Adult Basic Education

Science

Physics 1104

Motion

Study Guide

Credit Value: 1

Text: *Science 10*. Ritter, Plumb et al.; Nelson, 2001

Physics Concentration

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

Table of Contents

Text: *Science 10*, Nelson

Other Resources: Scientific Calculator
Graph or Quad Paper

To the Student

I. Introduction to Physics 1104

The purpose of this course is to introduce you to the study of motion and investigate the principles of kinematics which are fundamental to later study of physics. Principles introduced in this unit will be the basis for further study in Physics at the 2000 and 3000 level. You will use skills from mathematics to assist you in your study of motion and build on the skills of graph making you have learned in your mathematics courses. Much of this unit involves calculations. Know how to use your calculator correctly. Be methodical in solving problems. Include units in all your answers and be aware of units in setting up your problems for solving.

In addition to your study guide and text, you will need a calculator and graph paper. As you work through each page of your study guide, you should ensure that your answers to the problems are correct, before proceeding to the next page. You will need to check with your instructor for answers as there are no solutions at the end of the chapter.

You will have two core labs for this course. Let your instructor know in advance that you are getting close to needing to do these labs. Each lab will require a written lab report, which will be evaluated as part of your course mark. In addition there are several other activities or written reports that you will be asked to submit for evaluation

II. Use of Science Study Guides

Before beginning this course, ensure you have the text and any other resources needed *(see the information in the Introduction to this course for specifics)*.

As you work through the Study Guide, you will see that it is divided according to the Units listed in the Table of Contents. When you open a unit it will have the following components:

To the Student

Reading for this Unit:
Here you will find the chapters, sections and pages of the text you will use to cover the material for this unit. Skim the sections of the textbook, look at the titles of the sections, scan the figures and read any material in the margins. Once you have this overview of the unit, you are ready to begin. Do not be intimidated by the content. You will work through the text, section by section, gaining knowledge and understanding of the material as you go.

References and Notes	**Work to Submit**
This left hand column guides you through the material to read from the text. Read any highlighted notes that follow the reading instructions. The symbols ▶▶ direct you to the materials that you should complete when finished a reading assignment.	You come across three (3) headings in this right hand column. **Writing:** This section comprises your notes for the unit. Here you will find either written questions or references to specific questions or problems from your text. You may want to write out each question followed by the answer. This material should be checked by your instructor before moving on to the next unit. Mathematical problems should have their solutions checked as you go. **Laboratory:** This section indicates if there is a Core Lab that should be completed for the unit. Let the instructor know in advance that you will be ready for the lab. A lab report should be submitted for each Core Lab. Your instructor will provide guidelines as to how s/he wants the report written. **Assignment:** This section indicates if there is an assignment that should be completed for the Unit. The information in the "References and Notes" column will indicate how you obtain the assignment. These assignments frequently relate the science content to technology, society and the environment.

III. 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%.

Unit 1 - Investigating Speed

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: *Science 10*

Chapter 9:	Introduction:	pages 338-348
	Section 9.5:	pages 354 - 359
	Section 9.7:	pages 362 - 365
	Section 9.8:	pages 366-368
	Section 9.10:	pages 372-373

References and Notes

Read pages 338 to 348 ▶▶

This section introduces you to some important concepts of measurements. Physical sciences involve the use of measurements to investigate the world around us. It is important that we understand how to make and record measurements and how to use the correct rules when we have calculations involving measurements.

In addition to Chapter 9 of your text, also refer to the Skills Handbook and the Glossary at the end of your text.

It will be necessary to use a calculator through this unit. Page 698 may be of assistance here. Also calculation rules are further explained on page 702 to 704.

Work to Submit

Writing:

