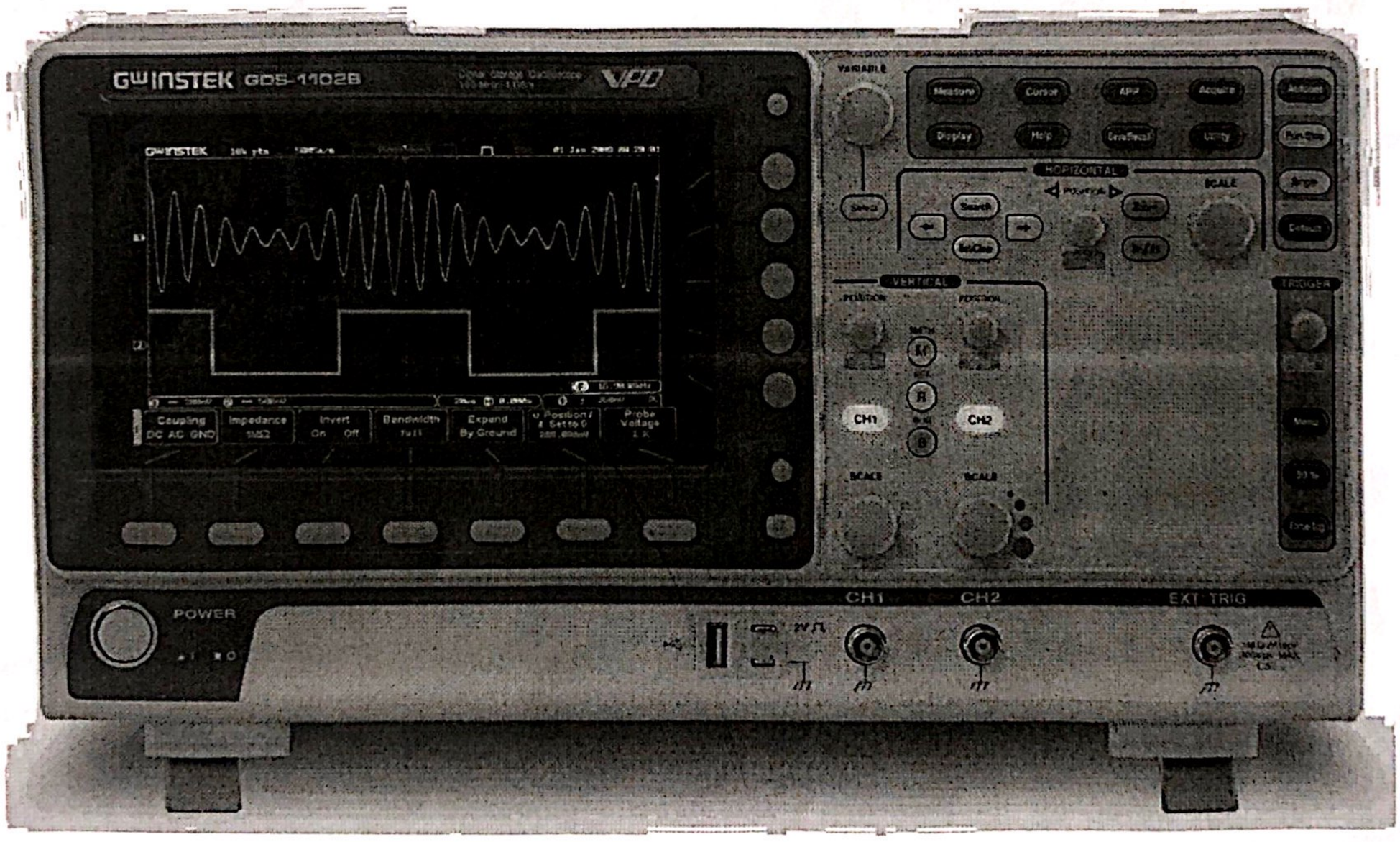
Student ID:	23201436	**Lab Section:**	05
Name:	Mohammad Zihan Zaman	**Lab Group:**	10 (Table)

Part 2: By Using Oscilloscope

Theory

Oscilloscope

An oscilloscope is a device that can measure a sequence of voltages over time and can display that information by plotting those on a screen. In fact, oscilloscopes available at our labs are dual channel (**CH1** and **CH2**), meaning, they can simultaneously show voltage vs time graphs across two separate sets of nodes.



An oscilloscope

In the default mode, an oscilloscope can show 2 separate graphs (yellow and blue) where the common x-axis for both of the graphs is **time**. The y-axis for the **yellow** graph is the voltage measured at **CH1** and the **blue** graph is the voltage measured at **CH2**.

