THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY
Department of Electronic and Computer Engineering
ELEC 1100

Laboratory 1: Instrumentation and Basic Circuits (5%)

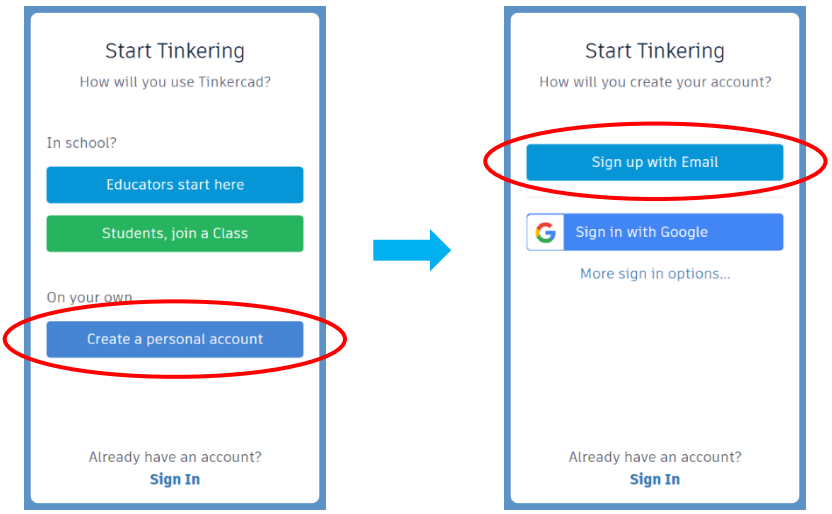
A) Objectives

- To familiarize with the components in Tinkercad (a free online software).
- To familiarize with the breadboard circuit design.

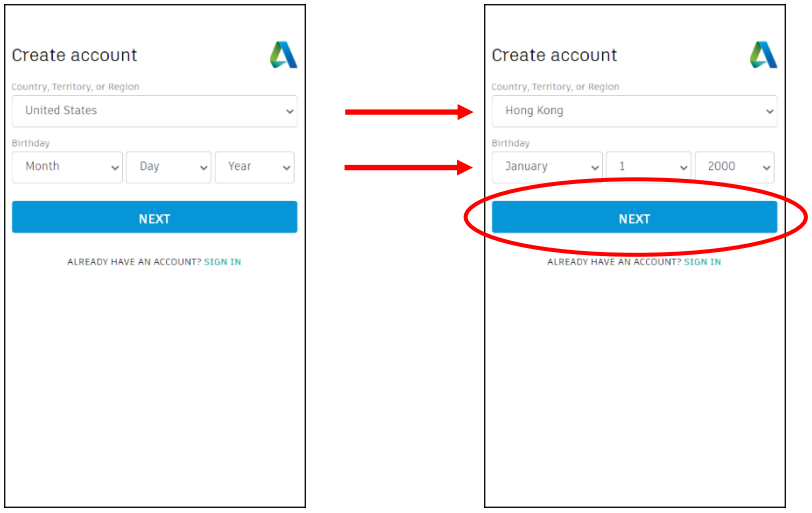
B) Prelab

- Get your electronic device ready to open **Tinkercad** https://www.tinkercad.com/. Click "JOIN NOW" on the top right corner to start the registration.

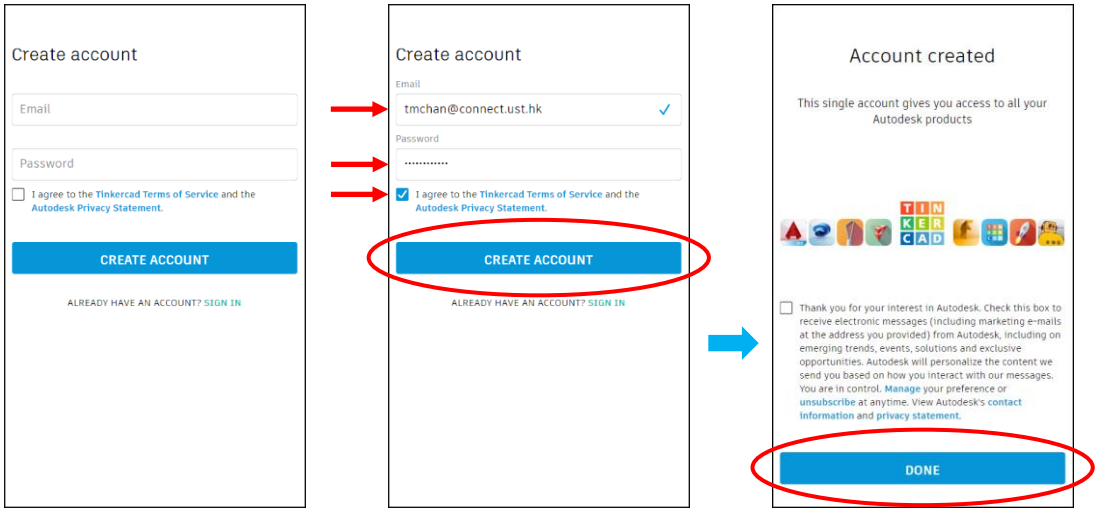
- Click "Create a personal account". Then click "Sign up with Email".



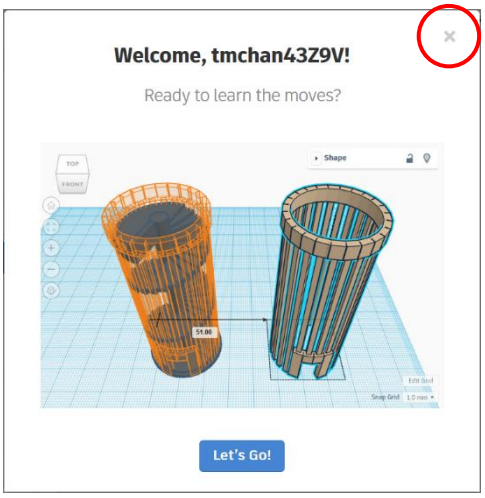
- Select your “Country” and “Birthday”. You don’t need to fill in your own birthday but it has to be more than age 13 for easy registration steps. Click “NEXT” to continue.



