Adult Basic Education

Science

Physics 3104C

Magnetic Fields, Matter and Energy

Curriculum Guide

Prerequisite: Physics 3104B

Credit Value: 1

<u>Physics Concentration</u>

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

Table of Contents

To the Instructor

I. Introduction to Physics 3104C

The similarities of gravitational, electric and magnetic fields were introduced in Physics 3102B. Electrical potential, current, voltage, and resistance in circuits were explored. In this course magnetic fields will be further explored and the induction of current by a magnetic field will be examined.

The final units of this course will study the relationship between matter and energy. This will draw on concepts from all Physics courses studied. Quantum theory is introduced and both the electronic and nuclear properties of the atom are studied. As much as possible the mathematical aspects of these topics has been reduced.

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	
Outcomes	**Notes for Teaching and Learning**
Specific curriculum outcomes for the unit.	Suggested activities, elaboration of outcomes, and background information.

Unit Number - Unit Title	
Suggestions for Assessment	**Resources**
Suggestions for assessing students' achievement of outcomes.	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/

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%.

Magnetic Fields, Matter and Energy

Outcomes

1.1 Understand magnetic fields.

1.1.1 Describe magnetic fields as regions of space in terms of poles and illustrate the source and direction of the lines of force.

1.1.2 Define a lodestone as a naturally occurring magnet.

1.1.3 Compare and contrast magnetic fields with gravitational and electric fields.

1.1.4 Explain the domain theory.

1.1.5 State and apply the law of magnetic forces.

1.1.6 Explain magnetic phenomena with reference to the domain theory.

Notes for Teaching and Learning

Remind students that not all metals are magnetic. You can demonstrate this using a magnet and a variety of metallic objects you may have on hand.

If you can break a bar magnet into half you can show it retains its magnetic orientation. This can help students accept the “domain theory”.

Suggestions for Assessment

Questions 1 to 5 on page 663 of text can be used to assess understanding of this material.

Resources

Concepts and Connections: pages 628 - 630

Concepts and Connections Teacher's Resource:
pages: 497 - 500

www.cdli.ca: Physics 3204: Unit 2: Section 3 Lesson 1
Multimedia Learning Objects - Electromagnetic Induction #28-29

Physics 3204 Curriculum Guide: pages 82 and 83

Outcomes

1.1.7 Map a magnetic field using a test compass.

1.1.8 Define the direction of magnetic field lines.

1.1.9 Draw magnetic field lines in the regions surrounding a single bar magnet, two bar magnets, opposite poles facing, and like poles facing.

1.1.10 Define ferromagnetic materials.

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

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

Notes for Teaching and Learning

Students may think that field *lines* actually exist. Emphasize these are a way of *representing* field strength and direction.

Suggestions for Assessment

Students can be asked to draw field lines around magnet or explain why compasses align themselves from north to south.

Students can be asked to write a report on how domain theory supports observations on other magnetic phenomena.

Resources

Concepts and Connections: pages 630 - 632

Concepts and Connections Teacher's Resource: pages 497 - 500

www.cdli.ca: Physics 3204: Unit 2: Section 3 Lesson 2

Physics 3204 Curriculum Guide: pages 82 and 83

Unit 2 - Electromagnetic Induction

Outcomes

2.1 Understand magnetic fields.

2.1.1 Explain Oersted's principle for straight conductors.

2.1.2 Illustrate the use of the left-hand rule #1.

2.1.3 Define paramagnetic and diamagnetic materials.

2.1.4 Explain Oersted's principle as applied to a solenoid.

2.1.5 Explain the solenoid as an electromagnet.

2.1.6 List four factors that determine the strength of an electromagnet.

2.1.7 Explain the role of permeability and its effects on electromagnetism.

2.1.8 List and briefly describe three applications of an electromagnet: lifting electromagnet, relay, and electric bell.

Notes for Teaching and Learning

You may want to supply students with a more detailed explanation of applications of electromagnets from other resources.

Careful if another text is used to support the material in this unit. Many texts use the "right-hand" rules as they treat current in the conventional (positive) manner.

Suggestions for Assessment

Ask students to write a brief report on one application of electromagnet.

Resources

Concepts and Connections: pages 633 - 637

Concepts and Connections Teacher's Resource: pages 501 and 502

Physics 3204 Curriculum Guide: pages 84 and 85

www.cdli.ca: Physics 3204: Unit 2: Section 3, Lesson 1. Page (c), Lesson 2, Lesson 3

Unit 2 - Electromagnetic Induction

Outcomes

2.2 Understand electromagnetic induction.

- 2.2.1 Define the motor principle.
- 2.2.2 Analyze qualitatively the force acting on a moving charge in a uniform magnetic field.
- 2.2.3 Analyze qualitatively electromagnetic induction by both a changing magnetic flux and a moving conductor.
- 2.2.4 State Faraday's law of electromagnetic induction.
- 2.2.5 Explain how alternating current can be generated.
- 2.2.6 Explain Faraday's iron ring apparatus.
- 2.2.7 Define transformer.

Notes for Teaching and Learning

A common misconception is that the magnet is the source of voltage. Stress that voltage is produced by the work done when a magnet and a closed loop of wire are moved.

If time permits you can demonstrate a transformer.

Students who are interested in careers in Electricity/Electronics would benefit from examining AC and DC generators. They are not part of the course, bu the instructor may choose to do this for enrichment.

Unit 2 - Electromagnetic Induction

Suggestions for Assessment

Students should complete and submit Core Lab #1: Electromagnetic Induction on page 691 to 692.

Students should submit the STSE, "The Physics of Cell Phones" Assignment.

Resources

Concepts and Connections: pages 691 and 692

Concepts and Connections: Teacher's Resource: pages 519 -526 Blackline Master 57-1; 59-1

www.cdli.ca: Physics 3204: Unit 2, Section 3, Lesson 4-8 (parts of these) Multimedia Learning Objects: 35-40

Study Guide: Appendix A: "The Physics of Cell Phones"

Unit 3 - Quantum Mechanics

Outcomes

3.1 Understand the basis of the quantum mechanical model of the atom in electromagnetic radiation.

3.1.1 Explain how quantum physics evolved as new evidence came to light and as laws and theories were tested and subsequently restricted, revised, or replaced.

3.1.2 Define quantum theory.

3.1.3 State the problems with the wave theory of light: energy is quantified, light has momentum, atomic particles exhibit wave properties, and neutral atoms are stable.

3.2 Understand black-body radiation.

3.2.1 Define black-body radiation.

3.2.2 Describe how the quantum energy concept explains black-body radiation.

3.2.3 Show how a black-body spectrum changes with temperature.

3.2.4 Use Wein's Law.

Notes for Teaching and Learning

A number of texts cover this material less quantitatively than *Concepts and Connections*. You want to offer one of these to students to read first.

Light behaves like waves in empty space and like particles when it interacts with matter.

Students probably are not familiar with the changing temperatures from Centigrade (Celsius) to Kelvin and vice versa. Point out that using Wein's Law requires temperatures in Kelvin.

Suggestions for Assessment

Ask students to list the problems with the wave theory of light. Later students should be able to explain how quantum theory overcomes these problems.

Questions like Problems 19 to 21 can be assigned.

Resources

Concepts and Connections: pages 694 and 695; 697 - 701

Concepts and Connections, *Teacher's Resource* pages: 541 - 543

www.cdli.ca: Physics 3204: Multimedia Learning Objects : 01, Unit 3, Section 1

Unit 3 - Quantum Mechanics

Outcomes

3.3 Understand the photoelectric effect.

3.3.1 Define the photoelectric effect.

3.3.2 Describe how the quantum energy concept explains the photoelectric effect.

3.3.3 State and solve problems using Planck's equation ($E = hf$).

3.3.4 Define the work function.

3.3.5 Relate the energy of the incident light (photon) to the work function.

3.3.6 Explain qualitatively the Compton effect, using the laws of mechanics, the conservation of momentum, and the nature of light.

3.3.7 Determine if incident light will cause the photoelectric effect for a given metal.

3.3.8 Explain how photon momentum changed scientific thinking on the properties of light (waves).

3.3.9 Explain how photon momentum revolutionized thinking in the scientific community.

Notes for Teaching and Learning

The material on momentum and photons is treated very qualitatively.

Multimedia Learning Object #3 would be very helpful here.

Again the text treats this material with a very mathematical approach. This course is less mathematical and other physics (or chemistry) texts may cover the material in a more qualitative manner.

