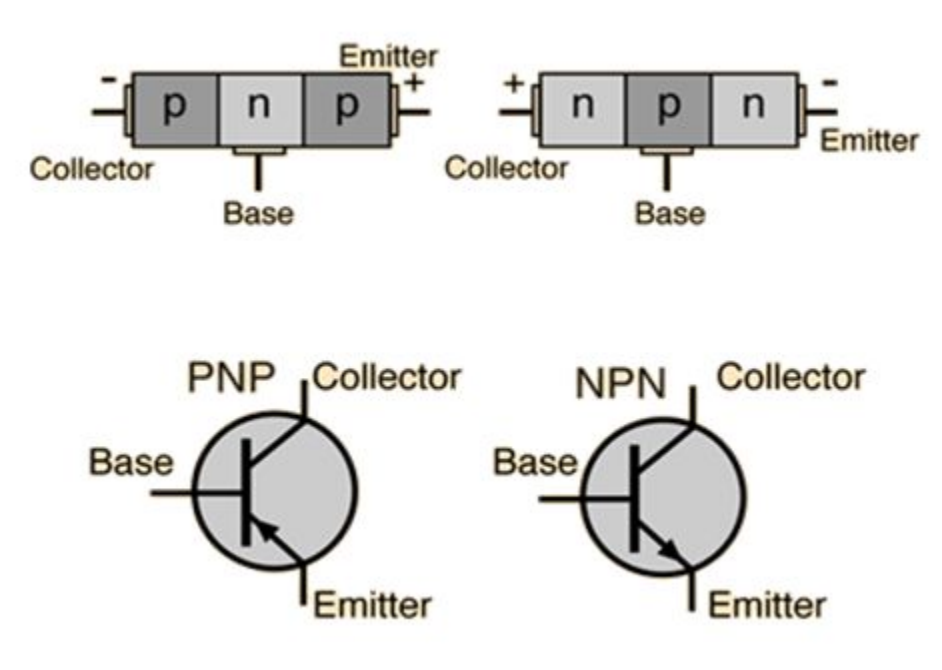
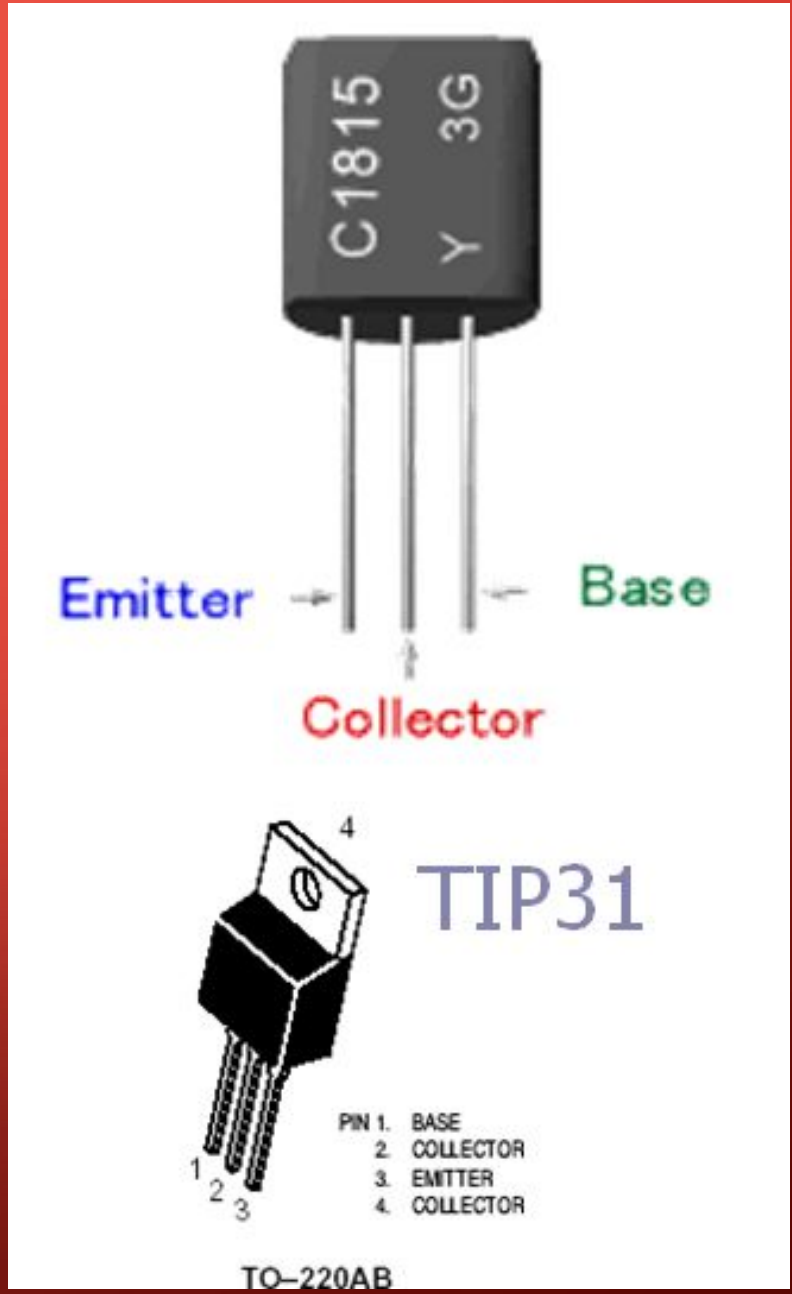
INTRO TO ELECTRONICS Cont'd

Transistors

act as amplifiers or switches



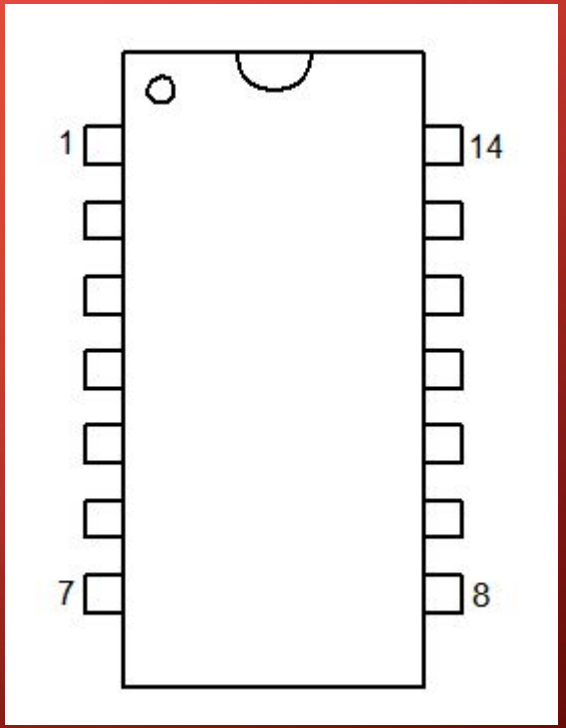


Integrated Circuits (IC)

