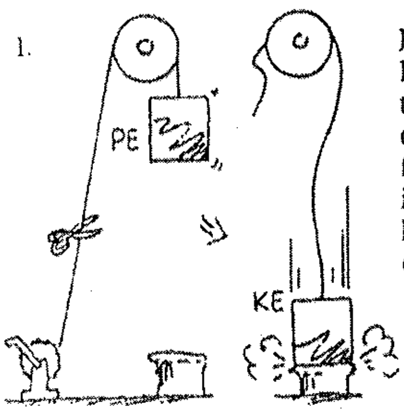
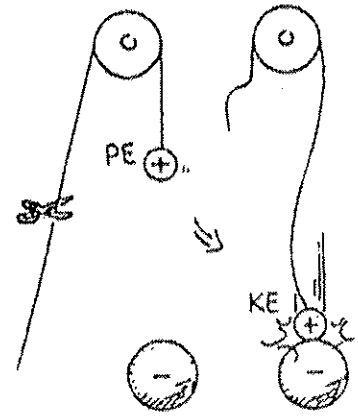
Electric Potential

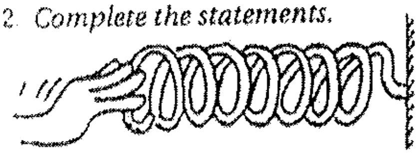
1. 

Just as PE (potential energy) transforms to KE (kinetic energy) for a mass lifted against the gravitational field (left), the electric PE of an electric charge transforms to other forms of energy when it changes location in an electric field (right). When released, how does the KE acquired by each compare to the decrease in PE?

____



2. *Complete the statements.*



A force compresses the spring. The work done in compression is the product of the average force and the distance moved. W = Fd. This work increases the PE of the spring.

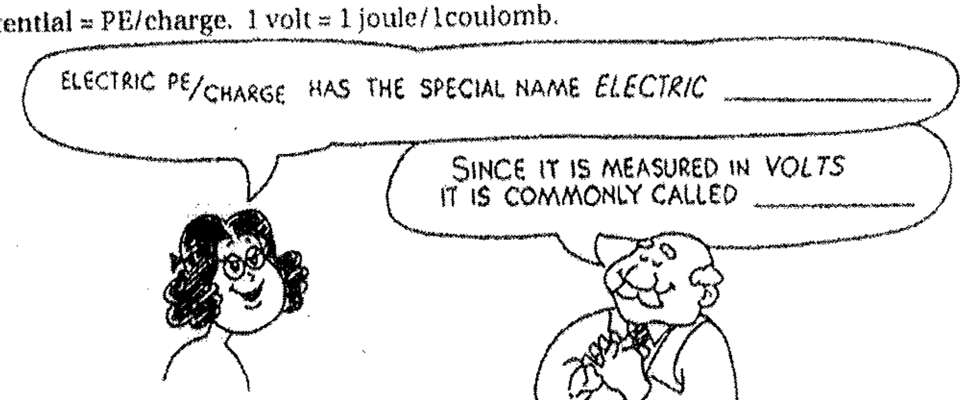
Similarly, a force pushes the charge (call it a test charge) closer to the charged sphere. The work done in moving the test charge is the product of the average ________ and the ________ moved. W = _______. This work ____________ the PE of the test charge.

If the test charge is released, it will be repelled and fly past the starting point. Its gain in KE at this point is ________________ to its decrease in PE.

At any point, a greater quantity of test charge means a greater amount of PE, but not a greater amount of PE *per quantity* of charge. The quantities PE (measured in joules) and PE/charge (measured in volts) are different concepts.

By definition: **Electric Potential** = PE/charge. 1 volt = 1 joule/1coulomb.

