Name:________________________________Date:________________Class:_________________

Student Worksheet

Transistor Mania

Safety
Hot glue guns can burn. Scissors can cut. Use them with care.

Introduction: Do you know what a transistor is? Transistors are what allow you to talk to friends on cell phones and search online for myriads of information. Videos games have become more detailed and faster because of advances in micro and nano-electronics. They are the building blocks of modern electronics. They must be incredibly complicated devices that are made in sophisticated laboratories with expensive tools, right? Let's find out!

As a class you may watch one or two videos on the history of transistors. Alternatively, your teacher may assign you to view these as homework. Following the viewing of the videos, there will be a class discussion about what your learned from each.

1. What was the size of the first vacuum tube computer?

2. How many transistors does Intel state could fit on the head of a pin?

3. Draw the schematic diagram of a Field Effect Transistor (FET).

4. List any questions you would like answered concerning transistors and they work on a computer chip.

Developed by Meghan Saxer
*Development and distribution partially funded by the **National Science Foundation***

NNIN Document: NNIN-xxxx
Rev: mm/yy

Materials per group:

- funnel
- cork
- cork borer
- clear plastic tube
- bendy straw
- wooden skewer
- balloon piece, cut into 1 square inch
- clear tape
- hot glue gun
- glue stick
- paper plate
- scissors
- clear plastic beaker, 200 mL
- 70 mL of sprinkles
- stopwatch
- butcher paper, 3 feet
- markers
- protractor

Question: Does the amount of power applied to the gate of a model transistor affect the output at the drain? Make a prediction in the space below.

Developed by Meghan Saxer
Development and distribution partially funded by the ***National Science Foundation***

Procedure: Making a Model Transistor

1. Put a line of hot glue along the top of the clear tube. Quickly insert the plastic funnel into the glued end of the tube. Make sure that the funnel is straight up and down. Set this aside standing up for the glue to dry.

2. Insert the skewer into the <u>long</u> part of the straw. Tightly tape the straw to the skewer.
3. Measure 2 cm from the end of the straw (where the skewer sticks out) and make a mark. Cut the skewer at the mark. Save the rest of the skewer for the next step.
4. Insert the wooden skewer (the part that was just cut off) into the <u>short</u> part of the straw. Tightly tape the straw to the skewer.

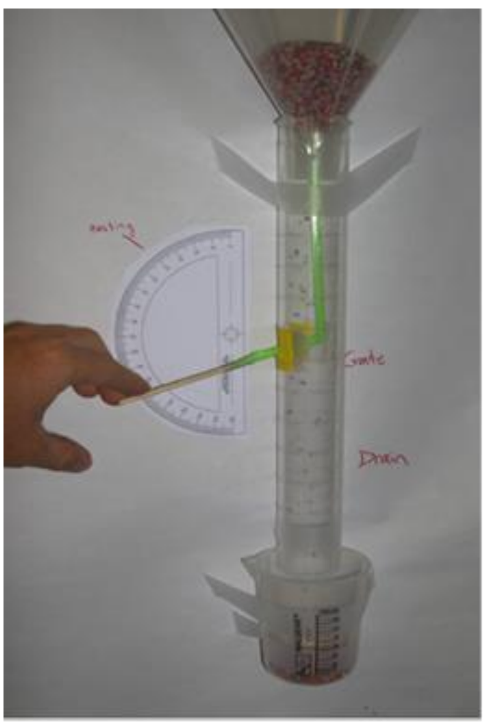
5. Measure 6 cm from the end of the straw (where the skewer sticks out) and make a mark. Cut the skewer at the mark.
6. Insert the long part of the straw into the hole in the side of the clear tube so that it sticks up through the funnel. The other end of the straw (with the 6 cm of skewer) should stick out of the hole on the side.

7. Make a hole (about 1 cm deep) in the small end of the cork with a cork borer. Put a small drop of hot glue into the hole of the cork and push it onto the top of the straw (with the 2 cm of skewer sticking out). The cork should fit snugly into the neck of the funnel.
8. Cut a small (about 1 cm) slit into the center of the balloon piece. Push the small part of the straw (with the 6 cm of skewer) through this slit. Tape the balloon piece to the clear tube so that it covers the hole. You now have a functional model transistor!

Developed by Meghan Saxer
Development and distribution partially funded by the ***National Science Foundation***

Procedure: Gathering data on the variations in the output of "electrons" due to different lever angles

Step 1:
Add sprinkles to the funnel represent free electrons**.**



Step 2:
Pull the lever. Note the angle and time it takes for the sprinkles to fill the container below (left).

Record observations in a table on the butcher paper (right).

Developed by Meghan Saxer
Development and distribution partially funded by the ***National Science Foundation***

NNIN Document: NNIN-xxxx

Rev: mm/yy

Record Your Observations:

1. Tape the butcher paper to the wall. Tape the model upright onto the paper. Tape the angles paper next to the *gate lever* of your device. Record the resting angle of the gate lever.
2. Sketch your device. Label the source, drain, and gate.

3. What do the sprinkles represent in your model?

4. Using our new terminology, describe what happens when you apply voltage to (you push down) the gate of your device.

5. At what angle does your device first "turn on?" (i.e. electrons start to flow) ___________

6. Does the amount of voltage at the gate affect the speed of your device? Time the flow of electrons at different gate angles to find out! (*Hint*: To stay organized, you can fill in the table below or make your own table on the butcher paper!)

Drainage Time vs. Gate Angle

	Time (s)			
Gate Angle (˚)	**Trial 1**	**Trial 2**	**Trial 3**	**Average**

Developed by Meghan Saxer
Development and distribution partially funded by the ***National Science Foundation***

7. What else do you notice? Record 3 intriguing observations.

Analyze the Results:

1. At what gate angle do the sprinkles flow the fastest? ________________
2. Graph your data table.

	Title:																	
Average Time (s)	**20**																	
	19																	
	18																	
	17																	
	16																	
	15																	
	14																	
	13																	
	12																	
	11																	
	10																	
	9																	
	8																	
	7																	
	6																	
	5																	
	4																	
	3																	
	2																	
	1																	
	0	**10**	**20**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**
	Gate Angle (˚)																	

National Nanotechnology Infrastructure Network *www.nnin.org*

Developed by Meghan Saxer
Development and distribution partially funded by the ***National Science Foundation***

NNIN Document: NNIN-xxxx

Rev: mm/yy

Draw Conclusions

1. Use a ruler to draw a line of best fit between the points on your graph and calculate the slope $(y_1 – y_2 \div x_1 – x_2)$.

2. What does the slope of your line represent?

3. Based on the data you collected, was your hypothesis correct? Explain why or why not using your data as evidence.

Developed by Meghan Saxer
Development and distribution partially funded by the ***National Science Foundation***

NNIN Document: NNIN-xxxx

Rev: mm/yy