

TRANSIT CORE COMPETENCIES CURRICULUM

MECHANICAL TOOLS

Tool Categories

- Ladders
- Elevated Work Surfaces
- Hand Tools
- Measuring Tools
- Vice & Clamps
- Power Tools
- Lifting Tools
- Presses
- Alignment Tools
- Cutting Tools
- Advanced Measuring Tools



Tool Categories

Ladders	6
ELEVATED WORK SURFACES	12
Roof Access Platforms	13
Scaffolding	18
HAND TOOLS	23
Screwdrivers	24
Pry Bar	32
Wrenches	38
Ratchets	43
Sockets & Extensions	48
Torque Wrenches	53
Hammers	61
Punches & Chisels	66
Pliers	72
Basic Hand Cutting Tools	77
Pullers	82
MEASURING TOOLS.....	86
Measuring Tape.....	87
Gauges	91
VICE AND CLAMPS	95
Vices	96
Clamps.....	100
POWER TOOLS	104
Power Drills	105
Power Screwdrivers.....	109
Impact Gun.....	116
Reciprocating Saw	122

Grinding Wheels	126
LIFTING TOOLS.....	133
Chain Hoist.....	134
Electric Crane	138
Come-Along.....	142
PRESSES.....	146
Hydraulic Presses	147
Mechanical Presses	151
ALIGNMENT TOOLS	157
Straightedge	158
Laser Alignment Tools	163
CUTTING TOOLS.....	168
Drill Bits.....	169
Countersink and Reamer.....	174
Cutoff Wheel.....	181
Tap and Die.....	186
Thread Chaser	194
ADVANCED MEASURING TOOLS	199
Calipers.....	200
Micrometers	204
Dial Indicators	208
Appendix	213
Hands-on Learning Activity Template (Sample)	214
Hands-on Learning Assessment Form Template (Sample)	216
Hands-on Learning Activity Template (Blank)	217
Hands-on Learning Assessment Form Template (Blank)	218

Introduction to Mechanical Tools and Reference Guides

Welcome to the Mechanical Tools section of the Transit Core Competencies Curriculum Program. This portion of the course is designed to introduce you to the common tools used in mechanical maintenance and repair work across transit settings. Whether you're new to the field or looking to reinforce your skills, this section will help you build confidence in identifying, using, and caring for essential tools on the job.

What You'll Find in This Section:

Each tool or tool group includes a **comprehensive reference guide** that covers:

- **Tool Overview:** What it is, what it does, and where it's commonly used
- **Key Components:** Parts of the tool and how they function
- **Safety Practices:** PPE and precautions specific to the tool
- **Standard Operating Procedures (SOPs):** Step-by-step guidance on proper use
- **Preventive Maintenance:** How to inspect, clean, and care for the tool
- **Types and Variations:** Examples of the most common types you'll encounter
- **Hands-On Learning Activities:** Suggested exercises to practice safe and effective tool use
- **Videos:** Some reference guides are accompanied by short instructional videos

How to Use These Guides:

- **Before training:** Skim through the guides to get familiar with tool names, visuals, and safety tips.
- **During training:** Use them as a reference during instructor-led demos and hands-on practice sessions.
- **After training:** Revisit the guides when reviewing what you've learned or preparing for tool certification or job tasks.
- **On the job:** These guides can be a valuable resource as you begin using them in real-world situations.



Ladders

Ladders

Ladders

Overview & Safety

Overview

Ladders are essential tools used for reaching elevated areas in various environments, such as construction, maintenance, household tasks, and industrial work. They come in multiple designs and sizes, each suited for specific tasks. They are typically made of aluminum, composite materials, steel and wood. Understanding the different types of ladders, their components and proper usage is critical for safety and efficiency.

Types of ladders include:

- A-frame (step)
- Extension
- Fixed ladder
- Rolling (warehouse)

Key Components:

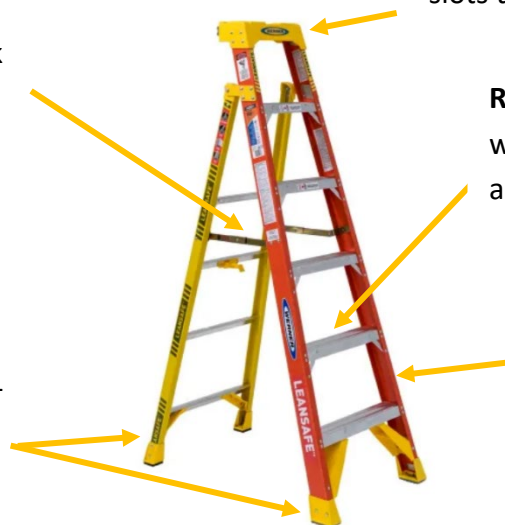
Spreaders (for step ladders): Hinges that lock in place to keep the ladder open.

Feet: The bottom portion that contacts the ground, often equipped with non-slip material for stability.

Top Cap: The top portion of a step ladder, sometimes designed with slots to hold tools.

Rungs/Steps: Horizontal bars where the user steps. Rungs are round, while steps are flat.

Rails (Stiles): The long side pieces that provide structural support for the ladder.



Safety

- ✓ **Weight Capacity:** Always choose a ladder rated for the weight of the user and any tools. Ladders are categorized **into different duty ratings, such as:**
 - **Type IAA:** Extra heavy-duty (375 lbs.)
 - **Type IA:** Heavy-duty (300 lbs.)
 - **Type I:** Industrial (250 lbs.)
 - **Type II:** Medium-duty (225 lbs.)
 - **Type III:** Light-duty (200 lbs.)
- ✓ **Overhead Lines:** Always maintain the proper clearance from any overhead power lines and practice safe working procedures for electrical work. Always wear the proper and inspected personal protective equipment (PPE) such as insulated gloves, insulated boots, safety goggles, hard hats, and more.
- ✓ **Proper Angle:** For extension ladders, the base should be set at a 75-degree angle. This can be tested using the "4-to-1" rule—place the base of the ladder one foot away from the wall for every four feet of height.
- ✓ **Stable Ground:** Place the ladder on a firm, even surface. Never use ladders on slippery or uneven surfaces.
- ✓ **3-Point Contact Rule:** Always maintain three points of contact (two hands and one foot, or two feet and one hand) while climbing or descending a ladder.
- ✓ **Height Limit:** Do not stand on the top two steps of a step ladder or the top three rungs of an extension ladder to prevent tipping over.
- ✓ Do not lean ladders against windows and weak surfaces.

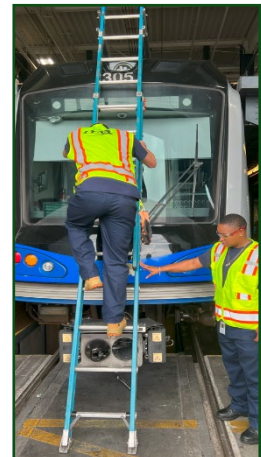
Standard Operating Procedures

Climbing the Ladder

- **Three-Point Contact:** Maintain three points of contact at all times (two hands and one foot or two feet and one hand).
- **Face the Ladder:** Always face the ladder when climbing up or down.
- **Carry Tools Safely:** Use a tool belt or a hoist line to carry tools. Avoid carrying tools in hand while climbing.
- **Move Slowly and Deliberately:** Avoid rushing or skipping steps.

Working from the Ladder

- **Do Not Overreach:** Keep your body centered between the side rails. Move the ladder if necessary to avoid leaning.



- **Use the Correct Rung/Step:** Do not stand on the top two rungs of a step ladder or the top three rungs of an extension ladder.
- **Secure Tools:** Keep tools secure to prevent them from falling. Use tool belts or pouches.

Insulated and Non-Insulated Ladders

- **Insulated Ladders** are ladders that are made with non-conductive materials (like fiberglass) that resist or do not conduct electricity and meet federal guidelines like OSHA and ANSI requirements.
- **Non-insulated ladders** are typically made of metal material (and will not prevent conducting electricity) and will not be safe to use around any electrical hazards.

Preventive Maintenance

Preventive maintenance involves regular inspections, cleaning, and care to ensure the ladder remains safe and functional over time. This process helps identify potential hazards or damage before they lead to accidents or equipment failure. Proper ladder maintenance also extends its lifespan and ensures compliance with safety regulations. Preventive maintenance tasks for ladders include:

Key Steps in Preventive Maintenance for Ladders:

A. Regular Inspections

1. **Check for Structural Integrity:** Look for any cracks, bends, or deformities in the ladder's rails, rungs, or steps.
2. **Inspect Joints and Hinges:** For extension or folding ladders, ensure that all hinges, joints, and locks are functioning smoothly and securely.
3. **Check Rungs/Steps:** Ensure that all rungs or steps are securely fastened, free from cracks, and capable of supporting weight.
4. **Test Non-Slip Surfaces:** Verify that the treads or rungs still provide adequate traction to prevent slips. Verify that the ladder is on a level and stable surface. Adjust the ladder or base, if necessary, to ensure stability.
5. **Inspect the Feet and Pads:** Ensure that the ladder's feet are intact, non-slip, and not excessively worn. Replace any damaged or missing rubber pads.

B. Cleaning:

1. **Remove Dirt and Debris:** Clean the ladder regularly to remove dust, dirt, oil, or grease that could cause slipping or affect stability.
2. **Rust and Corrosion Control:** For metal ladders, check for signs of rust or corrosion. Clean rusted areas and apply anti-rust treatment if necessary.

C. Lubrication:

1. **Lubricate Moving Parts:** For ladders with extendable sections or hinges, lubricate the moving parts (such as pulleys or locks) to ensure smooth operation and prevent jamming or malfunction.
2. **Avoid Over-Lubrication:** Be cautious not to over-lubricate, as excess oil or grease on steps or rungs could create a slipping hazard.

D. Storage:

1. **Store in a Dry Area:** Ladders should be stored in a dry, covered location to prevent rust (for metal ladders) or rotting (for wooden ladders).
2. **Avoid Stacking or Leaning Improperly:** Store the ladder securely in a horizontal position, with proper support along its length, or in a designated ladder storage rack to prevent bending.
3. **Protect from Harsh Environments:** Keep ladders away from direct sunlight or extreme temperatures, which could weaken the materials over time.

Types of Ladders

Commonly Used Ladders	
	A-frame (step) • Description: A self-supporting ladder with flat steps. It opens like a folding frame, providing stability on both sides. • Uses: Ideal for tasks that don't require much height, like painting, changing light bulbs, or accessing shelves. • Height Range: Typically ranges from 4 to 12 feet.
	Extension • Description: A non-self-supporting ladder that can extend in length using sliding sections. • Uses: Designed for high-reach tasks such as roofing, exterior painting, or window cleaning. • Height Range: Can extend up to 40 feet or more. • Best Practice: Inspect the top contact point, ensure it is flat, not slick, and strong enough to hold the forces applied
	Fixed Ladder • Description: Permanently attached to a structure, often found on buildings, tanks, or other tall structures. • Uses: Used for consistent access to specific locations, such as rooftops or equipment platforms. • Height Range: Can be customized to fit specific applications.
	Rolling Ladder • Description: a type of portable ladder that is mounted on wheels or casters, allowing it to be easily moved from one location to another. • Uses: highly versatile and are commonly used in environments that require frequent access to high shelves or storage areas. • Height Range: Come in various sizes ranging from 2 steps – 16+ steps.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a ladder:

- ☐ Select proper ladder for a given task
- ☐ Perform a pre-use ladder inspection
- ☐ Demonstrate proper usage and safety procedures
- ☐ Demonstrate ability to set up a ladder of all types and explain safety procedures
- ☐ Demonstrate the ability to use the ladder and critique the approach (3-points of contact, center of gravity, facing ladder)
- ☐ Other:

Notes/Comments:

A close-up photograph of a yellow metal scaffolding structure, showing various pipes, joints, and cross-braces. The structure is complex and industrial in appearance.

Elevated Work Surfaces

Roof Access Platforms Scaffolding

Roof Access Platforms

Overview & Safety

Overview

Vehicle Roof Access Platforms come in a variety of styles to allow safe access to the roof of buses and other such vehicles. The development of low-floor buses has forced the location of many components up on the roof such as energy storage systems for battery buses, fuel tanks for compressed natural gas and hydrogen fuel cell buses, air conditioning and other equipment.

Commonly used in commercial and industrial settings, these platforms help workers navigate over obstacles like pipes, ducts, or uneven surfaces. They're typically made from durable materials like aluminum or steel and often include features such as platform, handrails, anti-slip surfaces, and ladders or stairs to enhance safety and compliance with workplace regulations.

Types of platforms include:

- Service platforms
- Cross-over platforms
- Step-over platforms
- Ladder platforms

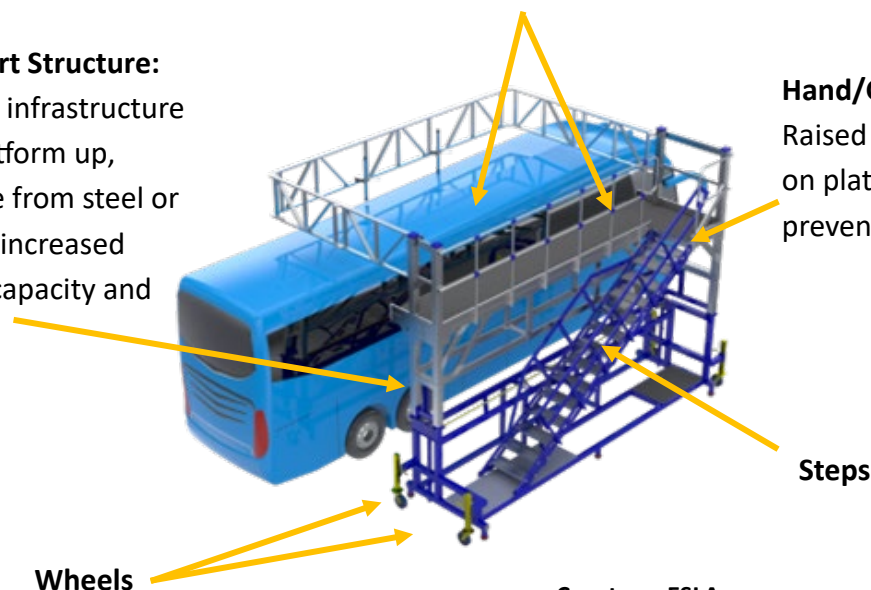
Frame/Support Structure:

Framework or infrastructure that holds platform up, typically made from steel or aluminum for increased load-bearing capacity and durability.

Platform/Deck: Walking surface, usually made from non-slip materials for safe passage and drainage.

Hand/Guardrails:

Raised guard sides on platform to help prevent falls.



Courtesy: ESLA

Safety Considerations

- ✓ **Pre-inspections:** Perform check of all platforms, handrails, and any anchor systems for loose parts, corrosion, structural damage, etc. before use.
- ✓ **Fall Protection:** Inspect guardrails, handrails, and check that they meet regulatory standards and guidelines.
 - Use personal or agency fall-arrest systems if required
 - Keep entry/exit points clear
- ✓ **Slip resistance:** If using outside, use serrated or anti-slip grating and footwear to prevent falls in inclement weather
 - Always maintain three points of contact (two hands and one foot, or two feet and one hand) while climbing or descending a ladder.
- ✓ **Openings:** Keep clear and protect any roof access hatches or self-closing swing gates when not in use.
- ✓ **Check manufacturer guidelines:** Confirm load capacity, load strength and ratings.
Do not exceed weight capacity of number of users.
- ✓ Make sure casters are in a locked position when accessing the platform.

Standard Operating Procedures

Personal Protective Equipment (PPE)

- **Wear the appropriate PPE and additional fall protection gear**
 - a. Hard hat, fall arrest/protection harness, non-slip shoes, high-visibility clothing
- **Carry Tools Safely:** Use a tool belt or a hoist line to carry any tools. Avoid carrying tools in hand while climbing.
- **Move Slowly and Deliberately:** Avoid rushing or skipping steps.

Communication and Supervision

- **Verification:** Use a “three-way” audible verification if moving a vehicle underneath the platform or accessing a vehicle roof. Confirm lockout/tagout has taken place before accessing the vehicle via the platform
- **Keep access openings clear or shut:** Manually close any opening or use self-closing safety gates instead on chains after gaining approval to open a gate.



Courtesy: [ESLA](#)

Preventive Maintenance

Preventive maintenance involves regular inspections, cleaning, and care to ensure the elevated work surface remains safe and functional over time. This process helps identify potential hazards or damage before they lead to accidents or equipment failure. Proper elevated platform maintenance also extends its lifespan and ensures compliance with safety regulations. Preventive maintenance tasks for these include:

Key Steps in Preventive Maintenance for Elevated Work Surfaces:

A. Regular Inspections

1. **Check for Structural Integrity:** Look for any damage, cracks, bends, or deformities (corrosion) in the platform's rails, rungs, or steps.
2. **Inspect Joints, Hinges and Openings:** Ensure that all hinges, joints, openings and locks are tight and function smoothly and securely.
3. **Check Rungs, Steps, and Handrails:** Ensure that all rungs or steps are securely fastened, free from cracks, and capable of supporting weight. Inspect handrails for structural integrity.
4. **Test Non-Slip Surfaces:** Verify that the rungs, treads, and handrails still provide adequate traction to prevent slips. Verify that the platform is on a level and stable surface.
5. **Inspect the Feet and Pads:** Ensure that the platform feet are intact, non-slip, and not excessively worn. Replace any damaged or missing pads.
6. **Schedule regular inspections and servicing:** Consult manufacturer recommendations and regulatory guidelines. Keep a log for all maintenance and inspection activity.

B. Cleaning:

1. **Remove Dirt and Debris:** Clean the platform regularly to remove dust, dirt, oil, or grease that could cause slipping or affect stability.
2. **Rust and Corrosion Control:** Perform an inspection after use for damage or signs of wear. Check for signs of rust or corrosion, and clean rusted areas and apply anti-rust treatment if necessary
3. **Lubricate Moving Parts:** For platforms with extendable sections or hinges, lubricate the moving parts (such as pulleys or locks) to ensure smooth operation and prevent jamming or malfunction.

4. **Avoid Over-Lubrication:** Be cautious not to over-lubricate, as excess oil or grease on steps or rungs could create a slipping hazard.

C. Storage:

1. **Store in a Dry Area:** Platforms should be stored in a dry, covered location to prevent rust.
2. **Protect from Harsh Environments:** Keep away from direct sunlight or extreme temperatures, which could weaken the materials over time.

Types of Platforms

Commonly Used Platforms



Courtesy: ESLA

Vehicle Roof Access Platforms

- **Description:** A type of portable platform mounted on wheels or casters, allowing it to be easily moved alongside the vehicle from one location to another.
- **Uses:** Commonly used in environments that require frequent and safe access to vehicle roofs to access roof-mounted equipment.
- **Height Range:** Come in various configurations to suit a variety of vehicles.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a roof-access platform:

- ☐ Select proper platform for a given task
- ☐ Perform a pre-use inspection
- ☐ Demonstrate ability to set up a platform of all types, proper usage, and explain safety procedures
- ☐ Demonstrate the ability to properly use a vehicle roof access platforms (if applicable)
- ☐ Other:

Notes/Comments:

Scaffolding

Overview & Safety

Overview

Scaffolding in transit refers to temporary structures used to support a work crew and materials while performing maintenance and/or repairs. The most common form will be rolling or mobile scaffolding, which includes frames, tubes, planks, and couplers.

This allows workers to work safely at different heights (depending on the task). Proper handling during transit is crucial to prevent damage, loss, or safety hazards, ensuring that scaffolding arrives ready for safe assembly and use on-site.

Types of scaffolding include:

- Rolling Scaffolding



Safety Considerations

- ✓ Check manufacturer guidelines: Confirm load capacity, load weight, and ratings.
Do not exceed weight capacity of number of users.
- ✓ **Fall Protection:** Inspect guardrails, handrails and toe board installations, and check that they meet regulatory standards and guidelines
 - Use personal or agency fall-arrest systems if required
 - Keep entry/exit points clear
- ✓ **Use locking mechanism:** Ensure brakes are locked when still or unlocked when actively moving a rolling scaffold.
 - Do not allow anyone to be on the platform when moving.
 - Keep the path clear before moving – check for holes, bumps, debris, etc.
- ✓ **Stable Ground:** Place scaffolding on a level, even surface, and secure its anchor. Never use on slippery or uneven surfaces.
- ✓ **Check stability:** Verify that the base remains its structural integrity
 - Do not lean scaffolding against windows and weak surfaces.

Standard Operating Procedures

Personal Protective Equipment (PPE)

- **Wear the appropriate PPE and additional fall protection gear**
- Hard hat, fall arrest/protection harness, non-slip shoes, high-visibility clothing
- **Secure Tools:** Keep tools secure to prevent them from falling. Use tool belts or pouches.
- **Move Slowly and Deliberately:** Avoid moving scaffolding before the path has been confirmed clear.

Communication and Supervision

- **Maintain Visuals:** Keep sight of any personnel or equipment in the path of movement.
- **Tag Systems:** Consider using a tag system to indicate whether a scaffolding platform is safe, unsafe, or may require maintenance. Place tags near eye level.
- **Briefings:** Use a pre-shift briefing to communicate scaffold maintenance status, location, weight limits, etc.



Photo Source: [Safety Platforms Ltd.](#)

Preventive Maintenance

Preventive maintenance involves regular inspections, cleaning, and care to ensure the elevated work surface remains safe and functional over time. This process helps identify potential hazards or damage before they lead to accidents or equipment failure. Proper elevated scaffolding maintenance also extends its lifespan and ensures compliance with safety regulations. Preventive maintenance tasks for these include:

Key Steps in Preventive Maintenance for Scaffolding:

A. Regular Inspections

1. **Check for Structural Integrity:** Look for any damage, cracks, bends, or deformities (corrosion) in the scaffolding's rails, rungs, wheels or steps.
2. **Inspect Joints and Hinges:** Ensure that all hinges, joints, and locks are tight and function smoothly and securely.
3. **Check Rungs/Steps:** Ensure that all rungs or steps are securely fastened, free from cracks, and capable of supporting weight.
4. **Test Non-Slip Surfaces:** Verify that the treads or rungs still provide adequate traction to prevent slips. Verify that the scaffolding is on a level and stable surface. Adjust or reposition, if necessary, to ensure stability.
5. **Inspect the Feet and Pads:** Ensure that the feet are intact, non-slip, and not excessively worn. Replace any damaged or missing pads or wheels.
6. **Schedule regular inspections and servicing:** Consult manufacturer recommendations and regulatory guidelines. Keep a log for all maintenance and inspection activity.

B. Cleaning:

1. **Remove Dirt and Debris:** Clean the scaffolding and platform regularly to remove dust, dirt, oil, or grease that could cause slipping or affect stability.
2. **Rust and Corrosion Control:** Perform an inspection after use for damage or signs of wear. Check for signs of rust or corrosion, and clean rusted areas and apply anti-rust treatment if necessary.
3. **Lubricate Moving Parts:** Check and lubricate the moving parts (such as wheels or locks) to ensure smooth operation and prevent jamming or malfunction.
4. **Avoid Over-Lubrication:** Be cautious not to over-lubricate, as excess oil or grease on steps or rungs could create a slipping hazard.

C. Storage:

1. **Store in a Dry Area:** Scaffolding should be stored in a dry, covered location to prevent rust and corrosion (for metal).
2. **Avoid Stacking or Leaning Improperly:** Store scaffolding securely in a horizontal position, with proper support along its length, or in a designated space to prevent damage.
3. **Protect from Harsh Environments:** Keep scaffolding away from direct sunlight or extreme temperatures, which could weaken the structure over time.

Types of Scaffolding

Commonly Used Scaffolding



Courtesy: ESLA

Rolling Scaffolding

- **Description:** Provides a flexible and convenient solution for various maintenance and repair tasks. This type of scaffolding is mounted on casters, allowing it to be easily moved from one location to another without the need for disassembly.
- **Uses:** Rolling scaffolding is particularly beneficial for projects that require frequent repositioning. Its mobility enables workers to access different areas of a vehicle or job site quickly and efficiently.
- **Height Range:** Come in various configurations to suit a variety of vehicles.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of scaffolding:

- ☐ Select proper scaffold for a given task
- ☐ Perform a pre-use inspection
- ☐ Demonstrate ability to set up a platform of all types, proper usage, and explain safety procedures
- ☐ Other:

Notes/Comments:



Hand Tools

Screwdrivers

Hammers

Pry Bar

Punches & Chisels

Wrenches

Pliers

Ratchets

Pullers

**Sockets &
Extensions**

**Basic Hand
Cutting Tools**

Torque Wrenches

Screwdrivers

Overview & Safety



Overview

A **screwdriver** is a hand tool used for turning screws, typically to drive them into materials or remove them. Screwdrivers come in a variety of types and sizes, each designed to match specific types of screw heads. They are essential in a wide range of automotive applications.

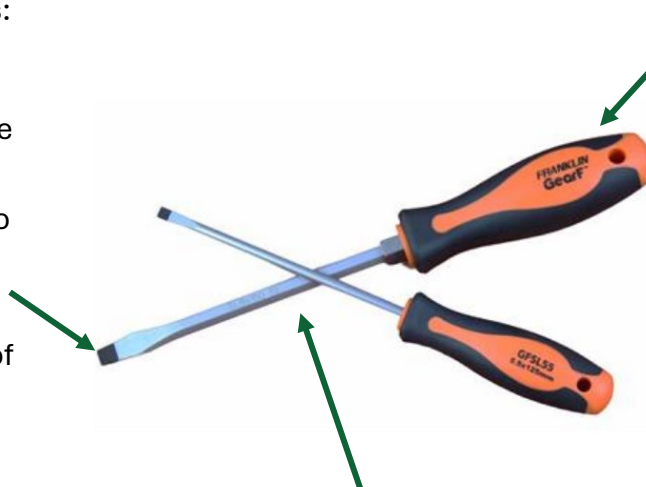
Types of screwdrivers include:

- Flathead (Common)
- Phillips
- Torx
- Hex (Allen)
- Angled
- Ratcheting
- Stubby
- Japanese Industry Standard (JIS)

Key Components:

Tip (Blade):

Working end of the screwdriver, designed to fit into the screw's head. Shape of the tip determines type of screw the screwdriver is compatible with.