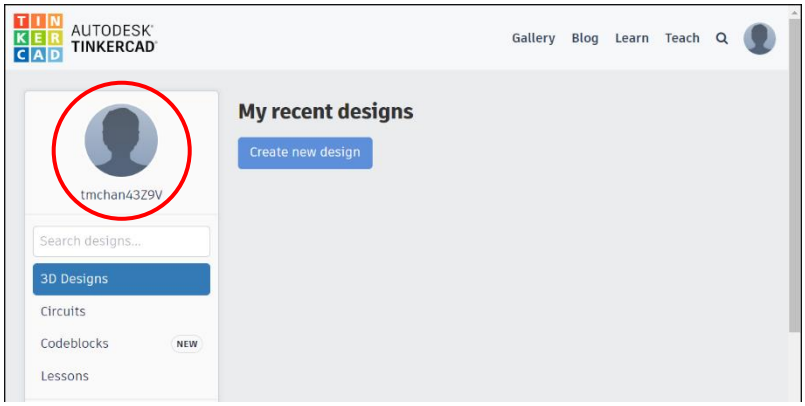
- Enter your email, password and check the agreement. The email is for Tinkercad verification and password recovery purpose. You may use either UST email or your personal email. Then click “CREATE ACCOUNT”. Finally, click “DONE” to finish.



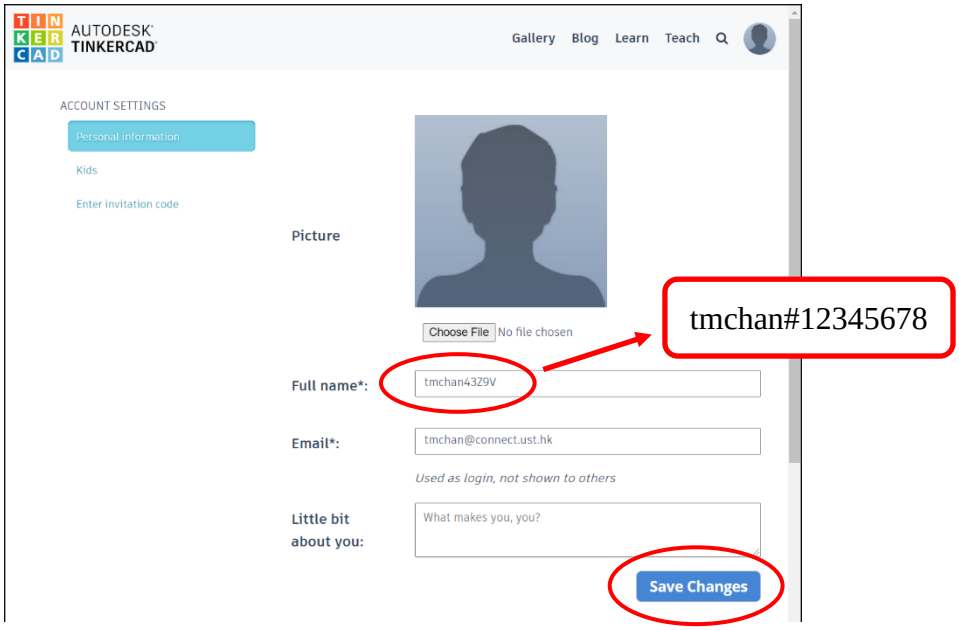
- A welcome screen appears with your full name (generated by Tinkercad). Simply click “X” to close.



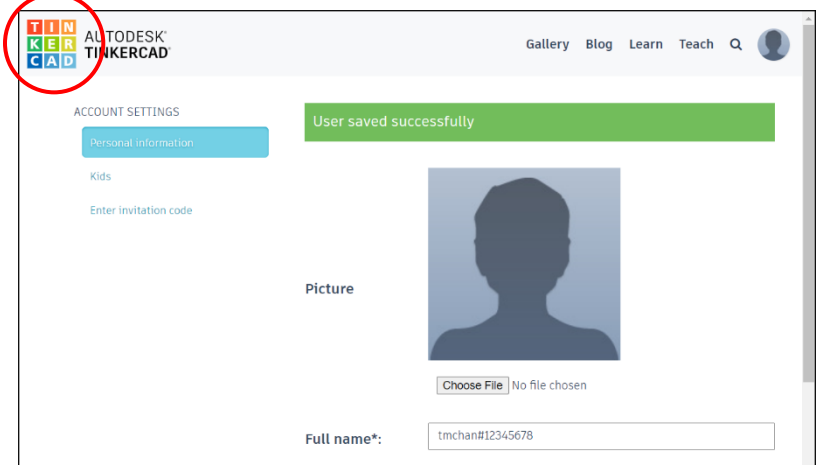
- You should see your dashboard as below. For identification and demo purpose, please change the full name accordingly. Click the profile picture.



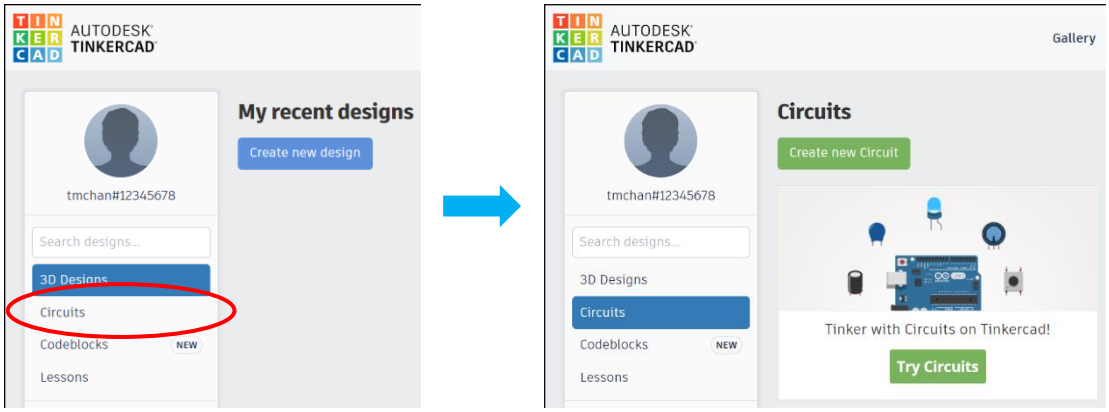
- In “Full name” field, change the generated name to your UST email with your student ID number. Then click “Save Changes”.



