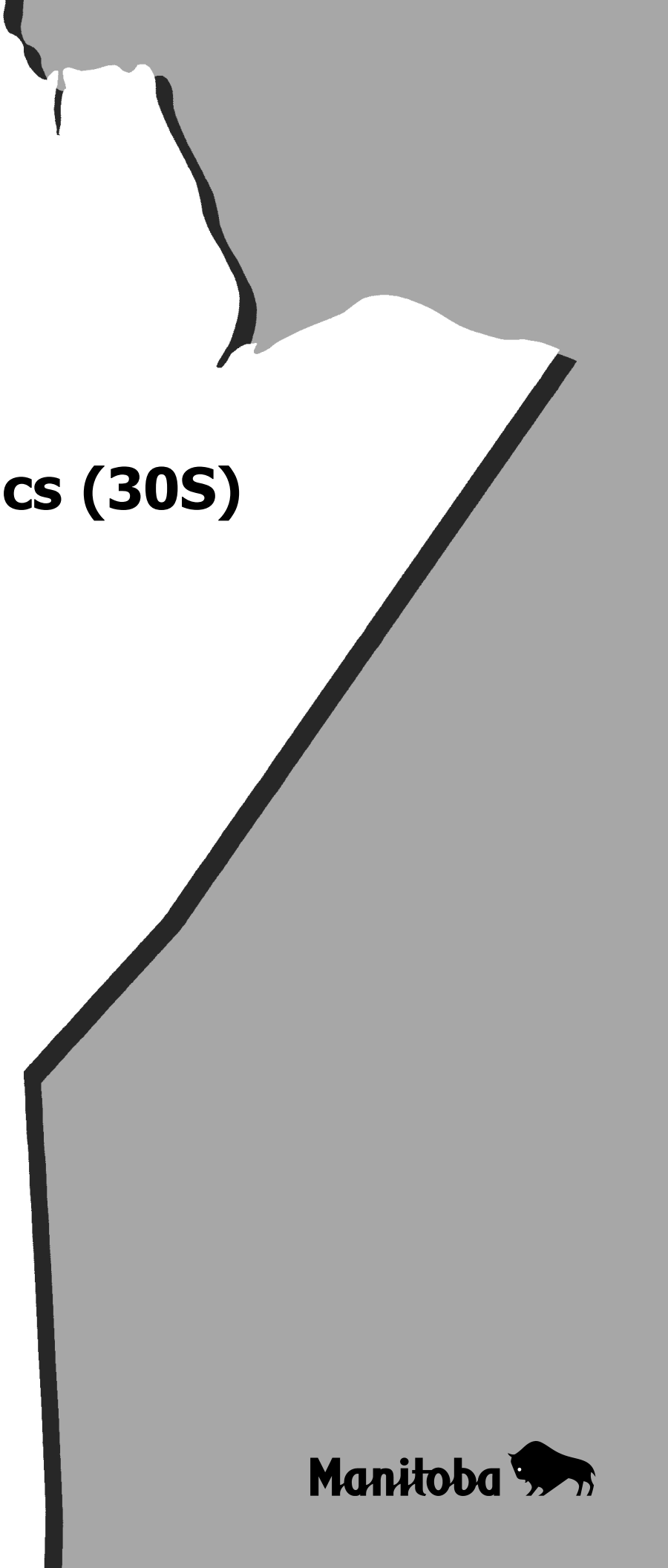
Grade 11 Physics (30S)

A Course for
Independent Study



Manitoba

GRADE 11 PHYSICS (30S)

A Course for
Independent Study

2010
Manitoba Education

Manitoba Education Cataloguing in Publication Data

Grade 11 physics (30S) : a course for independent study.

ISBN-13: 978-0-7711-4592-6

1. Physics—Study and teaching (Secondary).
2. Physics—Programmed Instruction. 3. Physics—Study and teaching (Secondary)—Manitoba. I. Manitoba. Manitoba Education.
510.76

Manitoba Education
School Programs Division
Winnipeg, Manitoba, Canada

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ACKNOWLEDGEMENTS

Manitoba Education gratefully acknowledges the contributions of the following individuals in the development of *Grade 11 Physics (30S): A Course for Independent Study*.

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INTRODUCTION

GRADE 11 PHYSICS: A COURSE FOR INDEPENDENT STUDY

Introduction

Overview

Welcome to Grade 11 Physics!

Grade 11 Physics deals with basic concepts that will form the foundation concepts necessary for you to study physics in the future. You have already studied many concepts in physics. For example, in Grade 9 Science you studied electricity. In Grade 10 Science you studied motion of vehicles and passengers, specifically how and why they move. We will be referring to concepts that you have studied in the past as the new concepts that you will be studying are introduced. In turn, the concepts that you learn in Grade 11 Physics will prepare you for Grade 12 Physics.

