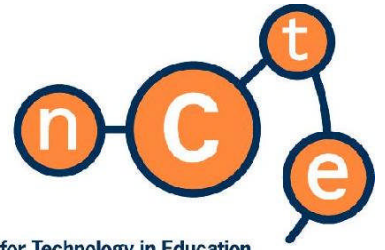




TECHNOLOGY  
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National Centre for Technology in Education  
Ionad Náisiúnta don Teicneolaíocht san Oideachas

# The Integration of ICT into Teaching and Learning of Electronics

# **Integrating ICT into the Teaching and Learning of Electronics**

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## **Please note**

- Screenshots used in this manual may appear different to those on computer screens used by participants; variations in versions of the software and differing operating systems may be in use.

Circuit Wizard is the electronic simulation software on which this module is based. This does not imply any endorsement by the NCTE of a product or company. The reader should be aware that typically there are many products and companies providing similar services in areas related to ICT. Participants should be as informed as possible before making decisions on purchases of ICT products or services.

# **Integrating ICT into the Teaching and Learning of Electronics**

## **Duration**

**12 hours**

## **Aims & Objectives**

The aim of the **Integration of ICT into learning and teaching of Electronics** course is to support the integration of ICT into the learning and teaching of basic electronic principles and the application of these principles in the design and production of circuits suitable for student project work.

The course involves hands-on practical work for teachers and focuses on using Circuit Wizard to enhance the teaching and learning of basic Electricity/Electronics across the technology subjects.

## **Introduction**

This course will show participant how to:

- Use Circuit Wizard, an electronic simulation software
- Design basic electronic circuits using Circuit Wizard
- Manufacture basic electronic circuits suitable for student projects
- Assemble and integrate electronic components onto a PCB
- Fault find assembled electronic circuits using a multimeter

The course materials contain a number of practical exercises. The objective of the exercises is to generate a task based approach to gaining skills in the use of software such as Circuit Wizard. The tasks are designed to focus on particular commands whilst emphasising the process to complete an exercise. The exercises have been designed in a sequence and to build on the knowledge gained in previous exercises.

Prior to commencing the course, it is assumed that participants have basic ICT skills.

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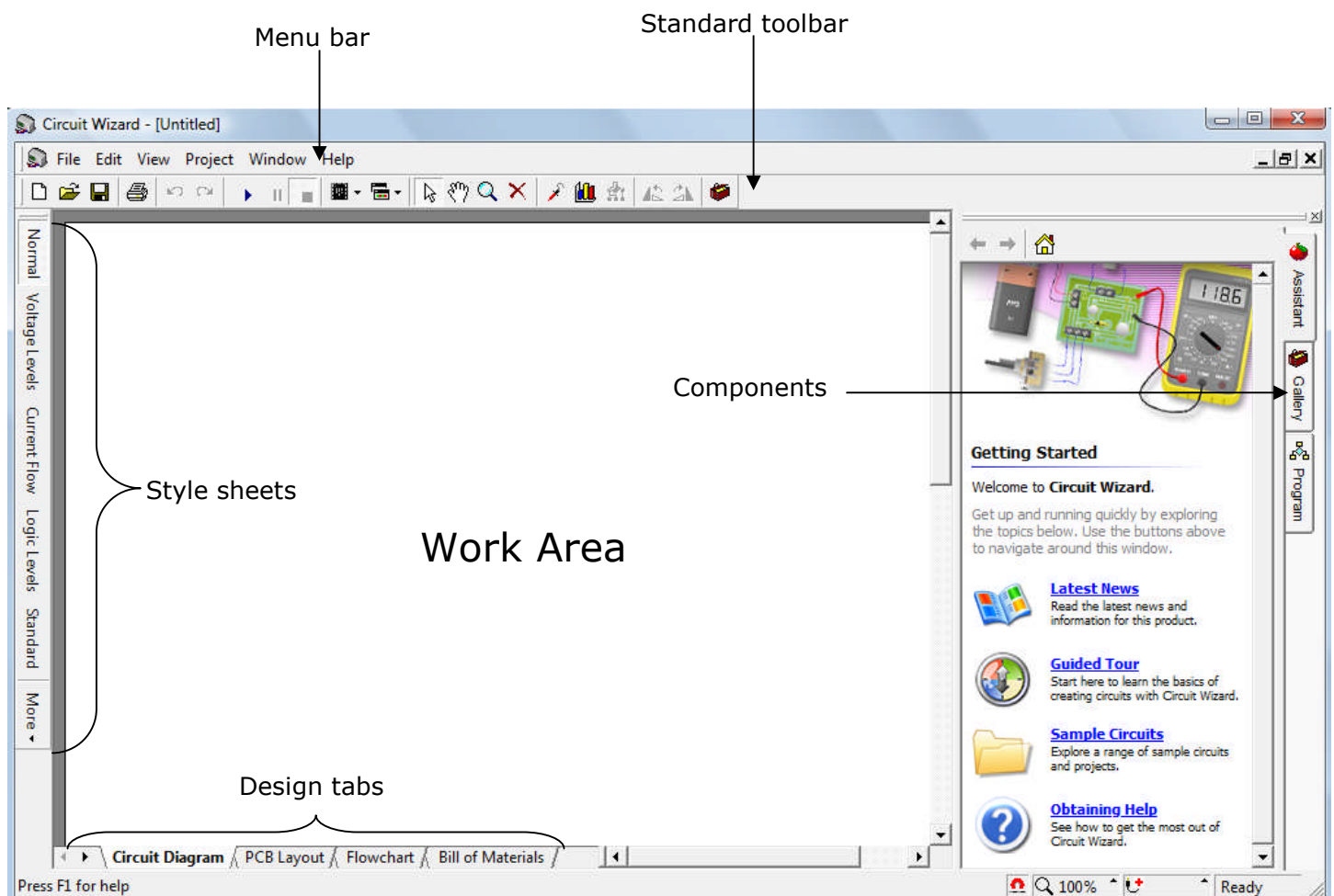
# Circuit Wizard

**To open Circuit Wizard:** Click the circuit wizard icon

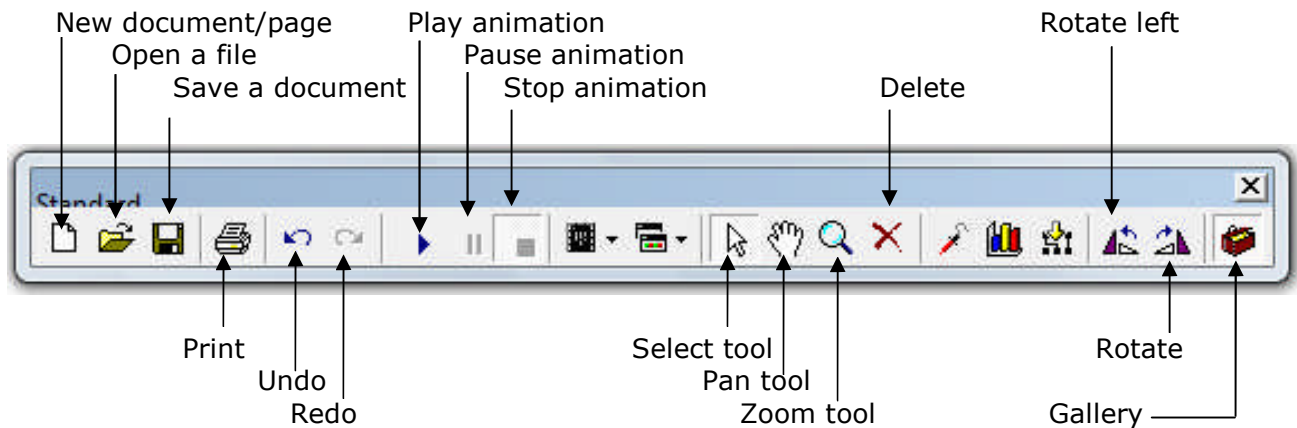


on the desktop or use the start menu.

## 1.1 Circuit Wizard Interface:



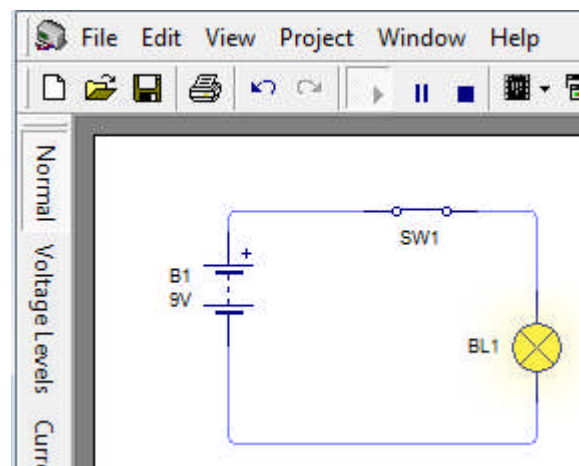
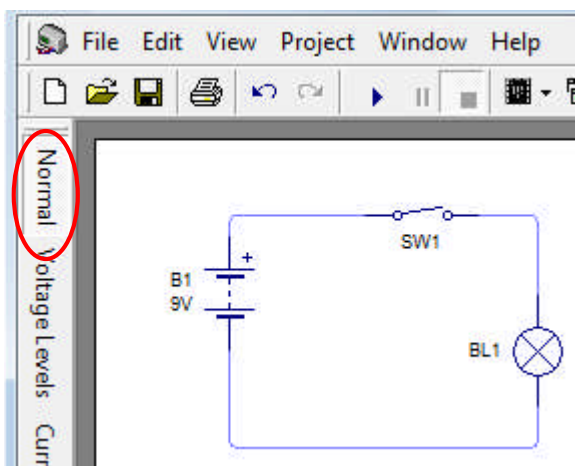
## 1.2 Standard Toolbar



## 1.3 Style Sheets

Change the way in which the circuit is displayed.

