

# "THE BUG"

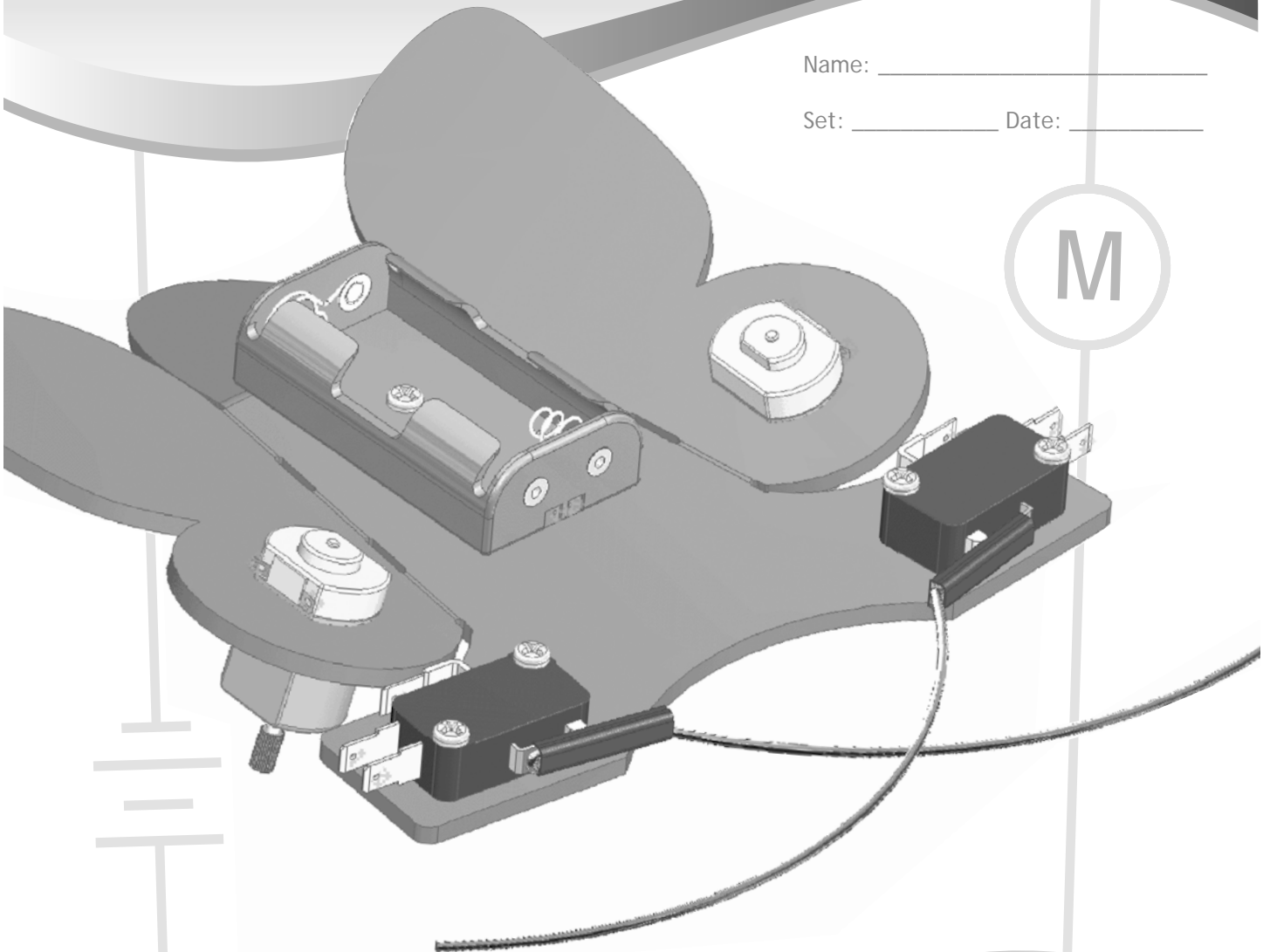
## ELECTRONICS LAB

Process  
#2

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

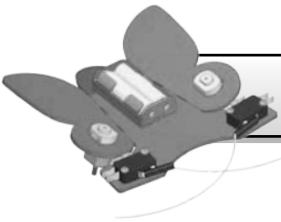
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M



### WHAT WILL YOU NEED?

- 1- Assembled Bug Body with no wiring (as shown above)
- 2- AA Batteries
- 6- Alligator Clip Leads
- 1- Multimeter (can be shared with other participants)
- 1-  $2.7\Omega$  Resistor (can be shared with other participants)
- 1- Metallic Marker (can be shared with other participants)



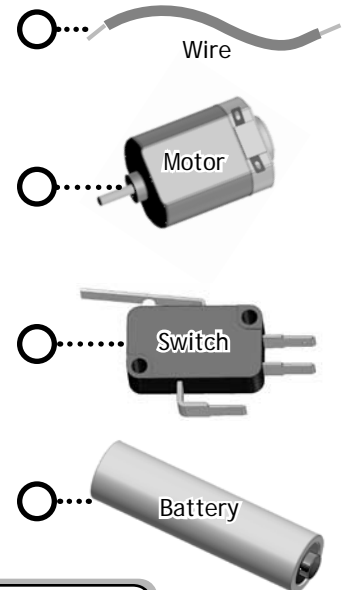
## A. PARTS OF A CIRCUIT

Draw lines to match the components with their category:

### Category:

- 1. SOURCE .....○  
Provides the electrical energy for a circuit
- 2. LOAD .....○  
The part of the circuit that uses electricity (changes electrical energy into a another form of energy)
- 3. CONDUCTOR (PATH) .....○  
Allows electricity to flow between components in a circuit
- 4. CONTROL .....○  
Regulates (controls) the flow of electricity in a circuit

### Component:



5. What is the load in a flashlight?

\_\_\_\_\_



## B. WHAT IS A CIRCUIT?

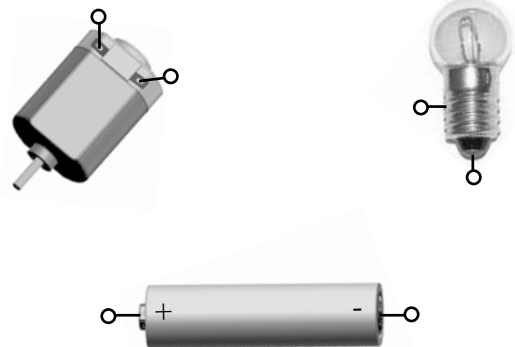
**Definition of a circuit:** A complete path through which electricity can flow (from the source, back to the source). Electricity flows from the negative side of the battery, through the circuit, to the positive side of the battery.

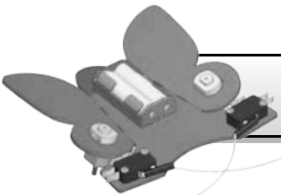
6. Draw wires that would create a complete circuit and turn the light bulb on. Draw your wires between the —o's.



7. Draw arrows next to the wires to show the direction electricity flows.

8. Draw wires to turn on the light bulb and motor.





## C. VOLTAGE

Voltage is the electrical pressure (force) that causes the flow of electricity.

### ELECTRICITY IS LIKE WATER...



High Voltage



Low Voltage

The amount of water exiting the nozzles is the same. The pressure of the water exiting the nozzles is different. Voltage is like water pressure.