Handle: The part that you grip. Often made of plastic, rubber, or wood for comfort and better control.

Shaft (Shank): The long, narrow portion between the handle and the tip, usually made of steel for durability. It transmits torque from the handle to the screw. Some shafts also feature a metal fitting just below handle to allow attachment of a wrench for greater leverage (see top photo).

Safety

- ✓ **Match the Screw Type:** Use the appropriate type of screwdriver (flathead, Phillips, Torx, etc.) that matches the screw head. Using the wrong type can strip the screw or damage the tool.
- ✓ **Correct Size:** Ensure the screwdriver tip fits snugly into the screw head. A poorly fitting screwdriver can slip and cause injury or damage to the workpiece.
- ✓ **Do NOT use it as a prybar, chisel, or punch!**

Standard Operating Procedures

Inspection

Visual Inspection

- **Handle Condition**
 - Check the handle for cracks, chips, or any signs of damage.
 - Ensure that the grip is intact, especially for rubber or plastic-coated handles, which may degrade over time.
 - Look for signs of wear that could cause the tool to slip in your hand during use.
- **Shank (Shaft) Condition**
 - Inspect the shaft for any bends, rust, or corrosion.
 - Ensure that the shaft is straight and free from any physical damage.
 - Rust or corrosion can weaken the screwdriver, making it unsafe to use.
- **Tip Condition**
 - Examine the tip for wear, rounding, or chipping.
 - A worn or damaged tip will not engage properly with screws, increasing the risk of stripping the screw head.
 - Flathead screwdrivers should have a straight blade, while Phillips and other shaped tips should maintain their defined points.

Functional Inspection

- **Tip Condition**
 - a. Check to make sure the tip of the screwdriver is not damaged.
 - b. A damaged tip can cause the screwdriver to slip, strip the screw, damage the tool and possibly cause injury.
- **Handle Security**
 - a. Ensure the handle is securely fastened to the shaft. Any wobbling or movement may indicate internal damage or wear.

Screwdriver Selection

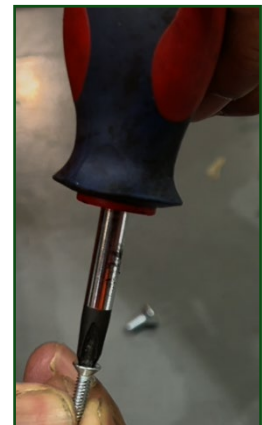
1. **Select the appropriate screwdriver:** Choose the right type (e.g., flathead, Phillips, Torx) and size based on the screw you are working with.
2. **Check for fit:** Check if the tip of the screwdriver fits securely in the corresponding screw head. Try a different size screwdriver for fit if uncertain. With flathead screwdrivers, make sure the tip extends through the entire slotted surface of the screw. Clean inside of the screw head if needed to ensure a solid, slip-free fit.
3. A poorly fitting screwdriver may cause damage to both the tool and the fastener, and may cause personal injury.
4. In space-restricted conditions where a conventional-sized screwdriver will not fit, consider a “stubby” version, one with a shorter shaft and handle for better access, or an angled screwdriver.

Positioning and Grip

5. **Grip the handle properly:** Hold the handle with a firm but comfortable grip.
6. **Apply even pressure:** Align the screwdriver tip with the screw head and press it firmly to prevent slipping.
7. **Avoid excessive force:** Do not apply more force than necessary to prevent damage to the screwdriver, screw, or workpiece.

Driving Screws

- **Insert the screw into the material:** Place the tip of the screw into the designated hole or area on the workpiece. In tight places, or if dropping a screw is a concern, use a magnetic-tip screwdriver or Screw Starter tool (see below) to hold the screw to get it started into the material or threaded opening.
- **Turn the screwdriver:** Rotate the screwdriver in a clockwise direction (for tightening) with steady pressure. Avoid turning too quickly, as this can cause the screwdriver to slip.
- **Check alignment:** Ensure the screw remains aligned with the hole to avoid cross-threading.
- **Drive the screw flush:** Drive the screw until it is flush with the surface of the workpiece, but avoid overtightening, which can strip the screw head or damage the material.



Loosening Screws

- **Insert the screwdriver into the screw head:** Make sure it fits snugly.
- **Rotate counterclockwise:** Turn the screwdriver slowly to loosen the screw.
- **Use proper leverage:** If the screw is stuck, apply even pressure and avoid sudden, jerky movements that could strip the screw head. Again, do not apply more force than necessary. If the screw will not move, try some penetrating oil and/or tapping the head of the screw with a punch of similar same size, careful not to damage the screw head.

Preventive Maintenance

Preventive maintenance on screwdrivers involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

1. Regular Inspections

- **Check for Damage:** Examine the screwdriver for any signs of physical damage, such as cracks in the handle, bent shafts, or worn-out tips.
- **Assess Wear and Tear:** Look for signs of excessive wear, especially on tips (for manual screwdrivers) or gears (for ratcheting screwdrivers).
- **Inspect Moving Parts:** For ratcheting screwdrivers, ensure that all moving parts operate smoothly without unusual noises or resistance.

2. Cleaning

- **Wipe Down:** After each use, wipe the handle and shaft with a clean, dry cloth to remove dirt, grease, and debris.
- **Tip Cleaning:** Use a brush or cloth to clean the tip, ensuring it remains free from rust and contaminants.

3. Lubrication

- Generally, manual screwdrivers have fewer moving parts, but occasionally applying a light machine oil to the shaft can prevent rust and ensure smooth operation.

4. Handling and Storage

- **Proper Storage:** Store screwdrivers in a dry, clean place to prevent rust and corrosion. Use toolboxes, pegboards, or magnetic strips to keep them organized and easily accessible.
- **Protect the Tips:** Use protective caps or sleeves for manual screwdriver tips to prevent damage and maintain their precision.
- **Avoid Moisture:** Ensure that the storage area is free from excessive moisture, which can lead to rusting and deterioration of materials.

5. Handle Maintenance

- **Grip Inspection:** Check the handle for cracks, chips, or loose parts. A damaged handle can affect grip and control, leading to potential accidents.
- **Secure Attachments:** For screwdrivers with interchangeable bits or attachments, ensure that these are securely fastened and in good condition.

6. Replacing Worn Parts

- **Tip Replacement:** For manual screwdrivers, replace worn or damaged tips to maintain effectiveness and prevent slipping. *However, keep in mind that not all screwdrivers will have a replaceable tip.*

Types of Screwdrivers

Flathead 	Phillips 
Tip: A single flat blade that fits into the slot of a screw. Usage: Commonly used for simple slotted screws found in a variety of applications. Pros: Simple design. Cons: The flathead can slip out of the slot easily, potentially damaging the screw or surrounding material.	Tip: A cross-shaped or "+" tip designed for Phillips screws. Usage: Widely used in electronics, automotive and in a variety of applications due to the popularity of Phillips screws. Pros: Provides better grip than flathead, reducing slippage. Cons: Can strip the screw head if too much force is applied or incorrect size tip used.
Torx 	Hex (Allen) 
Tip: Star-shaped with six points, designed for Torx screws. Usage: Common in automotive, electronics, and appliance industries, as well as in some security screws. Pros: High torque transfer with less risk of stripping the screw. Cons: Requires specific Torx screws.	Tip: Hexagonal tip designed for hex screws or bolts. Usage: Automotive, bicycles, and machinery. Pros: Offers better torque and reduces the risk of stripping screws. Cons: Limited to hex screws.

Stubby Screwdrivers 	Ratcheting Screwdrivers 
Tip: Available with a variety of different tips. Usage: Several automotive applications. Pros: Allows easier access when space is limited. Cons: May not offer the same grip leverage	Tip: Accepts a variety of different tips. Usage: Applicable to several automotive applications. Pros: Helps maintain contact with screw without resetting your grip between twists. Accommodates interchangeable bits.
Screw Starter 	Angled Screwdriver 
Tip: Flatheads and Phillips Usage: Variety of applications where access to screws is limited due to space constraints. Pros: Offers access to screws in tight placed where handled screwdrivers may not fit. Cons: Reduced leverage.	Tip: Flathead and Phillips Usage: Variety of applications where inserting screws may be difficult due to limited space. Pros: Grips screw head. Thin profile allows screw to be started in tight spaces or where dropping screw may be an issue. Cons: Screw may become dislodged from tool if not properly secured.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a screwdriver:

- ☐ Provide different size drives and screws to show proper driver selection
- ☐ Install and remove different screws with different drivers
- ☐ Use a screw starter to insert screw
- ☐ Other:

Notes/Comments:

Pry Bar

Overview & Safety

Overview

A pry bar is a hand tool designed to apply leverage for lifting, prying, separating, aligning, or removing components. Pry bars are commonly used in transit maintenance to separate tightly fitted parts, remove seals or trim pieces, align bolt holes, and assist with equipment installation or removal. They are designed to withstand high loads while providing controlled leverage.

Common types of pry bars include:

- Flat Pry Bar/Utility Pry Bar*
- Rolling Head/Heel Pry Bar
- Aligning (Taper) Pry Bar*
- Pinch Bar

*flat pry bars and aligning pry bars are typically the most commonly used.

Key Components:

Handle:

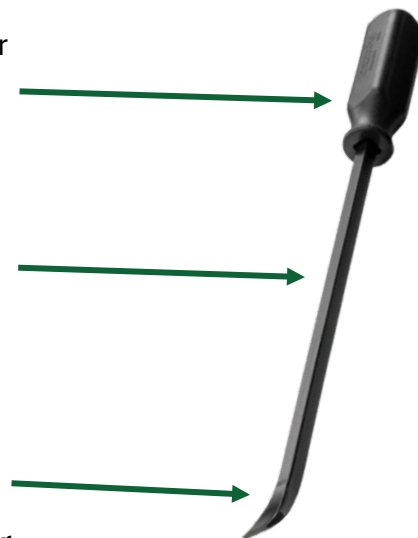
The section the user grips. Some pry bars have textured or rubber-coated handles for improved comfort and grip.

Shaft:

The main body of the pry bar, typically constructed from hardened steel to withstand bending forces while transmitting leverage.

Working End (Tip):

The angled, tapered, or curved end designed to fit into narrow gaps and apply leverage. Different tip styles are intended for different applications such as prying, aligning, or lifting.



Safety

- ✓ Wear safety glasses to protect against flying debris or sudden movement of components.
- ✓ Select the correct pry bar length and style for the task. Longer pry bars provide greater leverage but require more control.
- ✓ Position your body to the side of the pry bar's path in case the tool slips.
- ✓ Keep hands and fingers clear of pinch points while applying force.
- ✓ Inspect the work area to ensure components are properly supported before prying.
- ✓ **Do NOT use a pry bar as a striking tool, chisel, punch, or hammer unless it is specifically designed for that purpose.**
- ✓ **Never extend the handle with a pipe ("cheater bar") to gain additional leverage**

Inspection

Visual Inspection

- **Handle Condition**
 - Check for cracks, chips, or excessive wear.
 - Ensure grip surfaces are secure and free of oil or grease.
- **Shaft Condition**
 - Inspect for bends, cracks, corrosion, or excessive wear.
 - Ensure the shaft is straight and free of damage.
- **Tip Condition**
 - Check the working ends for mushrooming, excessive wear, cracks, or deformation.
 - Ensure beveled edges remain properly shaped.

Functional Inspection

- Structural Integrity
 - a. Verify the pry bar is rigid and shows no signs of flexing or cracking.
- Working End
 - a. Ensure the tip fits securely into the work area without slipping excessively.

Pry Bar Selection

1. Choose the appropriate pry bar based on the amount of leverage needed and the available working space.
2. Select the proper tip style for the application:
 - a. Flat tips for separating parts
 - b. Rolling head styles for controlled leverage
 - c. Tapered tips for aligning holes
3. Use the shortest pry bar that safely performs the task. Longer pry bars create greater force but reduce control.
4. Never substitute another tool (such as a screwdriver) when a pry bar is required.

Positioning and Grip

5. Grip the pry bar firmly with both hands whenever possible.
6. Position the tip securely against a solid surface before applying force.
7. Apply slow, steady pressure rather than sudden jerking motions.
8. Keep your body balanced and avoid placing yourself directly in the path of the tool if it slips.

Using a Pry Bar

- Insert the working end into the gap or contact point. Ensure the pry bar is seated securely before applying force.
- Use controlled leverage to lift, separate, align, or reposition the component.
- Reposition the tool as necessary rather than applying excessive force.
- Stop immediately if the pry bar begins slipping or if excessive force is required.

Preventive Maintenance

Preventive maintenance helps ensure the pry bar remains safe and effective throughout its service life.

1. Regular Inspections

- Inspect for bent shafts, cracked steel, worn tips, or corrosion.
- Remove damaged pry bars from service.

2. Cleaning

- Wipe clean after each use.
- Remove grease, dirt, rust, and debris.

3. Rust Prevention

- Apply a light coat of oil when storing for extended periods.
- Store in a dry environment.

4. Storage

- Store on pegboards, tool racks, or in toolboxes where the tips will not become damaged.
- Keep pry bars organized by size and style.

Types of Pry Bars

Commonly Used Pry Bars	
Flat pry bar 	Versatile pry bar that is commonly used for nail pulling, prying, and disassembly and removal of materials in light construction jobs and home materials. It is a carpentry type pry bar. Photo source: Stanley Uline
Angled End Pry Bar 	Pry bar that is longer and features a bent tip with a plastic or rubber handle. Typically used for lifting, tight space applications, and pushing and prying assemblies apart. Photo source: Tekton
Aligning pry bar 	This pry bar has a straight shaft with one chiseled flat end and a longer, tapered pointed end, commonly used for prying assemblies apart and aligning holes, particularly in heavy duty applications like auto and construction work. Photo source: Grainger
Rolling Head/Heel pry bar 	A pry bar with a curved rolling head edge that rolls against a work surface as a built-in fulcrum to create higher mechanical leverage during lifting. Typically used for simple disassembly prying, seal removal, and alignment applications. Photo source: Amazon

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a pry bar:

- ☐ Compare different pry bar lengths and discuss how leverage changes.
- ☐ Practice separating two fitted components without damaging either surface.
- ☐ Use an aligning pry bar to line up bolt holes before fastener installation.
- ☐ Demonstrate proper body positioning while applying leverage.
- ☐ Compare the effectiveness of different pry bar styles for the same task.
- ☐ Other:

Notes/Comments:

Wrenches

Overview & Safety

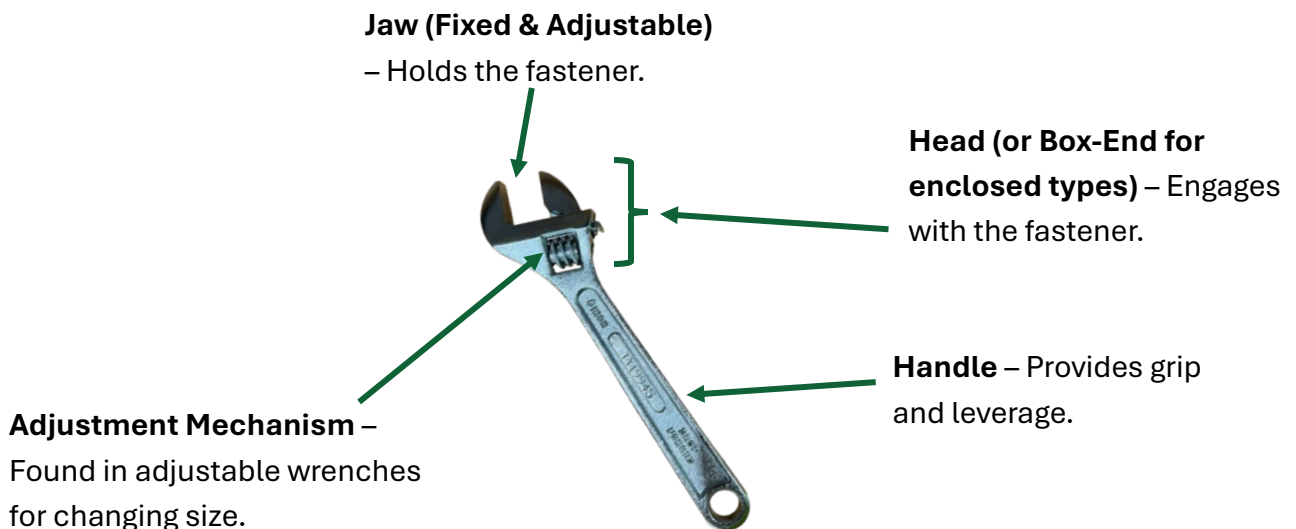
Overview

A **wrench** is a hand tool used to apply torque to fasteners such as nuts and bolts, allowing them to be loosened or tightened. Wrenches come in various types; each designed for specific applications.

Types of wrenches include:

- Adjustable Wrench
- Box-End Wrench
- Combination Wrench
- Open-End Wrench
- Pipe Wrench

Key Components:



Ratchet Mechanism – Present in ratcheting wrenches for continuous turning motion.

Safety

General Safety Tips

- ✓ Always use the **right size wrench** to prevent slippage.
- ✓ **Pull** rather than push a wrench to avoid injury if it slips.
- ✓ Ensure the **wrench is fully seated** on the fastener before applying force.
- ✓ Avoid using a “**cheater**” (i.e., use of another wrench on the other end to gain more leverage) as it may break the tool.
- ✓ Do not **strike a wrench** unless it's designed for that purpose.
- ✓ Keep hands away from pinch points and fast-moving parts.
- ✓ Inspect wrenches regularly for **cracks, worn edges, or deformations**.

Standard Operating Procedures

Select the Proper Wrench

- Choose the right size and type for the job.
- Ensure a **tight fit** on the fastener.

Position the Wrench Correctly

- Place it squarely on the nut or bolt.
- Avoid placing excessive stress on one side.



Apply Force Properly

- Pull towards your body rather than pushing away.
- Use steady, controlled force instead of jerky movements.

Tighten or Loosen Fasteners

- Turn **clockwise (right) to tighten** and **counterclockwise (left) to loosen** (unless it's a reverse-threaded fastener).
- Use a **torque wrench** for precision tightening when required.



After Use

- Clean the wrench and return it to its designated storage location.
- Report and replace any damaged tools.

Preventive Maintenance

Preventive maintenance of wrenches involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

- ✓ **Cleaning** – Wipe off dirt, grease, and debris after each use.
- ✓ **Lubrication** – Apply a small amount of oil to moving parts (e.g., adjustable wrenches and ratchets).
- ✓ **Storage** – Keep wrenches in a **dry place** to prevent rust.
- ✓ **Inspection** – Check for wear, cracks, or rounded edges regularly.
- ✓ **Avoid Overloading** – Do not exceed the wrench's designed torque capacity.

Types of Wrenches

Commonly Used Wrenches

Box-End Wrench 	Encloses the fastener head for a more secure grip.
Open-End Wrench 	U-shaped opening to grip two opposite faces of a fastener.
Combination Wrench 	Open-end on one side and box-end on the other.
Adjustable Wrench (Crescent Wrench) 	Movable jaw for different sizes of fasteners.
Pipe Wrench 	Used for gripping and turning pipes.
Flare Nut Wrench 	Special open-end wrench for use with flare fittings (i.e., those on hydraulic brakes).

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a wrench:

- ☐ Demonstrate the selection of an appropriately sized wrench for the type of fastener being used
- ☐ Demonstrate how to use box end wrench
- ☐ Demonstrate how to use open end wrench
- ☐ Other:

Notes/Comments:

Ratchets

Overview

Overview

A **ratchet** is a tool used with sockets and extensions to tighten or loosen fasteners, primarily nuts and bolts. The benefit of ratchets is that they allow motion of handle travel in one direction, which can be changed to either tighten or loosen fasteners. A ratchet may also be known as a socket wrench.

For example, instead of rotating the tool handle a full 360-degrees clockwise to tighten a fastener, you can stop at any point and “freewheel” the handle back in the other direction to any point when you’re free to resume the tightening. To loosen a fastener, you activate a lever or other device on the tool, and it works in reverse.

Check here for more detail: <https://toolsadvisers.com/what-is-a-ratchet-tool/>

Photo source: [The Home Depot](#)



Safety Considerations

- ✓ **Inspect Before Use:** Check for cracks, worn teeth, or damaged mechanisms in the ratchet head or handle.
- ✓ **Use the Right Size Tool:** Ensure the ratchet and socket match the fastener size to prevent slipping or rounding.
- ✓ **Avoid Over-Torquing:** Do not exceed the tool's rated torque; use a torque wrench if precise force is needed.
- ✓ **Use in Proper Direction:** Confirm the ratchet is set to the correct direction (tighten or loosen) before applying force.
- ✓ **Maintain a Firm Grip:** Always grip the handle securely and pull (rather than push) when possible to reduce injury risk.
- ✓ **Keep Hands Clear:** Watch for pinch points, especially when working in tight or confined spaces.
- ✓ **Don't Use as a Hammer or Pry Bar**
- ✓ Only use the tool for its intended purpose to avoid damaging it or injuring yourself.
- ✓ Always use the **right size socket with a ratchet** to prevent slippage.
- ✓ Ensure the **ratchet is fully seated** on the fastener before applying force.
- ✓ Keep hands away from pinch points and fast-moving parts.
- ✓ Inspect ratchets regularly for **cracks, worn edges, or deformations**.

Standard Operating Procedures

Select the Proper Ratchet

- Choose the right size and type for the job.
- Ensure a **tight fit** on the fastener.



Position the Socket Correctly

- Place it squarely on the nut or bolt.
- Avoid placing excessive stress on one side.

Apply Force Properly

- Pull towards your body rather than pushing away.
- Use steady, controlled force instead of jerky movements.

Tighten or Loosen Fasteners

- Turn **clockwise (right) to tighten** and **counterclockwise (left) to loosen** (unless it's a reverse-threaded fastener).
- Use a **torque wrench** for precision tightening when required.



Photo Source: [The Home Depot](https://www.homedepot.com)

After Use

- Clean the socket and ratchet and return it to its designated storage location.
- Report and replace any damaged tools.

Preventive Maintenance

Preventive maintenance of ratchets involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

- ✓ **Cleaning** – Wipe off dirt, grease, and debris after each use.
- ✓ **Lubrication** – Apply a small amount of oil to moving parts (e.g., adjustable wrenches and ratchets).
- ✓ **Storage** – Keep in a **dry place** to prevent rust.
- ✓ **Inspection** – Check for wear, cracks, or rounded edges regularly.
- ✓ **Avoid Overloading** – Do not exceed the designed torque capacity.

Types of Ratchets

Standard Ratchet 	Most common type - features a single handle and a reversible mechanism. It's ideal for general-purpose fastening and loosening tasks. Typically comes in three sizes to be used with ¼, 3/8 and ½ sockets and extensions. The different sizes refer to size of drive head. Larger drive sizes are used for larger sockets and smaller drive sizes for smaller sockets. Also available with different length handles to suit various applications – long handle for more leverage, shorter “stubby” handle for tight spaces.
Flex-Head Ratchet 	Equipped with a pivoting head, allowing for greater access to tight spaces. Also available in various sizes as described for standard ratchets.
Air/Battery Ratchet 	Powered by compressed air or battery to provide higher torque output and faster operation.
Ratcheting Wrench 	Combines the functionality of a wrench with a ratchet mechanism, providing both turning power and adjustable sizing. Available in various sizes. Note: extra space provided for ratcheting mechanism may make it difficult to gain access to certain bolt heads in tight spaces.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a ratchet:

- ☐ Demonstrate the selection of an appropriately sized ratchet for the type of fastener being used
- ☐ Other:

Notes/Comments:

Sockets & Extensions

Overview & Safety



Overview

A **socket** is a tool used with a **ratchet, torque wrench, or breaker bar** to tighten or loosen fasteners, primarily nuts and bolts. Sockets provide **secure engagement** around fasteners, reducing the risk of rounding edges compared to open-end or box-end wrenches.

Extensions are attached to the socket to allow for a long reach.

Types of sockets include:

- 12-Point & 6-Point Sockets
- Deep Sockets
- Hex (Allen) Sockets
- Impact Sockets
- Spark Plug Sockets
- Standard (Shallow) Sockets
- Swivel (Universal) Sockets
- Torque Limiting Extensions

Key Components:

Fastener End –

Engages with the nut or bolt (6-point or 12-point opening).

Drive End – Connects to the ratchet, breaker bar, or torque wrench.



Socket Body –

Cylindrical structure that fits around the fastener.

Retention Mechanism – A ball detent or pin lock secures the socket to the ratchet.

Safety

General Safety Tips

- ✓ **Match the socket drive size** (e.g., 1/4", 3/8", 1/2") with the correct tool.
- ✓ Always use **impact-rated sockets** with power tools to prevent breakage.
- ✓ Check the socket for **cracks or wear** before applying force.
- ✓ Ensure the **socket is fully seated** on the fastener to avoid slipping.
- ✓ Do not exceed the **torque rating** of the socket to prevent failure.
- ✓ Wear **safety glasses** when using impact tools.

Standard Operating Procedures

Select the Correct Socket

1. Select the Correct Socket

- Match socket size to fastener size for a snug fit.
- Use **impact sockets** if using an air or electric tool.



Photo source: [Ace Hardware](#)
[\[Youtube\]](#)

Attach the Socket to the Drive Tool

- Securely lock the socket onto the ratchet, breaker bar, or torque wrench.
- Ensure the socket is firmly in place before use.

Position the Socket on the Fastener

- Fully seat the socket onto the nut or bolt.
- Avoid angling the socket improperly, as it may slip or round off the fastener.

Apply Proper Force

- Use a **ratchet** for general tightening/loosening.
- Use a **breaker bar** for stuck fasteners requiring extra torque or when necessary to increase force.
- Use a **torque wrench** when a precise torque setting is required.

- Avoid Overloading – Do not exceed the torque rating of the socket or the fastener.

Remove and Store Properly

- After use, clean the socket and return it to storage.
- Inspect sockets for wear or damage before putting them away.

Preventive Maintenance

Preventive maintenance of sockets involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

- ✓ **Cleaning** – Wipe off dirt, grease, and debris after each use.
- ✓ **Lubrication** – Lightly oil the drive end to prevent rust.
- ✓ **Storage** – Keep sockets in a designated **socket rail, organizer, or case** to prevent loss.
- ✓ **Inspection** – Regularly check for **cracks, chips, or worn edges**.

