Adult Basic Education

Science

Physics 2104B

Forces, Momentum, Work and Energy

Curriculum Guide

Prerequisite: Physics 2104A

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 2104B

Physics 2104B applies the concepts learned in Physics 2104A to the forces of gravity, friction and springs. Impulse and Momentum are then studied and these concepts are applied to sports. Finally the relationship between energy, work and power will be examined to develop a better understanding of the world.

The content of Physics 2104B follows closely on the material in Physics 2104A which is a prerequisite. Again students will need a scientific calculator and an understanding of trigonometry.

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** Suggestions for assessing students' achievement of outcomes.	**Resources** 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

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/

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%.

Forces, Momentum, Work and Energy

Unit 1 - Gravity and Friction

Outcomes

1.1 Investigate gravity.

1.1.1 Distinguish between mass and weight.

1.1.2 Investigate the relationship between acceleration and net force for a constant mass of an object.

1.1.3 Investigate the relationship between acceleration and mass for a constant net force.

Notes for Teaching and Learning

Students are aware that we weigh less on the moon. However the everyday use of the word weight will cause problems here.

Unit 1 - Gravity and Friction

Suggestions for Assessment

Question 7 on page 186 of *Concepts and Connections* relates what was learned in this unit to Biology. Question 24 on page 187 introduces some information on plants as applied to gravity.

Resources

Concepts and Connections: pages 158 - 168

Center for Distance Learning and Innovation: www.cdli.ca:
Physics 2204: Unit 02, Section 01, Lesson 1

Unit 1 - Gravity and Friction

Outcomes

1.2 Investigate friction.

1.2.1 Explain, qualitatively and quantitatively, what is meant by friction, and describe static and kinetic friction.

1.2.2 Show the qualitative relationships for both static and kinetic friction.

1.2.3 Analyze natural and technological systems to interpret and explain their structure and dynamics.

1.2.4 Determine one of frictional force, normal force or coefficient of friction give the other two variables or a means for determining the other variables.

Notes for Teaching and Learning

One starting point for this part of Unit 5 is to investigate friction with the Kinetic Friction Lab. You may want to demonstrate static friction by using Lab 5.2 on page 191.

Students may have trouble with the more advanced questions in this section. You may need to take them through Section 5.4 and ask them to complete several questions e.g. 32, 33 on page 187 to 188.

Note: Section 5.6 of the text is covered in Unit 6.

Unit 1 - Gravity and Friction

Suggestions for Assessment

Any of the problems in Section 5.5 on page 188 can be used. Students must submit Lab #3 for grading purposes.

Additional problems that can be assigned for review or for testing from Chapter 5:

Problems: 11, 23, 35, 46, 51, 53, 54

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

Resources

Concepts and Connections: pages 172 - 179; Core Lab #1: Kinetic Friction: page 191

Physics 2204 Curriculum Guide: pages 48 and 49

Physics Concepts and Connections Test Bank

Unit 2 - Momentum

Outcomes

2.1 Understand momentum and impulse.

2.1.1 Define linear momentum and explain why it is a vector quantity.

2.1.2 Calculate the third quantity given two of an object's mass, velocity, and momentum.

2.1.3 Define impulse, and use Newton's second law to show how it is related to change in momentum.

2.1.4 Calculate the impulse given the net force and the time over which it acts.

2.1.5 Solve numerical and non-numerical problems by using the concept of impulse.

2.1.6 Experimentally determine the that momentum is conserved in one-dimensional collisions.

Notes for Teaching and Learning

Ensure that students understand that impulse equals a change in momentum. Also that impact is force measured in Newtons and is not to be mistaken for impulse.

Question 2 on page 286 does not involve a decrease in force, but an increase in velocity. $F\Delta t = m\Delta v$. If time increases and the force doesn't change, then mΔv increases. The ball's mass does not change so its velocity will increase.

The conservation of momentum is experimentally determined in this unit. Students will not develop this concept further.

Unit 2 - Momentum

Suggestions for Assessment

Students are expected to submit Core Lab #2 and the questions associated with *The Physics of Karate.*

Extra questions can be found by using the examples on the Center for Distance Learning and Innovation site.

Resources

Concepts and Connections: pages 277 - 282; 307. Core Lab #2: Linear Momentum in One Dimension: pages 315 and 316

Physics 2204 Curriculum Guide: pages 52 - 55

Study Guide: "The Physics of Karate"

www.cdli.ca
Center for Distance Learning and Innovation: Physics 2204: Unit 2, Section 3

Unit 2 - Momentum

Outcomes

2.2 Understand Conservation of Momentum

2.2.1 Write an equation applying the law of conservation of momentum to a one dimensional collision between two objects in terms of two masses and the two velocities before and after the collision.