9. Draw lines to match the batteries with their specified voltage. Voltage is measured in volts. It can be abbreviated as "V".



○...12V



○...9V

Car Battery

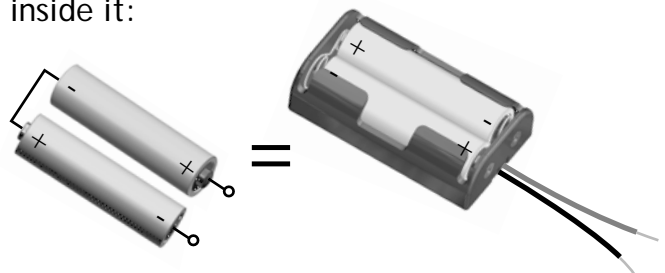
### FINDING VOLTAGE

10. Use a multimeter to measure the voltage generated by one AA battery.



\_\_\_\_\_ Volts

Your battery holder connects the batteries inside it:



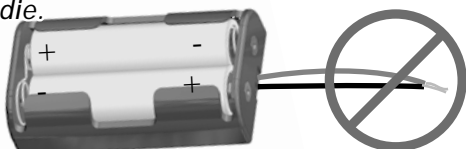
11. Place two AA batteries into the battery pack. Connect the multimeter to the battery pack wires. What does the meter read?

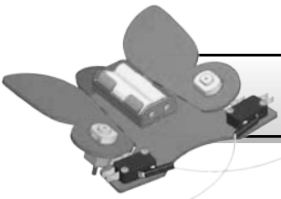
\_\_\_\_\_ Volts

### ! WARNING!!!

Touching the red and black battery pack wires together will cause a short circuit and ruin your batteries.

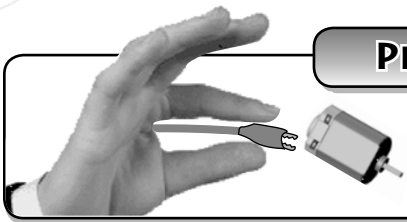
*Nothing cool happens. The batteries just heat up and die.*





# THE BUG LAB

**PINCH AND PULL**



Pinch to open alligator clips before pulling them off components.

## D. SPIN THE BUG!!!

### WITH ONE BATTERY

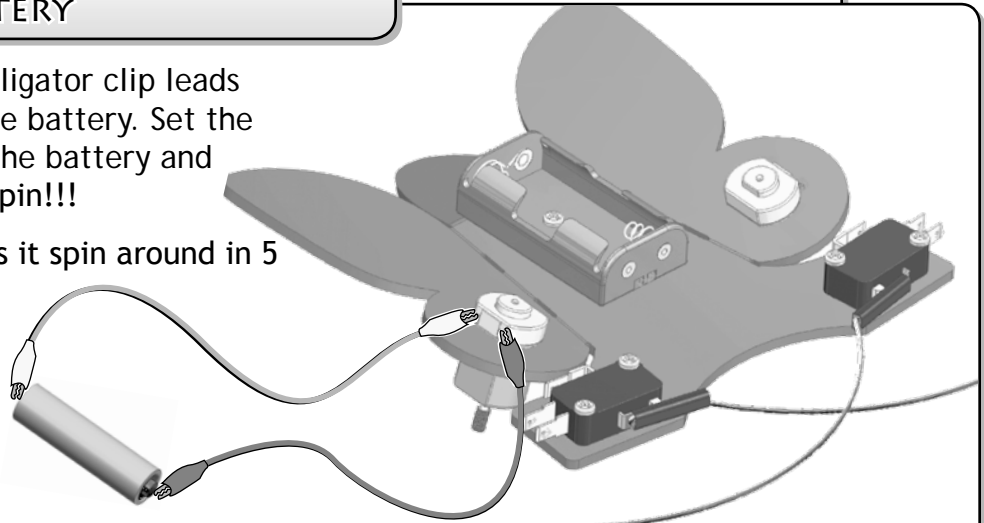
Wire the circuit shown. Alligator clip leads will need to be held on the battery. Set the bug down (while holding the battery and leads). Watch it go for a spin!!!

12. How many times does it spin around in 5 seconds?

\_\_\_\_\_

13. How many volts are powering the motor?



\_\_\_\_\_



### WITH TWO BATTERIES

Wire the circuit shown. No alligator clip leads are needed. Connect the battery pack wires directly to the motor leads.

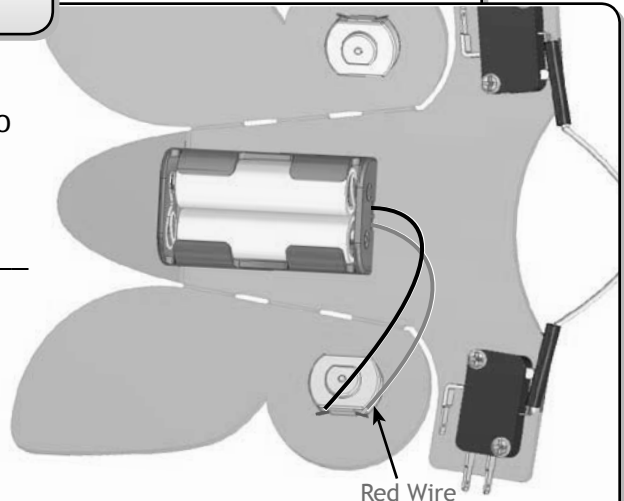
14. How many times does it spin around in 5 seconds? \_\_\_\_\_

15. Did your bug spin clockwise  or counter clockwise ? \_\_\_\_\_

16. How many volts are powering the motor? \_\_\_\_\_

17. Why does your bug spin at a different speed with two the batteries powering it rather than one.

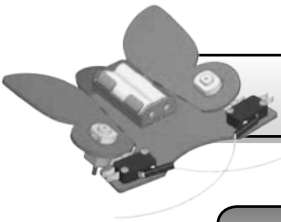
\_\_\_\_\_



Red Wire

18. How can a multimeter tell if a battery is bad?





## E. WHERE IS REVERSE ?

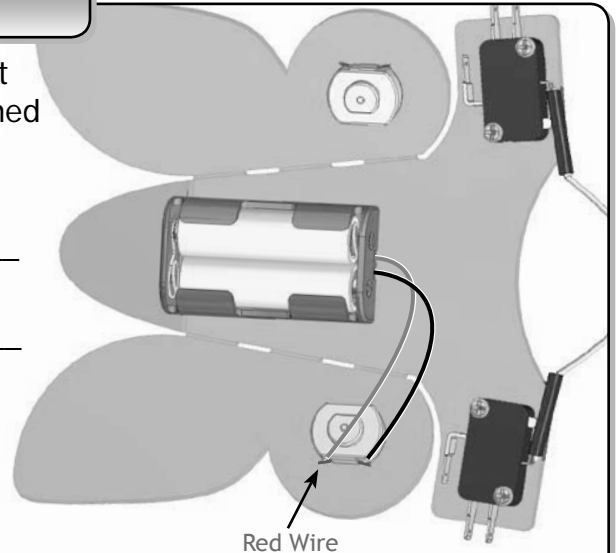
Wire the circuit shown. This is not the same as the last circuit you wired. The red and black wires have switched places on the motor.

