# 1.2 Equipment Essentials

## Warm Up

Your teacher will give you a pendulum made from some string and a washer. One swing of the pendulum back and forth is called a period and measured in seconds. Work with a partner to determine the period of your pendulum. Outline your procedure and results below. When you are done, identify one thing you would change in your procedure to improve your answer.

### Using a Calculator

A calculator is a tool that helps you perform calculations during investigations and solving problems. You'll have your calculator with you for every class. At the same time, however, you are not to rely on it exclusively. You need to understand what the question is asking and what formula or calculation you need to use before you use your calculator. If you find yourself just pushing buttons to find an answer without understanding the question, you need to talk to your teacher or a classmate to figure it out. Many times you'll just need one concept clarified and then you can solve the problem.

Every calculator is different in terms of what order of buttons you need to push to find your answer. Use the Quick Check below to ensure you can find trigonometric functions and enter and manipulate exponents. If you cannot find the answers for these questions, check with your teacher immediately.

### Quick Check

Using your calculator, what are the answers to the following mathematical statements?

1. $\sin 30°$ _____
2. $\tan^{-1} .345$ _____
3. $34^2$ _____
4. $(3.2 \times 10^{-4}) \times (2.5 \times 10^{6})$ _____
5. pi – cos 60° _____

### Measuring Time

For objects that have a regularly repeated motion, each complete movement is called a **cycle**. The time during which the cycle is completed is called the **period** of the cycle. The number of cycles completed in one unit of time is called the **frequency** ($f$) of the moving object. You may be familiar with the frequencies of several everyday objects. For example, a car engine may have a frequency of several thousand rpm (revolutions per minute).


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The turntable of an old phonograph record player may have frequencies of 33 rpm, 45 rpm, or 78 rpm. A pendulum 24.85 cm long has a frequency of one cycle per second. Tuning forks may have frequencies such as 256 vibrations per second, 510 vibrations per second, and so on.

Any measurement of time involves some sort of event that repeats itself at regular intervals. For example, a year is the time it takes Earth to revolve around the Sun; a day is the time it takes Earth to rotate on its axis; a month is approximately the time it takes the Moon to revolve around Earth. Perhaps *moonth* would be a better name for this time interval.

All devices used to measure time contain some sort of regularly vibrating object such as a pendulum, a quartz crystal, a tuning fork, a metronome, or even vibrating electrons. With a pendulum you can experiment with the properties to make it a useful timing device. When a pendulum undergoes regularly repeated movements, each complete movement is called a cycle, and the time required for each cycle is called its period.

A frequency of one cycle per second is called a **hertz** (**Hz**). Higher frequencies (such as radio signal frequencies) may be expressed in kilohertz (kHz) or even megahertz (MHz), where 1 kHz is 1000 Hz, and 1 MHz is 1 000 000 Hz.

### The Recording Timer

In Investigation 1-1, you will use a device called a recording timer like the one in Figure 1.2.1. The timer is a modified electric buzzer. A moving arm driven by an electromagnet vibrates with a constant frequency, and each time it vibrates, it strikes a piece of carbon paper. The carbon paper makes a small dot on a moving piece of ticker tape. The small dots are a record of both time and distance. If you know the frequency of vibration of the timer, you can figure out the period of time between the dots, because period ($T$) and frequency ($f$) are reciprocals of one another.

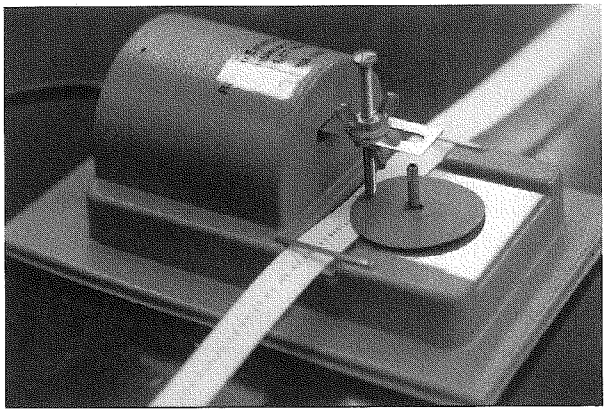

**Figure 1.2.1** *A recording timer that uses ticker tape to record time and distance*

$$T = 1/f, \text{ and } f = 1/T$$

If you measure the distance between the dots, this will tell you how far the object attached to the tape has moved. Knowing both distance and time, you can also calculate speed, since the speed of an object is the distance travelled divided by the time.

## Using a Motion Probe

Another method for recording motion is a motion probe. There are several different models that can be used, but they all follow the same basic principles. Using a computer or graphing calculator, the probe is plugged in and run via a software program. The software program collects data on the motion you are studying and represents them as a graph on your computer screen.

Using the data collected, you can analyze the motion. Your teacher will demonstrate how to use the motion probe in your lab.