This vocational instructional module on using and reading voltmeters is one of eight such modules designed to assist recently arrived Arab students, limited in English proficiency (LEP), in critical instructional areas in a comprehensive high school. Goal stated for this module is for the student enrolled in electronics courses to use and read voltmeters. Each module consists of these parts: title; program goal and performance objectives; a pronunciation key; a language page which offers the pronunciation, definition, and usage of key terms in English and in Arabic; a pretest; bilingual (English and Arabic) language (vocabulary and usage) activities; evaluation; pretest and activity answer sheets; and a list of supplementary materials and their location. For each of the six activities in this module the objective, a list of materials needed, procedure, and evaluation are provided in addition to the necessary activity sheets or pages. (YLB)
FORDSON BILINGUAL DEMONSTRATION PROJECT

USING and READING VOLTMETERS

قراءة واستعمال الفولتميترات
ABOUT THE PROJECT

The Fordson Arabic Bilingual Demonstration Project is designed to assist recently arrived Arab students, limited in English proficiency (LEP), to adapt to a large and comprehensive high school. The project consists of academic and vocational instructional modules, reading services to teachers and students, bilingual aide and resource services, computer and television modules, staff development activities, and home-community liaison.

ABOUT THE INSTRUCTIONAL MODULES

The modules were designed to assist LEP students in critical instructional areas throughout the school curriculum. These areas of focus were determined by a needs survey of the entire Fordson school community. Each module consists of seven parts: title, objectives, pretest, language (vocabulary and usage) activities, evaluation, and supplementary materials. Modules were translated, duplicated, and field tested.

ABOUT THE AUTHOR

Rick Topolewski did his undergraduate work at Western Michigan University and his graduate training at the University of Michigan. Rick has worked in the Industrial Education area at Fordson High School for the past 16 years. The skills developed in this unit were those he and his students defined as critical for a better understanding of the reading of voltmeters.
CREDITS AND ACKNOWLEDGEMENTS:

Special Assistance:

Jean H. Miller, Ed.D. - Editor
Pat Coulter - Reading Consultant
Susan Field - Special Needs Coordinator
Albert R. Harp - Translation Editor
Wendy Sample - Graphics
Christine Rajda - Typist
Tahsine Bazzi - Translation

Demonstration Staff:

Clark Burnett - ESL Instructor/Audio-Visual Consultant
Albert Harp - Bilingual Resource Coordinator
Fouad Moawad - Bilingual Instructor
Jim Petrie - Facilitator
Wafa Unis - Instructional Aide/Home Community Liaison
Issaaf Beydoun - Instructional Aide
Elham Hamdan - Instructional Aide
Karim Michael - Instructional Aide
Rihab Ahmad - Secretary

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Mr. Bill Letsche - Principal, Fordson High School

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METERS

VOLTMETERS: HOW THEY ARE USED AND READ

Developed By:

Richard R. Topolewski

ERIC
This bilingual module has been developed to assist limited English proficiency students in electronics to use and read voltmeters. This unit is designed for students enrolled in electronics courses.

GENERAL OBJECTIVE:

The student will:

1. understand how meters are to be used;
2. know how to read the meter to determine various electrical measurements;
3. apply the knowledge and skill in meter usage with electrical circuitry.

SPECIFIC OBJECTIVES:

The student will:

1. identify and label the various parts, scales, and voltage measuring ranges of the volt-ohm-milliammeter (multimeter) with 90% accuracy;
2. acquire and follow precautionary procedures in using voltmeters at all times;
3. describe how a volt-ohm-milliammeter is connected to an electrical circuit as a voltmeter to the satisfaction of the teacher;
4. understand and use basic vocabulary related to the voltmeter and its usage to the satisfaction of the teacher;
5. read voltage measurements with 80% accuracy.
Part I of the Post Test will be used as the Pre Test.

Give the student Part I of the Post Test at the end of the Module.
To the teacher: for Part I you can use SCAN-TRON for easy scoring and item analysis.

Part I:

1. The term voltage means:
   a. electrons
   b. protons
   c. force or electrical pressure
   d. power in watts

2. Direct current is an electrical flow that moves in:
   a. two directions
   b. one direction

3. A voltmeter is a ______ used to measure an electrical potential in volts.
   a. ruler
   b. generator
   c. measuring instrument
   d. electrical component
   e. switch

4. A voltmeter is connected to the circuit or battery in ______ to measure the voltage.
   a. series
   b. parallel
   c. both in series and parallel

Go on to next page.
5. A meter that can measure voltage, electrical current and electrical resistance is called a ________.
   a. watt meter
   b. ohm meter
   c. current meter
   d. volt-ohm-milliammeter (V.O.M.)

