

- 11) Correctly complete the following sentence with the appropriate word provided:
Flue gas(es) must be analyzed to check _____ efficiency and the levels of toxic gases.
- a) Combustion
 - b) Natural gas
 - c) Fuel
 - d) Carbon dioxide
- 12) Correctly complete the following sentence with the appropriate word provided:
A _____ measures the difference in “draw” and “no draw” flow pressures
- a) Flue gas analyzer
 - b) Pressure and temperature gauge
 - c) Combustible gas indicator
 - d) Manometer

6. Electrical testing instruments

Overview

Purpose

The gas technician/fitter must use various electrical testing instruments. This Chapter identifies them and describes the basic ways to handle and store them.

Objectives

At the end of this Chapter you will be able to:

- describe the purposes of electrical testing instruments; and
- describe storage and handling requirements of electrical testing instruments.

Terminology

Term	Abbreviation (symbol)	Definition
Amperes	A	Flow rates of electric charge.
Milliamperes (mA)	mA	
Microamperes	μ A	
Ohms	Ω	Measurements of resistance.

- 7) Select the correct manometer pressure reading for the following figure?



- a) 7 inches w.c.
 - b) 4 inches w.c.
 - c) 10 inches w.c.
 - d) 12 inches w.c.
- 8) Select the correct manometer pressure reading for the following figure?



- a) 6 inches w.c.
 - b) 5 inches w.c.
 - c) 3 inches w.c.
 - d) 7 inches w.c.
- 9) Correctly complete the following sentence with the appropriate word provided:
Combustion is a rapid _____ reaction during which oxygen combines with combustible elements of a fuel to release heat energy.
- a) Liquid
 - b) Heat
 - c) Chemical
 - d) Oxygen
- 10) Which of the following is not a temperature measuring device?
- a) Dial thermometer – bimetal
 - b) Slope thermometer
 - c) Spirit-filled thermometer
 - d) Digital thermometers employing thermocouples or infrared technology

Term	Abbreviation (symbol)	Definition
Kilohms	kΩ	
Resistance		The ability of a substance to resist the flow of current.
Volts	V	Measures of electric potential.
Millivolts	mV	
Volts direct current	Vdc	Measure of electric potential in a direct current circuit.
Volts alternating current	Vac	Measure of electric potential in an alternating current circuit.

Purposes of electrical testing instruments

This section enables the gas technician/fitter to recognize various electrical testing instruments and the purpose they serve. Unit 5 *Introduction to Electricity* provides specific information in greater detail.

The testing instruments a gas technician/fitter may encounter while working on electrical equipment will either be permanent or hand-held and portable.

Electrical systems may require a number of different tests to diagnose problems or simply record operating conditions. The following are some common electrical instruments used in the gas industry:

- alternating current (ac) or direct current (dc) voltage meters or combinations of the two;
- amperage meters to read current;
- ohmmeters to read resistance;
- multimeters, which combine the functions of the meters above, and can be used to measure small values of voltages and amperages, among others; and
- power meters to measure wattage and usage.

It is essential to know what type of electrical power you are dealing with. Electrical meters may be analogue or digital:

Type	Description
Analogue meters	Have a scale and pointer. The pointer's movement is directly and continuously related to the measured quantity.
Digital meters	Interpret the measured quantity electronically in discrete numerical data (digits).

Electrical testing instruments come in a variety of different makes, models, and configurations. Depending on the task, the gas technician/fitter will need one or more meters to conduct the testing.

Voltmeters and millivoltmeters

Electrical potential and voltage are measured in volts (V) or millivolts (mV).

Voltmeters measure the difference of electric potential between two points in a circuit. In the field, a multimeter is more commonly used.

An analogue voltmeter operates without batteries. It draws a very small current from the measured circuit. This current drives a pivoted coil to which the pointer is attached. The scale is marked in volts or millivolts.

Ammeters and microammeters

The size of an electric current flow is measured in amperes (A), milliamperes (mA), or microamperes (μ A).

Ammeters measure the current flowing through a circuit. In the field, a clamp on multimeter is more commonly used.

An analogue ammeter operates without batteries. It is inserted into the circuit so that the full current being measured flows through the instrument. The current drives a pivoted coil to which the pointer is attached. The scale is marked in amperes, milliamperes, or microamperes.

Ohmmeters

The ability of a substance to resist the flow of current is called resistance and is measured in ohms (Ω) or kilohms (k Ω).

You can use an ohmmeter to measure both resistance and continuity of a circuit. (An open circuit represents an infinitely large resistance to current flow.) It is easily distinguished from an ammeter or voltmeter because its scale reads from right to left. In the field, a multimeter is more commonly used.