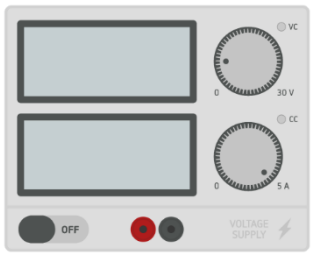
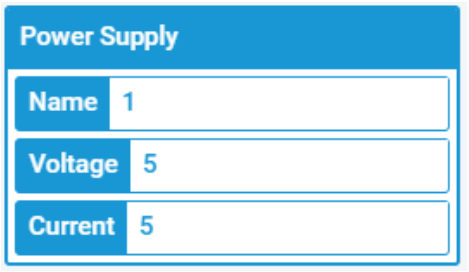
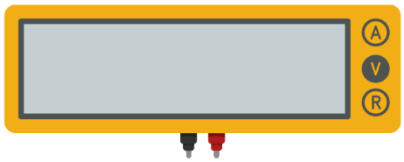
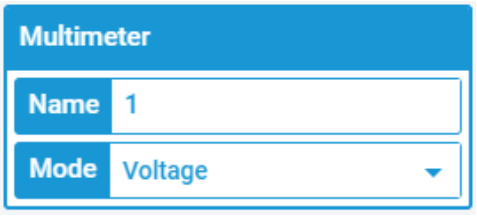
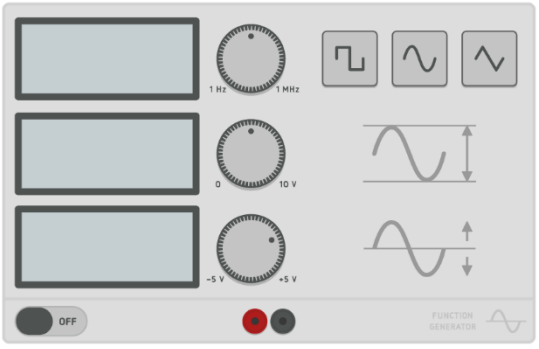
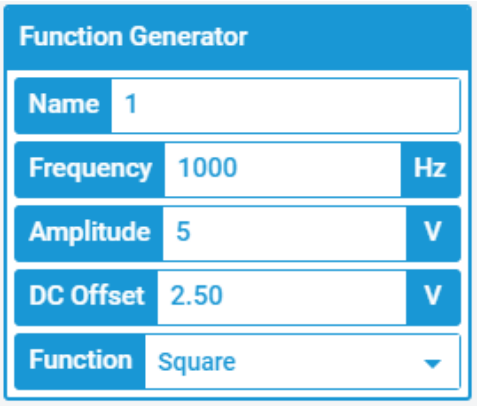
- You should see message “User saved successfully”. Click the Tinkercad logo on top left corner to go back to your dashboard.

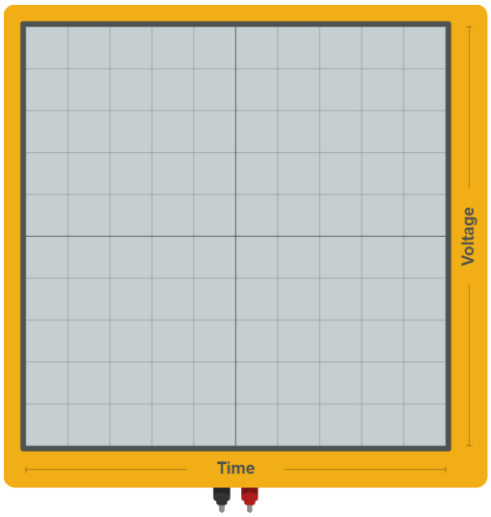
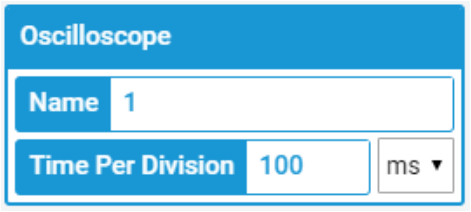


- Click “Circuits” to go to your Circuits dashboard. All of your saved circuits shall appear on this page, if any.



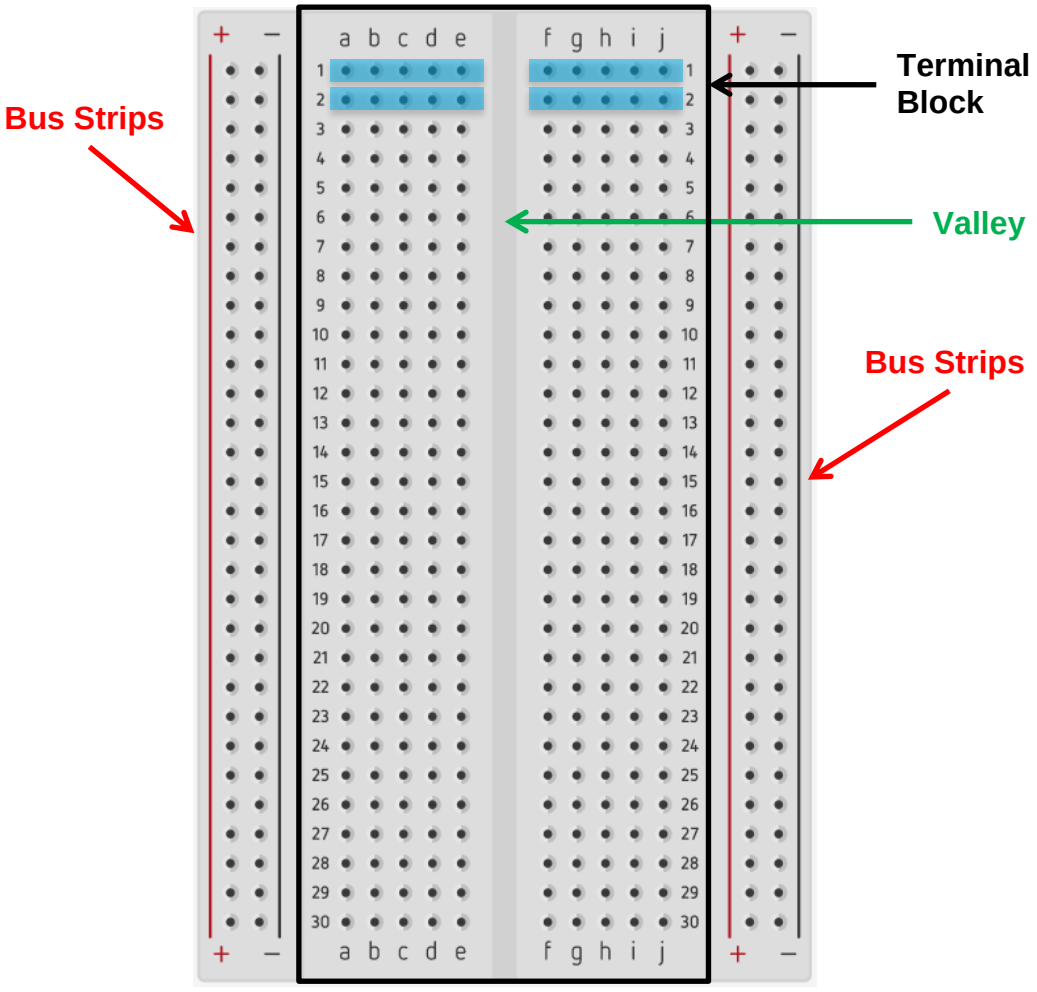
C) Instruments in Tinkercad

Item	Values you can input
1) Power Supply 	1) Default values 
2) Multimeter 	2) Default values 
3) Function Generator 	3) Default values 

