

COMMON WRENCHES

INTRODUCTION

A wrench is a hand tool used to provide grip and mechanical advantage in applying torque to turn objects—usually nuts and bolts.

Wrenches allow us to use less force to rotate a nut compared to using our hands and fingers. The longer the handle of the wrench, the more force we can apply.

There are three variations of a common wrench: Open end wrench; Box end wrench; and a combination wrench.

Common wrenches are also called ***Spanners***.



☐ Completed

Preparation

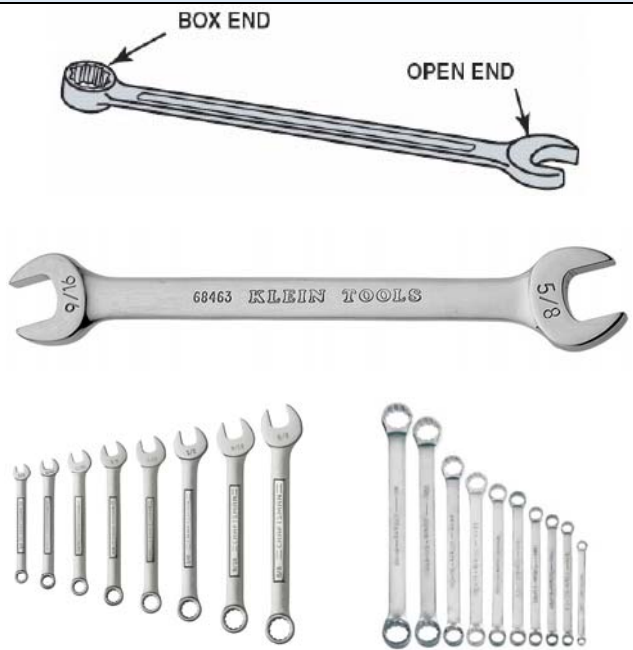


- Determine any required Personal Protection Equipment.
- Inspect tools to ensure working condition.
- Be aware of any dirt or grease build-up on tools or hands that would reduce a firm grip.

REQUIRED ITEMS


- ☐ Assorted wrenches
 - ☐ Open-end, Box-end, Combination.
 - ☐ High offset box-end
 - ☐ Very big
 - ☐ Tiny
- ☐ Gloves for protection in tight and dangerous areas
- ☐ Eye protection when having to pound on equipment
- ☐ Items required for Hands-On Instruction and Student Exercises

PHYSICAL CHARACTERISTICS

OVERVIEW	
<p>A common wrench has a straight shank and two ends. The ends are a fixed size designed specifically to fit over certain sized bolt or nut. An end of a wrench may be open end or box end.</p> <p>The width of the wrench ends are typically stamped on the wrench ends or on the shank near the ends.</p> <p>Wrenches are very strong and tough. They are made from chromium-vanadium alloy steel using a drop-forged process. They are frequently chrome-plated to resist corrosion and for ease of cleaning.</p> <p>Common wrenches are typically sold in sets containing a variety of end sizes to match the many different sizes of nuts and bolts.</p>	

☐ Completed

Special Note: Wrenches are designed to fit onto a bolt or a nut. For the remainder of this document when referencing the operations of a wrench, instead of saying “bolt or nut”, we will simply say “bolt”, with the understanding that a wrench is also used on a nut.

OPEN END WRENCH	
<p>An Open End wrench is a common wrench that both ends have a U-shaped opening that grips two opposite faces of the bolt.</p> <p>Each end is a different size.</p> <p>The openings are typically tilted by 15 degrees.</p>	

☐ Completed – Open end wrench

BOX END WRENCH

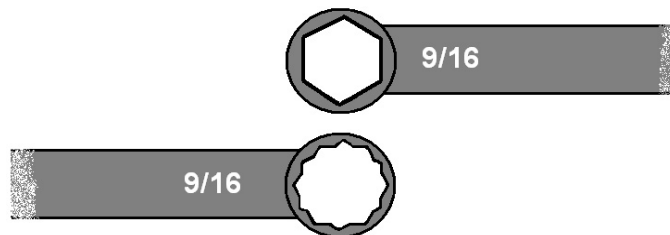
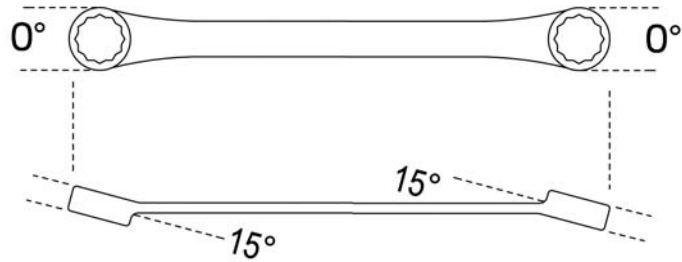
A **Box End** wrench is a common wrench that both ends have an enclosed opening that grips the faces of the bolt.