6. Deflection on a meter means:
   a. the amount the pointer will move
   b. polarity of the voltage
   c. the current movement

7. The markings on the meter face that represent different voltage levels is called the:
   a. meter ruler
   b. voltage ranges
   c. voltage scales

8. A meter control which can be set to different measuring levels found on a voltmeter is called the:
   a. meter ruler
   b. voltage ranges
   c. voltage scales
   d. range switch

Go on to next page.
9. A positive or negative condition that may exist across two different points in an electrical circuit is called:
   a. current  
   b. power  
   c. resistance  
   d. polarity

10. Checking that the correct polarity is observed when using a D.C. voltmeter is connecting:
   a. the positive test lead to the positive point and negative test lead to the negative point.
   b. the positive test lead to the negative point and the negative test lead to the positive point.

11. If correct polarity is not observed when using a voltmeter:
   a. the pointer will move down scale  
   b. the pointer will move up scale  
   c. the pointer will not move

12. When measuring a D.C. voltage, the D.C. polarity function switch must be set on:
   a. -D.C.  
   b. A.C.  
   c. +D.C.
13. The maximum voltage you can measure on a 50 volt range is:
   a. 10 volts  
   b. 50 volts  
   c. 25 volts  
   d. 30 volts

14. Full scale deflection on a meter scale indicates:
   a. minimum value  
   b. zero value  
   c. maximum value  
   d. medium value
for the voltage range the meter is set on.

15. When setting the voltmeter on the proper range for a voltage level to be measured, make sure the voltage range is:
   a. lower than the voltage to be measured  
   b. higher than the voltage to be measured

16. A parallel connection is an electrical hook-up that has:
   a. two or more electrical current paths  
   b. only one electrical current path

Go on to next page.
17. The wires used to connect a meter to an electric circuit or battery are called:
   a. cables
   b. electric power wire
   c. test leads
   d. power cords

18. Terminal jacks on a meter are the points where the test leads are connected to the meter?
   a. true
   b. false

19. The positive (+) test lead is colored red and the negative (-) test lead is colored black.
   a. true
   b. false

20. When measuring D.C. voltage, the terminal jacks to use are marked positive(+) and negative (-) common.
   a. true
   b. false
PRONUNCIATION KEY

/a/ as in Adam
/ä/ as in cake
/e/ as in let
/e/ as in meet
/i/ as in sit
/i/ as in ice cream
/o/ as in hot
/o/ as in Coke
/u/ as in Seven Up
/u/ as in blue
/b/ as in boy
/c/ equals /s/ as in cents (10¢)
/k/ as in cat
/d/ as in day
/f/ as in four
/g/ as in go
/dz/ as in page
/h/ as in he
/j/ equals /dz/ as in jail
/k/ as in kick
/l/ as in Cola

/m/ as in man
/n/ as in man
/p/ as in Dr. Pepper
/qu equals /kw/ as in quit
/r/ as in run
/s/ as in sun
/t/ as in ten
/v/ as in van
/w/ as in woman
/x/ as in extra
/y/ as in yet (sometimes /ë/ as in many)
/z/ as in zebra
/sh/ as in shut
/ch/ as in church
/ng/ as in sing
/th/ (voiced) as in this
/th/ (unvoiced) as in thing
/oo equals /u/ as in food
/u/ as in good
1. alternating current (A.C.)
(ol' tēr nāt 'ing kur' ēnt)
electrical current that changes
direction and flows back and forth in a circuit; electric
current that changes polarity

The electric circuits in your home operate on alternating current.

2. deflection (dē flēk' shūn)
the amount a pointer (meter needle) will move in an
electric meter to show a reading

The voltmeter indicated a deflection of 10 volts.

3. direct current (D.C.)
(dī rekt' kur' ēnt)
electrical current that flows in only one direction
from a negative to a positive polarity

Batteries supply direct current to the flashlight.
4. **electric meter**
   \(\text{electric meter}\)
   an electrical measuring instrument that can be used to measure voltage or current or electrical resistance

   The **electric meter** was connected to the circuit to measure voltage.

5. **full scale**
   \(\text{full scale}\)
   the maximum value or deflection a meter can indicate

   The voltmeter shows **full scale** deflection to indicate maximum value.

