

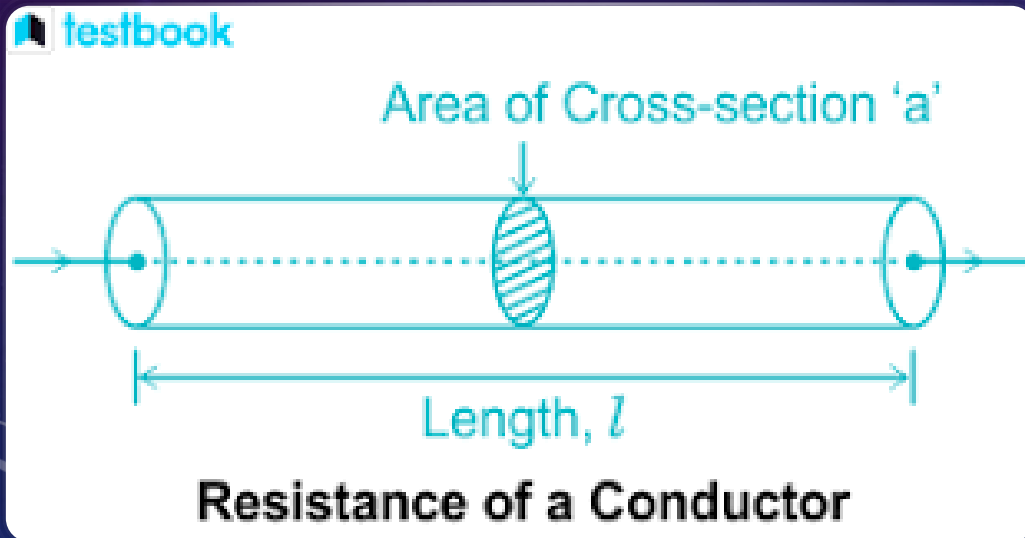
The background features a dark blue gradient with technical diagrams. On the left, a large circular scale with numerical markings from 140 to 260 is visible. Several circular diagrams with arrows and dashed lines are scattered across the page, suggesting electrical or mechanical concepts.

ELECTRICITY LESSON 3: POWER AND EFFICIENCY

BY MR. K

RESISTORS AND OTHER CONDUCTORS... WHAT DETERMINES/AFFECTS THEIR RESISTANCE?

- **The material a conductor is made of** plays a role in its resistance. Some materials are more conductive than others, and the more conductive the material, the less resistant.
- As **temperature** increases, so does resistance in conductors. The warmer the conductor, the more resistant
- The size of a conductor can also play a role
 - **Length** and resistance are directly correlated. As length doubles, so does resistance
 - **Cross sectional area** and resistance are inversely correlated. As cross sectional area is doubled, resistance is halved.



REMEMBER, WHATEVER YOU DO TO THE LENGTH,
YOU DO TO THE RESISTANCE, AND WHATEVER YOU
DO TO THE DIAMETER OR RADIUS, YOU DO THE
OPPOSITE SQUARED TO THE RESISTANCE

SO, IF YOU DOUBLE THE LENGTH, YOU DOUBLE THE RESISTANCE, IF YOU CUT THE LENGTH
IN HALF, YOU CUT THE RESISTANCE IN HALF

IF YOU DOUBLE THE DIAMETER (MULTIPLY IT BY 2), YOU DIVIDE THE RESISTANCE BY 2^2 . IF
YOU HALF THE DIAMETER (DIVIDE IT BY 2), THEN YOU MULTIPLY THE RESISTANCE BY 2^2

EXAMPLES

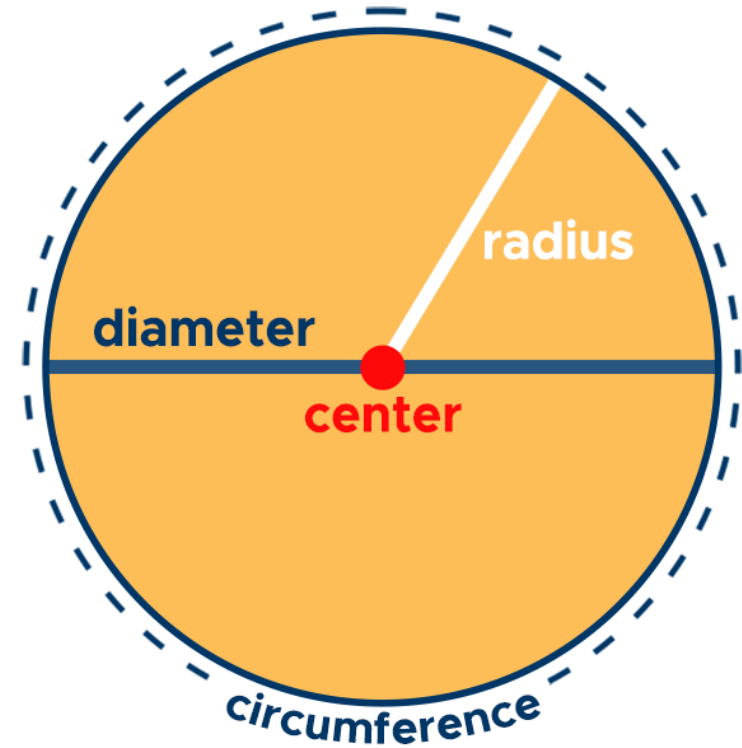
• If a resistor of $10\ \Omega$ becomes 5 times longer, what is its new resistance?