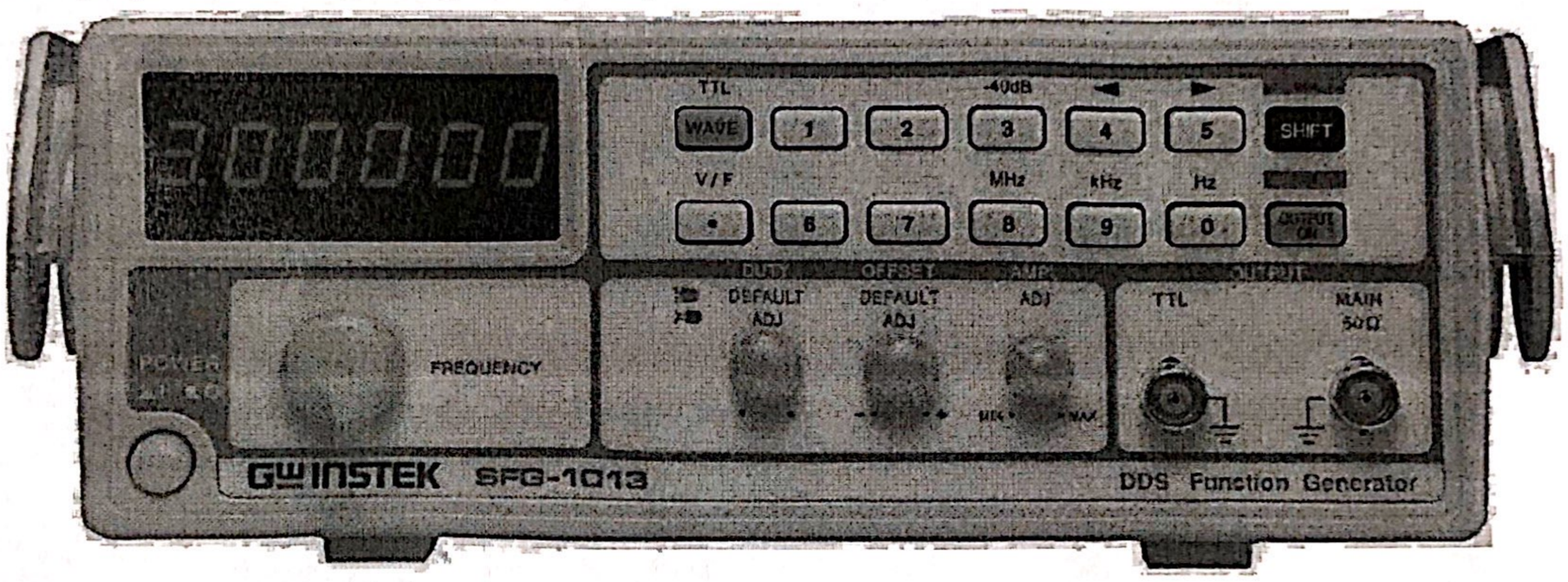
However, there is another mode called the **"XY" mode** where we can plot voltage from **CH1** on the x-axis vs voltage from **CH2** on the y-axis. This is exactly how we can plot I-V characteristics on an oscilloscope. If we connect the voltage, V across the two terminals to **CH1** and measure the current I on **CH2**, we could plot the I-V characteristics. However, oscilloscopes can only measure voltages. This can easily be done using a 1 kΩ resistor since

the voltage (in volts) across a 1 kΩ resistor is equivalent to the current (in milliamperes) through that resistor.

There is another hurdle to overcome regarding the negative terminals of the two oscilloscope channels. Although they seem separate, in actuality, **the two negative terminals are internally shorted.** Hence, we need to connect both the channels in such a way that there negative terminals are connected at the same node. In fact, connecting only one of the negative terminals at that node is enough. But this is a challenge since we may want the inverted voltages. This can be easily done through the GUI by pressing the channel buttons. For example, if we want to invert **CH1**, it can be done by pressing the glowing **CH1** button and then turning **On** "**Invert**" mode (detailed procedures are discussed later).

Function Generator

A function generator is a device that can generate various shapes of electrical waveforms. We can produce signals of different frequencies, amplitudes, and wave shapes, such as sine waves, square waves, triangular waves, etc.



A Function Generator

In the previous part, we collected data using a multimeter, and the supply voltage was changed with a knob on the DC power supply. However, an oscilloscope samples thousands to millions of data points per second. So, manually adjusting the supply voltage is not possible. However, for that, we may use a function generator that creates a 1 kHz signal of the maximum amplitude (10 V) as the supply voltage V_S.

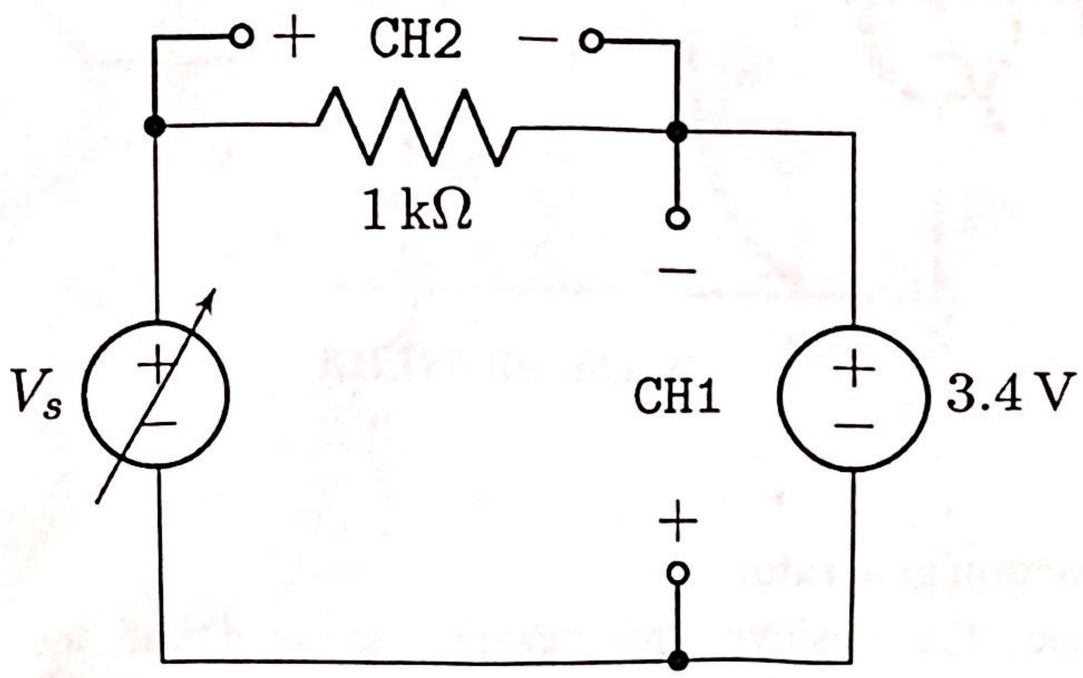
Apparatus

- Oscilloscope
- Function Generator
- DC power supply
- A 100 kΩ potentiometer
- Light Dependent Resistors (LDRs)
- Breadboard

