Adult Basic Education

**Science**

# Physics 2104A

# Kinematics and Dynamics

## Curriculum Guide

**Prerequisite:** Physics 1104 or Science 1206

**Credit Value**: 1

**Physics Concentration**

Physics 1104
**Physics 2104A**
Physics 2104B
Physics 2104C
Physics 3104A
Physics 3104B
Physics 3104C

## Table of Contents

# To the Instructor

## I. Introduction to Physics 2104A

This course introduces students to concepts related to motion. Starting with the familiar concept of speed, students increase their understanding of motion in Physics through the use of graphs and problem solving. The concepts introduced here are fundamental for all Physics courses.

Students taking this course need to know how to solve for unknowns, draw scale diagrams and use a scientific calculator. If students don't have these prerequisite skills, they will have to be taught as students need them in the unit.

## 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**<br><br>Specific curriculum outcomes for the unit. | **Notes for Teaching and Learning**<br><br>Suggested activities, elaboration of outcomes, and background information. | **Suggestions for Assessment**<br><br>Suggestions for assessing students' achievement of outcomes. | **Resources**<br><br>Authorized and recommended resources that address outcomes. |

## 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*

*Science 10*
*Nelson Science 10 Teacher's Resource for Unit 3 - Motion*

*Physics: Concepts and Connections*
*Physics: Concepts and Connections Teacher's Resource Guide*

### *Recommended Resources*

*Science 1206: Motion Curriculum Guide*:
http://www.ed.gov.nl.ca/edu/sp/sh/sci/sci1206/unit4.PDF

*Nelson Publishing Web Site:* *http://www.science.nelson.com*

*Computerized Assessment Bank for Nelson Science 10,* Nelson.

## To the Instructor

***Other Resources***

*Center for Distance Learning and Innovation*: http://www.cdli.ca/

*Physics tutorials on the web:* http://www.physicsclassroom.com/Default2.html

*Great physics links:*
http://www.sciencejoywagon.com/physicszone/phylinks.htm

*Physics Central:* http://www.physicscentral.com/

*Physics Note-A-Rific:*
http://www.studyphysics.ca/index_files/Page618.htm

## V. Recommended Evaluation

| | |
|---|---|
| Written Notes | 10% |
| Labs/Assignments | 20% |
| Test(s) | 20% |
| Final Exam *(entire course)* | 50% |
| | 100% |

**The overall pass mark for the course is 50%**.

# Kinematics and Dynamics

## Unit 1 - Position - Time Graphs

### Outcomes

1 .1 Develop an understanding of relative motion and apply this to moving objects.

1 .1.1 Analyze graphically and mathematically the relationship among displacement, velocity, and time.

1 .1.2 Explain how one can tell from the position–time graph whether the magnitude of an object's velocity is increasing, decreasing, or constant.

1 .1.3 Determine the direction of motion of a uniformly accelerating object from its position–time graph using the sign convention that motion to the right is positive and motion to the left is negative.

### Notes for Teaching and Learning

The introduction to this material is covered well in the Science 10 text. This could be a good starting point for students. Use the material in Physics 1104 - Motion. If a student has recently finished Physics 1104, you should find that this section of this course is just a quick review of the material in the Science course.

To avoid students marking up the text you may want to copy and enlarge the graphs they are asked to work on for problems at the end of the chapter.

The answers to numerical problems are found at the end of the text. The *Teacher's Resource Guide* CD ROM has the worked solutions to the problems as well as answers to the concept questions.

Frequently check students work as they progress through this unit. If students are studying Physics for the first time, they may feel overwhelmed by the math. Remind them that physics is a course for which the saying "practice makes perfect" is very true. As they work through the units they should start to develop confidence in their abilities.

## Unit 1 - Position - Time Graphs

### Suggestions for Assessment

The Blackline Masters have extra graphs for students to work on. This could be used for testing or as alternates to the problems in the book. Questions can be drawn from the Test Bank for *Concepts and Connections*.