7400 series typically used for logic gate experiments

Very susceptible to
voltage variations and
static discharge

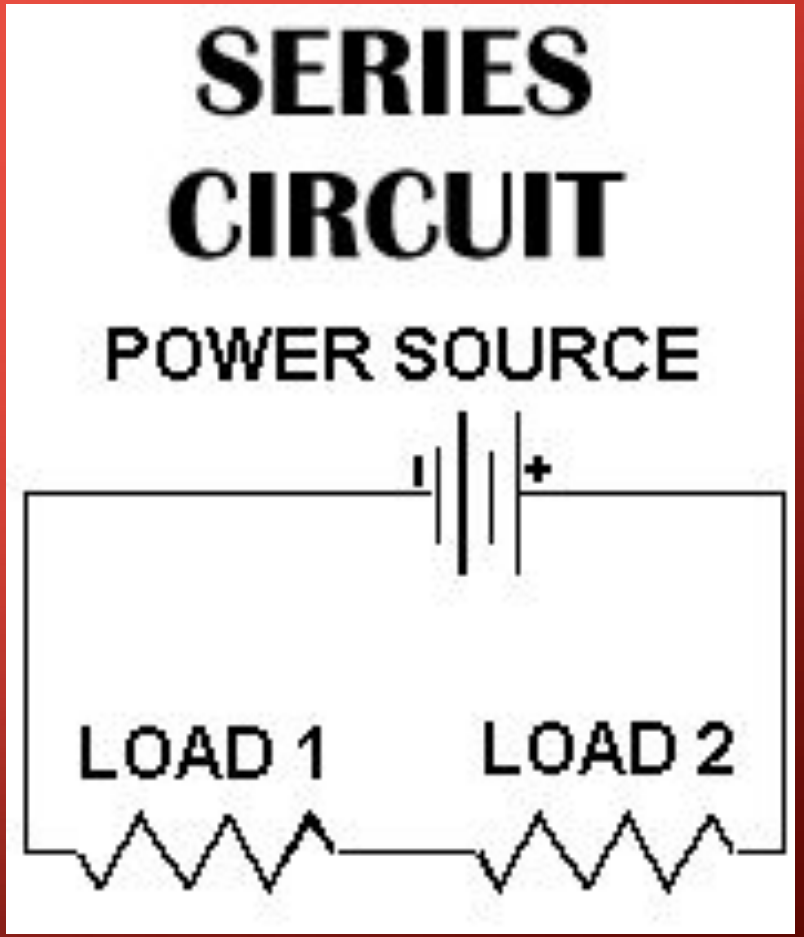
Note pin 1 on diagram



SERIES CIRCUIT

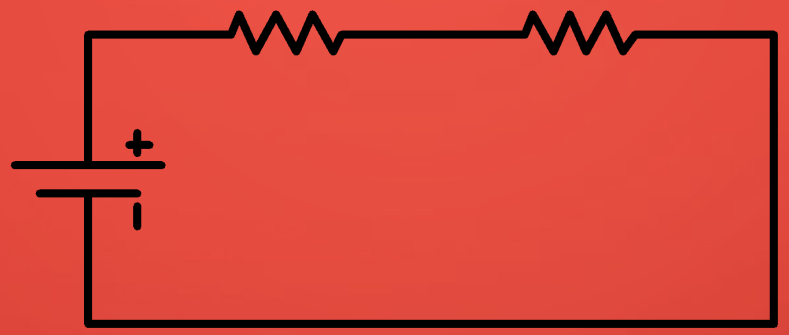
- A series circuit is one with all loads in a row. Like links in a chain. There is only ONE path for the electricity to flow.

- If this circuit was a string of light bulbs, and one blew out, the remaining bulbs would turn off.



SERIES CIRCUITS

One current path, therefore the current is the same everywhere



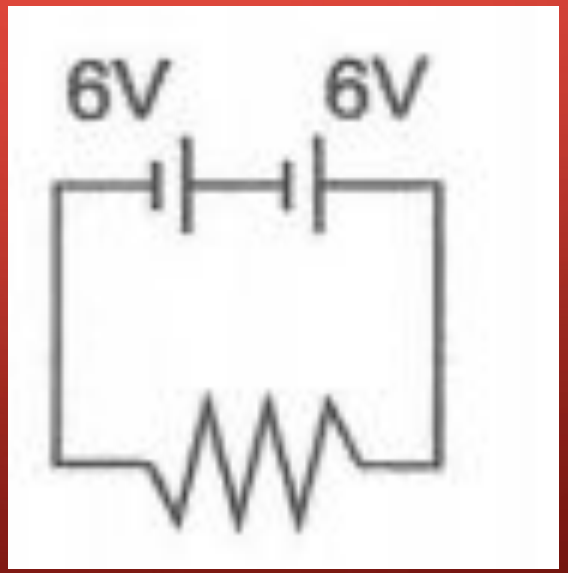
Total resistance is the sum of the individual resistances

$$R_T = R_1 + R_2 + \ldots$$

The supply **voltage is shared** between components in a **series circuit**. The sum of the **voltages** across components in **series** is equal to the **voltage** of the supply.

Batteries in Series

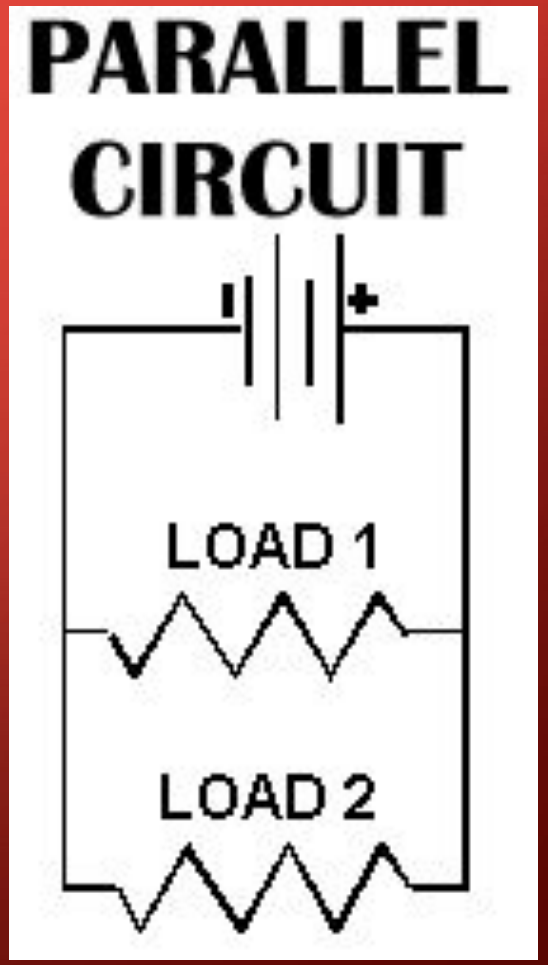
When batteries are wired in series, you simply add up all of the voltages for the total voltage in the circuit. The circuit below would have a total voltage of 12 V.



