8TH GRADE MATHEMATICS:

AIM: USING OHM’S LAW TO SOLVE MATH PROBLEMS

HOME WORK: HANDOUT BY MR. AKOMAH

ENCHEANCING STUDENTS SKILLS IN INVERSE OPERATION USING OHMS LAW

Learning Objectives: Students will...

1. Become aware of Ohm's Law, the relationship between current, voltage, and resistance in a series circuit.
2. To solve selected problems using Ohm's Law & Inverse operation and other math concepts.
3. To study Ohm's law and its application in simple series circuits; to determine current voltage and resistance

CONGITIVE DEMANDS ON THE LESSON

LEVEL I: MATHEMATICAL SKILL

LEVEL II: CONCEPTUAL UNDERSTANDING

LEVEL III: PROBLEM SOLVING

PREPARED

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FOR:
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MOTIVATION: HAVE A STUDENT READ THE FOLLOWING:
Ohm’s Law shows the relationship between ohms, volts and amps. This lesson will help us comprehend the daily use electricity in our homes.

LESSON INTRODUCTION: HOW THIS MATH CONNECTS:
TEACHER: Explain to students the daily use of mathematics in all aspects of our lives. Draw the schematics of a circuit and explain to students how Electricians use the formulas to install the correct gauge of wire to carry the load.

Materials needed per student:
- Pencil
- Calculator with √ key & memory +/- functions
- Electricity and Ohm’s Law Worksheets
- Electricity and Ohm’s Law Example Problem handout
- Formulas, Equations, and Laws handout and two Ohm’s Law handouts

NOTE: Ohm’s Law states that in a simple electrical circuit, the voltage equals the electrical current times the resistance.

\[ V = IR \]

where:
- \( V \) is the voltage in volts
- \( I \) is the current in amperes or amps
- \( R \) is the resistance in ohms

**Vocabulary:** CURRENT, VOLTAGE, RESISTANCE

Current: Indicates the amount of electrons passing through the wire and is measured in amperes or amps for short. \{I\} is the unit symbol for Amps.

EXPLANATION: Current is what flows in a wire or conductor like water flowing down a pipe.

VOLTAGE: The force that drives electrical charges through a circuit is measured in volts. \( V = IR \)

RESISTANCE: Determines how much current will flow through a component. Resistors are used to control. \( R = \frac{V}{I} \)

Teacher used training aids:
- 9 volt battery
- 18” lengths of insulated wire with clips
Problem #1:  GIVE STUDENTS TIME TO ANALYZE THE PROBLEM  (LEVEL III)
A 110 volt wall outlet supplies power to a strobe light with a resistance of 20 ohms. How much current is flowing through the strobe light?

SOLUTION:

\[ V = 110 \text{ VOLTS} \quad R = 20 \text{ OHMS} \quad I = ? \]

\[ V = IR \]

REPLACE VARIABLE WITH VALUES

\[ 110 \text{ VOLTS} = I (20) \]

DIVIDE BOTH SIDES BY 20

\[ \frac{110 \text{ VOLTS}}{20} = I(20) \]

ANSWER:  \[ I = 5.5 \text{ Amp.} \]

Problem #2
A CD player with a resistance of 50 ohms has a current of 0.2 amps flowing through it. Sketch the circuit diagram and calculate how many volts supply the CD player.

SOLUTION:

\[ V = ? \quad R = 50 \text{ ohms} \quad I = 0.2 \]

\[ V = IR \]

\[ V = 50 (0.2) \]

ANSWER:  \[ V = 10 \text{ Volt.} \]

Problem #3
A 120-volt power source supplies a lamp with a resistance of 200 ohms. What is the current flow of the circuit?

\[ V = 120 \text{ VOLTS} \quad R = 20 \text{ OHMS} \quad I = ? \]

\[ V = IR \]

REPLACE VARIABLE WITH VALUES

\[ 120 \text{ VOLTS} = I (200) \]

DIVIDE BOTH SIDES BY 20

\[ \frac{120 \text{ VOLTS}}{200} = I(200) \]

ANSWER:  \[ I = 0.6 \text{ Amp} \]

Problem #4
A source has a current of 0.2 Amperes and a resistance \( R = 1000 \text{ ohms} \), Find the Voltage.

