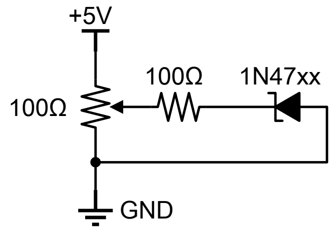
# Activity: Zener Diode Reverse Voltage versus Current






**Required Components**

Power Supply: 5V
Potentiometer: 100Ω
Resistor: 100Ω
One of these zener diodes: 1N4727, 1N4728, 1N4729, or 1N4730

**Procedure**

1. Assemble the circuitry shown in the figure to the right. It is nearly the same as the activity for Diode Voltage versus Current activity, but notice that the zener diode is inserted with the polarity reversed. We say this diode is ***reverse biased***.
2. Start by adjusting the potentiometer such that there is zero ohms between the +5V rail and the 100Ω resistor.
3. Measure the voltage across the 100Ω resistor. If your circuit is connected properly and the potentiometer is adjusted correctly, the voltage should measure within 0.25V of:
   - 1N4727 – 1.5V
   - 1N4728 – 1.25V
   - 1N4729 – 1.0V
   - 1N4730 – 0.85V

   Record this voltage in the first row, first column of the table to the left.
4. Without disturbing the circuit, measure the voltage across the zener diode and record this in the first row last column of the table.
5. You are required to take at minimum ***ten*** (10) equally-spaced voltage readings for the resistor voltage as you decrease the voltage down to zero volts. Determine a good spacing for your voltage readings. I suggest taking a voltage reading either every 0.05V or every 0.10V, depending on which diode you have. (1N4727 and 1N4728 take readings every 0.1V; 1N4729 and 1N4730 take readings every 0.05V).
6. Turn the potentiometer slowly to decrease the voltage across the 100Ω resistor. At each appropriate resistor voltage reading, take the zener voltage reading and record the values sequentially in the table.
7. Notice that there will still be a voltage across the zener even when the current flow is zero. You can continue to turn the potentiometer and observe this voltage will eventually decrease to zero.
8. Calculate the current through the resistor-zener circuit using ohm's law and the measured voltage across the 100Ω resistor (you may assume the resistor value is exactly 100Ω to simplify the calculation).

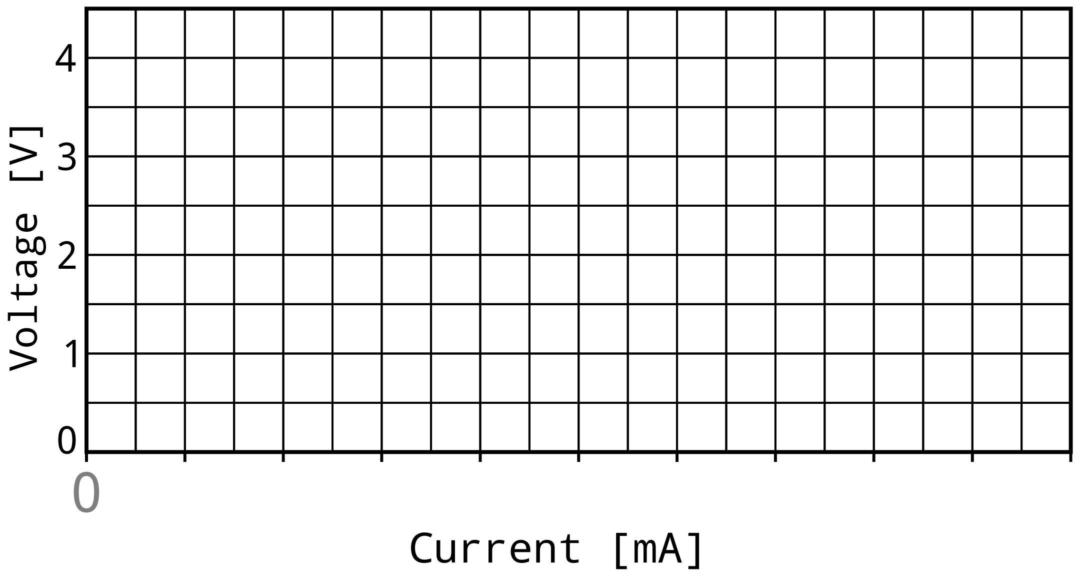
| | Measured Resistor Voltage [V] | Calculated Circuit Current [mA] | Measured Zener Voltage [V] |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |
| 12 | | | |
| 13 | | | |
| 14 | | | |
| 15 | | | |
| 16 | | | |
| 17 | | | |
| 18 | | | |
| 19 | | | |
| 20 | | | |

# Activity: Zener Diode Reverse Voltage versus Current



**Analysis**

1. Plot the points for the calculated diode ***reverse voltage*** versus the circuit ***current*** on the graph, below. As neatly as possible, draw a smooth curve to join the points. Label the graph.



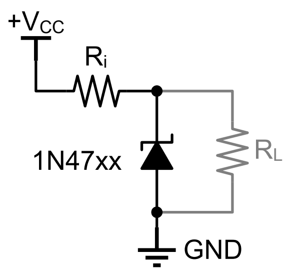

Although we did not measure it, zener diodes act like normal diodes when they are connected with the normal diode polarity, as we connected the diode in the activity to measure *Diode Forward Voltage versus Current*. When a diode is connected this way, it is ***forward biased***.

When a zener diode is connected with the polarity opposite the usual way – i.e. with the ***cathode*** (what is normally the negative terminal) connected to a positive voltage relative to the ***anode*** (what is normally considered the positive terminal), it is ***reversed biased***.

As the ***reverse bias voltage*** is increased across the zener diode, it eventually reaches its ***breakdown voltage***. At this voltage the diode no longer stops the current, and it will start to conduct.

For an ***ideal zener diode***, the breakdown voltage is at one exact voltage. Any voltage level below the breakdown voltage and zero current flows. Any voltage above the breakdown voltage and any extra current not flowing into a parallel branch will go through the zener diode.

Thus, and ideal zener diode is a ***voltage regulator***. In the circuit to the right, the voltage across the load, RL in the diagram, will be constant at the zener breakdown voltage. As the load draws more current, less current will flow through the zener diode. As the load draws less current, the zener diode will shunt the unused current to ground.




There is an obvious limit: the maximum current that can be drawn by the load will be when there when the zener draws zero current.

As we can see from the graph you drew, the breakdown voltage isn't actually a single voltage; it depends on the current through the zener. The zener diode can be used as a ***voltage regulator*** (to generate an approximately constant voltage supply) as long as precision is not required.

Additional circuitry can be added to the zener to make the precision better, but that is learning for another day...