

Jockey Club STEAM Education Resources Sharing Scheme

# WE Speak Louder

Learning Portfolio

Name: \_\_\_\_\_

Class: \_\_\_\_\_

School: \_\_\_\_\_

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School of Science and Technology  
Hong Kong Metropolitan University

Ho Man Tin, Kowloon, Hong Kong

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## Laboratory Safety

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For safety reasons, students must read the following rules and regulations prior to enter the laboratory and follow them through inside the laboratory:

- (1) No eating or drinking in the laboratory
- (2) Always wear long trousers or dresses, and shoes with full coverage of toes and feet. No shorts or sandals.
- (3) Tie your hair if it is too long.
- (4) Wear your basic personal protective equipment (PPE) including a lab coat, and latex or nitrile gloves before handling any chemical or biological sample.
- (5) Wear additional PPE such as goggles as instructed by laboratory staff.
- (6) Do not touch any of your personal belongings, such as worksheets, mobile phones or electronic devices when wearing your gloves.
- (7) Wash your hands thoroughly after taking off your gloves or before leaving the laboratory.
- (8) Keep the lab bench clean and tidy. No personal belongings should be placed on the bench.
- (9) Dispose all solid waste in the designated container.
- (10) Discard all liquid biological wastes in 1:99 diluted bleach.
- (11) Discard syringe, sharp glasses, or broken glassware in sharp boxes.
- (12) Do not leave any fire unattended.
- (13) Consult laboratory staff when in doubt.
- (14) Locate the Emergency Exits, evacuation path, and fire extinguishing devices.
- (15) Notify laboratory staff **IMMEDIATELY** in case of accidents or emergencies.

Handwashing is one of the most important and effective ways to avoid possible contact with infectious diseases. Students are required to follow the handwashing procedures recommended by the Centre for Health Protection, Department of Health, HKSAR as shown below:

- (1) Wet hands under running water.
- (2) Apply liquid soap and rub hands together to make a soapy lather.
- (3) Away from the running water, rub the palms, back of hands, between fingers, back of fingers, thumbs, fingertips and wrists. Do this for at least **20 seconds**.
- (4) Rinse hands thoroughly under running water.
- (5) Dry hands thoroughly with a clean cotton towel, a paper towel, or a hand dryer. Dispose paper towel properly.
- (6) The cleaned hands should not touch the water tap directly again.
- (7) Turn off the tap after splashing water to clean the faucet; or using the paper towel to wrap the faucet.



Source: Centre for Health Protection, Department of Health, HKSAR Government (2020). Perform Hand Hygiene Properly.

## Unit 1 – Studying a Loudspeaker

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### 1. Purpose

To study the characteristic of a loudspeaker and learn its performance.

### 2. Introduction

Loudspeakers can be found in our daily lives, such as TV and phones. The loudspeaker converts electrical signals to sound so that we can hear them. How does the speaker work? Is there any limitation?

In this unit, students will investigate the characteristics of a loudspeaker by testing it with common lab equipment. They will study the performance and limitations of the speaker.

### 3. Objectives

Upon completion of *Unit 1*, students should be able to:

- *Describe* the major components of a loudspeaker.
- *Measure* the performance of a loudspeaker.
- *Discuss* the characteristics of a loudspeaker.

### 4. Scope

Description	Duration (hr/min)
Introduction	15 min
- Introduce the signal generator and oscilloscope	
Study a loudspeaker	30 min
- Demonstrate all the essential parts of a loudspeaker	
Study the performance of the loudspeaker	1 hr
- Discuss the parameters for sound quality	
- Discuss the human audible frequency	
Summary	15 min
<b>Total</b>	<b>2 hours</b>

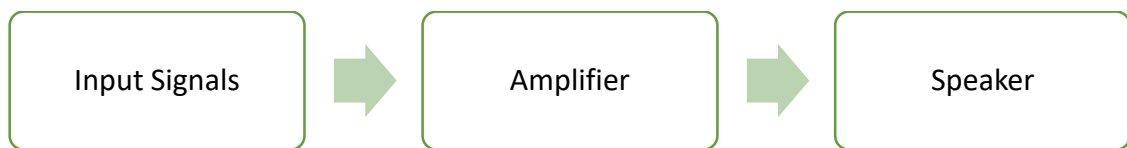
## 5. Equipment and Materials

For each group of students,

- a loudspeaker
- a function generator
- an oscilloscope
- some connecting wires
- some resistors

## 6. Introduction of a loudspeaker

A block diagram of the key components of a loudspeaker is shown in Figure 1.



