Measuring Yourself Using the Metric System

Lesson Plan

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Goal: Provide the students with a conceptual idea of common metric units and their prefixes.

Grade and Course: 9th grade Pre-Algebra

KY Standards: MA-HS-2.2.1

Objectives: The student will be able to:

1) Know when to use grams, meters, and liters for different measurements.
2) Know how grams, meters, and liters relate to U.S. units of measurement (i.e. pounds, feet, and gallons).
3) Have a concept of commonly used prefixes (milli-, kilo-, and centi-) for each unit.
    a) Know that these prefixes can be used for other units, in this case hertz, as well.

Resources/materials needed:

The attached worksheet is needed along with the following, which are classified by each station:

1. A beaker that measures in liters, a beaker that measures in mL, water
2. nickel, triple beam balance, weighing scale
3. meter stick, pencil, ruler
4. computer, microphone, program in appendices A and B

Description of Plan:

Introduce liters by asking the class how you purchase a large bottle of pop/soda/soft drink (2 liter bottle). Then ask the class how you purchase milk (1 gallon). Do the same for meters and grams and compare them to feet and pounds. If further detail is desired, talk about why we use different systems of measurements and maybe make an analogy between this and different languages in each country.

Separate the students into four groups and have them complete the worksheet attached. Each group will be assigned to a station and will rotate when they complete that section of the worksheet. It is very helpful if you have enough aids to man each station.

At the liters station, the students will have a beaker containing 1 L of water and another containing 100 mL (or less if preferred) of water. This is a less time consuming station, so there is an option of having the students pour 1 L and 1 mL of water into the beakers.

At the grams station, students will weigh a nickel on the triple beam balance (about 5 grams), and then weigh themselves in pounds on the weighing scale. The worksheet requires them to convert this value into kilograms.

At the meters station, students will measure a short pencil in centimeters and millimeters and then measure themselves in meters.

At the microphone station, the students will use the program in appendix A and B to find the pitch, or frequency (in Hertz), of their voice by speaking into the microphone. They will convert this to kilohertz. Since this was performed at a rural school, the students were asked if they hunt. Animal sounds were downloaded from the internet and input into the microphone and program. The students were then explained how bird calls were imitated for hunting purposes.

If time allows, talk to them about how a CD is sampled at 44.1 kHz, or radio stations are represented in MHz to give them a better idea about the unit hertz.

If time allows, have the students discuss their results at each station.

Lesson Source: Yours truly

Instructional Mode: Short lecture followed by a lab

Date Given: 01-29-2008 **Estimated Time**: 1 class period (45 minutes)

Date Submitted to Algebra^3: 03-22-2008

Name: _____

Understanding Metric Units

While at a station (liters, grams, meters, and microphone) answer the questions below that label. Units that you should use for your answer are in parentheses. **WRITE UNITS WITH ALL ANSWERS!**

1. Liters
    a. How much water is in the smallest beaker in milliliters (mL)? _____
        i. How much is that in liters (L)? _____
    b. How much water is in the larger container in liters (L)? _____
        i. How much is that in milliliters (mL)? _____
2. Grams

a. How much does a nickel weigh in grams (g)? _____
    i. How much does it weigh in milligrams (mg)? _____
b. How much do you weigh in pounds (lbs)? _____
    i. How much do you weigh in kilograms (kg)? Hint: Divide your above answer (in pounds) by 2.2. _____
    ii. How much do you weigh in grams (g)? _____
    iii. How much do you weigh in milligrams (mg)? _____

3. Meters

a. How long is the pencil in millimeters (mm)? _____
    i. Commonly, centimeters are used instead of millimeters. How long is the pencil in centimeters? _____
b. How tall are you in meters (m)? _____
c. Your football field is 100 yards or 0.09144 kilometers (km) long. How many football fields are in a kilometer? Hint: Divide 1 km by the length of a football field in kilometers. Round to the nearest whole number. _____

4. Microphone

Note: The typical adult male's voice is 85 to 155 Hz. The female's is 165 to 255 Hz.

a. What is your frequency in hertz (Hz)? _____
    i. What is your frequency in kilohertz (kHz)? _____

Additional questions:

1. What units should you use: grams, meters, or liters, if you were trying to find the weight of a car? Would it make more sense to measure it using kilo- or milli- of this unit?

2. What units should you use: grams, meters, or liters, if you measure out cough syrup? Would it make more sense to measure it using kilo- or milli- of this unit?

3. What units should you use: grams, meters, or liters, if you were measuring the distance between Owingsville and Lexington? Would it make more sense to measure it using kilo- or milli- of this unit?

Appendix A:

The following is MATLAB code for that should be compiled to load the program:

```
function varargout = my_two_axes(varargin)
% MY_TWO_AXES Application M-file for my_two_axes.fig
%   MY_TWO_AXES, by itself, creates a new MY_TWO_AXES or raises the existing
%   singleton*.
%
%   H = MY_TWO_AXES returns the handle to a new MY_TWO_AXES or the handle to
%   the existing singleton*.
%
%   MY_TWO_AXES('CALLBACK',hObject,eventData,handles,...) calls the local
%   function named CALLBACK in MY_TWO_AXES.M with the given input arguments.
%
%   MY_TWO_AXES('Property','Value',...) creates a new MY_TWO_AXES or raises the
%   existing singleton*.  Starting from the left, property value pairs are
%   applied to the GUI before my_two_axes_OpeningFunction gets called.  An
%   unrecognized property name or invalid value makes property application
```

```
%   stop.  All inputs are passed to my_two_axes_OpeningFcn via varargin.
%
%   *See GUI Options - GUI allows only one instance to run (singleton).
%
% See also: GUIDE, GUIDATA, GUIHANDLES

% Edit the above text to modify the response to help my_two_axes

% Last Modified by GUIDE v2.5 28-Jan-2008 15:57:58

% Begin initialization code - DO NOT EDIT
gui_Singleton = 1;
gui_State = struct('gui_Name',       mfilename, ...
                   'gui_Singleton',  gui_Singleton, ...
                   'gui_OpeningFcn', @my_two_axes_OpeningFcn, ...
                   'gui_OutputFcn',  @my_two_axes_OutputFcn, ...
                   'gui_LayoutFcn',  [], ...
                   'gui_Callback',   []);
if nargin & isstr(varargin{1})
    gui_State.gui_Callback = str2func(varargin{1});
end

if nargout
    varargout{1:nargout} = gui_mainfcn(gui_State, varargin{:});
else
    gui_mainfcn(gui_State, varargin{:});
end
% End initialization code - DO NOT EDIT

% --- Executes just before my_two_axes is made visible.
function my_two_axes_OpeningFcn(hObject, eventdata, handles, varargin)
% This function has no output args, see OutputFcn.
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
% varargin   command line arguments to my_two_axes (see VARARGIN)

% Choose default command line output for my_two_axes
handles.output = hObject;

% Update handles structure
```

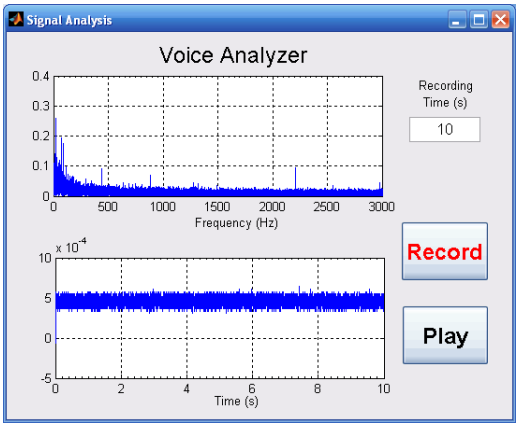
```
guidata(hObject, handles);

% UIWAIT makes my_two_axes wait for user response (see UIRESUME)
% uiwait(handles.figure1);


% --- Outputs from this function are returned to the command line.
function varargout = my_two_axes_OutputFcn(hObject, eventdata, handles)
% varargout  cell array for returning output args (see VARARGOUT);
% hObject    handle to figure
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Get default command line output from handles structure
varargout{1} = handles.output;

% --------------------------------------------------------------------
function varargout = Play_Callback(h, eventdata, handles, varargin)
% hObject    handle to Play (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)
%sprintf('hi');
%set(handles.Play,'ForegroundColor','b');

wavplay(handles.sound,handles.samp_freq);


% --------------------------------------------------------------------
function varargout = plot_button_Callback(h, eventdata, handles, varargin)
% hObject    handle to plot_button (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

%time = set(handles.rec_time,'String'
time = str2num(get(handles.rec_time,'String'));
if (time > 10)
   time = 10;
   set(handles.rec_time,'String','10')
end
if (time < 3)
   time = 3;
```

```
   set(handles.rec_time,'String','3')
end
Fs = 11025;
y = wavrecord(time*Fs,Fs);
handles.sound = y;
handles.samp_freq = Fs;

%wavplay(y,Fs);

yfft=fft(y);
yfftmag=abs(yfft);

% amplitude vector that will be output versus frequency
% Do not plot the DC component and the last half (replicate) of the spectrum
output = yfftmag ( 2 : round(length(yfftmag)/2) );

% frequency vector in hertz
f= ( 2 : round(length(yfftmag)/2) ) * Fs / length(yfftmag);

% rec_time vector in seconds
t = ( 1:length(y) ) / Fs;

% find location and value of maximum value of the sound
%[ maxf, temp ] = max ( output );
%loc=f(temp);

% Create frequency plot
axes(handles.frequency_axes)
plot(f,output)
set(handles.frequency_axes,'XMinorTick','on')
set(handles.frequency_axes,'XLim',[0 3000])
grid on
datacursormode on

% Create rec_time plot
axes(handles.time_axes)
plot(t,y)
set(handles.time_axes,'XMinorTick','on')
grid on

%set(handles.f1_input,'String',loc)
```

```
my_two_axes_OpeningFcn(h, eventdata, handles, varargin);



function rec_time_Callback(hObject, eventdata, handles)
% hObject    handle to rec_time (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    structure with handles and user data (see GUIDATA)

% Hints: get(hObject,'String') returns contents of rec_time as text
%        str2double(get(hObject,'String')) returns contents of rec_time as a double


% --- Executes during object creation, after setting all properties.
function rec_time_CreateFcn(hObject, eventdata, handles)
% hObject    handle to rec_time (see GCBO)
% eventdata  reserved - to be defined in a future version of MATLAB
% handles    empty - handles not created until after all CreateFcns called

% Hint: edit controls usually have a white background on Windows.
%       See ISPC and COMPUTER.
if ispc && isequal(get(hObject,'BackgroundColor'),
get(0,'defaultUicontrolBackgroundColor'))
   set(hObject,'BackgroundColor','white');
end
```

Appendix B:

This is a ".fig" file that is a figure file used to set up the GUI for the user to use. Below is a screenshot of the GUI. Please email me (straxel@gmail.com) if you would like the program.


Signal Analysis
Voice Analyzer
0.4
0.3
0.2
0.1
0
0
500
1000
1500
2000
2500
3000
Frequency (Hz)
Recording
Time (s)
10
Record
x 10^-4
10
5
0
-5
0
2
4
6
8
10
Time (s)
Play