PARALLEL CIRCUIT

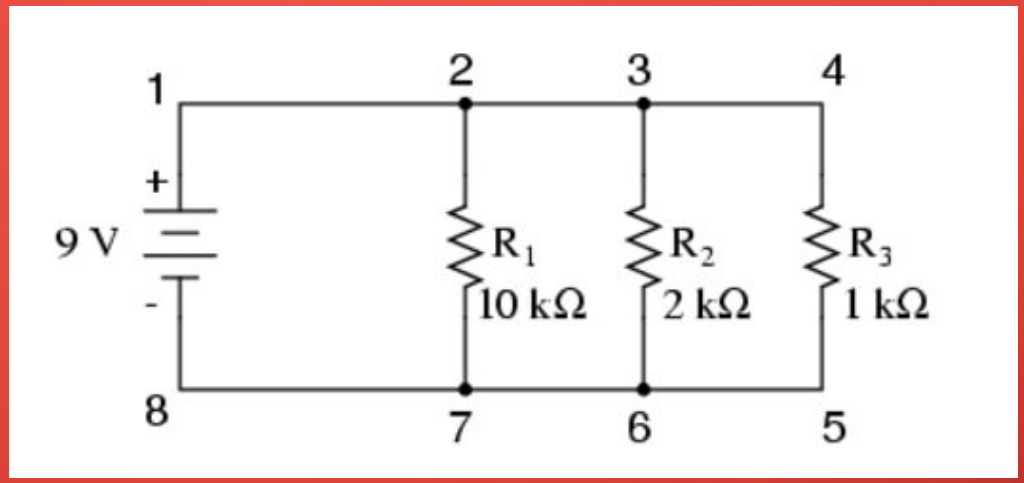
- A parallel circuit is one with two or more paths for the electricity to flow. In other words, the loads are *parallel* to each other.

- If the loads in this circuit were light bulbs and one blew out, there is still current flowing to the others as they are still in a direct path from the negative to positive terminals of the battery.



PARALLEL CIRCUITS

More than one current path for electrons to follow



The sum of the currents between 2 and 7, 3 and 6, and 4 and 5 must equal the total current in the circuit.

Voltage is the same through each path

CALCULATING TOTAL RESISTANCE FOR A PARALLEL CIRCUIT

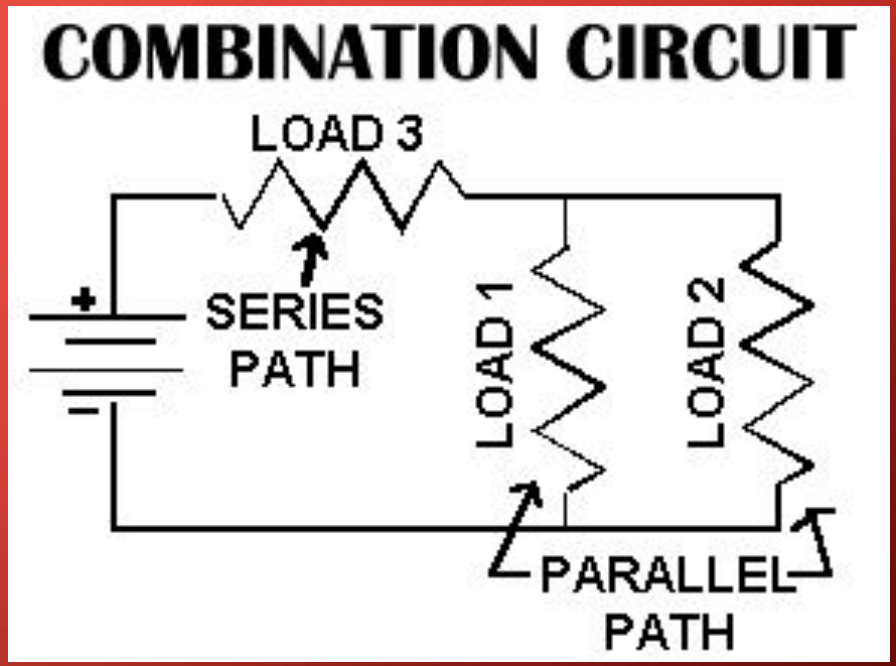
$$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \cdots \frac{1}{R_n}}$$

Example:

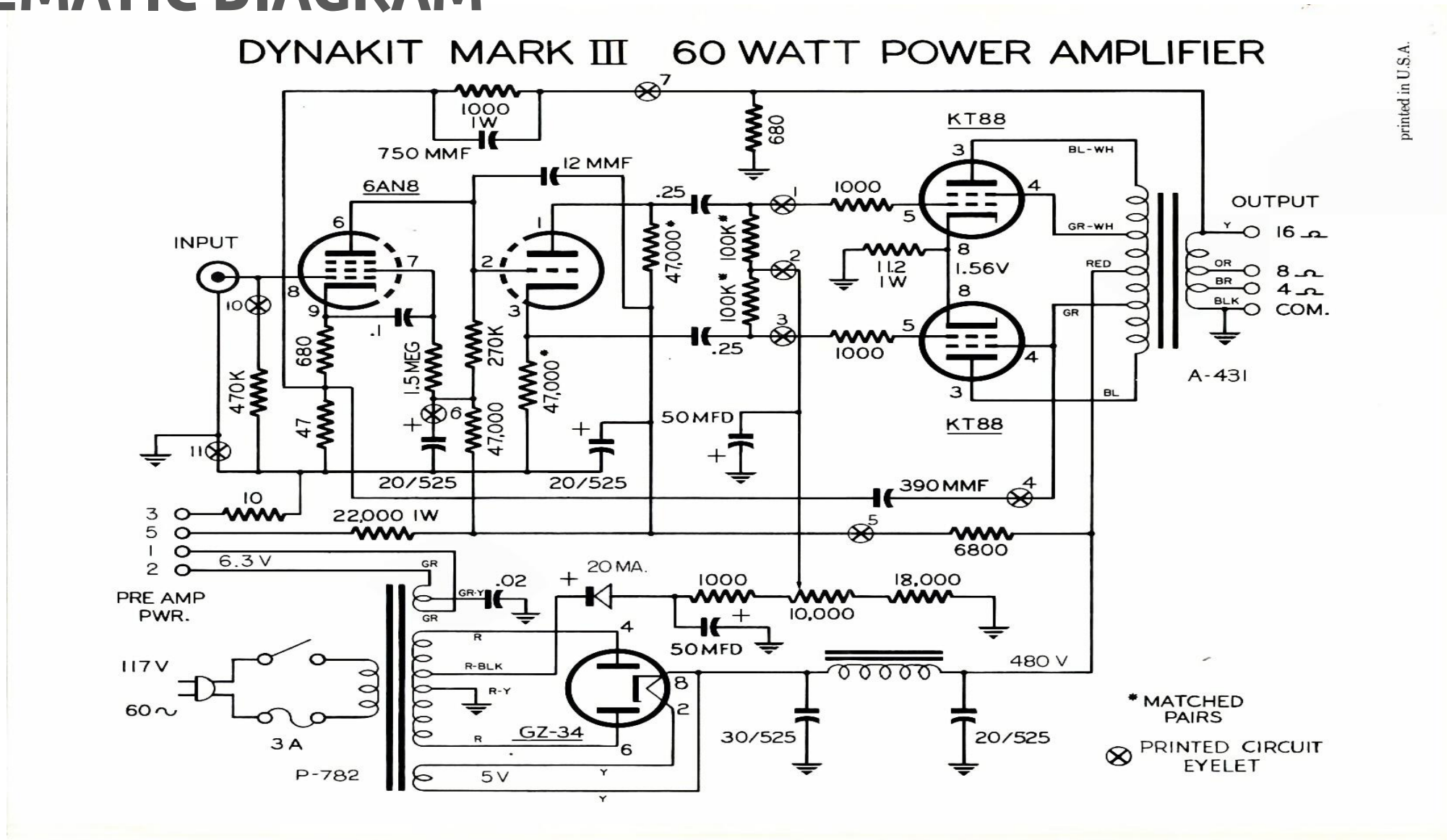
$$\frac{1}{\frac{1}{20\Omega} + \frac{1}{30\Omega} + \frac{1}{30\Omega}} = 8.57\Omega$$

COMBINATION CIRCUIT

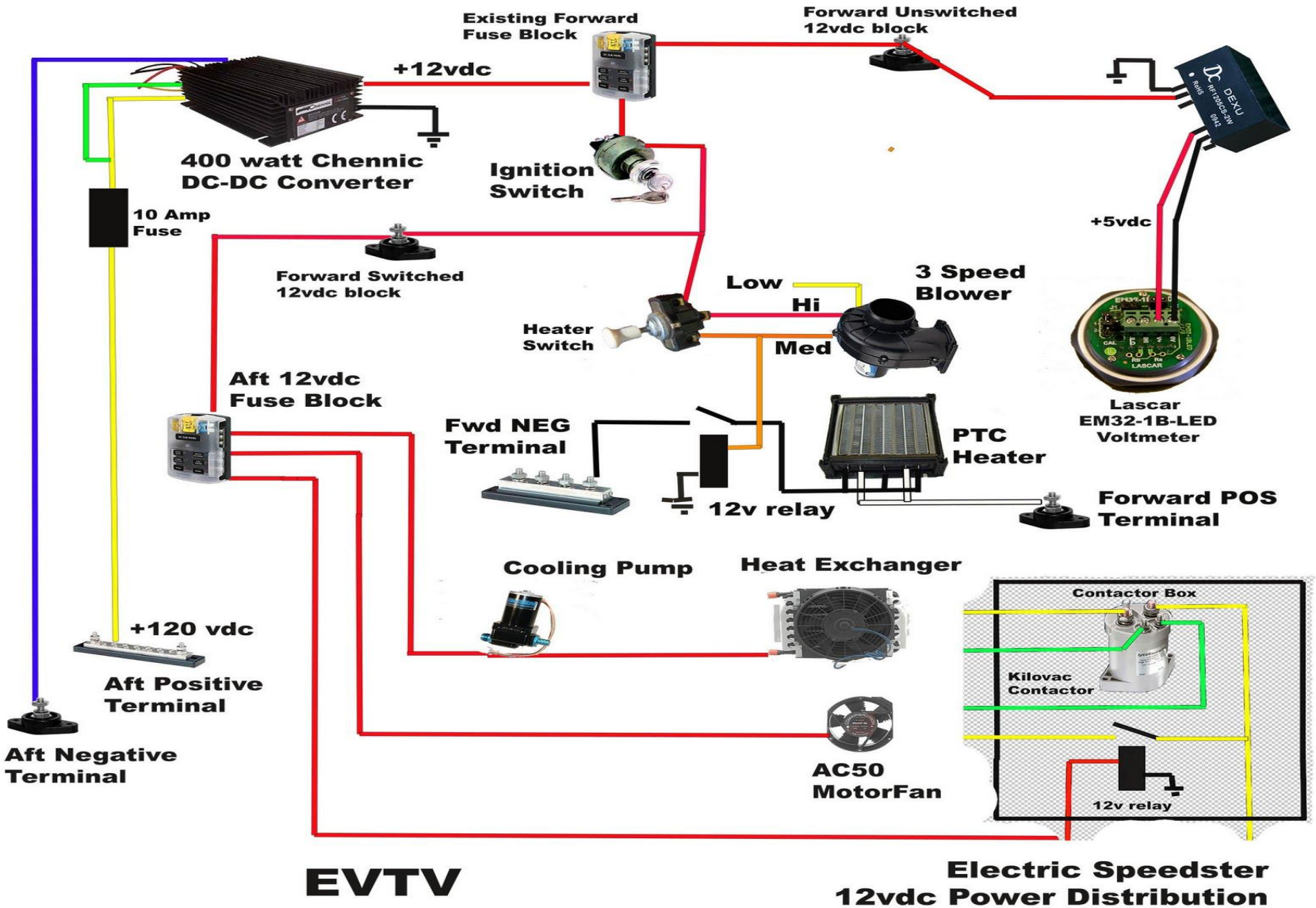
- A combination circuit is one that has a "combination" of series and parallel paths for the electricity to flow. Its properties are a synthesis of the two. In this example, the parallel section of the circuit is like a sub-circuit and actually is part of an overall series circuit.