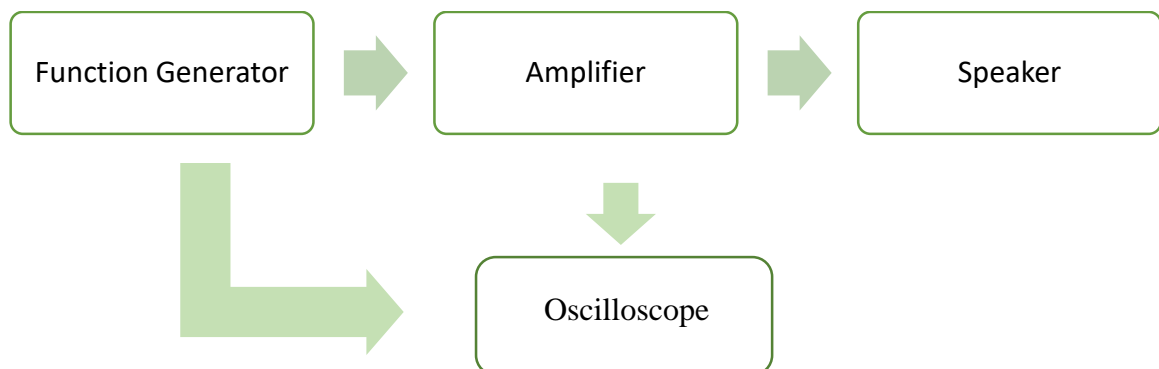
**Figure 1. Key components of a loudspeaker.**

### Instruction

The video clip “Introduction” gives you an introduction to the unit.

## 7. Experiments

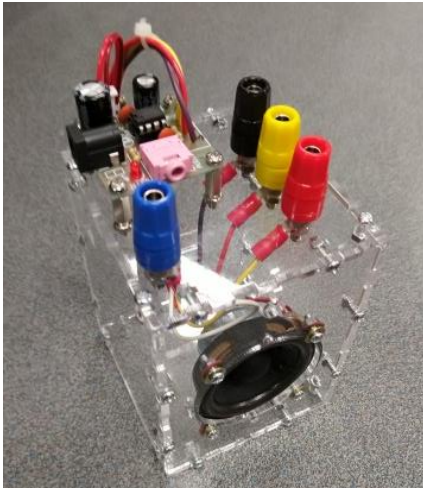
A block diagram of the setup of the experiment is shown in Figure 2.



**Figure 2. Setup of the experiment**

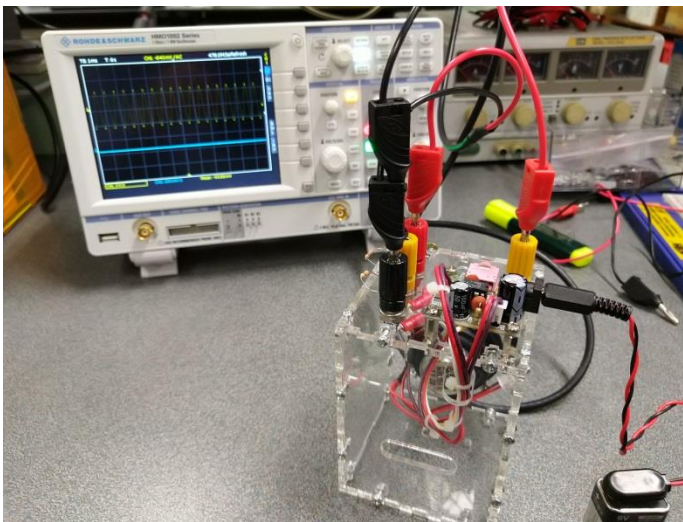
### Instruction

The video clip “How to Setup Experiment?” shows how to build the suggested circuit. The circuit is also shown in Figure 3.



**Figure 3.**

The video clips, “Change the Amplitude of Input and Observe the variations of the Output” and “Change the Frequency of Input and Observe the variations of the Output”, show the connections of the input and output. The oscilloscope is used to measure the input and output signals.



**Figure 4.**

# WE Speak Louder

## Unit 1 – Studying a Loudspeaker

## Student Worksheet

## 1. Measuring the Input and Output Signals

(1) Use the oscilloscope to find the amplitudes of input and output signals, respectively.

The amplitude of Input signal voltage $V_{in}$	$V_{in} =$	V
The amplitude of Output signal voltage $V_{out}$	$V_{out} =$	V

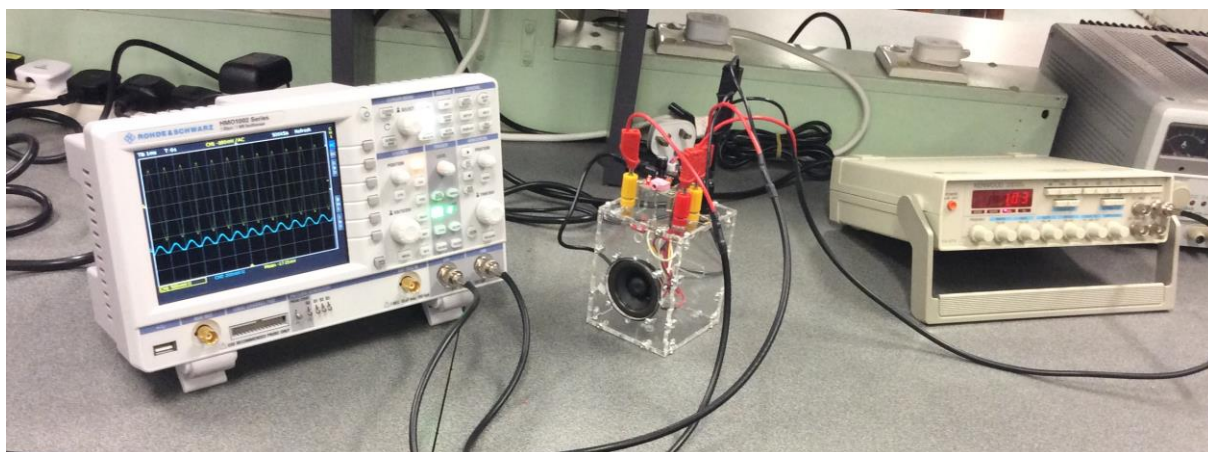
(2) Use the oscilloscope to find the frequencies of input and output signals, respectively.