Solution:

\[ V = IR \]

REPLACE VARIABLE WITH VALUES

\[ V = 0.2A (1000 \Omega) = 200 \text{V} \]

\[ V = 200 \text{V} \]
ANOTHER LESSON COMPONENT: DRAW ON BOARD AND EXPLAIN:
EXPLAIN TO STUDENTS: Most homes are wired in Series or Parallel Circuit

Resistances in Series
When resistances $R_1$, $R_2$, $R_3$, ... are connected in series, the total resistance $R_S$ is:

$$R_S = R_1 + R_2 + R_3 + ... R_S$$

Resistances in Parallel
When resistances $R_1$, $R_2$, $R_3$, ... are connected in parallel, the total resistance $R_P$ is:

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ... \frac{1}{R_N}$$
**EXAMPLE:** Find the total resistance, current, & voltage across each resistor.

\[ \begin{align*}
1 & \quad R_1 = 3 \, \text{k}\Omega \\
2 & \quad R_2 = 10 \, \text{k}\Omega \\
3 & \quad R_3 = 5 \, \text{k}\Omega \\
4 & \quad \text{Battery} = 9 \, \text{V}
\end{align*} \]

**Solution:**

\[ \begin{align*}
R_s &= R_1 + R_2 + R_3 + \ldots R_s \\
R_s &= 3 + 10 + 5 + \\
R_s &= 18 \, \text{Ohms}
\end{align*} \]

\[ \begin{align*}
I_{\text{TOTAL}} &= \frac{E_{\text{TOTAL}}}{R_{\text{TOTAL}}} = \frac{9\, \text{V}}{18} \\
I_{\text{TOTAL}} &= \frac{9\, \text{V}}{18\, \text{K}\Omega} = 500\, \mu\text{A}
\end{align*} \]

\[ \begin{align*}
E_{R1} &= I(R1) = 500\, \mu\text{A} (3\, \text{K}\Omega) \\
E_{R2} &= I(R2) = 500\, \mu\text{A} (10\, \text{K}\Omega) \\
E_{R3} &= I(R3) = 500\, \mu\text{A} (5\, \text{K}\Omega)
\end{align*} \]

**FIND THE TOTAL RESISTOR, TOTAL CURRENT, EACH CURRENT, AND EACH VOLTAGE ACROSS EACH RESISTOR:**

\[ \begin{align*}
\Delta V_{\text{tot}} &= 60 \, \text{V} \\
R_1 &= 17 \, \Omega \\
R_2 &= 12 \, \Omega \\
R_3 &= 11 \, \Omega
\end{align*} \]

\[ I_{\text{battery}} = I_1 = I_2 = I_3 = 1.5 \, \text{amp} \]

\[ \begin{align*}
\Delta V_1 &= I_1 \cdot R_1 = (1.5 \, \text{A}) \cdot (17 \, \Omega) = 25.5 \, \text{V} \\
\Delta V_2 &= I_2 \cdot R_2 = (1.5 \, \text{A}) \cdot (12 \, \Omega) = 18 \, \text{V} \\
\Delta V_3 &= I_3 \cdot R_3 = (1.5 \, \text{A}) \cdot (11 \, \Omega) = 16.5 \, \text{V}
\end{align*} \]
\[ \Delta V_{\text{tot}} = 60 \text{ V} \]

**FIND THE TOTAL RESISTOR, TOTAL CURRENT, EACH CURRENT, AND EACH VOLTAGE ACROSS EACH RESISTOR:**

**SOLUTION**

\[ 1 / R_{\text{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{17} + \frac{1}{12} + \frac{1}{11} \]

\[ I_{\text{tot}} = \frac{\Delta V_{\text{battery}}}{R_{\text{eq}}} = \frac{60 \text{ V}}{4.29063 \ \Omega} \]

\[ I_{\text{tot}} = 14.0 \text{ amp} \]

\[ I_1 = \Delta V_1 / R_1 \quad \Delta V_2 = \Delta V_2 / R_2 \quad \Delta V_3 = \Delta V_3 / R_3 \]

\[ I_1 = (60 \text{ V}) / (17 \ \Omega) \quad I_2 = (60 \text{ V}) / (12 \ \Omega) \quad I_3 = (60 \text{ V}) / (11 \ \Omega) \]

\[ I_1 = 3.53 \text{ amp} \quad I_2 = 5.00 \text{ amp} \quad I_3 = 5.45 \text{ amp} \]

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**EXAMPLE**

**FIND THE TOTAL RESISTANCE OF THE CIRCUIT**

**SOLUTION:**

\[ \begin{array}{cccc}
1 & 1 & 1 & 1 \\
\text{--} & \text{--} & \text{--} & \text{--} \\
R_T & R_1 & R_2 & R_3 \\
1 & 1 & 1 & 1 \\
\text{--} & \text{--} & \text{--} & \text{--} \\
\end{array} \]

\[ R_T = 1 \text{ OHM} \]

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**Extensions**

Students will solve problems with circuits dealing with series and parallel circuits.