6. **linear scale**
   \(\text{linear scale}\)
   an equally divided scale where the divisions are the same distance apart

   The voltmeter has a **linear scale** because the divisions are evenly spaced.
7. **multimeter (můlˈ tĭ mĕˈtər)**
   single measuring instrument that measures volts, electric current, and ohms

   The volt-ohm-milliammeter is a multimeter because it can measure more than one item.

8. **non-linear scale**
   (non linˈ ē er skāl)
   a scale that is not equally divided and the scale divisions do not have equal value at all points on the scale

   An ohmmeter has a non-linear scale.
9. parallel connection (par' ā lēl 'kō nēk'shūn)
an electrical connection that has two or more electrical current paths

When one electrical component is attached across another component the connection will be parallel.

10. polarity (pō' lēr' i tī)
a positive (+) or negative (-) condition that may exist across two different points in an electric circuit

The polarity of the battery terminal was positive.

11. range switch (rānj swīch)
a meter control which can be positioned into different measuring levels or ranges

The voltmeter range switch was positioned to the 50 volt range.

12. series connection (sēr' ēz 'kō nēk'shūn)
an electrical connection that has only one electrical current path

The light switch is connected into the circuit in series.
13. **terminal jack** (turˈ mə nəl ˈjak)  
   a point where an electrical connection is made

   The terminal jacks on the D.C. voltmeter are marked negative (-) and positive (+).

14. **test leads** (tɛst lɛdz)  
   wire used to connect a meter to an electric circuit

   The wire test leads are about six (6) inches long.

15. **voltage** (vˈoltij)  
   force that exists between a positive and a negative polarity; electrical pressure that causes electrons to flow in a circuit

   The battery voltage is 1.5 volts.

16. **voltage scale** (vˈoltij ˈskæl)  
   a marked meter face that represents different voltage levels

   A voltage scale of 10 volts was used to take the measurement.
17. **voltmeter (vōlt mē tēr)**
   measuring instrument designed
to measure an electrical
potential in volts

The voltmeter measured 2 volts
across the lamp in the electrical
circuit.

18. **volt-ohm-milliammeter (V.O.M.)**
   (vōlt ōm mil' ē am' mē tēr)
meter that can measure voltage,
or electric current, or electrical
resistance.

A multimeter is also a
volt-ohm-milliammeter.
For the student:

You are going to learn:

the various parts, scales, and voltage ranges of a volt-ohm-milliammeter (V.O.M.).

In order to do this you will be given:

a. a volt-ohm-milliammeter (V.O.M.);
b. a diagram of a V.O.M. with the labeled parts;
c. a diagram of a V.O.M. without the labeled parts;
d. a writing instrument.

You will be doing the following:

completing activity 1 in you module.

We will know you can do this when:

you are able to name and spell the parts of the V.O.M. meter correctly.
STUDENT ACTIVITY 1

Using the labeled diagram on the following page, locate and observe those same parts on the actual V.O.M. meter.
STUDENT ACTIVITY 1

DIAGRAM OF VOLT-OHM-MILLIAMMETER (V.O.M.)
WITH LABELED PARTS

pointer (needle)

voltage scales

linear scale

non linear scale

meter case

meter face

pointer zero adjustment

range switch

device terminals

D.C. polarity function switch

2.5V
10V
50V
100V
500V
1000V

range switch

250 μA
0.50 mA
2.0 mA
20 mA
200 mA

Using the unlabeled diagram on the following page, fill in the names of the parts with correct spelling.

Do not refer to the labeled diagram.
STUDENT ACTIVITY 1

DIAGRAM OF V.O.M.
LABEL THE PARTS INDICATED
For the student:

You are going to learn:

to read the 0-250 volt scale
found on the meter face.

In order to do this you will be given:

information pertaining to 0-250
volt scale and a diagram showing
voltage scales. Refer to Diagram
number 1. See page 21.
The instrument used to measure voltage is called a voltmeter. The meter that you will be using in class is actually three (3) meters in one: a voltmeter which measures voltage, an ammeter which measures current, and an ohm meter which measures electrical resistance. This meter is called a multimeter V.O.M.
STUDENT ACTIVITY 2

smaller markings which have no numbers

DIAGRAM # 1
to be used with STUDENT ACTIVITIES 2, 3 & 4.
In this activity you will be using the meter only as a voltmeter. Therefore the scales on the meter face will be read as voltage values. The D.C. voltage scales which you will be using are shown in Diagram 1. Note there are three different D.C. voltage scales:

0-250, 0-50, and 0-10.

