INTRODUCTION
In this course it is often necessary to calculate frequencies by taking reciprocals of periods. Sometimes the period will be in units of seconds. With sound signals, however, the period will usually be in the millisecond range, and occasionally even the microsecond range.

Many students have difficulty taking reciprocal of period which is in milliseconds. For example, they will write \( \frac{1}{(4.2 \text{ ms})} = 0.24 \text{ Hz} \) or even \( 0.24 \text{ mHz} \). This is not correct. Remember that 4.2 ms is shorthand for \( 4.2 \times 0.001 \text{ s} = 0.0042 \text{ s} \):

\[
\frac{1}{4.2 \times 0.001 \text{ s}} = \frac{1}{0.0042 \text{ s}} = 238 \text{ Hz}
\]

This homework will give you some practice take reciprocals of numbers which have prefixes like milli- and micro- on their units. You will need a calculator to do this homework.

DEFINITIONS

\[
\begin{align*}
M &= \text{mega} = x \times 10^6 = x 1,000,000 \\
k &= \text{kilo} = x \times 10^3 = x 1,000 \\
m &= \text{milli} = x \times 10^{-3} = x 0.001 \\
\mu \text{ (or } u) &= \text{micro} = x \times 10^{-6} = x 0.000001
\end{align*}
\]

PROCEDURE

Method 1

The most direct way to calculate a reciprocal is simply to write the number without a prefix before you take its reciprocal. This is what was done in the introduction to take the reciprocal of 4.2 ms. Just write out 4.2 ms as 0.0042 s, put 0.0042 into your calculator and push the \( \frac{1}{x} \) button (\( x^{-1} \) on some calculators), or you can divide 1 by 0.0042.
The only problem with this approach is that you may make a mistake when translating the prefix, for example, writing 4.2 ms = 0.042 s, which is not correct. But if you are careful, you can use this method perfectly well.

**Method 2**

Since you will use your calculator to take the reciprocal, it is often more reliable to make use of the scientific notation feature of your calculator to deal with the metric unit prefix. A prefix like m (*milli-*) means “multiply by $10^{-3}$.” That is, 4.2 ms = $4.2 \times 10^{-3}$ s.

On most calculators today, you can enter a number directly into the calculator using scientific notation. This is done using a button which is marked either “EE” or “EXP,” depending on what brand of calculator you have. To get $4.2 \times 10^{-3}$ s into your calculator, you take the following steps:

4.2
EE ← Button for scientific notation (called EXP on some calculators).
+/- ← Button to get a minus sign (called CHS on some calculators).
3

At this point, your calculator display should be something like: 4.2 –03 or 4.2E-3. Notice that this means $4.2 \times 10^{-3}$, not $4.2^{-3}$.

Then, to take the reciprocal (to find the frequency) just hit the $1/x$ button. Your calculator display may be 2.381 02, which means $2.381 \times 10^2 = 238.1$ Hz. (Note: some calculators will display 238.1 directly on their screen after hitting the $1/x$ button.)

The advantage to this method is that you put the number part (4.2) directly into the calculator, and then put the unit prefix (*milli-*) directly into the calculator as -03. You never make a mistake counting zeros while moving the decimal point.

Calculations of period from frequencies are done in the same way. Say you have a frequency of 2 kHz and you want to find the period:

$$T = \frac{1}{f} = \frac{1}{2 \times 10^3 \text{Hz}} = 5 \times 10^{-4} \text{s} = 0.5 \text{ms}$$

To do this on your calculator, you would push:

2
EE
3
to get a display of 2 03. Then your push 1/x, and the calculator displays 5 -04, which means $5 \times 10^{-4} = 0.0005$. This is the same as $0.5 \times 10^{-3}$, so the period is 0.5 ms.

On the next page you will find some practice problems. Do them and hand them in to your instructor at the beginning of the *SoundScope* lab period.
METRIC UNIT PREFIX WORKSHEET

Name ____________________________

Time your section meets ____________

If your answer is less than 0.01 or greater than 1000, then express your answer using a prefix. For example, if \( f = 44 \text{ kHz} \), then write your answer as:

\[
T = \frac{1}{44 \times 1000 \text{ Hz}} = 0.000023 \text{ s} = 23 \mu\text{s}.
\]

\( f = 16 \text{ Hz} \) \hspace{1cm} T = \\

\( f = 16 \text{ kHz} \) \hspace{1cm} T = \\

\( f = 750 \text{ Hz} \) \hspace{1cm} T = \\

\( T = 0.010341 \mu\text{s} \) \hspace{1cm} f = \\

\( T = 0.167 \text{ ms} \) \hspace{1cm} f =