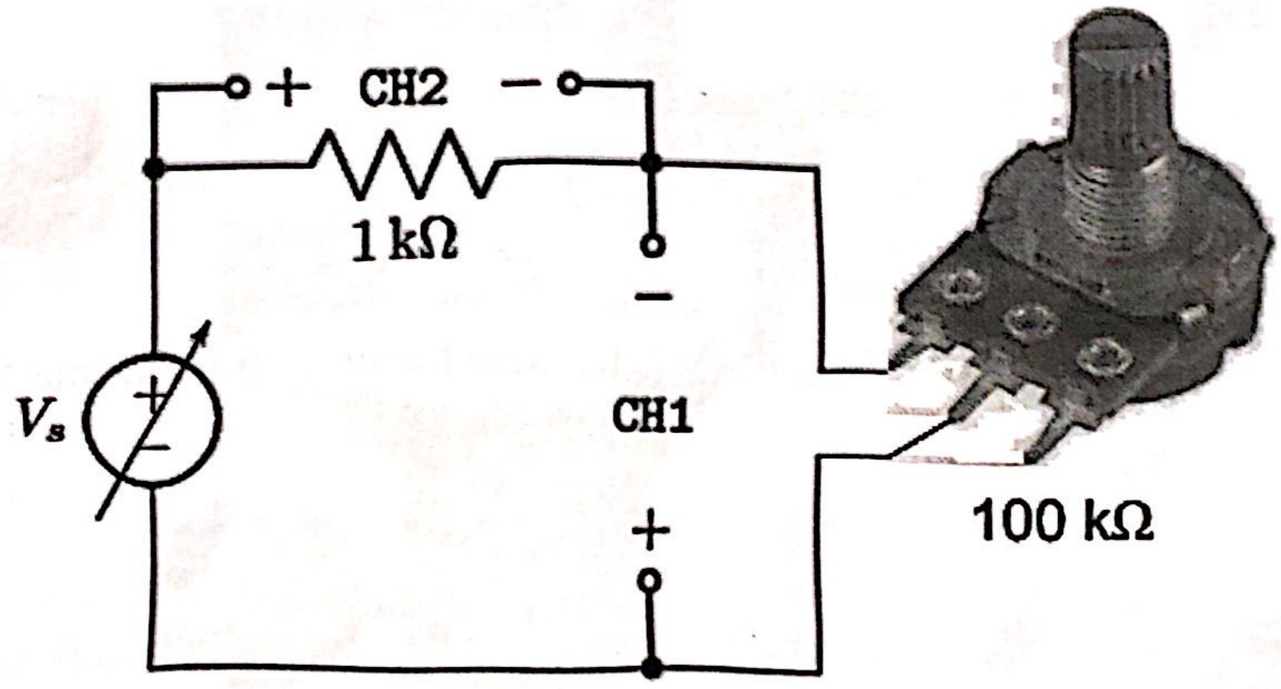
- Jumper wires

Procedures

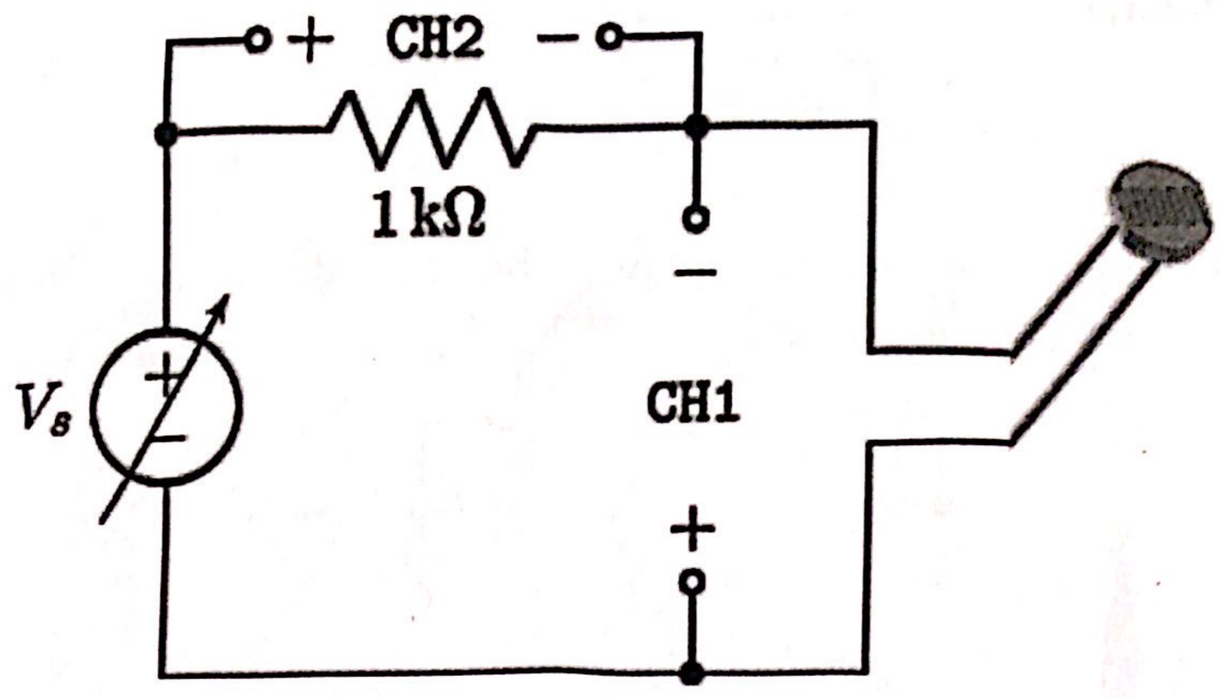
- Construct the following circuits on a breadboard. Try to minimize the number of jumper wires in your circuit:



Circuit 4 (DC Voltage Source)



Circuit 5 (Potentiometer)

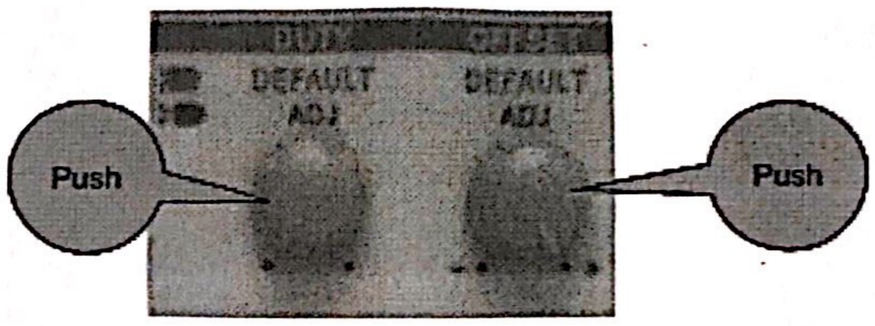


Circuit 6 (LDR)

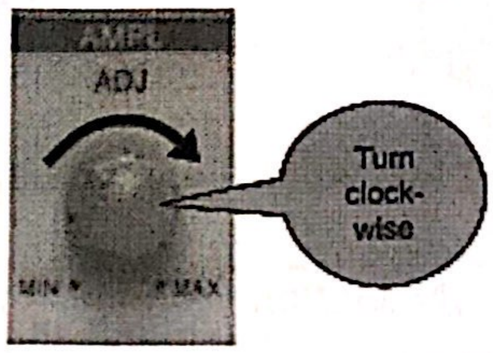
➢ Setup the **function generator**:

➢ Connect the positive and negative terminals of the function generator according to the positives and negatives of the supply voltage V_S.

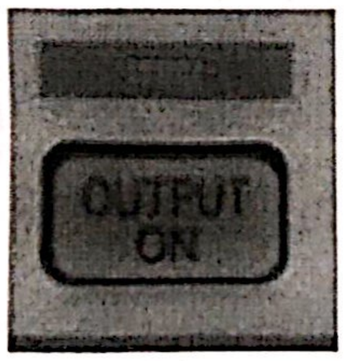
➢ Make sure the **DUTY** and **OFFSET** adjustment knobs are **pushed in** **(default mode).**



➢ Set the **AMPL** (amplitude) adjustment knob to the **MAX** position.