Find these scales on Diagram 1.

Referring only to the 0-250 volt scale on Diagram 1, you will notice the values of voltages would be between zero and a maximum of 250 volts. At deflection point A of the scale, there is a 50 volt mark. At deflection point B of the scale, there is a 100 volt mark.

In this activity, you will be using the meter only as a voltmeter. Therefore the scales on the meter face will be read as voltage values. The D.C. voltage scales which you will be using are shown in Diagram 1. Note there are three different D.C. voltage scales:

0-250, 0-50, and 0-10.

Find these scales on Diagram 1.

Referring only to the 0-250 volt scale on Diagram 1, you will notice the values of voltages would be between zero and a maximum of 250 volts. At deflection point A of the scale, there is a 50 volt mark. At deflection point B of the scale, there is a 100 volt mark.
Note that between 50 and 100 and 150 on the scale are smaller marks which have no numbers. These smaller marks which have no numbers represent 5 volts each on this scale. Therefore, as an example for Diagram 1, the pointer deflection at C indicated 105 volts. The pointer deflection at D indicated 125 volts, and the pointer deflection at E indicated 180 volts.

What is the voltage value on the 0-250 volt scale at deflection point:

A__________________ volts

B__________________ volts

F__________________ volts

G__________________ volts
What is the maximum voltage you can read on the 250 volt scale?

______________________ volts

What is the value of each of the smaller markings (which have no numbers shown) on the 0-250 volt scale?

______________________ volts
Refer to Diagram 2 on the next page. Indicate the voltage readings at the various pointer deflections marked with letters on the 0-250 volt scale.

<table>
<thead>
<tr>
<th>Pointer Deflection</th>
<th>Voltage Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
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<td>F</td>
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<td>G</td>
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<tr>
<td>H</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td></td>
</tr>
</tbody>
</table>
DIAGRAM # 2

to be used with STUDENT ACTIVITIES 2, 3, & 4.

تمارين لطلاب رقم 2، 3، و 4.
For the student:

You are going to learn:

to read the 0-50 volt scale found on the meter face.

In order to do this you will:

a. read the information given
b. refer to Diagram 1. See page 21.

للطالب:

سوف تتعلم:

أن تقرأ المقياس الذي يتراوح مداه بين الصفر والخمسين فولت و الموجود على وجه العداد.

ومن أجل أن تقوم بهذا الأمر سوف:

أ - تقرأ المعلومات التي ستعطي لك
ب - ترجع إلى الرسم البياني رقم 1.
In this activity, you will be using the voltage scale 0-50 volts from Diagram 1. Find this scale on the diagram. You will notice the values of voltages would be between zero and a maximum of 50 volts. At deflection point A of the scale, there is a 10 volt mark. At deflection point B of the scale, there is a 20 volt mark.

Note that between 10 and 20 and 30 again there are the smaller markings which have no numbers. These smaller markings now will represent 1 volt each on the 0-50 volt scale.

Therefore as an example from Diagram 1, the pointer deflection at C indicated 21 volts. The pointer deflection at D indicates 25 volts and the pointer deflection at E indicates 36 volts.
STUDENT ACTIVITY 3 (continued)

What is the voltage value on the 0-50 volt scale when the deflection point is at:

A = _______ volts  
B = _______ volts  
F = _______ volts  
G = _______ volts

What is the maximum voltage you can read on the 50 volt scale?

__________ volts

What is the value of each smaller marking (which have no numbers shown) on the 0-50 volt scale?

__________ volts
From Diagram 2 indicate the voltage readings at the various pointer deflections on the 0-50 volt scale.

<table>
<thead>
<tr>
<th>Pointer Deflection</th>
<th>Voltage Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>= ___________ volts</td>
</tr>
<tr>
<td>B</td>
<td>= ___________ volts</td>
</tr>
<tr>
<td>C</td>
<td>= ___________ volts</td>
</tr>
<tr>
<td>D</td>
<td>= ___________ volts</td>
</tr>
<tr>
<td>E</td>
<td>= ___________ volts</td>
</tr>
<tr>
<td>F</td>
<td>= ___________ volts</td>
</tr>
<tr>
<td>G</td>
<td>= ___________ volts</td>
</tr>
<tr>
<td>H</td>
<td>= ___________ volts</td>
</tr>
<tr>
<td>I</td>
<td>= ___________ volts</td>
</tr>
<tr>
<td>J</td>
<td>= ___________ volts</td>
</tr>
</tbody>
</table>

Diagram 2: Voltmeter Scale
For the student:

You are going to learn:

to read the 0-10 volt scale found on the meter face.