- $50\ \Omega$

• If a $20\ \Omega$ resistor's diameter is doubled, what is its new resistance?

- $5\ \Omega$

Area of a Circle



$$A = \pi r^2$$

POWER

- Power, P , is the measure of energy used over a period of time, or, electrical energy converted to other forms of energy per second
- The formula for power is $P = E/t$, and the unit for power is a watt (W). It is equal to a joule (J) per second
- When looking at circuits, its rare that we look at energy and time. We commonly observe circuits with respect to current, resistance, and voltage
- This is where algebra really comes in handy...

TIME TO DERIVE

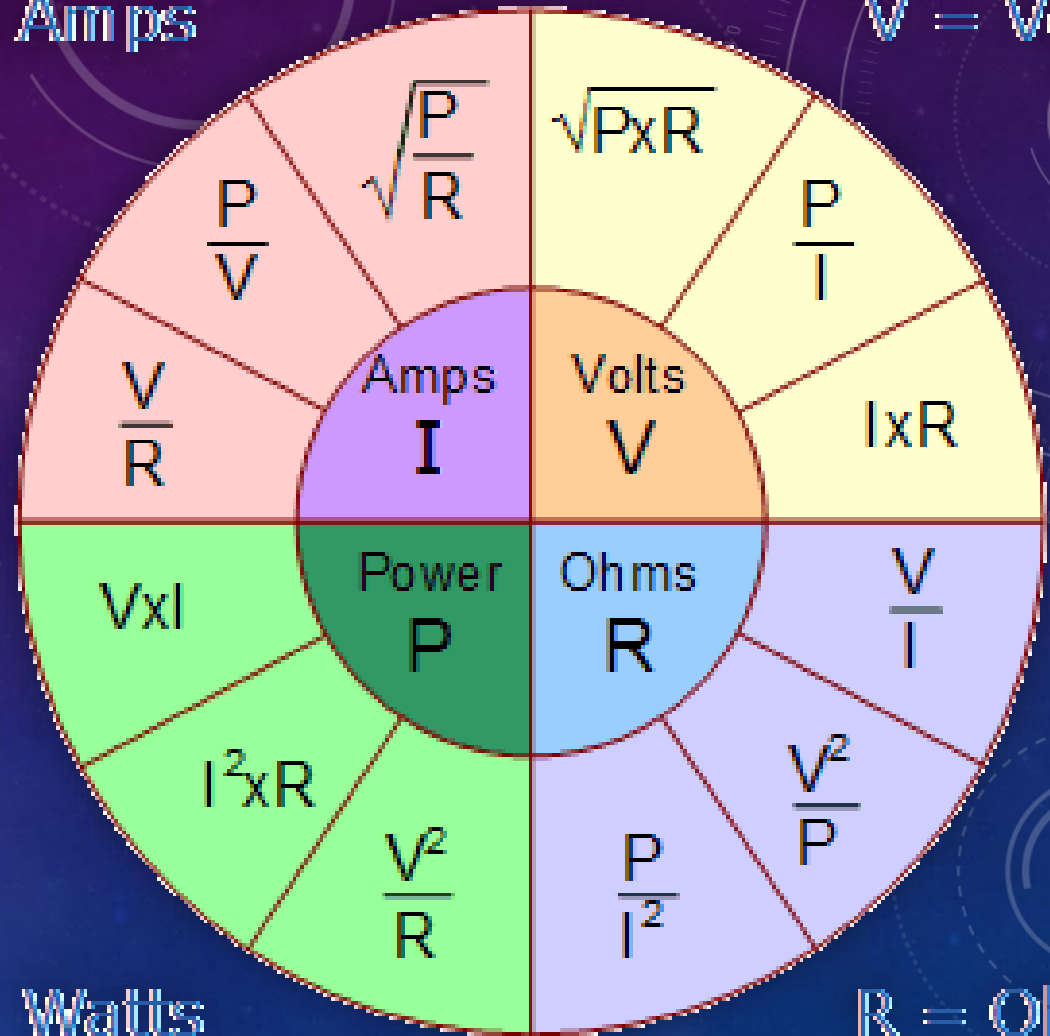
- 2 common values that we use to observe circuits are current (I) and potential difference (V), so lets try to substitute and rearrange the formula for power so that we have more usable variables I & V
- In $P=E/t$, we can choose either E or t to start replacing. Remember $V=E/Q$, therefore $E=VQ$
- Now we have $P=VQ/t$
- If you remember we had a formula for current: $I=Q/t$, therefore...
- $P=VI$