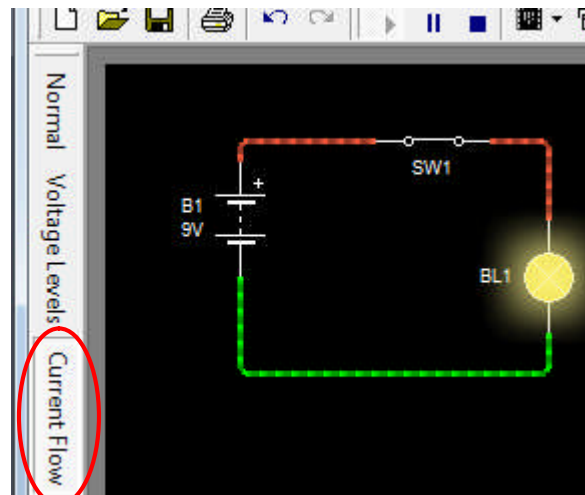
Normal style sheet: When the circuit is animated the components will respond as in a real circuit.



Current Flow style sheet: When the circuit is animated current flow is displayed.

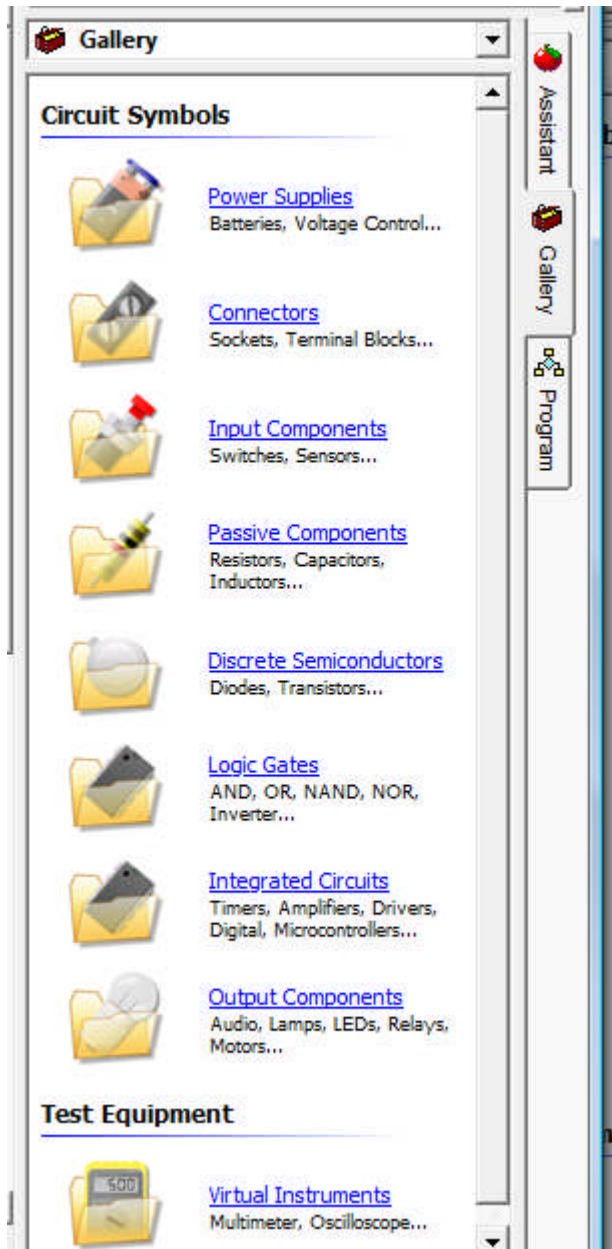
Red = high voltage level  
Green = low voltage level

It has a black background for contrast. This can be changed by selecting View → Display → Background and selecting a colour of choice.

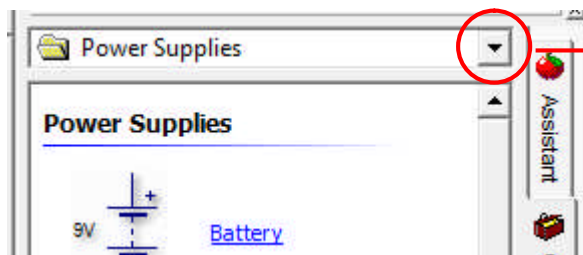
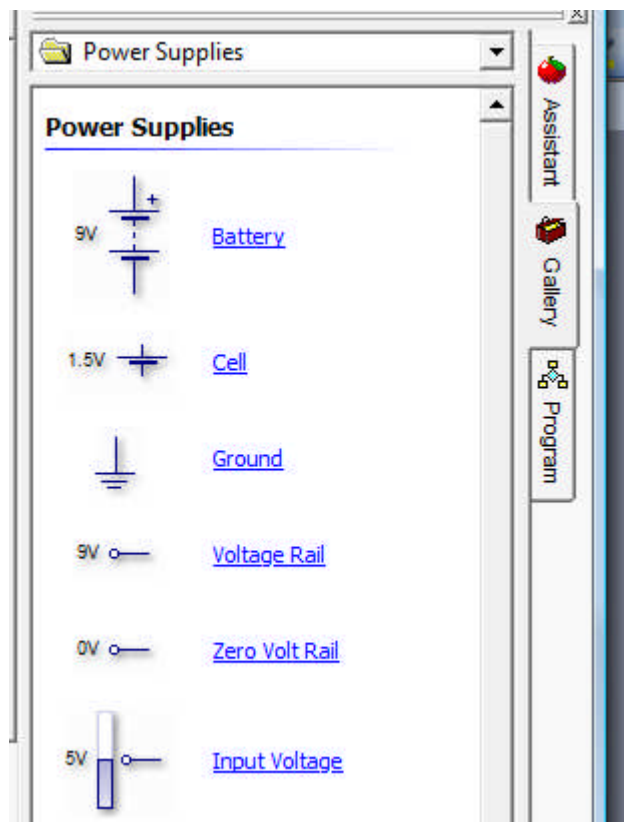


## 1.4 Gallery

The gallery gives quick access to all the available components. When the gallery tab is first selected the components are displayed grouped by their function into folders as shown below left.

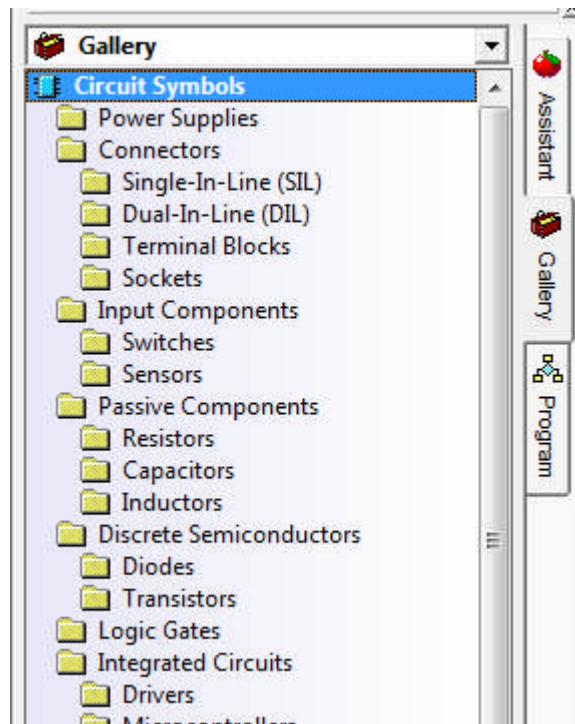


Clicking on any folder such as Power Supplies will open the folder and display its contents (below right). Any component can be inserted into the work area by clicking on it and dragging it into the work area.



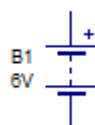
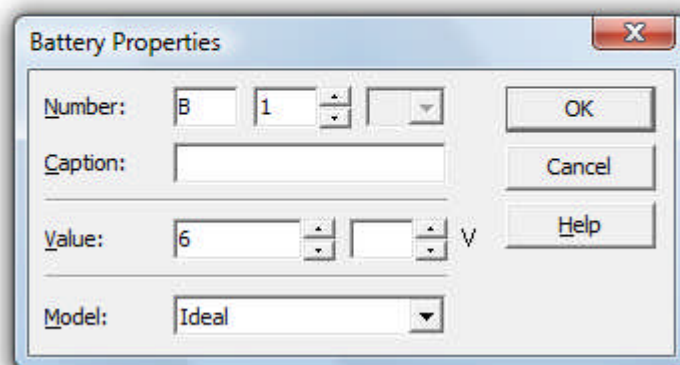
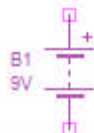
To insert a component from another folder click the drop down list to display the folders.

Gallery display when drop down list is selected.



### ***1.5 To Set the Properties of a Component***

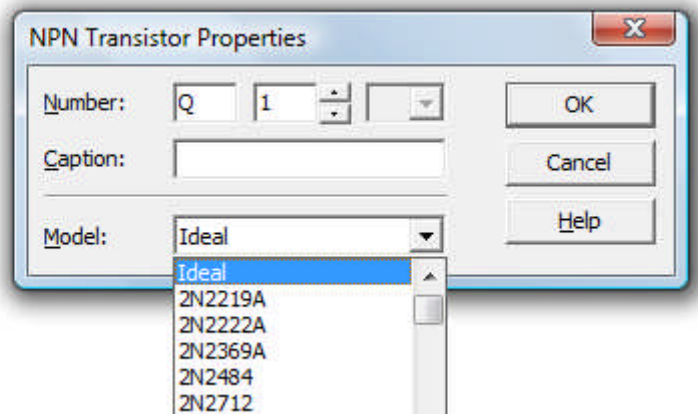
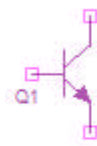
Double click the component to open the Property window. The default setting for the battery is 9V. Type or select a new value as shown below. The change takes affect when OK is clicked.



Modified Symbol

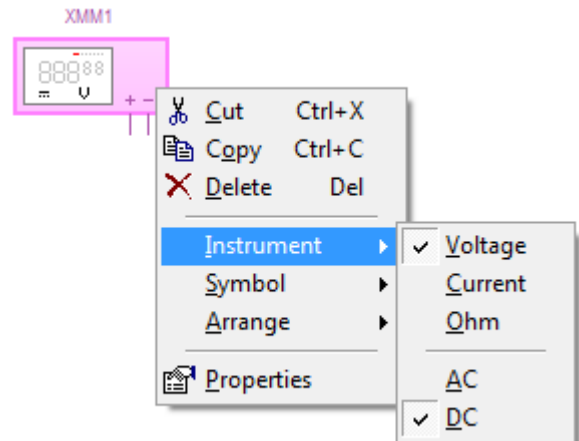


For some components such as transistors specific types can be selected in the property window as shown below.