In order to do this you will:

a. read the information given
b. refer to Diagram 1.
In this activity, you will be using the voltage scale 0-10 volts from Diagram 1. Find this scale on the diagram. The value of voltages on this scale would be between zero and a maximum of 10 volts. At deflection point A of the scale, there is a 2 volt mark. At deflection point B of the scale, there is a 4 volt mark.

Note that between 2 and 4 and 6 there are the smaller markings which again have no numbers. These smaller markings now will represent .2 volts each (2/10 of a volt) on the 0-10 volt scale.

As an example from Diagram 1, the pointer deflection at C indicates 4.2 volts. The pointer deflection at D indicates 5 volts and the pointer deflection at E indicates 7.2 volts.
Look at Diagram 1. What is the voltage value on the 0-10 volt scale when the pointer is at:

A = ___________ volts
B = ___________ volts
F = ___________ volts
G = ___________ volts

What is the maximum voltage you can read on the 0-10 volt scale?

________________ volts

What is the value of each smaller marking (which have no numbers shown) on the 0-10 volt scale?

________________ volts
From Diagram 2 indicate the voltage readings at the various pointer deflections on the 0-10 volt scale.

<table>
<thead>
<tr>
<th>Pointer Deflection</th>
<th>Voltage Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>________________volts</td>
</tr>
<tr>
<td>B</td>
<td>________________volts</td>
</tr>
<tr>
<td>C</td>
<td>________________volts</td>
</tr>
<tr>
<td>D</td>
<td>________________volts</td>
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<tr>
<td>E</td>
<td>________________volts</td>
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<tr>
<td>F</td>
<td>________________volts</td>
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<tr>
<td>G</td>
<td>________________volts</td>
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<td>H</td>
<td>________________volts</td>
</tr>
<tr>
<td>I</td>
<td>________________volts</td>
</tr>
<tr>
<td>J</td>
<td>________________volts</td>
</tr>
</tbody>
</table>

Diagram 2
For the student:

You are going to learn:

how to use the various voltage ranges on the V.O.M. multirange voltmeter.

In order to do this you will:

a. read the information given
b. refer to Diagram 3. See page 37.
Often you will need to measure voltage levels much smaller or higher than what the voltage scales on the meter face may indicate. For this purpose, a multirange voltmeter is used. It has two or three meter scales and a range switch. Which scale to use is determined by the setting of the range switch. The range to use will be determined by how high a voltage you want to measure.

Refer to Diagram 3. In order to measure a voltage level between zero and 250 V, the range switch would be set at the 250 V. setting (position Y. on Diagram 3). Then the voltage scale you would take your readings from would be the 0-250 volt scale. (You have already become familiar with this scale in student activity 2).
**CHART A**

<table>
<thead>
<tr>
<th>RANGE SWITCH POSITION</th>
<th>VOLTAGE VALUE AT POINTER POSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SETTING</strong></td>
<td><strong>RANGE</strong></td>
</tr>
<tr>
<td>V</td>
<td>2.5 V</td>
</tr>
<tr>
<td>W</td>
<td>10 V</td>
</tr>
<tr>
<td>X</td>
<td>50 V</td>
</tr>
<tr>
<td>Y</td>
<td>250 V</td>
</tr>
<tr>
<td>Z</td>
<td>1000 V</td>
</tr>
</tbody>
</table>
If you are measuring voltage levels much smaller than 250 volts, as an example, let us say voltages between zero and 2.5 volts, then you would set the range switch to the 2.5 volt setting (position Y. on Diagram 3). The voltage scale you would use would still be the 0-250 volt scale, but the full scale.

Likewise if you are measuring voltage levels between zero and 10 volts, you would set the range switch to the 10 volt setting (position W on Diagram 3) and use the meter scale marked 0-10 volts. The maximum voltage that would deflect the pointer full scale is 10 volts.

If it becomes necessary to measure volt levels much higher than 10 volts, as an example, let us say voltages between zero and 1,000 volts then you would set the range switch to the 1,000 volt setting (position Z on Diagram 3). The voltage scale you would use would still be 0-10 volts, but the full scale deflection would be read as 1,000 volts and not 10 volts. Once again the maximum voltage you can measure on the 1,000 volt range is 1,000 volts and the numbered values on the meter scale take on new values.
STUDENT ACTIVITY 5 (continued)

Do you get the idea? It requires a little thought. Let us see how well you understand.