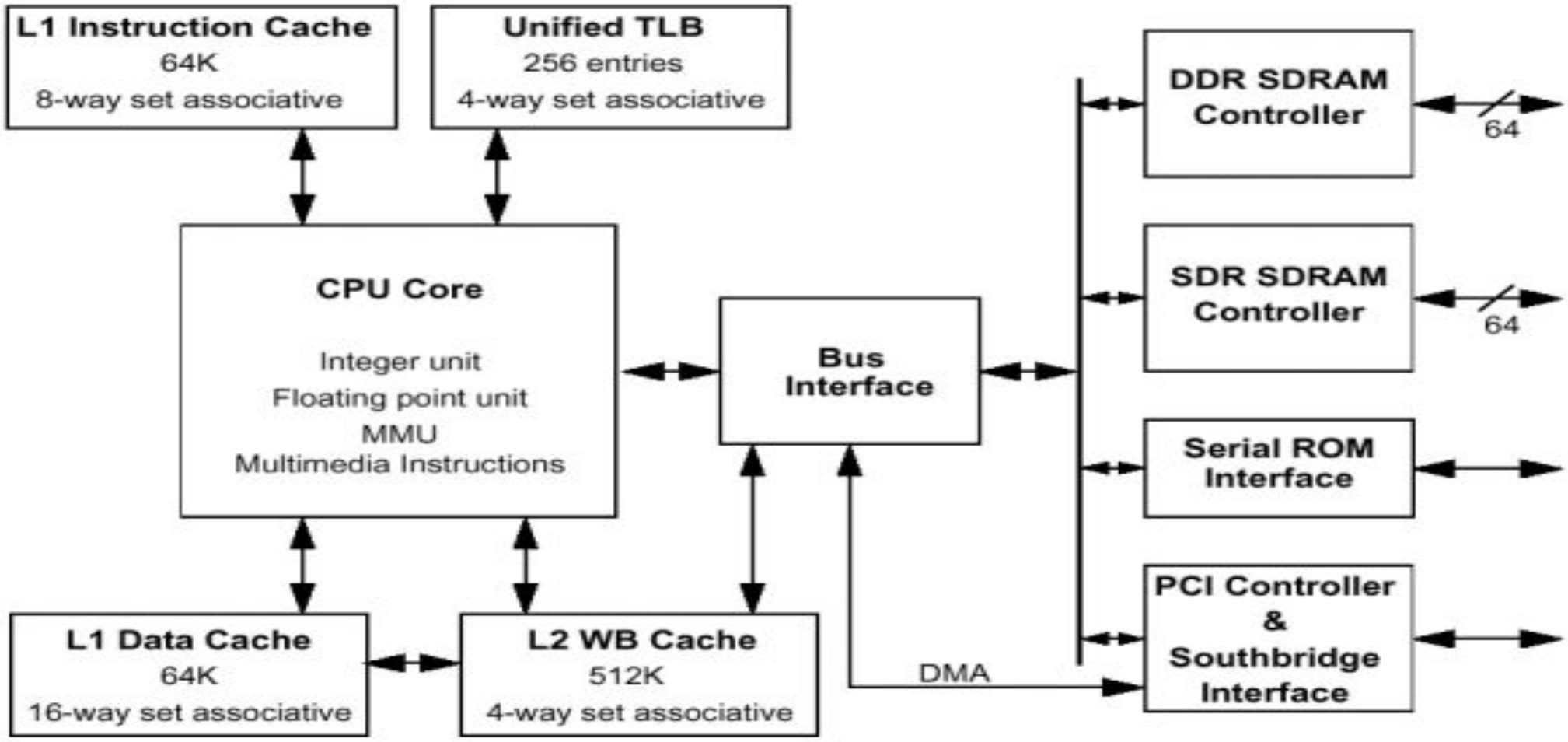
SCHEMATIC DIAGRAM



PICTORIAL DIAGRAM



BLOCK DIAGRAM



OHM'S LAW (Review)

"Current (I) is proportional to Voltage (V) and inversely proportional to Resistance (R)"

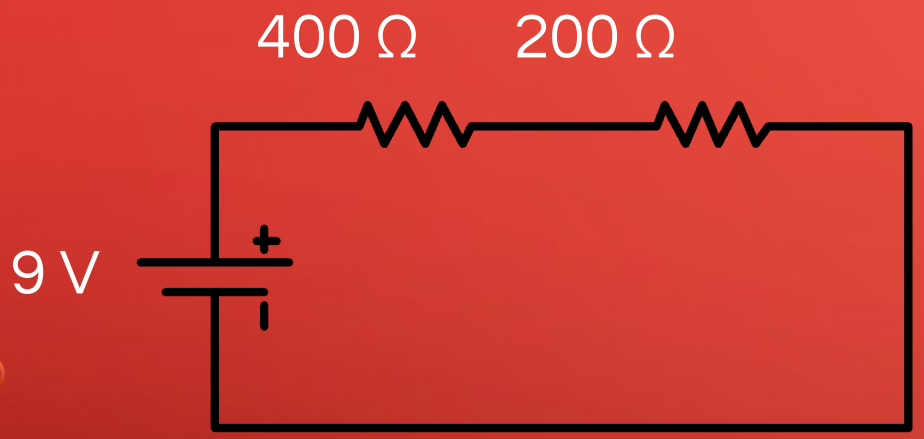
$$I = \frac{V}{R} \qquad V = I \times R \qquad R = \frac{V}{I}$$

QUESTION ON SHEET (#5)

If the battery used is 9V and one resistance is 400 ohms and the second one is 200 ohms, what is the total current in the circuit (in amps)?

ANSWER

If the battery used is 9V and one resistance is 400 ohms and the second one is 200 ohms what is the total current in the circuit (in amps)?