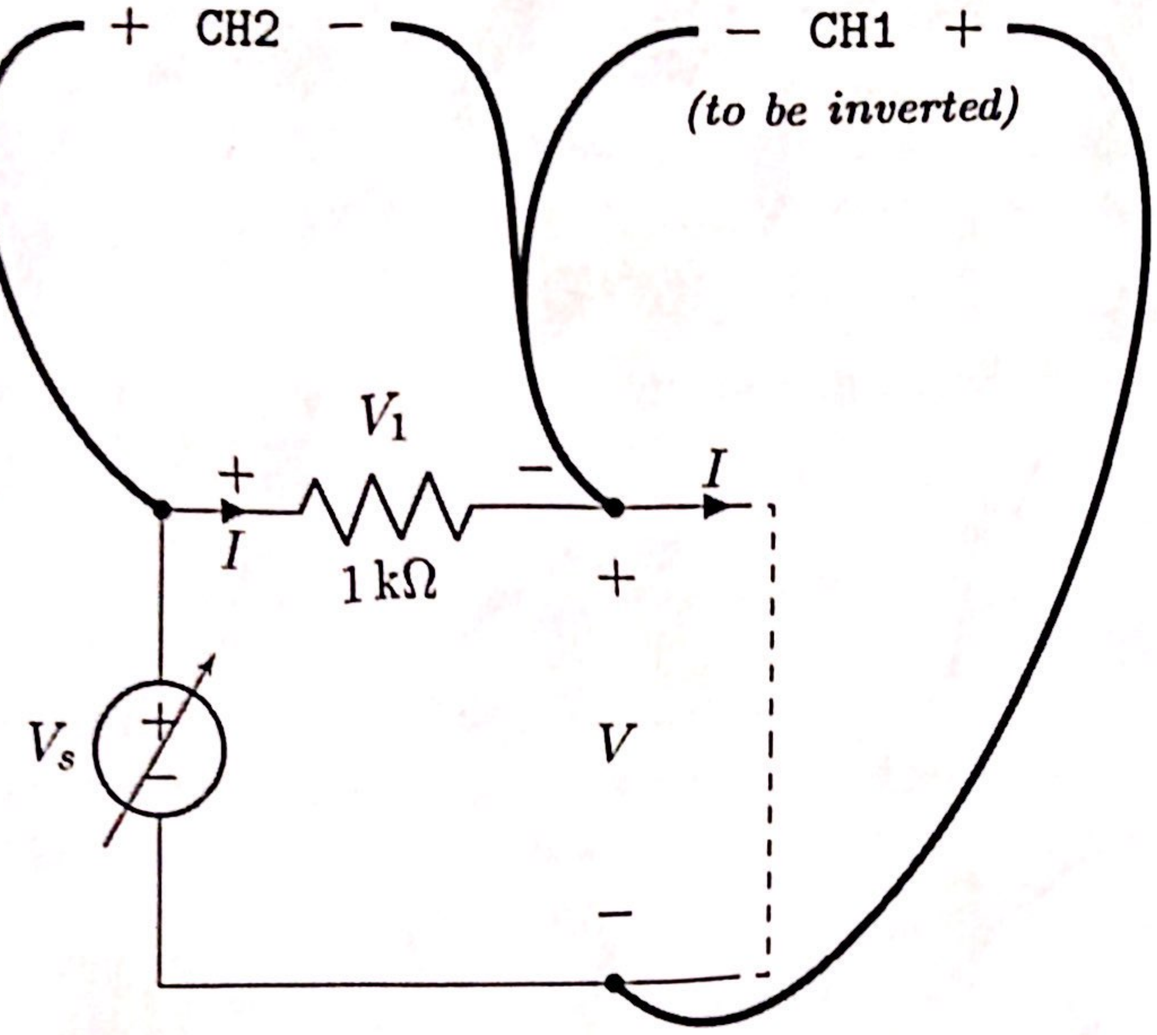


➢ Turn on the **output**.



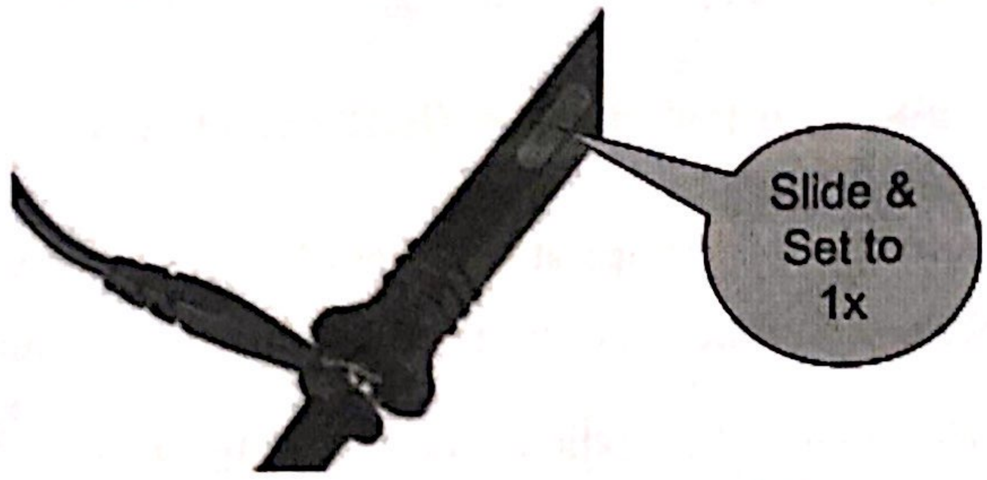
➢ Setup the **oscilloscope**:

➢ Connect the channels of the oscilloscope as demonstrated in this figure:

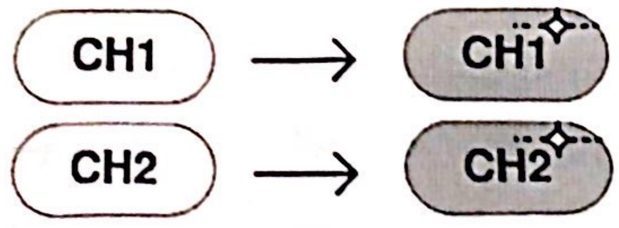


Connecting oscilloscope channels

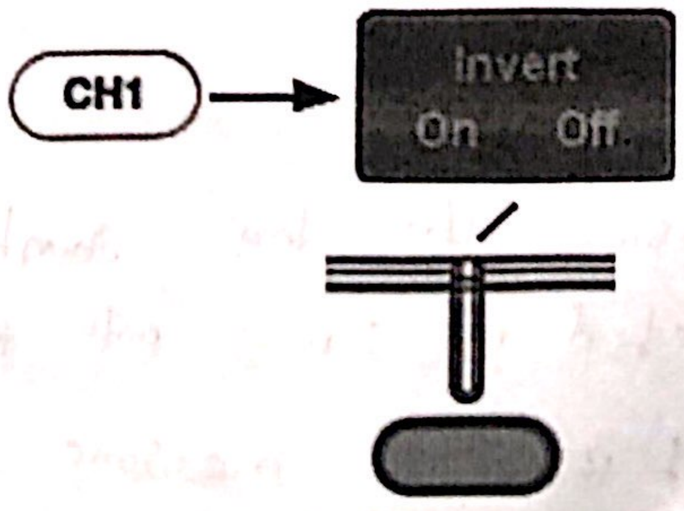
➢ Set the oscilloscope probe scaling to **1x** (not 10x).