Frequency of Input signal $f_{in}$	$f_{in} =$  Hz
Frequency of Output signal $f_{out}$	$f_{out} =$  Hz
Are the values the same?	Yes or No



- (3) Find the gain of your amplifier. That is the ratio of the amplitudes of the output signal to the input signal =  $V_{out} / V_{in}$ .

$$Gain = \frac{V_{out}}{V_{in}} =$$




**Figure 5.**

- (4) Compare the shape of the waveforms of the input signal with the output signal. Are they the same? Yes or No?



- (5) Change the waveform of input in the function generator. What do you observe about the shape of a waveform in the oscilloscope?




## 2. Changing Amplitude

- (1) Change the amplitude of the input signal with the function generator. Compare the input and output waveforms. What do you find? (e.g. the shape of waveform, amplitudes).



- (2) Listen to the sound coming from the speaker. What do you find? What about the loudness?



### 3. Changing Frequency

- (1) Change the frequency of the input signal in the function generator. Compare the input and output waveforms. What do you find? (e.g. the shape of waveform, amplitudes).

- (2) Gradually increase the frequency of the input and listen to the sound coming from the speaker. What is the highest frequency of input that you can hear?

Note: The frequency range of human hearing is 20 Hz to 20 kHz.

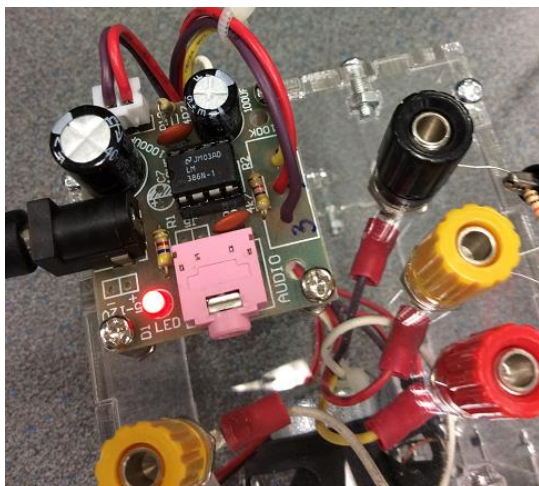
The highest frequency is

Hz

- (3) Compare your results with your classmate. Are they the same?

- (4) The video “Explaining the Results” details the results.

#### 4. Modifying the Circuit of Your Speaker



**Figure 6.**

#### Instruction:

The video “Modifying the Circuit” provides ways to modify the circuit. Please repeat the measurement of output signals and record the results. What is the ratio of the amplitudes of the output signal to the input signal? i.e.  $V_{out} / V_{in}$

$V_{in} =$

$V_{out} =$

New gain of the speaker

$\frac{V_{out}}{V_{in}} =$

#### 5. Summary

In this unit, you used a function generator to produce an input signal and amplify the signal via the amplifier. The output signal was played through the speaker. You had compared the input and output waveforms on the oscilloscope.

You have investigated the effect of changing the amplitude and frequency of input signals. You should have a better idea of waves after this experiment. Besides, you learnt that there is a limitation on the frequency that human ears can detect. Finally, you have modified the circuit to change the gain of the speaker.

## Unit 2 – Building a Simple Amplifier

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### 1. Purpose

To build a simple amplifier with ICs, capacitors and resistors. Students will investigate the characteristics and limitations of the amplifier.

### 2. Introduction

Amplifiers are very important devices in common electronic equipment. The amplifier can take a weak input signal and magnify the amplitude in the output. One daily example is the amplifier used in Hi-Fi.

In this unit, the student will build a simple amplifier using ICs, resistors and capacitors. Students will study the properties of the amplifier by comparing the input and output signals.

### 3. Objectives

Upon completion of *Unit 2*, students should be able to:

- *Build* a simple amplifier
- *Describe* the properties of a simple amplifier
- *Compare* the input and output signals of a circuit
- *Describe* the limitations of an amplifier and its applications in daily life.