Assign a grade for working through the problems for the unit.

### Resources

*Concepts and Connections*: pages 5-23

Blackline Masters 2-1, 3-1, 3-2 and 5-1

www.cdli.ca
Center for Distance Learning and Innovation site: Physics 2204 - Unit 1, Section 1.

## Unit 2 - Velocity-Time Graphs

### Outcomes

2.1 Develop an understanding of velocity and apply it to solving problems.

2.1.1 Determine if the velocity is increasing, decreasing, or constant given velocity–time graphs.

2.1.2 Analyze graphically the relationship among displacement, velocity, and time.

2.1.3 Use the five kinematics equations to solve kinematics problems using algebraic techniques, including the manipulation of formulae.

### Notes for Teaching and Learning

The material on graphing from Section 2.1 - 2.2 is covered well in Physics 1104. For students who have trouble with the material in Section 2.3, you may want to refer them to the Physics 1104.

Students would need a lot of help deriving the kinematics equations. ABE students will not be expected to do this.

Solving some of the kinematics problems will involve solving quadratic equations. Students will probably not have covered the quadratic formula in math yet, so it will be necessary to help them identify when an equation is a quadratic and how to use the quadratic formula to solve for the unknown. For some students, solving simple algebraic quadratics might be a good ideas, before attempting to solve them in kinematics problems.

You may want to provide the students with a copy of the formula sheet for Physics 2104 A found in Appendix A of the curriculum guide. They should be given this for quizzes and will find it a handy reference for solving problems in this course.

## Unit 2 - Velocity-Time Graphs

### Suggestions for Assessment

Blackline Masters 7-1 and 10-1 provide extra problems with just the identified variables; i.e. no words. This might be a good assessment of a students ability to manipulate variables.

Use the formula sheet in the Appendix A for any tests, etc. Students are not expected to memorize these formulas.

Extra problems are found in the Curriculum Guide for Physics 2204.

### Resources

*Concepts and Connections*: pages 23-56 and Core Lab: page 77

*Concepts and Connection Teacher's Resource Guide*: pages 47-58

*Physics 2204 Curriculum Guide:* pages 26-31

Blackline Master 7-1, 10-1, pages 301-302

Center for Distance Learning and Innovation site: Physics 2204 - Unit 1, Section 3 Lesson 2 (Simulated Lab on Acceleration Due to Gravity)

## Unit 2 - Velocity-Time Graphs

### Outcomes

2.2 Investigate the motion of a falling object.

2.2.1 Carry out an experiment to investigate the motion of an object falling vertically near Earth.

2.2.2 Solve kinematics problems using algebraic techniques, including the manipulation of formulae (and including the special case of acceleration due to gravity).

2.2.3 Collect and analyze data for motion in one dimension.

### Notes for Teaching and Learning

Problems 54 and 55 on page 74 involve acceleration due to gravity.

If you do not have the equipment to run a "hands on" lab activity, and have access to the Internet, you may want to use the Physics 2204: Unit 1: Section 2: Lesson 3 to simulate this lab activity.

## Unit 2 - Velocity-Time Graphs

### Suggestions for Assessment

Blackline Masters 7-1 and 10-1 provide extra problems with just the identified variables; i.e. no words. This might be a good assessment of students ability to manipulate variables.

Use the formula sheet in the Appendix A for any tests, etc. Students are not expected to memorize these formulas.

Extra problems are found in the Curriculum Guide for Physics 2204 and on the Center for Distance Learning and Innovation site. You may want to use some of the testing material on this site to determine your students progress.

### Resources

*Concepts and Connections*: pages 53-64; Lab 2.2, page 77

*Concepts and Connections Teacher's Resource Guide:* pages 47-58

*Physics 2204 Curriculum Guide:* pages 26-31

Blackline Master 7-1, 10-1, pages 301-302

Center for Distance Learning and Innovation site: Physics 2204 - Unit 1, Section 3 Lesson 2 (Simulated Lab on Acceleration Due to Gravity)

## Unit 3 - Vectors and Relative Motion

### Outcomes

3. 1 Develop skills with vectors and use them to represent displacement, velocity and acceleration.