19. Does your bug spin clockwise ↻ or counter clockwise ↺ ? \_\_\_\_\_

Is that different from question 15 (before you switched the red and black wires)? \_\_\_\_\_

20. Switching the wires did what to the flow of electricity through the motor?  
\_\_\_\_\_

21. Switching the wires did what to the rotation of the motor?  
\_\_\_\_\_



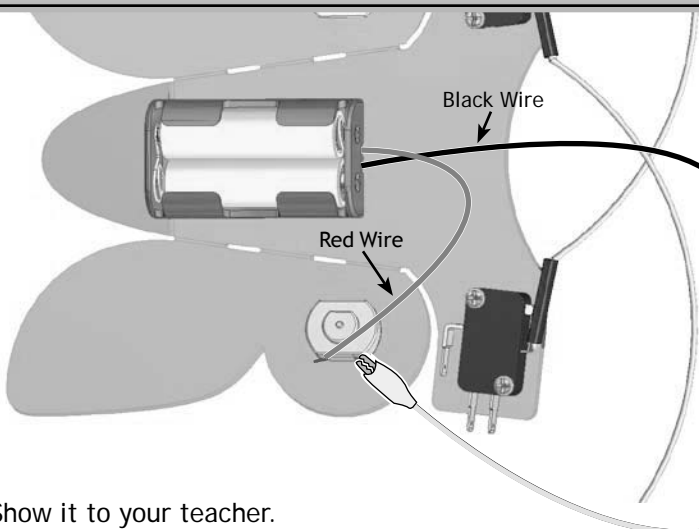
22. Would an incandescent light bulb continue to glow if you change the direction electricity flows through it?



## F. A REMOTE CONTROLLED BUG

### WITH ONE WORKING MOTOR

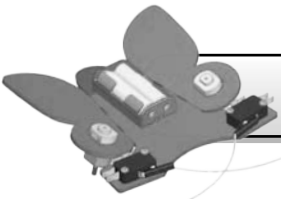
23.



Touching alligator clips **A** and **B** together works like a switch to turn the motor on and off.

Show it to your teacher.

Teacher Signature: \_\_\_\_\_

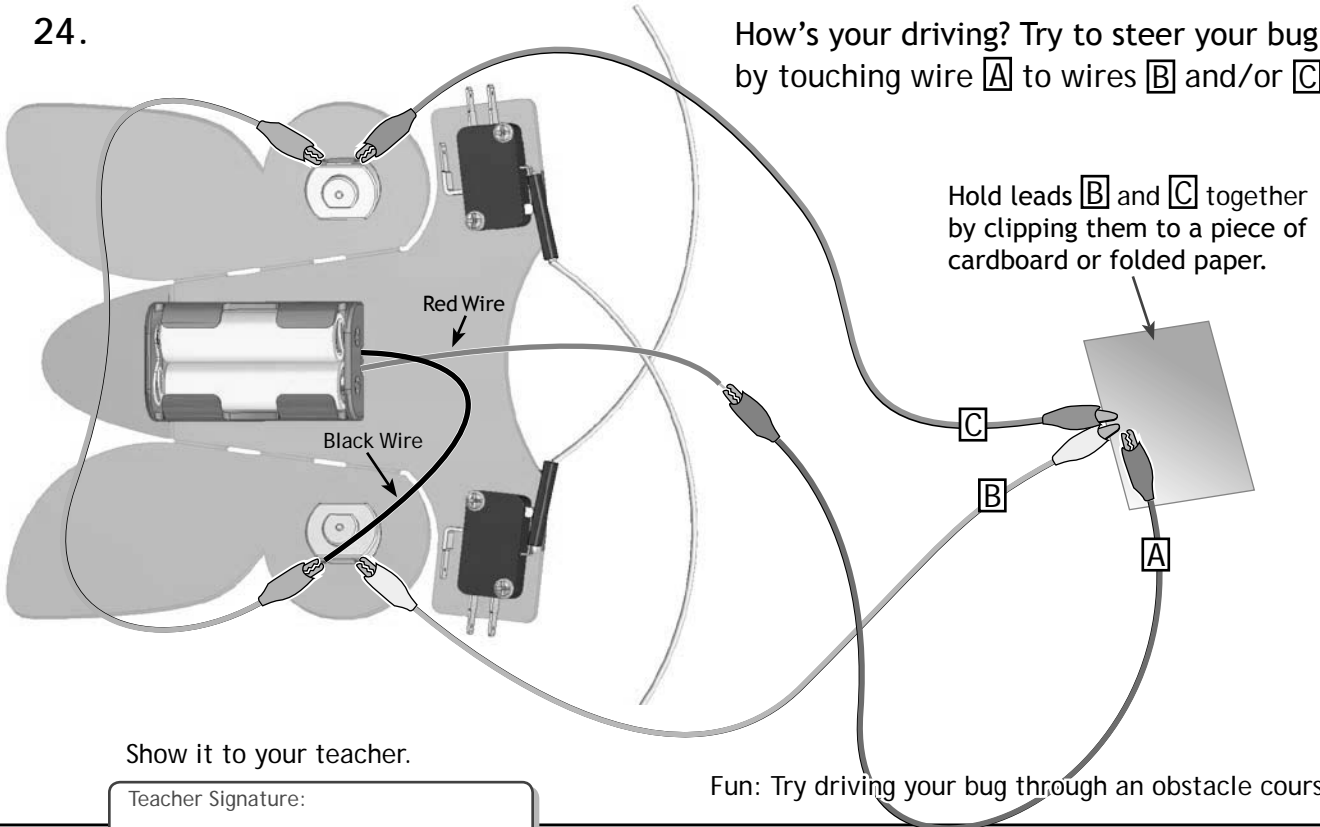


## G. A REMOTE CONTROLLED BUG (CONTINUED)

### WITH TWO WORKING MOTORS

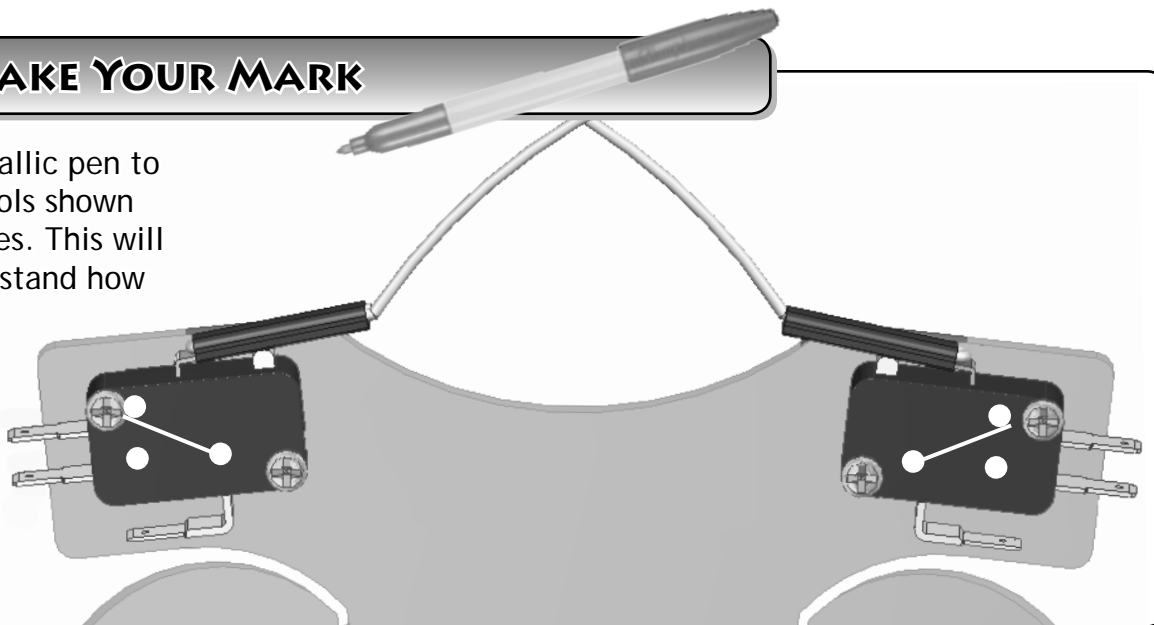
24.