2.2.2 Calculate the sixth quantity given any five of the two masses of objects involved in a one-dimensional collision, their velocities before, and their velocities after the collision.

2.2.3 Use appropriate language and conventions when describing events related to momentum.

2.2.4 Describe the functioning of a technology based on principles of momentum.

Notes for Teaching and Learning

The effect of collision time upon force has many real world applications. It is involved in the use of airbags and padded dashboards in cars, where lengthening the time the person is in contact with the airbag or dashboard reduces the force of the impact if there is a collision.

Unit 2 - Momentum

Suggestions for Assessment

Additional problems are available on page 311 to 312 of the text.

Resources

Concepts and Connections: pages 277 - 282; 307. Core Lab #2: Linear Momentum in One Dimension: pages 315 - 316

Physics 2204 Curriculum Guide: pages 52 - 55

Study Guide: "The Physics of Karate"

www.cdli.ca
Center for Distance Learning and Innovation: Physics 2204: Unit 2, Section 3

Unit 3 -Work and Power

Outcomes

3.1 Understand the relationship between force, distance and work.

3.1.1 Compare the physics use of the term "work" with everyday usage.

3.1.2 Analyze quantitatively the relationships among force, distance, and work.

3.1.3 List the conditions under which work is done on an object when a force is applied to that object.

3.1.4 Define work in terms of an object's displacement and the force acting on it in the direction of the displacement.

3.1.5 Apply the concept of work to novel situations involving mass, force, distance, and direction.

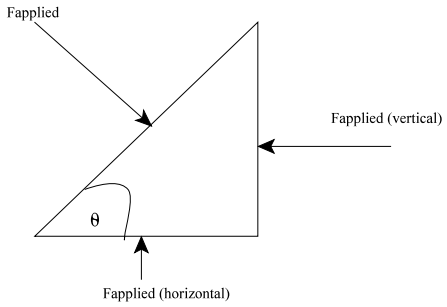
3.1.6 Calculate the third term given two of work, displacement, and force.

3.1.7 List the conditions under which work is done on an object when a force is applied to that object.

Notes for Teaching and Learning

Compare work to impulse. With impulse a force is exerted for a time interval. Work has a force exerted over a distance. Remind students that for physics, it is not work unless the force makes the object move a distance. Also because of the vector nature of the components of work, it is possible that work will be zero if an object is pushed forward 3 m and then pushed back 3 m. The total work done will be zero as the work forward will cancel the work back.

When the force applied is at a different angle, students will have to find the component of the force in the direction that the object is moving (often the horizontal component) of the applied force.



$\cos\theta$ = adj/hyp or adj = $\cos\theta$ x hyp.
In this case the adj is the horizontal component that is sought and the hypotenuse is the applied force.

Also make sure the students still have their kinematics equations from Physics 2104A as they will need them again.

Unit 3 -Work and Power

Suggestions for Assessment

Extra problems are available on the Center for Distance Learning and Innovation site.

Also problems are available at the end of the chapter for Sections 9.2: Problems 21 to 40 (a) on pages 369 and 370.

Resources

Concepts and Connections: pages 325 - 332

Concepts and Connections Teacher's Resource Guide: pages 323 - 332

Physics 2204 Curriculum Guide pages 60 - 63

www.cdli.ca
Center for Distance Learning and Innovation
Physics 2204: Unit 3
Section 2, Lessons 1-4

Unit 3 -Work and Power

Outcomes

3.2 Understand the relationship between force distance, work, time and power.

3.2.1 Define power.

3.2.2 Calculate one of the following when given the other two: power, work (or a means to determine the work), and time.

3.2.3 Analyze quantitatively the relationships among work, time, and power.

3.2.4 Relate energy transfers to work done.

Notes for Teaching and Learning

Keep in mind the fact there will be no work if the direction of motion changes by 180^{o}.

Unit 3 -Work and Power

Suggestions for Assessment

Extra problems are on the Center for Distance Learning and Innovation site and also problems 41 - 46 on pages 370 and 371 of the text.

If sufficient students are available, Lab 9.3 could be done for enrichment and developing a greater understanding of power.