### 4. Scope

Description	Duration (hr/min)
Introduction <ul style="list-style-type: none"><li>- Present the scope and schedule of the project and learning objectives</li><li>- Demonstrate the end-products of the amplifier</li></ul>	15 min
Build a Simple Amplifier <ul style="list-style-type: none"><li>- Demonstrate all the available parts of making an amplifier</li><li>- Teach the basic of circuits design</li></ul>	30 min
Testing and evaluation of the end-products <ul style="list-style-type: none"><li>- Measure the input and output of a simple amplifier</li><li>- Compare the input and output of the amplifier</li><li>- Investigate the performance of amplifier in different frequencies</li></ul>	1 hr
Summary	15 min

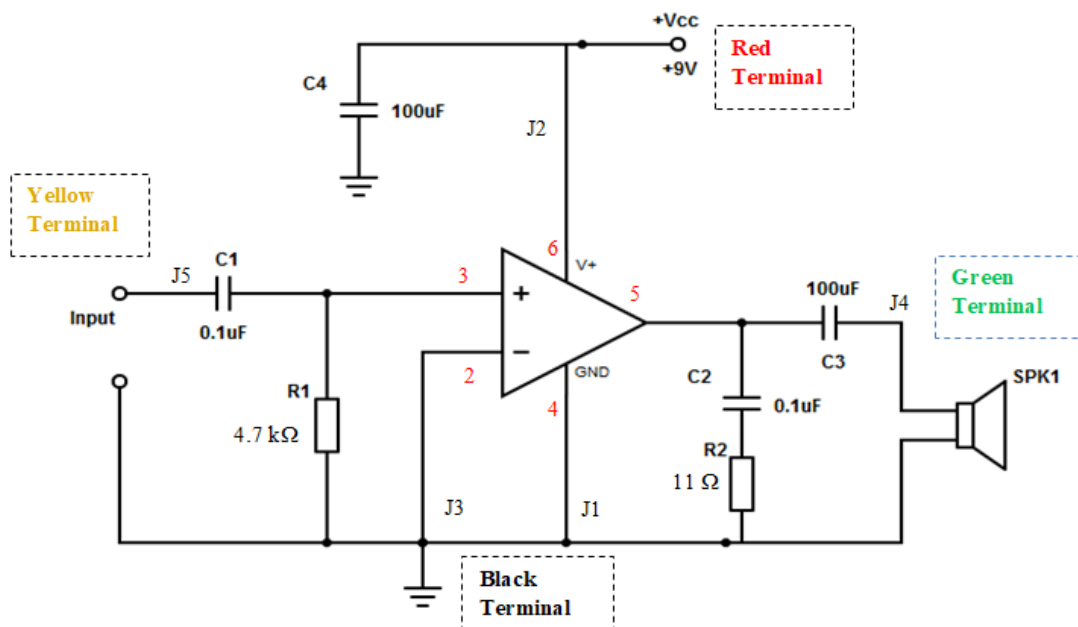
## 5. Equipment and Material

For each group of students,

- a LM386 Audio Amplifier IC package
- a function generator
- an oscilloscope
- some connecting wires
- some resistors
- some capacitors
- a speaker
- a breadboard

## 6. Introduction of a simple amplifier

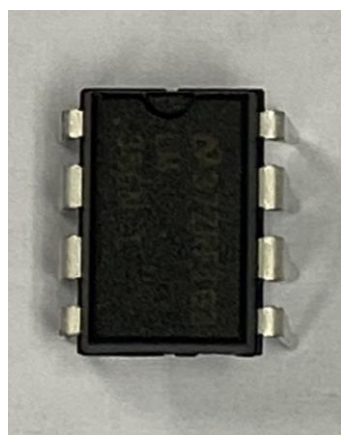
A circuit diagram of a simple amplifier is shown in Figure 1.



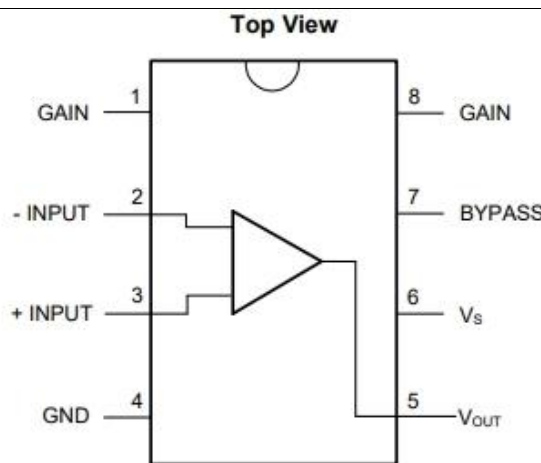
**Figure 1. A circuit diagram of a simple amplifier.**

In this unit, we will build a simple amplifier circuit with discrete electronic devices such as capacitors, resistors and an LM386 Audio Amplifier IC package on a breadboard. After building the circuit, we will test the performance of our amplifier circuit.

The LM386 Audio Amplifier is a general-purpose single-channel audio amplifier, as shown in Figure 2(a). The internal pin connections of an IC package are shown in Figure 2(b).