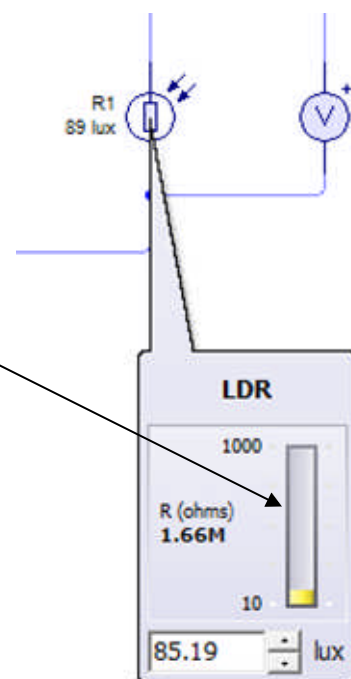
## 1.6 Using the Digital Multimeter

Right click on the digital multimeter and select the instrument type: voltage, current or ohm.



## 1.7 Sensor Simulation

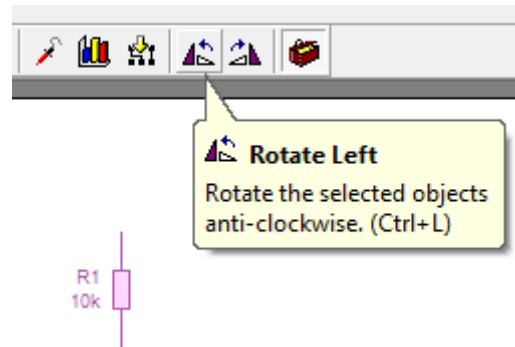
Animate the circuit. Right click on the sensor such as the LDR shown on right. Change the resistance of the LDR to mimic dark and light conditions by dragging the bar up or down with the mouse.



## 1.8 Rotating a Component

Select the component. Clicking rotate left will turn the component 90° anticlockwise for each click.

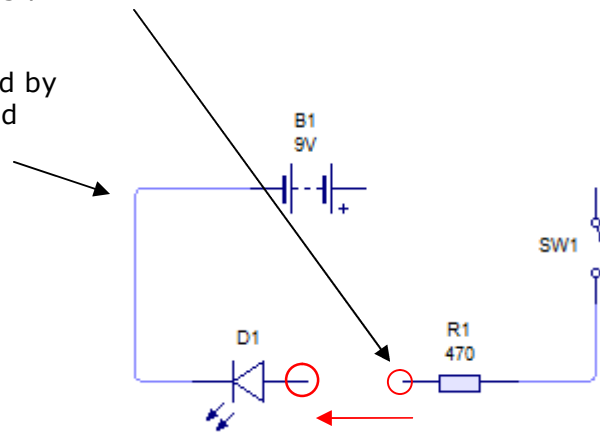
Clicking rotate will turn the component 90° clockwise for each click.



## 1.9 Drawing a Circuit

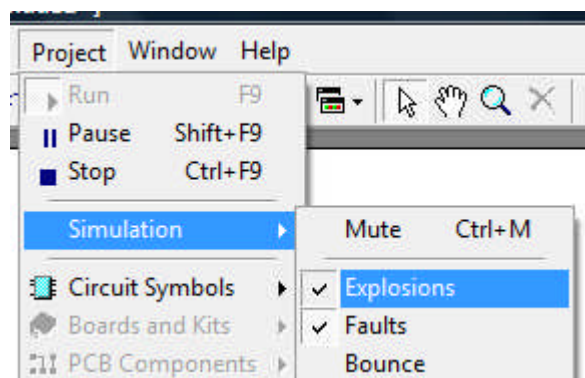
Place the components into the work area. To connect with a wire move the cursor over the components pin, click and drag to connecting pin or wire.

A bend in the wire connection can be created by releasing the mouse at the bend position and completing the link by clicking on the components connecting pin.



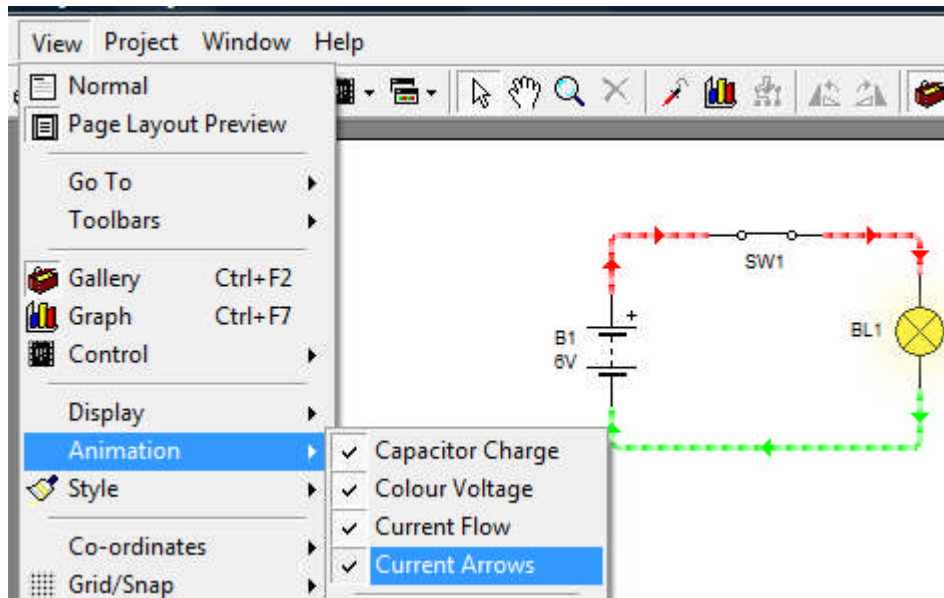
## 1.10 Circuit Simulation

Before simulating a circuit turn on Explosions and Faults as shown below to ensure the simulation mimics a real circuit as closely as the software allows.



## 1.11 Current Direction

Viewing the direction of current flow can be enhanced by turning on Current Arrows using the View Menu.

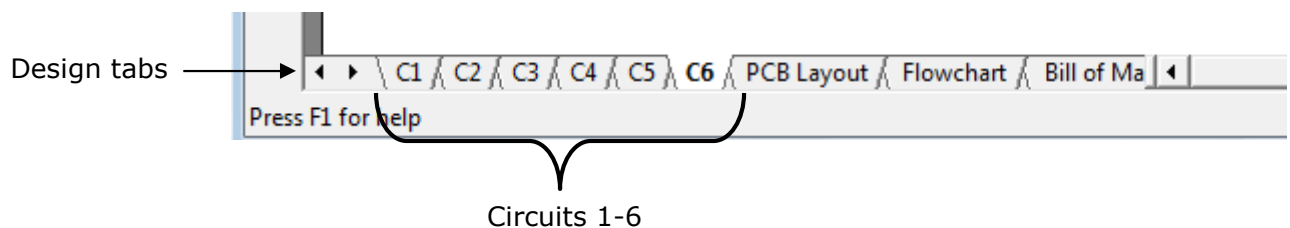


## 1.12 Course Structure

There are five Circuit Wizard files to be used in this course:

- Electric Circuits
- Motor Control
- Sensors
- Transistor Circuits
- Relay Control

Each file has a number of circuits that can be opened by clicking on the tabs in the design tabs area.

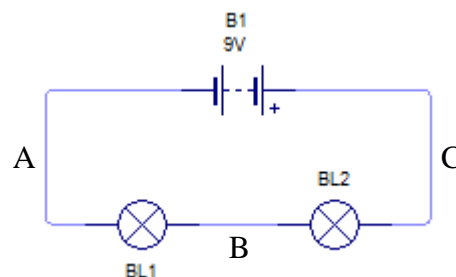


## 2. Electric Circuits

1. Open the file called **Electric Circuits**.

What type of circuit is Circuit 1?

\_\_\_\_\_



Delete the connections between the components. Insert an ammeter at points A, B and C and connect all components to form a circuit. Record the current at A, B and C.

**A:** \_\_\_\_\_

**B:** \_\_\_\_\_

**C:** \_\_\_\_\_

2. Build the series circuit below.



Remove Bulb 1 what happens? \_\_\_\_\_

\_\_\_\_\_

Replace Bulb 1 and remove Bulb 2. What happens?

\_\_\_\_\_

\_\_\_\_\_

Explain why the above happens:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Suggest a suitable application for a series circuit: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

3. Use the multimeter to measure the voltage of the battery and the resistance of the given resistor.

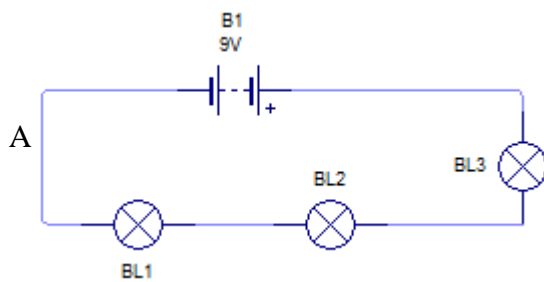
Voltage: \_\_\_\_\_ Resistance of resistor: \_\_\_\_\_

Apply Ohm's Law and calculate the current flowing in the circuit.

$$I = \frac{V}{R} = \text{---} = \text{---}$$

Build a series circuit with the battery, resistor and crocodile clips. Use the multimeter to check your answer.

4. Open Circuit 2 (tab C2). Measure the current at point A.  
Is the current the same, larger or smaller than the current in Circuit 1? \_\_\_\_\_



Explain your answer:

---

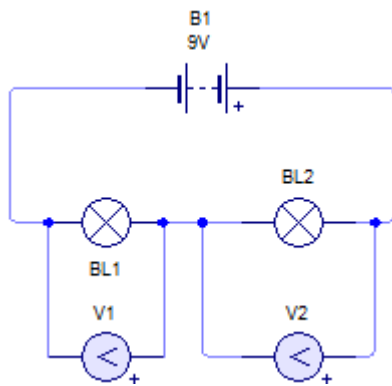
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5. Open Circuit 3 (tab C3) and insert voltmeters to measure the voltage across each bulb.



$$V1 = \text{_____} \quad V2 = \text{_____}$$

$$V1 + V2 = \text{_____}$$

Explain your answers?

