Adult Basic Education

Science

Physics 2104C

Waves, Light and Sound

Curriculum Guide

Prerequisite: Physics 2104B

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 2104C

This course uses the study of light and sound to introduce the concept and properties of waves. Light waves are studied and phenomena like the rainbow are explained. In studying sound waves, music and cell phones are explored.

A sudent taking this course needs to know how to solve for unknowns and use a scientific calculator. A basic understanding of trigonometry is essential. The student must be able to use a calculator to find sine and inverse sine values. If the student doesn't have these prerequisite skills, these skills will have to be taught as the student needs them in the course.

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

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

To the Instructor

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%.

Waves, Light and Sound

Unit 1 - Waves

Outcomes

1.1 Understand the characteristics of waves.

1.1.1 Describe the production, characteristics, and behaviours of longitudinal and transverse mechanical waves.

1.1.2 Define the frequency and the period of a wave, and show how they are related.

1.1.3 Calculate the frequency or the period of a wave given one of the two variables.

1.1.4 Explain what is meant by the cycle and amplitude of a wave, and give examples.

1.1.5 Describe what is meant by a transverse wave, recognize its crests and troughs, and define the wavelength, amplitude, and period of a periodic wave.

Notes for Teaching and Learning

The concepts associated with mechanical waves follow from simple harmonic motion covered in Physics 2104 B. If there is a long time interval since the student finished that course, the instructor may want to review that Unit with the student.

Some students believe that the wave's medium moves along with the wave. Students may picture the motion of the medium to that of a roller coaster. The instructor may want to spend a little time clarifying this.

Unit 1 - Waves

Suggestions for Assessment

Students can be asked to sketch and label waves with particular dimensions. Problems 31-36 on page 435 provide extra questions. There are also extra questions and activities on the Center for Distance Learning and Innovation site.

Resources

Concepts and Connections: pages 384-390

Concepts and Connections Teacher's Resource Guide: pages 181-187

Blackline Master: 53-1

Physics 2204 Curriculum Guide: pages 78-81

Center for Distance Learning and Innovation: Physics 2204: Unit 4: Section 1: Lessons 1-5
www.cdli.ca

Outcomes

1.1.6 Explain what is meant by a longitudinal wave, recognizing its compressions and rarefactions, and describes how such waves are created and transmitted, giving examples.

1.1.7 Identify points in phase and points out of phase on a wave train.

1.1.8 Draw diagrams of two waves in phase.

1.1.9 Draw diagrams of two waves completely out of phase.

1.1.10 Apply the universal wave equation to explain and predict the behavior of waves.

1.1.11 Calculate the value of any given variable in the wave equation, given the values of the other two variables, or information from which these can first be determined.

Notes for Teaching and Learning

The remainder of this chapter will deal with light waves. Students should keep in mind that other waves can have other speeds and also that light waves are transverse waves.

Remind students that they have met the unit Hz (Hertz) before and that it is simply cycles per second (s^{-1}).

Unit 1 - Waves

Suggestions for Assessment

Additional questions are found on page 436, numbers 37-43.

The Center for Distance Learning and Innovation site has extra questions etc.

Resources

Concepts and Connections: pages 384-393

Concepts and Connections Teacher's Resource Guide: pages 181-187

Blackline Master: 53-1

Physics 2204 Curriculum Guide: pages 78-81

Center for Distance Learning and Innovation: Physics 2204: Unit 4: Section 1: Lessons 1-5
www.cdli.ca

Unit 2 - Light Properties I

Outcomes

2.1 Understand the properties of light.

2.1.1 Describe how light, as a form of energy, is produced and transmitted.

2.1.2 Calculate the third quantity given two of the speed of light, the distance it travels, and the time taken.

2.1.3 Explain the term "rectilinear propagation".

2.1.4 Differentiate between a beam and a ray of light.

Notes for Teaching and Learning

The demonstration of the pinhole camera from the *Teacher's Resource* is good for showing the rectilinear propagation of light. Once constructed it can be used over and over again with students.

The Center for Distance Learning and Innovation site is very good for this. Diagrams there are very good for helping students visualize these light properties.

Unit 2 - Light Properties I

Suggestions for Assessment

Extra problems are available on page 436: #45 - 46.