**Figure 2(a). The LM386 Audio Amplifier**



**Figure 2(b). The internal pin connections of an IC package**

### Instruction:

The video “Introduction” gives you an overview of the experiment.

## 7. Building the Circuit

### Instruction:

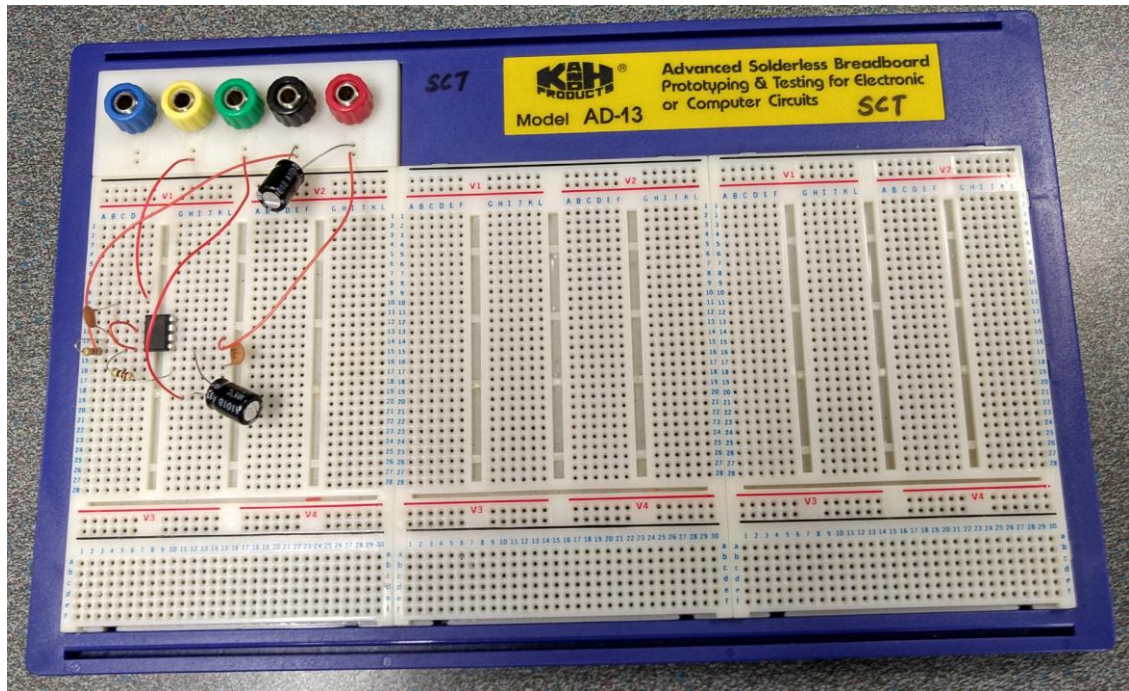
The video “How to Build the Circuit?” explains how to build the circuit. Follow the circuit diagram in Figure 1 and Table 1 to connect the corresponding components together. A prototype circuit can be found in Figure 3.

Component	Lead A	Lead B
J1	14A	Black Terminal
J2	13L	Red Terminal
J3	12E	14E
C2	14L	16L
R2	16G	14D
C3	14I (+)	19I (-)
J4	19H	Green Terminal
C1	9C	13C
R1	13B	14B
J5	9F	Yellow Terminal
C4	Red Terminal (+)	Black Terminal (-)

**Table 1.**

Pins	Position
Pin 1	11F
Pin 8	11G
Pin 4	14F
Pin 5	14G

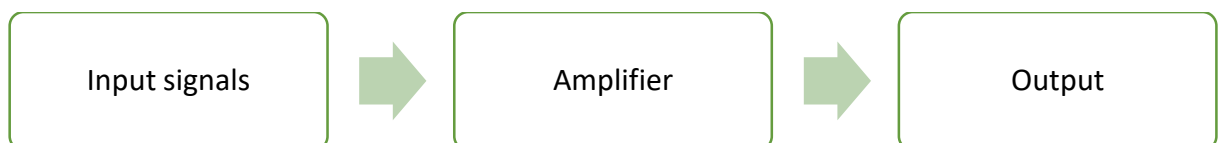
**LM386 (Refer to Figure 2(b)).**



**Figure 3.**

## 8. Testing Your Amplifier

After building your circuit, you are ready to test the performance of your amplifier. Figure 4 shows a block diagram of your system.

