Chapter 18
Bat and Ball Projects

In the matter of physics, the first lessons should contain nothing but what is experimental and interesting to see. A pretty experiment is in itself often more valuable than twenty formulae extracted from our minds.

– Albert Einstein

18.1 Introduction

Twelve simple projects are described in this chapter that you can undertake at home or elsewhere. The projects deal with the flight of balls through the air and the properties of bats and balls. The object of each project is to get you thinking about the physics of baseball and softball. The best way to do that is to undertake a few experiments yourself. You can play or watch baseball or softball for your whole life without ever thinking about the physics behind it. But if you do start thinking about it, then you will probably be surprised that there is much more physics in the game than you ever thought possible. Depending on your background and interests, a baseball or softball game can be viewed as a whole series of physics experiments, an exercise in psychology or biomechanics, or just simply a fun sport to play and watch. To others, it is more important than any of those things. It is matter of life and death.

The project experiments described below are meant to serve several purposes. First, the phenomena described in this book are all based on experimental evidence. The experimental results are just as important, if not more important, than our attempts to explain them. The second purpose is just as important as the first. That is, the projects were chosen so that you can do them yourself without the need for expensive equipment. The experiments are not only relevant to the physics of baseball and softball, but are simple enough to be conducted in a meaningful way by almost anyone. The experiments are interesting and fun in themselves, and will hopefully encourage and motivate you to explore some of these or your own experiments in more detail, and to seek out the explanations provided in this book and in the additional references. A third purpose is to demonstrate how physicists go about their work. Some people think we just calculate everything. More often than not, we do an experiment, try to explain it, discover that we don’t have enough information to explain it properly, then plan a better experiment. This process can easily go on for a year or more before we figure out what we want to know. Only rarely does the process take less than a week, although each project described below should take only a few hours or less.
As any physics student knows, physics can be dry and uninteresting if presented as a series of laws and equations that need to be memorized for the purpose of passing an exam. The most interesting part of any physics lesson or lecture is usually the demonstration of the effects being described, especially if the demonstration ends in a spectacular explosion, or at least a loud noise or something catching fire. None of the project experiments lead to such a result, but they are still interesting since they concern the physics of baseball and softball, and since ball games are something that many people are passionate about. It is possible to be just as passionate about experimental physics, not just because it is fun but because it is the best way to determine what really happens to a bat or ball when someone throws or hits a baseball or softball. By that we mean the physics of the process. If you want to know what happens to your body when you throw or hit a ball, then it is best to ask a biomechanist or physiologist.

18.2 Flight of the Ball

The first four projects are concerned with the flight of the ball through the air. Everyone knows that gravity pulls the ball downward, but what is the effect of the air? Does it make any difference if the ball is spinning? How much difference?

Project 1: Effect of Gravity on the Flight of a Ball

The effect of gravity on a ball can be demonstrated and understood by a simple experiment. Get hold of two balls, one in each hand, and hold them both at about head height. Throw one of them at low speed in a horizontal direction so that it lands about 6–10 ft in front of you. At the instant you release the ball, release the other ball so that it falls straight down. The question here is: which ball will land first? A common answer is that the thrown ball takes longer to land because it has to travel farther. The correct answer is that both balls land at the same time. If you find that they don’t land at the same time then you made a mistake. Either you didn’t release both balls from the same height, or at the same time, or you threw one of them slightly upward or downward rather than horizontally.

If you were to take video film of the two balls, then you would get a result similar to that shown in Fig. 18.1. If the ball is dropped vertically from a height of 6 ft then it falls in a straight line and takes just over 0.6 s to hit the ground. As it falls, it accelerates, so it travels a greater distance in any 0.1-s period than in the previous 0.1-s period. If the ball is thrown horizontally at 15 ft s$^{-1}$, then it will land about 9 ft away but it still takes just over 0.6 s to land. The thrown ball travels farther but it doesn’t take longer to get there since it is launched at a higher speed. At any given time, both balls will have fallen exactly the same vertical distance, because the acceleration in the vertical direction is exactly the same.