

UNIT V - ELECTRICITY

Lesson 10 : Cost and Electrical Power Use

Competency/Objective: Calculate cost and electrical power using Ohm's Law.

Study Questions

1. What is the power equation, Ohm's Law, and their applications?
2. How is electricity measured?
3. How is the cost of electricity determined for each plan?

References

1. *Agricultural Structures (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1999, Unit V.
2. Transparency Masters
 - a) TM 10.1: Formulas
 - b) TM 10.2: Measuring Electricity
3. Activity Sheet
 - a) AS 10.1: Calculating Electrical Costs

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Lesson 10: Cost and Electrical Power Use

TEACHING PROCEDURES

A. *Review*

Lesson 9 described how branch circuits are run to the individual outlets and light fixtures within agricultural structures. After the circuits are in place and electricity is available, calculating the power used in those systems becomes important. This lesson introduces the mathematical formulas needed to determine the amount of power used and explains how to calculate the cost of electricity.

B. *Motivation*

Ask students if they know how to read an electric meter. If possible, show them a meter, and have them try to read it.

C. *Assignment*

D. *Supervised Study*

E. *Discussion*

1. When calculating power usage, four factors are important: wattage, voltage, amperage, and resistance. They are needed to find values for both the power equation and Ohm's Law, which is the basic mathematical formula for electrical power. Discuss the formulas and their use. Show students TM 10.1 to demonstrate how to multiply and divide to calculate the different values.

What is the power equation, Ohm's Law, and their applications?

- a) Power equation
 - 1) Mathematical formula that expresses the amount of power used in an electrical circuit or system
 - 2) Indicates the relationship between wattage (P), amperage (I), and voltage (E)

$$P = I \times E$$

- 3) Primarily used to calculate power usage in watts but can also be used to determine the amperage or voltage of a system
 - 4) Important when testing an electrical system for efficient operation and for calculating the power use of individual branch circuits or the total system
- b) Ohm's Law
 - 1) Mathematical formula that expresses the relationship between electromotive force (E), electric current (I), and resistance (R).

- (a) Electromotive force, measured in volts, is the pressure created by the movement of electrons.
- (b) Electric current is measured in amps.
- (c) Resistance is measured in ohms.

$$E = I \times R$$

- 2) AC circuits - impedance (Z) rather than resistance
 - (a) Impedance describes the counter electromotive force created by the directional change in the AC circuit.
 - (b) The strength of the resistance depends on the rapidity of the directional change.
 - 3) Determines the energy efficiency of an electrical circuit, looking at factors such as voltage drop.
 - (a) It helps electricians determine if changes need to be made in a system.
 - (b) The equation can also help in determining if it would be feasible to expand an existing system.
2. Obtaining accurate measurements of electrical consumption is necessary to calculate the cost of the electricity used. Explain how meters are used to monitor usage. TM 10.2 provides examples showing how to read one type of meter.

How is electricity measured?

- a) Measured by power companies using a watt-hour meter, which measures and instantly records electrical consumption in watts or kilowatts
 - 1) Attached to the electrical system at the meter base
 - 2) Located at or near the service entrance panel in homes and on individual structures or at the power pole when a number of structures will be operating on the electrical service
 - b) Commonly use two types of meters
 - 1) Newer type - uses a rotating meter similar to the mileage indicator on a car
 - 2) Older type - has several rotating pointers that turn as electricity is used
 - (a) The first dial is read counterclockwise.
 - (b) The second dial is read clockwise.
 - (c) The third dial is read counterclockwise.
 - (d) The fourth dial is read clockwise.
 - (e) The numbers are written down from left to right.
 - (f) If the pointer is between numbers, the smaller number is read.
3. Discuss how the cost of electricity is calculated. Bring in information on local rates and have students practice calculating the cost of electrical power. Hand out AS 10.1.

How is the cost of electricity determined?

- a) Calculating the cost of electricity requires the rate scale from the electric company and the total kilowatt-hours consumed.
- b) To calculate the total use over a period of time, the previous meter reading is subtracted from the current one.
- c) The basic calculation involves multiplying the rates charged by the amount of electricity used.

F. *Other Activities*

As students complete AS 10.1, ask them to track the daily usage of electrical power. Have them describe any fluctuations in daily usage and explain the cause of those fluctuations.

G. *Conclusion*

The power equation and Ohm's Law measure the flow of electricity through the electrical system of agricultural structures. These formulas make it possible to calculate loads for each structure, check electrical costs, and plan for future expansion to meet electrical needs.

H. *Answers to Activity Sheet*

I. *Answers to Evaluation*

1. .91 amps, .73 amps
2. 83.33 volts, 1.33 volts
3. 720 watts, 4,800 watts
4. $E = I \times R$, where E = electromotive force, I = electric current, and R = resistance
5. To describe the counter electromotive force created by the directional change in the AC circuit
6. Watt-hour meter
7. 1,111 watts used
 $100 \times \$.055 = \5.50
 $200 \times \$.045 = \9.00
 $500 \times \$.035 = \17.50
 $311 \times \$.025 = \7.78
TOTAL = \$39.78

EVALUATION

Using the power equation, determine the missing values.

1. Find the amperes:

a. Volts - 11 Watts - 100 _____

b. Volts - 240 Watts - 175 _____

2. Find the volts:

a. Watts - 500 Amps - 6 _____

b. Watts - 12 Amps - 9 _____

3. Find the watts:

a. Volts - 120 Amps - 6 _____

b. Volts - 240 Amps - 20 _____

Complete the following short answer questions.