Types of Sockets

Commonly Used Sockets

Standard (Shallow) Sockets	12-Point Sockets	Allen Head (Socket Head) Bolts
		
Shorter sockets for general use.	Allow more angles of engagement but may slip under high torque. Courtesy of Klein Tools Catalog	More secure grip on hexagonal fasteners. Courtesy of Harbor Freight

Spark Plug Socket 	Socket Extensions 	Swivel (Universal) Sockets 
Special sockets with rubber inserts specifically sized to fit and grip spark plugs. Courtesy of Grainger Industrial Supplies Catalog	Available in various sizes and lengths to provide extra reach. Can also be used with swivel sockets for added reach flexibility	Allow movement for accessing fasteners at angles.
Torx Bit/Sockets 	Deep Sockets 	Impact Sockets 
Torx is a trademark for a type of bit/socket characterized by a 6-point star-shaped pattern designed specifically to fit torx fasteners. Courtesy of Harbor Freight Tools Catalog	Longer sockets for reaching fasteners on extended bolts.	Made of hardened steel for use with power tools.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a socket:

- ☐ Match 1/4, 3/8 and 1/2 ratchets with appropriate socket size
- ☐ Use combination ratchet and socket to install then remove fastener
- ☐ Demonstrate use of a socket in combination with extension and swivel (universal) socket
- ☐ Demonstrate use of an impact socket
- ☐ Other:

Notes/Comments:

Torque Wrenches

Overview & Safety



Overview

A **torque wrench** is a specialized tool used to apply a specific amount of torque (rotational force) to a fastener, such as a bolt or nut as required by the manufacturer's manual or guidelines. A torque wrench ensures that fasteners are tightened to the correct specification, preventing under-tightening or over-tightening, which could lead to mechanical failure. In some applications, torquing of fasteners may need to be done in stages and/or in a specific sequence (i.e., star pattern) for more uniform torque application (when torquing wheels for example).

The units of measurement for torque wrenches are typically based on a force applied at a given distance from the point of rotation. The most common units of measurement for torque wrenches include:

- Newton-Meters (Nm)
- Pound-Feet (lb-ft or ft-lb)
- Pound-Inches (lb-in)

Conversion between units may be necessary, with conversion between units as follows:

- 1 Nm = 0.73759 lb-ft
- 1 lb-ft = 1.35582 Nm
- 1 lb-ft = 12 lb-in

Key Components:

Head: The end where sockets are attached, usually designed to accommodate different socket sizes.

Adjustable Mechanism: A dial or micrometer on the handle to set the desired



Ratchet Mechanism: Many torque wrenches feature a ratchet for easier use, allowing for continuous motion without removing the tool from the fastener.

Scale or Gauge: Displays the torque value to help users adjust to the required settings.

Handle: The grip area where the user holds the wrench.

Safety

- ✓ **Under-Tightening:** Can lead to fastener loosening, leaks, or failure of the assembly.
- ✓ **Over-Tightening:** May cause damage to fasteners or components, potentially leading to shearing or distortion.
- ✓ **Do Not Use as a Breaker Bar:** Torque wrenches are not designed for loosening tight bolts; use a breaker bar for that purpose.
- ✓ **Avoid Dropping:** Dropping the wrench can affect its accuracy, so handle it with care.
- ✓ Torque wrenches are not intended to be used for removal or installation, only for final torque specs.

Standard Operating Procedures

SOPs

1. **Verify Torque Specifications:** Identify the specific torque value required for the fastener from the manufacturer's manual or guidelines.

Setting the Torque Value

2. **Unlock the Torque Wrench:** Some wrenches have a locking mechanism to prevent accidental adjustments.
3. **Set the Desired Torque:** Rotate the dial or micrometer on the handle to adjust to the required torque value. Double-check the setting on the scale or display. (see photo)
4. **Lock the Torque Wrench:** Lock the setting in place to avoid changes while in use.



Photo Source: [Tekton](#)

Choosing the Correct Socket

5. **Select the Appropriate Socket:** Ensure that the socket matches the size of the fastener being tightened. Attach it securely to the wrench.
6. **Check Socket Condition:** Make sure the socket is clean and undamaged for safe use.

Positioning

7. **Align the Wrench Properly:** Place the socket over the fastener and ensure that the torque wrench is aligned perpendicular to the fastener. Avoid using any extensions, unless they are rated for torque use.

8. **Steady the Tool:** Ensure the torque wrench is steady to avoid slippage, which could cause inaccurate torque readings or injury.

Applying Torque

9. **Grip the Handle:** Hold the torque wrench by the handle only. Avoid gripping it near the head, as this can affect torque accuracy.
10. **Apply Smooth and Steady Pressure:** Begin tightening the fastener by applying a slow, steady pressure until the wrench reaches the preset torque value.
11. **Click-Type Wrench:** Stop tightening when you hear or feel the “click.” Do not apply further force after the click.
12. **Beam or Dial Wrench:** Stop tightening when the needle or dial reaches the required torque value.
13. **Electronic Wrench:** Follow the tool’s electronic indication (light or sound) when the set torque is achieved.
14. In some applications, torque may need to be **applied in stages** (starting with lower torque value and working up to final setting) and **applied in a star pattern** as described above.



Storage

15. Always ensure torque setting is returned to zero (0) before returning to storage.

Preventive Maintenance

A torque wrench is a precision tool, and consistent maintenance helps preserve its accuracy and prevents damage or failure during use. Preventive maintenance for a torque wrench includes:

1. Regular Inspections

- **Visual Check for Damage:** Inspect the torque wrench for visible signs of wear or damage, such as cracks in the handle or shaft, bent or broken components, and wear on the head or ratchet mechanism.
 - Ensure that the ratchet mechanism clicks smoothly and does not jam or slip.
- **Check for Corrosion:** Look for any signs of rust, especially around the head and ratchet mechanism, which could affect accuracy.
- **Inspect the Drive and Head:** Check the drive end (where sockets attach) and the ratchet head for any signs of wear or rounding.
 - Ensure the ratcheting mechanism operates smoothly.
- **Inspect the Locking Mechanism:** Verify that the locking mechanism (if applicable) engages and disengages smoothly. The locking mechanism should securely hold the torque setting.
- **Handle and Scale Condition:** Make sure the handle and scale markings (for adjustable wrenches) are clear and readable. If the markings are faded, you may not be able to set the torque value accurately.
 - Ensure that the torque scale (dial or digital display) is legible and free from dirt or damage.
 - For digital wrenches, ensure the display functions properly.
- **Calibration:** Should be performed every year to ensure settings are accurate.

2. Cleaning

- **Wipe the Wrench After Use:** After each use, wipe down the torque wrench with a clean, dry cloth to remove any dirt, grease, or debris.
- **Avoid Harsh Chemicals:** Do not use strong chemicals or solvents that could damage the wrench's surface or internal components.
- **Clean Moving Parts Carefully:** If necessary, use compressed air or a soft brush to clean out any debris from the ratcheting mechanism or drive head.

3. Lubrication

- **Lubricate the Ratcheting Mechanism:** For torque wrenches with a ratchet head, lightly lubricate the ratcheting mechanism as recommended by the manufacturer to keep it working smoothly.
- **Avoid Over-Lubrication:** Be careful not to apply too much oil, as excessive lubrication can attract dust or debris, which may interfere with the tool's accuracy or operation.

4. Proper Storage

- **Store in a Protective Case:** Always store the torque wrench in its case or a protective box to shield it from impacts or environmental damage.
- **Release the Tension After Use** (For Adjustable Wrenches): When not in use, set the torque wrench to its lowest setting to release tension on the internal spring. This helps maintain calibration and prolongs the tool's accuracy.
- **Avoid Extreme Temperatures:** Store the wrench in a dry place away from extreme heat or cold, which could affect the tool's internal components and calibration.

Types of Torque Wrenches

Commonly Used Torque Wrenches

Beam Torque Wrench 	Click-Type Torque Wrench 	Dial Torque Wrench 
• Not commonly used • Mainly used for rotational torque • Handle has a pivot point – must keep it centered and not touching the beam for an accurate reading	• Commonly used for setting torque value for bolts (in/lb, ft/lb, Nm)	• Not commonly used • Mainly used for a high level of accuracy
Electronic Torque Wrench 	Split Beam Torque Wrench 	Torque Multiplier 
• Commonly used for general fasteners (in/lb, ft/lb, Nm). • Can be used as a regular torque wrench; also has capabilities to be used for angles.	• Very commonly used for general fasteners (in/lb, ft/lb, Nm). • Ability to change angle of head to fit in tight areas.	• Used to loosen or tighten high torque value items

Torque Screw Driver



- Used in precise low torque applications

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Learning Objective: Demonstrate the ability to use a torque wrench

Suggested hands-on learning activities for use of a torque wrench:

- ☐ Demonstrate which type of torque wrench to use for application and correct size (i.e. ¼, ⅜, ½ or larger). Have the learner talk through inspection and calibration process.
- ☐ Demonstrate proper usage and technique and safety procedures
- ☐ Gather a torque wrench with ft. lbs, inch lb. and Nm readings. Give the trainee 5 values and have them set the wrench to those values.
- ☐ Torque a series of bolts according to a manufacturer's recommendation using a graduating procedure (i.e., from lower to final torque setting) to a defined sequence (i.e., star pattern).
- ☐ Demonstrate proper after care, return torque setting to zero and put tool away in proper location
- ☐ Other:

Notes/Comments:

Hammers

Overview and Safety

A **hammer** is a simple hand tool used for a variety of tasks, such as striking chisels and punches, shaping materials, driving nails and breaking objects. Hammers are essential tools due to their simplicity and versatility.



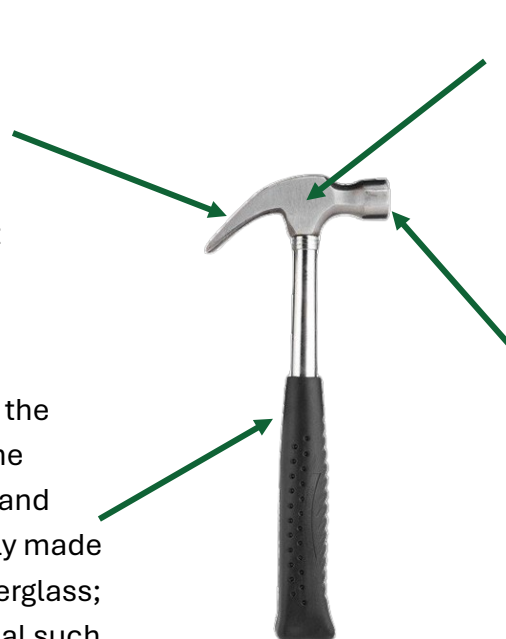
Common types of hammers include:

- Ball peen hammer
- Brass hammer
- Claw hammer
- Sledgehammer
- Soft-Faced/Mallet/Dead Blow Hammers

Key Components:

Claw or Peen: On some hammers (like claw hammers), the opposite side of the head has a claw used for pulling out nails.

Handle: The long part of the hammer that is held in the hand. Provides leverage and control. Handles typically made from wood, metal, or fiberglass; often coated with material such as rubber for comfort.



Head: The heavy, solid part attached to the top of the handle. It's designed for striking.

Face: The flat or rounded part of the head that makes contact with the material.

Peen (Optional): On ball-peen hammers, the back of the hammer head is rounded, used for shaping metal.

Safety

- ✓ **Wear PPE:** Gloves and safety glasses are recommended. So are ear plugs if loud noise is generated.
- ✓ **Check Condition:** Regularly inspect hammers for loose heads or cracks in the handle, which could cause injury.
- ✓ **Use the Right Hammer:** Choosing the appropriate hammer for the task ensures effectiveness and reduces the risk of damage or injury.

To grip the hammer properly:

- ✓ **Hold Near the End of the Handle:** For maximum leverage and power, grip the hammer at the end of the handle. Holding the hammer closer to the head reduces force but can increase control for precision tasks.
- ✓ **Ensure a Firm Grip:** Keep a firm, but not overly tight, grip on the handle. This allows for better control and reduces the risk of slipping.

Standard Operating Procedures

Position Your Body Properly

1. **Square Your Shoulders:** Stand with your feet shoulder-width apart and square your shoulders to the object you're hammering.
2. **Swing with Your Elbow and Wrist:** Use your elbow and wrist to generate the swing, rather than just your shoulder. This provides better control and accuracy. Make sure to keep your fingers clear and use eye protection and other PPE as appropriate.
3. **Bend Your Knees Slightly:** For tasks that require repetitive hammering, bending your knees slightly can help reduce strain on your back and shoulders.

Start With a Light Tap

4. **Driving Nails:** Start with a light tap to seat the nail before using full force. This prevents the nail from bending or slipping. Drill a small pilot hole if needed.
5. **Strike Straight:** Hold the nail or object at the correct angle and hit it straight to ensure proper driving.



Swing the Hammer

6. **Lift to Shoulder Height:** Lift the hammer to about shoulder height for controlled force.
7. **Use Your Elbow and Wrist:** Swing the hammer using your elbow and wrist for better accuracy and power.
8. **Strike with the Hammer Face:** Always hit the target with the flat face of the hammer head for even force distribution.
9. **Follow Through:** Let the hammer follow through naturally after impact to absorb shock and prevent strain on your hand and wrist.

Preventive Maintenance

Preventive maintenance for hammers involves regular checks and care to ensure the tool remains safe and effective for use. Key steps include:

1. **Handle Inspection:** Check the hammer handle for cracks, splinters, or signs of wear, especially if it's made of wood. Replace damaged handles to prevent breakage during use.
2. **Head Security:** Ensure the hammerhead is securely attached to the handle. A loose head can cause accidents or reduce the hammer's effectiveness. Re-tighten or replace if necessary.
3. **Head Surface Condition:** Inspect the striking surface of the hammerhead for chips, dents, or mushrooming, which can indicate overuse or damage. File down any mushrooming to prevent fragments from breaking off.
4. **Cleaning:** Keep the hammer clean by wiping off dirt, grease, or debris that may affect grip or function.

Types of Hammers

Commonly Used Hammers

Ball Peen Hammer 	Brass Hammer 	Claw Hammer 
Metalworking tasks	Delicate work shaping metal	Driving and removing nails
Soft-Faced/Mallet/Dead Blow Hammers 	Sledgehammer 	
For striking materials without damaging them, such as woodworking or assembling delicate parts. Heads are typically made of plastics, rubber or soft metals such as copper, aluminum, and lead. Also see Brass Hammer.	Used in demolition or driving stakes	

Hands-on Learning

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a hammer:

- ☐ Proper identification of hammers. Have the learner physically hold the tool and describe the parts and what to look for during inspections, including checking for defects.
- ☐ Set a variety of hammers out. Have the learner describe what hammer they would use for specific applications and why.
- ☐ Have the learner demonstrate proper usage of a hammer
- ☐ Other:

Notes/Comments:

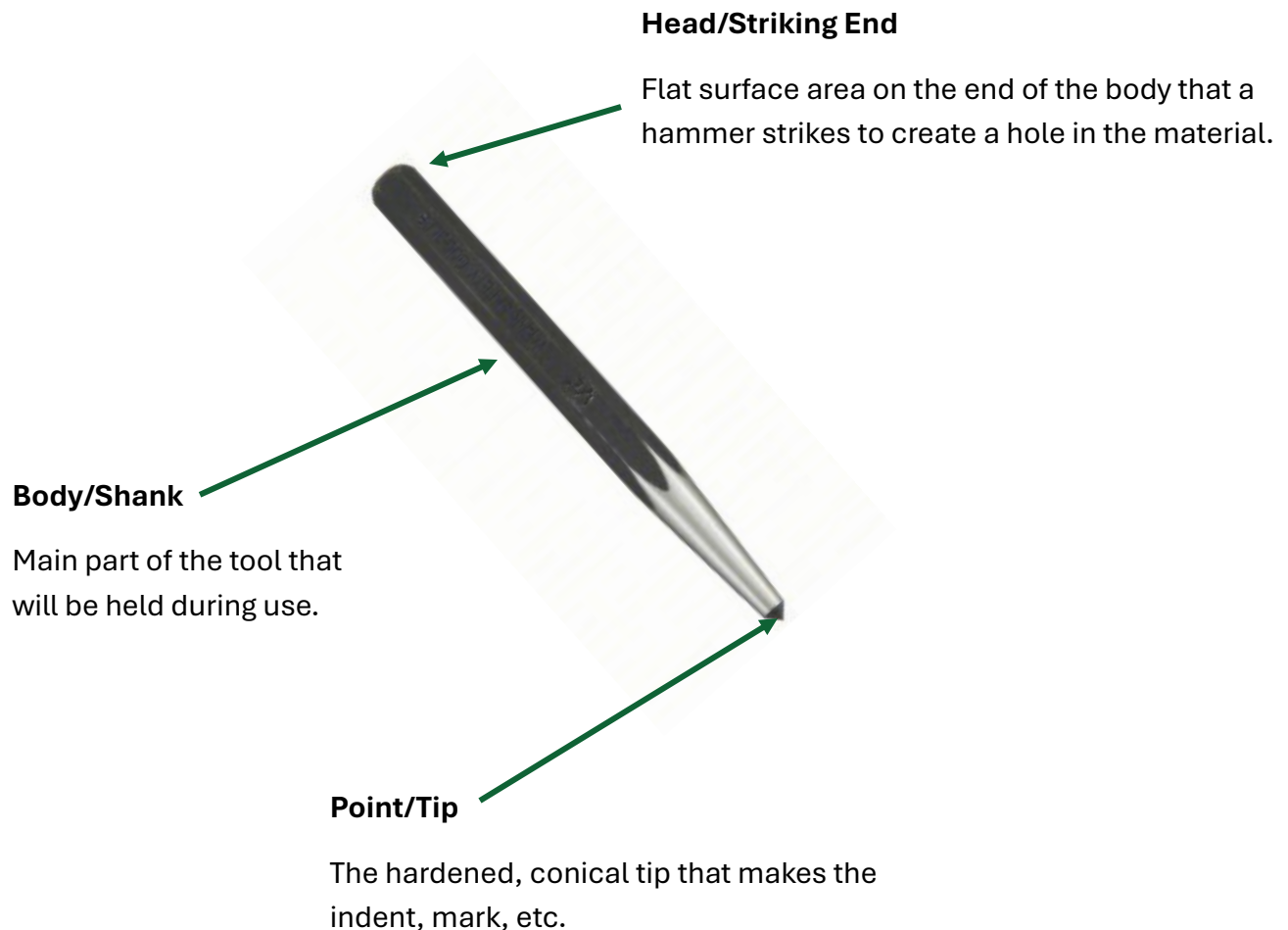
Punches & Chisels

Overview

Overview - Punches

A **punch** is a handheld tool, usually in the form of a hardened metal rod with one end coming to either a point to create a small indentation in a material to guide a drill bit (center punch), or a blunt end to drive out or insert pins, dowels or rivets from a hole (drift/solid punch).

Key Components (center punch shown):



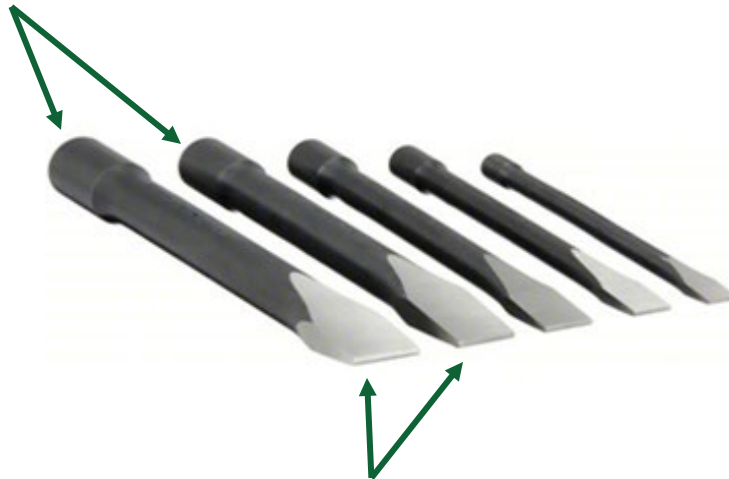
Overview – Chisels

Chisels are hand tools that allow you to carve, shape, or cut hard materials like stone, wood, or metal. They have sharp-edged blades and a handle to apply controlled force typically with a hammer. The sharp edge of the chisel provides precise cutting, and are available in different shapes and sizes to meet the needs of different tasks.

Although chisels are specifically designed for use on wood, stone and metal, we will focus on cold metal chisels designed to shape and cut metals. Cold chisels work on unheated metal. There are also hot chisels, which work on metal softened by heat from a forge or torch, which are typically used in blacksmithing applications (not covered here).

Key Components:

Handle: Provides a comfortable and secure grip, allowing for precise control, and a head atop the handle for striking it with a hammer.



Blade: Heart of the chisel, responsible for cutting the material. It is forged from high-carbon steel, known for its hardness and durability.

Standard Operating Procedures

Pre-Operation

- Locate and wear the appropriate PPE
 - Safety hard hat, safety gloves, safety glasses or goggles, closed-toe shoes (particularly around metal-work)
- Check for wear, misalignment or damage to the tool, and that the punch (and die) is sharp and correctly installed
- Make sure the material you are working with is secure, either manually or with a clamp.
- Wear required PPE.

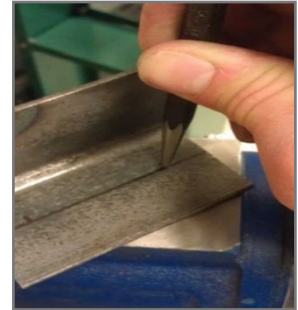


Photo source: [Instructables.com](https://www.instructables.com)

Operation

- Position the material securely.
 - Make sure the material you are working with is secure, either manually or with a clamp.
- Align the tool directly over your target.
- Apply a steady amount of controlled force.

Post-Operation

- Inspect the material
 - Check the punched hole for size, cleanliness and accuracy – rework as needed.
- Clean off the tool and store properly in a safe, dry environment to reduce rust or damage.

Inspection & Maintenance

Inspection and maintenance for a press involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Check for tool wear or damage- look for cracks, chips, or deformation in the punch/chisel.
- Inspect alignment - ensure punch/chisel are properly aligned and seated to avoid off-center punching.
- Examine cutting edges - make sure the punch/chisel tip is sharp and not rounded or burred.
- Test movement (for mechanical punches) - Ensure smooth operation of moving parts; no sticking or grinding.
- Check for rust or corrosion - surface corrosion can affect accuracy and performance.

Weekly / After Heavy Use:

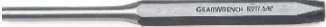
- Clean the tool after each use - wipe down the punch/chisel to remove debris, dust, and punched material.
- Lubricate moving parts - use appropriate oil or grease on hinges, joints, or mechanical parts.
- Sharpen or replace worn punches/chisel - maintain sharpness to ensure clean cuts and reduce strain on the tool.
- Store properly - keep the tool in a dry, secure location; use protective covers if available.

Quick Tips for Users:

- ✓ **Never bypass safety devices or guards.**
- ✓ **Keep hands and body clear** of the point of operation.

Types of Punches & Chisels

Commonly Used Punches & Chisels

Center Punch 	Use with hammer to create a small indentation in material at center of hole to be drilled. Prevents drill bit from “walking” (sliding) on material for more precise drilling Photo courtesy of Grainger
Pin Punch 	Primary use is to drive out or insert solid or small diameter pins, dowels, or rivets from a hole (without damaging the surrounding material or the pin). Commonly used after a roll pin or solid pin has been loosened with a starting punch. Photo courtesy of Home Depot
Drift (Solid) Punch 	Metal rod with a hardened tip Useful in driving out small items like pins and rivets Also used for making impressions or indents in materials Photo courtesy of Tekton
Chisels 	A metal working chisel has a solid, hardened steel cylindrical shaft available with different width blades typically available as sets. They are angled on both sides to form a wedge-shaped point for cutting.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a punch:

- ☐ Demonstrate use of center punch
- ☐ Demonstrate use of a drift (solid) punch
- ☐ Demonstrate use of a cold chisel
- ☐ Other:

Notes/Comments:

Pliers

Overview & Safety

Overview

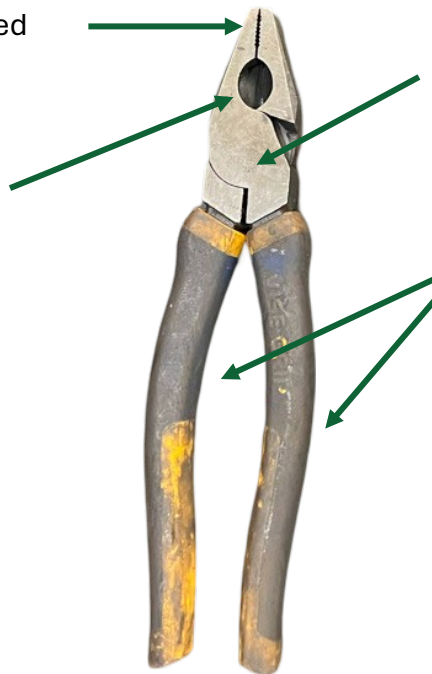
Pliers are hand tools designed for gripping, bending, cutting, and manipulating materials. They work through a pair of pivoted jaws, offering mechanical advantage for tasks requiring grip strength and precision. Pliers are essential in electrical work, mechanical maintenance, plumbing, fabrication, and general repair tasks.

Key Components:

Jaws – The gripping or cutting surfaces; vary in shape based on type.

Cutting Edge (on some types) – Built-in blades for cutting wires or materials.

Spring Mechanism (optional) – Automatically reopens pliers after a squeeze.



Pivot Point / Rivet – Acts as the fulcrum, allowing jaws to open and close.

Handles – Often rubber-coated or insulated for grip and electrical safety.