This course is divided into four major topics. Each topic contains two or three modules, organized as follows:

Topic 1: Mechanics

- Module 1: Kinematics
- Module 2: Vectors
- Module 3: Dynamics

Topic 2: Fields

- Module 4: Gravitational Fields
- Module 5: Electric Fields
- Module 6: Magnetic Fields and Electromagnetism

Topic 3: Waves

- Module 7: Waves in One Dimension
- Module 8: Waves in Two Dimensions

Topic 4: Sound and Light

- Module 9: Sound
- Module 10: Models, Laws, and Theories, and the Nature of Light

What Will You Need?

In order to complete this course, you should have access to the following:

- **The Grade 11 Physics (30S) Laboratory Activities DVD:** This DVD contains seven laboratory activities that you need to view and complete as assignments. It also contains four optional laboratory activities that you may complete for enrichment. You can obtain a copy of this DVD by contacting the Independent Study Option (ISO) at 1-800-465-9915 and asking for #DV-0040.
- **Equipment to view the DVD:** This could be a DVD player or a computer with a DVD drive.
- **A Computer with Internet Access (optional):** If you do not have a computer with Internet access, you will still be able to complete the course but you need to use alternative ways of accessing the required information.
- **A Computer with a Spreadsheet program (such as Microsoft Excel):** This is not a requirement, but it would be a useful resource.
- **A Computer with Graphical Analysis:** Graphical analysis software helps you produce and analyze graphs. If you do not already have access to this software and you are attending school, ask your school's ISO Facilitator how you can obtain access. If you are not attending school, phone the Independent Study Option offices at 1-800-465-9915, and a copy will be mailed to you.
- **A Calculator:** We recommend that you use a non-programmable, non-graphing calculator as you work on this course because this is the kind of calculator you will be allowed to use while you complete your exams. In other words, you will not be allowed to use a programmable calculator such as the TI-83 while you write your exams.

Note: You do not need a textbook to complete this course. All of the content you will need is in this package and the course's DVD.

If you do not have access to one or more of these resources, contact your tutor/marker.

How Will You Know How You're Doing?

You will know how well you are learning by how well you complete the following things:

Midterm and Final Exams

The course contains a midterm exam and a final exam. You will write them both under supervision. The midterm exam is based on Modules 1 to 6 and is worth 20% of the final mark of the course. You will write it when you have completed Module 6.

The final exam is worth a total of 30% of your final mark. Most of it (25% of your final mark) is based on Modules 7 to 10. A small portion of it (5% of your final mark) is based on Modules 1 to 6. You will complete it when you have completed Module 10.

You will be allowed to use a calculator to write your exam, but you will not be allowed to use a programmable calculator such as a TI-83. The calculator that you bring with you should be a **non-programmable, non-graphing calculator**.

In order to write your exams, you will need to apply for them. **If you are attending school**, ask your school's ISO Facilitator to add your name to the ISO exam eligibility list. Do this at least three weeks prior to the next scheduled exam week. **If you are not attending school**, check the **Examination Request Form** for options available to you. The Examination Request Form was mailed to you with this course. Fill in this form and mail or fax it three weeks before you are ready to write your exam. The address is:

ISO Registration
555 Main Street
Winkler, MB R6W 1C4
Fax: 204-325-1719
Phone: 1-800-465-9915

Optional Practice Exams

To help you prepare to write your midterm and final exams, we have provided optional practice midterm and final exams and their answer keys. These exams follow a similar format to the actual exams that you will be writing, so we strongly recommend that you complete them and check your answers. That will increase your chance of doing well on your exams. You can download them here: http://www.edu.gov.mb.ca/k12/dl/downloads/index.html.

If you are unable to download the Optional Practice Exams and their keys, phone the Independent Study Option at 1-800-465-9915.

Assignments

Most modules contain assignments that you will be sending to your tutor/marker for assessment. They are found in most lessons and are worth a total of 50% of your final mark.

What is a Typical Lesson Like?

The lessons in this course contain the following parts:

- **Learning Outcomes:** These are the learning outcomes for Grade 11 Physics prescribed by Manitoba Education, Citizenship and Youth. Learning outcomes are the things a student should have accomplished upon completion of the lesson.
- **Key Words:** This section contains a list of the important words that will be used throughout the lesson.
- **Introduction:** The introduction sets the stage for the lesson. It may draw upon prior knowledge or briefly describe the organization of the lesson.
- **Body of the Lesson:** The body of the lesson develops the concepts. It contains explanations, diagrams, and fully completed examples.
- **Learning Activity:** Most lessons have one or more learning activities. These include questions that you should complete in order to help you practice or review what you have just learned. Once you have completed a learning activity, check your answers with the key at the end of the module.
- **Lesson Summary:** The summary briefly describes the concepts that were developed within the lesson.
- **Assignments:** Assignments are found at the end of most lessons. In total, all assignments will be worth a total of 50% of your final mark. You will send these to your tutor/marker at the end of every module or every second module.

What if You Need Help?

The following two people can help you be successful in your course:

Your Tutor/Marker

Tutor/markers are experienced teachers who tutor ISO students and mark assignments and exams. If you are having difficulty at any time during this course, be sure to contact your tutor/marker. They are there to help you. If you are not sure how to contact your tutor/marker, phone the Independent Study Option at 1-800-465-9915.

Your Learning Partner

A learning partner (or "study buddy") is **someone you choose** to help you learn. It may be someone who knows something about physics, but it doesn't have to be. A learning partner could be someone else who is taking this course, a teacher, parent, sibling, or a friend, or anybody else who can help you. Most importantly, a learning partner should be someone you feel comfortable with and will support you as you work through this course.

Your learning partner can help you keep on schedule, check your work, help you make sense of assignments, read your course with you, or look at your learning activities and respond to them. You may even study for your exam with your learning partner.

How Much Time Will You Need?

Learning through independent study has several advantages over learning in the classroom. You are in charge of how you learn and can choose how quickly you will complete the course. You don't have to wait for your teacher or classmates, and you can work as quickly as you want. You can also complete as many lessons at a time as you want. We really want you to succeed. Read the next few pages to get an idea of how to pace yourself.

Why is the Course so Large?

This course seems larger than it actually is. Remember that this course package includes all the things that you would find in a regular face-to-face physics course taught in a classroom, such as the following:

- all the information that is normally found in a textbook
- all the notes that a teacher would hand out in class
- all the assignments that a teacher would hand out in class
- all the learning activities that a teacher would hand out in class, along with the answer keys
- all the explanations and instructions that a teacher would either say or write on a blackboard or whiteboard

This course also contains many diagrams and graphs, which tend to take up more room than straight text. This makes the course seem larger than it actually is.

In other words, even though there are many pages to this course, it should not take you more time to complete than if you were learning Grade 11 Physics in a classroom. You will be spending at least 45 minutes per school day to complete the course in a regular school year, or at least at least 90 minutes daily in a semester. Look at the following three charts and decide which chart best describes the time of year when you want to cover the course. This will help you plan its completion on time.

Chart A: Semester 1

Here is a suggested timeline that you can follow if you start your course in September and need to complete it by the end of January.

Module	Completion Date
Module 1	September 15
Module 2	September 30
Module 3	October 10
Module 4	October 20
Module 5	October 30
Module 6 and Midterm Exam	November 12
Module 7	November 25
Module 8	December 5
Module 9	December 20
Module 10 and Final Exam	January 15

Chart B: Semester 2

Here is a suggested timeline that you can follow if you start your course in January and need to complete it by June.

Module	Completion Date
Module 1	February 10
Module 2	February 24
Module 3	March 10
Module 4	March 25
Module 5	April 15
Module 6 and Midterm Exam	April 29
Module 7	May 11
Module 8	May 25
Module 9	June 5
Module 10 and Final Exam	June 15

Chart C: Full School Year (Not Semestered)

Here is a suggested timeline you can follow if you have registered for this course in September and would like to complete it by June.

Module	Completion Date
Module 1	September 25
Module 2	October 15
Module 3	November 5
Module 4	November 20
Module 5	December 20
Module 6 and Midterm Exam	January 15
Module 7	February 15
Module 8	March 15
Module 9	April 15
Module 10 and Final Exam	May 31

Do not wait until the last minute to complete your work, since your tutor/marker may not be available to mark it. Make sure that you leave enough time for your work to travel through the mail, as it might take over a week. It may also take a few weeks for your tutor/marker to mark everything and send the marks to your school.

If you need this course to graduate this school year, remember to schedule and complete your final exam by June 1.

When Do You Send in Your Assignments?

You'll be emailing your assignments to your tutor/marker as soon as you have completed them. Each time you mail something, you must include the Module Cover Sheet. Here is a chart showing exactly what you will be mailing in at the end of each module.

Module	Completion Date
Module 1	All assignments in Module 1
Module 2	All assignments in Module 2
Modules 3 and 4	All assignments in Modules 3 and 4
Modules 5 and 6	All assignments in Modules 5 and 6
Modules 7 and 8	All assignments in Modules 7 and 8
Modules 9 and 10	All assignments in Modules 9 and 10

What are the Guide Graphics For?

Graphics have been placed inside the margins of the course to identify a specific task. Each graphic has a specific purpose to guide you. A description of each graphic is described below:

- Assignment: This is an assignment that you complete and send to your tutor/marker. You will be sending in your assignments at the end of every module or every second module.
- Internet: If you have access to the Internet, you can use it to get more information. Internet access is optional.
- Learning Activity: Complete this learning activity to help you review or practice what you have learned and prepare for your assignment and exam. You will not send learning activities to your tutor/marker.

- Learning Partner: Ask your learning partner to help you with this task.
- Mail-in: It is now time to mail in your assignments.
- Time: This icon gives you an approximate idea of the amount of time you will need to complete this lesson or assignment. The actual time that it takes to complete an assignment varies from student to student, so these are just rough guides. If you find that you have completed an assignment in much less time than is listed on the icon, then you may need to spend more time on it. If you find that you are spending much more time than indicated, it may be time to move on.
- Video Lab: This is an assignment that you will complete by watching a lab on DVD and completing a lab report.
- Exam Preparation: This icon refers to content in the course that is likely to be found on either the midterm or final exam, so make sure you learn it well.

What are Learning Activities?

Learning activities are not assessed. You simply complete them and check your answers yourself (the answer keys are found at the end of the module). **Do not email learning activities to your tutor/marker.**

Make sure you complete each learning activity, as it will help you practice what you have learned and prepare you to successfully complete your assignments and exams.

What is the Lesson Focus?

The lesson focus is the part of the course that describes what you will be learning. It includes a list of the lesson's specific learning outcomes (SLOs) along with their individual numbers (which look something like SLO 1.2.3). The SLO numbers are for teachers, so you can ignore them.

Please note that all other assignments have a marking rubric or answer key right after them. Your tutor/marker will use these to assess your assignment. They will help you complete your assignment and receive the best mark possible. Assignment 1.1 does not have one because it does not lend itself to one.

A Note to Classroom Teachers Using this Course as a Resource

The SLOs for each lesson are listed in Appendix D, which is found at the end of this course.

NOTES

LESSON 1: INTRODUCTION TO PHYSICS (2 HOURS)

Learning Outcomes

When you have completed this lesson, you should be able to

- ❑ describe what physics is
- ❑ list and describe the four modes of representation
- ❑ describe a relationship among variables using the four modes of representation

Key Words

physics	visual mode	numerical mode
graphical mode	symbolic mode	variables
independent variable	dependent variable	constant
line of best fit	slope	

Introduction

This first lesson will provide you with a description of the meaning of physics, which is not as easy as it might seem. This lesson will also examine the different ways that we look at things in physics. One way of describing things in physics is to use equations. Your understanding of the concepts of physics will come from analyzing a situation using a variety of methods that we call **modes of representation**. It is only through the process of looking at a situation from a variety of angles (or "modes") that a full understanding can be achieved. This course will employ a variety of these modes of representation.

What is Physics?

This question does not have a simple answer, or, rather, it has a simple answer but that answer by itself is not very helpful. If you look up physics in a dictionary or even in the back of a physics textbook, you will usually find an unhelpful statement, such as: "physics is the study of the properties and relationships between matter and energy." While this is not wrong, it doesn't really help you understand what it is. So to help understand what physics is, let's take a backwards approach.

In school, science is often divided into three main parts, or **disciplines**. They are physics, chemistry, and biology. Of the three, most people have at least a beginning understanding of biology—it is the "study of living things." Most people also know that chemistry concerns itself with "chemicals"—what they are made up of and how they interact with each other. While these descriptions of biology and chemistry are not very complete, they are at least a beginning. It is rare that people are able to provide even such a rudimentary definition of physics. So here is the *first* way that you can think of physics: physics is the *rest of science* after chemistry and biology have been accounted for.

You probably already know at least approximately what "science" is all about. For example, you are likely aware that the following things can be learned about in science and are therefore a part of science:

- The production of lightning and thunder
- The inner workings of the heart
- How rainbows are produced
- The rusting of certain metals
- Gravity
- How plants produce food
- The burning of gasoline

In this list, the item "inner workings of the heart" clearly involves life and is therefore best considered to be a part of biology, as is the item on "how plants produce food." The "rusting of certain metals" and the "burning of gasoline" involve the behaviours and interactions of different kinds of substances, and so are considered to be part of chemistry. All of the other items are physics!

It might seem silly identifying physics as "the rest of science," but historically this is pretty much how what we now call physics came to be.

The following points are summarized from the section "From Philosophy to Physics" in the book *The Search for Knowledge* by Isaac Asimov:

- In ancient times, there was no such thing as science, and certainly no physics, chemistry, or biology. Instead there were "philosophers" who were literally "lovers of wisdom."
- Some philosophers studied natural phenomena and were referred to as "natural philosophers," which is essentially what we would now think of as "scientists."
- The Greek word for "natural" is "physikos"—so physics was initially considered to be the same as "science."
- When people eventually specialized into specific areas of study, these areas were given their own names (mathematics, astronomy, geology, chemistry, and biology) and were removed from the topic of "physics."
- What we now call physics is what remains after the above have been removed.
- Splitting up science into separate areas is artificial, and in fact these areas tend to blend into each other.

Why Study Physics?

People are likely to give you different answers to this question because each might value different things. So here are several answers to this question in no particular order. Note that these are not necessarily *all* the answers!

1. Asking why one would study physics is like asking why one would learn how to draw, to play an instrument, or to play a sport. Sure, there *might* be a life-changing benefit (maybe you will get fabulously rich by becoming a famous artist/musician/athlete), but it is also perfectly acceptable to pursue these activities just for interest and fun. Many people actively doubt this about physics, preferring instead to think of physics as being very dull and certainly not something that could ever be "fun." Of course, some of these same people are fascinated to learn about such things as electricity, black holes, curve balls, and holograms—all of which involve physics. In other words, knowledge of physics helps to satisfy our natural curiosity about the world around us—everything from tsunamis to forensics.
2. Studying physics is necessary or, at least, strongly recommended for certain careers, such as engineers, medical doctors, dentists, pilots, meteorologists, and, of course, physicists.

3. Understanding physics can also be very practical, often when you least expect it. For example, understanding basic physics concepts can help you make more informed choices when buying many things (such as stereos, computers, and even cars), or how to get better mileage from your car.
4. A good foundation in physics can go a long way toward helping you understand other topics you may find interesting, such as chemistry, biology, computers, astronomy, geology, and music.

The Four Modes of Representation

If you consider the various branches of physics and the underlying principles, a common theme exists:

> Physics is the study of relationships in the world we perceive around us.

However, those relationships are embedded in a social and historical context—a set of lenses through which the relationships are perceived and acted upon. For example, we contemplate "something interesting," and then build models to identify fundamental characteristics to determine how they interact and influence each other. From these relationships, we are able to predict the behaviour of other "interesting things" that have the same or similar parameters. A major component of physics, then, is the study of relationships in a variety of different forms.

These different modes of representation are the different ways we look at a situation and the different ways we can represent the relationships within that situation. The more modes of representation we use, the better we will understand those relationships—that is, the physics that underlines that situation.

Mode Number 1: Visual

Have you ever been bored and played with an elastic band? You likely noticed that the more you pull, the more the band stretches. This is a simple experiment whose results can be expressed in words so that you get a picture in your mind of what is happening.

> Because it gives you a picture in your mind, it is an example of the **visual mode** of representation.

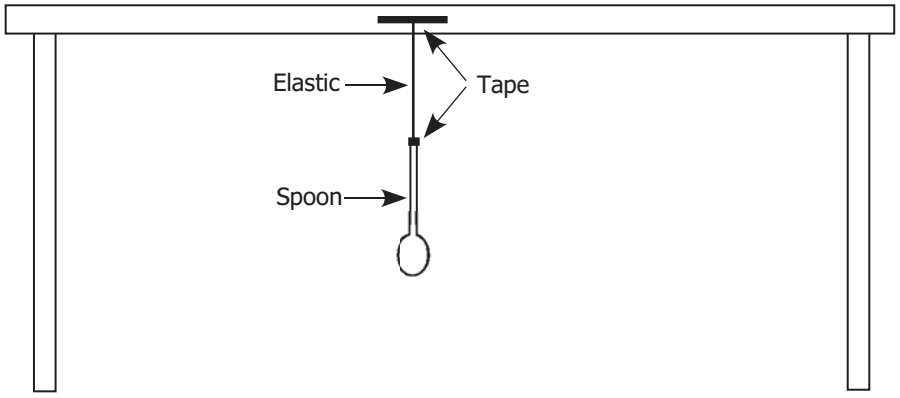
Sometimes this is also called a **qualitative** description because it describes the quality of the event. Qualities include things like pull and stretch.

For the remainder of this lesson, you will need the following things:

1. a thin elastic band cut once to make an elastic "string"
2. tape (transparent, masking, or duct will do)
3. a 30-cm ruler
4. five metal tablespoons.

Test your elastic string to be sure you can stretch it a bit and it will not break. Then tape one end to the edge of a table or counter so that the other end will hang over the edge and be a fair bit above the ground.

Visual Mode of Representation



Now we are ready to move on to the next mode.

Mode Number 2: Numerical

To get a more exact relationship between pull and stretch, we must collect data or numbers. This is called a quantitative description. In the **numerical** mode of representation, we must define the measurements and use equipment to collect the data.

> The **numerical mode** describes the relationship using numbers.

The data can then be examined to determine an exact relationship. There are basically three kinds of data:

1. **constants**—values that are the same during the experiment
2. **independent variables**—values that are set by the experimenter
3. **dependent variables**—values that are measured during the experiment

In our case, the elastic string is a constant. The number of tablespoons is the independent variable. The amount the elastic stretches will be the dependent variable.

Now that the string is taped to the edge of a table or countertop:

1. Place a piece of tape on the string about 10 cm down from the edge of the table.
2. Measure the exact length with the ruler and record it in the table below in the space with a (*).
3. Tape one spoon to the string so that the end of the handle is on the top edge of the piece of tape.
4. Let the spoon hang freely and measure the string length from the table edge to the tape mark (spoon handle top), and record this information in the table.
5. Tape another spoon on top of the first, just as they rest together inside a drawer.
6. Measure the length, record information in the table, and repeat until you have used all four spoons. Hopefully, the whole thing will not pull off the table before you are finished!

Number of Spoons	String Length (cm)	Stretch (cm)
0	(*)	0
1		
2		
3		
4		

Now calculate the amount the string stretched for each spoon added. You will do this by subtracting the original length, (*) amount, from each length. Consider the example below:

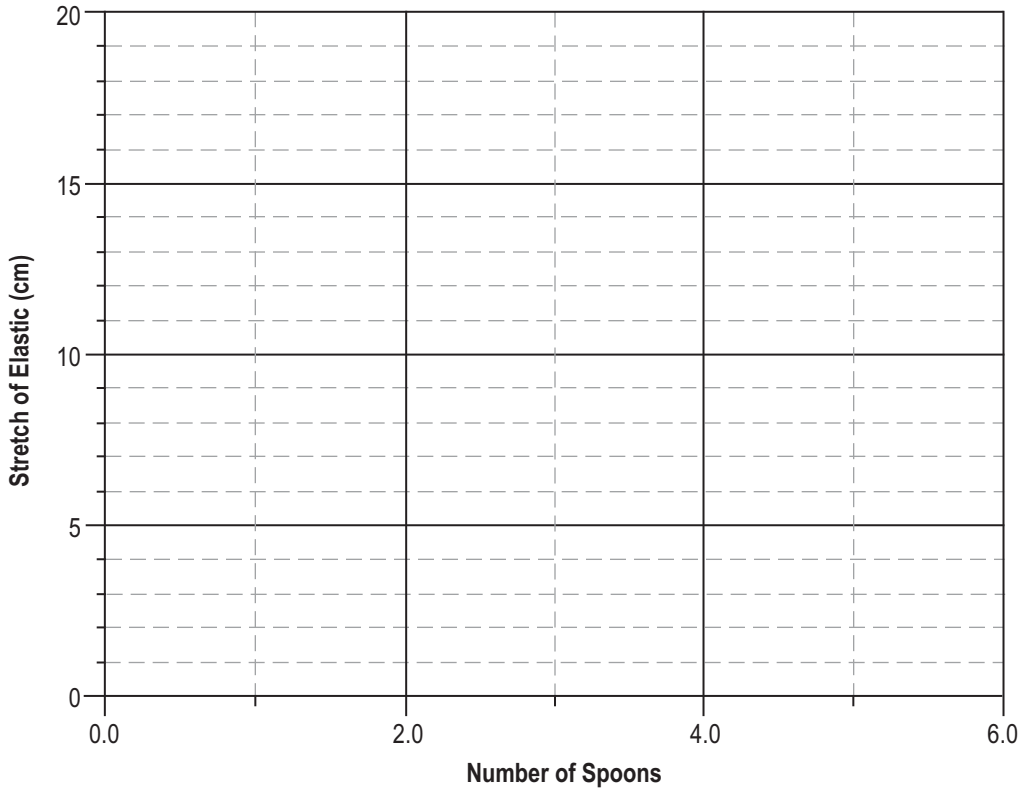
Number of Spoons	String Length (cm)	Stretch (cm)
0	(*) 9.7	0
1	11.0	2.3
2	14.2	4.5
3	16.6	6.9
4	18.9	9.2

Mode Number 3: Graphical

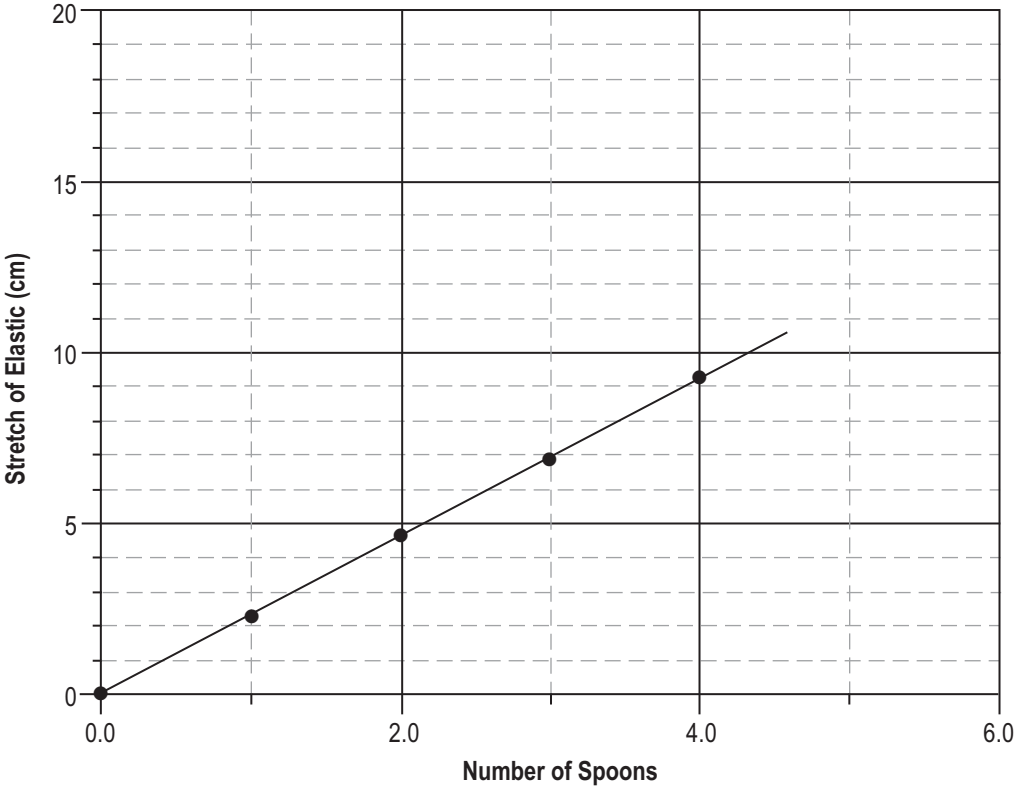
The **graphical mode** is a mathematical picture of the data.

For this graph, place the amount of stretch on the vertical axis and the number of spoons on the horizontal axis. When placing the numbers along the axes, start at zero and distribute the numbers evenly. After placing the data points on the graph, join them with a line of best fit. A **line of best fit** is a straight line through the data points so that it touches as many points as possible and has as many points above as below the line. Do not draw a line from one data point to the next. You may want to add a title to the graph.

Plot your data on the graph below.



Using the example data the graph would look like:



You learned in mathematics that the equation of a straight line can be written as $y = mx + b$ where m represents the slope of the line and b represents the y-intercept. In this case the y-intercept is zero since the graph begins at the origin. For this course, the y-intercept will remain at zero for the data we collect.

For the graph above, the y-values are the values of the stretch of the string. The x-values represent the number of spoons. In this case we could determine the value of the slope. The slope is determined by dividing the difference in the y-coordinates by the difference in x-coordinates for two points. Choose two data points that are on your line of best fit. If we use the coordinates (0,0) as (x_1, y_1) and (3,6.9) as (x_2, y_2), then the slope is

$$m = k = \frac{y_2 - y_1}{x_2 - x_1} = \frac{6.9 \text{ cm} - 0.0 \text{ cm}}{3.0 \text{ spoons} - 0.0 \text{ spoons}} = 2.3 \text{ cm/spoon}$$

Determine the slope of your graph.

$$m = k = \frac{y_2 - y_1}{x_2 - x_1} =$$

Mode Number 4: Symbolic

The **symbolic mode** represents the relationship as an algebraic equation/formula.

Generally, an algebraic equation is determined by using the graph. The purpose of the algebraic equation is to predict new situations that were not recorded in the experiment. For example, "How much will the string stretch with five spoons?" We can start by writing a word equation as:

Stretch of string = (slope of line) x (number of spoons)

Then we can introduce some algebraic symbols, such as:

S = stretch of string
n = number of spoons

Using the data from the example, the algebraic equation will then be:

$S = 2.3n$

If we had placed five spoons on the string, then we would predict the stretch to be:

$$\begin{aligned} S &= 2.3n \\ &= 2.3(5) \\ &= 11.5 \text{ cm} \end{aligned}$$

Determine the stretch of your string with five spoons and then test it by adding another spoon to your apparatus.

Note: The algebraic equations we will develop in this course have accepted symbols and are written in a traditional way. For the purpose of explaining the modes of representation, we have used arbitrary symbols and format for a well accepted law of nature. The law is called Hooke's Law and predicts how all elastic materials will behave when a force (push or pull) is applied to them. The accepted format for Hooke's Law is:

$F = kx$

Where F = the force applied, measure in Newtons
k = the spring constant (how stiff the spring is), measure in Newtons/metre
x = the stretch or compression of the spring, measured in metres

You do not need to understand Hooke's Law at this point. What you have to understand are two things:

1. There are four ways (modes) to express an event. All of the modes are important when dealing with physics. We do not want you to think of physics as simply plugging numbers into formulas and calculating an answer. You should be able to explain an event in any or all of the modes.
2. There are accepted ways of representing the algebraic equations we will come across in this course. Sometimes it may not seem to make sense why certain symbols are being used. Just remember that physics is an old science and tradition is important. Also, there are only so many symbols to choose from and many are used more than once in different contexts.

Learning Activity 1.1

Recording Data

Now you will get the chance to review and practice what you have learned by completing this learning activity. Remember, you do not submit learning activities for assessment. Instead, you complete them in order to prepare yourself to complete the assignments (which are submitted for assessment). Once you have completed this learning activity, check your answers in the answer key at the end of this module.

1. A person is moving slowly at a constant speed to the right. Every second, the distance travelled from the origin is recorded. The diagram below is one way to **visually** record the data. In this situation, the independent variable is the time.

   • At t = 0.0 s, the distance travelled d = 0.0 m.
   •⟶ At t = 2.0 s, d = 1.0 m
   •⟶ At t = 4.0 s, d = 2.0 m
   •⟶ At t = 6.0 s, d = 3.0 m
   •⟶ At t = 8.0 s, d = 4.0 m
   •⟶ At t = 10.0 s, d = 5.0 m

   a) Express the data above numerically in the form of a data table. Construct the data table horizontally. Be sure to label the rows correctly.

   b) Now construct a graph of the data above.

c) To illustrate the symbolic mode, determine the mathematical equation that relates the distance and the time. Include the magnitude of the slope in your answer.

2. If you were asked by another student "What is physics?", what would you say?

Lesson Summary

Physics is not easy to define. Isaac Asimov, in tracing the development of the study of science from ancient times, made the following statements:

- In ancient times, there was no such thing as science, and certainly no physics, chemistry, or biology; instead there were "philosophers" who were literally "lovers of wisdom."
- Some philosophers studied natural phenomena and were referred to as "natural philosophers," which is pretty nearly what we would now think of as "scientists."
- The Greek word for "natural" is "physikos"—so physics was initially the same as "science" in general.
- When people eventually specialized into specific areas of study, these areas were given their own names (mathematics, astronomy, geology, chemistry, and biology) and were removed from "physics."
- What we now call physics is what remains after the above have been removed.
- Splitting up these areas of study was an artificial, somewhat arbitrary construct, and in fact these areas tend to blend into each other

The aspect of physics that we will be investigating is the study of relationships in the world we perceive around us.

In order to learn and fully understand the concepts of physics, you must look at the situation in a variety of methods called modes of representation.

For our investigation into the effect on an elastic's amount of stretch from the pull of different numbers of spoons attached to it, the following are the four modes of representation.

1. Visual Mode

   The **visual mode** gives you a picture of the phenomenon in your mind.

2. Numerical Mode

   The **numerical mode** describes the relationship using numbers.

3. Graphical Mode

   The **graphical mode** is a mathematical picture of the data.

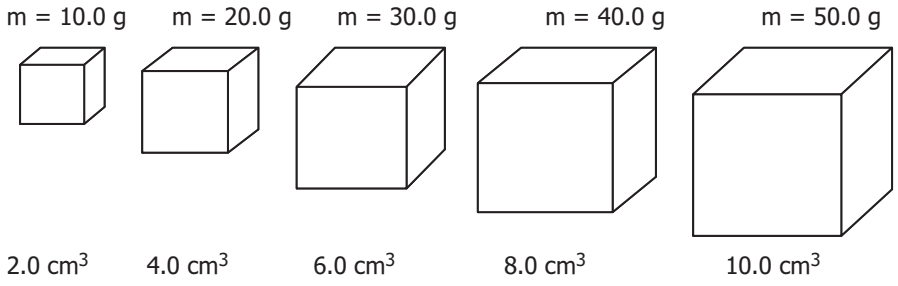
4. Symbolic Mode

   The **symbolic mode** represents the relationship as an algebraic equation/formula.

Assignment 1.1 Part A: Symbolic Mode (5 MARKS)

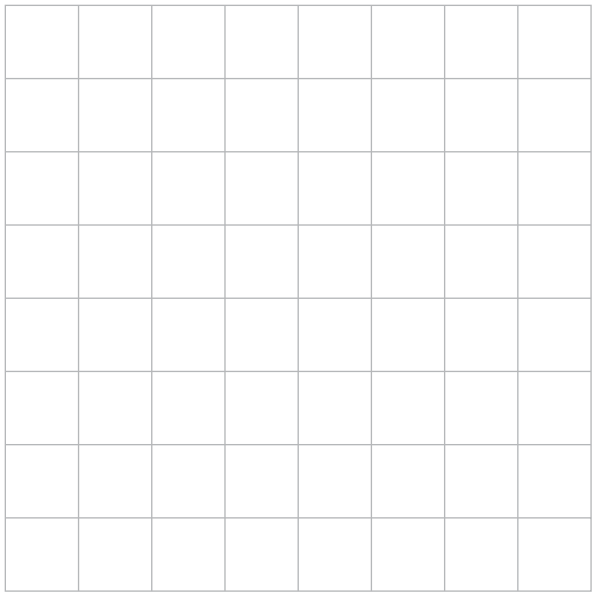
The following assignment must be submitted to your instructor for assessment. Be sure to show all your work and explain the method you used to arrive at your answer. Submit your answers to all Module 1 assignments together when you have completed the module.

A student wants to determine the mathematical relationship between the mass of an object and the volume of the object. In the experiment, it is important to ensure that the material that the object is made of remains constant. The visual representation of this situation is shown below. The volume is the independent variable. As the volume is changed, the mass is recorded.



a) Express the data above numerically in the form of a data table. Construct the data table horizontally. Be sure to label the rows correctly.

b) Now construct a graph of the data above.



c) To illustrate the symbolic mode, determine the mathematical equation that relates the volume and the mass. Include the magnitude of the slope in your answer.

Method of Assessment

The maximum grade for this solution is five (5) points. The mark will be determined as follows:

- 1 mark for setting up the data table correctly in part (a)
- 1 mark for correctly labelling the axes, distributing the numbers evenly along the axis, and writing a reasonable title
- 1 mark for plotting the points and drawing the straight line
- 1 mark for determining the slope in part (c)
- 1 mark for writing the correct mathematical equation in part (c)