The box end it often bent at 15 degrees.

Each end is a different size.

The enclosed opening is twelve-points or six-points.

Some varieties of box end wrenches have a deep crook at the ends.

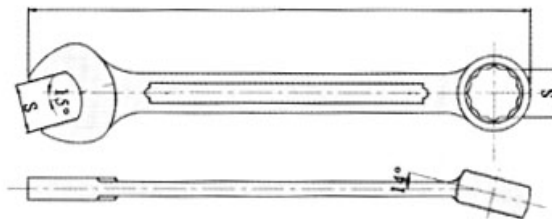


☐ Completed – Box end wrench

COMBINATION WRENCH



A **Combination Wrench** is a common wrench that has both an open end and a box end.

The ends are the *same* size.



Also available is a short or stubby variant of the combination wrench.	
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☐ Completed – Combination Wrench

BOLT SIZES – SAE AND METRIC	
Overview – Worldwide, there are two measurements standards. The Imperial System based on inches (mainly used in the USA) and the metric system based on the millimeter (mainly used by the remainder of the world.)	
<p>SAE – In the early 1900's the Society of Automotive Engineers was formed to establish various standards in the car industry, including the physical characteristics of nuts and bolts. SAE used the imperial measurement standard to specify the size of nuts and bolts. Hence, the tools used to turn SAE bolts are specified as Imperial units of measure.</p> <p>It is also important to note when referencing a size that is less than one inch, the SAE standard is to specify the size in fractions of an inch (such as 1/4, 1/2, and 3/16) rather than decimals (such as 0.25, 0.5, and 0.1875).</p>	<p>Typical SAE wrench sizes (in inches) include:</p> <ul style="list-style-type: none"> • 1/4 • 5/16 • 11/32 • 3/8 • 7/16 • 1/2 • 9/16 • 5/8 • 11/16 • 3/4 • 13/16 • 7/8 • 15/16 • 1 • 1-1/8 
<p>Metric - Metric is the preferred fastener measurement throughout most of the world. Metric specifications of nut and bolt sizes are based on millimeters.</p> <p>While the wrench size chart at the right appears to be whole numbers of millimeters, decimals will be used when a needed. Such as 2.5mm or 6.5mm.</p>	<p>Typical metric wrench sizes include:</p> <ul style="list-style-type: none"> • 6mm • 7mm • 8mm • 9mm • 10mm • 11mm • 12mm • 13mm • 14mm • 15mm • 16mm • 17mm • 18mm • 19mm • 20mm 

☐ Completed – Bolt Sizes – SAE and Metric

HANDS ON INSTRUCTION – ESTIMATING SIZE

The purpose of this exercise is to visually look at a nut or bolt and guess its size. Assume bolts are SAE size. Remember that the students have yet receive the lesson on scales and rules.

- A. Visualizing one inch. With your fingers, demonstrate one inch. Demonstrate a half-inch. Eighth inch. Sixteenth inch.
- B. Draw two lines on a paper to represent, one inch, half-inch, quarter inch, eighth inch and sixteenth. Try to memorize these sizes.
- C. The mentor will present to the student a nut or bolt. The student is to guess the size, then verify the guess by selecting a wrench of that size and putting it on the bolt.
- D. If the guess is wrong, have the student guess how much more, or less, the size needs to be, then to guess again the size of the wrench.



☐ Completed – Hands On Instruction – Estimating Size

USAGE

GENERAL RULES

Always keep wrenches clean to help prevent rust and to allow a better and firmer grip.

Avoid pounding on a wrench when trying to loosen a tight nut.

Never expose a wrench to excessive heat as high temperature can reduce the strength of the tool by drawing the temper.

SELECTING THE CORRECT WRENCH

There are three factors to consider when selecting the proper wrench. 1. The ease of access to the location of the bolt and any possible interference of the swing of the wrench; 2. The size of the bolt head will determine the size of the wrench you select; 3. The tightness of the bolt if you are loosening a bolt.

