

Adult Basic Education

# Science

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## Physics 3104A

# Force, Motion and Energy

## Curriculum Guide

**Prerequisite:** Physics 2104C

**Credit Value:** 1

### Physics Concentration

Physics 1104

Physics 2104A

Physics 2104B

Physics 2104C

**Physics 3104A**

Physics 3104B

Physics 3104C



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## To the Instructor

### I. Introduction to Course

Students will build on the knowledge gained in Physics 2104A and Physics 2104B on forces and motion. Newton's Laws that were introduced in Physics 2104A are explored in much greater detail. Static equilibria are also studied.

Students taking this course need to know how to solve for unknowns, draw scale diagrams and use a scientific calculator. Students also need a solid understanding of trigonometry which is covered in Mathematics at the 2000 level. It is strongly recommended that students complete a course in trigonometry before starting Physics 3104A.

### 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	
<b>Outcomes</b>  Specific curriculum outcomes for the unit.	<b>Notes for Teaching and Learning</b>  Suggested activities, elaboration of outcomes, and background information.	<b>Suggestions for Assessment</b>  Suggestions for assessing students' achievement of outcomes.	<b>Resources</b>  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*

*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.

#### *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/>

## To the Instructor

*Physics Note-A-Rific:*

[http://www.studyphysics.ca/index\\_files/Page618.htm](http://www.studyphysics.ca/index_files/Page618.htm)

### V. Recommended Evaluation

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

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





# **Force, Motion and Energy**

## Unit 1 - Motion in Two Dimensions

### Outcomes

1.1 Understand projectile motion.

1.1.1 Add and subtract linear and perpendicular vectors algebraically and graphically.

1.1.2 Add vectors in two dimensions.

1.1.3 Determine the horizontal and vertical components of vectors.

1.1.4 Define projectile motion.

1.1.5 Analyze qualitatively and quantitatively the horizontal and vertical motion of a projectile.

1.1.6 Solve problems finding  $v_x$  and  $v_y$  at any point along the path, range, maximum height, and final velocity (magnitude and direction).

1.1.7 Sketch the  $x$  and  $y$  displacement, velocity, and acceleration vector components at any point along the path of a projectile.

### Notes for Teaching and Learning

A solid understanding of the use of vectors is essential.

It is no longer acceptable to use scale diagrams. Students need to be able to use trigonometric functions to solve vector problems. Components of vectors are essential for this course. Students need to know how to solve quadratic formulas. Their mathematics instructor may have to be asked to give some help here.

The Center for Distance Learning and Innovation site for Math 1204, Unit 5, Section 5, Lesson 3 is a good review of Vectors. Vector components are covered well on the Center for Distance Learning and Innovation site for Physics 2204: Unit 2, Section 1, Lesson 3.

Blackline Masters 2-1, 2-2, and 3-1 provide extra work on vectors.

Blackline Master 4-1 and 5-1 provide extra examples of projectile motion.

Projectile motion calculation will involve some trigonometry. Students who have not covered this in Math, will need to have it taught before starting this material.

It is important to stress that downward vertical displacements and acceleration are **negative**. Remind students that any vector that is up or to the right is positive, while vectors that are down or to the left are negative.

## Unit 1 - Motion in Two Dimensions

### Suggestions for Assessment

Blackline Masters can be used for assessment of vectors.

Physics 3204 Curriculum Guide page 29 and page 31 suggest several types of questions to assess parabolic motion understanding.

### Resources

*Concepts and Connections:* pages 79-84

Blackline Masters: 2-1, 2-2, 3-1

*Concepts and Connections:* pages 84-94  
Core Lab #1: Lab 3.1 on pages 119 and 120

Blackline Masters: 4-1, 5-1

*Physics 3204 Curriculum Guide*

Center for Distance Learning and Innovation  
site: Physics Multimedia Learning Objects: 01-11  
[www.cdli.ca](http://www.cdli.ca)

## Unit 2 - Applications of Newton's Laws I

### Outcomes

2.1 Understand Newton's Laws applied to an inclined plane and string-and-pulley systems.

2.1.1 Apply Newton's laws in two dimensions.

2.1.2 Solve problems where an object is pushed or pulled at an angle along a horizontal surface, with or without friction.