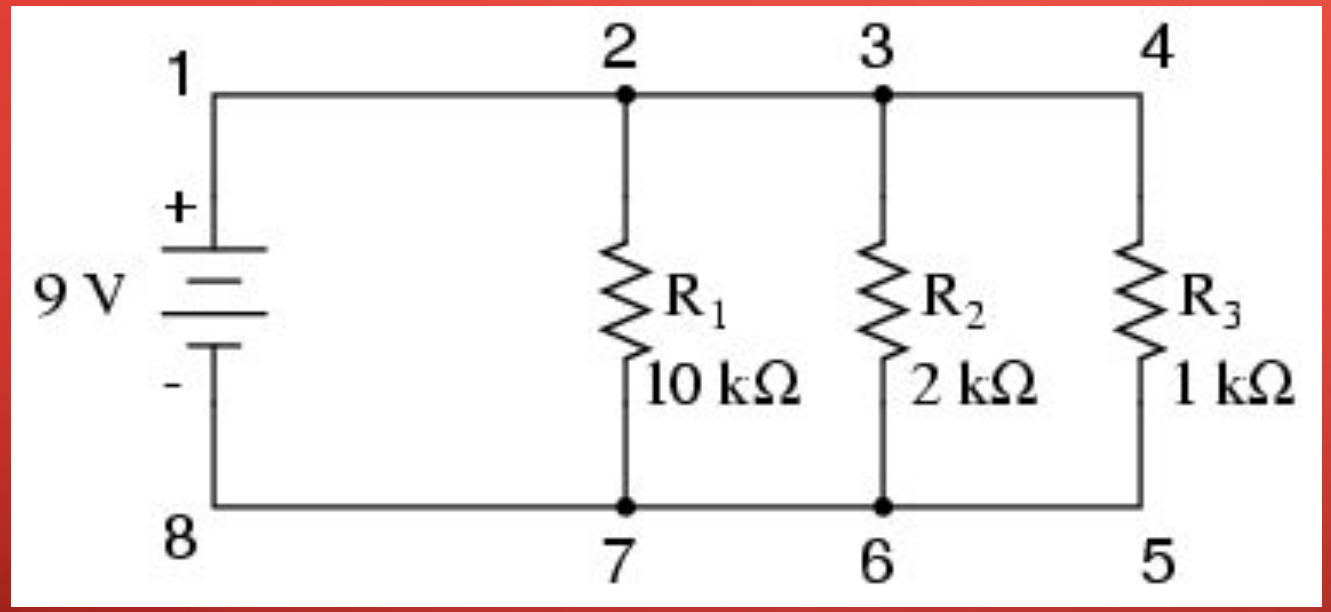
Total Resistance = 400 Ω + 200 Ω
= 600 Ω

Using Ohm's law:
V = I x R
9 = I x 600
9 / 600 = I
I = 9 / 600
I = 0.015 Amps

There are 1000 mA in one amp, so you can re-write this as: I = 15 mA

PARALLEL CIRCUIT QUESTION

What is the total current of the circuit below?

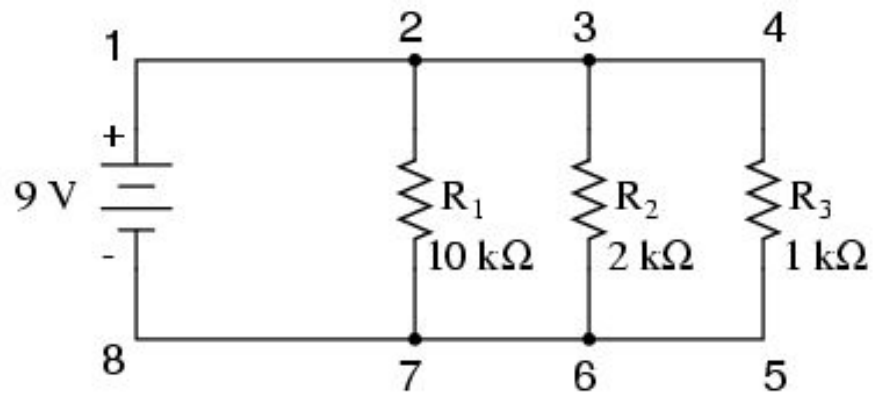


STEPS:

1) Find the total resistance of the circuit

2) Use equation V = I x R to find the current. This value is the total current in the system

ANSWER – PARALLEL CIRCUIT QUESTION



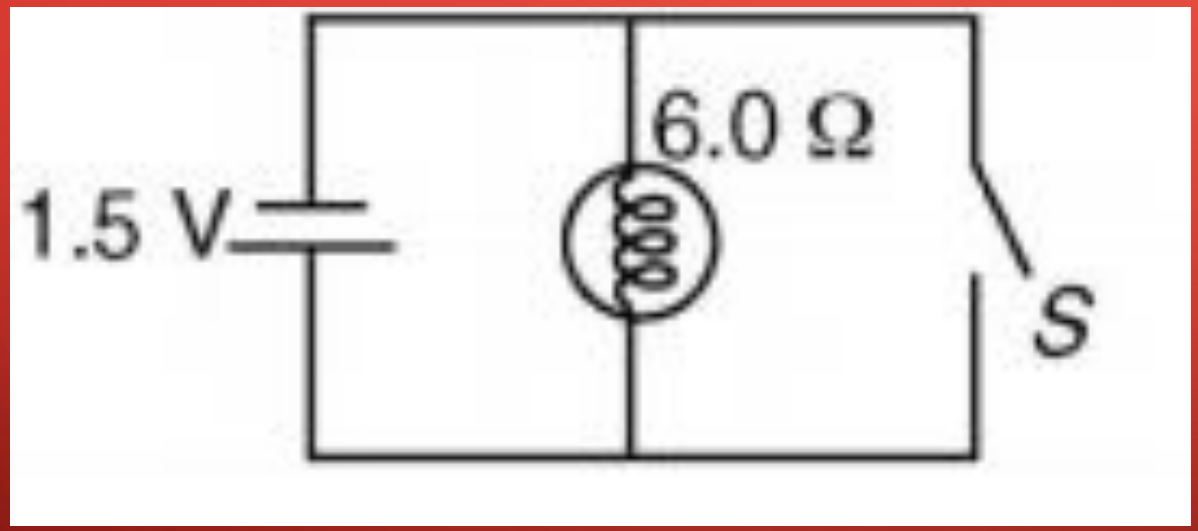
Total Resistance = $\dfrac{1}{(1/10{,}000) + (1/2000) + (1/1000)}$

Total Resistance = 625 Ω

V = I x R
9 = I x 625
I = 9 / 625 → I = 0.0144 Amps → I = 14.4 mA

Short Circuit

Electricity follows the path of least resistance. When it takes a shortcut, it is called a shortcut.



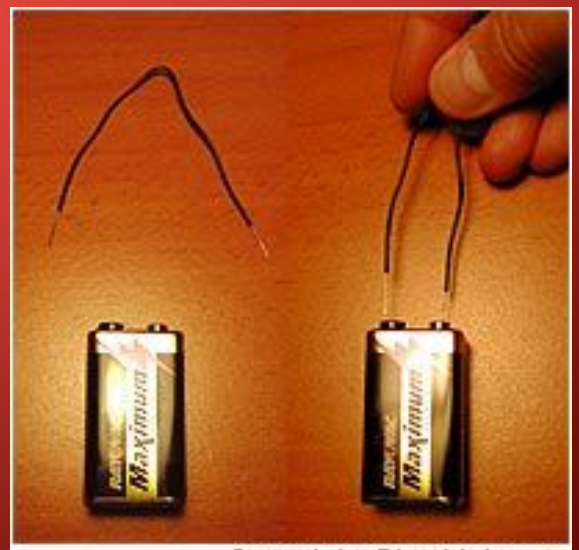


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Image: The simplest example of a 'Short Circuit'. All you need is a battery and a piece of wire. If you do this in dark you may notice faint sparking when you connect + to - of the battery.

LIGHT EMITTING DIODES

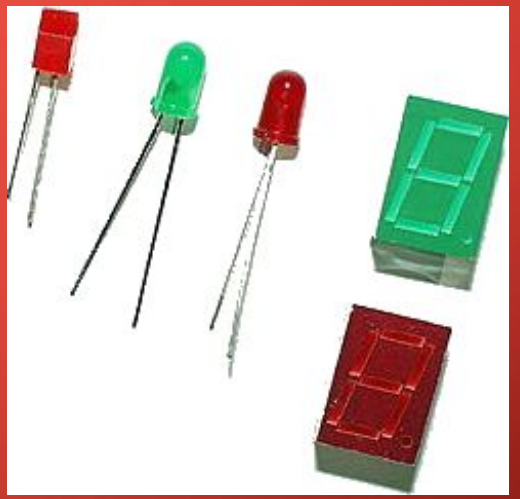
A type of diode designed to emit light

Can be visible or IR

~2 V forward voltage drop

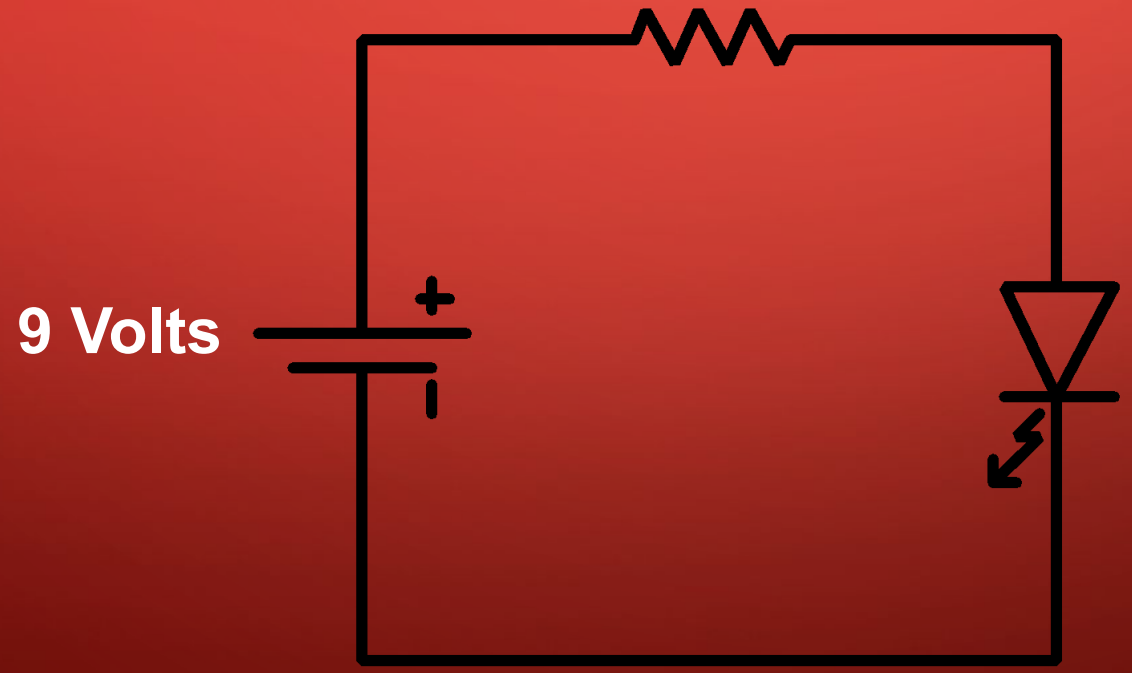
Typically draws 20 mA (0.020 A)

Schematic Symbol…



SIMPLE LED CIRCUIT

You want to protect the LED so you want to keep the current at 20 mA or 0.02 Amps. The LED uses 2 Volts to turn on but you need to protect it from using the remaining 7 volts (the battery is 9 volts). You need to choose a resistor to protect the LED.