1. Accessibility

The location of the bolt head can be a factor in selecting a wrench. The surrounding area around the bolt must have room to swing the wrench. If there is no interference, then any wrench is a possibility.

Depending on the circumstances, and based on your knowledge of the characteristics of each wrench, you may need to select a wrench that provides the best swing clearance when turning the nut. While a full 360-degree clearance would be nice, often it is acceptable to get a half-turn of a nut and then readjust the wrench for another half-turn.



This bolt is completely accessible within the entire surrounding area that the wrench will be swinging.



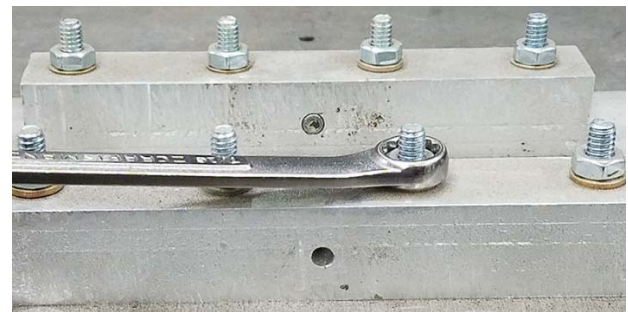
The 15-degree offset of a standard box end wrench can sometimes provide the clearance you need.

SELECTING THE CORRECT WRENCH - CONTINUED

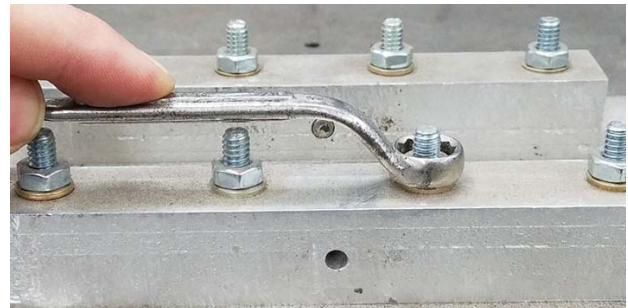
Accessibility (Continued)



Access is somewhat limited. Less than half rotation can be achieved. This may be OK. Would another wrench be better?



The box end wrench offers a 15-degree bend to help clear other objects. But in this case, it is not enough.



A box end wrench with a deep crook will provide full clearance from the surrounding objects.



There is no room over the top of the nut to slide a box end wrench onto the nut. Only an open end wrench can be used.

☐ Completed – Usage – Selecting the Correct Wrench (Accessibility)

SELECTING THE CORRECT WRENCH - SIZE

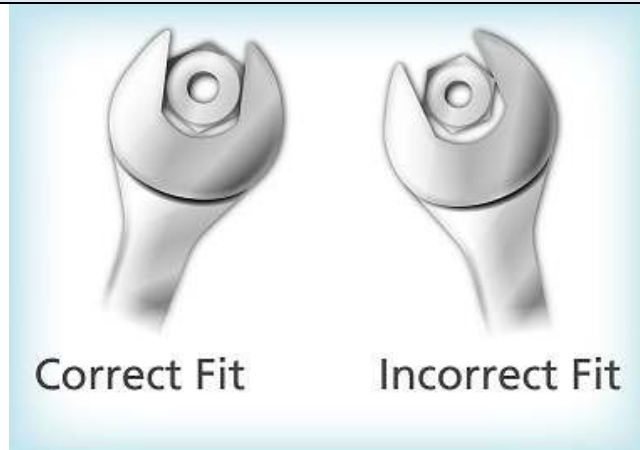
2. Size

Pick a wrench to match the size of the bolt head.

- You must first understand by the context of the situation. Is the bolt SAE or metric?
- Then guess the correct size of wrench based on the size of the bolt. Unfortunately, bolt heads are not marked with its size.

Inexperienced mechanics tend to grab multiple wrenches from the toolbox and hope that one is the correct size. However, you should develop the skill of looking at a bolt and properly identifying its size.

CAUTION: Metric sizes can sometimes appear to be the correct SAE size. Wiggle the wrench to test how correct the fit is. If necessary, return to the tool crib and select a different size wrench.



Make certain the wrench is as snug to the bolt as possible.



A nut becomes “rounded” when the corners of a hex nut or bolt fails. This can occur when a wrench is too big for the nut, or too much force is applied to a very tight nut. In this case, the nut failed to turn and the material on the nut deformed against the high pressure of the wrench.

☐ Completed – Usage – Selecting the Correct Wrench (Size)

SELECTING THE CORRECT WRENCH - TIGHTNESS

When you know that a bolt is relatively new or there is no appearance of rust or damage, it may be assumed that a modest torquing effort will be required to loosen or tighten a nut. As such, selecting any common wrench may be sufficient for this operations.

The challenge occurs when you believe that extra force will be required to loosen a tight or rusted nut.



The open end wrench only applies pressure on two corners of a hex nut. Never apply a large amount of pressure to a hex nut with an open end wrench unless there is no other choice. Once a bolt is loosened with a better wrench, then an open end wrench can be used.



A 12-point box end wrench is better than an open end wrench when more torque is needed for a tight nut. Also, a 12 point box end wrench is easier to work with as it only needs to be rotated 30 degrees to engage another set of flats.



The 6 point box end wrench has twice the surface area in contact with the hex nut so it is less likely to round off the corners of the nut.

TIGHTENING

Finger Tight

Assemble the parts, nuts, bolts and washers as required and ***finger tighten*** the bolt or nut. For new and undamaged hardware, this should result in a light clamping force which requires a wrench to finish the effort by applying the final torqueing, which may be one turn or less.

With self-locking nuts or threads with burrs, your fingers may not be strong enough to spin the nut to the finger tight position. You'll need to use a wrench to turn the nut to its final location, which could be many full turns of the nut. In these cases, the challenge is keeping the wrench on the nut because it tends to easily slip off the nut.

Final Torqueing

Place the wrench onto the nut. Make sure the wrench properly aligned and fully engaged with the nut as much as possible.

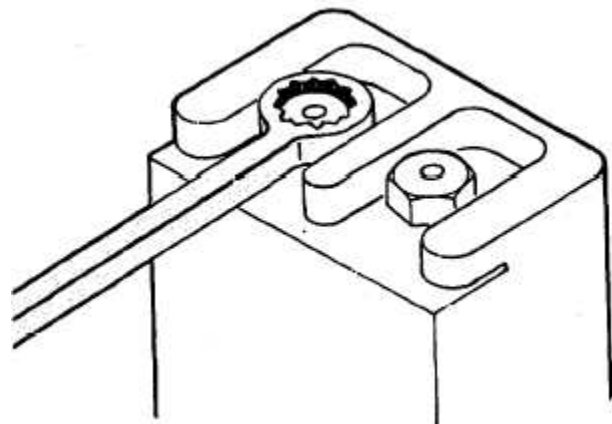
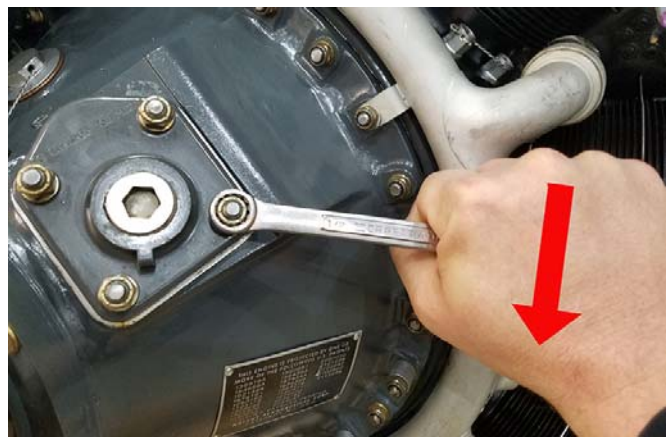
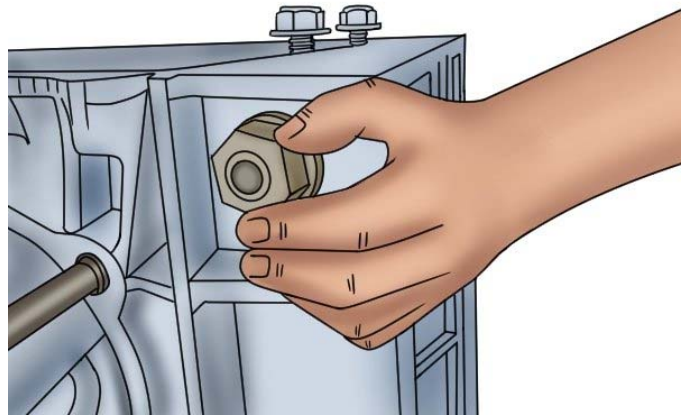
Grip the wrench by wrapping your fingers around the shank of the wrench with your thumb towards the end of the wrench to be used. For more leverage, move your grip further away from the end.

Swing the wrench clockwise to tighten. This is also known as ***Righty-Tighty***.

When tightening a nut, use your senses and experience to avoid over-tightening which can strip or damage a bolt. Some applications require the use of a ***torque wrench*** to apply an exact measured amount of force on a nut or bolt. Torque wrenches are covered in a future section.

Remember, only use an open end wrench when necessary because they are most likely to round off the head of a nut or bolt while tightening. Box end wrenches are best for tightening. If the swing of your wrench is restricted by objects surrounding the nut, you may have to relocate the wrench onto nut.

The phrase ***snug tight*** means to torque the nut more than your fingers could possibly remove, but less than full tightening.

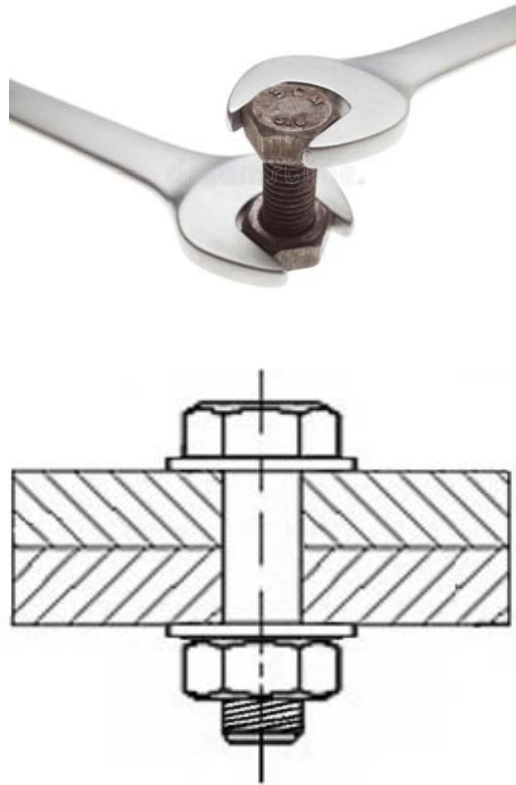


TIGHTENING - CONTINUED

Nut and Bolt

A very common arrangement is a nut and bolt. After the nut and bolt are finger tight you will need two wrenches to finish tightening.

In a situation with a nut and a bolt, try not to rotate the bolt. Only turn the nut. Turning the bolt may scratch or score the bolt, thus weakening it. (One exception is if the nut is a self-locking flange-nut.)



☐ Completed – Usage – Tightening

LOOSENING

Place the wrench onto the nut. Make sure the wrench is properly aligned and fully engaged with the nut.

Grip the wrench by wrapping your fingers around the shank of the wrench with your thumb towards the end of the wrench to be used. For more leverage, move your grip further away from the end.

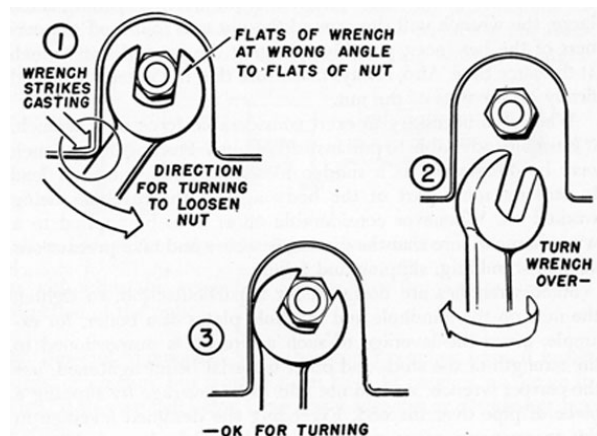
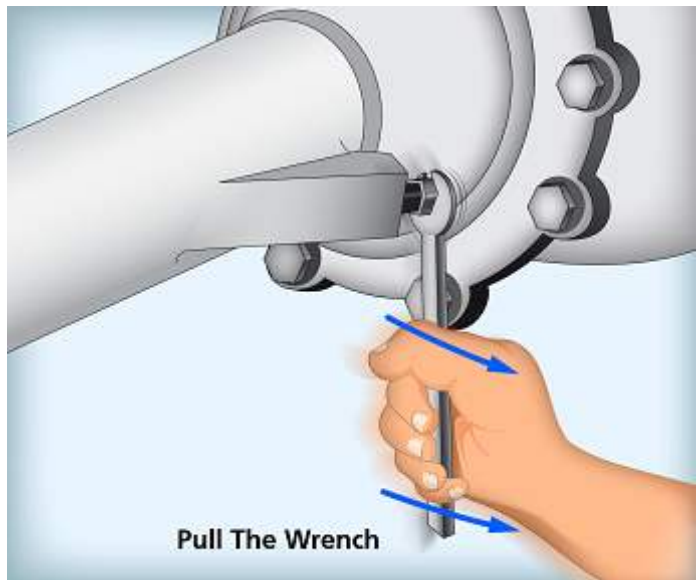
Swing the wrench counter-clockwise to loosen. This is also known as Lefty-Loosey.

When loosening a nut, pull on the wrench to avoid hurting your knuckles if the wrench suddenly breaks loose or if the wrench slips.

- Consider repositioning your body to get the best pulling leverage with your arm and body.
- Consider pulling with your other hand to avoid pushing the wrench.
- If you must push a wrench to loosen a bolt consider wearing gloves if there is a risk of damaging your knuckles.

Remember, only use an open end wrench when necessary because they are most likely to round off the head of a nut or bolt while tightening. Box end wrenches are best for tightening.

If the swing of your wrench is restricted by objects surrounding the nut, you may have to relocate the wrench onto nut.



LOOSENING - CONTINUED

Add leverage

Use a second wrench or a steel pipe to extend the length of the wrench to gain additional leverage.

Careful, this may damage the nut or your wrench.



Penetrating Oil

Add penetrating oil to the threads and wait for the oil to soak into the threads. Penetrating oil helps to loosen debris in the threads and provide lubrication to reduce friction.

Wear eye protection.



Heat

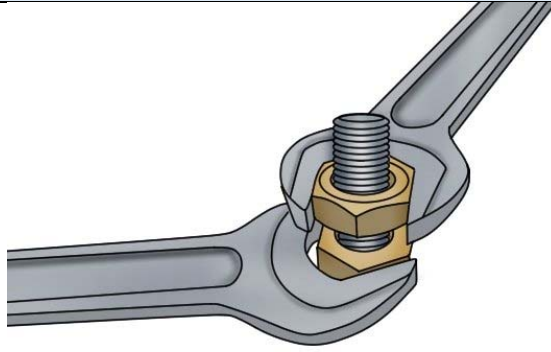
Add heat to the nut or threaded body and a MAP or propane torch. Try to avoid heating the bolt. The intent is to cause the nut to expand more than the bolt thus reducing the tightness and friction. Also, the different expanding surfaces often loosens debris and allows penetrating oil to soak deeper into the threads.



LOOSENING - CONTINUED

Jam Nuts

Tighten nuts against each other and then turn just the bottom nut to remove a stud.



□ Completed – Usage – Loosening

OTHER REAL WORLD SITUATIONS

Square Nut

Although not as common today, you may encounter a bolt or nut that is square-shaped rather than hex-shaped.

Only open end wrench will work on square nuts. A box end wrench will not fit on a square nut.



Machine Screw and Nut

In smaller applications you may encounter a machine screw head that requires a screwdriver. In this case you will be using a wrench on the nut and a screw driver on the machine screw head.



☐ Completed – Usage – Other Real World Situations

HANDS ON EXPERIENCE

- Bolt in a threaded hole.
- Bolt and hex nut that clamp two objects together.
- Bolt and nylon-lock nut that clamp two objects together.
- Nut or bolt that can only be turned a few degrees due to wrench swing interference.
- Snug tight.
- Very tight nut. (Add leverage)
- Removing studs using two jam-nuts.
- Turning a nut that is facing away from you.
- Left-hand thread.
- Wrench application that is neither a nut nor bolt.
- Addle clamp with wires fastened by a machine screw and nut.
- Estimating SAE sizes.
- Estimating metric sizes.

☐ Completed – Hands On Experience

Step 4 – Performance Standards Review

- ☐ Student applied all required safety precautions.
- ☐ Student correctly identified all wrenches listed in the introduction.
- ☐ Student correctly explained and demonstrated the application of each wrench.
- ☐ Student cleaned the work area and properly stored all tools and equipment.

Additional Comments:

Step 5 – Sign-Off

Student: _____

Mentor: _____

Date: _____