A series parallel combination circuit

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**Summary:** Ohm's Law is the equation $V = I \cdot R$ that shows the relationship between voltage, current and resistance in a simple electrical circuit. It applies both the AC and DC circuits.

**Series:**

$$R_{\text{equivalent}} = \frac{V}{I} = \frac{V_1 + V_2 + V_3 + \ldots}{I} = \frac{V_1}{I_1} + \frac{V_2}{I_2} + \frac{V_3}{I_3} + \ldots = R_1 + R_2 + R_3 + \ldots$$

Series key idea: The current is the same in each resistor by the current law.

**Parallel:**

$$\frac{V}{R_{\text{equivalent}}} = I = I_1 + I_2 + I_3 + \ldots = \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} + \ldots$$

$$\frac{1}{R_{\text{equivalent}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

Parallel key idea: The voltage is the same across each resistor by the voltage law.
HANDOUT:

HOME WORK: BY MR. A. AKOMAH {PLEASE SHOW YOUR STEPS}

1. The unit of electrical pressure is the _____________.

2. The unit of electrical current is the _____________.

3. The unit of electrical resistance is the _____________.

4. The current in a circuit is
   (a) _____________ proportional to the applied voltage.
   (b) _____________ proportional to the resistance.

5. The relation between current, voltage and resistance in a circuit is expressed
   by the equation
   Amperes _____________.

6. If a generator supplies 60 volts across a resistor and a current of 10 amperes
   flows through the circuit, what is the ohmic value of the resistor?

7. A generator is supplying 120 volts to a circuit which comprises two resistances, 6
   ohms and 4 ohms, in series. What is the current flowing in the circuit?

8. What voltage must a generator have to produce a current of 6 amperes through
   resistances of 2 ohms, 3 ohms, and 5 ohms connected in series?

9. Four resistors, of 8 ohms, 6 ohms, 2 ohms and one of unknown resistance, are
   connected in series. A generator supplies 120 volts across this circuit. The IR-drop
   across the 6-ohm resistance is 36 volts. (a) What current is flowing in the circuit?
   (b) What is the total circuit resistance? (c) What ohmic value has the unknown
   resistor?

10. A generator supplies 100 volts to 3 resistors in series, whose resistances are 2 ohms,
    3 ohms and 5 ohms. (a) What current flows in the circuit? (b) What is the current in
    each resistor?

ANSWERS : TO THE ABOVE

1. volt  2. Ampere  3. Ohm  4. (a) directly  (b) inversely
5. volts/ohms  6. 6 ohms  7. 12 amperes  8. 60 volts  9. (a) I = 6 amperes
   (b) R_t = 20 ohms  (c) R_x = 20 ohms  10. (a) I = 10 amperes  (b) I = 10 amperes
EXAMPLE:

Voltage = 10V
R1 = 4 Ohm
R2 = 4 Ohm
R3 = 2 Ohm

Remember that "Rt" means Total resistance of the circuit. 
R1, R2, etc. are Resistor one, Resistor two, etc.

Now we will apply the formula above to this example:

\[
\frac{1}{Rt} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}
\]

Therefore:

\[
\frac{1}{Rt} = \frac{1}{4} + \frac{1}{4} + \frac{1}{2}
\]

It is easiest to change the fractions into decimal numbers (example 1 divide by 4 equals .25):

\[
\frac{1}{Rt} = .25 + .25 + .5
\]

\[
\frac{1}{Rt} = 1
\]

Now you have to get rid of the 1 on the left side so...

\[
Rt = 1/1
\]

\[
Rt = 1 \text{ Ohm}
\]

NOW, Let's try a more complex one:

Voltage = 120 Volts
R1 = 100 Ohms
R2 = 200 Ohms
R3 = 1000 Ohms
R4 = 1 Ohms

\[
\frac{1}{Rt} = \frac{1}{100} + \frac{1}{200} + \frac{1}{1000} + 1
\]

\[
\frac{1}{Rt} = .01 + .005 + .001 + 1
\]

\[
\frac{1}{Rt} = 1.016
\]

\[
Rt = 1/1.016 = .98 \text{ Ohms}
\]