Resources

Concepts and Connections: pages 394-395

Concepts and Connections Teacher's Resource: pages 189-192

Physics 2204 Curriculum Guide: pages 82-83

www.cdli.ca: Physics 2204: Unit 4:Section 02: Lesson 07

Unit 2 - Light Properties I

Outcomes

2.2 Understand reflection of light.

2.2.1 Describe the reflection of light from a smooth plane surface, such as a mirror.

2.2.2 Explain qualitatively and quantitatively, with respect to light, the phenomenon of wave reflection.

2.2.3 Describe the reflection of light from a smooth plane surface, such as a mirror.

2.2.4 State the law of reflection.

2.2.5 Describe the formation of images in plane mirrors.

2.2.6 Use geometry to show how the position of an image in a plane mirror can be located.

Notes for Teaching and Learning

Explain to students that a "plane" mirror is the common flat mirror that they are familiar with. Other mirrors exist like circus/amusement park mirrors and their properties are different.

To illustrate that being able to see an image in a mirror is dependent on the position of the viewer, a demonstration involving two students and a mirror can be done. An object is placed far to the left and one student directly in front of the mirror and the second student far to the right. It may surprise the students that only one can see the object.

The text problems emphasize if images can be seen. Give students some problems of determining the image using the rules of Figure 10.23 and simple objects like arrows (↑).

Unit 2 - Light Properties I

Suggestions for Assessment

Ask students to draw what a letter e.g. K would look like in a mirror.

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

Resources

Concepts and Connections: pages 396-400

Concepts and Connections Teacher's Resource: pages 193-196

Physics Curriculum Guide: pages 82-83

ww.cdli.ca : Physics 2204 Unit 4: Section 2: Lesson 9

Unit 2 - Light Properties I

Outcomes

2.3 Understand refraction of light.

2.3.1 Describe what is meant by refraction of light, and explain why it occurs.

2.3.2 Compare the speed of light in air, in water, or in glass, with that in a vacuum.

2.3.3 Given the index of refraction, draw accurate diagrams for a ray of light passing through a variety of materials.

2.3.4 Define the index of refraction in terms of the speed of light.

2.3.5 Calculate the third quantity given two of the index of refraction, the speed of light in a medium, and the speed of light in a vacuum

Notes for Teaching and Learning

An analogy can be used to explain what happens as light moves through different media: When your car drives off the smooth highway and into the rough shoulder off the road, the shoulder slows down the right side of your car and causes it to "pull" to the right. This is similar to what happens to light striking a material.

Unit 2 - Light Properties I

Suggestions for Assessment

Extra problems are available on the Center for Distance Learning and Innovation site. Also problems 57-61 on page 438.

Resources

Concepts and Connections: pages 400-404

Concepts and Connections Teacher's Resource: pages 197-204

Physics 2204 Curriculum Guide: pages 84-85

www.cdli.ca: Physics 2204: Unit 4: Section 2: Lesson 11

Unit 2 - Light Properties I

Outcomes

2.4 Understand Snell's Law.

2.4.1 State Snell's law of refraction.

2.4.2 Calculate the third quantity given two of the angle of incidence, the angle of refraction, and the index of refraction.

Notes for Teaching and Learning

Ensure students complete the problems on sine and inverse sine (Sin^{-1}) . Problems with inverse sine may result from improper use of their calculators. It may be necessary to change the angles from radians to degrees using the mode function on the calculators.

Unit 2 - Light Properties I

Suggestions for Assessment

Extra problems are available in the text on pages: 438-439 : Problems: 64-69.

Core Lab #1: Snell's Law is to be submitted.

Resources

Concepts and Connections: pages 405-406; 442

Lab 10.1: page 442

Concepts and Connections Teacher's Resource: page 205

Physics 2204 Curriculum Guide: pages 84-85

www.cdli.ca: Physics 2204: Unit 4:Section 2: Lesson 10 (includes lab)

Unit 3 - Light Properties II

Outcomes

3. 1 Understand light phenomena.

3. 1.1 Describe the phenomenon of total internal reflection.

3. 1.2 Define the critical angle.

3. 1.3 Describe and apply the principle of superposition as it applies to transverse waves.