3.0 Define the following terms and indicate the SI units:
- (a) distance
- (b) time

3.0 Explain what is meant by significant digits.

3.0 Write the certainty rules for (a) multiplying and dividing and for (b) adding and subtracting.

Unit 1 - Investigating Speed

References and Notes	Work to Submit
Go to page 349 ▶▶	3.0 Complete Questions 2 to 9.
Before proceeding, check your answers to the assigned questions	
Read pages 354 to 355 ▶▶	3.0 Define each of the following terms: (a) average speed (b) instantaneous speed (c) uniform motion
*You are introduced here to one of the many formulas in this course. The Greek letter Δ, read delta is used a lot. When you see it say the words "change in" that is Δt reads change in time and refers to the difference in the **second** time measurement (t_2) and the **first** time measurement (t_1).*	
Notice that your text uses italics for symbols that represent quantities and that these are also found in equations.	
As you review the work to submit, note that there is a problem to complete after you study a sample problem. Do the work in that order, so you encounter similar problems to work on that you have seen a solution to.	
Study Sample Problem 1 on page 355 ▶▶	3.0 Complete Problems 3(a) and 8(b) on page 358
Study Sample Problem 2 on page 356 ▶▶	3.0 Complete Problems 5, 6 and 7(a) on page 358 .
Study Sample Problem 3 on page 356 ▶▶	3.0 Complete Problems 8 (a) and (b) on page 358 .
Study Sample Problem 4 on page 357 ▶▶	3.0 Complete Problem 9 on page 358 .

Unit 1 - Investigating Speed

References and Notes

Read pages 362 to 365 ▶▶

*This section of the course involves using graphs to understand relationships and solve problems. The graphs in this course always involve time as an **independent variable (on the x axis)**. An independent variable is a variable chosen by the investigator who is trying to see a relationship between that variable (time) and another variable that is called the **dependent variable (on the y axis)**.*

The relationship we are studying in this unit is how distance travelled by an object depends on time i.e the distance an object has moved in a given time depends of how long it has been moving.

Page 699 reviews how to construct and use graphs. If you have not done any graphing recently, it is a good idea to study the graphing skills section carefully.

Recall that the equation for a straight line is $y = mx + b$ where m is the slope of the line and b is the y intercept.

Work to Submit

3.0 Complete the remaining Problems 10 and 11 on page 358.

3.0 What does the slope of a distance-time graph represent?

Unit 1 - Investigating Speed

References and Notes

Also recall that the slope can be found using any two points (x_1,y_1) and (x_2,y_2) and the formula

$$m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}.$$

When we plot time (t) on the x axis and distance (d) on the y axis, our slope becomes $\frac{\Delta d}{\Delta t}$ *which is speed (v).*

Go to page 365 ▶▶

You will find it easier to answer the next questions if you complete problems 5 and 6 first.

Now return to the start of the questions on page 365 ▶▶

Read the Case Study on pages 366 to 368 ▶▶

This is an interesting application of monitoring speed on highways.

Read Investigation 9.10 on page 372 to 373. This is a Core lab for this course. Let your instructor know you are ready to do this lab.▶▶

Guidelines for your report are found on page 691 of your text.

Work to Submit

3.0 Complete Problems 5 and 6.

3.0 Complete Problems 1 to 4.

Assignment:

3.0 Submit to your instructor the Case Study. Include the Questions (a) to (i) found throughout the readings and Questions 1 to 6 of *Understanding Concepts*. This will be part of your final grade.

Laboratory:

3.0 Submit your lab report to your instructor.

Unit 2 - Investigating Acceleration

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: *Science 10*

Chapter 10:
- Section 10.3 pages 384-389
- Section 10.4: pages 390-392
- Section 10.6: pages 396-397
- Section 10.7: pages 398-401
- Section 10.8: pages 402-403

References and Notes

Read pages 384 to 385 to Sample Problem 1 ▶▶

Note that acceleration can be a positive or negative number. If an object is slowing down, acceleration is negative.

Review Sample Problem 1 on page 385 and Problem 3 on page 386 ▶▶

Review Sample Problem 2 on page 386 ▶▶

Review Sample Problem 4 and 5 on page 387 ▶▶

Review Sample Problem 6 on page 388 ▶▶

Work to Submit

Writing:

3.0 Define each of the following terms and including an example with your definition:
- (a) acceleration
- (b) constant acceleration
- (c) average acceleration