Resources

Concepts and Connections: pages 325 - 332; Lab 9.3 on page 380

Concepts and Connections Teacher's Resource Guide: pages 323 - 332

Physics 2204 Curriculum Guide: pages 60 - 63

www.cdli.ca
Center for Distance Learning and Innovation
Physics 2204: Unit 3
Section 2, Lessons 1-4

Unit 4 - Kinetic and Potential Energy

Outcomes

4.1 Understand relationships involving kinetic and potential energy.

4.1.1 Define and give examples of two types of kinetic energy.

4.1.2 Define and give examples of six types of potential energy.

4.1.3 Define an object's kinetic energy in terms of its mass and speed.

4.1.4 Solve numerical problems related to kinetic energy.

4.1.5 Analyze common energy transfer situations using the closed-system work–energy theorem.

4.1.6 State the work–energy theorem as it applies to an object experiencing a force on a horizontal frictionless surface.

Notes for Teaching and Learning

Many students will have covered the different types of kinetic and potential energy in Junior High Science, but a review is a good idea as it may have been a long time since they met this information. For this reason questions have been assigned from Section 9.1.

Unit 4 - Kinetic and Potential Energy

Suggestions for Assessment

Extra problems are available at the end of Chapter 9 and on the Center for Distance Learning and Innovation site.

Students can be asked what will happen to kinetic energy if the mass is doubled or if the mass is tripled and the speed is doubled etc.

Resources

Concepts and Connections: pages 179 - 181; 332 - 341; Lab 9.2 on page 378

Concepts and Connections Teacher's Resource Guide: pages 145 - 156

Blackline Master 43-1 on page 317

Physics 2204 Curriculum Guide: pages 62 and 63

www.cdli.ca
Center for Distance Learning and Innovation : Physics 2204: Unit 3, Section 3, Lessons 01-05

Unit 4 - Kinetic and Potential Energy

Outcomes

4.1.7 Calculate the value of any variable given the value of the other variables, or information from which they may be found, using the expression for the work–energy theorem.

4.1.8 Describe the relationship between the concepts of work and energy.

Notes for Teaching and Learning

Unit 4 - Kinetic and Potential Energy

Suggestions for Assessment

Extra problems are available at the end of Chapter 9 and on the Center for Distance Learning and Innovation site.

Students can be asked what will happen to kinetic energy if the mass is doubled or if the mass is tripled and the speed is doubled etc.

Lab 9.2 could be done before proceeding to potential energy.

Resources

Concepts and Connections: pages 179 - 181; 332 - 341; Lab 9.2 on page 378

Concepts and Connections Teacher's Resource Guide: pages 145 - 156

Blackline Master 43-1 on page 317

Physics 2204 Curriculum Guide: pages 62 - 63

www.cdli.ca
Center for Distance Learning and Innovation : Physics 2204: Unit 3, Section 3, Lessons 01-05

Unit 4 - Kinetic and Potential Energy

Outcomes

4.2 Understand potential energy.

4.2.1 Analyze quantitatively the relationships among mass, height, gravity, gravitational potential energy, and kinetic energy.

4.2.2 Define gravitational potential energy in terms of height, mass, and the force of gravity.

4.2.3 Solve numerical problems related to gravitational potential energy.

4.2.4 Solve numerical problems involving Hooke's Law.

4.2.5 Analyze quantitatively the relationships among mass, the extension of a spring, the spring constant and the potential energy of a spring.

4.2.6 Analyze natural and technological systems to interpret and explain their structure.

Notes for Teaching and Learning

Stress the relative nature of potential energy. Students should be familiar with relative motion and may find relative potential energy more easy to understand.

Hooke's Law is introduced in Chapter 5. This introduction is needed to understand much of the information in the remainder of Chapter 9 of the text.

The spring constant can be found from the slope of the graph of F versus x.

Physics 2204 Curriculum Guide, page 64 is recommended for elaborations on the potential energy of a spring.

Unit 4 - Kinetic and Potential Energy

Suggestions for Assessment

Extra problems are available on pages 373 to 374.

Core Lab #3: Work and Kinetic Energy is the be submitted for grading.

It is strongly recommended a quiz be given to students at this point to ensure concepts are understood before proceeding with the remainder of the course. This quiz should be used to identify areas that the student needs extra work etc. so he/she will better prepared for the material in the remainder of the course.

Resources

Concepts and Connections: pages 179 - 181; 332 -b341; Lab 9.2 on page 378

Concepts and Connections Teacher's Resource Guide: 145 -156

Blackline Master 43-1 on page 317

Physics 2204 Curriculum Guide: pages 62 and 63

www.cdli.ca
Center for Distance Learning and Innovation : Physics 2204: Unit 3, Section 3, Lessons 01-05

Unit 5 - Conservation of Energy

Outcomes

5.1 Understand and apply the Law of Conservation of Energy.

5.1.1 State the law of conservation of energy as it applies to mechanical energy.

5.1.2 Solve problems using the law of conservation of energy, including changes in gravitational potential energy and kinetic energy.