4) Oscilloscope	4) Default values
	

5) Breadboard

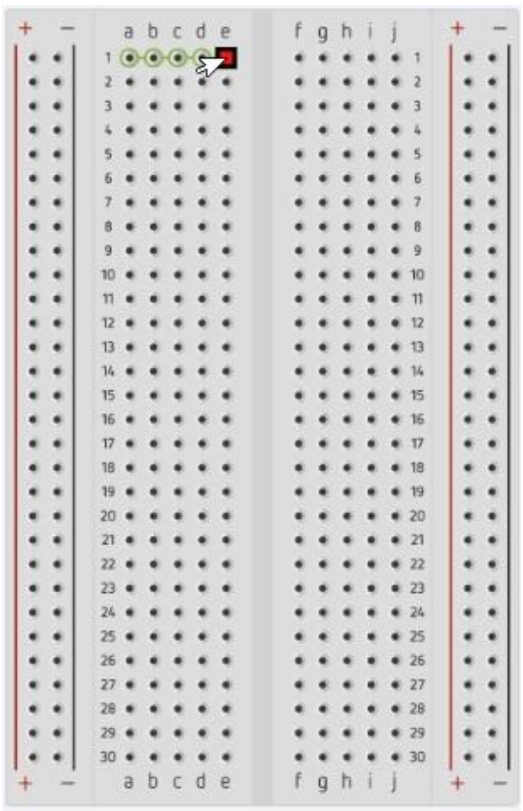
The breadboard in Tinkercad is as shown in the figure below. It helps you to connect components together to form a complete circuit and allow centralized connections to external power/signal sources and various equipment.

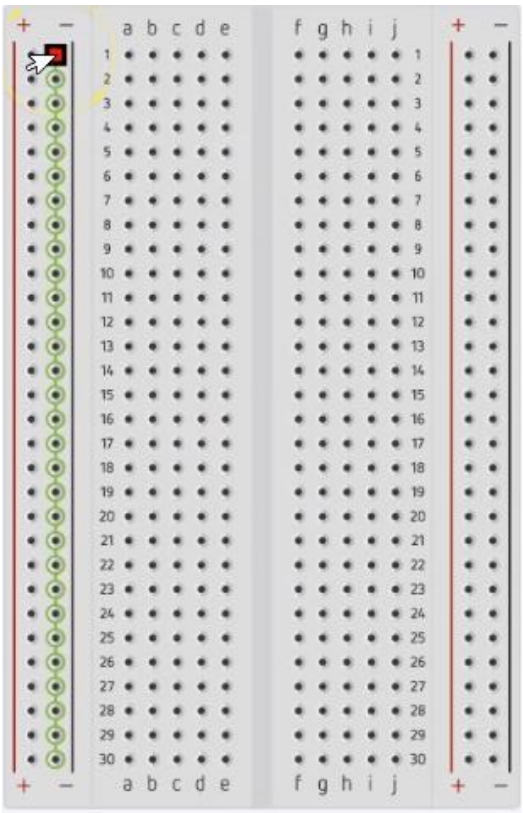


The **long strips** on both sides of the breadboard are marked by red and black lines, with plus (+) and minus (-) signs, respectively. They are called the **buses**, also referred to as rails, and are typically used to centralize the supply of electrical power to your circuits. Thus they are usually connected from a battery pack or other external power supply with corresponding polarities. As shown in the above picture, the red line beside a column of holes indicates that the holes are electrically connected (with metal strips underneath a real breadboard). **Same annotation for the black line.** Any component pins will be electrically connected when they are inserted into the same column. And these two columns of holes are electrically insulated and are independent of each other.

Within a **terminal block**, a blue color row (illustration only) indicates that 5 holes in a row are electrically connected (with metal strips underneath a real breadboard). Any component pins will be electrically connected when they are inserted into the same row. Rows of 5-hole are electrically insulated and are independent of each other. Component connections are mainly done within this **block** area.

In Tinkercad, when you move your mouse pointer over a hole on a breadboard, it shows a red square spot. All other holes that are electrically connected to that hole will be highlighted by green circles and linked together. This is a good reminder for you not to connect unwanted component pins together.



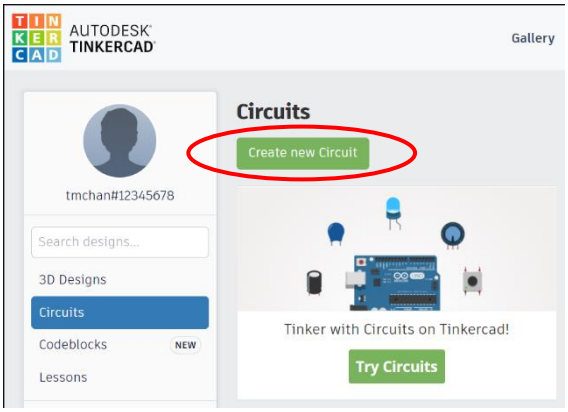


D) Tinkercad Simulation Part

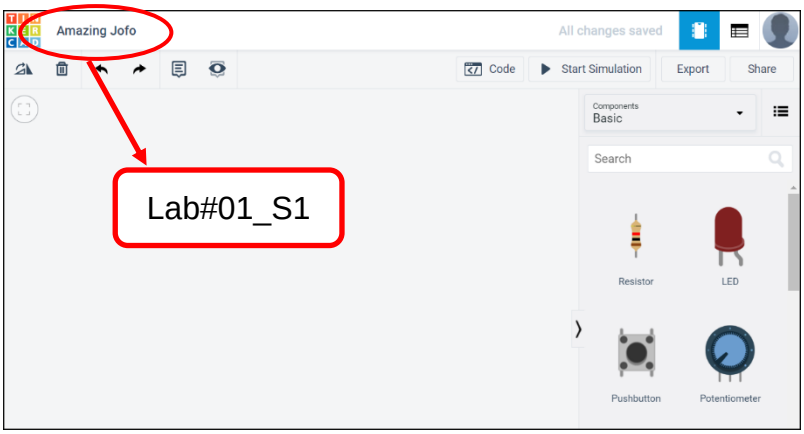
Simulation 1: Use of Power Supply and Multimeter **[Lab#01_S1]**

In this experiment we use a multimeter to measure voltage output from a power supply in Tinkercad.

Step 1: Click “Create new Circuit”.

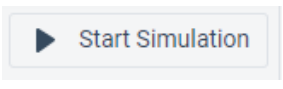


Step 2: Circuit editor appears with randomly assigned circuit name (beside the Tinkercad logo). Change it to a meaningful name by clicking the name and type “Lab#01_S1” (as shown above in the simulation heading). Press ENTER to finish.