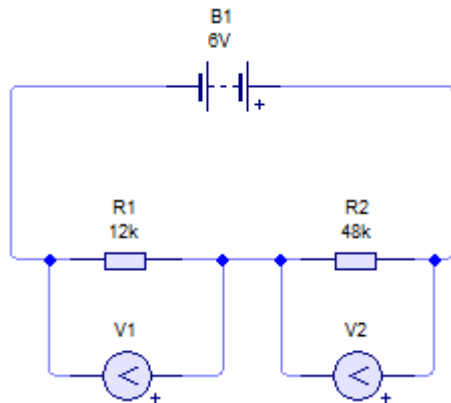
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6. Open Circuit 4 (tab C4) and measure the voltage across each resistor.



$$V1 = \text{_____} \quad V2 = \text{_____}$$

$$V1 + V2 = \text{_____}$$

Why are the voltages not equal?

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---

---

Calculate the voltage division for each resistor using the formulae below:

$$V1 = \frac{R1}{R1 + R2} \times V_{in} = \frac{\text{_____}}{\text{_____}} \times \text{_____} = \text{_____}$$

$$V2 = \frac{R2}{R1 + R2} \times V_{in} = \frac{\text{_____}}{\text{_____}} \times \text{_____} = \text{_____}$$

Compare the ratios  $R_1:R_2$  and  $V_1:V_2$ . What do you notice?

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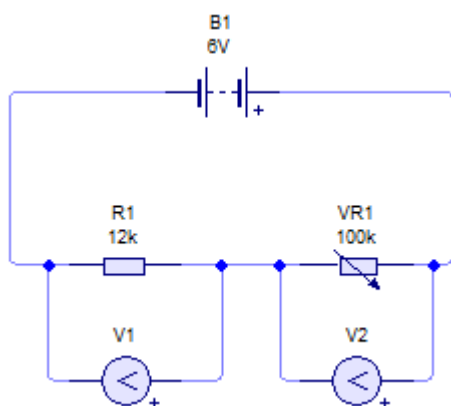


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Replace  $R_2$  with a variable resistor. Change  $R_2$  so that it is larger and then smaller than  $R_1$  and note the reading of  $V_2$  compared to  $V_1$ .



Explain what happens:

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7. Complete the following sentence from the list below:

In a series circuit there is \_\_\_\_\_ path for the \_\_\_\_\_ to flow around. The current in a series circuit is the \_\_\_\_\_ at all points in the circuit. The \_\_\_\_\_ is divided between the \_\_\_\_\_ in the ratio of their \_\_\_\_\_.

(components, voltage, applied voltage, one, two, current, resistance, same, different)

8. Open Circuit 5 (tab C5).

What type of circuit is Circuit 5? \_\_\_\_\_

How many paths can the current flow around in this circuit?

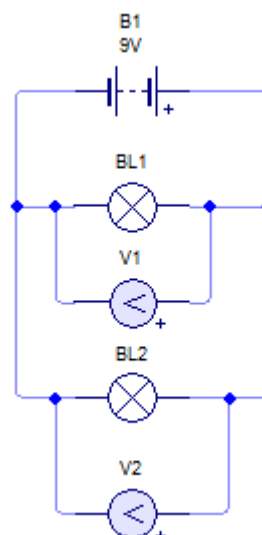
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Measure the voltage across  $BL_1$  and  $BL_2$ .

$V_1 =$  \_\_\_\_\_  $V_2 =$  \_\_\_\_\_



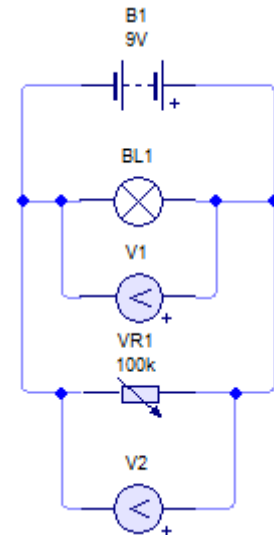
Insert a variable resistor in place of BL2 as shown opposite.

Vary the resistance of the variable resistor and note the value of V1 and V2.

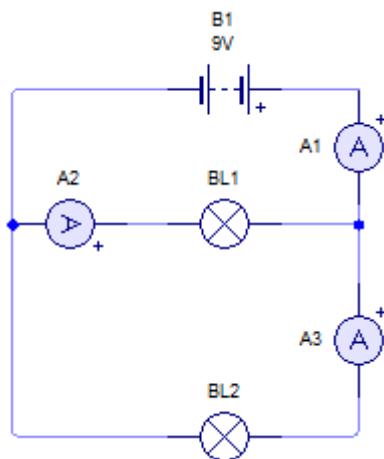
Complete the following sentence from the list below:

The \_\_\_\_\_ across each \_\_\_\_\_ in a parallel circuit is \_\_\_\_\_ to the \_\_\_\_\_.

(equal, voltage, all, applied voltage, current, different, resistance, path)



9. Open Circuit 6 (tab C6). Insert ammeters as shown and measure the current.

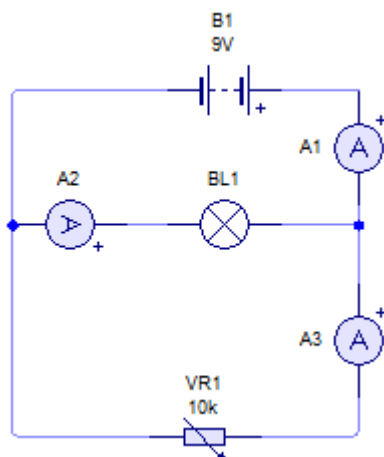


A1 = \_\_\_\_\_ A2 = \_\_\_\_\_

A3 = \_\_\_\_\_

A2 + A3 = \_\_\_\_\_ + \_\_\_\_\_ = \_\_\_\_\_

Change BL2 to a 10k variable resistor and animate the circuit. Vary the resistance of the variable resistor and note the ammeter readings.



What happens to the current in a parallel circuit?

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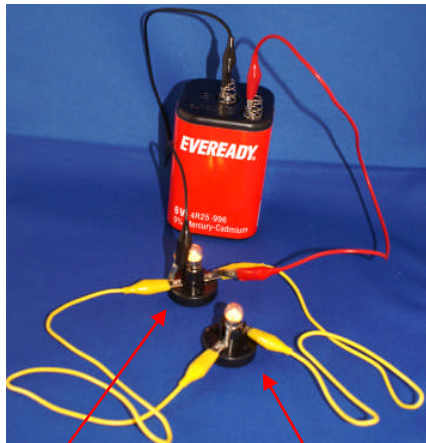


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10. Build the parallel circuit below.



Bulb 1

Bulb 2

Remove Bulb 1 what happens? \_\_\_\_\_

Replace Bulb 1 and remove Bulb 2. What happens?

Explain why the above happens:

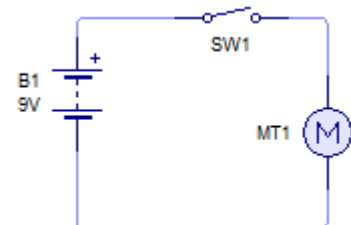
Suggest a suitable application for a parallel circuit: \_\_\_\_\_

11. Replace bulbs with the given resistors and use the multimeter to confirm the voltage drop across each resistor is equal to the applied voltage.

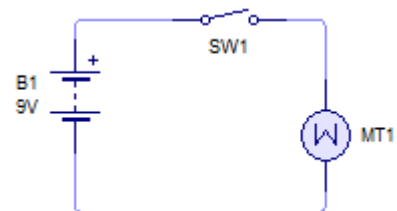
### 3. Motor Control

12. Open the file **Motor Control**.

Animate Circuit 1a and note the rotation of the motor.



Animate Circuit 1b and note the rotation of the motor.

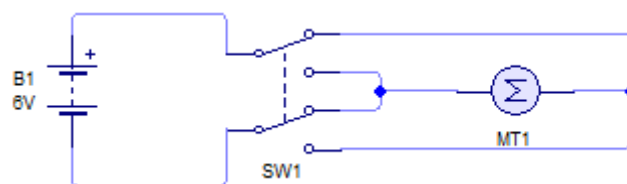


What is the difference between the two circuits?

What is the cause of this difference?



13. Open Circuit 2 (tab C2). Use the 6V battery, DPDT switch and motor to create the circuit below.



Animate the circuit and explain what happens:

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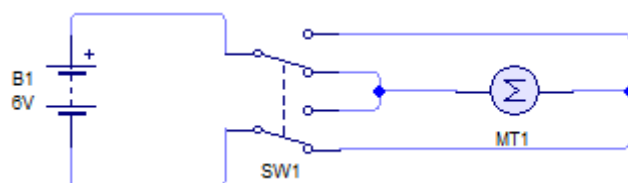
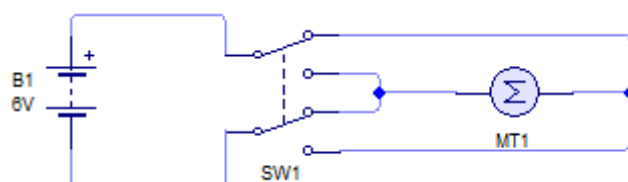
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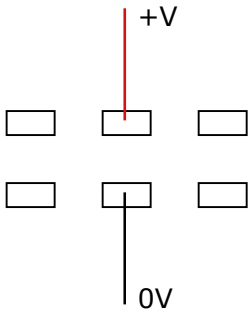
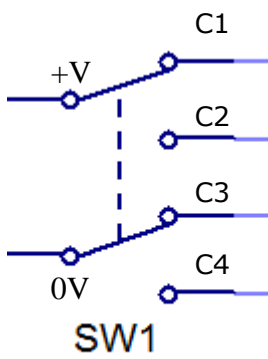
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Draw in the path of current flow for each throw of the switch below.

