

## STUDY GUIDE 2: 2-D Motion, Newton's Laws of Motion

### Objectives for Study Guide 2

11. State Newton's first, second, and third laws. Be able to identify the reaction force to any force acting on a body. Distinguish between mass and weight.
12. Draw a diagram representing a body isolated from its environment in an inertial coordinate frame, indicate with arrows all forces that act on it, and identify the source of each force. Such a diagram is called a "free-body diagram".
13. Apply Newton's laws to determine the acceleration of an object and present a clear, concise written solution of the problem.
14. Solve more complicated Newton's 2nd law problems, particularly those involving friction forces and/or circular motion.

### Suggested Study Procedure for Chapter 4.

**Study** Secs. 4.1 through 4.6.

**Study** lots of Examples – all of them are actually worth looking at.

**Answer** Discussion Questions 2, 5, 7, 9, 14, 30, 31, 32.

**Do** Exercises 5, 9, 11, 22, 29, 31.

**Do** Problems 39, 43, 50, 54, 58.

- A. We now come to Newton's laws of motion, the key to understanding the way the physical world works. So far, you have learned how to describe the motion of objects; now you will learn what it takes to get an object to move or to change its state of motion -- namely, FORCE.
1. Sec. 4.1 emphasizes that force is a vector quantity (with magnitude AND direction) and shows you how two or more forces add together vectorially to produce a "net force."
  2. Your common sense probably tells you that a force is required to keep an object moving with constant velocity, because that's the way the world around you seems to work. You might then INCORRECTLY assume that the velocity is proportional to the force you apply. Newton tells us that the foolproof AND CORRECT way to analyze motion is to determine the NET FORCE acting on the object. An object subject to NO NET FORCE moves with CONSTANT VELOCITY (read all about it in Sec. 4.2). If the net force is NONZERO, the object will ACCELERATE in a proportionate amount, where the constant of proportionality is the mass of the object (read all about this in Sec. 4.3!). This is what Newton has summarized in his first two laws of motion.
  3. Unlike Newton's first two laws, which refer to a single object, Newton's third law pertains to the INTERACTION between TWO objects, and the misunderstanding of this little detail has led countless students astray. If you stick with the text statement on p. 123, you can't possibly go wrong!

“If body A exerts a force on body B (an “action”), then body B exerts a force on body A (a “reaction”). These two forces have the same magnitude but are opposite in direction. These two forces act on DIFFERENT bodies.”

The implications of this law are explored in Sec. 4.5 and subsequent sections.

- B. Section 4.6 introduces the indispensable concept of the **free-body diagram** – the concept we use to analyze the situation of **any** object subject to forces. Plan on getting familiar with the rules of constructing free-body

diagrams because we will be using these diagrams as an integral part of our work in the next chapter and right on through to the end of the course!

### **Suggested Study Procedure for Chapter 5.**

**Study** Secs. 5.1-5.4.

**Study** all the Examples.

**Answer** Discussion Questions 1, 4, 10, 11, 15, 19, 28, 31.

**Do** Exercises 8, 14, 21, 24, 29, 45, 51.

**Do** Problems 74, 78, 89, 99, 120.

- A. Chapter 5 shows how the physics presented in Chapt. 4 can be applied to a variety of real-world situations including inclines and elevators (Secs. 5.1 and 5.2), frictional forces (Sec. 5.3), and circular motion (Sec. 5.4). Study carefully the one-size-fits-all Problem-Solving Strategy appearing on p. 140 – absolutely ALL problems involving known forces can be analyzed by this SAME approach (even the Sec. 5.1 stuff is a special case of this Second Law general approach). PLEASE BE AWARE that your instructors and graders expect you to follow this approach from now on in all of your homework and exam solutions. Proper application of this approach will help you avoid errors. Believe it or not, your instructors use the same approach when they do such problems, at least if they want to avoid mistakes!

### **LABORATORY WORK FOR STUDY GUIDE 2**

In **Experiment #3** you will practice drawing free-body diagrams after experimenting with an electronic device that measures force (a force plate). In **Experiment #4** you will analyze the motion of a cart that is influenced by friction.

Experience shows that students who read the instructions and answer the preliminary questions before going to the lab complete the work more quickly and easily. See

<http://www.wpi.edu/Academics/Depts/Physics/Courses/ph1110a13/ph1110a13Labs/>.

### **HOMEWORK ASSIGNMENTS FOR STUDY GUIDE 2**

**Reading Questions #5 – due in by 6AM Friday, Sept. 13. - based on Sects. 5.1, 5.2**

Just as with Reading Questions #4, Reading Questions #5 will be submitted via the web. Go to [www.masteringphysics.com](http://www.masteringphysics.com). Then login using the username and password you have chosen.

After logging in, click on Assignment List and select Reading Questions #4. If you need any review you can repeat Assignment #0.

In Reading Questions #4, you will get 4 chances to submit a correct answer. These are short reading assignments. They help prepare you for that day's lecture.

**Homework Assignment #5 – due by Noon Saturday, Sept. 14.**

Just as with Assignment #4, this assignment is to be submitted via the web. In your web browser, Go to [www.masteringphysics.com](http://www.masteringphysics.com). Then login using the username and password you have chosen

After logging in, click on Assignment List and select Assignment #5. If you need any review, you can always do that by repeating Assignment 0, a brief, noncredit tutorial on how to enter answers in Mastering Physics.

In Assignment #5, you will get **4** chances to submit a correct answer. If your first answer is incorrect, you should consider making use of the hints

Reading Questions #6 – due in by **6AM Monday, Sept. 16.** - based on Sects. 5.3, 5.4

Homework Assignment #6 – due by **Noon on Tuesday, Sept. 17.**

Reading Questions #7 – due in by **6AM Wednesday, Sept. 18.** - based on Sects. 6.1-6.4

Homework Assignment #7 – due by **Noon on Thursday, Sept. 19.**