



Lecture-17

Automotive Measurement and Math (Part B)

Contents

- ❑ Other measurements and measuring tools
- ❑ Using basic mathematics

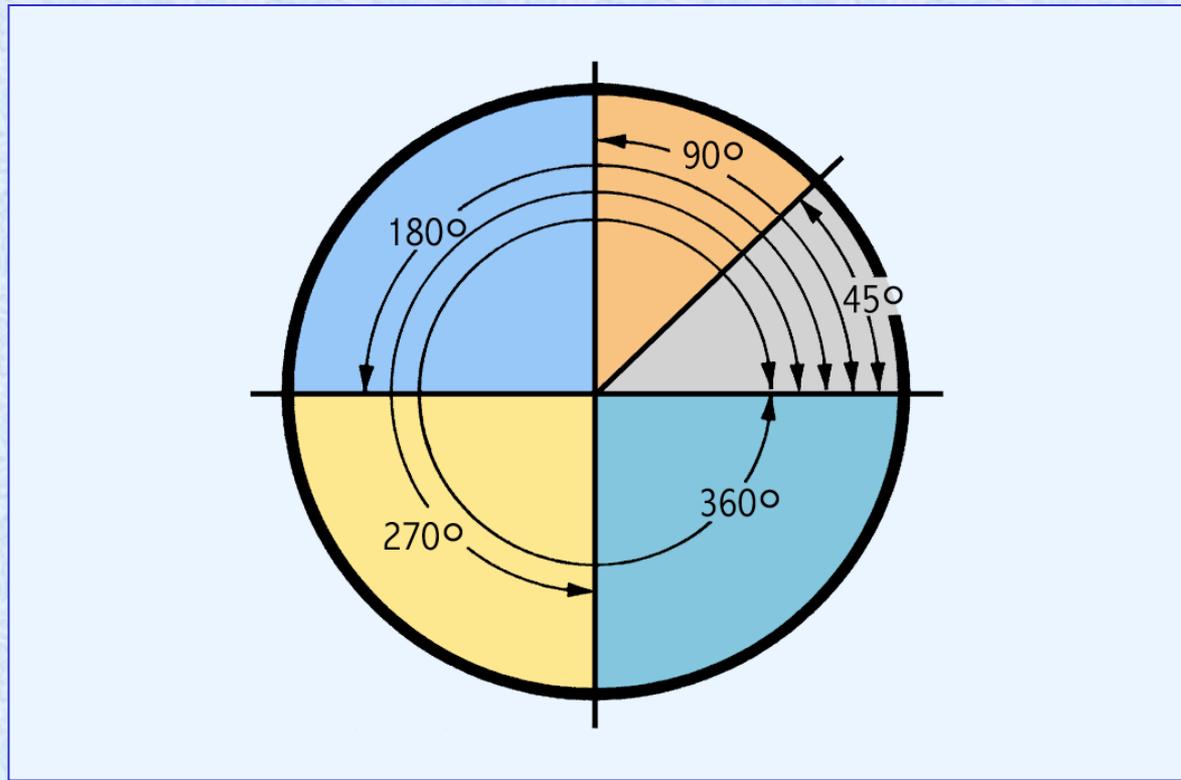
Other Measurements and Measuring Tools

A technician may make other types of measurements and use other types of measuring tools

Angle Measurement

- A circle can be divided into 360 equal parts, called degrees
 - abbreviated “deg.” or the symbol ($^{\circ}$)
- Specifications are normally given in degrees when you are measuring rotation of a part or an angle formed by a part

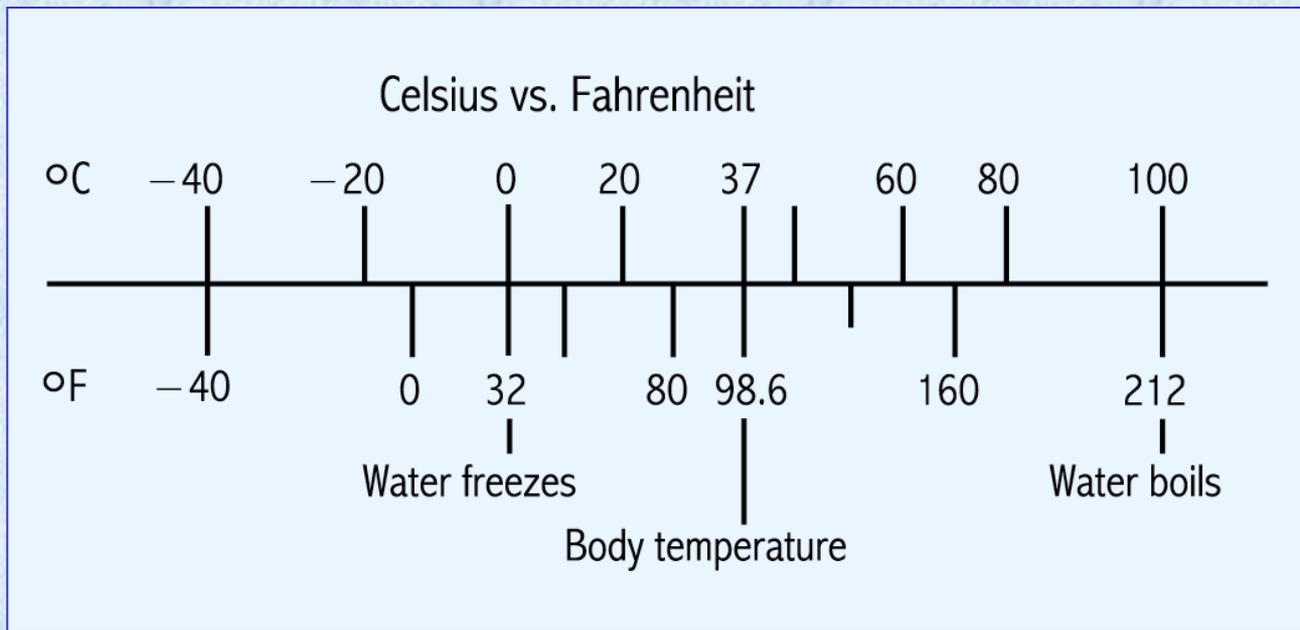
Angle Measurement



Temperature Measurement

- ❑ Temperature gauges, or thermometers, are used to measure temperature
- ❑ Temperature may be read in either customary Fahrenheit (F) or metric Celsius (C)

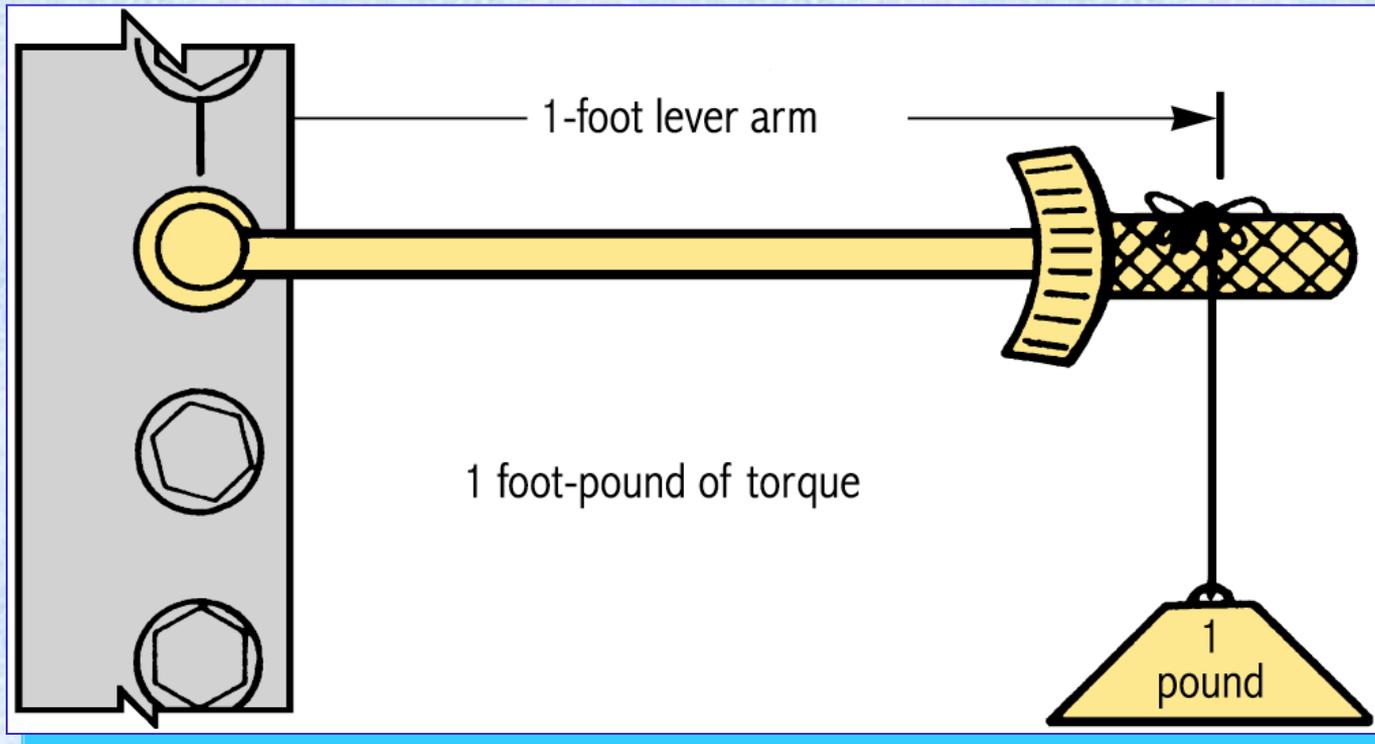
Temperature Measurement



Torque Wrench

- ❑ Used to apply a specific amount of turning force to a fastener, such as a bolt or nut
- ❑ Scales usually read in foot-pounds (ft-lb) and Newton-meters (N•m)

Torque Wrench Theory



One foot-pound equals one pound of pull
on a one-foot-long lever arm

Flex Bar Torque Wrench



Uses a bending metal beam to make the pointer read torque on the scale

Dial Indicator Torque Wrench



Very accurate type of torque wrench

Ratcheting Torque Wrench



Torque value is set by turning the handle.
The fastener is tightened until the wrench
clicks.

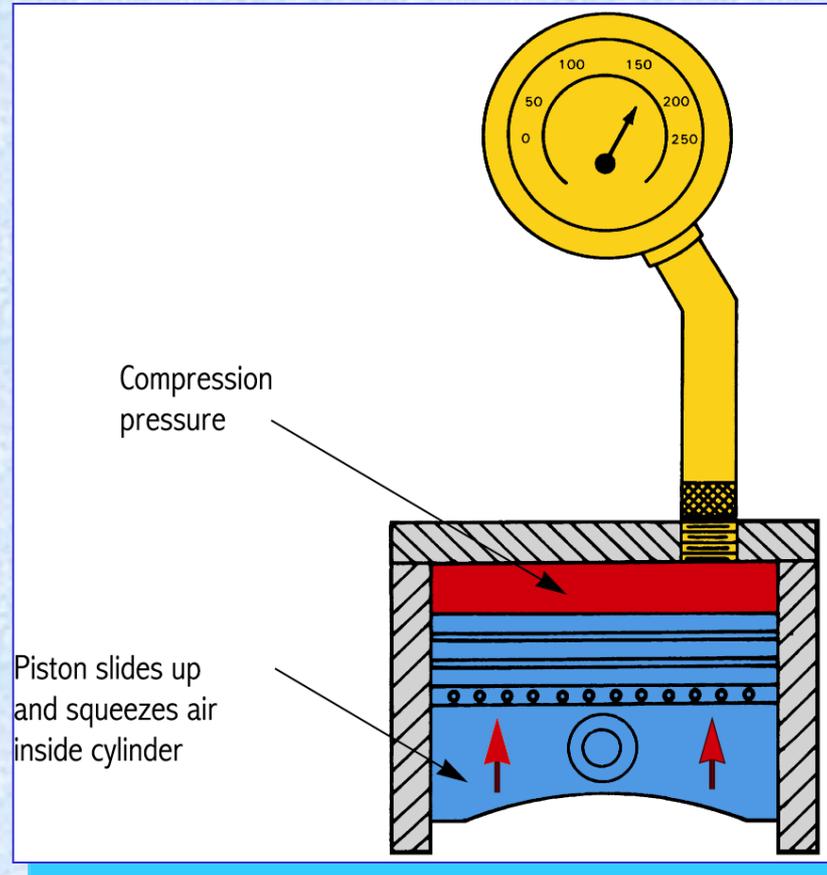
Pressure Gauge

- ❑ Used to measure air and fluid pressure
- ❑ Common units of measure found on the pressure gauge scale:
 - pounds per square inch (psi)
 - kilograms per square centimeter (kg/cm²)
 - kilopascals (kPa)

Pressure Gauge

- Common pressure measurements taken in the automotive shop:
 - tire air pressure
 - fuel pump pressure
 - air conditioning system pressure
 - engine compression pressure

Pressure Gauge



Using a pressure gauge to measure engine compression pressure

Vacuum Gauge

- ❑ Used to measure negative pressure, or vacuum
- ❑ Common units of measure found on the vacuum gauge scale:
 - inches of mercury (in./hg.)
 - kilograms per square centimeter (kg/cm²)
- ❑ Used to measure engine intake manifold vacuum and vacuum solenoid functions

Using Basic Mathematics

- ❑ Automotive technicians often use mathematics
- ❑ Technicians must be able to add, subtract, multiply, and divide
- ❑ Technicians must also be able to work with fractions and decimals

Addition

- ❑ Combining two or more numbers to find the total quantity or number of something
- ❑ Result is called the sum or total

Addition

- Numbers may be written in a string:

$$5 + 3 + 4 = 12$$

- Numbers may be written in a column:

$$\begin{array}{r} 5 \\ 3 \\ \underline{+4} \\ 12 \end{array}$$

Addition

- ❑ When there are large numbers or a long series of numbers, it is best to write them in a column so sums of 10 and over can be carried to the next column
- ❑ Always start adding from the right-hand column so that sums exceeding 9 can be carried from that column to the next column to the left

Addition

- ❑ Used in adding up the cost of parts and labor when preparing a bill
- ❑ If parts total \$125, labor charges are \$95, and tax is \$8, what is the total bill?

$$\begin{array}{r} \$125 \\ 95 \\ \underline{+8} \\ \$228 \end{array}$$

Subtraction

- ❑ Taking away a certain quantity from another
- ❑ Amount left after subtracting is the remainder or difference

Subtraction

- ❑ Numbers may be written in a string:

$$495 - 125 = 370$$

- ❑ Numbers may be written in a column:

$$\begin{array}{r} 495 \\ -125 \\ \hline 370 \end{array}$$

Subtraction

- A customer's bill totaled \$253, but there had been a \$25 deposit before the work was done. What is the amount due?

$$\begin{array}{r} \$253 \\ -25 \\ \hline \$228 \end{array}$$

Division

- ❑ Used to find out how many times one number is contained in another
- ❑ The number being divided is called the dividend
- ❑ The number a dividend is divided by is called the divisor
- ❑ The answer is called the quotient

Division

Numbers may be written in three ways:

$$860 \div 10 = 86$$

or:

$$\frac{860}{10} = 86$$

or:

$$10 \overline{) 860} = 86$$

Division

- Ten fuel pumps had been ordered and placed in stock
- The total bill for the pumps came to \$860
- What is the cost of each fuel pump?
- The cost of each pump is \$86

Multiplication

- ❑ Shortcut for adding the same number over and over
- ❑ Result is called the product

Multiplication

- ☐ Numbers may be written in a string:

$$15 \times 12 = 180$$

- ☐ Numbers may be written in a column:

$$\begin{array}{r} 15 \\ \times 12 \\ \hline 180 \end{array}$$

Multiplication

- A customer purchased four new tires at a cost of \$104 each
- What is the price for the four tires?

$$\begin{array}{r} \$104 \\ \times 4 \\ \hline \$416 \end{array}$$

Fractions

- ❑ Used to represent a portion of a whole number
- ❑ Fractions are written as two numbers, one over the other or one beside the other:

4 (numerator)
5 (denominator)

or:

4/5

Decimal Fractions

- ❑ Also have a denominator
- ❑ Denominator is always a multiple of 10, but it is never written
- ❑ A decimal point is used in its place—
 $9/10$ is written as 0.9

Decimal Fractions

The number of digits to the right of the decimal point tells what multiple of 10 the denominator is:

0.9 is $9/10$

0.09 is $9/100$

0.009 is $9/1000$

0.0009 is $9/10,000$

Addition and Subtraction of Decimals

- Line up the decimal points in a column
- The decimal point in the answer must be in the same position as the decimal point in the column

$$\begin{array}{r} 1.5 \\ 9.356 \\ 3.62 \\ \underline{.96} \\ 15.436 \end{array}$$

Multiplying Decimals

- ❑ Multiply the two numbers, ignoring the decimal points
- ❑ Count the total number of digits to the right of the decimal points in both of the numbers that were multiplied
- ❑ Starting at the right-hand digit, count to the left the same number of digits in the answer
- ❑ Place the decimal point to the left of the last digit counted

Dividing Decimals

- ❑ Dividing decimals is similar to dividing whole numbers
- ❑ If neither the dividend nor the divisor contains a decimal point but the division does not come out even:
 - place a decimal point to the right of the last number of the dividend
 - add one or more zeros after the decimal and continue dividing

Dividing Decimals

$$\begin{array}{r} 7.71 \\ 7 \overline{) 54.00} \\ \underline{49} \\ 50 \\ \underline{49} \\ 10 \\ \underline{7} \\ 3 \end{array}$$

Dividing Decimals

- When the dividend has a decimal and the divisor does not:
 - divide as usual
 - place a decimal point in the answer directly above the decimal point in the dividend
 - it will occur at the time that the division process moves past the decimal point

Dividing Decimals

$$\begin{array}{r} 2.01 \\ 25 \overline{) 50.25} \\ \underline{50} \\ 02 \\ \underline{0} \\ 25 \\ \underline{25} \\ 0 \end{array}$$

Dividing Decimals

- When the divisor has a decimal point:
 - if the dividend does not have a decimal point, add one at the far right
 - if the dividend has a decimal point, move it one place to the right for each decimal place in the divisor
 - move the decimal point in the divisor accordingly to the right
 - use zeros as place holders, if necessary

Dividing Decimals

$$2.5 \overline{) 50.25}$$

$$\begin{array}{r} 20.1 \\ 25 \overline{) 502.5} \\ \underline{50} \\ 02 \\ \underline{0} \\ 25 \\ \underline{25} \\ 0 \end{array}$$

Place a decimal point in the answer directly above the relocated decimal point in the dividend