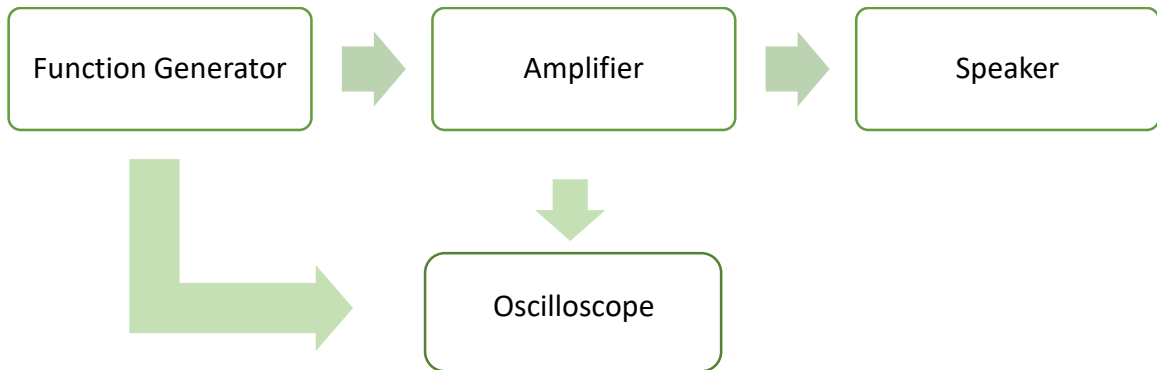


**Figure 4. Block diagram of your system.**



## 9. Experiments

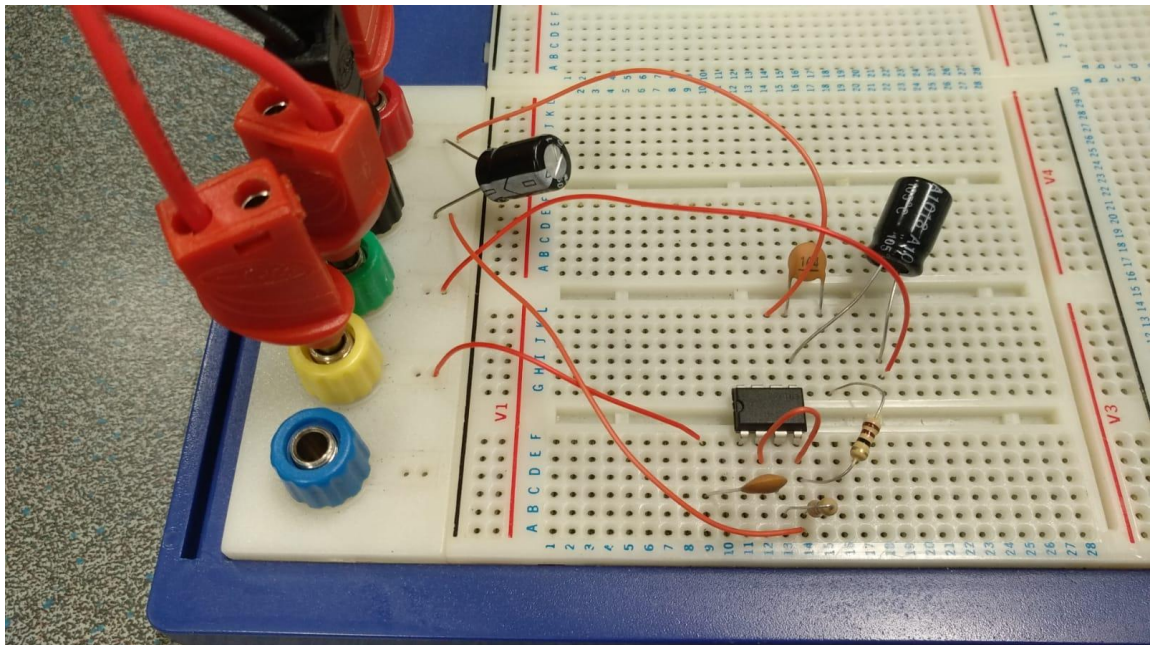
A block diagram of the setup of the experiment is shown in Figure 5.