3. 1.1 Define scalar and vector quantities.

3. 1.2 Distinguish between scalar and vector quantities, using distance and displacement, respectively, as examples.

3. 1.3 Use vectors to represent position, displacement, velocity.

### Notes for Teaching and Learning

Blackline Masters from Science 10 provide a good introduction to adding vectors using scale diagrams.

The Science 10 text gives the students no answers so you will need to provide them with numerical solutions to problems

The Science 10 texts covers graphical (scale diagram) addition of vectors well. Students will need extra help to solve vector problems algebraically. If your students have access to a computer , the Center for Distance Learning and Innovation site for Physics 2204, Unit 1, Section 02, Lesson 01, particularly the third page, is good for this.

It cannot be emphasized enough that mastery of vectors is essential for the rest of this and other Physics courses. If students are having problems at this point, you will want to provide enough material for practice to ensure they understand vectors before proceeding further.

The instructor may decide students do not have to solve vectors algebraically for this course. They must be able to do it for Physics 3104A. If you want to leave it until then, their math and trigonometry skills may have "caught up" at that point.

## Unit 3 - Vectors and Relative Motion

### Suggestions for Assessment

Problems from Activities and Test Yourself on the Center for Distance Learning and Innovation site will be good for evaluating students' understanding and mastery of vectors.

See page 25 of the Physics Curriculum Guide for additional suggestions related to assessment of this material.

### Resources

*Science 10*- Unit 3: Blackline Master 11.1 (b), 11.3, 11.4, 11.5 (a) and (c)

*Science 10*: pages 414-417; 420-423; 426-429

Physics 2204 -Unit 1 Section 2 on the Center for Distance Learning and Innovation site: www.cdli.ca

*Physics 2204 Curriculum Guide:* page 25

## Unit 3 - Vectors and Relative Motion

### Outcomes

3. 2 Solve kinematics exercises/problems involving relative motion.

3. 2.1 Explain what is meant by, and identify the frame of reference for, a given motion to distinguish fixed and moving frames.

3. 2.2 Calculate the third quantity given two of the displacement of an object relative to a medium, the displacement of the medium relative to Earth, and the displacement of the object relative to Earth.

3. 2.3 Calculate the third quantity given two of the velocity of an object relative to a medium, the velocity of the medium relative to Earth, and the velocity of the object relative to Earth, with all velocities in the same direction.

3. 2.4 Calculate the third quantity given two of the velocity of an object relative to a medium, the velocity of the medium relative to Earth, where these are in opposite directions, and the velocity of the object relative to Earth.

### Notes for Teaching and Learning

Refer to the Physics 2204 Curriculum Guide pages 32, 34 and 36 for extra sample problems for students. A number of the text problems require Law of Cosines to solve. This is beyond the scope of the course.

You may also have to explain what is meant by terms like wind velocity, air velocity and ground velocity as they are new to most students.

Keep relative motion problems simple for this course. Restrict them to the type found in Example 7 on pages 97 to 98.

## Unit 3 - Vectors and Relative Motion

### Suggestions for Assessment

See the strategies in *Physics 2204 Curriculum Guide*.

Suggestions for assessment are the same as for Relative Motion outcomes.

At this point students should prepare for their first test in the course.

Additional problems that can be assigned for review or for testing from the three chapters of *Physics: Concepts and Connections* are:

**Chapter 1**: 15 - 19, 21, 24 - 25, 31 - 33, 39 - 40, 43 - 44

**Chapter 2**: 1, 8, 33, 35, 37, 39, 43, 44, 46, 48, 50, 54, 57, 66

**Chapter 3**: 40 - 43

You may choose to develop your quiz with the Test Bank for the text.