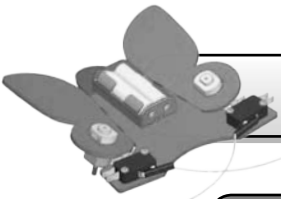
How's your driving? Try to steer your bug by touching wire **A** to wires **B** and/or **C**.



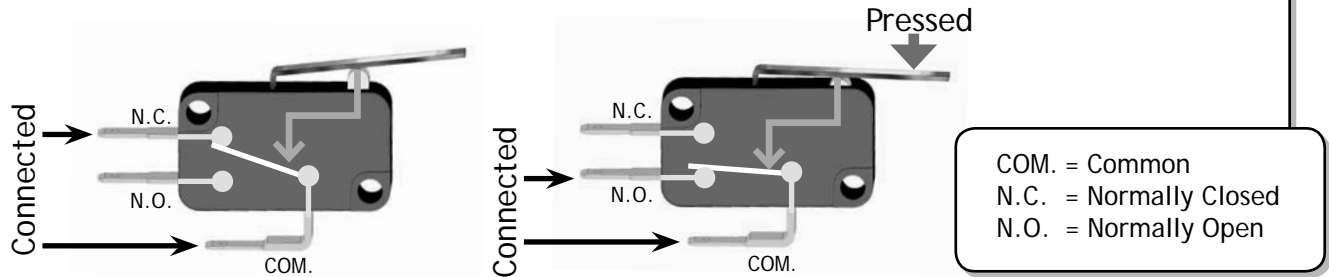
## H. MAKE YOUR MARK

25. Use a metallic pen to draw the symbols shown on your switches. This will help you understand how they work.





## I. SWITCHES



Answer the following questions based upon the switch diagrams above:

26. What does the COM. lead connect to when the switch is **not pressed**?

\_\_\_\_\_

27. What does the COM. lead connect to when the switch is **pressed**?

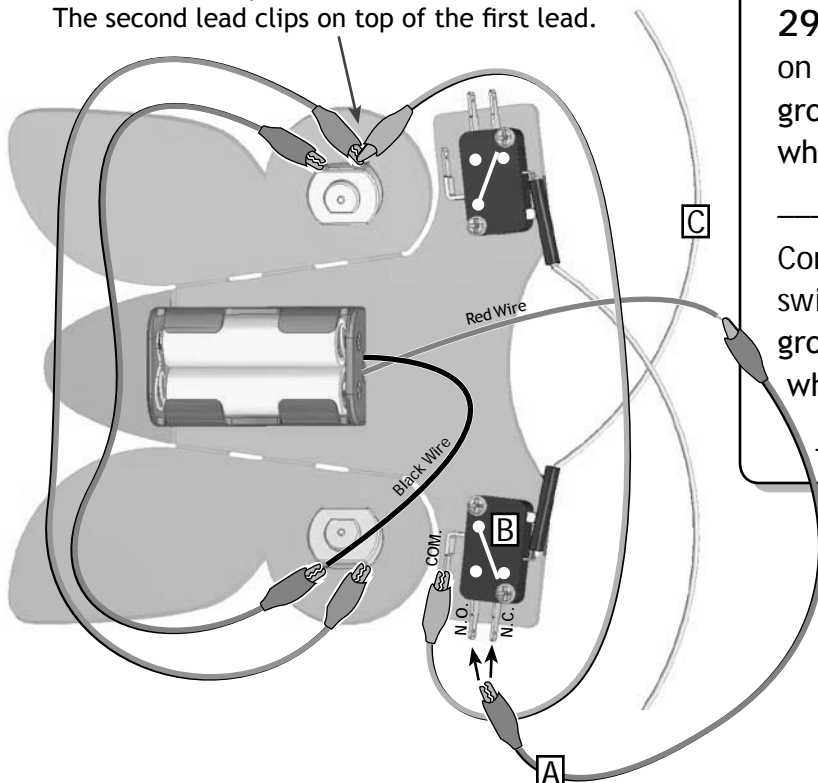
\_\_\_\_\_

28. Does the COM. lead ever connect to the N.C. lead and N.O. lead at the same time?

\_\_\_\_\_

## SWITCH YOUR BUG

The first lead clips to the motor terminal.  
The second lead clips on top of the first lead.

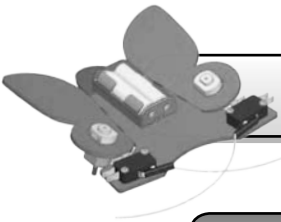


29. Connect wire **A** to the N.C. lead on switch **B**. Set the bug down on the ground. Press feeler **C**. What happens when feeler **C** is pushed?

Connect wire **A** to the N.O. lead on switch **B**. Set the bug down on the ground. Press feeler **C**. What happens when feeler **C** is pushed?

30. Show your wired bug to your teacher. Explain how switch **B** works, and how it can make your bug stop or go when pushed.

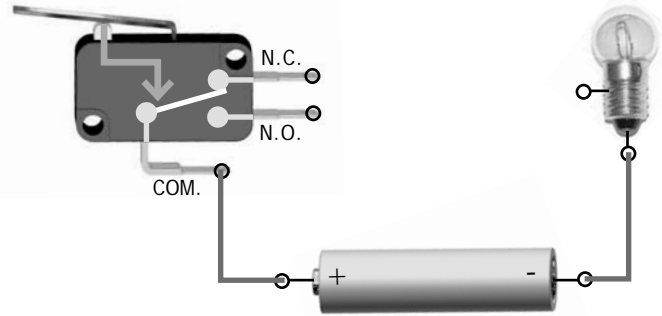
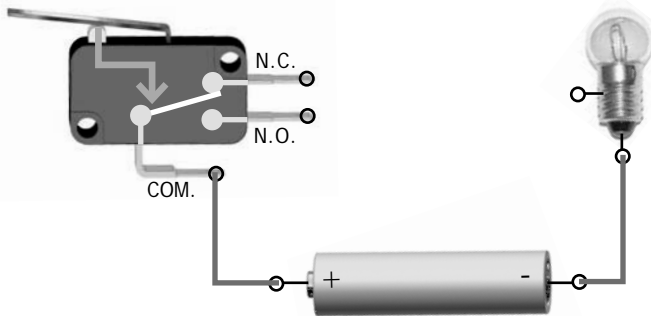
Teacher Signature: \_\_\_\_\_