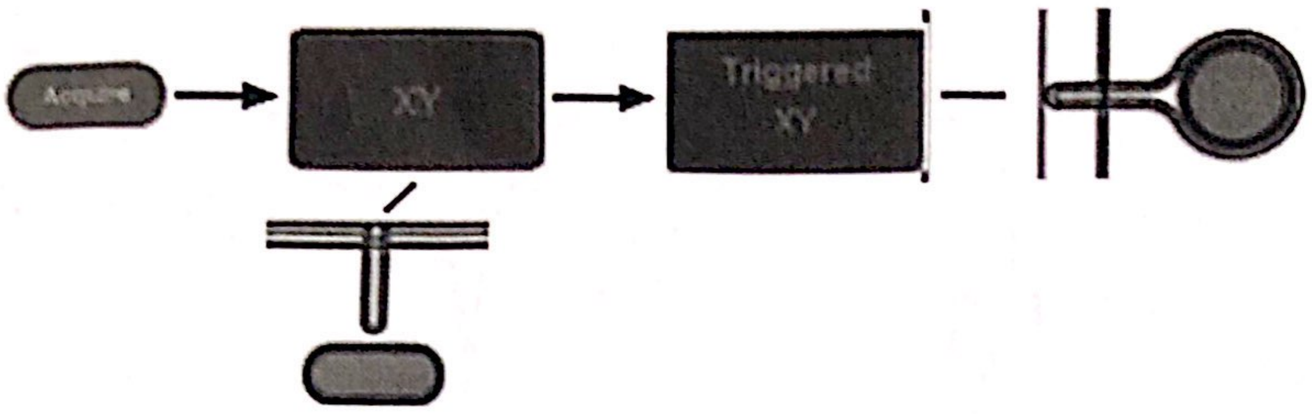
➢ Make sure both channels are turned on. These buttons should be glowing:



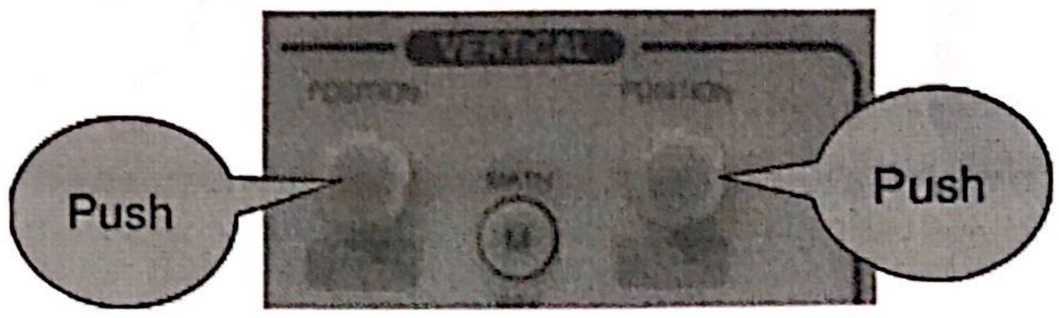
➢ Invert **CH1** by pressing the bottom menu buttons and set it to **On**.



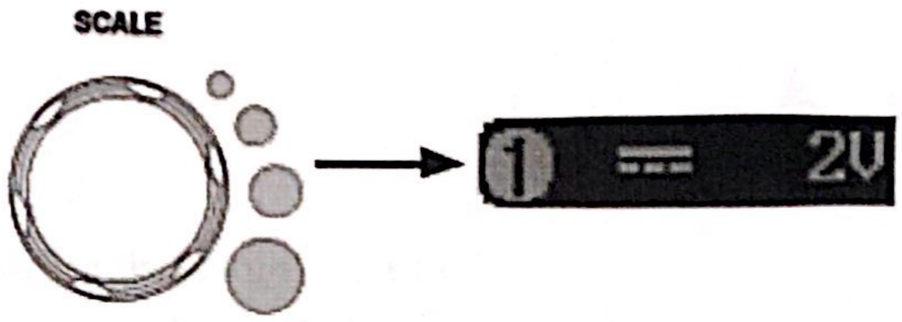
➢ Go to **XY** Mode:



➢ Set position to origin by **pushing** the **position knobs** on each channel.



➢ Turn both channel knobs so that the voltage resolutions are at **2V per division.**



Questions

5. Refer to the illustration of an **Oscilloscope** on page 11 to answer the following questions–

(a) In the normal mode of operation, an oscilloscope always plots–

☑ voltage as a function of time ☐ current as a function of time

(b) In the X-Y mode of operation, an oscilloscope plots Channel-1 along the -

☐ x-axis ☑ y-axis

(c) What is the function of the button "**Measure**"?

☐ It measures the total resistance of the circuit.

☐ It adds the voltage waveforms fed to the channels.

☑ It displays the properties of the voltage waveforms fed to the channels.

(d) Is there any way to observe the one you haven't selected in (a)?

1) To measure voltage drop shunt resistor can be connected in series with the circuit

2) current Probe: To measure the high current signal it is used.

6. Refer to the illustration of a **Function Generator** on page 11 to answer the following questions:

(a) If you are asked to set a sinusoidal voltage with a dc offset $v(t) = 5 + 5sin(2\pi 100t)\ (Volt)$ in a **Function Generator,** specify the values of the following parameters. On the rightmost boxes, put a checkmark ✔ to indicate the ones that need to be set on the Function Generator.

• Amplitude of the voltage =	5	V	✓
• Peak to peak of the voltage =	10	V	
• Natural Frequency, f =	100	Hz	✓
• Angular Frequency, ω =	200π	$rads^{-1}$	
• Initial Phase, ϕ =	0	^{o}	
• DC Offset =	5	V	✓

(b) List the buttons you need to press sequentially to set a frequency equal to $1.23\ kHz$. Add boxes if necessary.