Safety Considerations

Personal Protective Equipment (PPE):

- Safety glasses (for flying debris when cutting)
- Gloves (for handling sharp materials, but avoid around rotating machinery)

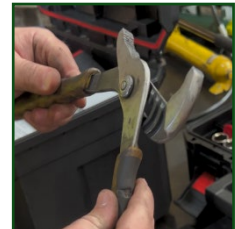
General Safety:

- Inspect pliers for cracks, rust, or loose pivot points.
- Use the correct type of pliers for the task.
- Never substitute pliers for a wrench or hammer.
- Avoid overloading or twisting pliers—they are designed for grip, not torque.
- Do not cut hardened wire or nails unless pliers are rated for it.
- Use insulated pliers when working near electrical circuits.
- Keep hands away from the cutting edge.

Standard Operating Procedures

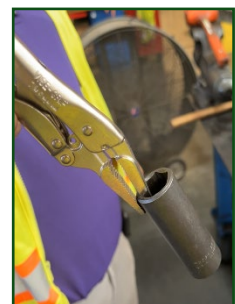
Pre-Operation

- Select the right pliers for the job.
- Inspect for damage, worn cutting edges, or loose pivots.
- Verify that handles are clean and grips are secure.
- Wear appropriate PPE.



Operation

- Grip the material firmly, applying pressure evenly.
- Use cutting edges only on materials they're rated for.
- Avoid using pliers for prying or hammering.
- Reposition instead of forcing if better leverage is needed.
- For locking pliers, ensure they're latched securely before use.



Inspection & Maintenance

Inspection and maintenance of pliers involve regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect jaws, cutting edges, and pivot rivets.
- Check for smooth jaw alignment and closing.
- Ensure grips are secure and not damaged.

Quick Tips for Users:

- ✓ **Use insulated pliers (rated) when working around live electricity.**
- ✓ **Apply force only perpendicular to the jaws**—don't twist sideways.
- ✓ **Replace pliers with worn or nicked cutting edges** to avoid poor cuts or injury.
- ✓ **Channel locks and locking pliers** give extra gripping power but need careful handling to avoid crushing materials.
- ✓ **Never use pliers as a substitute for a wrench**—they can slip and cause injury or damage.

Types of Pliers

Commonly Used Pliers		
Bent Nose Pliers 	Channel Lock/Tongue & Groove (Channellocks) 	Crimping Pliers 
Angled jaws for accessing hard-to-reach areas.	Adjustable jaws for gripping large objects.	Used to crimp connectors onto cables or wires.

Diagonal Cutters 	Fencing/Lineman's Pliers 	Locking Pliers (Vice-Grips) 
Cutting wire, nails, and soft metals.	Heavier-duty pliers for gripping, twisting and cutting heavy wire or cable.	Locks onto objects for hands-free gripping or clamping.
Needle-Nose Pliers 	Round Nose Pliers 	Slip Joint Pliers 
Long, pointed jaws for precision work, reaching into tight spaces.	Shaping loops and curves in wire.	Adjustable jaw opening; general gripping and bending.
Wire Strippers 		
Stripping insulation off electrical wires.		

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of pliers:

- ☐ Demonstrate use of vice-grip to remove a rounded nut
- ☐ Use needle-nose to properly bend a cotter pin
- ☐ Use wire strippers to properly strip a piece of wire
- ☐ Other:

Notes/Comments:

Basic Hand Cutting Tools

Overview & Safety

Overview

Hand cutting tools are manually operated tools designed to cut, shape, or remove material from wood, metal, plastic, or other workpieces. They are essential in construction, maintenance, fabrication, woodworking, and general repair tasks.

Common types include **utility knives, handsaws, hacksaws, tin snips, chisels, bolt cutters, diagonal cutting pliers, and wire cutters.**



Key Components: Hacksaw; Varies by Tool

Frame (for saws) – Holds the blade under tension (hacksaws, coping saws).

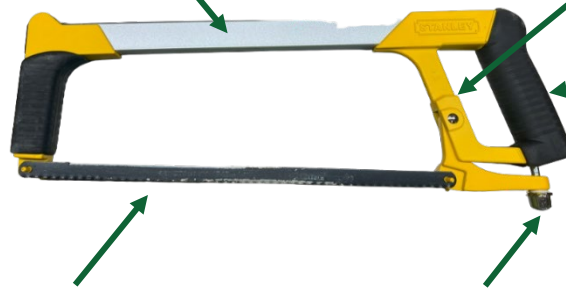
Guard / Safety

Features – Protects the user from accidental cuts (on some tools).

Blade / Cutting Edge – Performs the actual cutting.

Handle / Grip – Provides user control and leverage.

Adjusting Screws / Bolts – Adjust blade tension or cutting size (on snips, saws).



Key Components: Tin Snips

Blade / Cutting Edge – Performs the actual cutting.

Handle / Grip – Provides user control and leverage.

Hinge / Pivot Point (for shears/snips) – Allows cutting action through leverage.



Safety Considerations

Personal Protective Equipment (PPE):

- Safety glasses (mandatory)
- Cut-resistant gloves (especially when handling sharp materials)
- Long sleeves (optional for added protection)

General Safety:

- **Inspect the tool and blade before use**—replace/sharpen dull or damaged blades immediately.
- **Use the right cutting tool for the material**—don't force tools beyond their design.
- Always **cut away from your body** and maintain control of the tool.
- Keep your **non-cutting hand out of the cutting path**.
- **Secure the material** with a clamp or vice when possible.
- **Retract or sheath blades** when not in use (utility knives).
- **Never carry cutting tools** in your pockets.
- For Hacksaws, the teeth should point in a forward direction; use the blade's entire length for cutting - understanding that cutting only takes place during forward (downward) thrusts.

Standard Operating Procedures

Pre-Operation

- Inspect the blade for sharpness, cracks, or wear.
- Check handles, grips, and safety guards for damage or looseness.
- Choose the correct tool and blade type for the material.
- Wear appropriate PPE.



Operation

- Secure the workpiece if possible.
- Use steady, controlled strokes—**avoid excessive force**.
- For saws, let the teeth do the cutting—don't twist or bend the blade.
- For knives, extend the blade only as far as needed.
- For snips and cutters, ensure full jaw closure without side loading.



Common Hand Cutting Tools and Uses

Commonly Used Cutting Tools

Bolt Cutters 	Chisel 	Hacksaw 
Cutting thick bolts, rods, or wire.	Shaping or cutting wood, stone, or metal.	Cutting metal pipes, rods, plastic, and light steel.
Hand Saw/Wood Saw 	Tin Snips/Aviation Snips 	Utility Knife 
Cutting wood and lumber	Cutting sheet metal or thin materials	General cutting of drywall, insulation, packaging, etc.
Wire Cutters/Cable Cutters 	Diagonal Cutting Pliers 	
Cutting heavier gauge electrical wire or cables	Cutting smaller gauge electric wires, cables or tie straps	

Inspection & Maintenance

Inspection and maintenance for cutting tools involves regular care and upkeep to ensure that any tools remain in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect blades and edges for dullness, chips, or cracks.
- Ensure moving parts (snips, bolt cutters) operate smoothly, lubricate if needed.
- Check handles and grips for cracks or wear.

Quick Tips for Users:

- ✓ **Sharp blades are safer than dull ones**—replace or sharpen regularly.
- ✓ **Never force a tool**—if it's not cutting easily, check for the right tool or sharpness.
- ✓ **Always cut away from yourself and others.**
- ✓ For metal cutting, use **fine-tooth blades** to prevent snags or jagged cuts.
- ✓ **Document tool damage or replacements** if part of a formal maintenance program.
- ✓ For Hacksaws, **begin cutting slowly** to establish a groove in the material. Build speed once the blade is securely in the groove.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of cutting tools:

- ☐ Use a hacksaw to cut a bolt
- ☐ Use tin snips to cut a circle/square in a piece of tin
- ☐ Other:

Notes/Comments:

Pullers

Overview & Safety

Overview

Pullers are mechanical tools designed to remove tightly fitted parts such as gears, pulleys, bearings, bushings, and wheels from shafts or housings. They apply controlled force through a center bolt, minimizing damage to components and reducing manual effort. Pullers are commonly used in mechanical, automotive, and industrial maintenance.

Key Components:

Anvil Surface (on Crossbar or Yoke) – Connects the arms and centers the forcing screw.

Forcing Screw (Center Bolt) – Threads into the crossbar to apply pulling force.

Hydraulic Cylinder (on hydraulic pullers) – Provides increased pulling force.

Adjustment Pins / Bolts (on adjustable models) – Modify jaw spacing or length.

Tip / Point – Contacts the shaft or component center.

Arms / Legs (2-Jaw, 3-Jaw, or Specialty) – Grasp the part to be removed.



Safety Considerations

Personal Protective Equipment (PPE):

- Safety glasses or face shield (high potential for parts to release suddenly)
- Gloves (to protect from sharp edges but avoid entanglement)
- Steel-toe boots (if working with heavy components)

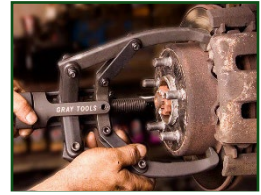


Photo source: [Gray Tools](#)

General Safety:

- Inspect puller before use for damage or wear.
- Choose the correct size and type of puller for the job.
- Ensure jaws grip securely and evenly.
- Center the forcing screw precisely to prevent slippage.
- Do not use impact tools on the forcing screw unless the puller is rated for it.
- Never exceed the puller's rated capacity.
- Stand clear when applying final force—stored energy can release suddenly.
- Use hydraulic pullers for heavy-duty applications—do not force manual pullers beyond their capacity.

Standard Operating Procedures

Pre-Operation

- Inspect the puller for cracks, bent arms, stripped threads, or worn tips.
- Select the correct puller size and jaw configuration (2-jaw or 3-jaw).
- Clean the part and area to be pulled for better grip and alignment.
- Lubricate the forcing screw for smoother operation.

Operation

- Position the jaws evenly around the component.
- Ensure the forcing screw is centered on the shaft or part.
- Tighten the forcing screw slowly and evenly, applying force gradually.

- Monitor for signs of slipping, distortion, or excessive force.
- Stop if excessive force is required—reassess setup or use a hydraulic puller.
- Once the part is free, release tension slowly and safely.

Post-Operation

- Carefully remove the puller from the part.
- Inspect tool and work area for damage or hazards.
- Clean and store the puller properly.

Inspection & Maintenance

Inspection and maintenance of a puller involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Check for bent arms, cracked components, or damaged threads.
- Inspect the forcing screw tip for rounding or wear.
- Ensure smooth movement of the forcing screw.
- Verify jaw gripping surfaces are clean and not worn out.

Quick Tips for Users:

- ✓ Use a **3-jaw puller** for balanced pulling and better grip when possible.
- ✓ **Lubricate the center screw** to reduce effort and avoid damaging threads.
- ✓ If the part **won't move**, apply heat (if appropriate) or switch to a hydraulic puller.
- ✓ **Never use a puller with missing or damaged arms**—it will fail under load.
- ✓ Always **check manufacturer capacity ratings** before applying force.
- ✓ Some pullers use bolts (instead of arms) to attach to what is being pulled. **Only use high strength bolts** – weaker bolts can break suddenly under load

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a puller:

- ☐ Use three-jaw puller to remove bearing or gear off of a shaft
- ☐ Other:

Notes/Comments:



Measuring Tools

Measuring Tape

Gauges

Measuring Tape

Overview & Safety



Overview

A **measuring tape** is a flexible ruler used to measure length, width, height, and distances. It is one of the most common tools in construction, maintenance, fabrication, woodworking, and general measuring tasks. Measuring tapes come in various lengths and materials, typically in both **imperial (inches/feet)** and **metric (cm/m)** units. Typical Imperial measurements include $\frac{1}{16}$, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{5}{8}$, and $\frac{3}{4}$ of an inch. Metric measures are based on variations of a meter “m”, which is about 1.1 yard. There are 100 centimeters “cm” in a meter, and 10 millimeters “mm” in a centimeter.

Key Components: Measuring Tape

Hook / End Clip –

Metal hook at the tape's end designed to grab onto surfaces.

Tape Blade –

Flexible, retractable metal or fiberglass tape with measurement markings.

Thumb Control /

Slide Lock –

Helps control extension and retraction.

Case / Housing –

Protects the coiled tape; often made of plastic or metal.

Spring Mechanism

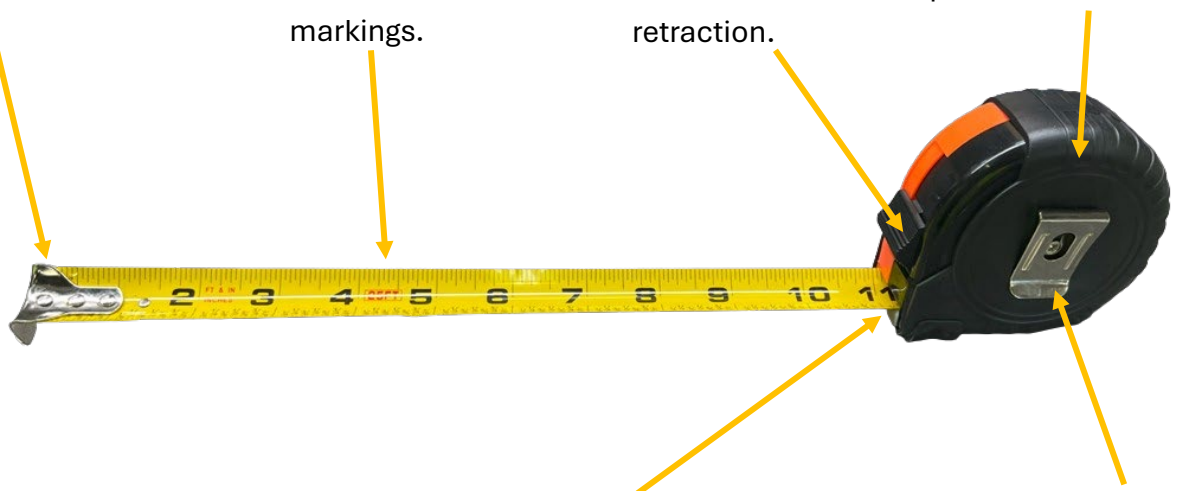
(inside)– Automatically retracts the tape into the case.

Locking Mechanism –

Stops the tape from retracting while measuring.

Belt Clip –

Allows the tape measure to be carried easily.



Safety Considerations

General Safety:

- Avoid letting the tape **snap back quickly**—sharp edges can cause cuts or eye injuries.
- Keep hands and fingers away from the **retracting tape**.
- Use **two people for long measurements** to maintain accuracy and prevent tape damage.
- Watch for **rust, kinks, or bends** in the tape—can cause incorrect readings.
- Be aware of surroundings when extending the tape—avoid hitting people or objects.

Standard Operating Procedures

Operation

- Hook the tape end securely or anchor it manually.
- Extend the tape smoothly—avoid whipping or snapping it out.
- Engage the lock to hold the tape while taking measurements.
- Read the measurement from the correct edge of the blade.
- Use the **"true zero" point**—account for the hook movement if necessary (hook compensation).
- For long distances, keep the tape level and taut to avoid sagging errors.



Quick Tips for Users:

- ✓ **Use the tape's hook properly**—it's designed to slide slightly for inside measurements (in cases where hook cannot fall over the outside of the item being measured) and outside measurements (in cases where hook can fall over or “hook” the outside of the item being measures).
- ✓ **Don't use the tape as a plumb line** or let it hang unsupported over long distances.
- ✓ **Mark measurements accurately**—use a sharp pencil, not the tip of the tape, to mark points.
- ✓ For **long measurements, brace the tape or have a second person assist** to avoid sagging.
- ✓ Regularly **check the tape against a standard** for accuracy—especially if dropped or bent.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a measuring tape:

- ☐ Use a tape measure to determine measurements (height, length, depth, etc.) for a piece of wood, metal, etc. using both Imperial and metric units.
- ☐ Use tape measure to indicate 3-5/8 inches, 2-3/4 inches, 10 cm and 5 mm on a piece of paper.
- ☐ Use a tape measure to demonstrate taking an inside measurement.
- ☐ Other:

Notes/Comments:

Gauges

Overview & Safety

Overview

Gauges are precision instruments used to measure and display pressure, temperature, force, level, or other variables in mechanical and industrial systems. Common gauges include pressure gauges, vacuum gauges, temperature gauges, dial indicators, and fuel/oil level gauges. They are critical for monitoring safe operating ranges and diagnosing equipment conditions.

Key Components

Pointer / Needle –

Indicates the current measurement.

Lens / Cover – Clear

protective cover over the dial.

Gauge Case / Housing -

Protects internal parts from dust, moisture, and damage.

Photo source: [Harbor Freight](#)



Movement

Mechanism (internal)

– Transfers Bourdon tube movement to the pointer.

Bourdon Tube (for pressure gauges) –

Metal tube that flexes under pressure, moving the needle.

Dial / Display Face –

Shows measured values, typically in psi, bar, inches, or mm.

Connection / Fitting – Threads or adapters to connect the gauge to the system.

Relief Vent / Blowout Plug – Safety feature to vent internal pressure if the gauge fails.

Safety Considerations

Personal Protective Equipment (PPE):

- Safety glasses (protection from potential gauge failure or system blowout)
- Gloves when handling hot or high-pressure systems

General Safety:

- Select the correct gauge type, range, and pressure rating for the system.
- Do not exceed the maximum rated pressure (often indicated with a red line).
- Install gauges where they are easy to read and safe from accidental impact.
- Stand clear when pressurizing the system—gauges can fail if defective.
- Replace cracked, fogged, or damaged gauges immediately.
- Ensure proper venting and relief features are functional.

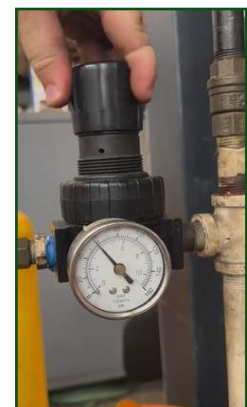
Standard Operating Procedures

Pre-Operation

- Inspect the gauge for cracks, leaks, or damage.
- Verify calibration date (for precision gauges).
- Confirm gauge range is appropriate for the system's pressure or temperature.
- Ensure fittings are properly tightened and leak-free.

Operation

- Monitor the gauge during operation—readings should stay within safe operating range.
- Watch for erratic needle movement, sticking, or fluctuating readings (signs of failure).
- Use isolation valves if the gauge is installed in a high-pressure system.
- Do not tap or hit gauges to "unstick" the needle—this can cause internal damage.



Inspection & Maintenance

Inspection and maintenance for gauges involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect the lens, dial, and needle for clear visibility and damage.
- Check connections for leaks or corrosion.
- Verify gauge needle returns to zero when not pressurized (for pressure gauges).
- Check for calibration sticker if required.

Calibration (Annually or As Needed):

- Perform calibration using a master gauge or certified calibration equipment.
- Remove from service if the gauge is more than the allowable percentage amount off its rated accuracy.

Quick Tips for Users:

- ✓ Always **choose a gauge rated 1.5x the system's maximum working pressure** for safety.
- ✓ **Replace gauges showing condensation or fogging**—it indicates seal failure.
- ✓ **Use snubbers or pulsation dampeners** on gauges exposed to pressure spikes.
- ✓ **Isolate gauges from vibration**—it shortens their lifespan and causes inaccurate readings.
- ✓ Document any **readings outside normal operating range** immediately—may signal system issues.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a gauge:

- ☐ Use an air regulator to set the air pressure to 20 psi, 50 psi, and 100 psi
- ☐ Other:

Notes/Comments:



Vice and Clamps

Vices

Clamps

Vices

Overview & Safety

Overview

Vices and clamps are mechanical devices used to hold materials securely in place during cutting, drilling, grinding, assembly, or gluing tasks. They are essential in workshops, fabrication, maintenance, and construction to ensure precision, safety, and control during work.

A vice is a heavy-duty mechanical tool used to firmly hold a workpiece in place during operations like sawing, drilling, filing, or grinding. It typically consists of two parallel jaws—one fixed and one movable—operated by a screw mechanism and are commonly mounted on workbenches and are essential in metalworking, woodworking, and general workshop tasks for stability and precision.

Key Components: Vices

Fixed Jaw –

Stationary part that holds one side of the material.

Locking Mechanism

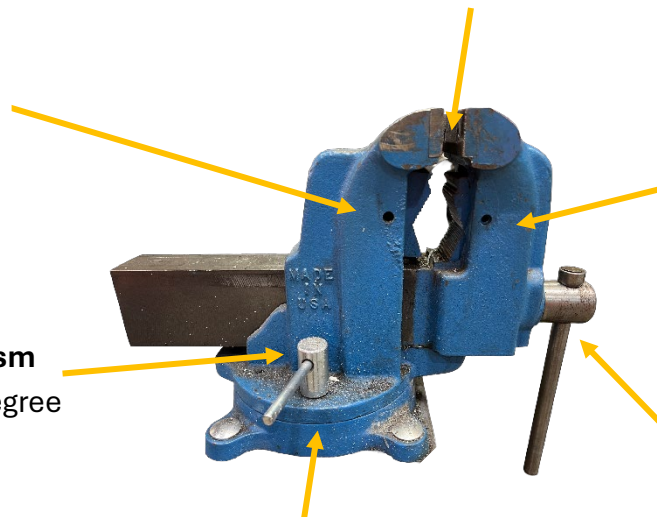
Lever – For 360-degree swivel.

Jaw Inserts / Faces – Can be smooth, serrated, or padded to grip different materials.

Sliding Jaw – Moves toward the fixed jaw to clamp the material.

Screw Mechanism / Handle – Adjusts the sliding jaw.

Base – Mounts to a workbench or surface, sometimes swivel-capable.



Safety Considerations

Personal Protective Equipment (PPE):

- Safety glasses
- Gloves (for material handling, but use caution around pinch points)

General Safety:

- Always inspect for cracks, wear, or damage before use.
- Ensure vice is properly secured to prevent movement.
- Position workpiece securely—avoid overextending beyond the jaws.
- Do not use excessive force or extension bars to tighten.
- Keep hands and fingers clear of moving parts and pinch points.

Standard Operating Procedures

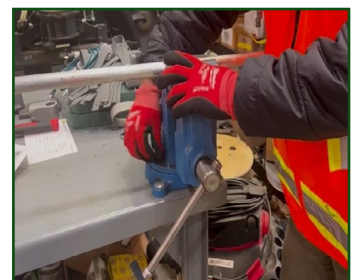
Pre-Operation

- Inspect the vice for damage, wear, or rust.
- Verify that jaws and moving parts are functioning smoothly.
- Clean the contact surfaces.
- Select the right size and type of vice for the task.
- Secure the vice to the bench and is properly placed.



Operation

- Place the workpiece between the jaws.
- Swivel vice to place workpiece in most convenient position
- Tighten slowly and evenly until the workpiece is secure but not damaged.
- Check that the workpiece is stable and will not shift during work.
- Re-check tightness during long operations or heavy tasks.



Post-Operation

- Loosen the jaws carefully to release the workpiece.
- Clean off debris, dust, or residue from the vice.
- Inspect for damage or wear.
- Store in a dry place to prevent rust.

Inspection & Maintenance

Inspection and maintenance of a vice involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Check for cracks, bent parts, or stripped threads.
- Ensure jaws align properly and grip securely.
- Verify smooth operation of screws or sliding arms.

Quick Tips for Users:

- ✓ Never **weld or grind directly on a vice** unless it's designed for that purpose.
- ✓ Regularly check that **bench-mounted vices** are still tightly secured to the bench.
- ✓ Store vices with screws lightly backed off to avoid pressure buildup and warping.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a vice:

- ☐ Mount a piece of aluminum in the vice
- ☐ Use vice to bend back piece straight
- ☐ Use vice to cut a piece of tubing
- ☐ Other:

Notes/Comments:

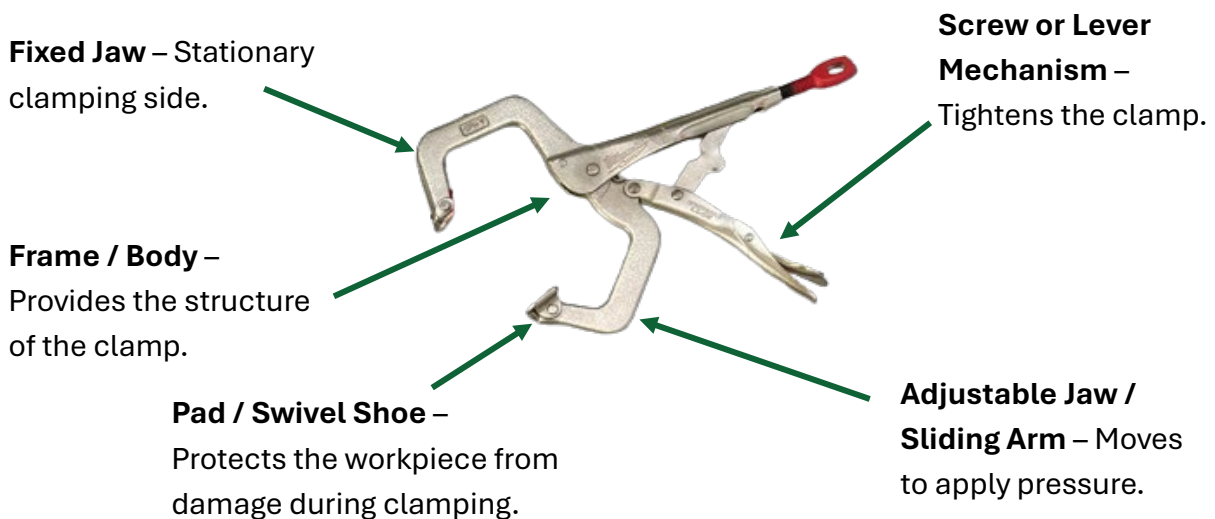
Clamps

Overview & Safety

Overview

A **clamp** specifically consists of two jaws that apply pressure to an object, keeping it stationary and aligned. Clamps are essential in woodworking, metalworking, and construction to ensure accuracy and safety while working, and holds objects securely in place during tasks such as cutting, gluing, welding, or assembly.

Key Components: Clamps (C-Clamps, Bar Clamps, Pipe Clamps, etc.)



Safety Considerations

Personal Protective Equipment (PPE):

- Safety glasses
- Gloves (for material handling, but use caution around pinch points)

General Safety:

- Always inspect for cracks, wear, or damage before use.
- Ensure clamp is properly secured to prevent movement.
- Position workpiece securely—avoid overextending beyond the jaws.
- Do not use excessive force or extension bars to tighten.
- Never hammer on clamps or over-tighten—they are designed for compression, not impact.
- Keep hands and fingers clear of moving parts and pinch points.