### Resources

*Concepts and Connections*: pages 95-103

*Concepts and Connections Teacher's Resource Guide:* pages 59-60
Blackline Master 11-1

*Physics 2204 Curriculum Guide:* pages 32-37

Center for Distance Learning and Innovation site for Physics 2204 - Section Unit 01 Lesson 02: www.cdli.ca

*Physics: Concepts and Connections* - Test Bank

## Unit 4 - Introduction to Dynamics

### Outcomes

4.1 Understand and apply Newton's First Law

4.1.1 State Newton's first law of motion, and describe applications.

4.1.2 Explain, using Newton's first law of motion, what is meant by an inertial frame of reference.

4.1.3 Physically demonstrate the property of inertia.

4.1.4 Explain how Newton's First Law applies to restraining devices in cars.

4.1.5 Apply Newton's laws of motion to explain inertia, the relationships among force, mass, and acceleration, and the interaction of forces between two objects.

### Notes for Teaching and Learning

Read page 66 of the Teacher's Resource Guide for *Physics: Concepts and Connections* for Misconceptions about Newton's First Law.

You may want to try the Demonstration on page 71 of the Teacher's Resource Guide.

Unit 2, Section, Lesson 1 of Physics 2204 on the Center for Distance Learning and Innovation site covers Newton's First law.

## Unit 4 - Introduction to Dynamics

### Suggestions for Assessment

Addtional questions are available on the Blackline Master 13-1.

You may want students to write further on car restraint systems. Discuss with the Communications Instructor if this would work well for writing across the curriculum.

### Resources

*Concepts and Connections*: pages 125-129

Blackline Master 13-1

*Physics 2204 Curriculum Guide:* page 44

*Concepts and Connections Teacher's Resource Guide:* pages 65 - 72

## Unit 4 - Introduction to Dynamics

### Outcomes

4.2 Understand and apply Newton's Second Law

4.2.1 State Newton's second law of motion, and describe applications.

4.2.2 Explain how Newton's second law of motion may be used to define the newton as a unit of force.

4.2.3 Calculate the third quantity given two of the net force, the mass, and the acceleration, or information from which they can be determined.

4.2.4 Solve exercises/problems involving Newton's laws.

### Notes for Teaching and Learning

You may choose to introduce Newton's Second Law using Core Lab #2. If you do not have the equipment, the Center for Distance Learning and Innovation site has a virtual lab in Unit 2, Section 2, Lesson 2 of the Physics 2204.

Demo 15-1 on page 77 may be appropriate for assisting students with understanding forces.

Lessons 3 and 4 from the Physics 2204 Center for Distance Learning and Innovation site covers Newton's Second Law and solving problems involving Newtons' Second Law.

## Unit 4 - Introduction to Dynamics

### Suggestions for Assessment

Lab #2 must be completed and submitted. Further questions on Newton's Second Law are in the text.

### Resources

*Concepts and Connections*: pages 129-131

*Physics 2204 Curriculum Guide*: pages 44 - 45

*Concepts and Connections Teacher's Resource Guide:* pages 75 - 80

Physics 2204 on the Center for Distance Learning and Innovation site: www.cdli.ca
Unit 2, Section 2: Lessons 2 - 4

## Unit 4 - Introduction to Dynamics

### Outcomes

4.3 Understand and use Free Body Diagrams (FBD).

4.3.1 Use vectors to represent forces.

4.3.2 Draw free-body diagrams.

4.3.3 Explain what is meant by net force and apply it to several situations.

4.3.4 Add two or more forces acting on an object to find the net or resultant force when the forces are in the same direction.

4.3.5 Add two or more forces acting on an object to find the net or resultant force when one or more of the forces are in the opposite direction to the others

4.3.6 Add two or more forces acting on an object to find the net or resultant force when one or more of the forces are perpendicular to the others.