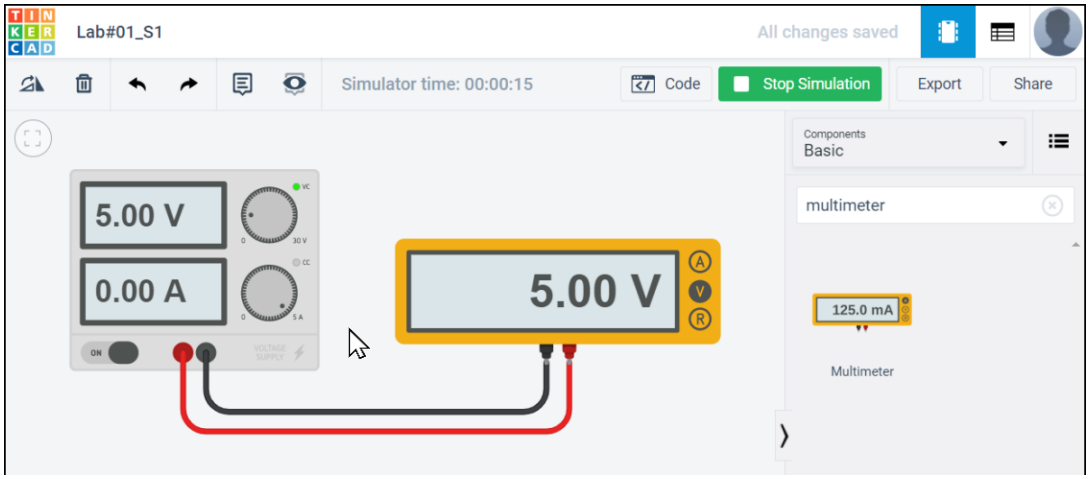
Step 3: Find the power suppply and the multimeter in instruments list.

Step 4: Connect the multimeter to the power supply to check the voltage. Positive to positive, negative to negative. You may change the wire color to be “Red” and “Black” accordingly.

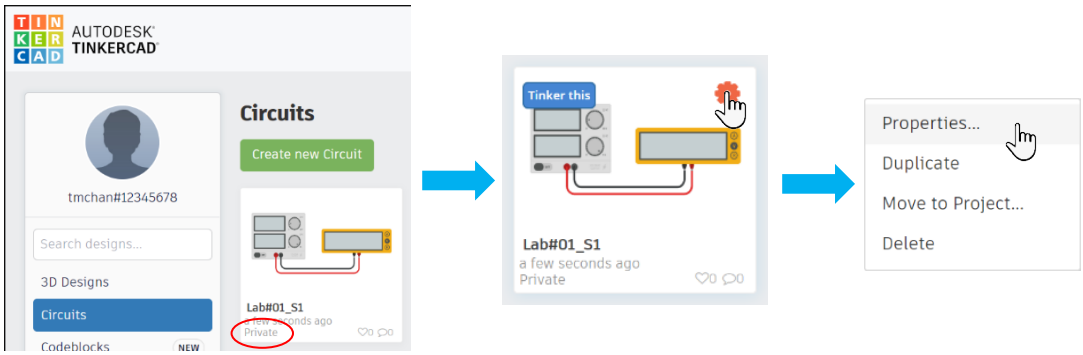
Step 5: Use the default settings at shown at page 2, click 

to run the simulation. The multimeter should show 5V.

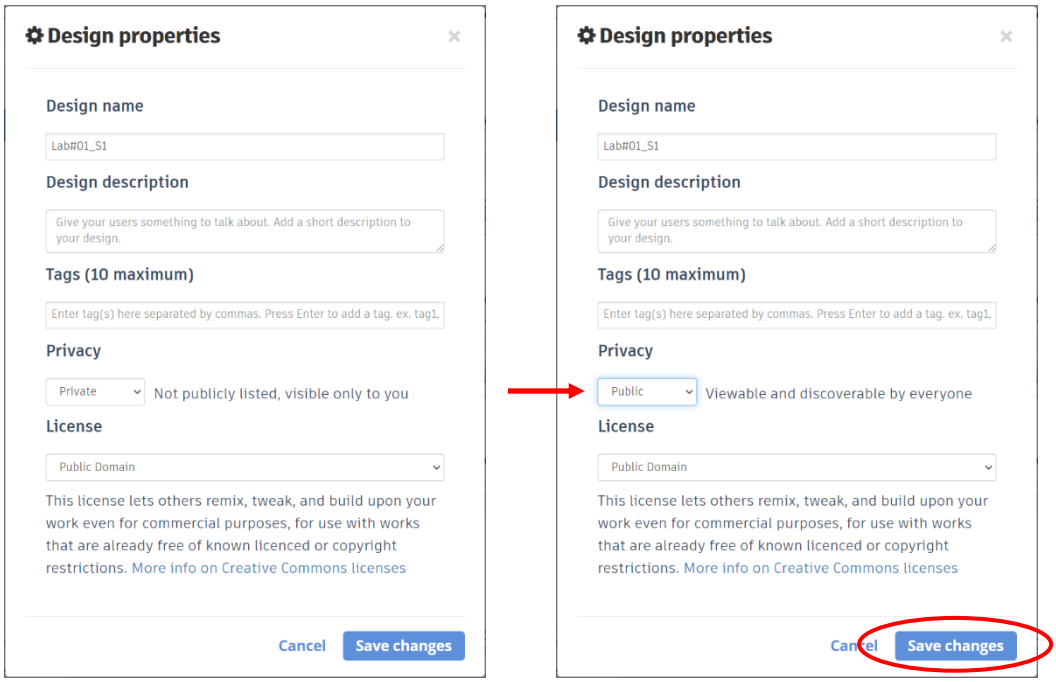
******TA Check 1: Demo to your TA.**



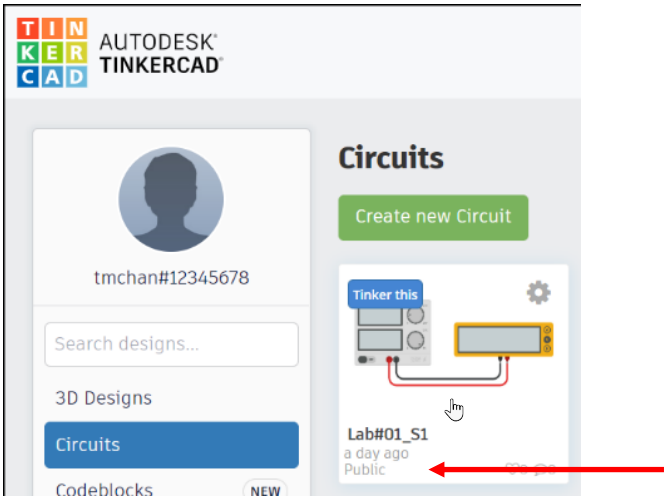
Step 6: Click the Tinkercad logo to go back to dashboard. You shall see your new circuit thumbnail appears. In order to submit your circuit for demo, you have to set the privacy to public. Move your mouse pointer over the thumbnail and an Options icon ⚙ will appear on the top right corner. Click it and select “Properties…”