3.0 What are the units for acceleration and how are they different from speed?

3.0 Answer Questions 4 to 8 (a) and 9 on page 388.

3.0 Answer Question 8 (b) on page 388.

3.0 Answer Questions 10 to 13 on page 389.

3.0 Complete Question 14 on page 389.

3.0 Complete Question 15 on page 389.

3.0 Complete Questions 1 and 2 on page 388.

Unit 2 - Investigating Acceleration

References and Notes	Work to Submit
Read pages 390 to 392 ▶▶	3.0 What information is available from the slope of the line of a graph of speed versus time? 3.0 Sketch what a graph of each of the following conditions would look like: (a) rapidly increasing speed (b) slowly decreasing speed (c) constant speed (d) rapidly decreasing speed 3.0 What does the area under the line represent in a speed-time graph?
Carefully review Sample Problems 1 and 2 on page 392 ▶▶	3.0 Complete Questions 5 and 6 on page 393. 3.0 Answer Questions 1 to 4 on page 393. 3.0 Answer Question 11 on page 393.
Read through Case Study 10.6 on pages 396 to 397. ▶▶ *Review your definition of the terms you wrote in your notes including that for instantaneous speed you met in Section 9.5 .*	**Assignment:** 3.0 Answer Questions (a) through (j) and Question 1 in Understanding Concepts. Submit your assignment.

Unit 2 - Investigating Acceleration

References and Notes	Work to Submit
Read pages 398 to 401: Review Figures 1 through 3 ▶▶	**Writing:** 3.0 Answer the following: (a) What type of **distance-time** graph do you get if the speed of an object is constant? (b) What type of **speed-time** graph do you get if the speed of an object is constant? (c) What generalization can you make about the instantaneous speed of an object if the object is moving at constant speed?
Review Figures 4 and 5 on page 399 ▶▶	3.0 Answer the following: (a) What type of **distance-time** graph do you get if the speed of an object is constantly increasing? (b) What type of **speed-time** graph do you get if the speed of an object is constantly increasing? Is the slope positive or negative? (c) How do you determine the instantaneous speed for an object whose speed is constantly changing?
Review Figure 6 on page 400 ▶▶	3.0 How do you determine the average speed for an object whose speed is changing?
Go to pages 400 to 401 ▶▶	3.0 Complete Questions 1 to 9.

Unit 2 - Investigating Acceleration

References and Notes

Read pages 402 to 403 ▶▶

This section is presented here to provide you with an understanding for the Investigation 10.9. This Investigation is not a Core Lab and your instructor may not choose to complete this. You should however work through the concepts as they will provide you with a better understanding of the material covered in Section 10.7.

The data used in this section comes from an air hockey table. The air hockey table provides a almost frictionless surface. (The role of friction is studied in Level 2 and 3 Physics, but has to do with resistance to movement.) In this case the air hockey table is not horizontal but on its side (not the way you would expect it to see it usually). Gravity is helping the puck to constantly accelerate as it moves down the table. (Acceleration due to gravity is also studied in Level 2 and 3 Physics.)

Work to Submit

3.0 What question is being asked here?

Unit 2 - Investigating Acceleration

References and Notes	Work to Submit
Study Figure 1 on page 402 and relate the dots 1 to 10 to the data obtained in Table 1 ▶▶	3.0 (a) First plot the distance-time graph using columns C and B data. (b) Now for each 100 ms (millisecond) or 0.10s. Calculate the change in distance in meters the puck has moved and use that to obtain the average speed for each time interval.
Remember $v_{av} = \Delta d/\Delta t$; now before actually calculating v_{av} change your d units from mm (millimeters) to m (meters) and your time units from ms (milliseconds) to s (seconds).	
Get values for time by assuming the average speed occurs half-way through each time interval. i.e if the average speed for the time between 100 ms and 200 ms was found to be 0.085 m/s, then next to that speed in your table write down time as being 150 ms (milliseconds). Convert your time to seconds and you can now plot your speeds (m/s) against time(s) and you should have the same plot that is given in Figure 2.	3.0 Next plot a speed-time graph. 3.0 Complete Questions 2 and 3(b) on page 403. **You should now prepare for Test #1.**
To prepare for your first quiz, you should review your notes and complete the questions indicated from the Chapters 9 and 10 Review sections. *Chapter 9 (pages 376 to 377)* ▶▶ *Chapter 10 (pages 410 to 411)* ▶▶	3.0 Complete Questions 1 to 12 and 14. 3.0 Complete Questions 1 to 16.

Unit 3 - Vectors

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: *Science 10*
Chapter 11: Section 11.1: pages 414 - 417
Section 11.6: pages 430 - 431
Section 11.7: pages 432- 436

References and Notes

The concept of vector quantities used in the next two chapters is a foreign concept to most of us. It is one that is common in physics. In physics we will often have to have some reference point to discuss what is happening

Read pages 414 to 417 ▶▶

Using vectors is like adding and subtracting sign numbers. If you are comfortable with doing that vectors won't be too difficult. If you are not comfortable, use your graphing skills to solve the problems.

Work to Submit

Writing:

3.0 Write the meaning of the following terms:
(a) Reference point
(b) Position
(c) Vector quantity
(d) Scalar quantity
(e) Displacement
(f) Vector

3.0 How is a scalar quantity different from a vector quantity (use an example)?

3.0 List the three rules used when drawing a single vector.

Unit 3 - Vectors

References and Notes	Work to Submit
Go to pages 416 to 417 ▶▶	3.0 Complete Questions 1 to 9 and 13.
Read pages 430 to 431. ▶▶	3.0 Complete Questions 1 to 4 of *"Understanding the Issue*".
Read pages 432 to 433. ▶▶	3.0 Define each of the following terms: (a) Velocity (b) Constant velocity (c) Average velocity
It is very easy to get speed and velocity mixed up. Remember velocity if a vector quantity and so has a direction included in it.	
*When solving problems involving velocity, remember it is change in displacement and that displacement is also a vector quantity, but time is **not** a vector quantity.*	
Read "Average Velocity" on page 433 ▶▶	3.0 Define average velocity.
Study Sample Problem 1 and 2 on pages 433 to 434. ▶▶	3.0 Complete Questions 3 to 5 on page 436.
Study Sample Problem 3 on page 434 ▶▶	3.0 Complete Questions 6 (a) to (e); 7(a), (b), (e) and (f) on page 436.
Carefully note the example illustrating the difference between average speed and average velocity found on page 435	
Complete Chapter Review Problems on pages 442 to 443 ▶▶	3.0 Questions 4 to 9, 10(a), 11(c), 15(b) to (c), 17(b), (c)

Unit 4 - Displacement, Velocity and Acceleration

To fulfill the objectives of this unit, students should complete the following:

Reading for this unit: *Science 10*

Chapter 12:
- Section 12.1: pages 446 - 451
- Section 12.2: pages 452 - 457
- Section 12.3: pages 458 - 459
- Section 12.4: pages 460 - 461
- Section 12.5: pages 462 - 465
- Section 12.6: pages 466 - 469

References and Notes

Read pages 446 to 448 to Sample Problem 1 and carefully study Figures 4, 5 and 6 ▶▶

It is important to see the similarities and differences between speed and velocity. Velocity is a vector quantity i.e. has a direction. Also it is possible for velocity to have a negative value, when the slope of the line is negative. Remember motion is always with reference to another object. So a negative slope above the x-axis indicates motion toward a reference point. Below the x-axis it is away from a reference point. [Figure 7 illustrates this point - study it carefully]

Study Sample Problem 1 on page 448 ▶▶

Work to Submit

Writing:

4.1 Complete Question 2 on page 450.

4.2 How can velocity be obtained from a position-time graph?

4.3 What does it mean when the slope of a position-time graph is negative?

4.4 Answer Questions 3 to 5 on page 450.

4.5 How is instantaneous velocity determined from a position-time graph?

Unit 4 - Displacement, Velocity and Acceleration

References and Notes

Study Sample Problem 2 on page 449 ▶▶

Remember to indicate direction

Go to page 486. ▶▶

Read pages 452 to 453 to the end of Sample Problem 1 ▶▶

This section investigates the information available in velocity-time graphs. It is important to recognize now that in these graphs the acceleration determined is now a ***vector*** *quantity. That is it has a direction associated with it and uses the symbol* $\vec{a}$ *now rather than just* ***a*** *.*

Read page 453 to 454 to the end of Sample Problem 2 ▶▶

Study Sample Problems 3 and 4 ▶▶

Read through the Case Study on Technology and Skiing on pages 458 to 459 ▶▶

Work to Submit

4.6 Answer Questions 6 to 7 on pages 450 to 451.

4.7 Complete Question 2 - 4, 9, and 11.

4.8 Complete Questions 2 to 4 on page 456.

4.9

(a) What is the direction of acceleration for an object whose velocity is increasing?

(b) What is the direction of acceleration for an object whose velocity is decreasing?