Power On → Frequency → 1 → . → 2 → 3 → kHz

(c) Turning the "**AMPL**" knob clockwise or counterclockwise will change the–

- ☐ Frequency of the voltage waveform
- ☑ Amplitude of the voltage waveform
- ☐ Phase of the voltage waveform

(d) What is the function of the button "**WAVE**"?

- ☐ It converts a voltage waveform into a current waveform
- ☐ It sets everything to default.
- ☑ It changes the types of voltage waveforms.

7. Put a checkmark ✔ beside the correct answers:

(a) The I-V characteristics of the following circuits were **straight lines** -

☑ Circuit 4 ☑ Circuit 5 ☑ Circuit 6

(b) The I-V characteristics of the following circuits went **through origin** -

☐ Circuit 4 ☑ Circuit 5 ☑ Circuit 6

(c) The following circuits were **equivalent to a resistor** -

☐ Circuit 4 ☑ Circuit 5 ☑ Circuit 6

(d) When the LDR was completely **in darkness,** the I-V characteristic line was -

☐ y-axis ☑ x-axis ☐ parallel to x-axis but shifted upwards

(e) When the *LDR* was completely **in darkness,** it was equivalent to -

☐ short circuit ☑ open-circuit ☐ 1 kΩ resistor ☑ $0A$ current source

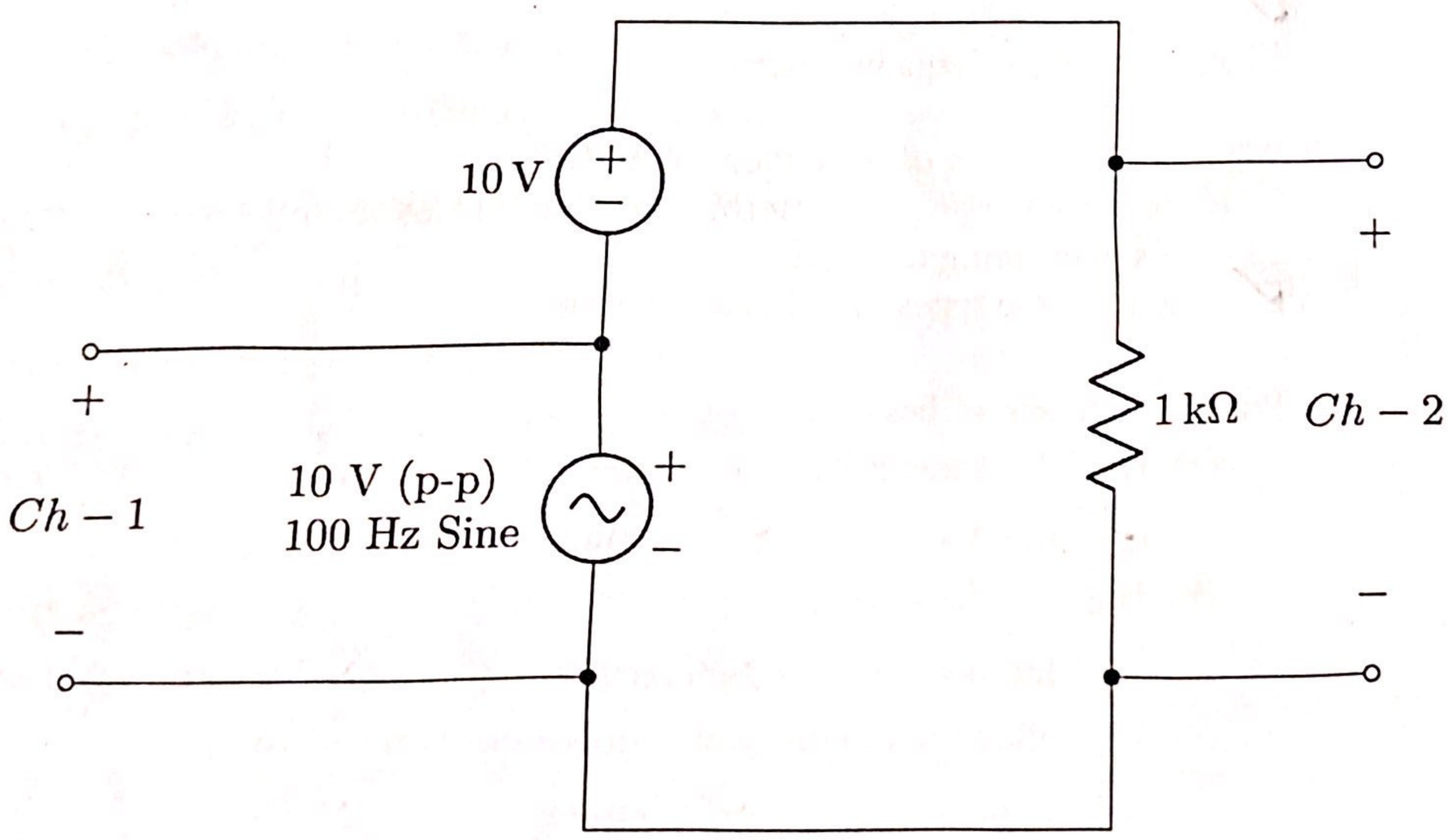
8. Why was it necessary to invert Channel 1 of the Oscilloscope to visualize the I *vs.* V plot of **Circuits 4, 5, and 6**?