### Notes for Teaching and Learning

The Center for Distance Learning and Innovation Physics 2204 in Unit 2, Section 2, Lesson 2 introduces FBDs. Lesson 3 covers Exploring Components. Students need a knowledge of trigonmetric functions in a right triangle to understand this material on the site. You may need to teach this also. Page 80 of the text gives trig formulas and identities. You may want to add them to the formula sheet. In the Study Guide perpendicular forces are not covered.

Students are given a list of forces that can act on an object in their Appendix A. See Appendix B.

You will need to point out to students that the normal force is **always** perpendicular to the surface and away from it.

## Unit 4 - Introduction to Dynamics

### Suggestions for Assessment

Use the Blackline Masters but don't choose angles that are perpendicular. Also on the Center for Distance Learning and Innovation site you will find "Test Yourself" material appropriate for evaluating students.

Test Bank for *Concepts and Connections* is also useful.

### Resources

*Concepts and Connections*: pages 131-137

Blackline Masters 18-1 and 19-1

Physics 2204 on the Center for Distance Learning and Innovation site: www.cdli.ca

## Unit 4 - Introduction to Dynamics

### Outcomes

4.5 Understand and apply Newton's Third Law.

4.5.1 State Newton's third law and describe applications.

4.5.2 Draw diagrams identifying the action–reaction pairs of forces in various interactions of particles or objects.

### Notes for Teaching and Learning

Often students believe that the faster, stronger entity exerts a more powerful force when two objects interact. Action-reaction pairs of forces have equal magnitude and opposite direction. Question students about what pair of forces are present as a brick falls to Earth; i.e. the brick experiences the gravitational attraction of Earth's mass and the Earth experiences the force of attraction from the brick.

## Unit 4 - Introduction to Dynamics

### Suggestions for Assessment

Select action-reaction pairs and ask students to identify the forces acting on each pair. *Applying the Concepts,* page 145, provides some questions.

Activities on the Center for Distance Learning and Innovation site can be assigned for evaluation purposes.

### Resources

*Concepts and Connections*: pages 142-145

Physics 2204 on the Center for Distance Learning and Innovation: Unit 2, Section 2, Lesson 7

# Appendix A

# Formula Sheet

# Physics 2104 A - Equations

$$\vec{v} = \frac{\Delta \vec{d}}{\Delta \vec{t}} \qquad \vec{a} = \frac{\Delta \vec{v}}{\Delta \vec{t}}$$

$$v_2 = v_1 + a\Delta t$$

$$\Delta d = \tfrac{1}{2}(v_2 + v_1)\Delta t$$

$$\Delta d = v_1 \Delta t + \tfrac{1}{2} a \Delta t^2$$

$$\Delta d = v_2 \Delta t - \tfrac{1}{2} a \Delta t^2$$

$$v_2^{\,2} = v_1^{\,2} + 2a\Delta d$$

$$\vec{v}_{og} = \vec{v}_{om} + \vec{v}_{mg}$$

$$c^2 = a^2 + b^2$$

$$\vec{F}_{net} = m\vec{a}$$

# Appendix B

# Forces

| Some Types of Forces | | | |
|---|---|---|---|
| **Force** | **Symbol** | **Definition** | **Direction** |
| Friction | $F_f$ | The contact force that acts to oppose sliding motion between surfaces. | Parallel to the surface and opposite to the direction of sliding. |
| Normal | $F_n$ | The contact force exerted by a surface on an object | Perpendicular to and away from the surface. |
| Tension | $F_T$ | The pull exerted by a string, rope or cable when attached to a body and pulled taut. | Away from the object and parallel to the string, rope or cable at the point of attachment. |
| Weight | $F_g$ | A field force due to gravitational attraction between two objects, generally Earth and an object. | Straight down toward the center of the Earth |
| Spring | $F_{spring}$ | A restoring force; that is the push or pull a spring exerts on an object. | Opposite the displacement of the object at the end of the spring. |