PRELAB: FREQUENCY AND PERIOD

INTRODUCTION
The frequency of a sound vibration is associated with its perceived pitch, and since pitch is one of the basic properties of sound, frequency is very important. This hand out will help you to understand the relationship between frequency and period, a related quantity. First, let’s have a quick review of frequency.

FREQUENCY
Frequency tells you how many events happen in a certain unit of time. As an example, try taking your pulse. That is, count the number of times your heart beats in one minute.

Heartbeat rate = ________ per minute

This is a frequency, because it tells how many beats there are in one unit of time. The unit of time you used was the minute, which is customary for pulse measurements. In science, however, the second is the standard unit of time. Since there are 60 seconds in a minute, you will have to divide the number above by 60 to get your pulse in standard units.

Heartbeat rate = ________ per second

Since a typical pulse is between 60 and 85 beats minute, your pulse in beats per second will probably be between 1.0 and 1.5.

PERIOD
Anything that happens over and over again at a regular time interval is said to be periodic. This is because the event is characterized by a certain period of time, namely the period of time it takes for the repeating event to happen once. This characteristic time is called, guess what, the period.

As an example, try tapping your finger of the table once every second (you can come close to one per second by counting “one-thousand one, one-thousand two, one-thousand three, . . .”). You are now making a periodic tapping sound with a period of 1 second—there is one second between taps. Now tap twice as often, every half-second. This makes the period 0.5 s.

Anything that happens repeatedly at regularly spaced intervals is periodic, and the time from the start of one event to the start of the next is the period.
PERIOD AND FREQUENCY

You know that your heart beats in a regular way, so it must be periodic. And since it is periodic, it must have a period. You also know that it has a frequency, because you measured it earlier. Pulse has both a period and a frequency. As another example, you have already seen that each pitch you can hear has a frequency somewhere above 15 Hz and below 20,000 Hz. Since you know that these are steady, periodic vibrations, you know that each pitch must also have a period. In fact, everything that has a period must also have a frequency. Frequency and period are really just two different ways of saying the same thing. So what exactly is the relationship between frequency and period?

It will be easier for you to remember the relationship between the two quantities if you figure it out for yourself. To see the general relationship, look at a few specific, simple examples. As you write down both the frequency and the period of several periodic events, a rather simple pattern will emerge, which you should summarize in a sentence. (Hint: You will see the pattern more quickly if you express numbers less than one as fractions rather than decimals.)

Remember, frequency tells you how many events happen in a certain unit of time. Period tells you how long it takes for one of those events to happen.

1. Tap your finger once every second, as before.
   a. What is the period? (How long between taps?) ______ sec
   b. What is the frequency? (How many taps in one second?) ______ Hz

2. Tap twice as often every $\frac{1}{2}$ second.
   a. What is the period? ______ sec
   b. What is the frequency? ______ Hz

3. Tap as fast as you can. This will be about 8 times per second.
   a. frequency ______ Hz
   b. period ______ sec

4. Now go the other way; tap slowly, every two seconds.
   a. period ______ sec
   b. frequency ______ Hz

5. Tap very slowly, every 4 seconds.
   a. period ______ sec
   b. frequency ______ Hz

Do you see the pattern? Write a sentence that describes the general relationship between period and frequency.
As a general rule, frequencies and periods you measure will not come out to be whole numbers, so you shouldn’t leave your answer as a fraction. Instead, you should express your answer in decimal form. For example, you might find that it takes 0.013 seconds for an event to happen once. It doesn’t do anyone much good to know that the frequency is \( \frac{1}{0.013} \) Hz. It is much more helpful to do the division and write the frequency as 77 Hz.

**T and f**

Instead of writing out the words “period” and “frequency” all the time, people like to use single letter abbreviations, so that they can put these variables into mathematical equations. The standard letter for period is \( T \) (uppercase) and, in this course, the standard letter for frequency is \( f \) (lowercase). If you continue to work and study in a sound related field, you will eventually encounter the symbol \( \nu \) (lower case Greek letter \( N \), pronounced “nu”) for frequency, but we will use the less technical \( f \).

**Units**

Appropriate units have to accompany all measurements (we will take points off when grading if you leave units out). Period is measured in seconds, so always write an “s” after the number, such as \( T = 0.013 \) s. Frequency has units of Hz, so don’t forget to write the “Hz” after the number, such as \( f = 77 \) Hz.

**Practice**

Calculate a few periods and frequencies with your calculator.

A. \( T = 0.0040 \, \text{s} \) \( f = \)

B. \( T = 0.5 \, \text{s} \) \( f = \)

C. \( T = 8 \, \text{s} \) \( f = \)

D. \( T = \) \( f = 400 \, \text{Hz} \)

E. \( T = \) \( f = 2222 \, \text{Hz} \)

F. \( T = \) \( f = 0.75 \, \text{Hz} \)