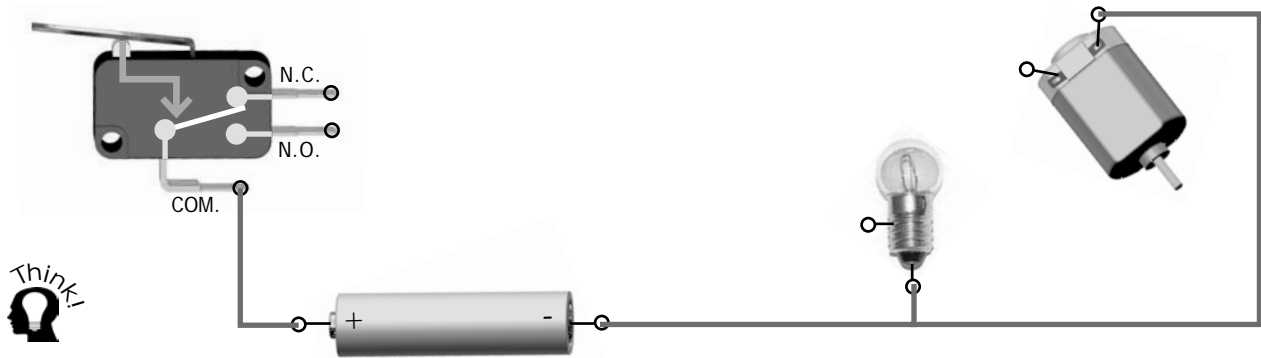
## J. SWITCH IT ON, SWITCH IT OFF

31. Draw a wire to create a circuit that will turn the **light on** when the **switch is pressed**.

32. Draw a wire to create a circuit that will turn the **light off** when the **switch is pressed**.

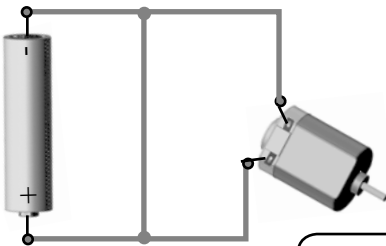


33. Draw wires to create a circuit that will turn the **motor on** when the **switch is pressed**, and the **light on** when the switch is not pressed.



## K. BEWARE OF "SHORT CIRCUITS"

Every circuit needs a source, path and load. If the load is missing, or bypassed, the circuit becomes "short circuited." "Short Circuit" = "Not Cool"



34. Electricity takes the easiest path. To flow through the motor it has to do work. Why is the motor short circuited?

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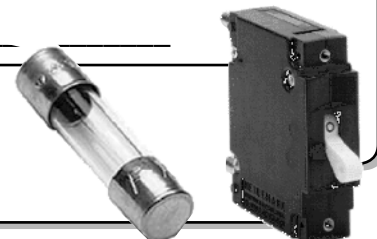


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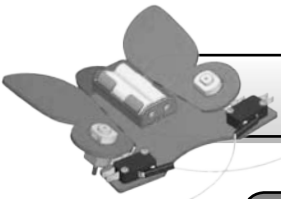


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Fuses and circuit breakers protect us from fires and damage that could be caused by a short circuit.



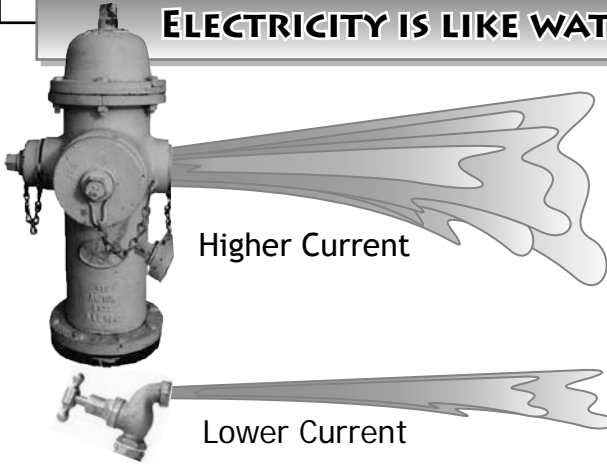




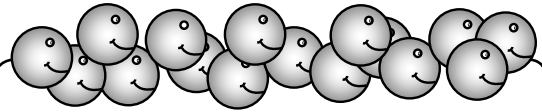
## L. WHAT IS CURRENT?

Current is amount (quantity) of electricity flowing through a circuit.

### ELECTRICITY IS LIKE WATER...



The same water pressure is exiting the hydrant and faucet. The amount (quantity) of water exiting the hydrant and faucet is different. Current is like the amount of water flowing.



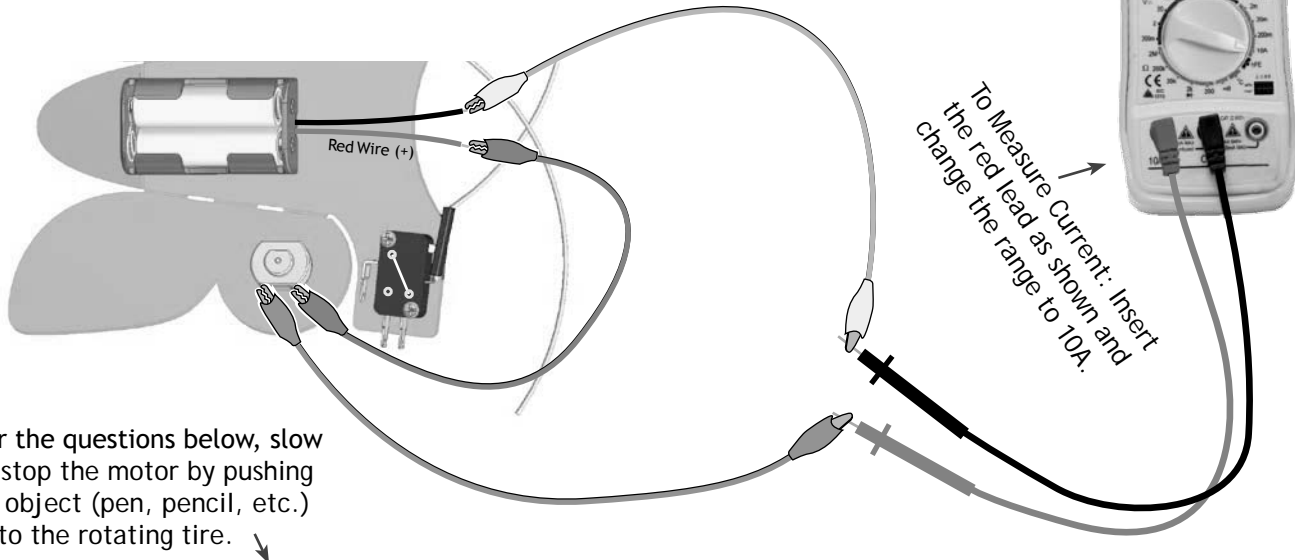
What do you get when 6,242,000,000,000,000 electrons pass by in 1 second?

Answer: **1 Amp**

Current is measured in Amps

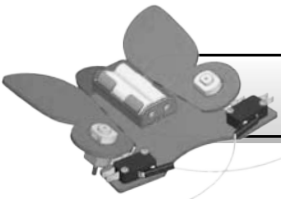
### MEASURING CURRENT

In a circuit, the load draws (takes) only the current it needs. Wire a multimeter into a circuit with a motor to see how much current it draws.