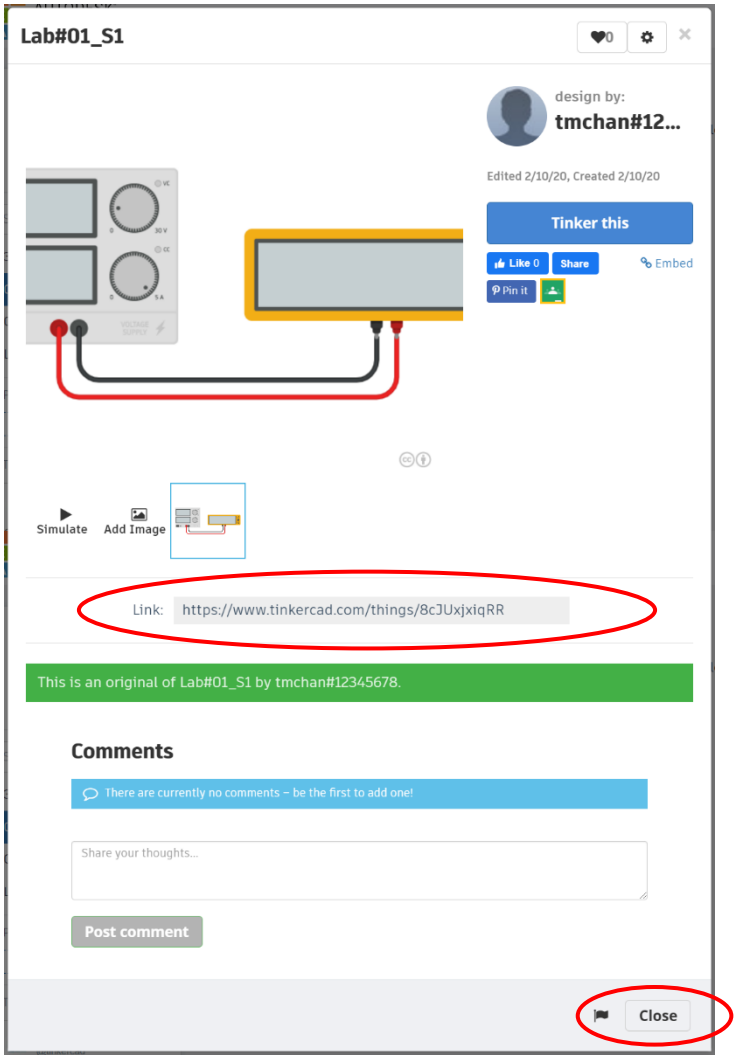
Step 7: “Design properties” dialog box pop-ups. Change the “Privacy” value to “Public”. Then click “Save changes”.



Step 8: You should see “Public” appears on the lower left corner of the thumbnail. Click the thumbnail picture to open share information.

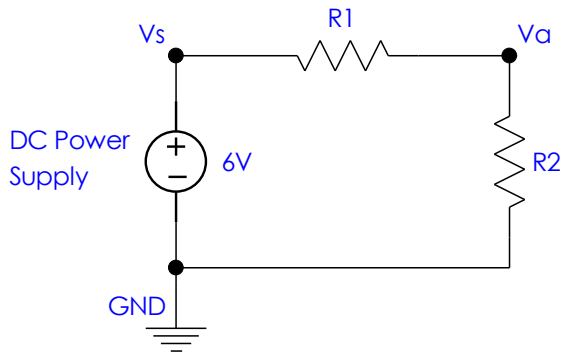


Step 9: Copy the share link to your summary sheet. Click “Close” to leave.



Simulation 2: Construct Simple Circuit [Lab#01_S2]

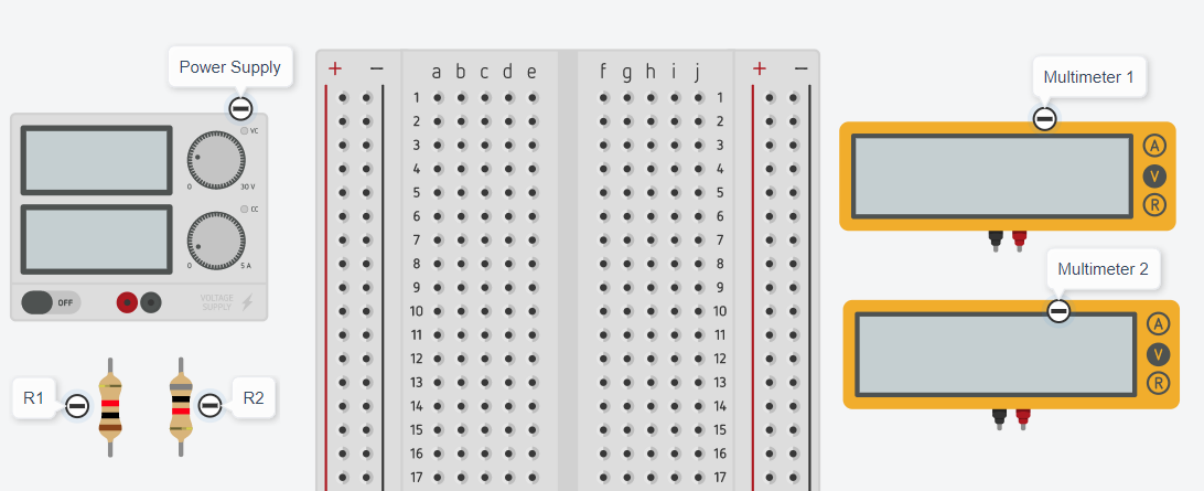
Follow the steps in this experiment to construct and test a simple circuit in Tinkercad.



Components list:

Power Supply	1
Breadboard	1
Resistor	2
Multi-meter	2

Components in Tinkercad

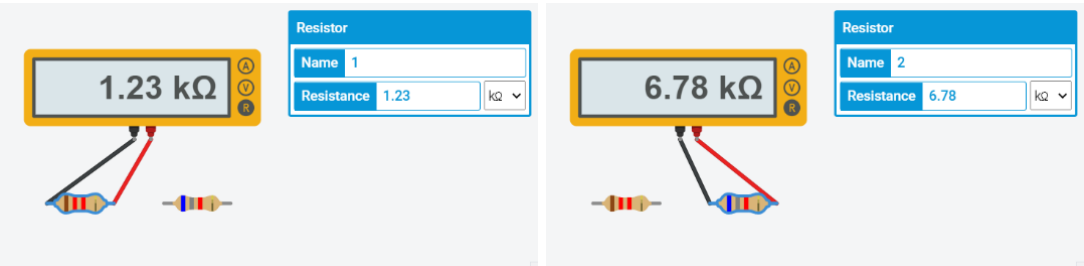


Step 1: Create a new circuit in **Tinkercad** and change the circuit name. Find components as needed.