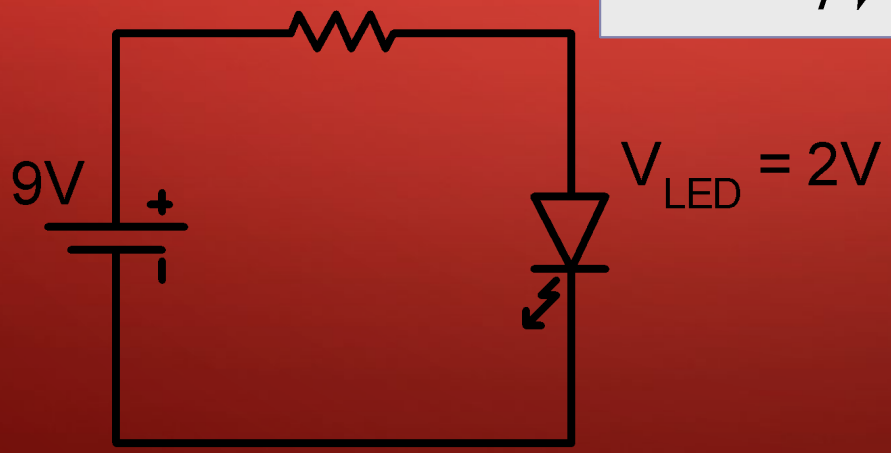


ANALYSING THE CIRCUIT

$$V_T = V_R + V_{LED}$$

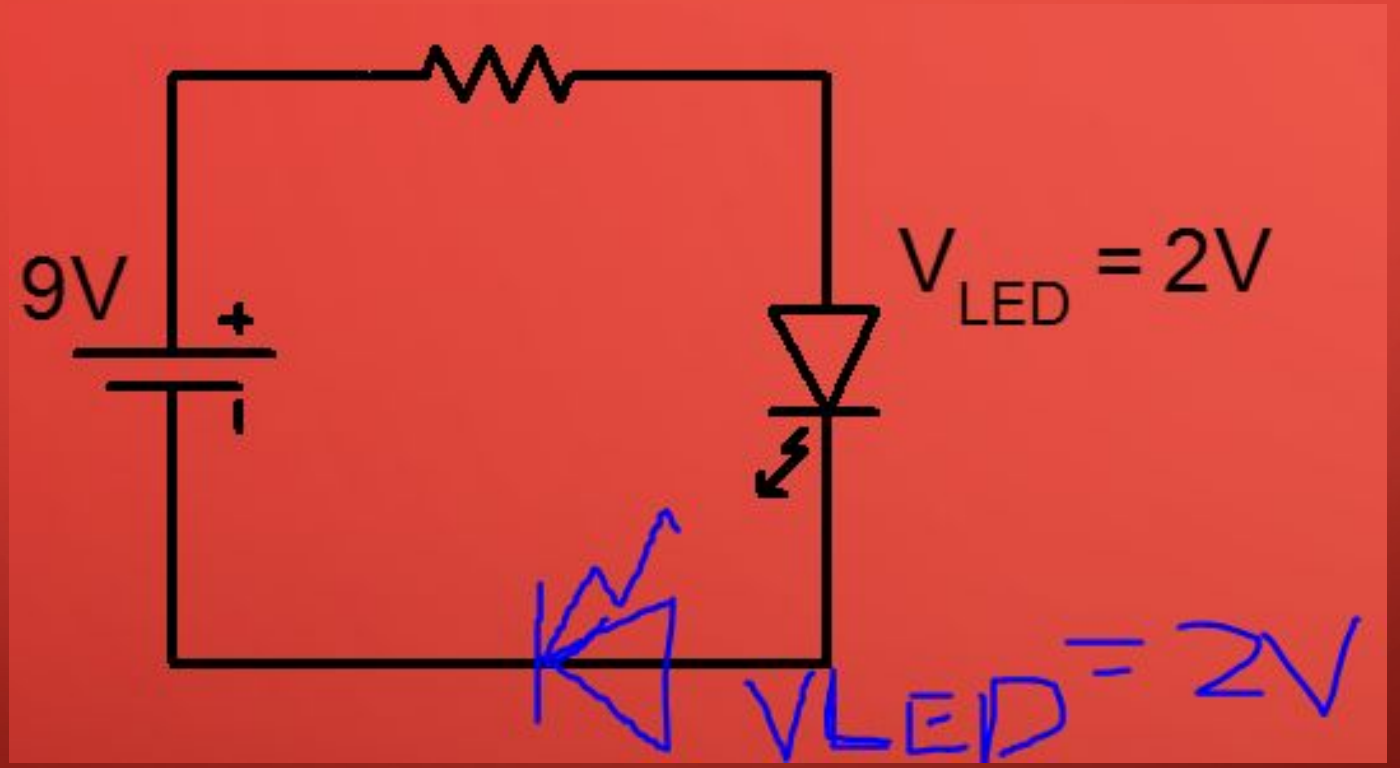
$$I_{LED} = I_R = 20\,mA$$

$$\begin{aligned} V_R &= V_T - V_{LED} \\ &= 9 - 2 \\ &= 7V \end{aligned}$$

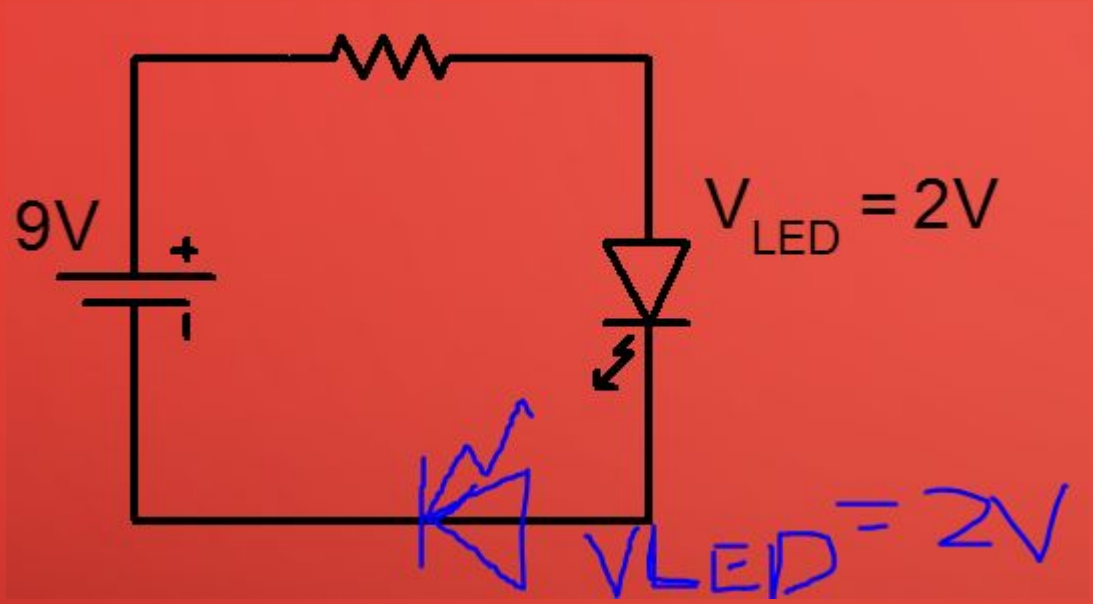


$$\begin{aligned} R &= \frac{V_R}{I_R} \\ &= \frac{7\,V}{0.020\,A} \\ &= 350\,\Omega \end{aligned}$$

CLASS QUESTION – FIND THE RESISTANCE IN THIS CIRCUIT



EXTRA QUESTION – ADDING ANOTHER LED



$$V_T = V_R + V_{LED}$$

1) Voltage is shared amongst all components in a series circuit

So the total voltage used by both LED's is (2V + 2V = 4V)

$$V_T = V_R + V_{LED}$$

2) 9 V = Vr + 4V
So you re-arrange the equation to the rest of the voltage flowing through the circuit:

Vr = 9V – 4V
Vr = 5V

3) So, to calculate the total current, you must do this:

V = I x R
5V = 20mA X R
R = 5V / 20 ma
Convert 20 mA into A, which is 0.02 Amps

4) The resistance should be:
R = V / I
R = 5 / 0.02 = 250 Ω