To provide some practice readings, the meter pointer (needle) in Diagram 3 is shown in position A, B, C, and D. The values of the indicated voltage for each range switch setting appears in chart A below the diagram. You are to read the meter first, then compare your readings with the answers given in Chart A.

After you have checked your voltage readings from Diagram 3 and chart A, complete the voltage readings for chart B using Diagram 4 on the next page.
### STUDENT ACTIVITY 5
#### DIAGRAM # 4

**CHART B**

<table>
<thead>
<tr>
<th>RANGE SWITCH POSITION</th>
<th>VOLTAGE VALUE AT POINTER POSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SETTING</strong></td>
<td><strong>RANGE</strong></td>
</tr>
<tr>
<td>V</td>
<td>2.5 V</td>
</tr>
<tr>
<td>W</td>
<td>10 V</td>
</tr>
<tr>
<td>X</td>
<td>50 V</td>
</tr>
<tr>
<td>Y</td>
<td>250 V</td>
</tr>
<tr>
<td>Z</td>
<td>1000 V</td>
</tr>
</tbody>
</table>
Student Activity 5

Diagram # 4

Chart B

<table>
<thead>
<tr>
<th>Range Switch Position</th>
<th>Voltage Value at Pointer Position</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Setting</strong></td>
<td><strong>Range</strong></td>
</tr>
<tr>
<td>V</td>
<td>2.5 V</td>
</tr>
<tr>
<td>W</td>
<td>10 V</td>
</tr>
<tr>
<td>X</td>
<td>50 V</td>
</tr>
<tr>
<td>Y</td>
<td>250 V</td>
</tr>
<tr>
<td>Z</td>
<td>1000 V</td>
</tr>
</tbody>
</table>
For the student:

You are going to learn:

how to connect a V.O.M. multimeter
to a circuit in order to make a
voltage measurement.

In order to do this you will be given
the following:

a. a real V.O.M. multimeter;
b. a flashlight battery (1 cell);
c. two (2) test leads - one red
    one black.

In order to do this activity you will:

a. read the information given;
b. refer to Diagram 5 on next page;
c. do whatever the activity states
    step by step;
d. hook up the real V.O.M. meter
    across the battery as indicated
    in Diagram 5.
Meter Scales

Set D.C. Polarity
function switch to + D.C.

Meter Terminal Jacks

Set Voltage
range switch to 2.5V range

Black (—) test lead

Red (+) test lead

Cell

Battery cell

Meter Connections To Measure
Voltage of Battery (1 cell)

Lamp (flashlight bulb)

Student Activity 6

Meter Scales

Set D.C. Polarity
function switch to + D.C.

Meter Terminal Jacks

Set Voltage
range switch to 2.5V range

Black (—) test lead

Red (+) test lead

Cell

Battery cell

Meter Connections To Measure
Voltage of Battery (1 cell)

Lamp (flashlight bulb)
To measure voltage a voltmeter must be connected properly to the circuit or battery. The connection must be in parallel; that is, across the circuit or across the battery terminals. Refer to Diagram 5. Also polarity must be observed in order for the pointer to deflect up-scale. If polarity is connected wrong, the pointer will move in the opposite or wrong direction.

STEP 1:
The red test lead is connected to the positive (+) terminal jack on the meter, and the other end connected to the positive terminal or point on the battery. The black test lead is connected to the negative (-) or common terminal jack on the meter and the other end connected to the negative terminal or point on the battery.
STEP 2:
Because the voltage of a single cell battery is between 1.5 volts to 2 volts, set the range switch on the meter to the 2.5 volt range. With the range switch set to the 2.5 volt range, you will be using the 0-250 volt scale but remember the maximum reading on this scale is 2.5 volts. All of the markings on this scale take on new values as learned in student activity 5.

STEP 3:
Set the D.C. polarity function switch to +D.C. position. (This switch should be left in this position all of the time.)

Note: Remember these three precautions when using a V.O.M. multimeter to make voltage measurements:

1. Connect the volt meter in parallel across the points of a circuit or battery.
2. Check for correct polarity. Positive red test lead attaches to the positive (+) terminal point of the battery. Negative black test lead attached to the negative (-) terminal point of the battery.
3. Check the voltage range switch setting. Make sure the switch is set to the voltage range high enough to measure the voltage level.
STEP 4:
Now, connect the V.O.M. meter test leads and battery as shown in Diagram 5 and actually hook-up the circuit as indicated in the diagram.