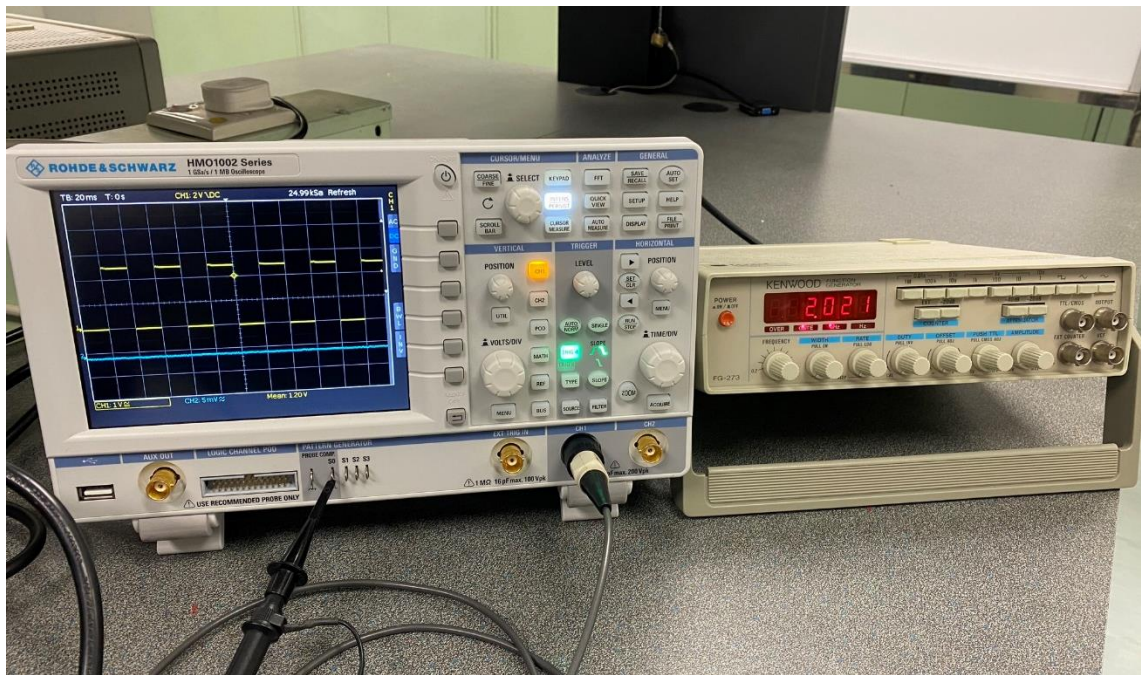
**Figure 5. Setup of the experiment**

### Instruction

The video “How to Setup the Experiment?” suggested the setup of the experiment. The video “How to Measure Your Input and Output?” shows how to connect the input and output. Use the oscilloscope to measure the input and output signals as shown in Figures 6 and 7.



**Figure 6.**



**Figure 7.**

# WE Speak Louder

## Unit 2 – Build a Simple Amplifier

### Student Worksheet

#### 1. Measuring the Input and Output Signals

(1) Use the oscilloscope to find the amplitudes of input and output signals, respectively.

The amplitude of Input signal voltage $V_{in}$	$V_{in} =$  <div style="text-align: right;">V</div>
The amplitude of Output signal voltage $V_{out}$	$V_{out} =$  <div style="text-align: right;">V</div>

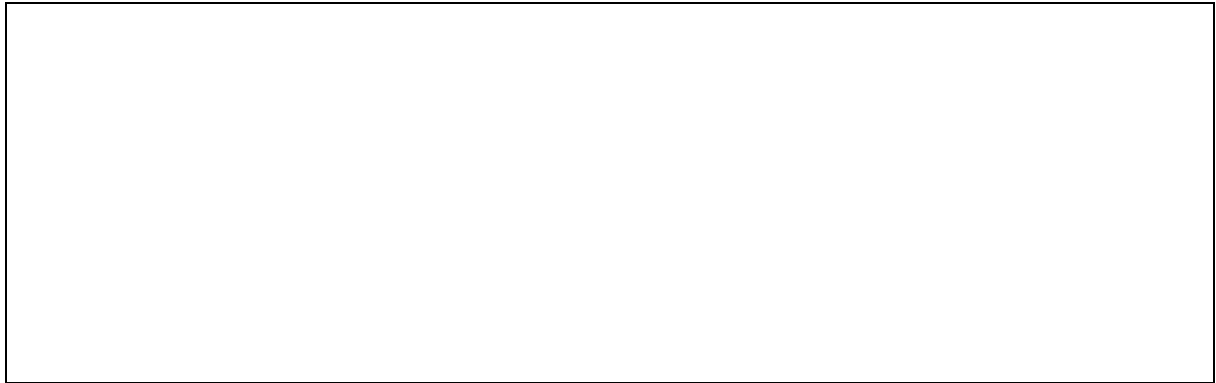
(2) Use the oscilloscope to find the frequencies of input and output signals, respectively.

Frequency of Input signal $f_{in}$	$f_{in} =$  <div style="text-align: right;">Hz</div>
Frequency of Output signal $f_{out}$	$f_{out} =$  <div style="text-align: right;">Hz</div>

(3) Find the gain of your amplifier. That is, the ratio of the amplitudes of the output signal to the input signal =  $V_{out} / V_{in}$ .

$Gain = \frac{V_{out}}{V_{in}} =$

- (4) Compare the shape of the waveforms of the input signal with the output signal. Are they the same? Write down your results.

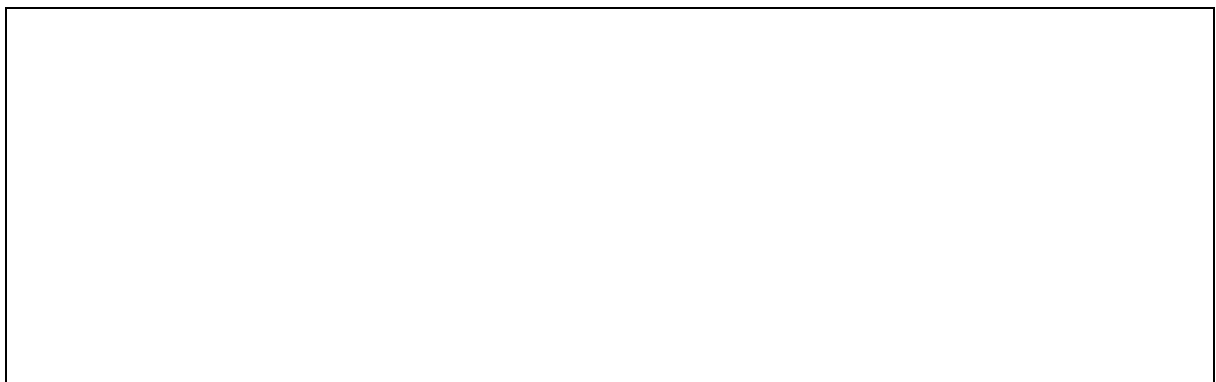


- (5) Change the waveform of input in the function generator. What do you find about the shape of a waveform in the oscilloscope?