2.1.3 Define an inclined plane and coordinate rotation.

2.1.4 Solve problems for both frictional and non-frictional inclined planes.

2.1.5 Determine the coefficient of friction on an inclined plane.

### Notes for Teaching and Learning

Material on Free Body Diagrams from Physics 2104A may also need to be reviewed.

Students will need to review Friction a unit covered in Physics 2104 B before applying friction concepts to the inclined plane. For this reasons material on friction covered in that course is included in their Study Guide. Vectors and Friction and Inclined Plane are topics covered on the Center for Distance Learning and Innovation site for Physics 3204: Unit 1, Section 2, Lessons 1 -3

You will have to explain Fig 6.2A of the text i.e. that  $\Theta_1 = \Theta_2$ . This relationship will be used throughout the applications of Newton's Laws for solving problems.

The relationship between adjacent and opposite sides of a right triangle will be used extensively for the next several units. It is very important that students be quite comfortable with these concepts for determining the perpendicular and parallel components of force.

## Unit 2 - Applications of Newton's Laws I

### Suggestions for Assessment

Other problems to offer students are on page 224: Problems 6-10 of the text

Also *Physics 3204 Curriculum Guide* page 35 has several problems.

### Resources

[www.cdli.ca](http://www.cdli.ca) Physics  
3204 Multimedia  
Learning Objects: 12-17

*Concepts and  
Connections: pages 53-  
64; 172-179; 194-196*

*Concepts and  
Connections Teacher's  
Resource pages 363 - 370*

*Physics 3204 Curriculum  
Guide*

## Unit 2 - Applications of Newton's Laws I

### Outcomes

2.1.6 Solve problems involving strings and pulleys, on both horizontal surfaces and inclined planes.

### Notes for Teaching and Learning

Students need to be sure they are including all forces acting on the objects. Omitting one force is often the cause of incorrect answers.

You may want to supply them with the list of forces found in the Physics 2104A Study Guide.

## Unit 2 - Applications of Newton's Laws I

### Suggestions for Assessment

Additional problems are on the Blackline Master 10-1 and also problem 14 on page 225.

### Resources

*Concepts and Connections:* pages 197-202

*Concepts & Connections: Teacher's Resource:* pages 369-370

Blackline Master 10-1

Center for Distance Learning and Innovation:  
Multimedia Learning Objects: 18-21  
[www.cdli.ca](http://www.cdli.ca)

## Unit 3 - Applications of Newton's Laws II

### Outcomes

3.1 Understand Newton's Laws applied to an uniform circular motion and centripetal force.

3.1.1 Define uniform circular motion and centripetal acceleration using the formula and when these are used in combination.

3.1.2 Describe uniform circular motion using algebraic and vector analysis.

3.1.3 Solve problems involving centripetal acceleration.

3.1.4 Explain quantitatively uniform circular motion using Newton's laws.

### Notes for Teaching and Learning

Students are to be provided with all the equations for circular motion. They are not expected to derive any of these.

It is important that students recognize the effects of forces. Forces can change the magnitude of the velocity (linear motion), the magnitude and direction of velocity (projectile motion) and in this unit it is seen that a force can change the direction only. Change in direction only is very difficult for students to accept. It may be needed to point this out often.

In solving problems here students must keep the directions of the vectors in mind. Students might be asked to indicate whether the values are positive or negative before solving the problems.



## Unit 3 - Applications of Newton's Laws II

### Suggestions for Assessment

Problems from the text may be used. The Curriculum Guide also has suggested problems.

Students are to complete and submit Core Lab #2.

### Resources

*Concepts and Connections:* pages: 202 - 206; Core Lab #2 pages 228 - 229

*Concepts and Connections Teacher's Resource Guide:* pages 371 - 373

*Physics 3204 Curriculum Guide:* 36 - 43

[www.cdli.ca](http://www.cdli.ca) Physics 3204: Section 3, Lesson 1 Multimedia Learning Objects: 23-32

## Unit 3 - Applications of Newton's Laws II

### Outcomes

3.2 Define centripetal force.

3.2.1 Solve problems involving centripetal force and acceleration on a horizontal surface and at the top and bottom of a vertical circle.

3.2.2 Solve problems for banked curves without friction.

### Notes for Teaching and Learning

Again stress watching the signs of the forces. It is important to know when the tension is greatest and least before students can solve problems.