Standard Operating Procedures

Pre-Operation

- Inspect the clamp for damage, wear, or rust.
- Verify that jaws and moving parts are functioning smoothly.
- Clean the contact surfaces.
- Select the right size and type of clamp for the task.
- Secure the vice to the bench or ensure the clamp is properly placed.

Operation

- Place the workpiece between the jaws.
- Tighten slowly and evenly until the workpiece is secure but not damaged.

- Check that the workpiece is stable and will not shift during work.
- Re-check tightness during long operations or heavy tasks.

Post-Operation

- Loosen the jaws carefully to release the workpiece.
- Clean off debris, dust, or residue from the vice/clamp.
- Inspect for damage or wear.
- Store in a dry place to prevent rust.



Photo source: [Family Handyman](#)

Inspection & Maintenance

Inspection and maintenance of clamps involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Check for cracks, bent parts, or stripped threads.
- Ensure jaws align properly and grip securely.
- Verify smooth operation of screws or sliding arms.

Quick Tips for Users:

- ✓ **Use wood, aluminum or soft jaw covers** when clamping delicate materials.
- ✓ Use **multiple clamps** for large workpieces to prevent bowing or shifting.
- ✓ Regularly check that **bench-mounted vices** are still tightly secured to the bench.
- ✓ Store clamps with screws lightly backed off to avoid pressure buildup and warping.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a clamp:

- ☐ Mount a piece of aluminum in the clamp
- ☐ Use a clamp to temporarily secure two pieces of wood/metal together in preparation to perform a task such as screwing or welding them together in a certain position.
- ☐ Other:

Notes/Comments:



Power Tools

Power Drills

Power Screwdrivers

Impact Gun

Reciprocating Saw

Grinding Wheels

Power Drills

Overview & Safety

Overview

A **power drill** is a handheld power tool used for drilling holes and driving fasteners in various materials such as wood, metal, plastic, and masonry. Available in both corded and cordless models.

Key Components (typical application):

Torque Adjustment / Clutch

(on cordless models) –
Controls torque to prevent overdriving screws.

Chuck (Keyed or Keyless) –

Holds drill bits or driver attachments.

Trigger Switch / Variable Speed Control

– Starts the drill and controls speed.

Battery Pack or Power Cord – Power source.

Chuck Key – Used to tighten a drill chuck (if applicable).

Motor Housing –

Encloses the motor; varies in power (amps/volts).

Forward / Reverse Switch –

Changes rotation direction for drilling or backing out screws.

Handle / Grip –

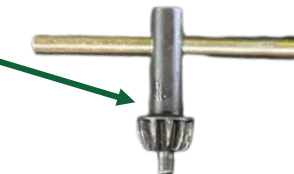
Ergonomic handle for better control.

Gear Selector (optional)

– Adjusts between low speed/high torque and high speed/low torque.

Auxiliary Handle (optional on larger drills)

– Provides additional control during heavy-duty drilling.



Safety Considerations

Personal Protective Equipment (PPE):

- Safety glasses or face shield
- Hearing protection (especially with hammer drills)
- Dust mask (for drilling into concrete, masonry, or dusty materials)
- Gloves (for material handling, but caution during use to prevent snagging)

General Safety:

- Inspect drill and cord/battery before use.
- Secure the workpiece with clamps when necessary.
- Use the correct drill bit for the material.
- Maintain proper footing and balance.
- Keep hands away from the rotating bit.
- Avoid loose clothing, jewelry, or long hair near moving parts.

Standard Operating Procedures

Pre-Operation

- Inspect drill, chuck, and cord/battery.
- Select and secure the correct bit.
- Verify that the work area is clean and material is stable.
- Set the proper gear and torque setting if adjustable.
- Wear proper PPE.

Operation

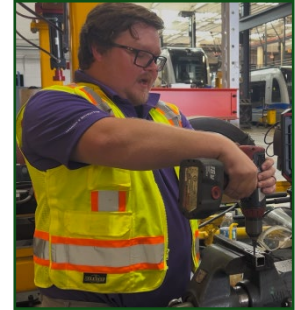
- Hold the drill with both hands when possible.
- Start drilling at low speed to avoid bit wandering.
- Apply steady, even pressure—let the drill do the work.
- Monitor bit and motor temperature during use.



- Adjust speed and pressure based on material hardness.

Post-Operation

- Release the trigger and allow the drill to stop fully.
- Disconnect power or remove the battery.
- Clean the drill and bit.
- Inspect for wear or damage.



Inspection & Maintenance

Inspection and maintenance of a power drill involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect the drill for cracks, damage, or loose parts.
- Check the power cord or battery for frays, cracks, or leaks.
- Inspect the chuck for wear or slippage.
- Verify bit condition (sharp, not bent or dull).

Quick Tips for Users:

- ✓ Use **pilot holes** when driving large screws or into hard material.
- ✓ Use center punch to help position the drill bit for increased accuracy
- ✓ **Hammer drills** are for masonry—regular drills are not.
- ✓ Let the **bit cool** if it gets too hot—overheating dulls bits quickly.
- ✓ Use **high speed for small bits / low speed for large bits**.
- ✓ Keep spare bits handy—**dull bits cause overheating and motor strain**.
- ✓ Careful not to let the drill bit “bite” into metal and either rotate workpiece or wrestle drill from your hands

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a power drill:

- ☐ Use drill to demonstrate drilling a hole in wood or metal piece
- ☐ Demonstrate use of center punch and pilot hole
- ☐ Other:

Notes/Comments:

Power Screwdrivers

Overview & Safety

Overview

A **power screwdriver** is a hand tool used for turning screws, typically to drive them into materials or remove them. Screwdrivers come in a variety of types and sizes, each designed to match specific types of screw heads. They are essential in a wide range of automotive applications.

Types of screwdrivers include:

- Flathead (Common)
- Phillips
- Torx

Key Components [Photo source: [The Home Depot](#)]

Screwdriver Bit:

Interchangeable drill bit (head) that fits into the screw head.

Trigger: Button that activates motor when pressed or squeezed. Has variable speeds depending on pressure on trigger.



Gearbox: (Internal)

system that adjusts the speed and torque from the motor towards the output shaft.

Handle: The part that you grip. Often made of plastic, rubber, or wood for comfort and better control.

Forward/Reverse Switch: Toggle button that lets the user switch rotation direction for driving or removing screws.

Safety Considerations

- ✓ **Match the Screw Type:** Use the appropriate type of screwdriver (flathead, Phillips, Torx, etc.) that matches the screw head. Using the wrong type can strip the screw or damage the tool.
- ✓ **Correct Size:** Ensure the screwdriver tip fits snugly into the screw head. A poorly fitting screwdriver can slip and cause injury or damage to the workpiece.
- ✓ **Wear the appropriate PPE:** Always use safety glasses to keep debris from flying into the eyes. Wear gloves if you handle rough or sharp materials.
- ✓ **Avoid wearing loose clothing or jewelry**
- ✓ **ALWAYS disconnect or power down the unit** before changing drill bits or performing any maintenance.

Standard Operating Procedures

Inspection

Visual Inspection

- Check the tool, cord or battery, and any drill bits for cracks, chips, or any signs of damage. Inspect the shaft for any bends, rust, or corrosion.
- Ensure that the grip is intact, especially for rubber or plastic-coated handles, which may degrade over time.
- Look for signs of wear that could cause the tool to slip in your hand during use.
- Rust or corrosion can weaken the screwdriver, making it unsafe to use.
- Examine the tip for wear, rounding, or chipping.
- A worn or damaged tip will not engage properly with screws, increasing the risk of stripping the screw head.
- Flathead screwdrivers should have a straight blade, while Phillips and other shaped tips should maintain their defined points.

Functional Inspection

- Tip Condition
 - a. Check to make sure the tip of the screwdriver is not damaged.
 - b. A damaged tip can cause the screwdriver to slip, strip the screw, damage the tool and possibly cause injury.
- Handle Security
 - a. Ensure the handle is securely fastened to the shaft. Any wobbling or movement may indicate internal damage or wear.

Screwdriver Selection

1. **Select the appropriate screwdriver:** Choose the right type of screwdriver and size based on the screw you are working with.
2. **Check for fit:** Check if the tip of the screwdriver fits securely in the corresponding screw head. Try a different size screwdriver for fit if uncertain. With flathead screwdrivers, make sure the tip extends through the entire slotted surface of the screw. Clean inside of the screw head if needed to ensure a solid, slip-free fit. A poorly fitting screwdriver may cause damage to both the tool and the fastener, and may cause personal injury.

Positioning and Grip

3. **Grip the handle properly:** Hold the handle with a firm but comfortable grip. Hold the screwdriver firm with both hands if necessary.
4. **Apply even pressure:** Align the screwdriver tip with the screw head and press it firmly to prevent slipping.
5. **Avoid excessive force:** Do not apply more force than necessary to prevent damage to the screwdriver, screw, or workpiece.

Driving Screws

- **Insert the screw into the material:** Place the tip of the screw into the designated hole or area on the workpiece. In tight places, or if dropping a screw is a concern, use a magnetic-tip screwdriver or Screw Starter tool (see below) to hold the screw to get it started into the material or threaded opening.
- **Squeeze the trigger:** Rotate the screwdriver in a clockwise direction (for tightening) with steady pressure. Avoid turning too quickly, as this can cause the screwdriver to slip.
- **Check alignment:** Ensure the screw remains aligned with the hole to avoid cross-threading.
- **Drive the screw flush:** Drive the screw until it is flush with the surface of the workpiece, but avoid overtightening, which can strip the screw head or damage the material.

Loosening Screws

- **Insert the screwdriver into the screw head:** Make sure it fits snugly. Try different bits if needed
- **Rotate counterclockwise:** Turn the screwdriver slowly to loosen the screw.
- **Use proper leverage:** If the screw is stuck, apply even pressure and avoid sudden, jerky movements that could strip the screw head. Again, do not apply more force than necessary. If the screw will not move, try some penetrating oil and/or tapping the head of the screw with a punch of similar same size, careful not to damage the screw head.

Preventive Maintenance

Preventive maintenance on screwdrivers involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

1. Regular Inspections

- **Check for Damage:** Examine the screwdriver for any signs of physical damage, such as cracks in the handle, bent shafts, or worn-out tips.
- **Assess Wear and Tear:** Look for signs of excessive wear, especially on the tips (for manual screwdrivers) or the motor and gears (for power screwdrivers).
- **Inspect Moving Parts:** For power screwdrivers, ensure that all moving parts operate smoothly without unusual noises or resistance.

2. Cleaning

- **External Cleaning:** Remove dust and debris from the exterior using compressed air or a soft brush.
- **Internal Cleaning:** Periodically, open the casing (if user-serviceable) to clean internal components, removing any buildup that could affect performance.

3. Lubrication

- **Power/Ratcheting Screwdrivers:** Lubricate gears, motors, and other moving parts as per the manufacturer's recommendations to reduce friction and prevent overheating.

4. Handling and Storage

- **Proper Storage:** Store screwdrivers in a dry, clean place to prevent rust and corrosion. Use toolboxes, pegboards, or magnetic strips to keep them organized and easily accessible.
- **Protect the Tips:** Use protective caps or sleeves for manual screwdriver tips to prevent damage and maintain their precision.
- **Avoid Moisture:** Ensure that the storage area is free from excessive moisture, which can lead to rusting and deterioration of materials.

5. Handle Maintenance

- **Grip Inspection:** Check the handle for cracks, chips, or loose parts. A damaged handle can affect grip and control, leading to potential accidents.
- **Secure Attachments:** For screwdrivers with interchangeable bits or attachments, ensure that these are securely fastened and in good condition.

6. Replacing Worn Parts

- **Tip Replacement:** For manual screwdrivers, replace worn or damaged tips to maintain effectiveness and prevent slipping.

Types of Power Screwdrivers

Commonly Used Power Screwdrivers

Cordless (Battery)



Photo source: [Harbor Freight](#)

Corded



Photo source: [Grainger](#)

Inline (Straight)



Photo source: [Lowes](#)

Right-Angle Screwdrivers



Photo source: [Ryobi Tools](#)

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a power screwdriver:

- ☐ Demonstrate proper inspection and usage of a power screwdriver unit
- ☐ Provide different size drives and screws to show proper driver selection
- ☐ Install and remove different screws with different drivers
- ☐ Use a screw starter to insert screw
- ☐ Other:

Notes/Comments:

Impact Gun

Overview & Safety



Overview

An impact gun is a powerful tool designed to deliver high torque output with minimal effort by the user. It is commonly used in automotive, construction, and industrial applications for tightening or loosening bolts, nuts, and other fasteners.

Key Components (typical application):

Drive: The connection point where sockets are attached, usually available in 1/2", 3/4", or 1" sizes for automotive and industrial applications.

Trigger: The operator presses the trigger to activate the motor, controlling the speed and torque applied.

Motor: The motor powers the tool, either electrically, pneumatically, or hydraulically.

Hammer and Anvil

Mechanism: The hammer stores energy and delivers it to the anvil, generating the tool's high torque.



Forward/Reverse Switch: This switch allows the user to alternate between tightening and loosening fasteners.

Photo source: [Mac Tools](#)

Safety

- ✓ **Personal Protective Equipment (PPE):** Always wear safety glasses to protect your eyes from flying debris, and hearing protection if the tool is loud.
- ✓ **Proper Socket Use:** Only use impact-rated sockets. Regular sockets may shatter under the force of an impact gun, leading to injury.
- ✓ **Controlled Torque:** Be cautious when tightening bolts, as over-torquing can damage fasteners or components. Consider using a torque wrench for precise tightening.
- ✓ **Secure Work Area:** Ensure the fastener and workpiece are stable before applying the impact gun.

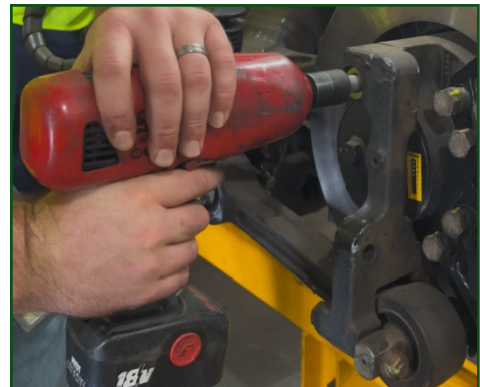
Standard Operating Procedures

Setup Procedures

1. Select the appropriate impact-rated socket size.
2. Attach the socket securely to the impact gun's drive.
3. If using extensions, ensure they are firmly locked in place.
4. On Pneumatic impacts add oil daily.

Tightening Fasteners

5. **Positioning:** Hold the impact gun firmly with both hands to control torque and prevent recoil.
6. **Align Socket:** Place the socket directly over the fastener head, ensuring proper alignment.
7. **Trigger Control:** Press the trigger gradually to control speed and torque. Start with lower power and increase as necessary.
8. **Monitor Torque:** Avoid over-tightening by monitoring the force applied. For critical fasteners, finish the job with a torque wrench to ensure precise torque values.



Loosening Fasteners

9. **Reverse Direction:** Use the forward/reverse switch to change the tool's direction to loosen fasteners.
10. **Apply Steady Pressure:** Hold the tool firmly and apply constant pressure. Allow the impact gun to do the work—do not jerk or force the tool.
11. **Stuck Fasteners:** For stubborn or rusted fasteners, use penetrating oil and give the impact gun time to break the fastener loose without applying excessive force.

Shutdown Procedures

12. **Release Trigger:** Stop the tool by releasing the trigger and allowing the tool to come to a complete stop.
13. **Disconnect Air or Battery:** For pneumatic tools, disconnect the air hose. For battery-powered tools, remove the battery.
14. **Remove Sockets:** Detach the socket or extension from the impact gun after use.

Preventative Maintenance

Preventive maintenance for impact guns involves regular care and inspections to ensure the tool operates efficiently and safely. Key preventive maintenance steps include:

1. **Lubrication:** Regularly oil the impact gun, especially the air motor and moving parts, to reduce friction and prevent wear.
2. **Inspection:** Check for any visible damage to the tool, such as cracks, worn-out parts, or loose components that could impact performance.
 - **Body and Casing:** Examine the body and outer casing for any visible cracks, dents, or signs of wear and tear.
 - **Handle and Grip:** Ensure the handle and grip are secure and undamaged. Check for any worn-out rubber grips, which may affect the handling and cause slipping.
 - **Trigger:** Inspect the trigger for smooth operation. It should not stick or feel too loose. A malfunctioning trigger may lead to unintended operation.
3. **Air Supply Maintenance:** Ensure that the air supply is clean, dry, and set at the correct pressure, as moisture and debris in the air line can damage the tool.
4. **Cleaning:** Keep the exterior and air intake of the impact gun clean to avoid dirt or debris affecting performance.
5. **Tightening and Adjustment:** Periodically check the tightness of screws, bolts, and other parts to ensure the tool remains properly assembled. Loose or missing fasteners can compromise the tool's performance and safety.
6. **Hose and Fittings Check:** Inspect the air hose and fittings for leaks or damage, as improper air delivery can affect the tool's performance.
7. **Storing Properly:** Store the impact gun in a clean, dry place to prevent rust and other environmental damage.

Types of Impact Guns

Commonly Used Impact Guns

	Pneumatic Impact Gun
	Corded Electric Impact Gun
	Cordless (Battery) Impact Gun

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Learning Objective: Demonstrate the ability to use an impact gun

Suggested hands-on learning activities for use of an impact gun:

- ☐ Perform a visual inspection and select proper size, using an impact socket
- ☐ Install and tighten a bolt/nut
- ☐ Remove a bolt/nut
- ☐ Other:

Instructor demonstration activities:

- ☐ Demonstrate how to not over-do with impact gun and how to not strip a bolt
- ☐ Demonstrate intentionally stripping to show what happens
- ☐ Demonstrate cross threading
- ☐ Other:

Notes/Comments:

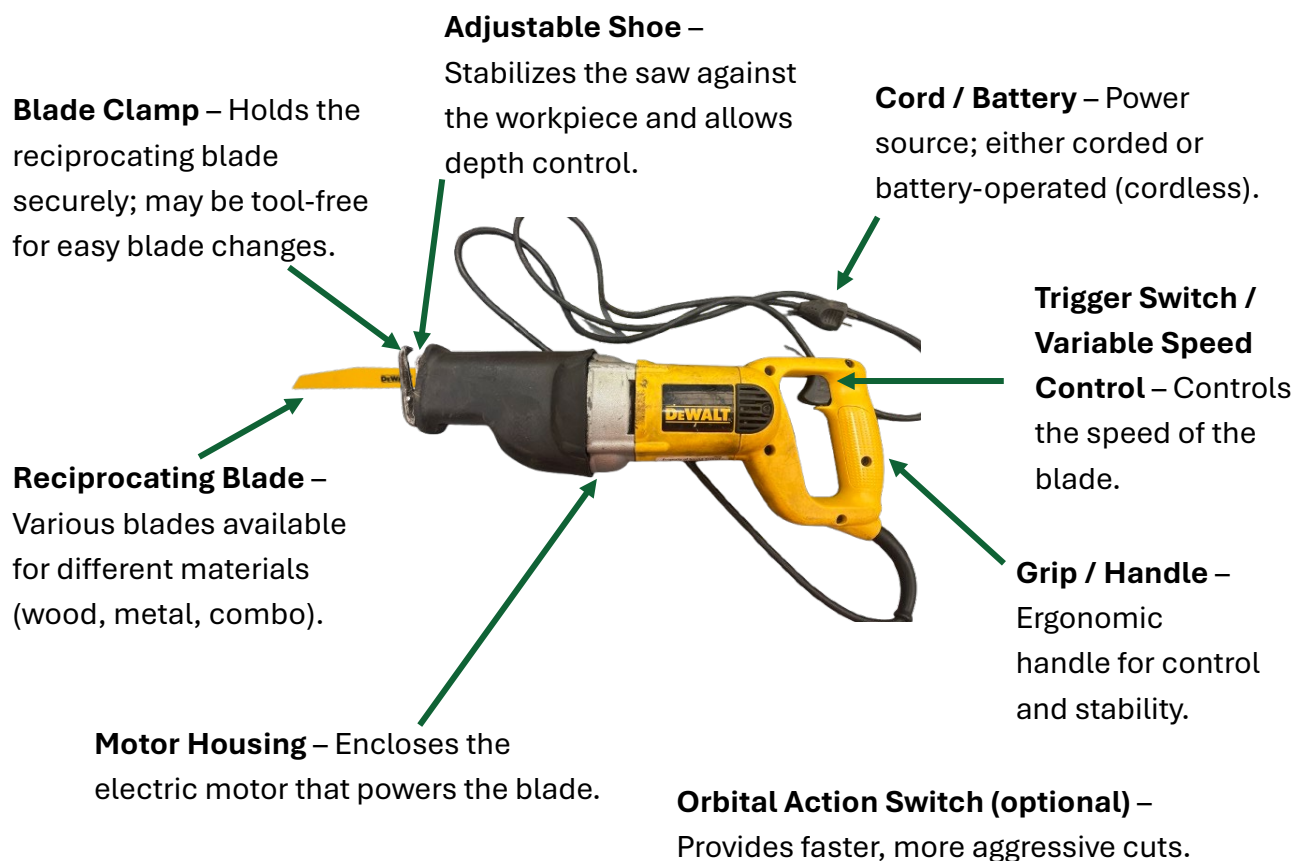
Reciprocating Saw

Overview & Safety

Overview

A **reciprocating saw** is a versatile, handheld power tool designed for cutting through a variety of materials such as wood, metal, PVC, and drywall. It's commonly used in construction, demolition, plumbing, and electrical work due to its ability to make fast, rough cuts in hard-to-reach places.

Key Components (typical application):



Safety Considerations

Personal Protective Equipment (PPE):

- Safety glasses or face shield
- Cut-resistant gloves
- Hearing protection
- Dust mask or respirator (if cutting materials that generate dust)

General Safety:

- Inspect tool and blade before use.
- Secure the material being cut.
- Keep hands away from the blade path.
- Ensure blade type matches the material being cut.
- Maintain a firm grip with two hands.
- Avoid loose clothing or jewelry near moving parts.
- Use proper body positioning to prevent loss of balance.

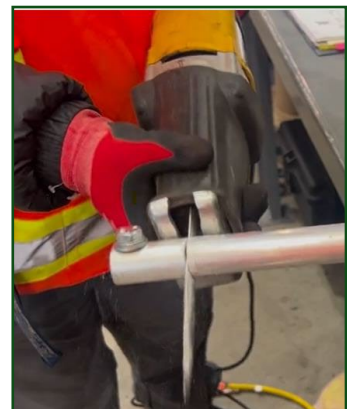
Standard Operating Procedures

Pre-Operation

- Inspect tool and blade condition.
- Select the appropriate blade.
- Verify work area is clear and material is secure.
- Wear required PPE especially eye protection.

Operation

- Position the shoe firmly against the workpiece.
- Start the saw at low speed to get the cut started.
- Increase speed as needed while maintaining control.



- Allow the blade to do the cutting—avoid forcing the saw.
- Monitor blade heat and wear.

Post-Operation

- Release the trigger and wait for the blade to stop fully.
- Disconnect power or remove the battery.
- Inspect blade and tool for damage.
- Clean the tool and work area.

Inspection & Maintenance

Inspection and maintenance of a reciprocating blade involve regular checks, care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Check blade for damage or excessive wear.
- Inspect the power cord or battery for damage.
- Ensure blade clamp is secure and functioning.
- Test trigger and speed control.

Blade Maintenance:

- Replace dull or damaged blades immediately.
- Store blades properly to prevent rust or damage.

Quick Tips for Users:

- ✓ Use **longer blades** for plunge cuts and hard-to-reach areas.
- ✓ **Oscillating feature** (if equipped) helps for faster wood cuts but avoid it on metal.
- ✓ Let the blade stop fully before setting the saw down.
- ✓ Use **bi-metal blades** for metal and **wood-cutting blades** for lumber.
- ✓ Use a hacksaw to start the cut as a way of preventing the blade “skating” across the surface.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a reciprocating saw:

- ☐ Cut a 2 x 4 piece of wood
- ☐ Cut a bolt, a piece of 90-degree angle iron, or steel
- ☐ Other:

Notes/Comments:

Grinding Wheels

Overview & Safety

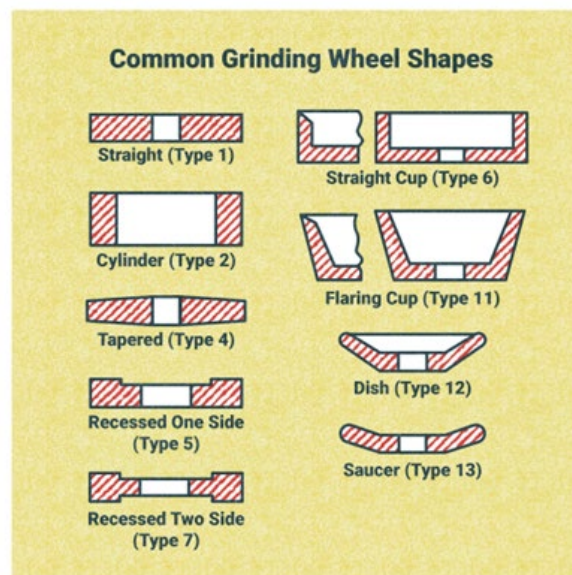


Overview

A **grinding wheel** is a circular tool made from abrasive particles bonded together. Available in various shapes and sizes, they are used for cutting, grinding, and finishing materials like metals, ceramics, and plastics. They are commonly used in industrial machining processes, such as shaping, sharpening, polishing, and removing excess material from a workpiece. Grinding wheels can be mounted on a portable hand-held grinder (electric or air powered), or a stationary bench grinder.