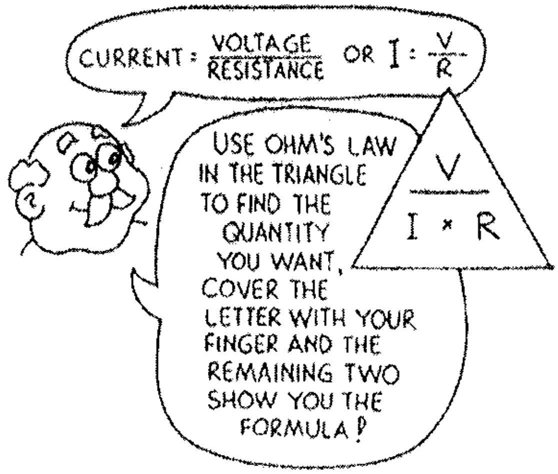
3. *Complete the statements.*

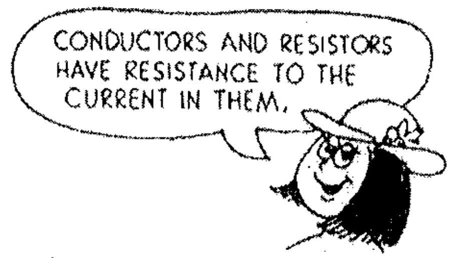


4. If a conductor connected to the terminal of a battery has a potential of 12 volts, then each coulomb of charge on the conductor has a PE of _________ J.

5. Some people get mixed up between force and pressure. Recall that pressure is force *per area*. Similarly, some people get mixed up between electric PE and voltage. According to this chapter, voltage is electric PE *per* ________________.

Chapter 23 Electric Current
Ohm's Law





1. How much current flows in a 1000-ohm resistor when 1.5 volts are impressed across it?

____

2. If the filament resistance in an automobile headlamp is 3 ohms, how many amps does it draw when connected to a 12-volt battery?

____

3. The resistance of the side lights on an automobile are 10 ohms. How much current flows in them when connected to 12 volts?

____

4. What is the current in the 30-ohm heating coil of a coffee maker that operates on a 120-volt circuit?

____

5. During a lie detector test, a voltage of 6 V is impressed across two fingers. When a certain question is asked, the resistance between the fingers drops from 400 000 ohms to 200 000 ohms. What is the current (a) initially through the fingers, and (b) when the resistance between them drops?

(a) ______________________ (b) ______________________

6. How much resistance allows an impressed voltage of 6 V to produce a current of 0.006 A?

____

7. What is the resistance of a clothes iron that draws a current of 12 A at 120 V?

____

8. What is the voltage across a 100-ohm circuit element that draws a current of 1 A?

____

9. What voltage will produce 3 A through a 15-ohm resistor?

____

10. The current in an incandescent lamp is 0.5 A when connected to a 120-V circuit, and 0.2 A when connected to a 10-V source. Does the resistance of the lamp change in these cases? Explain your answer and defend it with numerical values.

____

____

Chapter 23 Electric Current
Electric Power

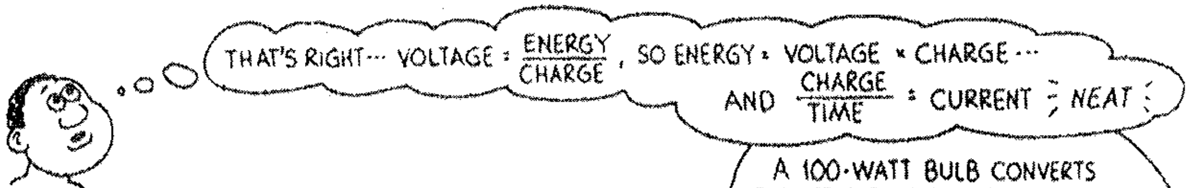
Recall that the rate energy is converted from one form to another is *power.*

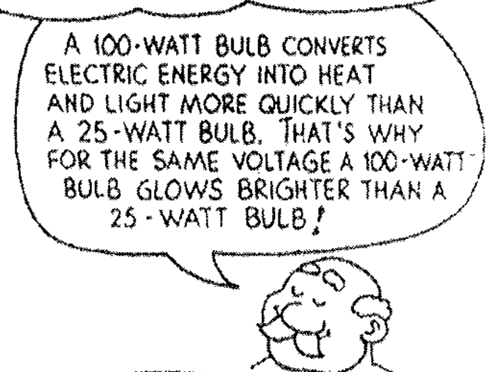
$$\text{power} = \frac{\text{energy converted}}{\text{time}} = \frac{\text{voltage x charge}}{\text{time}} = \text{voltage x } \frac{\text{charge}}{\text{time}} = \text{voltage x current}$$