The Center for Distance Learning and Innovation site has extensive coverage of this material. It also has an optional section on Orbits.

For the lab the Physics Curriculum Guide suggests that the length of the string not be too long.

## Unit 3 - Applications of Newton's Laws II

### Suggestions for Assessment

Questions are available on Blackline Master 12-1, in the Curriculum Guide and on the Center for Distance Learning and Innovation site.

### Resources

*Concepts and Connections*: pages 238 - 252

*Concepts and Connections Teacher's Resource Guide*: pages 371 - 376

*Physics 3204 Curriculum Guide*: pages 36- 43

[www.cdli.ca](http://www.cdli.ca) Physics 3204: Section 3, Lessons 2 - 7

Multimedia Learning Objects: 23 - 32

Blackline Master 12-1

## Unit 4 -Introduction to Statics

### Outcomes

4.1 Understand static equilibrium.

4.1.1 Differentiate between dynamic and static equilibrium.

4.1.2 Identify translational and rotational effects of forces.

4.1.3 Solve translational equilibria problems using vector addition and free-body diagrams.

4.1.4 Demonstrate stability and centre of mass.

### Notes for Teaching and Learning

The static equilibria problems are solved by finding net forces acting on a body or alternatively finding the components of a force. Students need to set up their diagrams and use right triangles to solve the problems. You might ask them to set up the force diagrams and explain to you how they would solve the problems, before actually working through the problems. In all cases, forces are being exerted to ensure zero translational motion.

## Unit 4 -Introduction to Statics

### Suggestions for Assessment

Problems 18-27 at the end of the Chapter on pages 267-268 can be used for evaluation or further problem solving. There are also problems on the Center for Distance Learning and Innovation site and in the Physics Curriculum Guide.

Students are to complete and submit Core lab #3.

### Resources

*Concepts and Connections:* pages 232 - 238

Core Lab #3:  
Investigation 7.1 pages  
272 - 273

*Concepts and Connections Teacher's Resource:* pages 385 -394

*Physics 3204 Curriculum Guide:* pages 44-51

[www.cdli.ca](http://www.cdli.ca) Physics  
3204: Unit 1, Section 4,  
Lesson 1  
Multimedia Learning  
Objects: 33-35

## Unit 4 -Introduction to Statics

### Outcomes

4.2 Understand torque.

4.2.1 Define torque (moment of force).

4.2.2 Use vector analysis in two dimensions for systems involving two or more masses, static equilibrium, and torque.

4.2.3 Calculate torque when forces applied are either perpendicular or at an angle.

4.2.4 Solve static equilibrium problems balancing forces and torque.

4.2.5 Demonstrate stable, neutral, and unstable equilibrium and the tipping angle.

### Notes for Teaching and Learning

The examples in the text for Section 7.4 have no diagrams. This makes it very difficult for students. They are instructed in the Study Guide to draw diagrams. These diagrams should be checked before the student works through the example.

In solving these problems look at the Center for Distance Learning and Innovation site. You may find it is easier for students to solve the problems if they set the total clockwise torques ( $\tau_{CC}$ ) to be equal to the total counterclockwise torques ( $\tau_{CCW}$ ). Also, it is **essential** to draw diagrams for these problem. (See page 50 of the *Physics 3204 Curriculum Guide*)

Example 6 is reworked at the end of the Study Guide with a different diagram. It should be stressed that only when the crane's arm is assumed to be uniform that the 200.0kg mass of the arm can be considered to be acting halfway through the arm. Again setting  $\tau_{CC} = \tau_{CCW}$  may be easier for students when solving these problems.

## Unit 4 -Introduction to Statics

### Suggestions for Assessment

Problems 18-27 at the end of the Chapter on page 267-268 can be used for evaluation or further problem solving. There are also problems on the Center for Distance Learning and Innovation site and in the Physics Curriculum Guide.

### Resources

*Concepts and Connections:* pages 238 to 252; Core Lab #3: Investigation 7.1 pages 272-273

*Concepts and Connections Teacher's Resource:* pages 393 - 402

*Physics 3204 Curriculum Guide:* pages 44-51

[www.cdli.ca](http://www.cdli.ca) Physics 3204: Unit 1, Section 4, Lesson 2  
Multimedia Learning Objects: 36-41