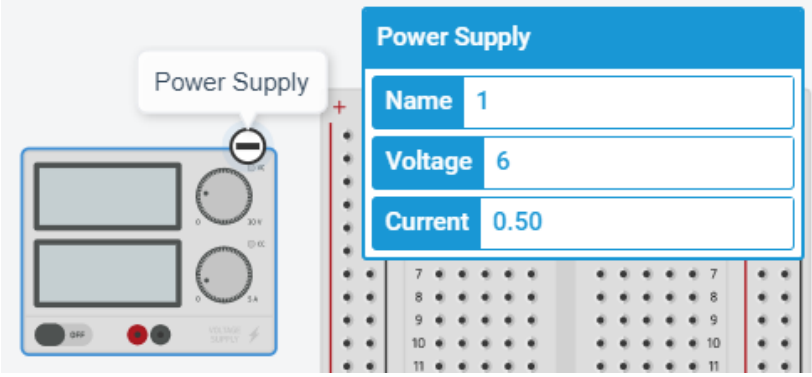
Step 2: Click on each resistor, assign resistance to R1 and R2.

Let R1 be the number represented by the first 3 digits of your student ID and R2 be the number of the last 3 digits of your student ID. For example, if your student ID is 12345678, then R1 = 1.23 (kΩ) and R2 = 6.78 (kΩ).

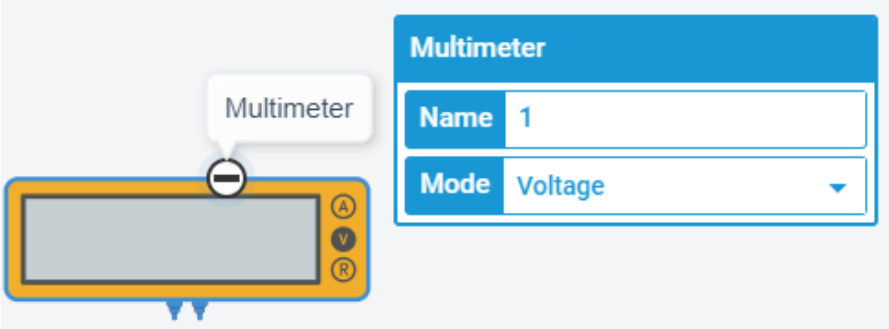
You may use multimeter to confirm the assigned resistances as shown below (remember to switch multimeter mode to "R" for measuring resistance).



Step 3: Set the power supply to 6V as given in the circuit diagram with current value 0.5.



Step 4: Choose the multimeter "Mode" to be "Voltage".



Step 5: Construct the circuit on the breadboard. Use Multimeter 1 to measure Vs and Multimeter 2 to measure Va. (You may refer to Tutorial notes for the breadboard arrangement.)

Step 6: Start simulation. Record the reading numbers to answer below questions in summary sheet.

Q1: Write down the assigned resistor values for R1 and R2.

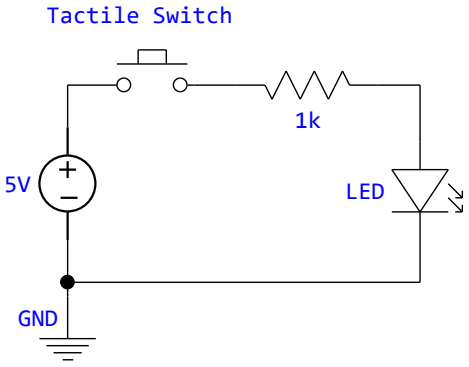
Q2: What are the values of Vs and Va?

Q3: Calculate the voltage ratio $\frac{Va}{Vs}$ and resistance ratio $\frac{R2}{R1+R2}$ see if they match.

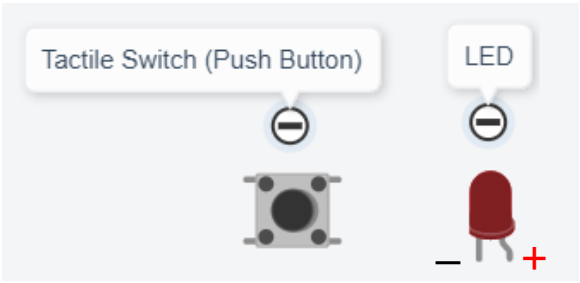
Simulation 3: Capacitor Effect in Circuit **[Lab#01_S3]**

In this experiment, we will study the effect of a capacitor in a circuit.

Step 1: Create a new circuit in **Tinkercad** and change the circuit name. Construct the following circuit on breadboard. Notice that polarity of LED. (You may refer to Tutorial notes for the breadboard arrangement)



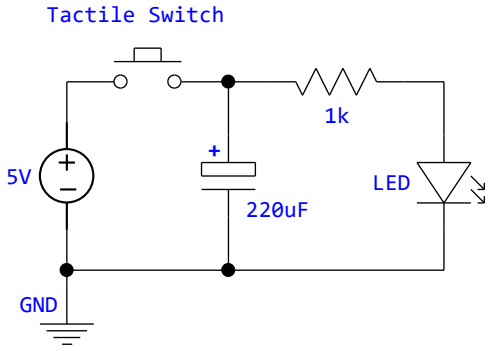
Components in Tinkercad

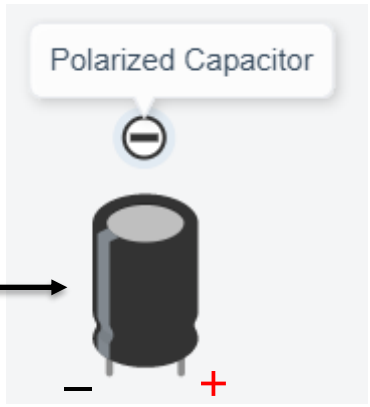


Step 2: Use a multimter to measure the voltage across the LED.

Step 3: Start simulation, click on the Push Button while observing the LED and the mutimeter.

Step 4: Add a capacitor to the circuit as below. Notice the polarity of the capacitor (negative: grey strip).





Step 5: Set power supply to be 5V, capacitance to be 220uF in Tinkercad.

Step 6: Start simulation, click on the Push Button while observing the LED and the multimeter.