Suggestions for Assessment

Following study of the work on black body radiation and the photoelectric effect, students should be able to explain how the concept of the photon explains these phenomena.

Create problems similar to number 24 on page 732 using different wavelength of light and different metals.

Resources

Concepts and Connections: pages 702 - 706; 707 - 711

Physics 3204: Curriculum Guide: pages 102 and 103

www.cdli.ca: Physics 3204. Multimedia Learning Objects 02-05, Unit 3: Section 01: Lessons 2-3, Section 02: Lesson 1-2, Section 03: Lesson 1.

Unit 4 - Model of the Atom

Outcomes

4.1 Understand the quantum mechanical model of the atom.

4.1.1 Explain qualitatively how the Bohr atomic model is a synthesis of classical and quantum concepts.

4.1.2 Describe qualitatively how the Bohr model of the atom explains emission spectra and absorption.

4.1.3 Describe qualitatively Bohr's radius.

4.1.4 Define qualitatively the energy of an electron in Bohr's atom.

4.1.5 Explain why the Bohr Model is limited to one-electron systems.

Notes for Teaching and Learning

From the Bohr Model, electrons are considered to be in levels. The levels an electron can exist at are like steps on a stair. You can be on the 3^{rd} step or 4^{th} step but not on the 3.5^{th} step.

The Lyman, Balmer and Paschen series result from light emitted as an electron falls from a higher level to a lower level. The Lyman series involves e's falling to the **first** level from levels 2,3,4... The Balmer series involves e's falling to the **second** level from levels 3,4,5,... The Paschen series involved e's falling to the **third** level from levels 4,5,6...

Tell students that the Bohr model is actually <u>not</u> correct but that it was so powerful because it explained the spectrum of hydrogen. They should know that the Quantum Mechanical Model of the atom exists but that it is beyond the scope of this course.

Suggestions for Assessment

Ask students to describe the evidence from the spectrum of hydrogen that supports the Bohr model.

Ask students to explain why electrons do not fall into the nucleus.

Ask students how the electron in hydrogen emits energy as it drops from level to level.

Ask students why it is important to recognize the wave-particle duality of light.

Ask students about what limits the Bohr Model to one electron systems.

Resources

Concepts and Connections: pages 712 - 718

Concepts and Connections, *Teacher's Resource*: pages 553 and 554

Blackline Master 64-1

Physics 3204: Curriculum Guide: pages 104 - 107

www.cdli.ca: Physics 3204: Multimedia Learning Objects 06-07, Unit 3: Section 4: Lessons 1-3

Unit 4 - Model of the Atom

Outcomes

4.1.6 Explain the relationship among the energy levels in Bohr's model, the energy difference between levels, and the energy of the emitted photons.

4.1.7 Summarize the evidence for the wave and particle models of light.

4.1.8 Define wave–particle duality.

4.1.9 Compare the measured wavelengths of electromagnetic energy to the emission spectra for hydrogen.

4.1.10 Give evidence of light being both a wave and a particle.

4.1.11 Explain how quantum physics evolved as new evidence came to light and as laws and theories were tested and subsequently restricted, revised, or replaced.

Notes for Teaching and Learning

Again other texts treat this material in a more qualitative manner. You may find one which is easier for students to understand.

A lot of material on the Quantum Mechanical Model of the atom is available on the Internet.

Suggestions for Assessment

Students could be asked to write a paper outlining the changes in understanding of the model of the atom that developed due to quantum theory.

Resources

Concepts and Connections: pages 712 - 718

Blackline Master 68-1

Physics 3204: Curriculum Guide: pages 104 - 107

www.cdli.ca: Physics 3204: Multimedia Learning Objects 06-07, Unit 3: Section 4: Lessons 1-3

Unit 5 - Nuclear Reactions

Outcomes

5.1 Understand nuclear particles and nuclear reactions.

5.1.1 Describe sources of radioactivity in the natural environment.

5.1.2 Describe the products of radioactive decay, and the characteristics of alpha, beta, and gamma radiation.

5.1.3 Name and define the following: electrons, neutrons, protons, nucleus, atomic number, atomic mass number, and isotope.

5.1.4 Define transmutations and radioactivity.

5.1.5 Define alpha decay, beta minus decay and beta plus decay, electron capture, and gamma decay.

5.1.6 Use $E = mc^2$ to determine energy released when an atom undergoes nuclear decay.

5.1.7 Predict products of nuclear decay reactions.

Notes for Teaching and Learning

Remind students that atoms are not the smallest particles of matter.

Review the structure of the atom and identify each particle's location and charge.

Make sure students understand α decay first before proceeding to other decay types.

Students are often very interested in this material as they have come across these terms on the news, etc.

You will need to make up problems to use $E = mc^2$.

Other decays that could be used are those in Problems 2 to 3 on page 751. Calculate the total mass of the reactant and product using Table 18.1 and find the difference for students to use in problems.

Unit 5 - Nuclear Reactions

Suggestions for Assessment

Set up tables like Problem 42 on page 773 for nuclear properties and isotopic symbols.

Many chemistry text have problems like this.

Ask why atoms do not fly apart.

Ask students to complete nuclear decay equations. The Handbook of Chemistry and Physics lists the isotopes of the elements and their means of decay.

Resources

Concepts and Connections: pages 738; 741 - 742; 744 - 749

Physics 3204: Curriculum Guide: pages 108 and 109

www.cdli.ca: Physics 3204: Multimedia Learning Objects 07-11, Unit 3: Section 6: Lessons 1-3

Outcomes

5.1.8 Define half-life.

5.1.9 Analyze data on radioactive decay to predict half-life.

5.1.10 Complete half-life calculations when the number of half-lives is limited to whole numbers.

5.1.11 Describe the sources of radioactivity in natural and constructed environments.

Notes for Teaching and Learning

Take students through an example where they start with 100g of substance where the half-life is a half-day (.5) day. Ask them how much will be remaining after two (2) days.

If there are 2 days - there are 4 half-lives:

100 g → 50g
50 g→ 25 g
25 g → 12.5 g
12.5 g → 6.25 g or 6.3 g (sig. figs.)

Students need to be able to use logs to solve some of the problems in text. If they have not studied logs in Math yet, you will have to ask the Math instructor to teach this topic **or** keep problems to the type that can be solved through reasoning (like above). Use Table 18.4 with its list of some half-lives to create problems.

Suggestions for Assessment

Students could be asked to write a page on radioactive dating.

Use problems of the type:

Given the half life of iodine - 131 is 8.04 days, how much iodine -131 remains from a 100g sample after 40.2 days?

Resources

Concepts and Connections: pages 751 and 752

Physics 3204: Curriculum Guide: pages 110 and 111

www.cdli.ca: Physics 3204: Multimedia Learning Objects 12, Unit 3: Section 4: Lessons 4

Unit 6 - Nuclear Energy

Outcomes

6.1 Understand the relationship between nuclear reactions and nuclear energy.

6.1.1 Compare and contrast fission and fusion.

6.1.2 Analyze examples of Canadian contributions to a particular development of science and technology.

6.1.3 Describe the three features and safety systems of the CANDU reactor.

6.1.4 Develop, present, and defend a position or course of action based on identifying multiple perspectives that influence the issue, and on interpreting data and the relationship among variables.

6.1.5 Describe the pros and cons of nuclear energy.

6.1.6 Apply quantitatively the laws of conservation of mass and energy using Einstein's mass-energy equivalence.

6.1.7 Predict reactant or product atomic numbers and/or mass for fission and fusion reactants.

6.1.8 Solve problems using $E = mc^2$.

Notes for Teaching and Learning

Explain that most of the energy of nuclear fission is in the kinetic energy of the fragments.

Supply the student with the Blackline Master (79-1) for the CANDU Nuclear Reactor.

Use the Blackline Master to have students describe the CANDU reactor.

Unit 6 - Nuclear Energy

Suggestions for Assessment

Give students problems in which there is a change of mass and ask them to calculate the energy associated with it.

Potential is there for an assignment on nuclear power. Other assignments could be on smoke detectors or radioactive dating.

Resources

Concepts and Connections: pages 754 - 769

Physics 3204: Curriculum Guide: pages 112 and 113

Blackline Masters: 78-1 and 79-1

www.cdli.ca: Physics 3204: Multimedia Learning Objects 13-15, Unit 3: Section 7: Lessons 1-3