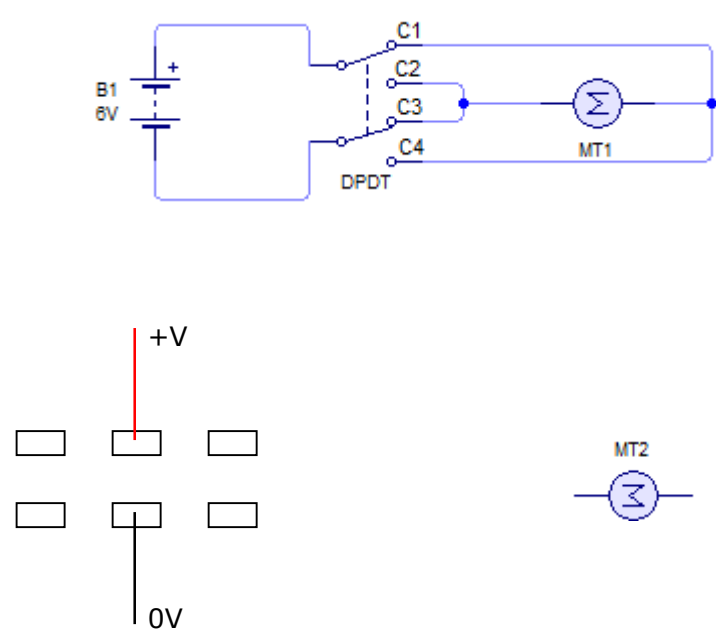


14. Using the multimeter set to continuity testing as shown below, match the contacts on the DPDT symbol to those on the DPDT switch.



DPDT switch contacts

15. Label the contacts on the DPDT switch below and use the circuit diagram to complete the real wiring diagram.

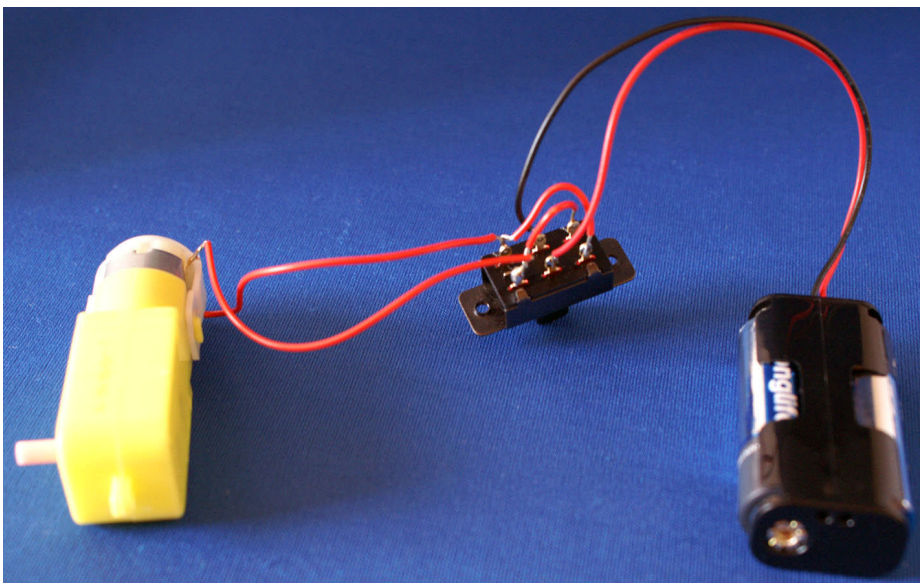


Suggest a suitable application for the circuit: \_\_\_\_\_

\_\_\_\_\_

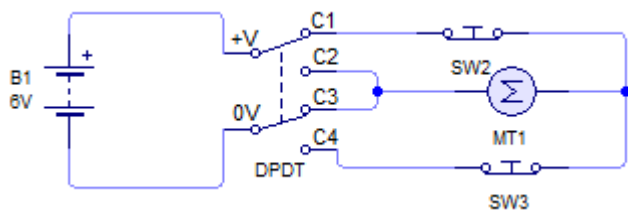
\_\_\_\_\_

16. Build the DPDT motor control circuit and test the motor is rotating forward and reverse.



17. Open Circuit 3 (tab C3). SW2 and SW3 are push-to-break switches. They are to be used as limit switches for the motor. Insert the limit switches into the circuit diagram as shown below.

Animate the circuit and check they are in the correct position. (Do not forget to open SW2 and SW3 to test the motor stops in both directions)

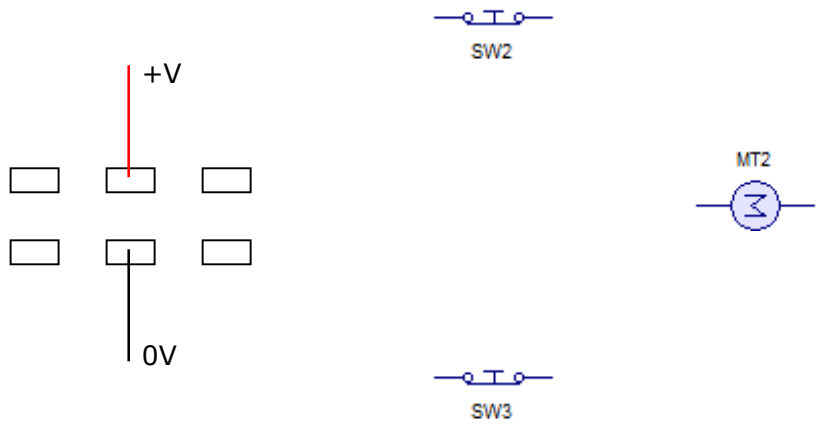


Suggest a suitable application for the circuit: \_\_\_\_\_

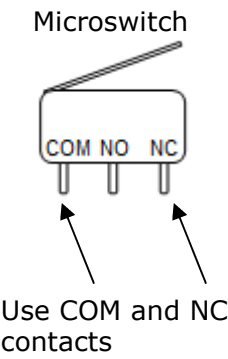
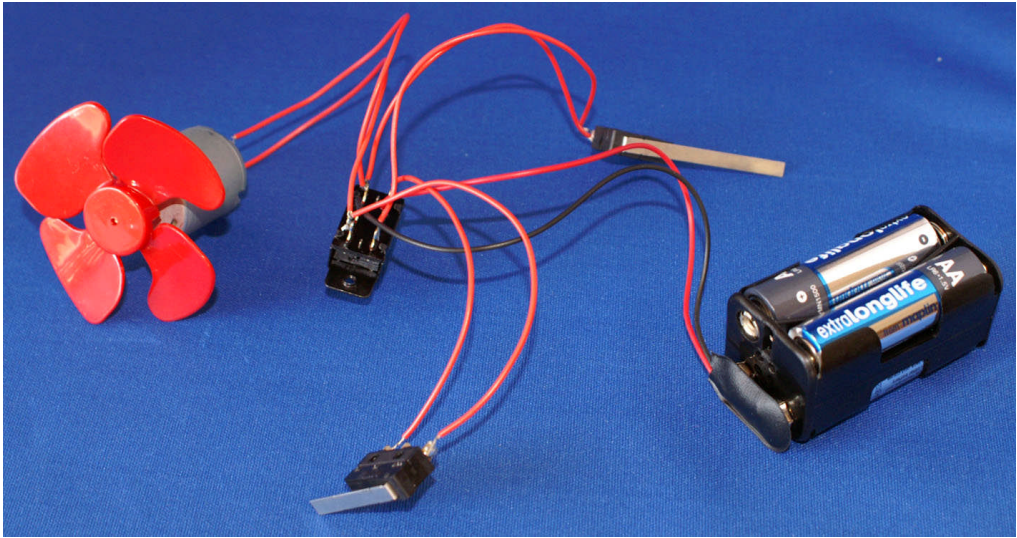
\_\_\_\_\_

\_\_\_\_\_

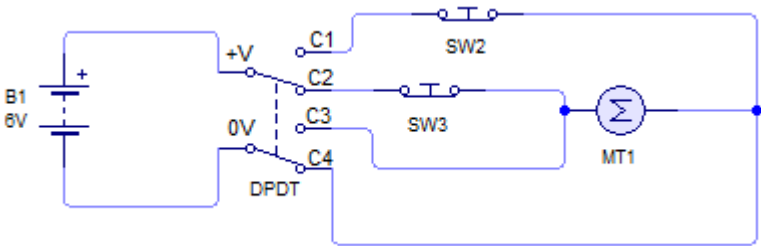
18. Label the contacts on the DPDT switch below and use the circuit diagram to complete the real wiring diagram.



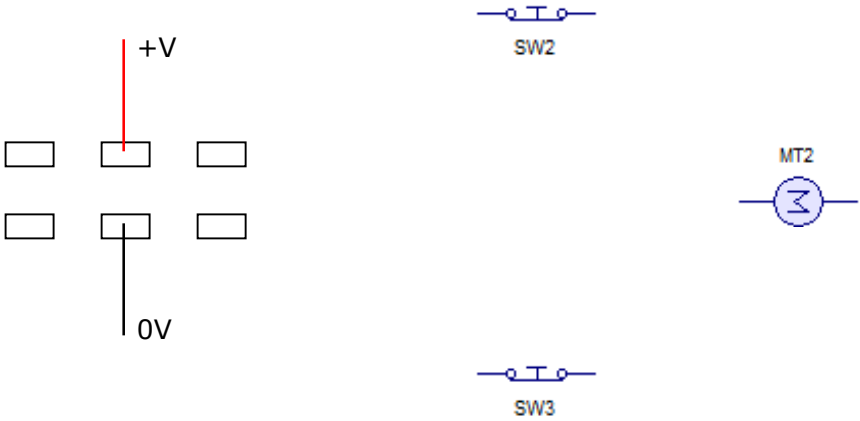
19. Build the motor control limit switch circuit and test the limit switches operate correctly.



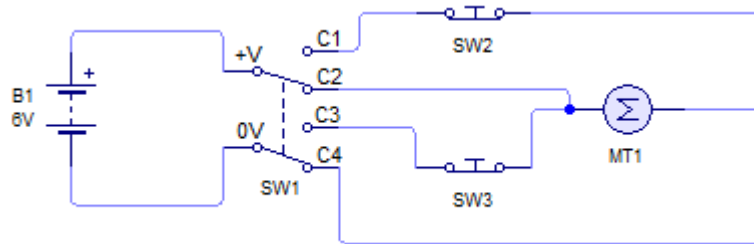
20. Reposition SW2 and SW3 as shown below, animate and test the limit switches. Will the limit switches operate as required?



Complete the real wiring diagram.



21. Open Circuit 4 (tab C4). SW2 and SW3 have been repositioned as shown below. Animate and test the circuit.



Will the limit switches operate as required? \_\_\_\_\_

Explain your answer:

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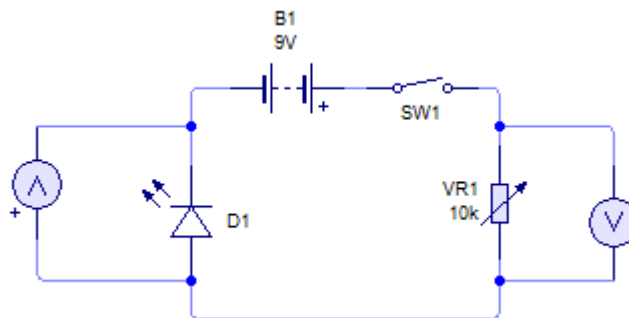


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## 4. Sensors

22. Open the file **Sensors**.

Insert two voltmeters as shown below into Circuit 1a and animate the circuit.



What happens to the voltages as the resistance of the variable resistor is reduced?

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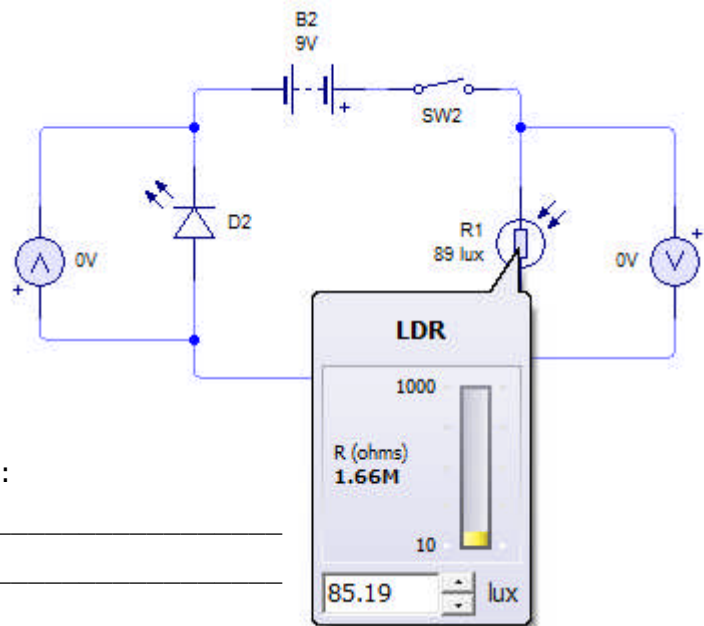
Why will the LED fail as the resistance of the variable resistor is reduced?

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The variable resistor has been replaced by an LDR in Circuit 1b. Animate the circuit and vary the resistance of the LDR.



Explain how the LDR works in this circuit:

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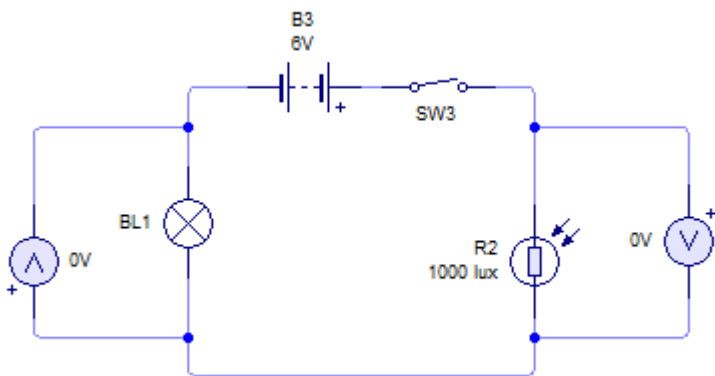
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What is the advantage of using the LDR instead of the variable resistor?

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Scroll down and animate Circuit 1c.



Why is there a poor level of light from the bulb?

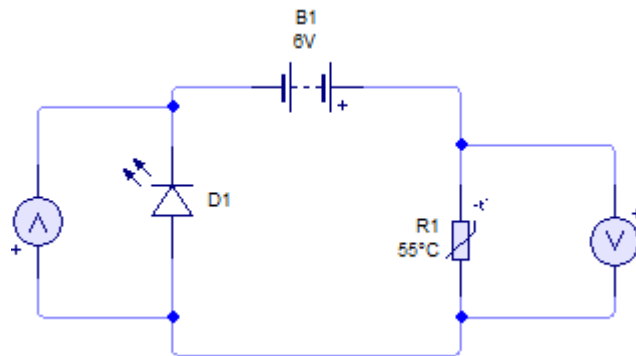
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23. Open Circuit 2 (tab C2). Animate the circuit and vary the resistance of the thermistor.



Explain how the thermistor operates in this circuit:

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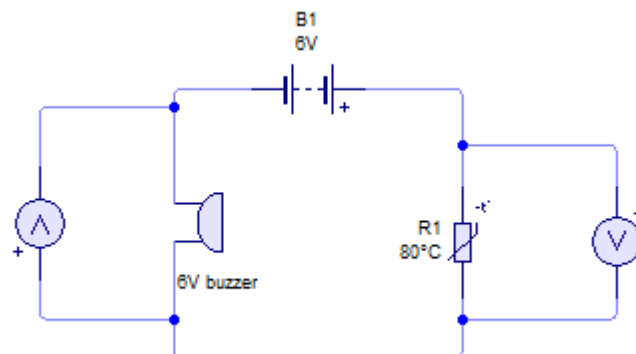


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Animate Circuit 2b where the LED has been replaced with a 6V Buzzer.



Why is there no sound?

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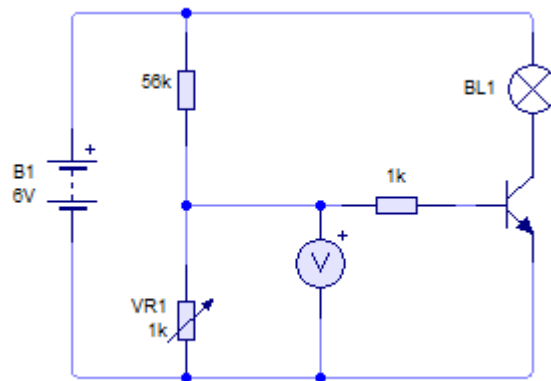
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How can the LDR and Thermistor circuits above be modified to increase the level of light from the signal lamp and sound from the Buzzer??????????



## 5. Transistor Circuits

24. Open the file **Transistor Circuits**. Animate Circuit 1.



Why is bulb BL1 not lighting?

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Increase the resistance of the variable resistor and note the voltage reading across the base of the transistor.

What effect does this have on the circuit?

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25. Open Circuit 2 (tab C2). Animate the circuit.

How does the circuit operate?

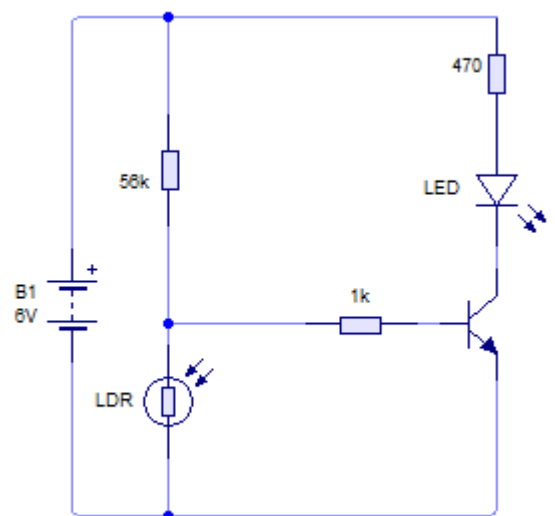
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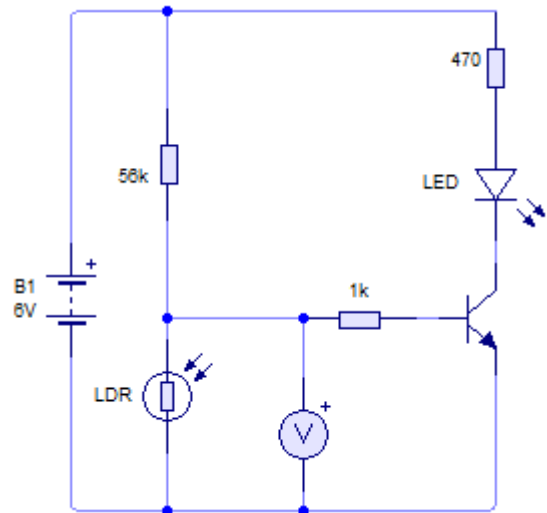
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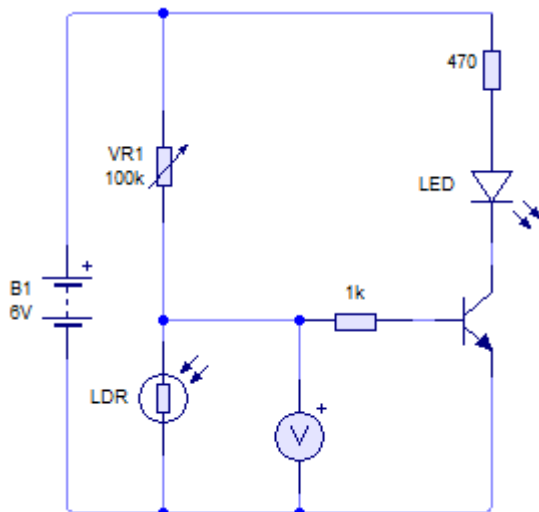


Insert a voltmeter across the LDR and complete the following sentence:

As it gets \_\_\_\_\_ the \_\_\_\_\_ of the LDR \_\_\_\_\_. This increases the \_\_\_\_\_ between the \_\_\_\_\_ and \_\_\_\_\_ of the transistor. Current flows in the circuit turning on the LED.



26. Scroll down to Circuit 2b. Change the 56k resistor to a 100k variable resistor. What effect does changing the resistance of the variable resistor have on the circuit?




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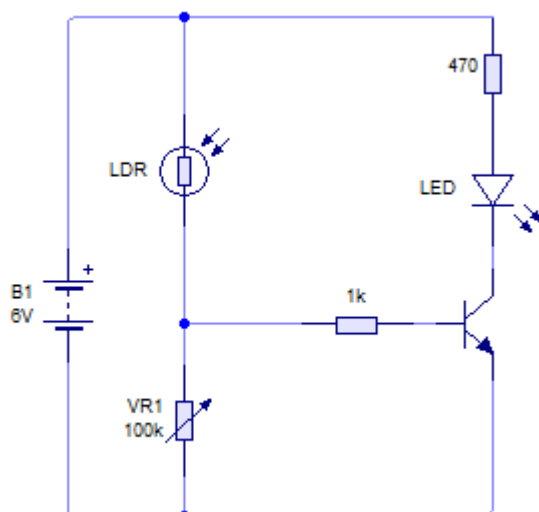
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Open Circuit 3 (tab C3). The position of the LDR and variable resistor, have been changed. What effect does this have on the operation of the circuit?




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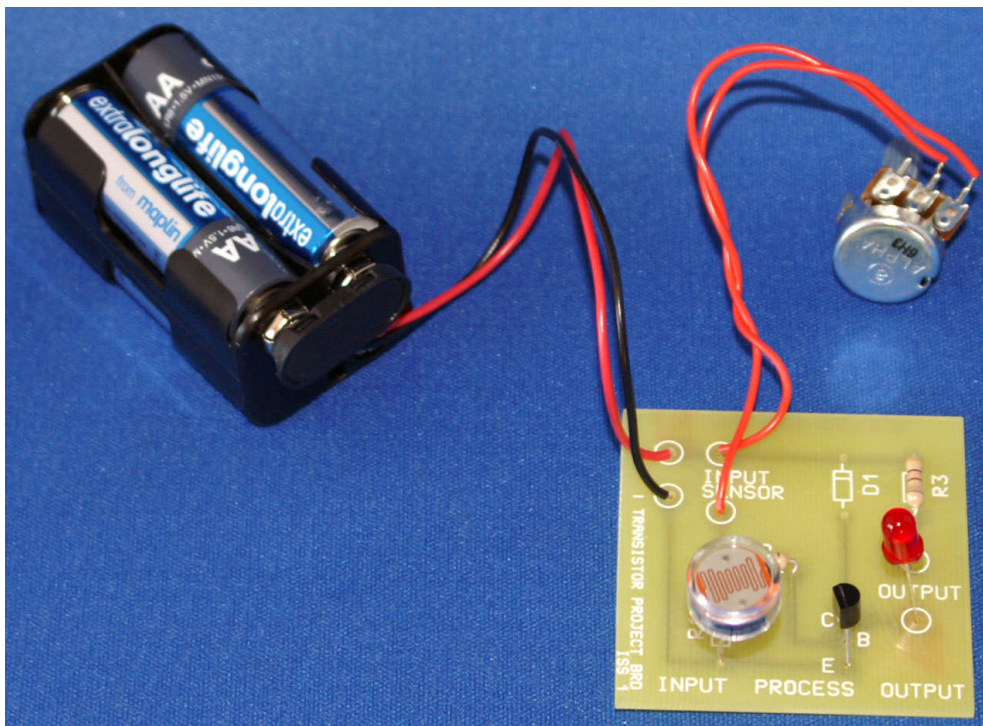
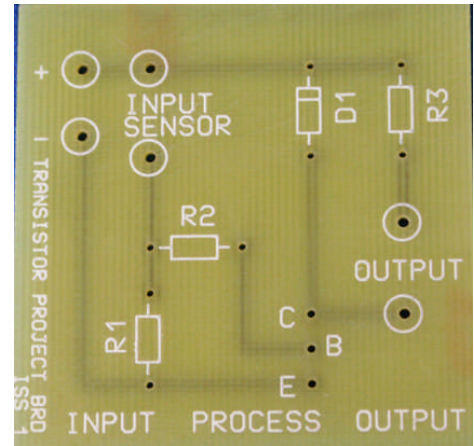
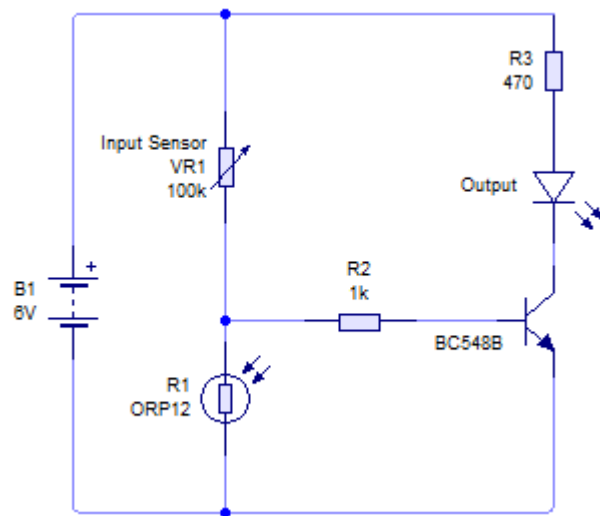
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27. Build the LDR transistor circuit below on the PCB provided and test the voltage levels in the circuit. (No diode required for D1 in this circuit).



BC548  
BC548A  
BC548B  
BC548C



Suggest a suitable application for the circuit:

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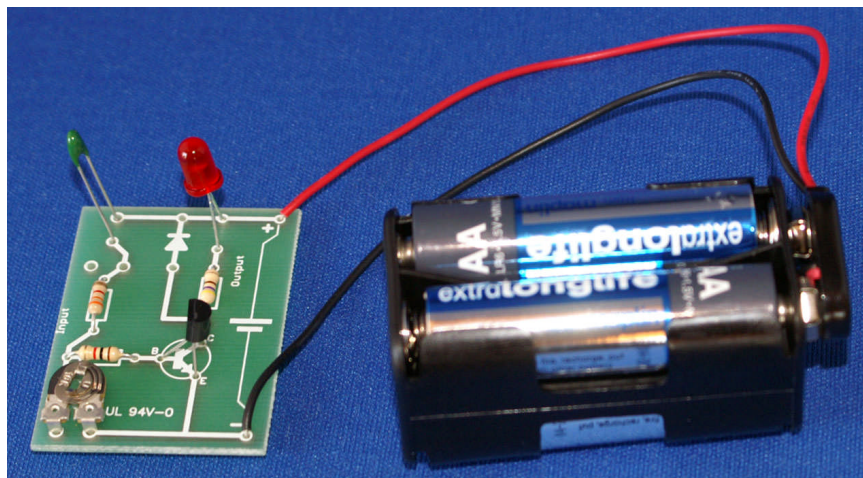
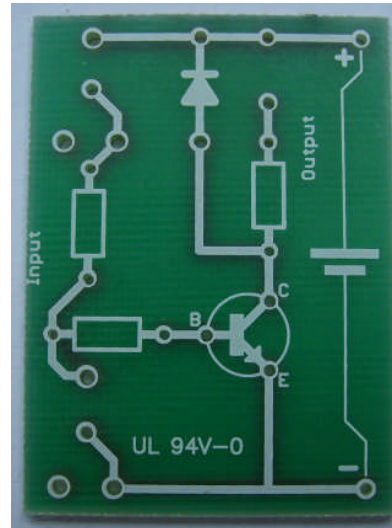
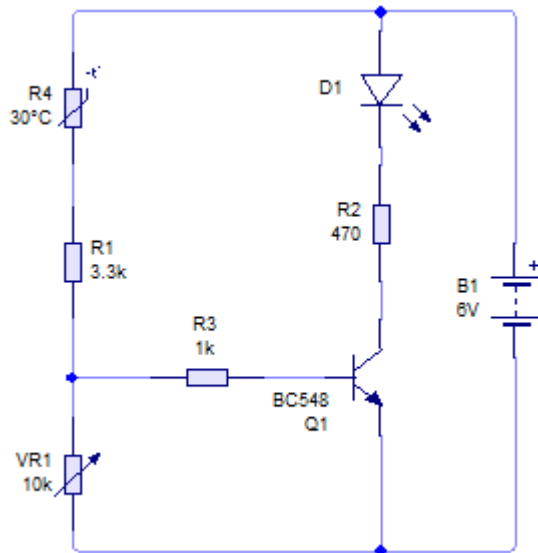


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28. Build the thermistor transistor circuit below on the PCB provided and test the voltage levels in the circuit. (No diode required for circuit).



Suggest a suitable application for the circuit:

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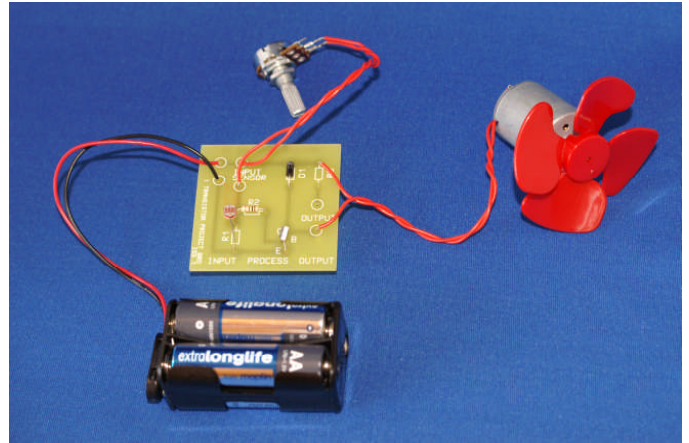
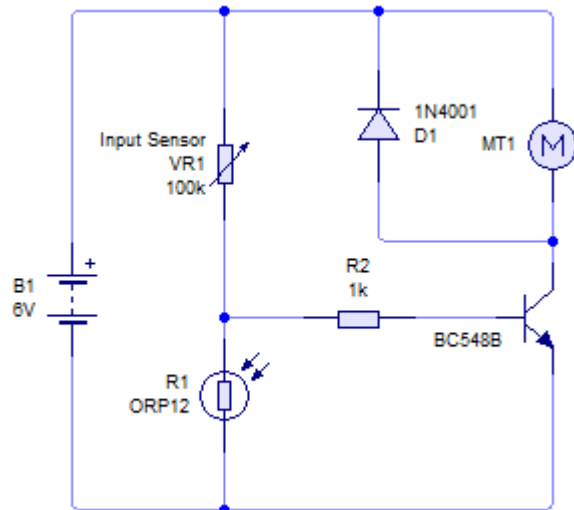


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29. BCX38B is a darlington pair transistor and can be used on the project board when the output is a motor/solenoid or bulb. A diode is required when the output is a motor or solenoid. Build the circuit below. The protective resistor (R3) used with an LED on the PCB is not required.