Example: Measuring 2 volts, you should have it set for the 2.5 volt range, always use the proper voltage range for the voltage you are going to be measuring.

*********************************************************************************
Never use a smaller voltage range than the level of voltage you will be measuring. This may damage the meter.
*********************************************************************************

You could not measure 50 volts on a 10 volt range setting. You must set the range switch to the proper voltage range. In order to measure 50 volts, the range switch would be positioned to the 50 volt setting.
STEP 5:

Measure the voltage from the single cell battery by reading the deflection of the pointer from the meter. What is the measured voltage of the single cell battery?

________ volts.

خطوة رقم ٤:

قم بأخذ قياس جهد حاسمة ذات خليّة واحدة single cell battery وذلك بقراءة انحراف المؤشر على العداد ما هي قيمة الجهد الذي قسته لهذه الحاسدة؟

فولت.
POST TEST

DIAGRAM #6

PART I

PART II
To the teacher: for Part I you can use SCAN-TRON for easy scoring and item analysis.

Part I:

1. The term voltage means:
   a. electrons
   b. protons
   c. force or electrical pressure
   d. power in watts

2. Direct current is an electrical flow that moves in:
   a. two directions
   b. one direction

3. A voltmeter is a ______ used to measure an electrical potential in volts.
   a. ruler
   b. generator
   c. measuring instrument
   d. electrical component
   e. switch

4. A voltmeter is connected to the circuit or battery in ______ to measure the voltage.
   a. series
   b. parallel
   c. both in series and parallel

Go on to next page.
5. A meter that can measure voltage, electrical current and electrical resistance is called a ________.
   a. watt meter  
   b. ohm meter  
   c. current meter  
   d. volt-ohm-milliammeter (V.O.M.)

6. Deflection on a meter means:
   a. the amount the pointer will move  
   b. polarity of the voltage  
   c. the current movement

7. The markings on the meter face that represent different voltage levels is called the:
   a. meter ruler  
   b. voltage ranges  
   c. voltage scales

8. A meter control which can be set to different measuring levels found on a voltmeter is called the:
   a. meter ruler  
   b. voltage ranges  
   c. voltage scales  
   d. range switch

Go on to next page.
9. A positive or negative condition that may exist across two different points in an electrical circuit is called:
   a. current
   b. power
   c. resistance
   d. polarity

10. Checking that the correct polarity is observed when using a D.C. voltmeter is connecting:
    a. the positive test lead to the positive point and negative test lead to the negative point.
    b. the positive test lead to the negative point and the negative test lead to the positive point.

11. If correct polarity is not observed when using a voltmeter:
    a. the pointer will move down scale
    b. the pointer will move up scale
    c. the pointer will not move

12. When measuring a D.C. voltage, the D.C. polarity function switch must be set on:
    a. -D.C.
    b. A.C.
    c. +D.C.

Go on to next page.
POST TEST (continued)

13. The maximum voltage you can measure on a 50 volt range is:
   a. 10 volts
   b. 50 volts
   c. 25 volts
   d. 30 volts

14. Full scale deflection on a meter scale indicates:
   a. minimum value
   b. zero value
   c. maximum value
   d. medium value

   for the voltage range the meter is set on.

15. When setting the voltmeter on the proper range for a voltage level to be measured, make sure the voltage range is:
   a. lower than the voltage to be measured
   b. higher than the voltage to be measured

16. A parallel connection is an electrical hook-up that has:
   a. two or more electrical current paths
   b. only one electrical current path

Go on to next page.
17. The wires used to connect a meter to an electric circuit or battery are called:
   a. cables
   b. electric power wire
   c. test leads
   d. power cords

18. Terminal jacks on a meter are the points where the test leads are connected to the meter?
   a. true
   b. false

19. The positive (+) test lead is colored red and the negative (-) test lead is colored black.
   a. true
   b. false

20. When measuring D.C. voltage, the terminal jacks to use are marked positive(+) and negative (-) common.
   a. true
   b. false
For the teacher: The pretest (Part I) should be used along with post test evaluation (Part II).

DIRECTIONS:
Use Diagram 6 on the following page. The meter pointer (needle) is shown on positions A, B, and C, and D. Fill in the values of the indicated voltage for each range switch setting that appears in Chart C below Diagram 6.

You are to read the voltage values from the meter scales for the various pointer positions first, then write your answers in Chart C.