The unit of power is the *watt* (or *kilowatt*). So in units form,

Electric power (*watts*) = current (*amperes*) x voltage (*volts*),

where 1 *watt = 1 ampere x 1 volt.*



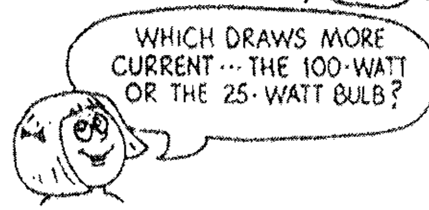


1. What is the power when a voltage of 120 V drives a 2-A current through a device?

____

2. What is the current when a 60-W lamp is connected to 120 V?

____



3. How much current does a 100-W lamp draw when connected to 120 V?

____

4. If part of an electric circuit dissipates energy at 6 W when it draws a current of 3 A, what voltage is impressed across it?

____

5. The equation

$$\text{power} = \frac{\text{energy converted}}{\text{time}}$$

rearranged gives

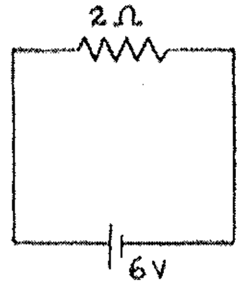
energy converted =

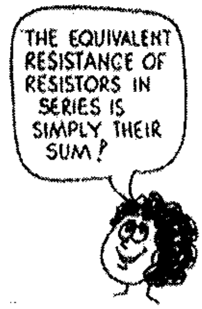
6. Explain the difference between a kilowatt and a kilowatt-hour.

____

7. One deterrent to burglary is to leave your front porch light on all the time. If your fixture contains a 60-W bulb at 120 V, and your local power utility sells energy at 10 cents per kilowatt-hour, how much will it cost to leave the bulb on for the whole month? Show your work on the other side of this page.

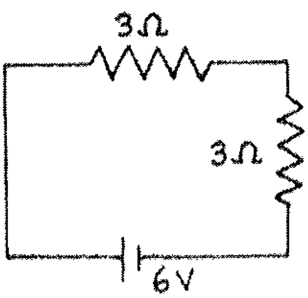
Chapter 23 Electric Current
Series Circuits





1. In the circuit shown at the right, a voltage of 6 V pushes charge through a single resistor of 2 Ω. According to Ohm's law, the current in the resistor (and therefore in the whole circuit) is

   ____________ A.



2. If a second identical lamp is added, as on the left, the 6-V battery must push charge through a total resistance of ______ Ω. The current in the circuit is then ____ A.

3. The equivalent resistance of three 4-Ω resistors in series is ____________ Ω.

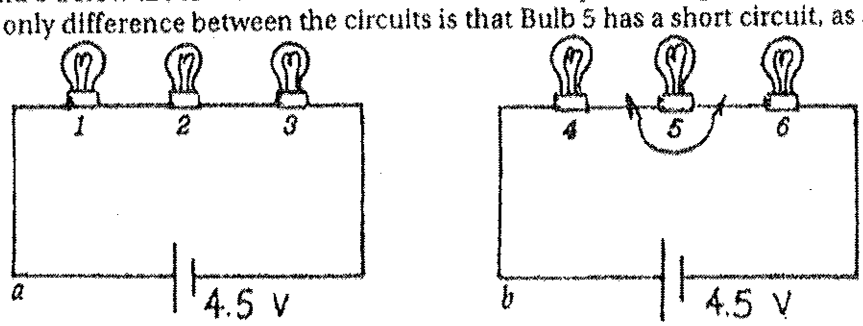
4. Does current flow *through* a resistor, or *across* a resistor? ________________

   Is voltage established *through* a resistor, or *across* a resistor? ________________

5. Does current in the lamps occur simultaneously, or does charge flow first through one lamp, then the other, and finally the last in turn?

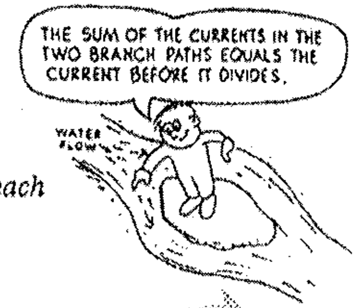
   ____

6. Circuits *a* and *b* below are identical with all bulbs rated at equal wattage (therefore equal resistance). The only difference between the circuits is that Bulb 5 has a short circuit, as shown.

