underline{\text{5.4}} \times \underline{\text{10}^{12}} \text{ ML}$

Appendix B

Core Lab # 2

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 (the opposite of expand).

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 concepts 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 2. 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).