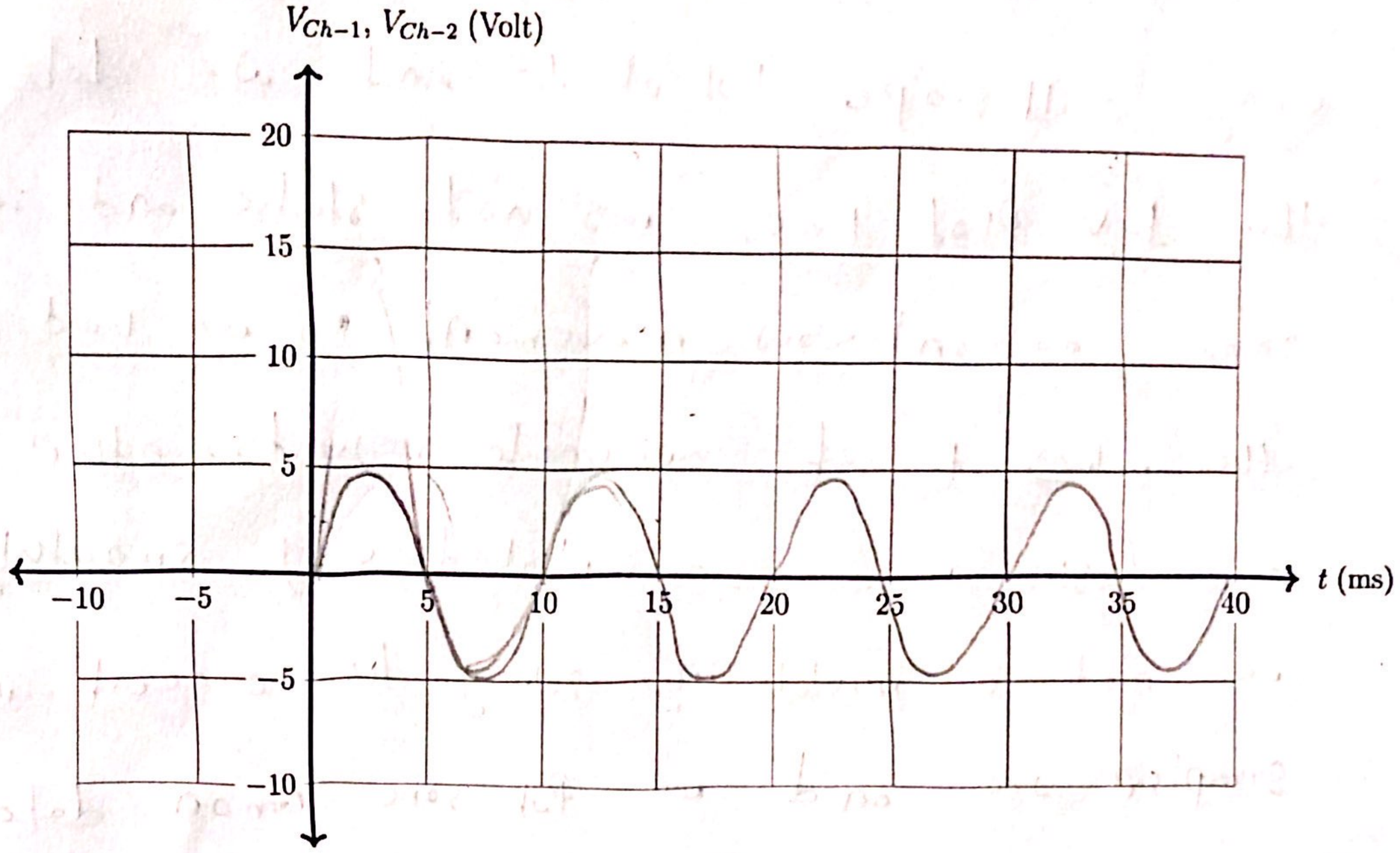
Inverter is used to change the orientation of the signal voltage on the CH signal ~~voltage~~ input connector To stabilize the wave form display channel 1 inverted as voltage source of circuit 4 is Properly aligned with the triggering of oscillation

9. Compared to the expected one, how the observed $I - V$ plot would be if we didn't invert the Channel-1 on the Oscilloscope?

- [x] The $I - V$ plot would mirror with respect to the y-axis.
- [ ] The $I - V$ plot would mirror with respect to the x-axis.
- [ ] The $I - V$ plot would still be the expected one.
- [ ] We wouldn't observe any graph.

10. Draw the waveforms that should be observed in Channel-1 and Channel-2 of an oscilloscope when both the channels are ON and are connected in a setup shown below. Draw both plots in the same template given below. Mark the waveforms according to their visualizing channel.





11. Write two significance/importance of I-V characteristics.

① IV characteristics help determine how an electrical component or device responds to different voltages

② we can extract important Parameters such as threshold voltage, resistance or breakdown voltage

Report

1. Fill up the theoretical parts of all the data tables.
2. Answers to the questions.
3. Attach the captured images of the $I - V$ plot observed for **Circuits 4, 5,** and **6.** in the Oscilloscope. Fit all the images on a single page and print.
4. Discussion *[your overall experience, accuracy of the measured data, difficulties experienced, and your thoughts on those]*. Add pages if necessary.

We have found the obtained results as satisfactory although there were some discrepancies while using oscilliscope but at the end we determined the I-V Plot line was not static and it had some continuous movement so we had to lower the values to get accurate results. other than that our tasks were accomplished very smoothly. Initially we made a mistake in solving the circuit into a simpler one and we put some wrong data initially which was later rechecked to determine the correct value