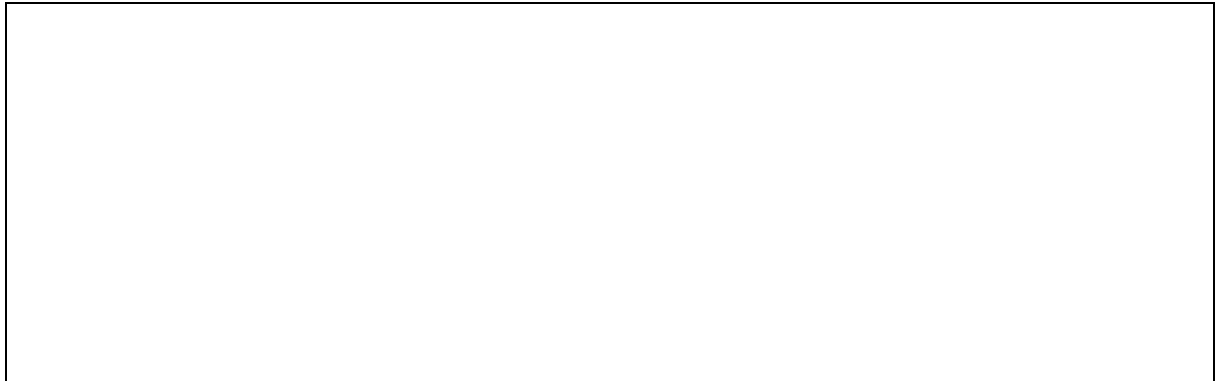
## 2. Changing Amplitude

Increase the amplitude of the input signal with the function generator. Compare the input and output waveforms. Is there any difference? What do you find?

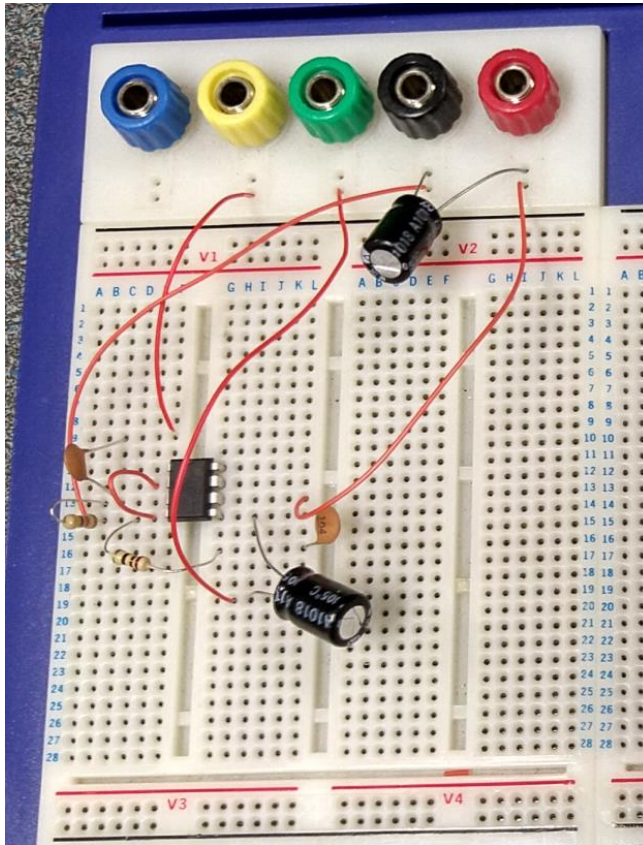


### 3. Changing Frequency

Increase the frequency of input signal in the function generator. Compare the input and output waveforms. Is there any difference? What do you find?



### 4. Modifying the Circuit of Your Speaker



**Figure 8.**

#### Instruction

The video “Modifying the Circuit” explains how to modify the circuit. You may refer to Figure 8 for reference. Repeat the measurements of output signals and record the

results. Find the gain of your amplifier, which is the ratio of the amplitudes of the output signal to the input signal =  $V_{out} / V_{in}$

$V_{in} =$

$V_{out} =$

New gain of the amplifier

$\frac{V_{out}}{V_{in}} =$

## 5. Summary

In these units, you built a simple amplifier with discrete components. The performance of the amplifier is investigated. You studied the effect of changing the amplitude and frequency of input signals. You also compared the input and output waveforms on the oscilloscope.