Common types of grinding wheels include:

- Straight wheel – Most widely used grinding wheel, featuring a cylindrical shape with a flat grinding surface.
- Cylinder wheel - Similar to straight wheels but with a larger width. Cylinder wheels are typically used for grinding internal diameters.
- Tapered wheel - Surface of the wheel tapers outward.
- Straight cup wheel – Surface is flat.
- Dish wheels - Flat center surface that's elevated at each edge.
- Other – see graphic below: [Open WA: Introduction to Machining: 11.2 Grinding Wheels](#)



- **Wire Wheel** – Like a grinding wheel, an abrasive tool but with metal wire bristles used for removing rust, paint, and other surface dirt. Also used for polishing, deburring, and prepping surfaces.
- Wire wheels come in a variety of styles, such as crimped, knotted, and standard twist knot, each designed for different tasks and surface textures. Like grinding wheels, can be mounted a portable hand-held grinder (electric or air powered), or a stationary bench grinder.

Key Components (of the wheel):

Bonding Material: Holds abrasive grains together and provides the wheel with its shape. Bonds can be made of vitrified clay, resinoid (synthetic resin), or rubber.



Wheel Structure: Refers to the spacing of the abrasive grains in the wheel. A more open structure allows for faster cutting, while a denser structure offers a smoother finish.

Photo source: [Lee Valley Tools](https://www.leevalley.com/)

Wheel Grade: Indicates the hardness of the bond that holds the abrasive grains. Softer grades wear away faster, exposing fresh abrasive grains, while harder grades hold grains longer.

Abrasive Grains: These are the cutting elements that grind the material. Common abrasives include aluminum oxide, silicon carbide, diamond, and cubic boron nitride (CBN).

Safety

- ✓ **Never use the side of the grinding wheel to grind**
- ✓ **DO NOT wear loose fitting clothing or jewelry** – these can get caught by the grinding wheel.
- ✓ **Wheel Inspection:** Always inspect the wheel for cracks, chips, or defects before use.
- ✓ **Wheel Mounting:** Ensure the wheel is properly mounted and balanced on the machine to prevent vibrations and accidents.
- ✓ **Protective Gear:** Operators should always wear safety goggles, face shields, gloves, and hearing protection while using a grinding wheel.

Standard Operating Procedures

Mounting the Grinding Wheel

1. **Correct Fit:** Ensure the grinding wheel's hole matches the grinder's spindle size and fits securely without excessive force.
2. **Tighten Wheel:** Secure the wheel using the appropriate flanges and ensure it is tightly but not over-tightened.

Setting Up the Machine

3. **Adjust Tool Rest:** If using a bench grinder, adjust the tool rest to within 1/8" (3mm) from the wheel.
4. **Position Wheel Guard:** Ensure the wheel guard covers the grinding wheel adequately and is adjusted to the correct angle.



Start-Up

5. **Clear the Area:** Ensure no loose materials or tools are around the grinder.
6. **Turn on the Grinder:** Start the machine and let the grinding wheel reach full operating speed before use.
7. **Check for Vibration:** If the machine vibrates excessively, stop the grinder and check the wheel's balance and mounting.

Grinding Procedure

8. **Hold the Workpiece Securely:** Firmly place workpiece in vice to prevent slipping or shifting during grinding. Swivel the vice as needed to obtain correct orientation
9. **Apply Light Pressure:** Do not force the workpiece against the wheel. Allow the abrasive to do the work, applying only light to moderate pressure.
10. **Maintain Control:** Keep the workpiece in contact with the tool rest (on bench grinders) and maintain a firm, controlled motion.
11. **Avoid Overheating:** For metal grinding, periodically cool the workpiece in water if it heats up excessively.
12. **Use the Full Surface:** To avoid uneven wear, move the workpiece back and forth across the entire surface of the grinding wheel.



Shutdown Procedure

13. **Turn Off the Grinder:** Once grinding is complete, turn off the machine and allow the grinding wheel to stop naturally. Never try to stop the wheel manually.
14. **Clean the Area:** Remove any debris or metal filings from the work area, and clean the grinder if necessary.

Preventive Maintenance

Preventive maintenance for grinding wheels involves regularly inspecting, maintaining, and replacing the wheels to ensure optimal performance and safety. Key aspects of preventive maintenance include:

1. **Regular Inspection:** Check for cracks, chips, or wear on the wheel surface that could compromise safety or efficiency. Examine the bonding material for signs of weakness, and ensure the abrasive grains are intact and not dislodged.
2. **Balancing:** Ensure the grinding wheel is properly balanced to prevent vibrations and uneven wear during operation.
3. **Dressing:** Periodically dress (reshape) the wheel to restore its cutting performance by removing any material buildup or glazing that can affect efficiency.
4. **Cleaning:** Remove debris, dust, and residual materials from the wheel and surrounding equipment to prevent contamination or overheating.
5. **Speed Check:** Verify that the wheel is operating at the recommended speed, as overspeeding can lead to wheel failure or accidents.
6. **Storage:** Store grinding wheels properly to protect them from moisture, temperature extremes, or physical damage.
7. **Replacement:** Replace wheels that are excessively worn, damaged, or nearing the end of their usable life to maintain performance and safety.

Types of Grinding Wheels

Commonly Used Grinding	
	Wire Wheel (mounted to a Bench Grinder – note the lack of protective guard)
	Portable hand-held grinder

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a grinding wheel:

- ☐ Set out an arrangement of grinding and wire wheels. Have the learner describe typical applications.
- ☐ Demonstrate proper PPE usage while performing tasks on a grinding/wire wheel.
- ☐ Demonstrate proper techniques for grinding. This should include correct installation and removal of the wheel.
- ☐ Demonstrate proper cleaning and profiling of the grinding wheel.
- ☐ Use the grinding wheel for cutting, grinding, and profiling a manufactured or installed parts. Example – use a grinding wheel to remove sharp edges.
- ☐ Demonstrate proper inspection methods. They must describe what they're looking for.
- ☐ Demonstrate knowledge in proper grinding materials. For example, which metals should NOT be used.
- ☐ Demonstrate attaching and removing abrasive wheels.
- ☐ Demonstrate proper fitting of safety guards on a bench grinder.
- ☐ Demonstrate proper fitting of tool rest/table on a bench grinder.

☐ Other:

Notes/Comments:



Lifting Tools

Chain Hoist

Electric Crane

Come-Along

Chain Hoist

Overview & Safety

Overview

A **Chain Hoist** is a mechanical lifting device used to raise or lower heavy loads by pulling on a hand chain. It uses a system of gears and a load chain to lift loads vertically. Chain hoists are widely used in construction, maintenance, industrial, and warehouse settings for lifting heavy objects safely and efficiently.

Key Components:

Upper Hook Assembly

– Connects the hoist to a beam, trolley, or anchor point.

Hoist Body

– High-strength chain that lifts and holds the load.

Load Chain

– High-strength chain that lifts and holds the load.

Hand Chain – Loop of chain used by the operator to activate the lifting mechanism.

Lower Hook (Hook Block Assembly)

– Connects the hoist to the load; equipped with a safety latch.



Photo source: [Brownsales.com](https://www.brownsales.com)

Safety Considerations

Personal Protective Equipment (PPE):

- Hard hat (overhead work)
- Safety glasses
- Gloves (for handling chains and hooks)
- Steel-toe boots

General Safety:

- **Inspect** the hoist and chains **before each use**.
- Never **exceed the rated capacity**—check the tag/label.
- Ensure the hoist is **mounted to a secure, rated anchor point**.
- Always lift **straight up and down**—no side loading.
- **Stay clear of the load path** — never stand or walk under a suspended load.
- Use **tag lines** if needed to control swinging loads.
- **Do not wrap the load chain** around the load—use proper slings or hooks.

Standard Operating Procedures

Pre-Operation

- Inspect chains, hooks, latches, and gears for damage or wear.
- Check the hoist's rated load capacity and verify it meets the job requirements.
- Ensure the top hook is properly secured, and the load is centered under the hoist.
- Confirm brake operation by testing lifting and holding functions without a load.

Operation

- Pull the **hand chain** slowly and steadily to lift the load.
- Keep the hand chain aligned and free of twists or knots.
- **Stop pulling if excessive force is needed**—reassess setup or load weight.
- **Lift only to the necessary height**—avoid excessive lifting.

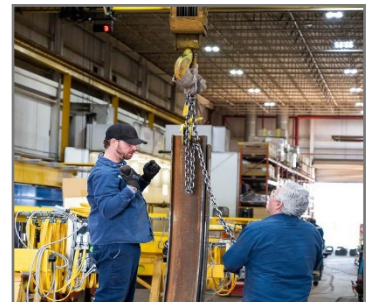


Photo source: [O'Brien Lifting Solutions](#)

- To lower, slowly pull the hand chain in the opposite direction, maintaining control.
- Do not leave suspended loads unattended.

Post-Operation

- **Lower the load completely** and release chain tension.
- Remove the load and inspect the hoist for damage.
- Clean the chain and hoist body as needed.
- Store or secure the hoist properly for the next use.

Inspection & Maintenance

Inspection and maintenance for a chain hoist involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect hand chain and load chain for **kinks, twists, corrosion, or damage**.
- Check both hooks for **deformation, cracks, or broken safety latches**.
- Verify smooth operation of the gears and brake mechanism.
- Ensure **load chain runs freely** through the sheave.

Quick Tips for Users:

- ✓ Always **know the weight of the load** and the hoist's capacity before lifting.
- ✓ **Use two people for large or awkward loads**—one to operate, one to guide.
- ✓ **Never side-pull**—hoists are designed for vertical lifting only.
- ✓ Keep **hands and fingers clear** of the chain and moving parts during operation.
- ✓ Regularly **document inspections and maintenance** to stay compliant with safety standards.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a chain hoist:

- ☐ Demonstrate proper lifting operations using a chain hoist
- ☐ Other:

Notes/Comments:

Electric Crane

Overview & Safety

Overview

An **electric crane** is a piece of lifting equipment powered by electricity. It is designed to move, lift, and lower heavy loads with precision and efficiency. It uses electric motors for its primary operations, including hoisting, traveling, and slewing (rotating), and is widely used in industrial, construction, and manufacturing environments.

Electric cranes come in various forms, such as overhead cranes, gantry cranes, tower cranes, and jib cranes, depending on the application and environment. Unlike diesel or hydraulic cranes, electric cranes produce less noise, require less maintenance, and generate zero on-site emissions, making them ideal for indoor use or areas with strict environmental regulations.

Key Components:

Wire Rope (s) –

Material that bears the load weight (evenly).

Pulley Mechanism: A mechanism to increase lift power and balance load.

Lifting Hook (Bottom Hook) –
Connects the hoist to the load; equipped with a safety latch.

Hoist: Electric lifting mechanism that helps lower or raise the load.
(above the crane)

Control System (*pictured above*) - Control unit that regulates operation of the electric crane.

Brake System – Automatically engages to hold the load when the hand chain is released.



Safety

Personal Protective Equipment (PPE):

- Hard hat (overhead work)
- Safety glasses
- Gloves (for handling chains and hooks)
- Steel-toe boots

General Safety:

- **Inspect** the crane and wires **before each use**.
- Never **exceed the rated capacity**—check the tag/label.
- Ensure the crane is **mounted to a secure, rated anchor point**.
- Always lift **straight up and down**—no side loading.
- **Stay clear of the load path** — never stand or walk under a suspended load.
- Use **tag lines** if needed to control swinging loads.
- **Do not wrap the load chain** around the load—use proper slings or hooks.

Standard Operating Procedures

Pre-Operation

- Inspect hooks, latches, wires and gears for damage or wear.
- Check the crane's rated load capacity and verify it meets the job requirements.
- Ensure the top hook is properly secured, and the load is centered under the crane.
- Confirm brake operation by testing lifting and holding functions without a load. Check power is being supplied to crane.



Operation

- Secure the load to hook using ropes, slings, or chains.
- **Use/push the activation button on the control box** - designated for the crane to move or operate the load lift.



- **Stop pulling if excessive force is needed**—reassess setup or load weight.
- **Lift only to the necessary height**—avoid excessive lifting.
- **Use/push the lower button on the control box** - designated for the crane to slowly lower the load lift.
- Do not leave suspended loads unattended.

Post-Operation

- **Lower the load completely** and release tension and any secure connections.
- Remove the load and inspect the hoist for damage.
- Return crane to original or resting position and begin shutdown procedure if finished.
- Clean and inspect cables and hoist body as needed.

Inspection & Maintenance

Inspection and maintenance for electric cranes involves regular care and upkeep to ensure that the unit remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect crane and load cables for **kinks, twists, corrosion, or damage**.
- Check hooks and gears for **damage, wear, deformation, cracks, or broken safety latches**.
- Verify smooth operation of the gears, control box, and brake mechanism.

Quick Tips for Users:

- ✓ Always **know the weight of the load** and the crane's capacity before lifting.
- ✓ **Use two people for large or awkward loads**—one to operate, one to guide.
- ✓ **Never side-pull**—hoists are designed for vertical lifting only.
- ✓ Keep **hands and fingers clear** of the chain and moving parts during operation.
- ✓ Regularly **document inspections and maintenance** to stay compliant with safety standards.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of an electric crane:

- ☐ Demonstrate proper lifting operations using an electric crane
- ☐ Other:

Notes/Comments:

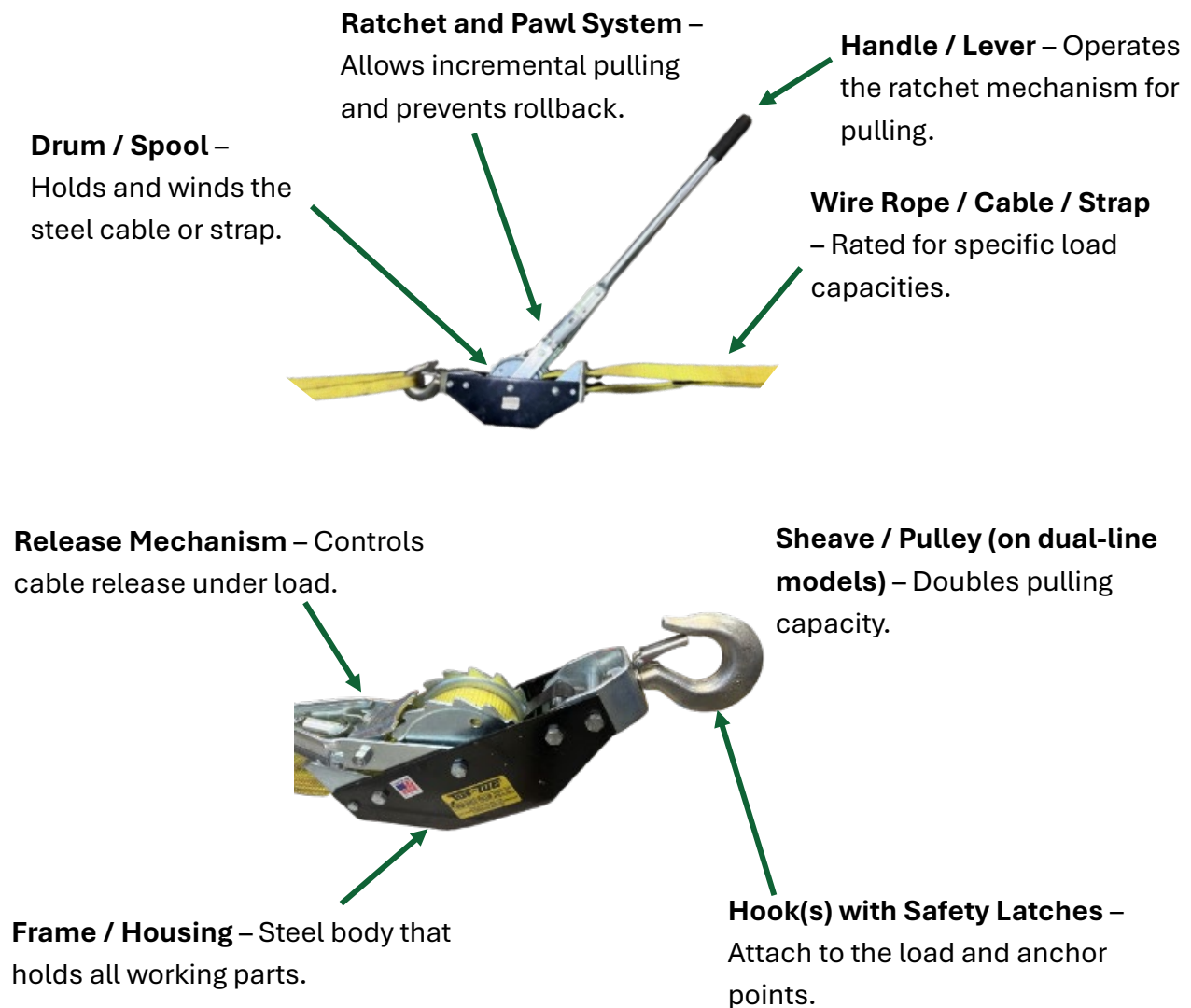
Come-Along

Overview & Safety

Overview

A **Come-Along** is a hand-operated mechanical tool used to pull, lift, or stretch heavy loads with a ratcheting winch and cable system. Commonly used in construction, utility work, vehicle recovery, fencing, tree removal, and material handling, a come-along provides controlled pulling power using a lever.

Key Components:



Safety Considerations

Personal Protective Equipment (PPE):

- Safety glasses or face shield (due to potential cable snapback)
- Heavy-duty gloves (to protect hands from frayed cable)
- Steel-toe boots (if working around heavy loads)

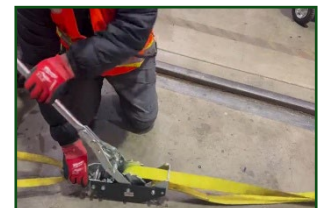
General Safety:

- Inspect the come-along and cable before every use.
- Never exceed the rated load capacity (check the tag/label).
- Keep hands, feet, and body parts clear of the cable path.
- Do not use for overhead lifting unless specifically rated.
- Stay out of the direct line of pull in case the cable or hooks fail.
- Use only approved anchor points rated for the load.
- Never wrap the cable around an object to create an anchor—it damages the cable.

Standard Operating Procedures

Pre-Operation

- Inspect the frame, cable, hooks, and pawls for wear, cracks, or damage.
- Verify the load rating and make sure it's appropriate for the task.
- Position the come-along between the load and a secure anchor point.
- Check the cable for kinks, frays, or corrosion.
- Wear required PPE.



Operation

- Attach both hooks securely with the safety latches closed.
- Engage the ratchet mechanism by moving the selector to the "pull" position.
- Operate the handle smoothly, advancing the cable and pulling the load.

- Maintain control of the handle at all times—do not let it snap back.
- Monitor the cable tension and alignment during use.
- Stop if resistance increases suddenly—check for obstructions or overloading.



Inspection & Maintenance

Inspection and maintenance with a come-along involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect cable or strap for fraying, broken strands, kinks, or corrosion.
- Check the ratchet mechanism and pawls for proper engagement.
- Inspect hooks and safety latches for cracks or damage.
- Verify that the frame is free of warping or cracks.

Quick Tips for Users:

- ✓ **Never "shock load" a come-along**—steady pulling only.
- ✓ **Always monitor the cable's condition**—replace immediately if frayed.
- ✓ **Use rated anchor points**—never attach to unstable objects.
- ✓ **Double-line models increase pulling power** but reduce range—use appropriately.
- ✓ **Stay clear of the cable line of fire**—a snapped cable can cause severe injury.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a come-along:

- ☐ Use a come-along to secure a pipe to a table
- ☐ Use a come-along to provide proper tension on a cable
- ☐ Use a come-along to lift a piece of heavy metal, wood, etc.
- ☐ Other:

Notes/Comments:



Presses

Hydraulic Presses

Mechanical Presses

Hydraulic Presses

Overview & Safety

Overview

Hydraulic and Mechanical Presses are powerful machines used to apply controlled force for bending, shaping, pressing, punching, stamping, or forming materials. These presses are common in metalworking, automotive, maintenance, and fabrication shops.

A **hydraulic press** specifically uses fluid pressure from a hydraulic pump to apply steady, adjustable force over a longer stroke.

Key Components:

Frame & Hydraulic Power Unit (HPU) - Provides structural support for press components and the overall system of tank, motor, hoses and pumps and chillers that create mechanical pressure.

Hydraulic Cylinder (Body) – Main core containing a piston to move cylinder and apply force from converted hydraulic energy.



Ram (Platen) – Moving surface or face that applies the force and presses the object or material.

Control System – Control unit that regulates the operation, pressure and speed of the press.

Safety Considerations (Hydraulic)

Personal Protective Equipment (PPE):

- Safety glasses or face shield (required)
- Heavy-duty gloves
- Steel-toe boots
- Hearing protection (especially on mechanical presses)

General Safety:

- Inspect the press and tooling before every use.
- Keep **hands, tools, and loose clothing clear** of the die area.
- Use **two-hand controls, foot pedals, or light curtains** to prevent accidental engagement.
- Ensure all **guards, barriers, and emergency stops** are in place and functional.
- Do not exceed the **rated capacity** of the press.
- Use proper blocking or supports when working under the ram.
- Always **lockout/tagout (LOTO)** the press for maintenance or die changes.

Standard Operating Procedures

Pre-Operation

- Review machine specifications and the job setup sheet.
- Inspect:
 - Hydraulic hoses and fluid levels (hydraulic)
 - Die and tooling condition
- Verify safety devices are functional.
- Wear required PPE.



Operation

- Position the material securely.
- Set the stroke depth, pressure, or cycle as needed.
- Use **both hands-on controls** or operate foot pedals safely.

- Run a test cycle without material to check operation.
- Monitor the process for alignment and abnormal sounds or behavior.
- Only operate at **assigned speeds and settings**.



Post-Operation

- Remove and store material and finished parts safely.
- Shut down the press using the proper sequence.
- Clean the area and machine.
- Report any damage or abnormal operation.

Inspection & Maintenance

Inspection and maintenance for a press involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect the press frame, ram, and tooling for cracks or wear.
- Check hydraulic fluid levels and inspect for leaks.
- Inspect safety devices, guards, light curtains, and e-stops.

Weekly / After Heavy Use:

- Lubricate moving parts per the manufacturer's schedule.
- Check alignment of the ram and tooling.
- Inspect hoses, fittings, and seals for wear.
- Clean hydraulic reservoir and check for fluid contamination.

Periodic (Monthly / Annually):

- Perform calibration and alignment checks.
- Replace worn hoses, seals, or gaskets.
- Inspect structural components for fatigue or cracks.
- Record inspections and maintenance activities.

Quick Tips for Users:

- ✓ **Never bypass safety devices or guards.**
- ✓ **Keep hands and body clear** of the point of operation. Use push sticks or tools.
- ✓ **Use correct pressure settings**—excess force can damage equipment or tooling.
- ✓ **Listen for abnormal noises**—they can signal misalignment or mechanical issues.
- ✓ **Lockout and tag out** before performing maintenance or die changes.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a hydraulic press:

- ☐ Use press to press a bearing in place
- ☐ Use press to bend a piece of metal
- ☐ Other:

Notes/Comments:

Mechanical Presses

Overview & Safety

Overview

Hydraulic and Mechanical Presses are powerful machines used to apply controlled force for bending, shaping, pressing, punching, stamping, or forming materials. These presses are common in metalworking, transit maintenance, and fabrication shops.

A typical mechanical press uses a motor-driven flywheel and crank mechanism to deliver force quickly and repeatedly; or a manually-activated/actuated lever

Types include: Arbor Press, Punch Press, Screw Press

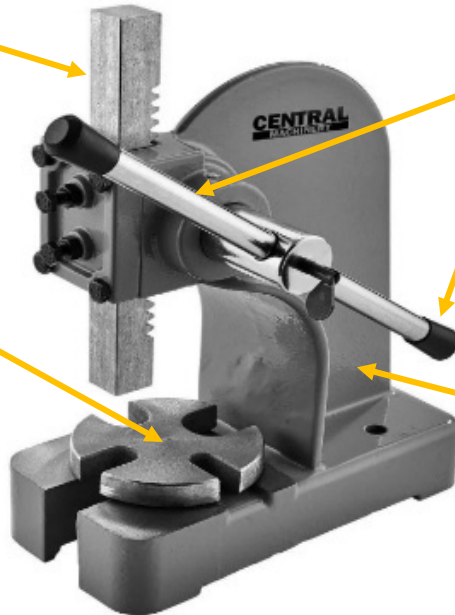
Key Components

Arbor – Mechanically driven ram with teeth that interact with gears on the handle to provide force.

Lever/Handle – Rotates the shaft with gears that interact with the arbor.

Worktable – Surface where workpiece(s) are placed.

Frame (Bolster Plate) – Offers structural support and stability.



Safety Considerations (Mechanical)

Training and Authorization:

- Only trained and authorized personnel should operate the press.
- Operators must understand the press's functions, safety devices, and emergency protocols.

Personal Protective Equipment (PPE)

- Wear appropriate PPE, such as safety glasses, gloves (if safe to do so), and steel-toed boots.
- Avoid loose clothing or jewelry that could get caught in the machinery.

General Safety:

- Always use **point-of-operation guards** or **presence-sensing devices** (e.g. light curtains).
- Do not bypass or disable any safety mechanisms.
- Ensure **two-hand control systems** are functioning properly, preventing accidental activation.
- Keep hands and body parts clear of the die area during operation.
- **Never reach into the die area** unless the machine is fully stopped and locked out.
- Use hand tools (e.g., tongs, push sticks) to load/unload parts when necessary.
- Ensure all **guards, barriers, and emergency stops** are in place and functional.
- Do not exceed the **rated capacity** of the press.
- Use proper blocking or supports when working under the ram.
- Ensure all stored energy (mechanical, electrical, pneumatic) is released or secured.
- Keep the work area clean and free of obstructions or slippery materials.
- Ensure adequate lighting and clear visibility around the press.
- Report any malfunctions, unsafe conditions, or near-misses immediately.

Standard Operating Procedures

Pre-Operation

- Review machine specifications and the job setup sheet.
- Check for any signs of wear, damage, or malfunction.
- Inspect all safety guards, interlocks, and emergency stop functions to ensure they're working.
- Ensure proper tool and die setup, alignment, and secure fastening.