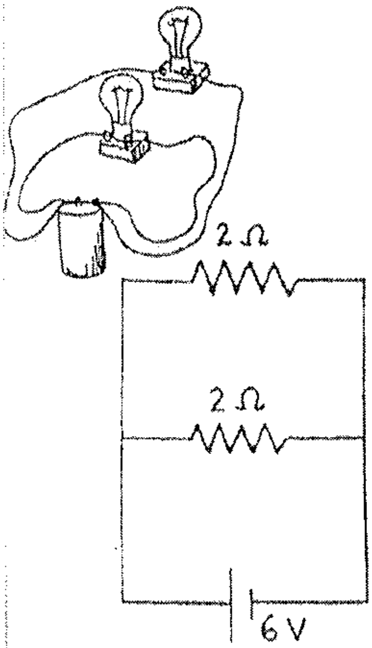


   a. In which circuit is the current greater? ________________
   b. In which circuit are all three bulbs equally bright? ________________
   c. What bulbs are the brightest? ________________
   d. What bulb is the dimmest? ________________
   e. What bulbs have the largest voltage drops across them? ________________
   f. Which circuit dissipates more power? ________________
   g. What circuit produces more light? ________________

Parallel Circuits



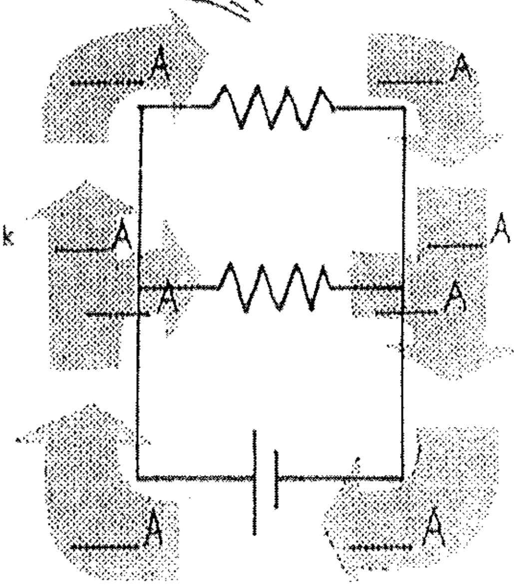
1. In the circuit shown below, there is a voltage drop of 6 V across *each* 2-Ω resistor.



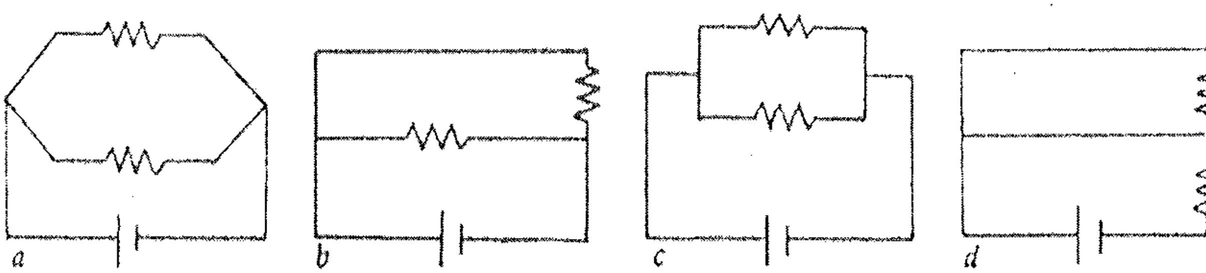
a. By Ohm's law, the current in *each* resistor is ________ A.

b. The current through the battery is the sum of the currents in the resistors, ________ A.

c. Fill in the current in the eight blank spaces in the view of the *same circuit* shown again at the right.



2. Cross out the circuit below that is *not* equivalent to the circuit above.



3. Consider the parallel circuit at the right.

   a. The voltage drop across each resistor is ____________ V.

   b. The current in each branch is:

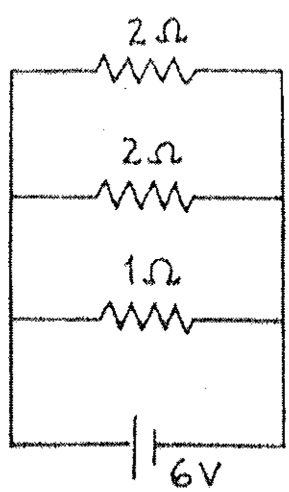
      2-Ω resistor ______ A

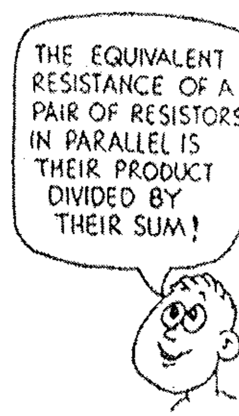
      2-Ω resistor ______ A

      1-Ω resistor ______ A

   b. The current through the battery equals the sum of the currents which equals ______ A.