Suggest a suitable application for the circuit:

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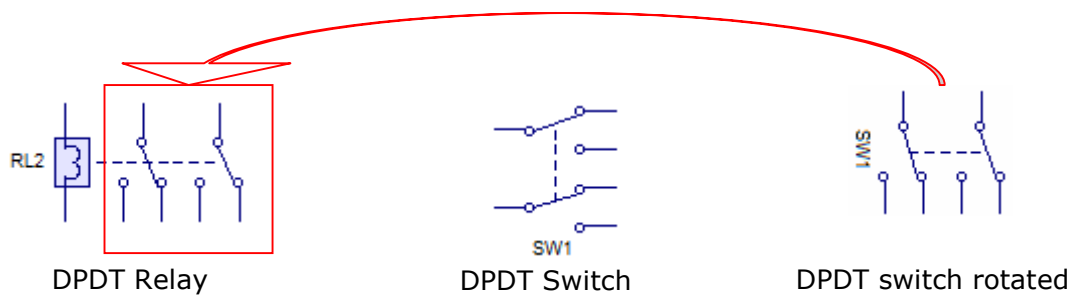
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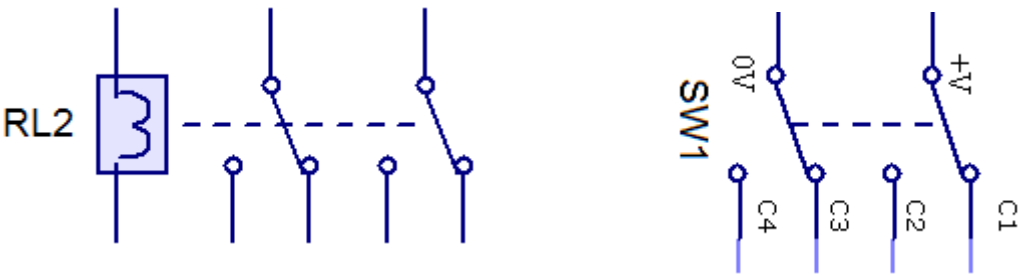
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## 6. Relay Control

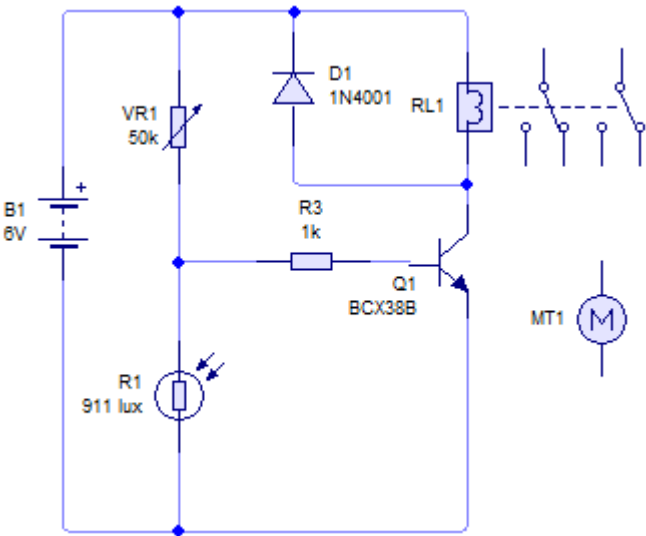
30. The electric symbol for the DPDT Relay and DPDT switch in its normal and rotated position are shown below. In its rotated position the DPDT switch is the same as the selected part of the relay.



Mark the contacts on the relay to match those on the DPDT switch.



31. Open the file Relay and complete the Circuit 1 diagram so the relay will rotate the motor forward and reverse. Animate the circuit to check that it operates correctly.



Explain how the circuit operates:

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Suggest a suitable application for the circuit:

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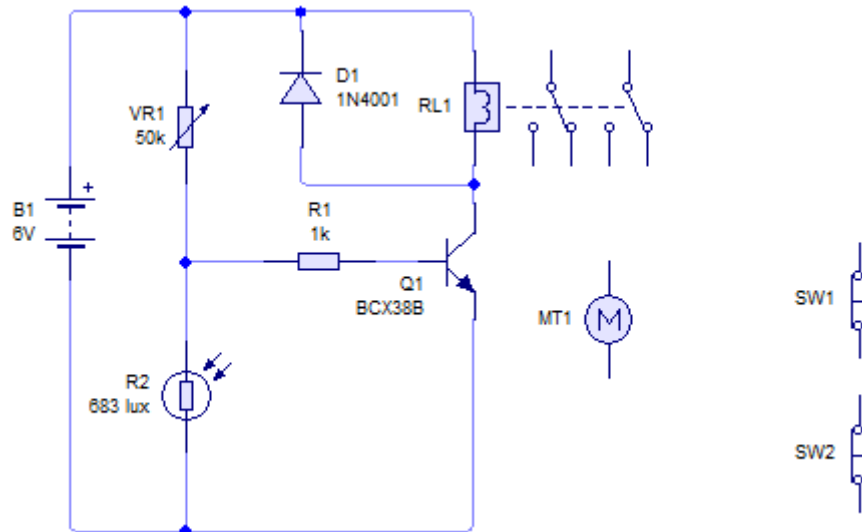


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32. Open Circuit 2 (tab C2) and complete the wiring diagram to include limit switches. Move the limit switches SW1 and SW2 as required. Animate the circuit to confirm that the motor will rotate forward and reverse with limit switch operation in both directions.



Suggest a suitable application for the circuit:

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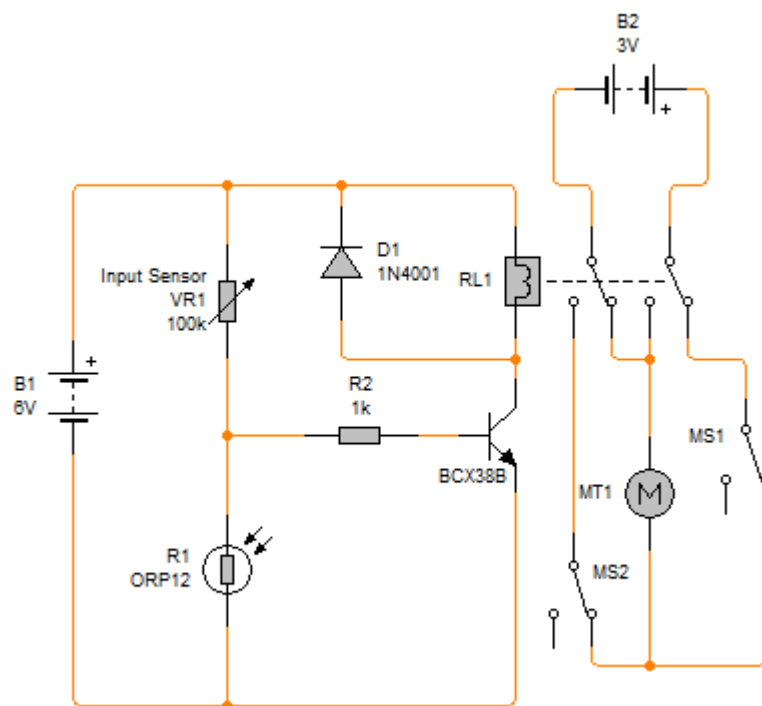


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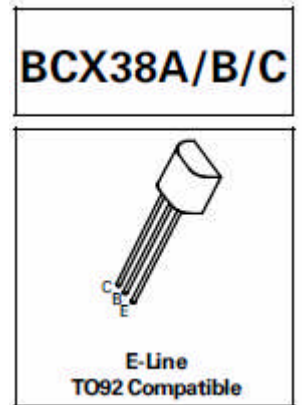
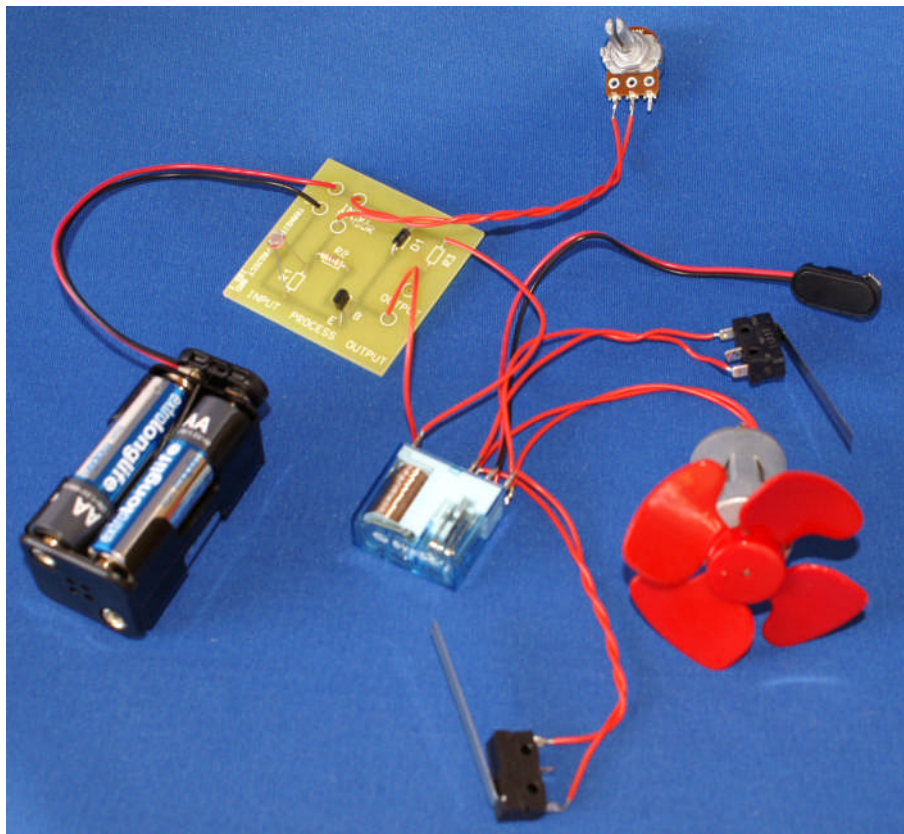


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33. Use the transistor project board to build the Relay circuit below and test its operation.







Suggest a suitable application for the circuit:

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