WAYS TO CALCULATE POWER WITH COMMON VALUES

If I asked you to calculate power in a test I would provide the green corner of this circle

I = Amps

V = Volts



P = Watts

R = Ohms

EXAMPLES:

#1) A voltage of 9V is hooked up to a resistor that has a current of 2A flowing through it. What is the power rating of the resistor?

#2) A resistor with a power rating of 100W receives 20V of electricity. What is the resistance of the resistor?

#3) A resistor with resistance 9Ω experiences a current of 2A. What is the power rating of the resistor?

PERCENT EFFICIENCY

- Not all resistors are 100% efficient, not all use the entirety of the energy they are supplied with
- Most devices come with a power rating. A power rating is how many watts of power are required to run the device. This power rating can be used to find how much energy the device needs to run
- The percent efficiency of a resistor (%Eff) is the useful energy output (how much energy the resistor uses), divided by total energy input from the power source, then multiplied by 100%

$$\%Eff = (\text{Useful E} / \text{Total E}) * 100\%$$

EXAMPLE

A stereo has a given power rating of 15W, and it is used to play August by Taylor Swift (a song that's roughly 5 minutes long). 3000J are used to make sound. What is the percent efficiency?

Given: $P = 15\text{W}$ / $t = 5\text{min} = 300\text{sec}$ / Useful $E = 3000\text{J}$

1st, use $P=E/t$ to find the total energy input

$$- E = P * t = 15\text{W} * 300\text{sec} = 4500\text{J}$$

Then, calculate %Eff

$$- \% \text{Eff} = \text{Useful } E / \text{Total } E * 100\% = 3000\text{J} / 4500\text{J} * 100\% = 67\%$$

$t = 30\text{minutes}$

There are 60 seconds in a minute... $30\text{min} \times 60 = 1800\text{sec}$

$P = 50\text{W}$

$E_{\text{used}} = 60000\text{J}$ (or 60kJ)

$P = E/t \mid E_{\text{input}} = P \times t = 50\text{W} \times 1800\text{sec} = 90000\text{J}$ (90kJ)

$\%Eff = E_{\text{used}}/E_{\text{input}} \times 100\% = 60\text{kJ}/90\text{kJ} \times 100\% = 67\%$

I TURN ON MY TV TO WATCH AN EPISODE OF HEARTSTOPPER. EACH EPISODE IS ROUGHLY 30 MINUTES LONG, AND MY TV HAS A POWER RATING OF 50W. THE TV PRODUCES 60000J (60KJ) OF LIGHT ENERGY. WHAT IS THE PERCENT EFFICIENCY OF MY TV?

SEE YOU NEXT CLASS!

The background is a dark blue gradient with a field of small white stars. On the right side, there are several technical diagrams. A large circular gauge with a scale from 0 to 210 is visible, with a white arrow pointing to approximately 180. Below it is a smaller circular diagram with a dashed outer ring and a solid inner ring, with an arrow pointing clockwise. In the bottom left corner, there is another circular diagram with a dashed arrow pointing counter-clockwise. The overall aesthetic is clean and technical.

REFERENCES

- https://www.google.com/imgres?q=size%20of%20conductor%20effect%20on%20resistance&imgurl=https%3A%2F%2Fblogmedia.testbook.com%2Fblog%2Fwp-content%2Fuploads%2F2023%2F01%2Fresistance-of-a-conductor-87e316ca.png&imgrefurl=https%3A%2F%2Ftestbook.com%2Felectrical-engineering%2Ffactors-affecting-resistance&docid=buRsZb3143tdDM&tbnid=1VyhPceAGByq_M&vet=12ahUKEwiYuvmY-d6QAxXf5skDHRtbOKgQM3oECCMQAA..i&w=334&h=174&hcb=2&ved=2ahUKEwiYuvmY-d6QAxXf5skDHRtbOKgQM3oECCMQAA
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