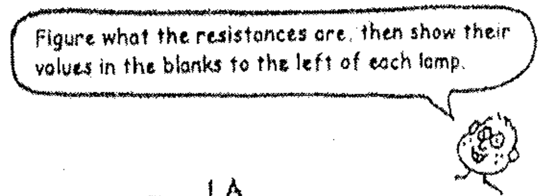
   c. The equivalent resistance of the circuit equals ______ Ω.

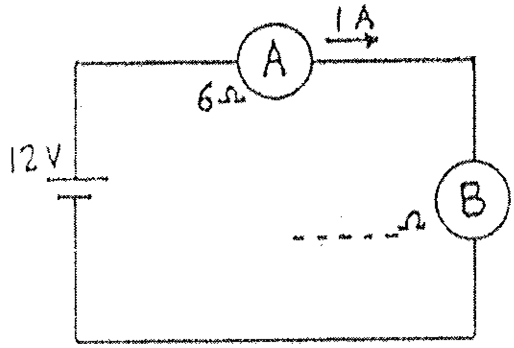




Chapter 23 Electric Current
Circuit Resistance

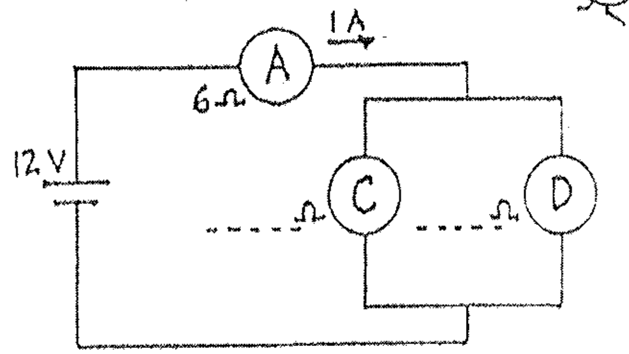
All circuits below have the same lamp A, with resistance of 6 Ω, and the same 12-volt battery with negligible resistance. The unknown resistances of lamps B through L are such that the current in lamp A remains 1 ampere.





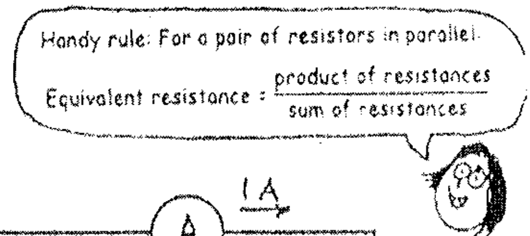
Circuit 1: How much current flows through the battery?