Operation

- Select the correct mode
 - Set stroke length, depth, pressure or cycle as needed
- Position the material securely.
- Run a test cycle without material to check operation.
- Monitor the process carefully for alignment and abnormal sounds or behavior.
- Test cycle with no load (dry run) to ensure proper setup

Post-Operation

- Wait until ram is fully retracted and ceases moving
- Remove and store material and finished parts safely.
- Clean the area of excess materials or scrap and machine.
- Report any damage or abnormal operation.

Inspection & Maintenance

Inspection and maintenance for a press involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect the press frame, ram, and tooling for damage, cracks or wear.
- Inspect safety devices, guards, light curtains, and e-stops.
- Test the brake and clutch systems (mechanical), and emergency stop button(s).

Weekly / After Heavy Use:

- Lubricate moving parts per the manufacturer's schedule.
- Check alignment of the ram and tooling.
- Inspect hoses, fittings, and seals for wear (hydraulic).
- Clean hydraulic reservoir and check for fluid contamination.

Periodic (Monthly / Annually):

- Perform calibration and alignment checks.
- Perform a dry run or without a load
- Inspect integrity of structural components for fatigue or cracks.
- Record inspections and maintenance activities.

Quick Tips for Users:

- ✓ **Never bypass safety devices or guards.**
- ✓ **Keep hands and body clear** of the point of operation. Use push sticks or tools.
- ✓ **Use correct pressure settings**—excess force can damage equipment or tooling.
- ✓ **Listen for abnormal noises**—they can signal misalignment or mechanical issues.

Types of Mechanical Presses

Commonly Used Mechanical Presses

	Arbor Press - Small, hand-operated press used to apply controlled force in tasks like press fitting, staking, broaching, and punching. Typically consists of a base, a vertical frame, a ram (or plunger), and a lever or handwheel that drives the ram downward. Photo source: Harbor Freight
	Punch Press - A mechanically or hydraulically powered machine used to cut, shape, or form materials—typically sheet metal—by applying force through a punch and die system. It operates by driving a ram downward, which forces the punch into the workpiece and against a die, creating precise holes or shapes. Photo source: DiAcro

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a mechanical press:

- ☐ Use press to press a bearing in place
- ☐ Use press to bend a piece of metal
- ☐ Other:

Notes/Comments:



Alignment Tools

Straightedge

**Laser Alignment
Tools**

Straightedge

Overview & Safety

Overview

Alignment tools are specialized instruments used to measure, adjust, and ensure the proper positioning of mechanical components, typically in rotating machinery, piping systems, or structural work. Accurate alignment reduces wear, prevents breakdowns, and improves system efficiency. Tools range from basic manual gauges to advanced laser systems.

Common types include **straightedge and feeler gauges, dial indicators, laser shift alignment tools, optical and laser levels, and plum bobs or levels.**

A **straightedge** is a tool used to check or draw straight lines and angles and help determine the flatness or straightness of a surface. It typically consists of a long, flat, and rigid bar made from materials such as metal, wood, or plastic, and it features at least one precision-ground straight edge. Commonly used in drafting, carpentry, machining, and engineering applications, and used to calibrate or inspect equipment surfaces for flatness and alignment.

They come in various lengths and types, including:

- Drafting straightedges (often transparent or marked with measurements)
- Machinist straightedges (usually made of steel or cast iron for high precision)



Straightedge – Simple tool used to check flatness or surface alignment.



Plumb Bob / Spirit Level / Precision Level – Verifies vertical or horizontal alignment.



Feeler Gauges – Thin metal strips of known thickness for measuring small gaps.



Shim Packs – Metal shims used to adjust and correct misalignment.

Safety Considerations

Personal Protective Equipment (PPE):

- Safety glasses
- Gloves (when handling heavy machinery or shimming)
- Steel-toe boots (if working around heavy equipment)

General Safety:

- Ensure all equipment is **locked out and tagged out (LOTO)** before starting alignment.
- Remove rotating equipment from service before measurement.
- **Use the right alignment tool for the accuracy needed**—improper tools can cause damage.
- Keep hands clear of pinch points when adjusting equipment or inserting shims.
- Do not force or over-tighten mounts or bolts during realignment.

Standard Operating Procedures

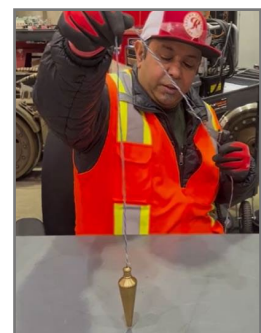
Pre-Operation

- **Review the equipment manual** for alignment specifications.
- Inspect all tools for wear, damage, and calibration.
- **Lockout/tagout (LOTO)** all machinery involved in the alignment process.
- Clean measurement surfaces—dirt or rust affects accuracy.



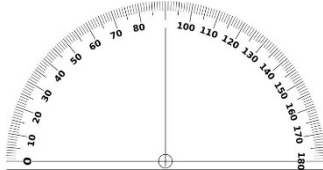
Operation

- Measure initial alignment using the chosen tool (dial indicator, laser, feeler gauges).
- Record **angular and parallel misalignment** readings.
- Use shims, adjust mounts, or reposition components to achieve correct alignment.
- Re-measure after each adjustment to confirm changes.
- Tighten fasteners in sequence while monitoring for alignment shift.



Common Types of Alignment Tools (Straightedges)

Commonly Used Straightedges

Plum Bob 	Protractor 	Magnetic Angle Gauge 
Vertical and horizontal alignment checks.	Measures, marks and sets angles Photo courtesy of History of Pencils.com	Another kind of angle measurement tool, with hands-free operation
Standard Level 	Straightedge 	Feeler Gauge 
Vertical and horizontal alignment checks.	Checking flatness, gap, or surface contact.	Measures clearance or precise small gaps between surfaces

Inspection & Maintenance

Inspection and maintenance for alignment tools and straightedges involves regular care and upkeep to ensure that any tools remain in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect dial indicators for smooth movement and zero calibration (if applicable).
- Ensure feeler gauges and straightedges are clean and free from damage.
- Verify that magnetic bases hold securely. (if applicable).

Quick Tips for Users:

- ✓ **Always record baseline readings** before making adjustments.
- ✓ **Use the right shim material** — stacking too many thin shims reduces accuracy.
- ✓ **Check alignment after tightening bolts** — movement can throw off adjustments.
- ✓ Clean all surfaces — **dirt or burrs give false readings** during alignment.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of alignment tools:

- ☐ Demonstrate proper use of a level – vertical and horizontal
- ☐ Demonstrate proper use of a straight edge
- ☐ Demonstrate proper use of a feeler gauge
- ☐ Other:

Notes/Comments:

Laser Alignment Tools

Overview & Safety

Overview

Laser alignment tools are precision instruments used to align components, machines, or structures with a high degree of accuracy. They use light — either in the form of laser beams or optical lines — to establish reference points, planes, or axis for alignment purposes in various industrial and engineering applications.

These tools project a concentrated beam of light that provides a straight, visible reference line or point, and often used in dynamic environments due to their long range, ease of setup, and ability to maintain accuracy over large distances. Common types include:

- **Rotary laser levels**
- **Laser shaft alignment systems**
- **Laser trackers**

Laser tools significantly **reduce setup time**, **improve accuracy**, and **minimize human error** and are essential in ensuring the proper installation and maintenance of equipment, reducing wear, energy loss, and downtime.



Laser Alignment System –
Advanced tool for accurate shaft
or coupling alignment.

Photo courtesy of [acoem](https://www.acoem.com)

Safety Considerations

Personal Protective Equipment (PPE):

- Use laser safety glasses rated to the specific laser class and wavelength; Avoid staring directly into reflections or beams.

General Safety:

- Know the laser classification and device being used
- Never direct the laser or device at reflective surfaces (mirrors, glass, etc.) or other people
- Ensure all equipment is **locked out and tagged out (LOTO)** before starting alignment.
- Use **warning signs or barriers** to limit access while laser is in use.
- Secure lasers and optical tools on **stable mounts or tripods** to prevent movement or misalignment. Avoid hand-holding during operation unless specifically designed for that.
- Operate and maintain the tool according to the **manufacturer's safety and operating guidelines**. Ensure regular calibration and inspections.
- Optical tools (e.g., autocollimators or alignment scopes) can cause **eye strain**—take breaks during extended use and use proper lighting.
- Eliminate trip hazards around tripods, cables, or mounted devices, and avoid bumping or shifting equipment mid-alignment.
- Ensure users are trained in both **tool operation and laser safety protocols**.
- Untrained personnel should not operate or adjust these tools.
- Turn off lasers or close shutters when the tool is not actively being used to avoid accidental exposure.

Standard Operating Procedures

Pre-Operation

- **Review the equipment manual** for alignment specifications.
- Inspect all tools for wear, damage, and calibration.
- **Lockout/tagout (LOTO)** all machinery involved in the alignment process.
- Clean measurement surfaces—dirt or rust affects accuracy.



Operation

- Measure initial alignment using the chosen tool.
- Record **angular and parallel misalignment** readings.
- Use shims, adjust mounts, or reposition components to achieve correct alignment.
- Re-measure after each adjustment to confirm changes.
- Tighten fasteners in sequence while monitoring for alignment shift.

Common Types of Alignment Tools and Tasks

Commonly Used Laser or Optical Alignment Tools	
Laser Shaft Alignment Tool	Optical or Laser Level
	
Precision aligning of motor and pump shafts. Photo courtesy of SKE	Structural or piping alignment over large distances.

Inspection & Maintenance

Inspection and maintenance for laser alignment tools involves regular care and upkeep to ensure that any tools remain in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect dial indicators for smooth movement and zero calibration.
- Check laser alignment systems for battery life and calibration date.
- Ensure feeler gauges and straightedges are clean and free from damage.
- Verify that magnetic bases hold securely.

Quick Tips for Users:

- ✓ **Always record baseline readings** before making adjustments.
- ✓ **Use the right shim material**—stacking too many thin shims reduces accuracy.
- ✓ **Check alignment after tightening bolts**—movement can throw off adjustments.
- ✓ Use **laser systems for the highest accuracy** on critical rotating machinery.
- ✓ Clean all surfaces—**dirt or burrs give false readings** during alignment.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of alignment tools:

- ☐ Demonstrate proper use of a Laser Shaft Alignment Tool.
- ☐ Other:

Notes/Comments:



Cutting Tools

Drill Bits

**Countersink and
Reamer**

Cutoff Wheel

Tap and Die

Thread Chaser

Drill Bits

Overview & Safety



Overview

A **drill bit** is a cutting tool used with a **drill** to create holes in various materials, such as metal, wood, and plastic. Drill bits come in different shapes and sizes, designed for specific materials and drilling applications.

Types of drill bits include:

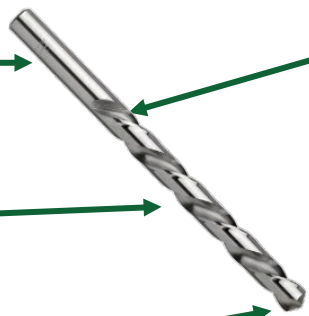
- **Twist Drill Bit** – Most common, used for drilling into wood, metal, and plastic.
- **Brad Point Bit** – Used for clean, precise holes in wood.
- **Masonry Bit** – Designed for drilling into concrete, brick, and stone.
- **Spade Bit** – Flat blade used for drilling large holes in wood.
- **Step Bit** – Tapered design for drilling different hole sizes in metal and plastic.
- **Forstner Bit** – Used for drilling precise, flat-bottom holes in wood.
- **Auger Bit** – Used for deep holes in wood with better chip removal.
- **Hole Saw** – Cuts large holes in wood, plastic, or metal.
- **Cobalt Bit** – Designed for drilling into hardened steel and other tough metals.
- **Carbide-Tipped Bit** – Used for hard materials like tile and glass.

Key Components:

Shank – The part of the drill bit that fits into the drill chuck.

Web – The core thickness of the drill bit, affecting strength and chip removal.

Cutting Edge – The sharp edge that cuts into the material.



Flutes – Spiral grooves that remove material from the hole.

Point (Tip) – The part that makes contact with the material first.

Safety

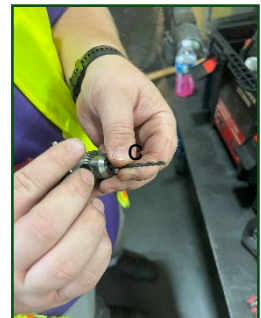
General Safety Tips

- ✓ Select the **correct drill bit** for the material you are drilling.
- ✓ Ensure the **drill bit is securely tightened** in the drill chuck.
- ✓ **Wear safety glasses** to protect against flying debris.
- ✓ Keep **hands and loose clothing** away from the spinning bit.
- ✓ Drill at the **proper speed**—slower speeds for hard materials, faster speeds for soft materials.
- ✓ Use **clamps or a vice** to secure the workpiece.
- ✓ Apply **steady pressure**—do not force the bit through the material.
- ✓ Remove **chips and debris** regularly to prevent clogging
- ✓ Allow the drill bit to **cool down** before touching it after extended use

Standard Operating Procedures

Choose the Correct Drill Bit

- Match the drill bit type to the material.
- Ensure the drill bit size matches the required hole diameter.



Secure the Drill Bit in the Chuck

- Insert the shank into the drill chuck.
- Tighten securely using the drill's key or hand-tightening mechanism.

Prepare the Work Area

- Secure the material using clamps or a vice.
- Mark the drilling spot with a **center punch** for accuracy.

Drill the Hole

- Set the drill to the correct **speed and torque setting**.
- Apply steady, moderate pressure—do not force the bit.
- Pull the drill bit out periodically to clear debris.

After Drilling

- Turn off the drill before removing the bit from the hole.
- Clean the drill bit and remove debris from the work area.
- Store the drill bit properly to prevent damage.

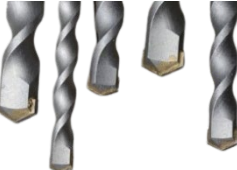
Preventive Maintenance

Preventive maintenance of drill bits involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

- ✓ **Cleaning** – Remove dust and debris after each use.
- ✓ **Sharpening** – Regularly sharpen dull bits using a bench grinder or sharpening tool.
- ✓ **Lubrication** – Use cutting oil when drilling metal to reduce heat and wear.
- ✓ **Storage** – Keep drill bits in a **case or organizer** to prevent dulling and damage.
- ✓ **Inspection** – Check for **dull edges, cracks, or bent shanks** before use.
- ✓ **Avoid Overheating** – Let the bit cool down and use proper drill speed to prevent damage.

Types of Drill Bits

Commonly Used Drill Bits		
Twist Drill bit	Brad Point Bit	Auger Bit
		
Most common, used for drilling into wood, metal, and plastic.	Used for clean, precise holes in wood.	Used for deep holes in wood with better chip removal.

Forstner Bit 	Spade Bit 	Masonry Bit 
Used for drilling precise, flat-bottom holes in wood. Courtesy of Rockler Companies Catalog	Flat blade used for drilling large holes in wood.	Designed for drilling into concrete, brick, and stone.
Center Punch 	Carbide-Tipped Bit 	Cobalt Bit 
Use with hammer to create a small indentation in material at center of hole to be drilled. Prevents drill bit from “walking” (sliding) on material for more precise drilling.	Used for hard materials like tile and glass.	Designed for drilling into hardened steel and other tough metals.
Hole Saw 	Step Bit 	
Cuts large holes in wood, plastic, or metal.	Tapered design for drilling different hole sizes in metal and plastic.	

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a drill bit:

- ☐ Drill an 1/8" hole, a 1/4" hole, and 1/2" hole
- ☐ Use a center punch to align drill bit with hole to be drilled
- ☐ Use a step bit to open up an existing hole
- ☐ Other:

Notes/Comments:

Countersink and Reamer

Overview & Safety

Overview

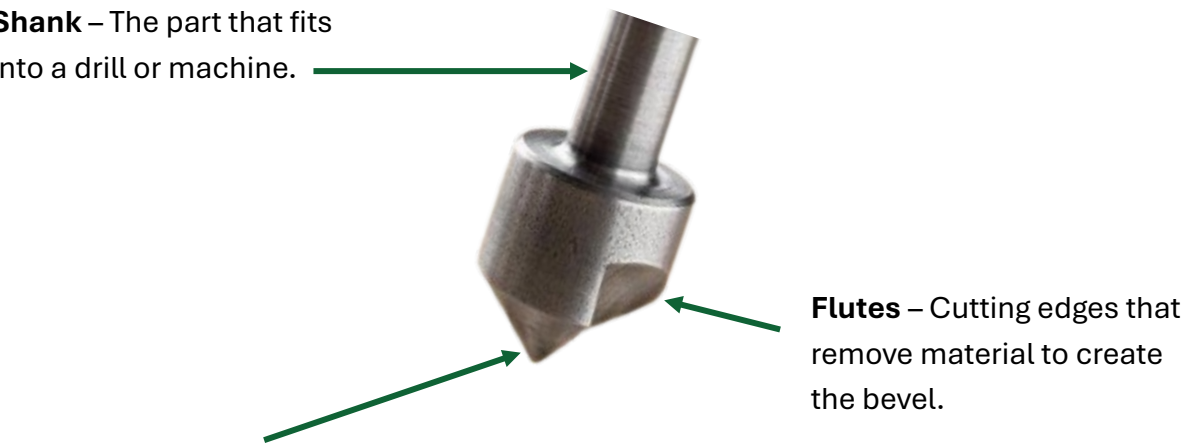
A **countersink** is a conical cutting tool used to create a beveled edge or recess in a hole. This allows flat-head screws or fasteners to sit flush with or below the surface of a material.

Types of countersinks include:

- **Single-Flute Countersink** – Used for softer materials like plastic or wood.
- **Multi-Flute Countersink** – Provides a smoother finish and is used for metals.
- **Adjustable Countersink** – Allows for depth control of the recess.
- **Combined Drill & Countersink** – Drills a hole and adds a chamfer in one step.

Key Components:

Shank – The part that fits into a drill or machine.



Point Angle – Typically 60°, 82°, or 90° depending on the screw type.

Flutes – Cutting edges that remove material to create the bevel.

Overview

A **reamer** is a precision cutting tool used to enlarge and refine an existing hole to an exact diameter with a smooth finish. Reamers do not drill holes but improve the accuracy of pre-drilled ones.

Types of reamers include:

- **Hand Reamer** – Designed for manual use with a wrench.
- **Machine Reamer** – Used with drill presses, lathes, or milling machines.
- **Straight Flute Reamer** – Provides precise hole sizing with minimal cutting.
- **Spiral Flute Reamer** – Helps remove chips more effectively, ideal for deep holes.
- **Tapered Reamer** – Used to enlarge and taper holes.

Key Components:

Square Drive

Surface – Point where driving tool is attached.

Shank – Attaches to a drill or tool holder.

Flutes – The grooved cutting edges that remove material.

Cutting Edge – The part that refines and smooths the hole.



Safety

- ✓ Always **secure the workpiece** to prevent movement.
- ✓ Use the **correct speed**—too fast can damage the tool, too slow can cause uneven cuts.
- ✓ Ensure the **reamer or countersink is aligned properly** with the hole.
- ✓ **Do not force the tool**—let it cut naturally to avoid breakage.
- ✓ Wear **safety glasses** to protect against flying debris.
- ✓ Keep hands away from the rotating tool.

Standard Operating Procedures

Using a Countersink

1. **Select the Correct Countersink**
 - Match the **angle** to the fastener type.
 - Choose the correct size for the hole diameter.
2. **Secure the Workpiece**
 - Use clamps or a vice to hold material steady.
3. **Drill the Countersink Hole**
 - Align the countersink with the hole.
 - Apply **light pressure** to avoid over-cutting.
 - Check depth frequently to ensure proper fit.
4. **Clean Up**
 - Remove burrs or debris from the hole.
 - Inspect the tool for wear or damage.



Using a Reamer

1. Select the Correct Reamer

- Ensure it matches the **desired hole diameter**.
- Choose **hand or machine reamer** based on the application.

2. Pre-Drill the Hole

- The hole should be **slightly smaller** than the final desired size.

3. Align the Reamer with the Hole

- Keep it **straight** to avoid uneven enlargement.

4. Ream the Hole

- Turn **slowly and steadily** to remove material evenly.
- Apply **cutting fluid** for metalwork to prevent overheating.

5. Clean Up

- Remove chips and debris.
- Wipe down the reamer and store it properly.

Preventive Maintenance

Preventive maintenance on countersinks and reamers involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

- ✓ **Cleaning** – Remove dust and chips after each use.
- ✓ **Lubrication** – Apply cutting oil for metalworking to overheating and prevent wear.
- ✓ **Storage** – Keep tools in **protective cases** to avoid damage.
- ✓ **Inspection** – Check for **dull edges, chipping, or misalignment**.
- ✓ **Sharpening** – Reamers and countersinks can be re-sharpened if they become dull.

Types of Countersinks

Commonly Used Countersinks

	Adjustable Countersink • Allows for depth control of the recess.
	Combined Drill & Countersink • Drills a hole and adds a chamfer in one step. Courtesy MSC Industrial Supply
	Multi-Flute Countersink • Provides a smoother finish and is used for metals.
	Single-Flute Countersink • Used for softer materials like plastic or wood.

Types of Reamers

Commonly Used Reamers	
	Hand Reamer (set) Designed for manual use with a wrench.
	Machine Reamer Used with drill presses, lathes, or milling machines.
	Straight Flute Reamer (kit) Provides precise hole sizing with minimal cutting.
	Spiral Flute Reamer Helps remove chips more effectively, ideal for deep holes. Courtesy of Drill America
	Tapered Reamer Used to enlarge and taper holes. Courtesy of Rockler

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a countersink and reamers:

- ☐ Drill a hole and demonstrate use of the proper countersink
- ☐ Drill a hole and ream to specified measurement
- ☐ Other:

Notes/Comments:

Cutoff Wheel

Overview & Safety

Overview

A **cutoff wheel** is a thin, abrasive disc used with power tools like angle grinders, die grinders, and rotary tools to cut through metal, plastic, ceramic, and other materials. Cutoff wheels are designed for **precise, straight cuts** and are commonly used in metal fabrication, construction, and automotive work.

Types of cutoff wheels include:

- Resin-Bonded Abrasive Cutoff Wheel
- Diamond Cutoff Wheel
- Reinforced Cutoff Wheel
- Non-Reinforced Cutoff Wheel
- Thin-Kerf Cutoff Wheel

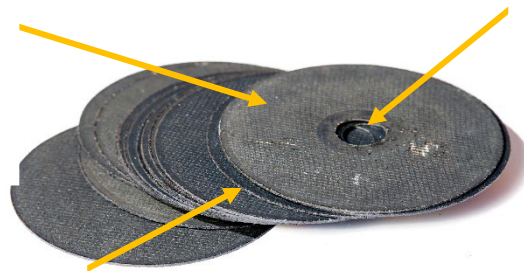
Key Components:

Abrasive Material –

The cutting surface, typically aluminum oxide, silicon carbide, or diamond.

Center Hole (Arbor Hole) –

Allows the wheel to be mounted onto a tool.



Bonding Agent – Holds the abrasive particles together (e.g., resin or metal bond).

Reinforcement (if applicable) –

Fiberglass mesh to enhance durability and safety.

Safety

General Safety Tips

- ✓ Always **wear proper PPE**: safety glasses, face shield, gloves, and hearing protection.
- ✓ Use the **correct wheel type** for the material you are cutting.
- ✓ Ensure the **cutoff wheel is rated for the tool's speed (RPM)**.
- ✓ Inspect the wheel for **cracks, chips, or damage** before use.
- ✓ Secure the **workpiece properly** to prevent movement during cutting.
- ✓ Never apply **side pressure**—cutoff wheels are designed for straight cuts only.
- ✓ **Allow the wheel to reach full speed** before making contact with the material.
- ✓ Avoid forcing the wheel—let the tool do the work.
- ✓ Keep bystanders clear of the **spark path and debris zone**.

Standard Operating Procedures

Using a Cutoff Wheel Safely

1. **Select the Correct Cutoff Wheel**
 - Match the **wheel material** to the workpiece (e.g., metal, tile, plastic).
 - Ensure the **wheel size and RPM rating** match the tool.
2. **Inspect and Mount the Wheel**
 - Check for **cracks, chips, or warping**.
 - Securely mount the wheel on the **grinder or cutting tool**.
 - Ensure the tool's **guard is in place** for protection.
3. **Secure the Workpiece**
 - Use a **vice or clamps** to hold the material steady.
 - Position the cut **away from your body and others**.

4. Make the Cut

- Hold the tool firmly and **start at full speed** before contacting the material.
- Use a **straight, steady motion**—avoid twisting or bending the wheel.
- Allow the wheel to do the work; **do not force it through the material**.



5. Turn Off and Clean Up

- Let the wheel come to a **complete stop** before setting the tool down.
- Remove and inspect the wheel for **wear or damage** after use.
- Clean up **debris, sparks, and dust** in the work area.

Preventive Maintenance

Preventive maintenance of cutoff wheels involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

- ✓ **Store wheels in a dry, cool area** to prevent moisture damage.
- ✓ **Check for cracks or damage** before and after each use.
- ✓ **Use only the correct mounting hardware**—loose fittings can cause breakage.
- ✓ **Replace worn-out wheels** before they become too small or thin.
- ✓ **Avoid dropping or striking** the wheel to prevent cracks.
- ✓ **Never exceed the wheel's RPM rating**—it can shatter under excessive speed.

Types of Cutoff Wheels

Commonly Used Cutoff Wheels

	Diamond Cutoff Wheel • Features a diamond-coated edge for cutting through hard materials like tile and stone. •
	Non-Reinforced Cutoff Wheel • Used in stationary equipment where lateral pressure is not applied. Courtesy American Rotary Tools Company (ARTCO) Catalog
	Reinforced Cutoff Wheel Has a fiberglass reinforcement layer for added strength and safety.
	Resin-Bonded Abrasive Cutoff Wheel • Made with aluminum oxide or silicon carbide for cutting metals.
	Thin Kerf Cutoff Wheel • Provides precise, clean cuts with minimal material loss. Courtesy of Norske Catalog

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a cutoff wheel:

- ☐ Cut a piece of 90-degree angle iron
- ☐ Cut a piece of all-thread rod or a bolt
- ☐ Other:

Notes/Comments:

Tap and Die

Overview & Safety



Overview

A **tap and die set** contain **various** tools used to create or repair screw threads in metal, plastic or wood.