4. What is the formula for Ohm's Law for DC circuits? What does each of the variables represent?

5. Why is impedance (Z) used in the formula for Ohm's Law for AC circuits?

6. What device is used by power companies to measure the amount of electricity used?

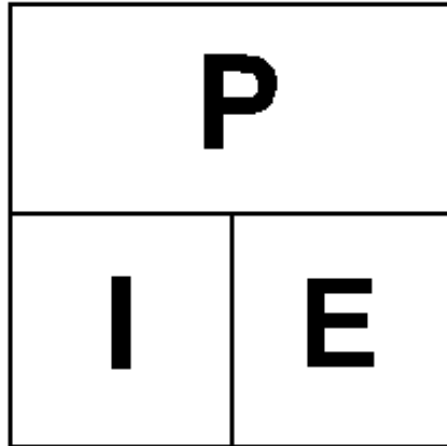
Calculate the cost of electricity for the problem below. Show your work.

7. Meter readings: Previous - 1,222 kWh Current - 2,333 kWh

Sliding rate scale:

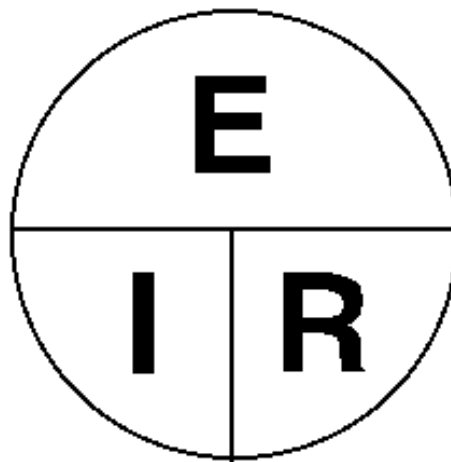
\$.055 for the first 100 kWh
\$.045 for the next 200 kWh
\$.035 for the next 500 kWh
\$.025 for the next 700 kWh
\$.01 for over 1500 kWh

Formulas



P = Wattage
I = Amperage
E = Voltage

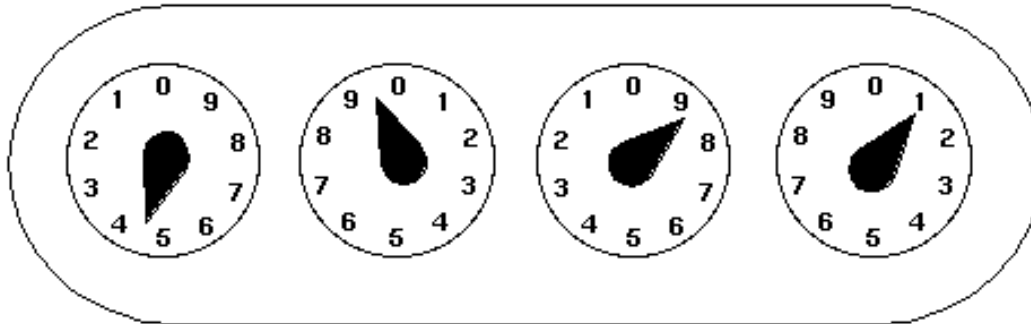
Note: Cover the letter of the value you wish to find to discover the method.



E = Voltage
I = Amperage
R = Resistance

Note: Cover the letter of the value you wish to find to discover the method.

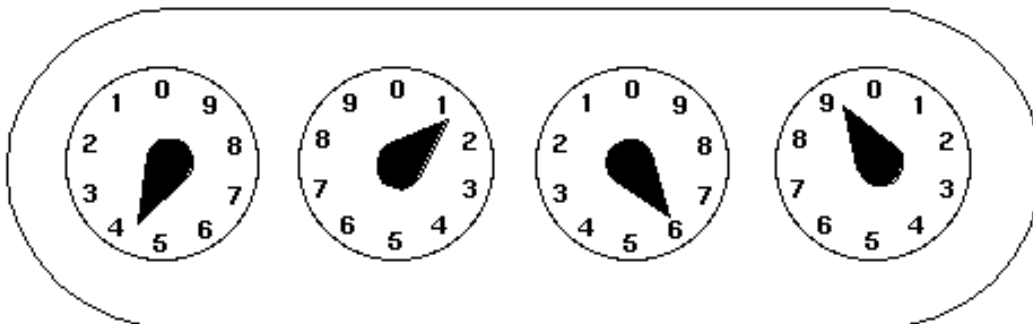
Measuring Electricity



July 15

First dial - number passed 4---
 Next dial - number passed -9--
 Next dial - number passed --8-
 Right dial closest number ---1

Reading = 4981 kwh



June 16

First dial - number passed 4---
 Next dial - number passed -1--
 Next dial - number passed --6-
 Right dial closest number ---9

Reading = 4169 kwh

4981- 4169 = 812 kwh used

Calculating Electrical Costs

Objective: Calculate the cost of the electricity used in the home based on current local utility rates.

Keep a record of the power used at your home over a five-day period. Find out the local utility rates for your area from your parents or the utility company. At the end of the week, calculate the cost of electricity used. Show your work.

Meter reading:

Start - _____ kWh End - _____ kWh

Utility rate:

Weekly usage:

Cost:

