Math Skills Laboratory

Lab 2 MS 3

MATH ACTIVITIES

Activity 1: Reading Voltage Scales on Multimeters

Activity 2: Solving Electrical Work Problems

MATH SKILLS LAB OBJECTIVES

When you complete these activities, you should be able to do the following:

1. ***Read the voltage indicated on the scale of a multimeter when the meter range and function are specified.***
2. ***Solve electrical work problems, given voltage and charge information.***

LEARNING PATH

1. ***Read the Math Skills Lab. Give particular attention to the Math Skills Lab Objectives.***
2. ***Solve the Practice Exercises for Activities 1 and 2.***

ACTIVITY 1

Reading Voltage Scales on Multimeters

EQUIPMENT

You'll need a volt-ohm-milliampere (VOM) meter or a copy of a VOM dial face for this activity.

Multimeters are common instruments used to measure electrical voltage, current and resistance. There are two basic types of multimeters—digital-readout meters, and VOM meters.

Digital-Readout Type: This type of multimeter gives a direct readout on a digital display. With this type of meter, you don't have to read scales. You just set the function and range switches and then read the number on the display.

VOM-Type: The volt-ohm-milliampere (VOM) meter has a large meter face (dial) that's calibrated for measurements of electrical voltage, current or resistance. A ***function switch*** sets the meter to read DC or AC. The setting depends on the voltage or current source you want to measure. A ***range switch*** sets the maximum value of voltage or current that you can read on the scales.

When you read the position of the needle on the meter scale, your position is important. You must be careful to avoid "parallax" errors while reading the VOM scale. These errors occur when your eyes aren't centered directly over the top of the needle. High-quality meters have a strip of mirror on the face of the meter. If you ***can see*** the image of the needle in the mirror while reading the scale, the meter reading taken at this position ***will be in error.*** If you ***cannot see*** the needle image while reading the scale, your eyes are directly over the needle and your reading ***will be correct.***

Most meter faces have multiple ranges for AC and DC readings. For example, the meter face shown in Figure 1 has three ranges labeled for the AC scales. Those ranges are 0-2.5, 0-5 and 0-10. Depending on the measurement to be made, the technician selects the proper function and range. For instance, if the technician has the meter set to read DC voltage in a 0-5-volt range, the technician uses the DC meter scale that's labeled "0-5."

The following example indicates how to read the needle position on a multimeter VOM scale.

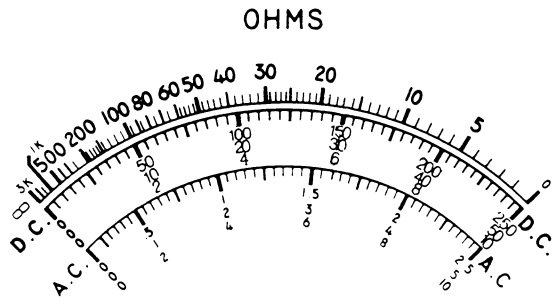
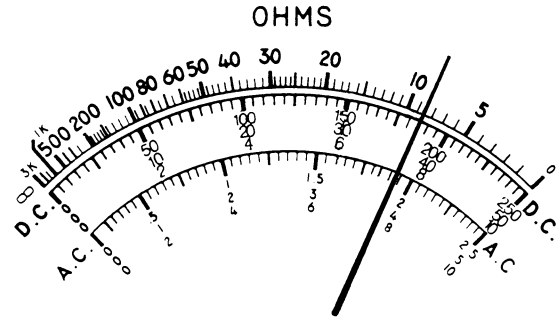


Fig. 1 Typical scales on a multimeter dial face. Note the three choices of scale for reading either AC or DC values. (The single scale at the top measures RESISTANCE, from right to left).

Example A: *Reading Voltage on a Multimeter*



Given: The function/range switch is set on DC/10 V. The needle indicates the readings shown in the figure above.

Find: The voltage reading.