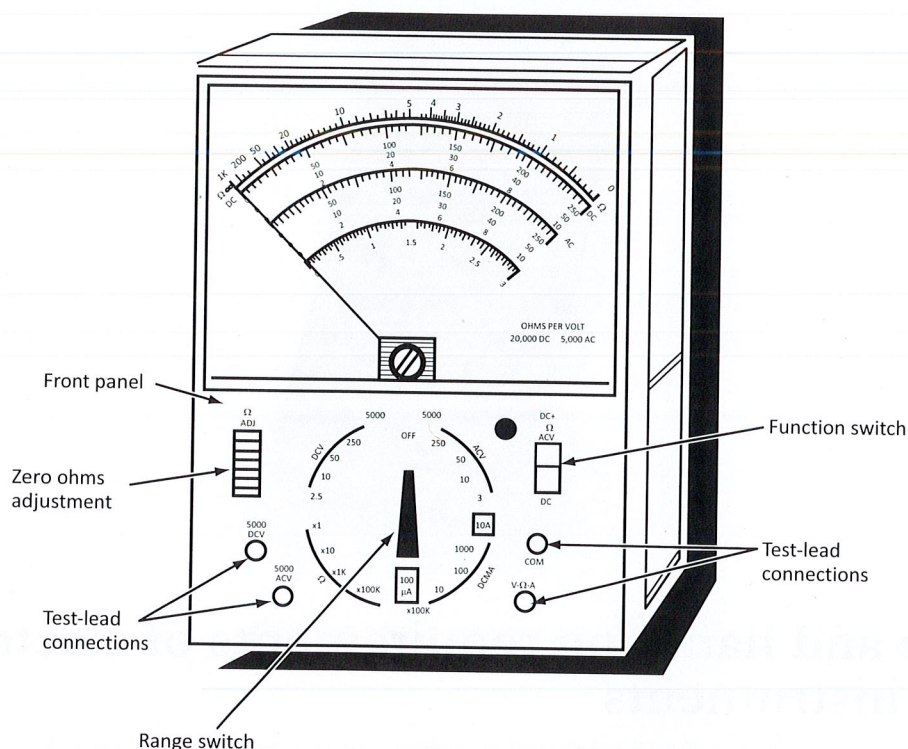
A flashlight type of battery powers the ohmmeter. This drives current through the tested circuit's resistance. This current drives a pivoted coil to which the pointer is attached. Although current is being measured, the scale is marked in ohms.

It is important to set the zero for each measurement. This action also tests the battery. It is also important to switch off the ohmmeter when you finish measuring, so that the battery is not drained.

Multimeters

A multimeter is essentially an ammeter, voltmeter, and ohmmeter combined in a single portable case. It has two advantages: it is easier to carry and less expensive than several single-function meters.

Figure 6-1
Analogue multimeter features



As shown in Figure 6-1, a multimeter has the following features:

- a function switch that sets the meter to measure ac, dc, or resistance;
- a range switch to select the correct range for the voltage, current, or resistance being tested;
- a zero-ohms adjustment knob (this compensates for variations in the internal battery voltage of the meter);
- a zero adjustment for the pointer (zero is set with a screwdriver before each measurement);
- a reset button to restore the instrument to normal operation if the internal circuit breaker shuts off due to overcurrent; and
- several jacks for connecting circuit leads.

The most common multimeter used today is the digital multimeter (DMM). It usually has multiple or auto ranges of use. See Figure 6-2.

Digital multimeter (DMM)

A DMM has all the functions of an analogue multimeter plus advanced features. The primary difference to the technician/fitter is the way the user reads the data. DMMs have extended features depending on the make and model; Unit 5 *Introduction to Electricity* discusses this in more detail.

Figure 6-2
Digital multimeter (DMM)



Storage and handling requirements of electrical testing instruments

The gas technician/fitter uses many varied tools. Some are simple and inexpensive, but others are complex, sensitive, and expensive. For the most part, electrical test instruments fall into the second category.

If you roughly handle or improperly use these instruments, they could be easily damaged. This will render them useless for accurate measurement, which could be dangerous.

To take care of instruments:

Do...	Do not/never...
<ul style="list-style-type: none"> • Store instruments in their cases when they are not in use. • Remove batteries if you must store the instruments for long periods. • Check the battery compartment from time to time to ensure that no corrosion is taking place due to leaking batteries. • Keep a spare set of batteries for digital instruments. Unlike some analogue instruments, they will not function without batteries. • Store test-leads so that they aren't allowed to become damaged—torn insulation, for example, could result in electrocution. 	<ul style="list-style-type: none"> • Allow them to become damp, or expose them to high temperatures and humidity.

Analogue instruments are more delicate than digital instruments—they have moving parts on jeweled bearings and can get out of alignment if badly mistreated. Despite this, they are designed for use in the field and have been around for much longer than digital instruments. Be careful with analogue instruments—do not, for example, allow them to bounce about in the back of a vehicle.

Assignment Questions – Chapter 6

- Which type of electrical meter uses a scale and pointer?
 - The analogue type
 - The digital type
 - The ammeter
- What do voltmeters measure?
 - The amount of resistance in a circuit
 - The amount of load on a circuit
 - The difference of electrical potential between two points in a circuit
- Which type of electrical meter measures the current flowing through a circuit?
 - An ammeter
 - An ohmmeter
 - A voltmeter
- In what Units is the resistance of an electrical circuit measured?
 - Amps
 - Ohms
 - Volts

- 5) Which type of electrical meter combines a voltmeter, ohmmeter, and ammeter in one Unit?
- a) An ohmmeter
 - b) An ammeter
 - c) A multimeter
 - d) A voltmeter
- 6) Which type of meter measures both resistance and continuity?
- a) An ohmmeter
 - b) A millivoltmeter
 - c) An ammeter
 - d) A multimeter
- 7) Which type of meter measures ac, cd, or resistance?
- a) A multimeter
 - b) A voltmeter
 - c) A wattmeter
 - d) An ammeter
- 8) Correctly complete the following sentence with the appropriate word provided:
It is essential to know when using an electrical meter, whether the power source is _____ current or direct current.
- a) Unused
 - b) Alternating
 - c) Stored
 - d) Power
- 9) Correctly complete the following sentence with the appropriate word provided:
Electrical test instruments should not be exposed to high temperature or _____.
- a) Low temperature
 - b) Dry atmospheres
 - c) Humidity
- 10) Correctly complete the following sentence with the appropriate word provided:
A test-lead _____ is potentially dangerous and could result in electrocution.
- a) With a thicker cord
 - b) That is very long
 - c) That is missing insulation
 - d) With a lot of insulation