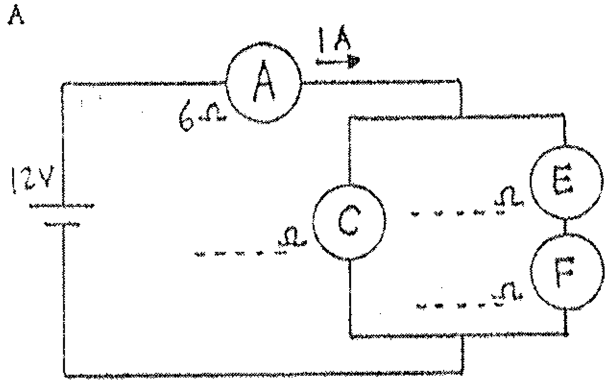
____ A



Circuit 2: Assume lamps C and D are identical. Current through lamp D is

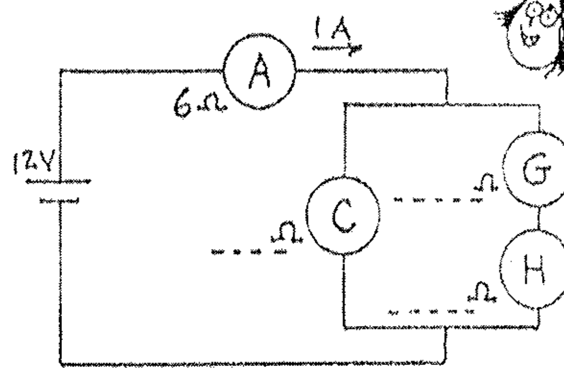
____ A





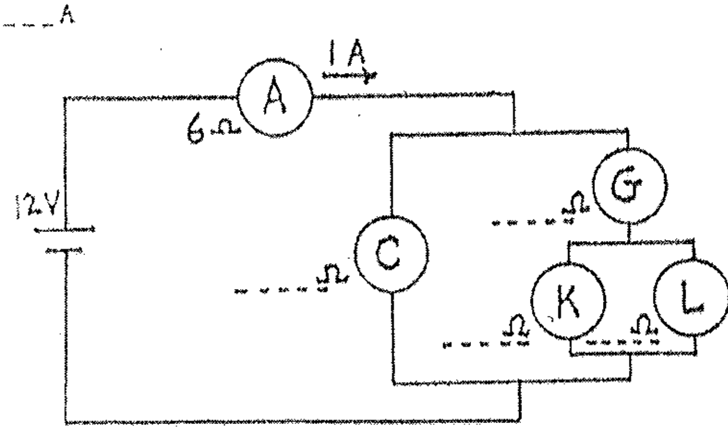
Circuit 3: Here identical lamps E and F replace Lamp D. Current through lamp C is

____ A



Circuit 4: Here lamps G and H replace lamps E and F, and the resistance of lamp G is twice that of lamp H. Current through lamp H is

____ A



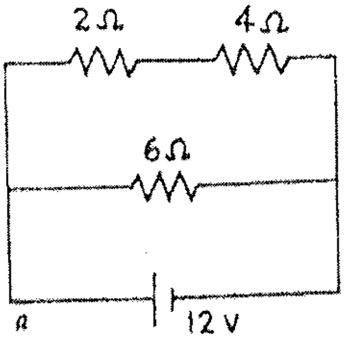
Circuit 5: Identical lamps K and L replace lamp H. Current through lamp L is

____ A

The equivalent resistance of a circuit is the value of a single resistor that will replace all the resistors of the circuit to produce the same load on the battery. How do the equivalent resistances of the circuits 1-5 compare?

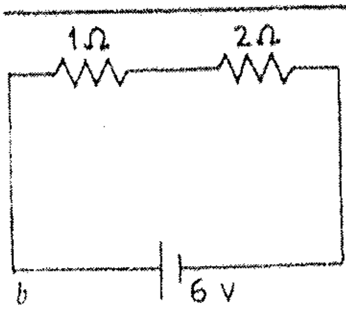
Chapter 23 Electric Current
Electric Power

The table beside circuit *a* below shows the current through each resistor, the voltage across each resistor, and the power dissipated as heat in each resistor. Find the similar correct values for circuits *b*, *c*, and *d*, and put your answers in the tables shown.



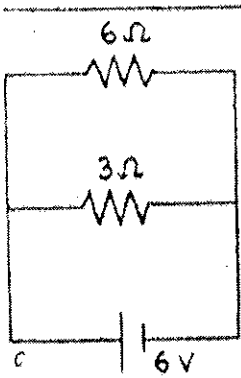
a

RESISTANCE	CURRENT ×	VOLTAGE =	POWER
2 Ω	2 A	4 V	8 W
4 Ω	2 A	8 V	16 W
6 Ω	2 A	12 V	24 W



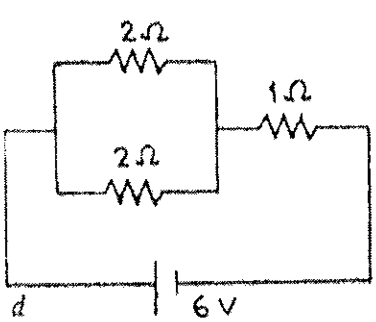
b

RESISTANCE	CURRENT ×	VOLTAGE =	POWER
1 Ω			
2 Ω			



c

RESISTANCE	CURRENT ×	VOLTAGE =	POWER
6 Ω			
3 Ω			



d

RESISTANCE	CURRENT ×	VOLTAGE =	POWER
2 Ω			
2 Ω			
1 Ω			