3. 1.4 Describe the constructive interference and destructive interference of pulses or waves, giving an illustration of each.

3. 1.5 Explain qualitatively with respect to light, the phenomenon of wave interference.

Notes for Teaching and Learning

The text investigates the various light phenomena from both a qualitative and quantitative view. Most of the quantitative explanations have been excluded for this unit.

The Center for Distance Learning and Innovation site has a number of excellent visuals for interference, refraction, diffraction etc for light. Use of these will be of great assistance in generating understanding of these concepts in students.

The Doppler effect will be restricted to sound for this course.

Unit 3 - Light Properties II

Suggestions for Assessment

Questions that can be asked:

1. If the speed of light were the same for the various temperatures and densities of air, would there still be mirages?

2. If light traveled at the same speed in raindrops as it does in air, would we still have rainbows? (Ans no as there would be no refraction, no dispersion of light and no rainbow).

3. Why are optical fibers often called "light pipes"?

4. We can hear sounds around corners, but we cannot see around corners, what is the difference?

Additional questions may be found on some of the activities/ test yourself sections of the various lessons on the Center for Distance Learning and Innovation site.

It is recommended that students have a test on the material to this point before proceeding further. This will help the instructor determine if any remedial material should be supplied before further concepts are added.

Students could be assigned to write several paragraphs on an application of total internal reflection other than the rainbow.

Resources

Concepts and Connections: pages 411 - 413; 414 - 415; 424 - 426

Concepts and Connections Teacher's Resource: pages 215 - 218; 223 - 224

Physics 2204 Curriculum Guide: pages 84 - 85

www.cdli.ca: Physics 2204: Unit 4: Section 01: Lessons: 7 -11
Section 02: Lessons:11-13

Unit 4 - Sound Properties I

Outcomes

4. 1 Understand the properties of sound.

4. 1.1 Describe how sound, as a form of energy, is produced and transmitted, giving examples.

4. 1.2 Explain how the transmission of sound is dependent on the medium.

4. 1.3 Calculate the third quantity given two of the speed of sound, the distance travelled, and the time taken.

4. 1.4 Calculate the value of air temperature or the speed of sound in air given either variable.

4. 1.5 Define Mach number and relate its value to the speed of sound in terms of subsonic, supersonic and hypersonic.

4. 1.6 Explain the phenomenon of the sonic boom, describe the problems it causes, and how such problems can be minimized.

Notes for Teaching and Learning

Students may have difficulty with the concept that sound travels through a medium, but the medium does not move along with the wave.

A vibrating tuning fork placed in water can be used to show sound waves being produced.

As sound waves are frequently represented like transverse waves on paper, students should be frequently reminded that sound waves are actually longitudinal.

The Core Lab may be done by simulation using the Center for Distance Learning and Innovation site. This core lab could be used to introduce the students to the concept of sound.

Unit 4 - Sound Properties I

Suggestions for Assessment

Extra problems are available on pages 477-479 of *Concepts and Connections* on waves and transmission and speed of sound.

Core Lab #2: Speed of Sound is to be submitted for grading.

Resources

Concepts and Connections: pages 445-458; page 483

Concepts and Connections Teacher's Resource Guide: pages 231-237

Physics 2204 Curriculum Guide: pages 88-95

www.cldi.ca: Physics 2204: Section 04:
Unit 01: Lesson 1
Unit 02: Lesson1 and Lesson 6

www.cldi.ca : Physics 2204: Section 04:
[Lab Simulations: Unit 02: Lesson 02 and Unit 02: Lesson 04]

Unit 4 - Sound Properties I

Outcomes

4. 1.7 Determine the speed of sound in air.

4. 1.8 Define sound intensity, and describe how it varies with distance from a point source.

4. 1.9 Define sound intensity level.

4. 1.10 Explain the Doppler effect phenomenon qualitatively and give examples.

4. 1.11 State the typical frequency range of human hearing, and the effect that aging can have on this range.

4. 1.12 Define ultrasonic frequencies, and give examples.

4. 1.13 Describe and evaluate the design of technological solutions and the way they function, using scientific principles.

Notes for Teaching and Learning

Students may have difficulty believing a sonic boom is being heard continuously. Many believe the sound only occurs as the plane “breaks the sound barrier”.