For the questions below, slow or stop the motor by pushing an object (pen, pencil, etc.) onto the rotating tire. ↓

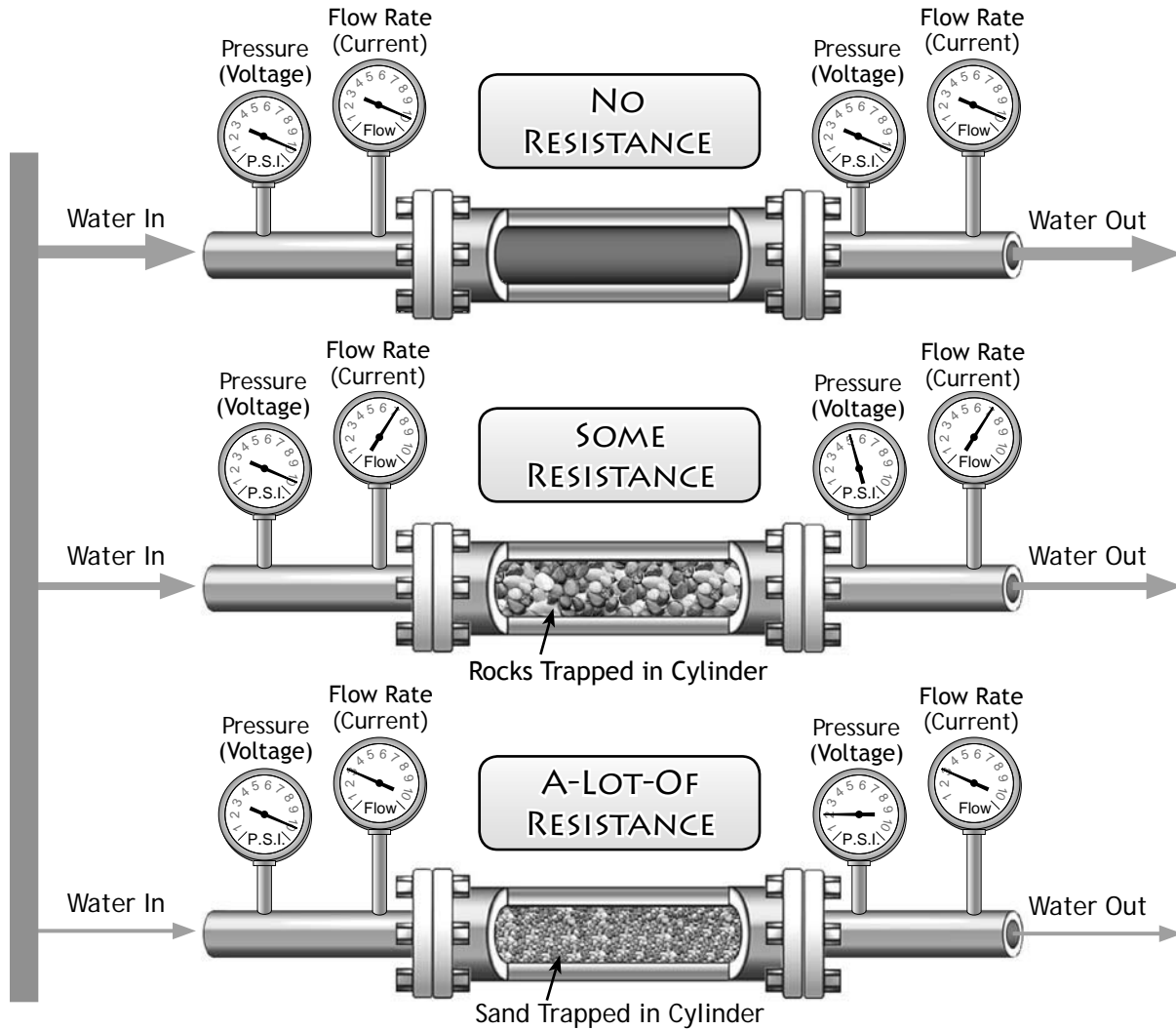
35. Slightly slow the motor down. What does the meter read? \_\_\_\_\_ Amps
36. Slow the motor down so it is almost stopped. What does the meter read? \_\_\_\_\_ Amps
37. Stop the motor. What does the meter read? \_\_\_\_\_ Amps
38. Complete the following sentence so it relates to current: The harder a motor has to work to turn its shaft, the more \_\_\_\_\_



## M. WHAT IS RESISTANCE ?

Resistance limits the flow of electricity (it gives it a hard time so it can not easily pass).

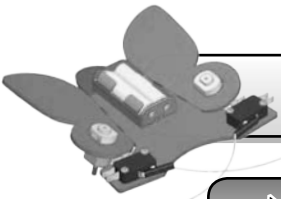
### ELECTRICITY IS LIKE WATER...



Complete the following sentences using the words: current, voltage or chickens  
Words can be used more than once. All words should be used at least once.



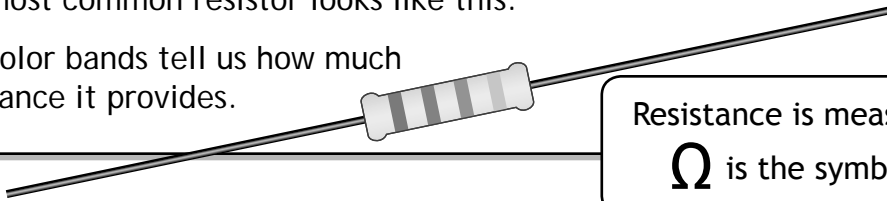
39. Resistance reduces the \_\_\_\_\_ and \_\_\_\_\_ in a circuit.
40. \_\_\_\_\_ decreases after a resistor (a component providing resistance).
41. \_\_\_\_\_ decreases when a resistor is placed in the circuit, but is the same before and after the resistor.
42. Alektorophobia is the name given to the fear of \_\_\_\_\_.



## N. RESISTORS

Resistance can be a very useful thing. Resistors are components which provide resistance in electrical circuits. There are many different types of resistors. The most common resistor looks like this:

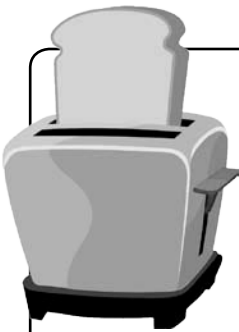
The color bands tell us how much resistance it provides.



Resistance is measured in Ohms

$\Omega$  is the symbol for Ohms

## RESISTANCE = TOAST & LIGHT



When electricity fights to get through a resistor, it causes the resistor to heat up. Special wires inside a toaster resist the flow of electricity, causing them to heat up and toast your bread.



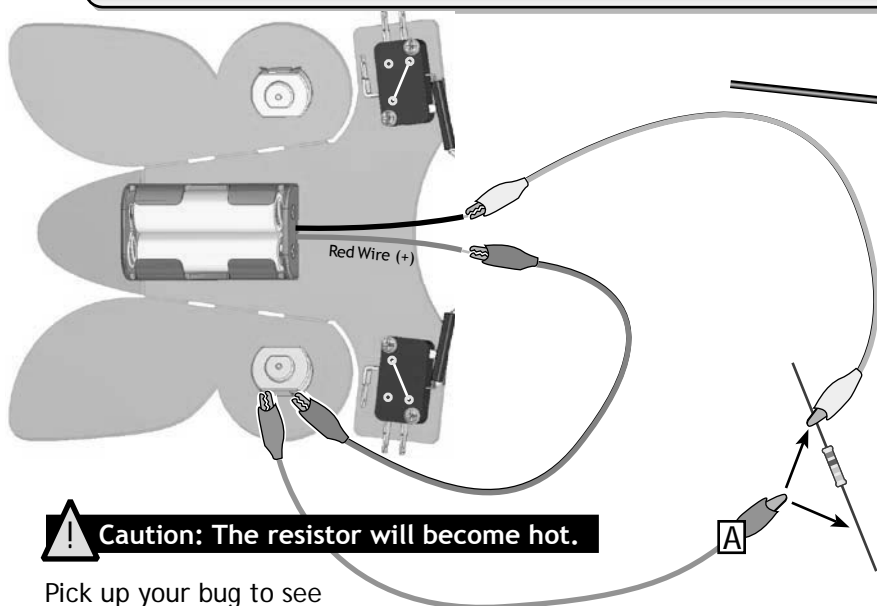
43. Incandescent light bulbs use resistance to generate light.

Complete this sentence: Incandescent light bulbs convert approximately 95% of the energy they use into \_\_\_\_\_

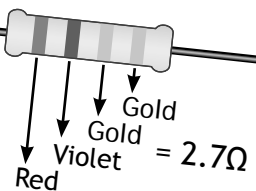
Clue: The answer is not "light"



## O. CAN YOU "RESIST" YOUR BUG?



The greater the resistor value, the greater the resistance.



44. Wire the circuit shown. Use a 2.7 Ohm Resistor. Attach alligator clip **A** to before and after the resistor.

Show it to your teacher.

Teacher Signature: \_\_\_\_\_

**! Caution: The resistor will become hot.**

Pick up your bug to see if the motor is running.

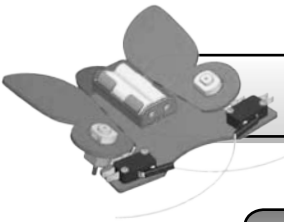
45. How did the resistor affect the motor?

\_\_\_\_\_  
\_\_\_\_\_

46. Would the motor turn faster or slower if a 10Ω resistor was used?



\_\_\_\_\_  
\_\_\_\_\_

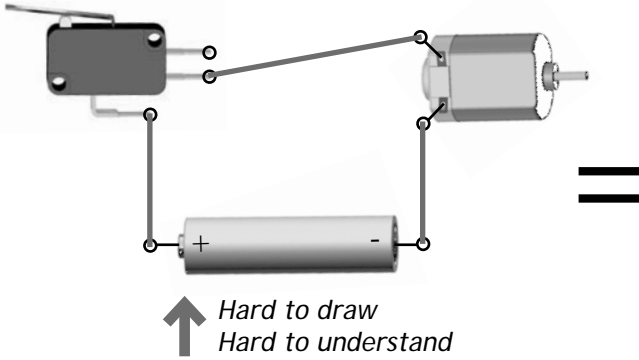


## P. SCHEMATICS

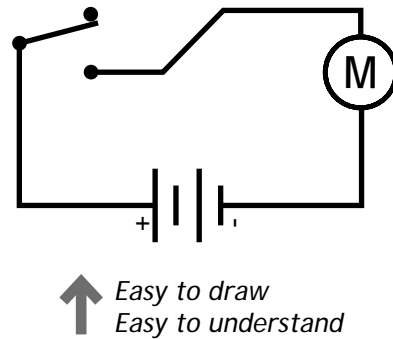
YOU DON'T HAVE TO BE AN ARTIST TO DRAW A CIRCUIT.



Circuit Drawing With Pictures

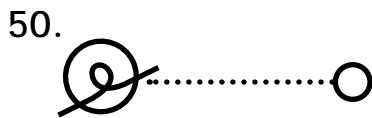
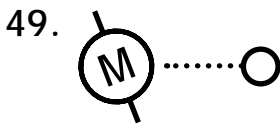
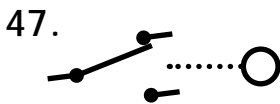


Schematic Diagram

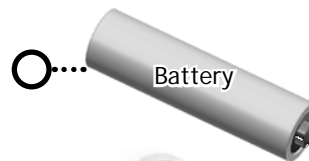
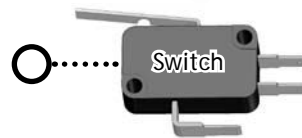
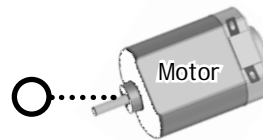


Draw lines to match the schematic symbol with the component it represents.

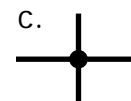
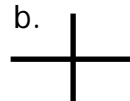
### Schematic:

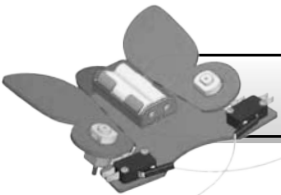


### Component:



52. Circle the example showing connected paths.





# THE BUG LAB

There are different types of switches which work differently and have different diagrams.

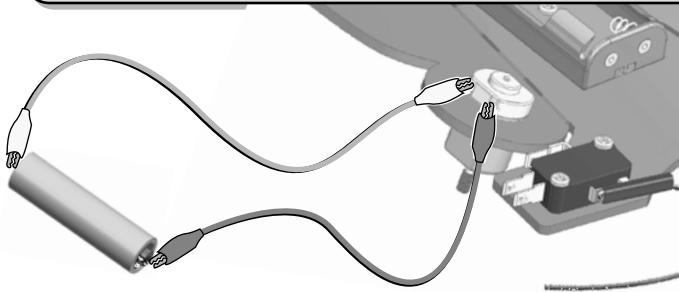


could be:

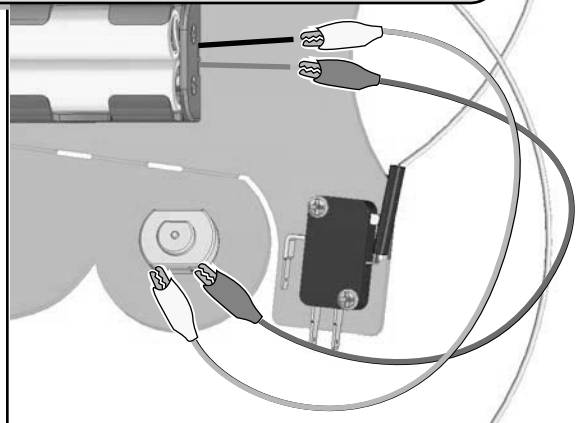


## SCHEMATICS (CONTINUED)

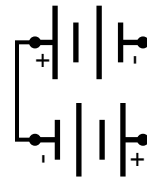
YOU WIRED IT, NOW CAN YOU DRAW IT?