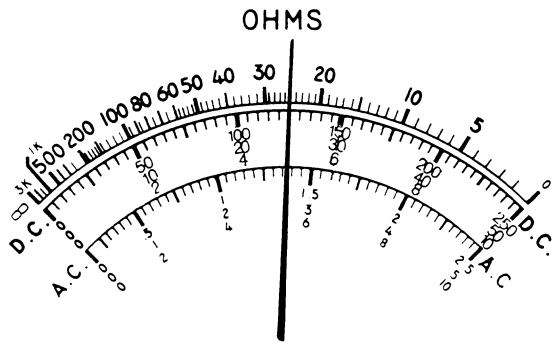
Solution: The needle intersects the DC/10-volt scale between the 7- and 8-volt marks. Since there are five intervals between 7 and 8, each index line represents $\frac{1}{5}$ of a volt—or 0.2 volt. The needle lies on top of the second line past the 7-volt mark. Thus, the reading is 7 volts + (2 × 0.2 V), or 7 volts + 0.4 volts.

The correct reading, then, is 7.4 V, DC.

Note: If the function/range switch had been set at DC/2.5 volts, the meter reading shown in Example A would have been ***1.85 volts.*** If the function/range switch had been set at DC/5 volts, the meter reading would have been ***3.7 volts.*** (See your instructor if you can't verify these results on your own.)

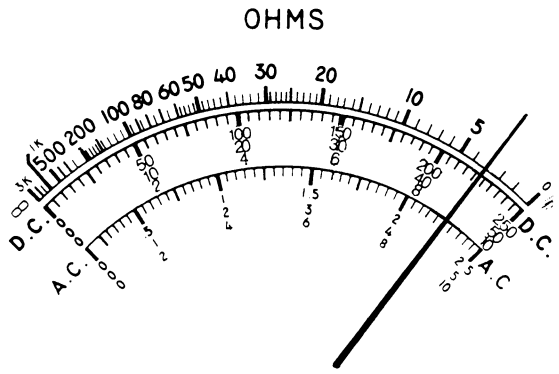
PRACTICE EXERCISES

Needle positions are shown on the face of a VOM meter with the given function/range setting. You should determine the correct voltage readings (indicated by the needle position) for each problem.



Problem 1:

Function/Range: DC/10 V
Reading is _____ volts, DC.
Function/Range: DC/5 V
Reading is _____ volts, DC.
Function/Range: DC/2.5 V
Reading is _____ volts, DC.



Problem 2:

Function/Range: AC/10 V
Reading is _____ volts, AC.
Function/Range: AC/5 V
Reading is _____ volts, AC.
Function/Range: AC/2.5 V
Reading is _____ volts, AC.

ACTIVITY 2

Solving Electrical Work Problems

Electrical work is given by the formula,

$W_{ELEC} = (\Delta V) \times q$

where: W_{ELEC} = the electrical work done in joules
ΔV = the voltage difference in volts
q = the charge moved in coulombs

The units of electrical work are joules. One joule is equal to one volt·coulomb.

PRACTICE EXERCISES

Problem 1:
Given: Five coulombs of charge flow in an electrical circuit. The charge is "pushed" by a voltage difference of 8 volts.
Find: a. The electrical work done in units of volt·coulombs.
b. The electrical work done in units of joules.
Solution:

Problem 2:
Given: A 6-volt DC motor does 400 joules of useful work.
Find: The charge that was moved to do this work.
Solution:

Problem 3:
Given: A motor/pump unit does 1500 N·m of work while pumping water. The motor/pump unit uses 1800 joules of electric energy while doing the work.
Find: The efficiency of the motor/pump unit.
Solution:

Problem 4:
Given: An industrial motor does 1500 joules of work while moving 50 coulombs of charge.
Find: The voltage supplied to the motor.
Solution:

Problem 5:
Given: Two coulombs of charge are moved by a 6-volt battery.
Find: a. The electrical work done.
b. The number of electrons displaced by the battery.
Solution: