Name: _____
Date: _____
Course _____
Instructor: _____

DC EXPERIMENT 4

Watt's Law

OBJECTIVES

1. Construct a simple circuit that lights up a light bulb
2. Measure the voltage and current in the circuit by using the multimeter
3. Calculate the power dissipation of the light bulb using Watt's Law

EQUIPMENT REQUIRED

Instruments	Components	Tools
Power Supply Digital Multimeter	Light Bulb × 2 (rated 3.6W) 27Ω Resistor (rated 2W)	Breadboard Conducting Wires Wire Stripper

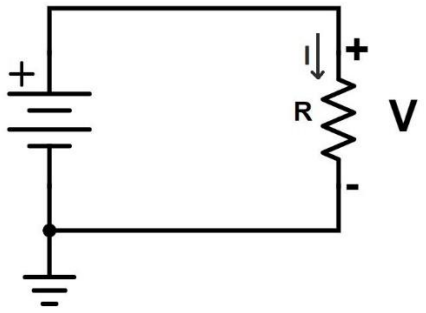
EQUIPMENT ISSUED

Check if your group has been issued with the instruments listed above. Note down the manufacturer model number for the instrument you used (if you don't know where to find it, ask your instructor). Also, note down your lab group number.

Item	Manufacturer Model #	Lab Group #
Power Supply [MEGO] Digital Multimeter [ZOYI]		

THEORY

In electric circuits, power is a measure of the electrical energy per unit of time. The power dissipation of a component, e.g. a resistor, can be represented in the following form:



Power: $P = VI$

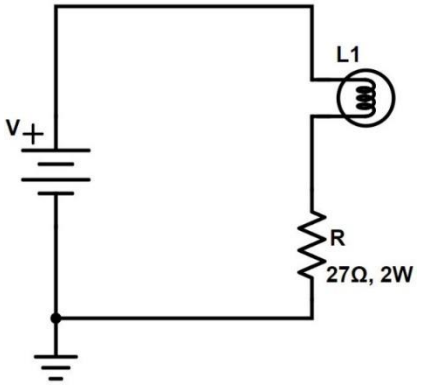
where V is the voltage across the resistor, and I is the current through the resistor. If the element has a constant resistance R, using the knowledge learnt from Ohm's law, we can rewrite Watt's law in the following forms:

$$P = \frac{V^2}{R}, \text{ or } P = I^2R$$

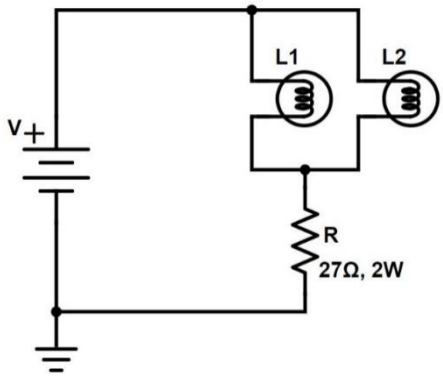
The unit of power is in Watts (W). A source of energy such as a voltage source will produce or deliver power while the connected load absorbs it. For example, light bulbs are devices that absorb electrical energy and convert it into heat and light. The rated power of an element represents its maximum capability to consume electrical power. In practice, light bulbs are given specific power ratings to ensure a safe operation.

OVERVIEW

Following the circuits in Figure 1, in this experiment you will implement Watt's law and visualize the effects when the light bulbs (L1 and L2) are operating at different power levels. You will also become more familiar with the basic concepts of power rating when dealing with simple power elements.



(a) Single Bulb Experiement



(b) Two Bulbs Experiment

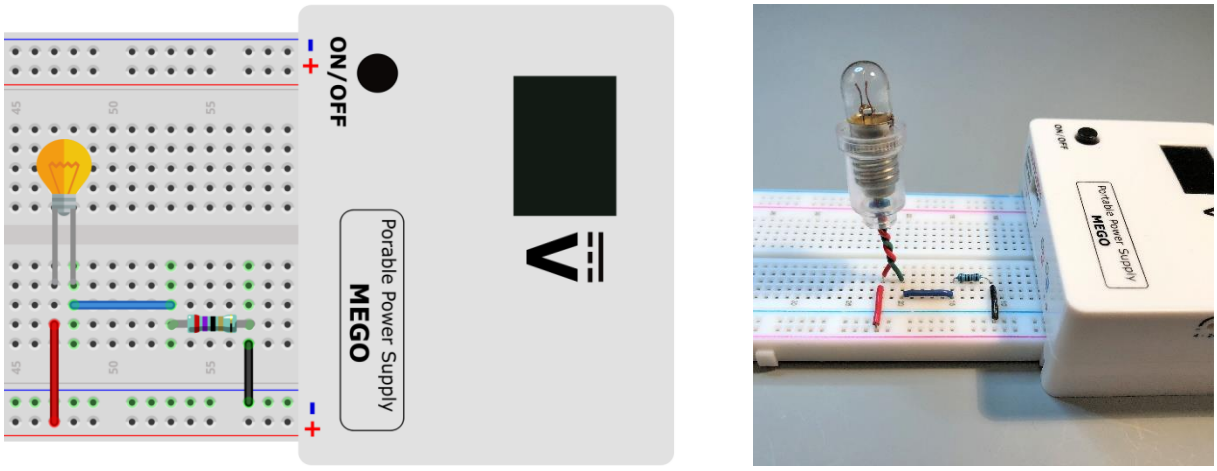
Figure 1

PROCEDURE

This experiment you are dealing with components that dissipate heat, so DO NOT touch the resistor and light bulbs during operation otherwise you might be burned. Follow the instructions carefully, make sure you read each step instruction before hands-on implementing.

Part I: Single Light Bulb

1. Check the default output voltage of the power supply. Set the output voltage to 7V, then turn it OFF and proceed to next step.
2. Using the given components (bulb and 27Ω resistor), construct the circuit of Figure 1 on the breadboard. Be sure all wires are plugged into the holes so that the circuit is well conducted.



(a) Pin Connection (b) Actual Setup

Figure 1

3. Turn ON the power supply, you should see the bulb is glowing. If not, check your circuit connection or ask your instructor for help. DO NOT touch the resistor or the bulb.
4. Now set the DMM in voltage mode and measure the voltage across the light bulb and across the resistor. Record the measured voltage of V_{R1} and V_{bulb} in the second column of Table 1.
5. Set the DMM in current mode [mA] and measure the current in the circuit. To measure current, you can simply replace small segment of wire (adjacent to the bulb) by DMM. Record the value in the third column of Table 1.

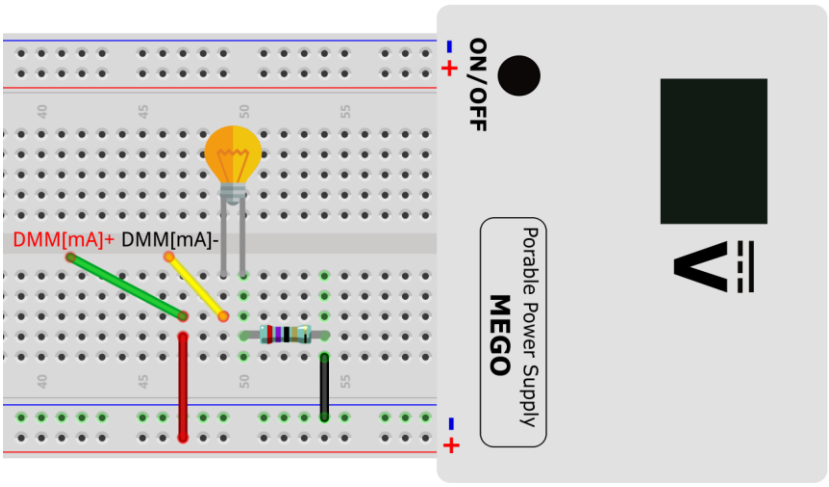


Figure 2

6. Calculate the power dissipation of the resistor and the light bulb using Watt's law,

$$P_{R1} = (V_{R1})(I_{R1}) = \_\_\_\_\_ mW$$

$$P_{bulb} = (V_{bulb})(I_{bulb}) = \_\_\_\_\_ mW$$

   also enter the calculated values in the last column of Table 1.

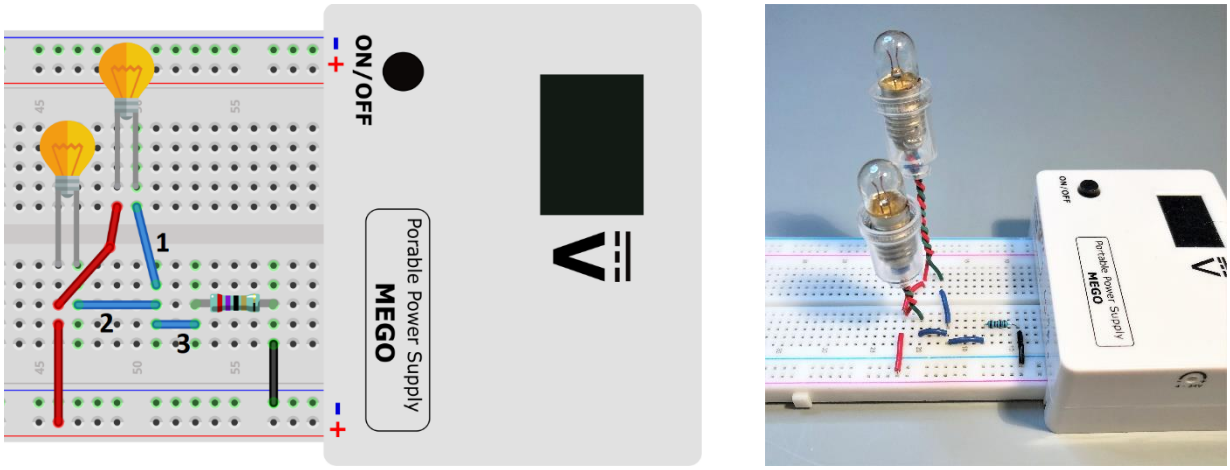
7. Once you have the Table 1 filled, Part I is completed. Turn off the DMM by switching the knob to position "OFF". Turn off the power supply and disconnect it from the breadboard.

TABLE 1

	Voltage (V)	**Current (mA)**	**Power (mW)**
R_1			
Light bulb			

Part II: Two light bulbs

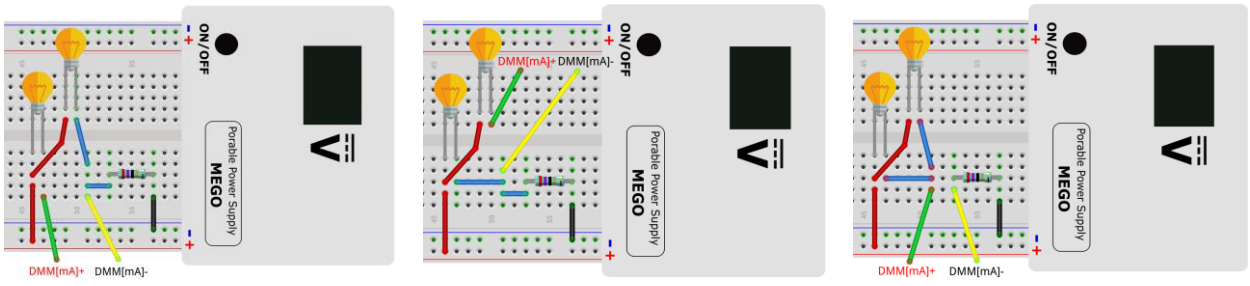
1. Construct the circuit shown in Figure 2. Use the same 27 Ω resistor, but you add another bulb in parallel this time. Be sure all wires are plugged into the holes so that the circuit is well conducted.



(a) Pin Connection (b) Actual Setup

Figure 3

2. Turn ON the power supply, and if it has the same output voltage of 7V, you should observe that two bulbs are dimmer as the single bulb experiment in Part I. DO NOT touch the resistor or the bulb.
3. Increase the power supply output voltage to 10V. Now the bulbs should have the same brightness as in Part I experiment.
4. Set the DMM in voltage mode and measure the voltage across the light bulbs and the resistor. Record the measured voltage of V_{R1}, V_{bulb1}, and V_{bulb2} in Table 2.
5. Set the DMM in current mode [mA] and measure the current flow through the right bulb, the left bulb and the resistor. You can replace wire 1, 2, 3 by the DMM while measuring currents. Follow the method as shown in Figure 4. Record the values in Table 2.



(a) Left bulb (b) Right bulb (c) Resistor

Figure 4: Measuring the currents using DMM

6. Calculate the power to the resistor and to the light bulbs. Enter the calculated values in Table 2.

TABLE 2

	Voltage	**Current**	**Power**
R_1			
Light bulb 1			
Light bulb 2			

EXERCISES

[For Part I Circuit]

1. With the power supply set to 7V, what were the power dissipations of the resistor R_1 and the light bulb?

2. How is the dissipated power of R_1 compared to its rated power? How is the dissipated power of the light bulb compared to its rated power? Show your results in percentage.

3. Given the results to questions 1 and 2, is it safe to operate this circuit?

[For Part II Circuit]

4. In Part II step 3, why was it necessary to increase the power supply voltage to maintain the brightness of both light bulbs?

5. With power supply voltage set to 10V, what was the power dissipation of resistor R_1? What were the power dissipations of both light bulbs?

6. Compare the power dissipation of R_1 to its rated power, show your results in percentage. Given the results to question 4 and 5, is it safe to operate this circuit?

7. In order not to exceed the power rating of R_1, how many additional light bulbs can be placed in parallel in Fig.2?