****** TA Check 2: Demo to your TA the multimeter readings.**

Step 6: Notice how the LED lighting changes when using a capacitor in the circuit. Answer below questions in summary sheet.

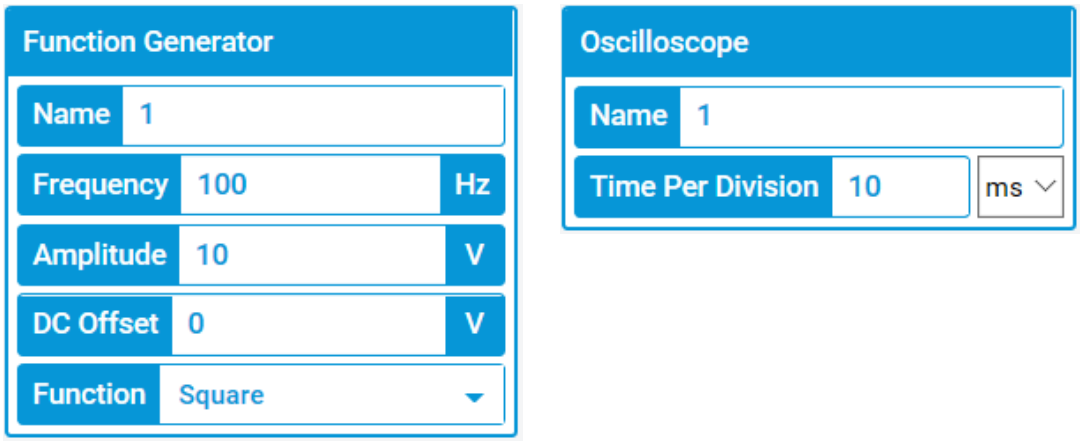
Q4: What is the purpose of using the resistor in the circuit?

Q5: Describe what happens after adding the capacitor. Explain briefly why this way (the function of the capacitor).

Simulation 4: Use of Function Generator and Oscilloscope **[Lab#01_S4]**

Step 1: Create a new circuit in **Tinkercad** and change the circuit name. Find the function generator and oscilloscope in instrument list.

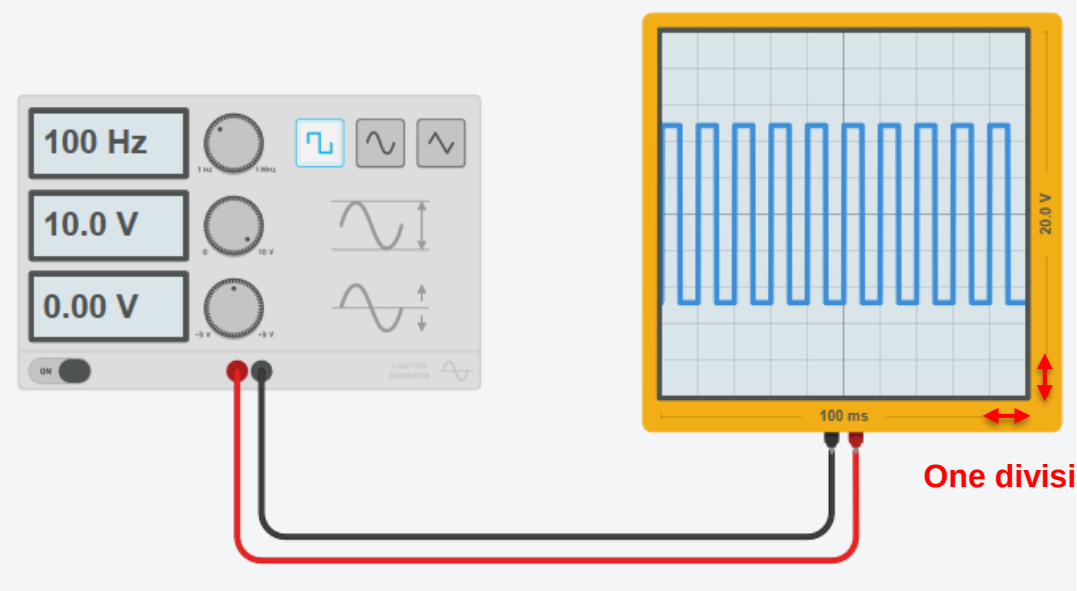
Step 2: Change the settings as below.



Note: In Tinkercad, the value of "Amplitude" = Vpp (peak to peak value).

Step 3: Connect the oscilloscope to the function generator to observe the square waveform.

Step 4: Start simulation, the generated square wave should be displayed on oscilloscope.



Step 5: Notice that value 20.0V is the sum of 10 divisions at voltage axis, and 100ms is the sum of 10 divisions at time axis. Answer below questions in your summary sheet.

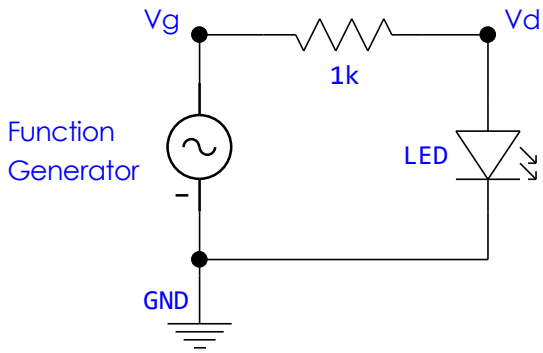
Q6: From the oscilloscope, what is the value of each division on the voltage axis?

Q7: From the oscilloscope, what is the value of each division on the time axis?

Q8: From the oscilloscope, what is the period (time for the signal to repeat) of the signal?

Simulation 5: Use Function Generator as AC Voltage Source **[Lab#01_S5]**

Step 1: Create the circuit on the right in Tinkercad. (You may refer to Tutorial notes for the breadboard arrangement)



Step 2: In this experiment, you need two Oscilloscopes. Use Oscilloscope 1 to measure Vg and Oscilloscope 2 to measure Vd.

Step 3: Keep using the settings of function generator & oscilloscope in Simulation 4.

Step 4: Start simulation, the LED should light up.

Step 5: Gradually reduce the frequency of the square wave, find the lowest frequency that you need to use to avoid the LED from blinking? (Give a rough number)

****** TA Check 3: Demo to your TA that the LED is blinking.**

Step 6: Notice the voltage drop between the waveforms on Oscilloscope 1 and Oscilloscope 2. Answer below questions in your summary sheet.

Q9: What is the lowest frequency that you need to use to **avoid** the LED from blinking? (Give a rough number)

Q10: Determine the voltage drop across the resistor from the waveforms.

Remember to change the circuit names and copy share links of your **Simulations 1-5** to the table in your summary sheet.