5.1.3 Solve problems using the law of conservation of energy, including changes in elastic potential energy.

5.1.4 Investigate the relationship between kinetic energy and potential energy.

5.1.5 Determine the percent efficiency of energy transfer, including the comparison of empirical and theoretical values of total energy, accounting for discrepancies.

5.1.6 Explain the role of friction in the loss of mechanical energy from a system.

Notes for Teaching and Learning

Unit 5 - Conservation of Energy

Suggestions for Assessment

Lesson 7 on the Center for Distance Learning and Innovation site has a lab activity on Conservation of Energy.

Extra questions are available on the Center for Distance Learning and Innovation site and on page 374.

Resources

Concepts and Connections: pages 342 - 349

Concepts and Connections Teacher's Resource: pages 157 - 164

Physics 2204 Curriculum Guide: pages 66 - 73
Appendix A: pages 111 - 119

www.cdli.ca
Center for Distance Learning and Innovation
Physics 2204: Section 3; Lessons 6-8

Unit 6 - Simple Harmonic Motion and Efficiency

Outcomes

6.1 Understand the principles of simple harmonic motion (SHM).

6.1.1 Analyze quantitatively the relationships among force, distance, and the spring constant.

6.1.2 Explain how a stretched coil spring can possess elastic potential energy.

6.1.3 Write an expression for potential energy stored in a spring.

6.1.4 Determine the third quantity given two of potential energy, *k*, and *x*.

6.1.5 Define SHM.

6.1.6 Explain qualitatively the relationship between displacement, velocity, time, and acceleration for simple harmonic motion (SHM).

6.1.7 Explain quantitatively the relationship between potential and kinetic energies of a mass in Simple Harmonic Motion.

6.1.8 Calculate speed and acceleration of a mass on a spring.

Notes for Teaching and Learning

As the mass on a spring is introduced earlier than Chapter 9, students start with this early material before proceeding to the relationship with energy.

It is important that students recognize that for problems of total energy for mass-spring systems that at the equilibrium position $x = 0$ and $E_K = E_s$.

An Appendix has been added to the Study Guide explaining in greater detail, the relationship of speed, energy and amplitude for a mass on a spring. Encourage students to understand what is happening regarding the mass on a spring at the various positions.

Amplitude is used here, but students have not met it before. As it is used in the problems, some time is needed to explain this to students.

Unit 6 - Simple Harmonic Motion and Efficiency

Suggestions for Assessment

Additional problems are available on the Center for Distance Learning and Innovation site and also on page 376 of *Concepts and Connections*.

Resources

Concepts and Connections: pages 357 - 361

Concepts and Connections Teacher's Resource: pages 425 - 433

www.cdli.ca
Center for Distance Learning and Innovation: Physics 2204: Unit 3: Section 3, Lesson 9

Physics 2204 Curriculum Guide: pages 64 and 65

Unit 6 - Simple Harmonic Motion and Efficiency

Outcomes

6.2 Understand efficiency in energy transfer processes.

6.2.1 Determine the percent efficiency of energy transfer, including the comparison of empirical and theoretical values of total energy, accounting for discrepancies.

6.2.2 Explain the role of friction in the loss of mechanical energy from a system.

6.2.3 Compute the percent efficiency of a system where energy is "lost" due to friction.

6.2.4 Analyze and describe examples where energy-related technologies were developed and improved over time.

6.2.5 Describe and evaluate the design of technological solutions and the way they function in terms of energy principles.

Notes for Teaching and Learning

Students are familiar with the concept of efficiency. They probably have heard advertisements regarding more efficient furnaces or heating systems, etc.

To provide students with further information on heat pumps, you can "google" the question "what is a heat pump"? Heat pumps cannot be used everywhere because it is not always possible to extract heat from the outside air. Many heat pump systems are tied into an alternate system so that the alternate system takes over when the outside air is too cold. In some regions the outside air is to too cold for such a lengthy period that it is not worth the cost of buying, installing and maintaining a heat pump.

Some companies in your community may have information on adding heat pumps to a home heating system.

Unit 6 - Simple Harmonic Motion and Efficiency

Suggestions for Assessment

Students can be asked to write a short paper on heat pumps - perhaps research with a local provider of heat pumps.

Calculations of the type 111 to 112 on page 372 could be used.

A final evaluation covering the entire course can be developed from the Test Bank, questions from the text and the Center for Distance Learning and Innovation site.

Resources

Concepts and Connections: pages 362 - 365

Concepts and Connections Teacher's Resource: pages 425 - 433

Physics 2204 Curriculum Guide: pages 70 - 73