There are 20 answers total.
PART II

Post Test

Diagram #6

Range Switch

Chart C

<table>
<thead>
<tr>
<th>Range Switch Position</th>
<th>Voltage Value at Pointer Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting</td>
<td>Range</td>
</tr>
<tr>
<td>V</td>
<td>2.5 V</td>
</tr>
<tr>
<td>W</td>
<td>10 V</td>
</tr>
<tr>
<td>X</td>
<td>50 V</td>
</tr>
<tr>
<td>Y</td>
<td>250 V</td>
</tr>
<tr>
<td>Z</td>
<td>1000 V</td>
</tr>
</tbody>
</table>
Student Activity #2

Referring to Diagram 1 - Deflection of pointer at point:

A = 50 volts
B = 100 volts
F = 215 volts
G = 240 volts

Maximum voltage you can read on the 250 volt scale is 250 volts.

The value of each smaller marking (which have no numbers shown) on the 0-250 volt scale is 5 volts each.

Referring to Diagram 2 - Deflection of pointer at point:

A = 25 volts
B = 60 volts
C = 75 volts
D = 95 volts
E = 135 volts
F = 150 volts
G = 170 volts
H = 185 volts
I = 225 volts
J = 235 volts
STUDENT ACTIVITY #3

Referring to Diagram 1 - Reflection of pointer at point:

- A = 10 volts
- B = 20 volts
- F = 43 volts
- G = 48 volts

Maximum voltage you can read on the 50 volt scale is 50 volts.

The value of each smaller marking (which have no numbers shown) on the 0-50 volt scale is 1 volt.

Referring to Diagram 2 - Deflection of pointer at point:

- A = 5 volts
- B = 12 volts
- C = 15 volts
- D = 19 volts
- E = 27 volts
- F = 30 volts
- G = 34 volts
- H = 37 volts
- I = 45 volts
- J = 47 volts
ANSWER KEY FOR STUDENT ACTIVITIES

Student Activity #4

Referring to Diagram 1 - Deflection of pointer at point:

A = 2 volts
B = 4 volts
F = 8.6 volts
G = 9.6 volts

Maximum voltage you can read on the 10 volt scale is 10 volts.

The value of each smaller marking (which have no numbers shown) on the 0-10 volt scale is .2 volts each.

Referring to Diagram 2 - Deflection of pointer at point:

A = 1 volt
B = 2.4 volts
C = 3 volts
D = 3.8 volts
E = 5.4 volts
F = 6 volts
G = 6.8 volts
H = 7.4 volts
I = 9 volts
J = 9.4 volts
ANSWER KEY FOR PART I OF PRETEST AND EVALUATION

Note: The same test is used for the pretest and evaluation.

Part I:

1. c
2. b
3. c
4. b
5. d
6. a
7. c
8. d
9. d
10. a
11. a
12. c
13. b
14. c
15. b
16. a
17. c
18. a
19. a
20. a

Part II: See following page.
ANSWER KEY FOR POST TEST
PART II

RANGE SWITCH

RANGE SWITCH POSITION

<table>
<thead>
<tr>
<th>SETTING</th>
<th>RANGE</th>
<th>SCALE</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>2.5 V</td>
<td>0-250</td>
<td>0.4 V</td>
<td>1.2 V</td>
<td>1.75 V</td>
<td>2.3 V</td>
</tr>
<tr>
<td>W</td>
<td>10 V</td>
<td>0-10</td>
<td>1.6 V</td>
<td>4.8 V</td>
<td>7 V</td>
<td>9.2 V</td>
</tr>
<tr>
<td>X</td>
<td>50 V</td>
<td>0-50</td>
<td>8 V</td>
<td>24 V</td>
<td>35 V</td>
<td>46 V</td>
</tr>
<tr>
<td>Y</td>
<td>250 V</td>
<td>0-250</td>
<td>40 V</td>
<td>120 V</td>
<td>175 V</td>
<td>230 V</td>
</tr>
<tr>
<td>Z</td>
<td>1000 V</td>
<td>0-10</td>
<td>160 V</td>
<td>480 V</td>
<td>700 V</td>
<td>920 V</td>
</tr>
</tbody>
</table>

ANSWERS
SUPPLEMENTARY MATERIALS

BOOKS:
Exploring Electricity and Electronics
by Howard H. Gerrish & William E. Dugger

FILMSTRIP:
Electrical Measurements
Set of 3 filmstrips
Set 67212

Meters
10 loop set
T 89-3917/1
Cartridged Super 8