4.10 Complete Question 6 on page 456.

4.11 Complete Questions 7 to 10 on page 457.

Assignment:

4.12 Write several paragraphs describing the technology involved in developing safe skis. This should include:

- how the ski base is formed and why.
- ski bindings
- turning control
- ski brakes

Unit 4 - Displacement, Velocity and Acceleration

References and Notes

Let your instructor know you are ready to complete Investigation 12.4 on page 460 ▶▶

After completing this lab, submit to your instructor a lab report. Use page691 of your text to help you write up your report.

Read pages 462 to 463 and study Sample Problems 1 and 2 (carefully note the signs) ▶▶

The calculations in this section are very similar to those in Section 10.3. You just need to remember that acceleration and velocity involve the addition of a direction. The direction is indicated by a positive or negative sign.

Make sure to watch your units as units for acceleration can get complicated. Use Table 1 on page 465 to assist you in assigning signs to velocity and acceleration values for solving problems.

When solving problems make sure you start each by writing down your givens, what you are trying to solve for and then your formulas and rearrange your formula to solve for your unknown.

Work to Submit

Laboratory:

4.13 Submit a written lab report. Include answers to Understanding Concepts, Questions 1, 2 and 4.

Writing:

4.14 Complete Problems 3 and 4 on page 465.

Unit 4 - Displacement, Velocity and Acceleration

References and Notes

Study Sample Problem 3 and Figure 2 as well as Sample Problem 4 on pages 463 to 464 ▶▶

Carefully study the information on page 466 and Figures 1(a) through 1(d). Now answer the questions ▶▶

The area between the line and the x-axis will provide the displacement on velocity-time graph. Remember the area of a rectangle is given by A =l x w and that of a triangle is A =1/2bh

It is very important to remember that the problems you are solving in this section will involve ***constant acceleration****. In the case of constant acceleration, the average velocity will be given by* $\frac{\vec{v}_1 + \vec{v}_2}{2} = \vec{v}_{av}$ *and just as you could solve for distance by rearranging the formula v = d/Δt or d = vΔt, displacement can be determined from*

$$\Delta d = \left(\frac{\vec{v}_1 + \vec{v}_2}{2} \right) \Delta t$$

Carefully study Figures 3 and 4, then Sample Problem 1 and 2. Note that the values found are vectors ▶▶

Note that the values found are vectors (i.e have a direction)

Work to Submit

4.15 Complete Questions 5 to 8 on page 465.

4.16 How can we use position-time graphs to find velocity?

4.17 How can we use a graph of velocity-time to find displacement?

4.18 Answer Question 2 on page 472.

Unit 4 - Displacement, Velocity and Acceleration

References and Notes	Work to Submit
It is very important to remember that these are vectors and you will need to assign positive or negative signs to the values i.e if one velocity is south and the other is north, then the velocity of one will be positive and the other negative.	
*While you should be able to construct and use position-time and velocity-time graphs, you will **not** be expected to use or derive the equation:* $\Delta \vec{d} = \vec{v}_1 \Delta t + \frac{1}{2}\vec{a}(\Delta t)^2$	
Solve for displacement using the areas ▶▶	4.19 Complete Question 4 on page 472.
	4.20 Complete Questions 5 to 8 on page 473.
Try this problem ▶▶ *Break it into two pieces and then add the total areas*	4.21 Complete Question 11.

Unit 4 - Displacement, Velocity and Acceleration

References and Notes

Prepare for final test by completing the following ▶▶

As you begin the review for your final evaluation, make sure you understand what each of the following formulas represent:

$v_{av} = \Delta d/\Delta t$, *slope = rise/run*

$a_{av} = \Delta v/\Delta t$

Remember the area of a rectangle is given by $A = l \times w$ and that of a triangle is $A = (\frac{1}{2})\, bh$.

$$\frac{v_1 + v_2}{2} = v_{av} \quad \text{and} \quad \frac{\vec{v}_1 + \vec{v}_2}{2} = \vec{v}_{av}$$

$$\Delta d = \left(\frac{\vec{v}_1 + \vec{v}_2}{2} \right) \Delta t$$

Work to Submit

4.22 Chapter 12: Review on pages 486 to 487.
Questions 1 to 12.

4.23 Unit 3 Review on pages 490 to 491.
Questions 1 to 9.
Questions 14 to 15.
Questions 17 to 20