Unit 7: Work & Energy

In the last several units we have been examining the laws of motion in classical mechanics. Using Newton’s laws we can now determine the motion of a point mass, given the forces acting on it, or indeed we can determine the forces, given the motion of the mass. However, there are other ways of describing motion and forces without explicitly solving the dynamical equations. In this unit we will introduce the concept of energy, which will prove to be very useful in discussing physical systems. Subsequently we will see under what conditions the energy of a system remains constant, leading to a powerful conservation law.

Of all the physical concepts, that of energy is perhaps the most far-reaching. Everyone, whether a scientist or not, has an awareness of energy and what it means. Energy is what we have to pay for in order to get things done. The word itself may remain in the background, but we recognize that each gallon of gasoline, each kilowatt-hour of electricity, each calorie of food, represents, in one way or another, the wherewithal for doing what we call “work”. We seldom think in terms of paying for force, or acceleration, or momentum, which are all vector quantities. Energy, a scalar property of a physical system, is the universal currency that exists in apparently countless denominations. Work, in physics, is a measure of energy transfer when this transfer from one denomination to another is accomplished by mechanical means.

Objectives: After completing this unit you should be able to:

1. Calculate the work done and the rate at which this work is done (power) on an object by an external force in moving that object, and

2. Use the work-energy relation to solve problems similar to those given in the Suggested Procedure.

Suggested Procedure:

1. Read in H&R, Chapter 7. If you haven’t seen line integrals before, you might want to consult a mathematics instructor or ask a tutor.
2. Read in Feynman, Chapter 13.

3. Read in Berkeley, Chapter 5, up to pg. 152.

4. Do the problems in H&R, pg. 129–132, #3, 14, 15, 19, 21, 27, 31. Then look back over some of the problems in the last unit and see which of them can be solved—perhaps more simply—using the work-energy relation.

5. If you have trouble with these problems, Chapter 6 of H&R SSGWPP should be of some help.

6. Do the problems in Berkeley, pg. 168, #1, 2, 4, 6. Remember, you are NOT expected to do every single problem given in the Suggested Procedure. Choose whichever problems you find most helpful.

7. Take a unit test.