53. Finish the schematic for the circuit shown above.

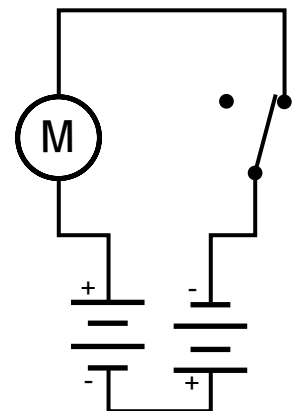
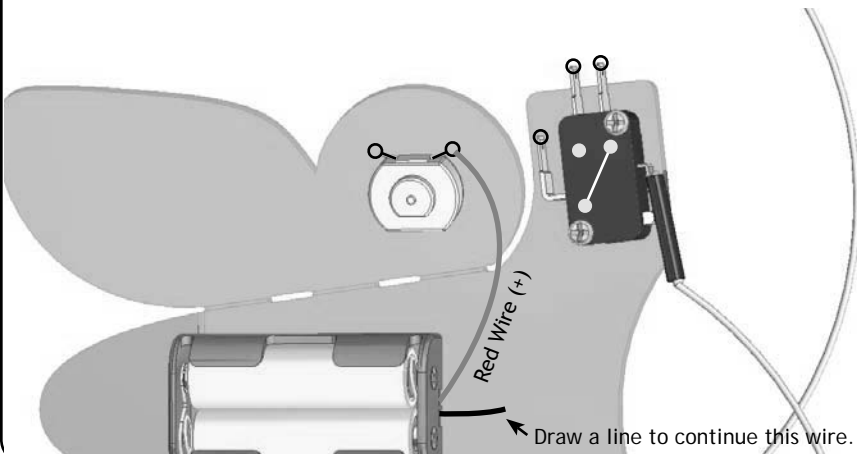


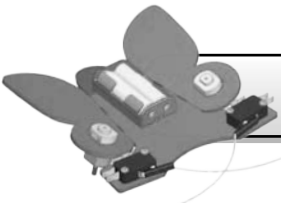
54. Finish the schematic for the circuit shown above.



(Schematic for 2 batteries in the battery pack)

55. Draw the wires onto the bug picture to match the schematic.

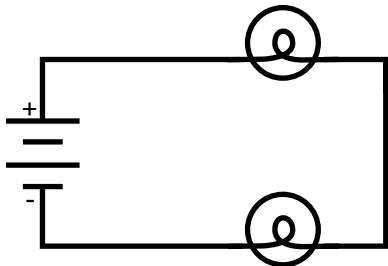




## Q. SERIES & PARALLEL CIRCUITS

### SERIES CIRCUIT

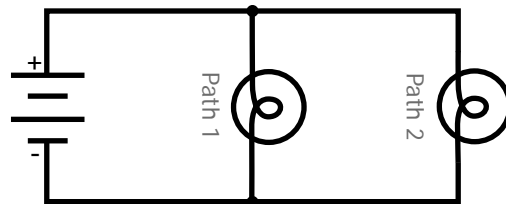
A Series Circuit has a single path for electricity to flow.



- The voltage is shared by (split between) the loads.
- Loads get the same (equal) current.

### PARALLEL CIRCUIT

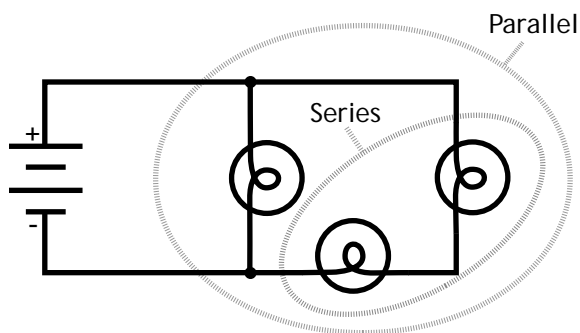
A Parallel Circuit has more than one path for electricity to flow.




- Loads get the same (equal) voltage.
- Current is split between the paths.

### SERIES-PARALLEL CIRCUIT

A Series-Parallel Circuit is a combination of Series and Parallel Circuits.



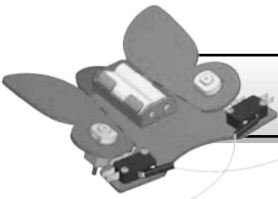
56. Draw a series circuit with 3 light bulbs and one battery. 

### HOW DO MINI LIGHTS WORK?



57. Most mini holliday lights contain loops of light bulbs. Each loop has 50 bulbs wired in series. Each loop is directly connects to 120V. What voltage does each bulb get? Show your math.



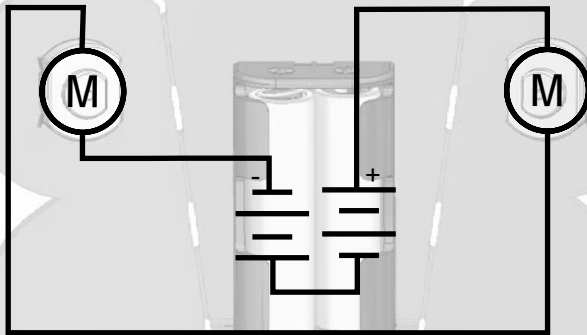


## R. SERIES & PARALLEL CIRCUITS (CONTINUED)

58. Draw a parallel circuit with 4 motors and one battery.



### BUG MOTORS IN SERIES



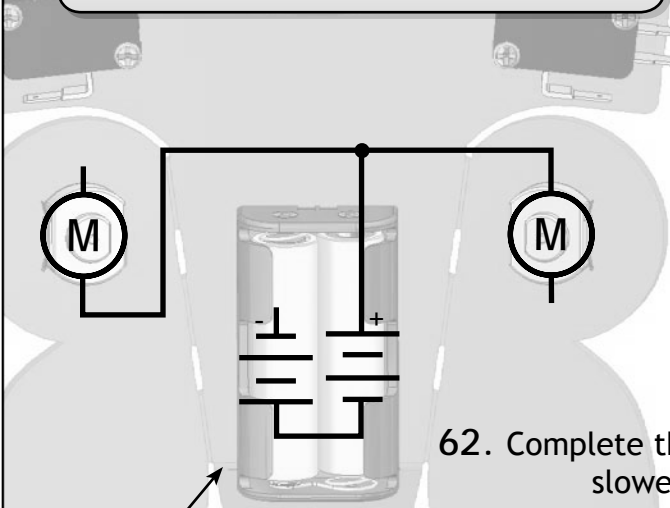
Use alligator leads to wire the bug motors in series. Let it go on a floor or table!!! Take note of its speed.

59. Pull an alligator lead off one motor. Notice what happens to the other motor. Complete the sentence: I can tell the motors are wired in series (where there is a single path for electricity to flow) because

\_\_\_\_\_

\_\_\_\_\_

### BUG MOTORS IN PARALLEL



60. Finish the schematic (draw paths) to connect the motors in parallel. Use alligator leads to wire the bug motors according to the schematic. Run the Bug on a floor or table.

61. Pull an alligator lead off one of the motors. Complete the following sentence: I can tell the motors are wired in parallel because

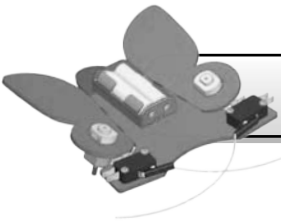
\_\_\_\_\_

\_\_\_\_\_

62. Complete the following sentence using some of these words: slower, faster, all, half, voltage, current

Note: The batteries are still wired in series

The motors wired in parallel turn \_\_\_\_\_ than the motors wired in series because they receive \_\_\_\_\_ the source \_\_\_\_\_.



## 5. IT'S PLAY TIME !!!

Now it's time to play. Earn extra points by wiring your bug and showing it off.

### Wire your Bug so it goes forward (using both motors) and...

1) stops when 1 switch is pushed (2pts)

Teacher Signature:

2) uses pencil lead (graphite) as a variable resistor (3pts)

Teacher Signature:

3) stops when either switch is pushed (3pts)

Teacher Signature:

4) stops the motor behind the switch that is pushed, but leaves the other motor running. (4pts)

Teacher Signature:

You will not be able to get your motors to reverse when a switch is pushed until you create the "Switch Harness." This is done next in the *Final Bug Wiring* section.



## Next Step: The Final Bug Wiring