Refer students to their Appendix A to read about the effects of age on hearing loss. They could also do a search on the Internet. Many students know older adults with hearing loss and may find this information interesting.

Unit 4 - Sound Properties I

Suggestions for Assessment

Ask students to explain what happens when a plane "breaks the sound barrier".

Questions 17 and 19 on page 477 can be given as an assignment.

Resources

Concepts and Connections: pages 458-463; 468-473; 483

Core STSE: "*Physics of Guitars"* from Appendix B of the Study Guide

Concepts and Connections Teacher's Resource Guide: pages 239-244

Physics 2204 Curriculum Guide: pages 88-95

www.cldi.ca: Physics 2204: Section 04: Unit02: Lesson 5

Unit 4 - Sound Properties I

Outcomes

4. 1.14 Analyze natural and technological systems to interpret and explain their structure.

4. 1.15 Analyze and describe examples where technological solutions were developed based on scientific understanding.

Notes for Teaching and Learning

Technological systems from the text can be further studied by researching the topic on the Internet.

Unit 4 - Sound Properties I

Suggestions for Assessment

The "Physics of Guitars" should be submitted for grading. The instructor may decide to wait until the end of Unit 5 before doing this application of physics.

Students could be asked to write an additional report on ultrasonic or electrocardiograph technologies and how they function.

Resources

Concepts and Connections: pages 458-463; 468-473; 483

Core STSE: "*Physics of Guitars"* from Appendix B of the Study Guide

Concepts and Connections Teacher's Resource Guide: pages 239-244

Physics 2204 Curriculum Guide: pages 88-95

www.cldi.ca: Physics 2204: Section 04: Unit 02: Lesson 5

Unit 5 - Sound Properties II

Outcomes

5.1 Understand wave properties using sound waves as examples.

5.1.1 Explain, with respect to sound, the phenomena of wave interference.

5.1.2 Describe how sound, as a form of energy, is produced and transmitted.

5.1.3 Explain how the transmission of sound is dependent on the medium.

5.1.4 Explain, with respect to sound, the phenomena of wave interference and reflection.

5.1.5 Explain how standing waves are produced.

5.1.6 Explain what is meant by resonance, and why it is important for engineers to take account of this phenomenon in designing buildings and bridges in windy areas.

Notes for Teaching and Learning

Videos or animations could be helpful for students in understanding interference patterns.

Students could build an interference pattern by using two points 25 cm apart. Using each point as a centre, have students draw concentric circles with radii that are whole number multiples of 10 cm (the wavelength). The circles represent crests. Help students identify nodal points and areas of constructive and destructive interference.

Unit 5 - Sound Properties II

Suggestions for Assessment

Additional questions can be found on the Center for Distance Learning and Innovation site.

Conceptual Questions 2-7; 18-22 on page 477 can be used for assessment.

Resources

Concepts and Connections: pages 486-492; 505-520

Concepts and Connections Teacher's Resource: pages 247-252

Blackline Master: 74-1 page 333

Physics 2204 Curriculum Guide: pages 88-95

Study Guide: Appendix B: "The Physics of Guitars"

www.cdli.ca Physics 2204: Unit 4:
Section 01: Lesson 10 and Lesson 11
Section 02: Lesson 1

Unit 5 - Sound Properties II

Outcomes

5.1.7 Explain the phenomenon of beats.

5.1.8 Explain how the structure of sound waves applies to music.

5.1.9 Examine how guitars produce music.

Notes for Teaching and Learning

Students in the classroom that have stringed instruments could be asked to bring one in and show how the different sounds are produced.

Unit 5 - Sound Properties II

Suggestions for Assessment

Additional questions can be found on the Center for Distance Learning and Innovation site.

Conceptual Questions 2-7; 18-22 on page 477 can be used for assessment.

Resources

Concepts and Connections: pages 486-492; 505; 508-509

Concepts and Connections Teacher's Resource: pages: 247-252

Blackline Masters: 74-1 page 333

Physics 2204 Curriculum Guide: pages 88-95

Study Guide: Appendix B:"The Physics of Guitars"

www.cdli.ca Physics 2204: Unit 4:
Section 01: Lesson 10 and Lesson 11
Section 02: Lesson 1