- **Taps** are used to cut internal threads inside a hole, allowing screws or bolts to be inserted (i.e., screwed in and out). They can also be used to re-cut internal threads (i.e., on a nut) that have been damaged.
- **Dies** are used to cut external threads on a cylindrical rod, creating bolts or threaded rods. They can also be used to re-cut external threads (i.e., on a bolt) that have been damaged.
- Coarse threads have a larger pitch (fewer threads per inch, or a bigger distance between threads) compared to fine threads. The pitch can be found by looking at a chart for either NC (National Coarse) or NF (National Fine) and changes depending on the diameter.
- Inch Size Thread Reference: <https://www.newmantools.com/taps/tapsinch.htm#nc>

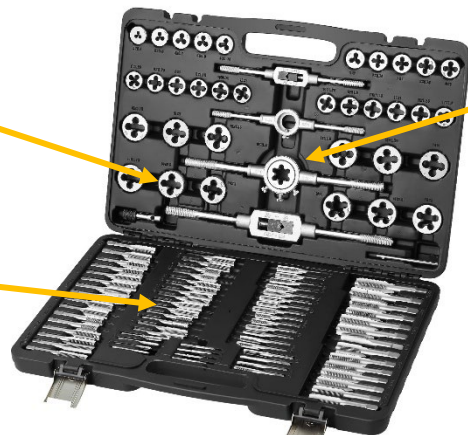
Types of taps and dies include:

- | | |
|--------------------|--------------------|
| • Straight Tap | • Adjustable Split |
| • Taper Tap | • Fixed Die |
| • Plug Tap | • Round Die |
| • Bottoming Tap | • Hex Die |
| • Spiral Flute Tap | |
| • Pipe Tap | |

Key Components (shown is a typical tap and die set – they are available for standard and metric threads):

Dies – The cutting tools for external threads.

Taps – The cutting tools for internal threads.



Die Stock Holder – Holds and turns the die to cut external threads.

Thread Gauge – Used to measure thread pitch and ensure proper size.



Safety

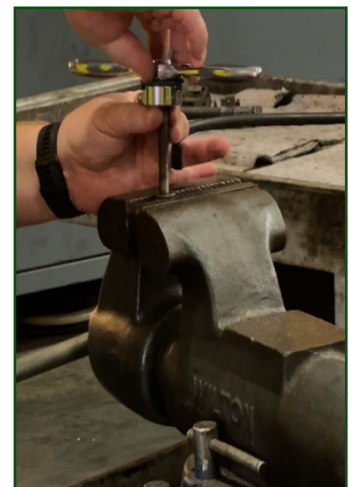
General Safety Tips

- ✓ Use **the correct tap or die size** for the material and thread type.
- ✓ Secure the **workpiece in a vice** to prevent movement.
- ✓ **Apply steady, even pressure** to avoid tool breakage.
- ✓ Use **cutting fluid** when threading metal to reduce heat and wear.
- ✓ **Turn slowly** and avoid forcing the tool to prevent breaking taps or dies.
- ✓ **Wear safety glasses** and gloves to protect against metal shavings.
- ✓ Remove chips frequently to prevent clogging and rough threads.

Standard Operating Procedures

Using a Tap (Cutting Internal Threads)

1. **Drill the Hole**
 - Use the correct **drill bit size** for the tap.
 - Refer to a **tap drill chart** to select the proper size.
2. **Secure the Tap in the Wrench**
 - Place the tap into the **tap wrench** and tighten it securely.
3. **Start Cutting Threads**
 - Insert the tap **straight into the hole** and turn it **clockwise** (right-hand threads).
 - Apply **cutting fluid** to reduce friction.
4. **Use the Back-and-Forth Method**
 - Turn **½ to 1 full turn forward**, then **¼ turn backward** to break chips.
 - Repeat until the desired thread depth is reached.
5. **Remove the Tap**
 - Back the tap out slowly and clean the hole.
 - Remove metal chips and debris.
 - Test to ensure proper alignment and thread engagement.



Using a Die (Cutting External Threads)

1. Prepare the Rod or Bolt

- Ensure the rod is the **correct diameter** for the desired thread size.
- File the end to create a **small chamfer** for easier threading.

2. Secure the Die in the Holder

- Place the die into the **die stock holder** and tighten it securely.

3. Start Cutting Threads

- Align the die **perpendicular** to the rod.
- Turn **clockwise** with steady, even pressure.
- Apply **cutting fluid** to reduce heat and friction.

4. Use the Back-and-Forth Method

- Turn $\frac{1}{2}$ to **1 full turn forward**, then $\frac{1}{4}$ **turn backward** to clear chips.
- Continue until the desired thread length is achieved.

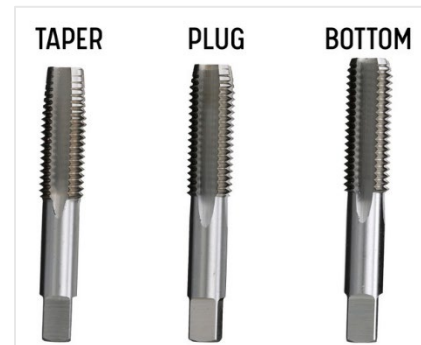
5. Remove the Die

- Back the die off the rod and inspect the threads.
- Clean off chips and apply lubricant for protection.
- Test to ensure proper alignment and thread engagement.

Preventive Maintenance

Preventive maintenance of tap and die sets involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

- ✓ **Cleaning** – Remove chips and debris after each use.
- ✓ **Lubrication** – Apply cutting oil before storage to prevent rust.
- ✓ **Inspection** – Check for **dull edges or chips** that affect thread quality.
- ✓ **Proper Storage** – Keep taps and dies in an **organized case** to avoid damage.
- ✓ **Avoid Overloading** – Do not force taps or dies into hard materials without proper preparation.



Source: [toolsghar](https://toolsghar.com)

Types of Tap and Die Sets

Commonly Used Taps	
	Bottoming Tap - Has little to no taper and is used to cut threads to the bottom of a blind hole.
	Pipe Tap - Used for cutting threads in pipes for fittings.
	Plug Tap - Has fewer tapered threads and is used after a taper tap.
	Spiral Flute Tap - Spiral point taps are designed to drive the chip formed by the cutting action forward. They are only appropriate for through holes.

	Straight Tap • Most common and they come in “plug”, “starting” and “bottoming” varieties (which only defines how far the cutting part of the flute extends toward the tip).
	Taper Tap • Has a gradual cutting edge for easier thread starting.

Commonly Used Dies	
	Adjustable Split Die Allows slight changes in thread diameter
	Die • Can be used with a wrench for rethreading bolts. • Most common type, used for creating standard threads • Can be either “Hex or “Round” style

For additional resources, below is an example of a Machinist Drill Bit Size Table for:

- **ANSI Drill Size Chart**
- **ISO Metric Drill Bit Size Table**

This chart is available for free download from [Aerospace News Abbott Aerospace UK Ltd.](#)

ANSI Size Drill Bit Chart						ISO (Metric Size Drills) & Conversion to Inches					
Drill (in.)	Decimal	Drill (in.)	Decimal	Drill (in.)	Decimal	Drill (mm)	Decimal (in.)	Drill (mm)	Decimal (in.)	Drill (mm)	Decimal (in.)
80	0.0135	1/8	0.1250	O	0.3160	0.35	0.0138	3.4	0.1339	8.0	0.3150
79	0.0145	30	0.1285	P	0.3230	0.4	0.0157	3.5	0.1378	8.1	0.3189
1/64	0.0156	29	0.1360	21/64	0.3281	0.45	0.0177	3.6	0.1417	8.2	0.3228
78	0.0160	28	0.1405	Q	0.3320	0.5	0.0197	3.7	0.1457	8.3	0.3248
77	0.0180	9/64	0.1406	R	0.3390	0.55	0.0217	3.75	0.1477	8.3	0.3267
76	0.0200	27	0.1440	11/32	0.3437	0.6	0.0236	3.8	0.1496	8.4	0.3307
75	0.0210	26	0.1470	S	0.3480	0.65	0.0256	3.9	0.1535	8.5	0.3346
74	0.0225	25	0.1495	T	0.3580	0.7	0.0276	4	0.1575	8.6	0.3386
73	0.0240	24	0.1520	23/64	0.3594	0.75	0.0295	4.1	0.1614	8.7	0.3425
72	0.0250	23	0.1540	U	0.3680	0.8	0.0315	4.2	0.1654	8.8	0.3445
71	0.0260	5/32	0.1562	3/8	0.3750	0.85	0.0335	4.25	0.1674	8.8	0.3465
70	0.0280	22	0.1570	V	0.3770	0.9	0.0355	4.3	0.1693	8.9	0.3504
69	0.0292	21	0.1590	W	0.3860	0.95	0.0374	4.4	0.1732	9.0	0.3543
68	0.0310	20	0.1610	25/64	0.3906	1	0.0394	4.5	0.1771	9.1	0.3583
1/32	0.0313	19	0.1660	X	0.3970	1.05	0.0413	4.6	0.1811	9.2	0.3622
67	0.0320	18	0.1695	Y	0.4040	1.1	0.0433	4.7	0.1850	9.3	0.3642
66	0.0330	11/64	0.1719	13/32	0.4062	1.15	0.0453	4.75	0.1870	9.4	0.3661
65	0.0350	17	0.1730	Z	0.4130	1.2	0.0472	4.8	0.1890	9.4	0.3701
64	0.0360	16	0.1770	27/64	0.4219	1.25	0.0492	4.9	0.1929	9.5	0.3740
63	0.0370	15	0.1800	7/16	0.4375	1.3	0.0512	5	0.1968	9.6	0.3780
62	0.0380	14	0.1820	29/64	0.4531	1.35	0.0531	5.1	0.2008	9.7	0.3819
61	0.0390	13	0.1850	15/32	0.4687	1.4	0.0551	5.2	0.2047	9.8	0.3839
60	0.0400	3/16	0.1875	31/64	0.4844	1.45	0.0571	5.25	0.2067	9.8	0.3858
59	0.0410	12	0.1890	1/2	0.5000	1.5	0.0591	5.3	0.2087	9.9	0.3898
58	0.0420	11	0.1910	33/64	0.5156	1.55	0.0610	5.4	0.2126	10.0	0.3937
57	0.0430	10	0.1935	17/32	0.5312	1.6	0.0629	5.5	0.2165	10.5	0.4133
56	0.0465	9	0.1960	35/64	0.5469	1.65	0.0650	5.6	0.2205	11.0	0.4331
3/64	0.0469	8	0.1990	9/16	0.5625	1.7	0.0669	5.7	0.2244	11.5	0.4528
55	0.0520	7	0.2010	37/64	0.5781	1.75	0.0689	5.75	0.2264	12.0	0.4724
54	0.0550	13/64	0.2031	19/32	0.5937	1.8	0.0709	5.8	0.2283	12.5	0.4921
53	0.0595	6	0.2040	39/64	0.6094	1.85	0.0728	5.9	0.2323	13.0	0.5118
1/16	0.0625	5	0.2055	5/8	0.6250	1.9	0.0748	6	0.2362	13.5	0.5315
52	0.0635	4	0.2090	41/64	0.6406	1.95	0.0768	6.1	0.2401	14.0	0.5512
51	0.0670	3	0.2130	21/32	0.6562	2	0.0787	6.2	0.2441	14.5	0.5708
50	0.0700	7/32	0.2187	43/64	0.6719	2.05	0.0807	6.25	0.2461	15.0	0.5906
49	0.0730	2	0.2210	11/16	0.6875	2.1	0.0827	6.3	0.2480	15.5	0.6102
48	0.0760	1	0.2280	45/64	0.7031	2.15	0.0846	6.4	0.2520	16.0	0.6300
5/64	0.0781	A	0.2340	23/32	0.7187	2.2	0.0866	6.5	0.2559	16.5	0.6496
47	0.0785	15/64	0.2344	47/64	0.7344	2.25	0.0886	6.6	0.2598	17.0	0.6693
46	0.0810	B	0.2380	3/4	0.7500	2.3	0.0905	6.7	0.2638	17.5	0.6889
45	0.0820	C	0.2420	49/64	0.7656	2.35	0.0925	6.75	0.2658	18.0	0.7087
44	0.0860	D	0.2460	25/32	0.7812	2.4	0.0945	6.8	0.2677	18.5	0.7283
43	0.0890	E	0.2500	51/64	0.7969	2.45	0.0965	6.9	0.2716	19.0	0.7480
42	0.0935	1/4	0.2500	13/16	0.8125	2.5	0.0984	7	0.2756	19.5	0.7677
3/32	0.0937	F	0.2570	53/64	0.8281	2.55	0.1004	7.1	0.2795	20.0	0.7874
41	0.0960	G	0.2610	27/32	0.8437	2.6	0.1024	7.2	0.2835	20.5	0.8071
40	0.0980	17/64	0.2656	55/64	0.8594	2.65	0.1043	7.25	0.2855	21.0	0.8268
39	0.0995	H	0.2660	7/8	0.8750	2.7	0.1063	7.3	0.2874	21.5	0.8465
38	0.1015	I	0.2720	57/64	0.8906	2.75	0.1083	7.4	0.2913	22.0	0.8661
37	0.1040	J	0.2770	29/32	0.9062	2.8	0.1102	7.5	0.2953	22.5	0.8858
36	0.1065	K	0.2811	59/64	0.9219	2.9	0.1142	7.6	0.2990	23.0	0.9055
7/64	0.1093	9/32	0.2812	15/16	0.9375	3	0.1181	7.7	0.3031	23.5	0.9252
35	0.1100	L	0.2900	61/64	0.9531	3.1	0.1220	7.75	0.3051	24.0	0.9449
34	0.1110	M	0.2950	31/32	0.9687	3.2	0.1260	7.8	0.3071	24.5	0.9646
33	0.1130	19/64	0.2968	63/64	0.9844	3.25	0.1280	7.9	0.3110	25.0	0.9843
32	0.1160	N	0.3020	1	1.0000	3.3	0.1299				
31	0.1200	5/16	0.3125								

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a tap and die set:

- ☐ Tap a smooth hole –
 - a. Choose the right size drill and pitch and coarseness for given thread (e.g., 5/16-18)
- ☐ Tap a cross-threaded hole
- ☐ Use a die to chase a cross-threaded bolt
- ☐ Use a die to create new threads on a dowel. a. Choose the right size rod and pitch and coarseness for given thread (e.g., 5/16-18)
- ☐ Other:

Notes/Comments:

Thread Chaser

Overview & Safety

Overview

A **thread chaser** is a tool used to clean, restore, or repair damaged threads on bolts, nuts, or threaded holes. Unlike taps and dies, which cut new threads, thread chasers remove dirt, rust, and small deformations without cutting away significant material, helping maintain the integrity of the threads.

Types of thread chasers include:

- Internal Thread Chaser
- External Thread Chaser
- Adjustable Thread Chaser
- Thread Restoring Files
- Adjustable Thread Chaser
- Spark Plug Thread Chaser

Key Components:

Thread Pitch Guide – Ensures the tool matches the correct thread size and pitch.

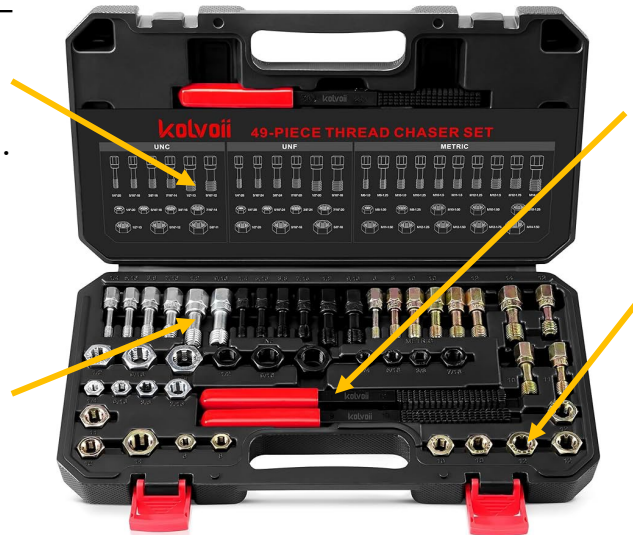
Internal Thread Chaser – A device to repair, clean or adjust the internal threads of nuts, bolts, or tapped holes.

Thread Restoring File – Another tool specialized for repairing threads.

External Thread Chaser – A device to repair, clean or adjust the external threads of bolts, studs or damaged external threads.

Cutting Edges – Edges that removes debris and reshapes minor imperfections in threads.

Adjustable Jaws (for some types) – Allows fitting to different thread sizes.



Safety

General Safety Tips

- ✓ Select the **correct size and pitch** for the thread being repaired.
- ✓ Ensure the **workpiece is securely held** in a vice or stable position.
- ✓ Apply **cutting fluid or lubricant** to prevent friction and overheating.
- ✓ Turn the tool **slowly and carefully** to avoid further damage to the threads.
- ✓ Do not **force the chaser**—if the threads are severely damaged, a tap or die may be needed instead.
- ✓ **Wear safety glasses** to protect against metal debris.

Standard Operating Procedures

Using an Internal Thread Chaser (For Nuts or Threaded Holes)

1. Inspect the Threads

- Determine if the threads are **dirty, rusted, or slightly damaged**.
- Ensure they are **not too damaged**—if the threads are stripped, a tap may be needed instead.

2. Select the Correct Thread Chaser

- Match the tool to the **thread size and pitch**.

3. Lubricate the Threads

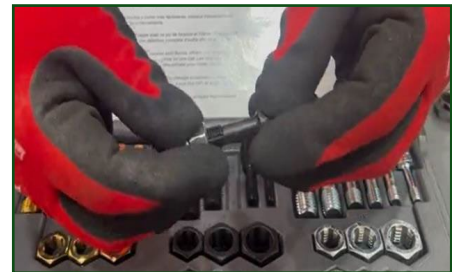
- Apply **cutting fluid or penetrating oil** for smoother operation.

4. Insert and Rotate the Chaser

- Turn the chaser **clockwise (right-hand threads)** or counterclockwise (left-hand threads).
- Use **gentle pressure** and back out slightly to clear debris.

5. Remove and Inspect

- Once the threads are cleaned, inspect them to ensure they are functional.
- If necessary, repeat the process or use a tap for deeper repair.



Using an External Thread Chaser (For Bolts, Studs, or Rods)

1. Inspect the Threads

- Check for **dirt, rust, or minor deformations**.

2. Select the Proper Chaser or Restoring File

- Ensure it matches the **thread size and pitch**.

3. Apply Lubrication

- Use **cutting oil** to help remove debris smoothly.

4. Align and Rotate the Tool

- Place the chaser on the threads and turn **clockwise** to restore them.
- Use **steady, controlled force**—do not rush the process.

5. Inspect and Test the Threads

- After cleaning, test the threads with a nut to ensure proper fit.



Preventive Maintenance

Preventive maintenance of thread chasers involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

- ✓ **Cleaning** – Remove metal shavings and debris after each use.
- ✓ **Lubrication** – Apply light oil to prevent rusting.
- ✓ **Inspection** – Check for **worn-out cutting edges** or dull areas.
- ✓ **Proper Storage** – Keep in an **organized case** to avoid damage.
- ✓ **Avoid Excessive Force** – If the threads are too damaged, use a tap or die instead.

Types of Thread Chasers

Commonly Used Thread	
	Adjustable Thread Chaser Designed to fit various thread sizes for versatility. Photo source: Draper Tools
	External Thread Chaser Used for restoring threads on bolts, studs, or rods.
	Internal Thread Chaser - Used to clean and repair threads inside a hole or nut.
	Spark Plug Thread Chaser Specially designed to clean and repair spark plug holes. One shown in photo has two thread sizes.
	Thread Restoring Files A handheld tool with multiple thread pitches for cleaning damaged threads.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a thread chaser:

- ☐ Use External Thread Chaser to clean and repair damaged threads on a bolt.
- ☐ Use Internal Thread Chaser to clean and repair threads inside a nut.
- ☐ Use Thread Restoring File to clean damaged threads.
- ☐ Other:

Notes/Comments:



Advanced Measuring Tools

Calipers

Micrometers

Dial Indicators

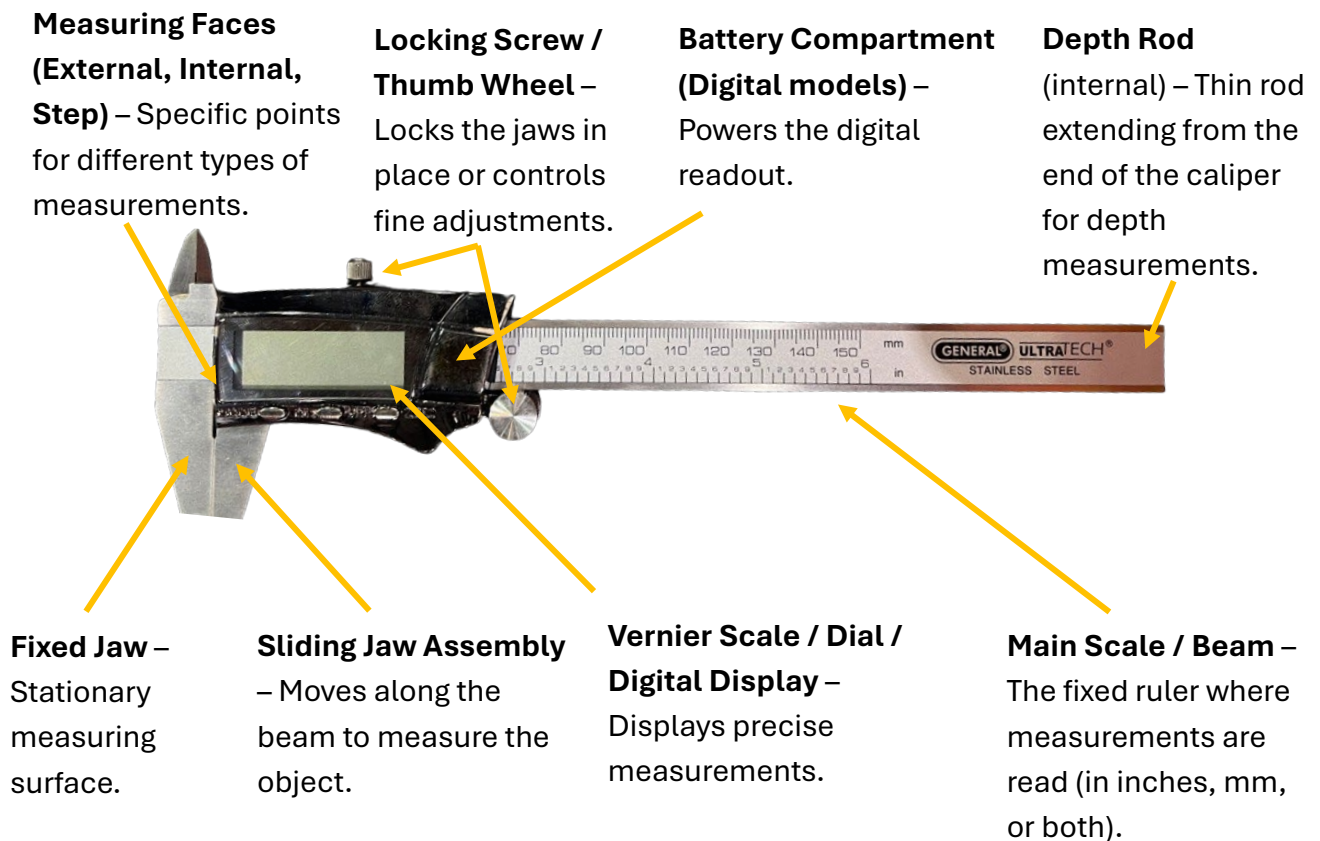
Calipers

Overview & Safety

Overview

Calipers are precision measuring tools used to measure internal, external, step, and depth dimensions with high accuracy. They are widely used in machining, metalworking, mechanical maintenance, and quality control.

Key Components:



Safety Considerations

Personal Protective Equipment (PPE):

- Safety glasses (if working around sharp or machined parts)
- Gloves (optional, for handling rough materials — but use carefully for dexterity)

General Safety:

- Handle calipers carefully — they are precision tools and easily damaged.
- Keep away from rotating machinery while measuring.
- Do not use excessive force — jaws are designed to lightly contact the material.
- Clean the part to remove burrs or debris before measuring.
- Be mindful of sharp edges on metal workpieces while measuring.

Standard Operating Procedures

Pre-Operation

- Inspect the caliper for damage, burrs, or contamination.
- Verify zero calibration (digital calipers should read “0.000” when fully closed).
- Clean the workpiece and the caliper measuring surfaces.
- Select the appropriate caliper for the size and accuracy needed.

Operation

- Use external jaws for outside dimensions, internal jaws for inside diameters, and the depth rod for depth measurements.
- Apply consistent, light pressure — do not force the jaws.
- Lock the caliper if you need to record or transfer a measurement.
- Read the measurement carefully (vernier scale requires aligning the lines precisely).
- Reset to zero after each use or when changing measurement points.



Inspection & Maintenance

Inspection and maintenance for a caliper involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect jaws, scale, and display for dirt, rust, or physical damage.
- Check that the sliding jaw moves smoothly without sticking.
- Ensure digital calipers power on and zero properly.

Weekly / After Heavy Use:

- Clean with a lint-free cloth; avoid solvents that could damage digital displays or seals.
- Lightly oil metal surfaces (for vernier and dial types) to prevent rust.
- Check for accuracy using gauge blocks or a known reference standard.
- Replace the battery in digital calipers if the display dims or blinks.

Calibration (Annually or As Required):

- Verify accuracy against certified standards.
- Document calibration date and status if used in quality control.

Quick Tips for Users:

- ✓ **Always zero the caliper** before taking any measurement.
- ✓ **Don't use calipers as a scribe, pry tool, or clamp** — it damages the tool.
- ✓ **Read the dial or vernier carefully**—parallax errors can lead to bad measurements.
- ✓ **Measure from the correct surfaces (external, internal, depth)** — improper use skews results.
- ✓ **Digital calipers auto shut-off** but remove the battery if storing long term.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a caliper:

- ☐ Use a caliper to measure the thickness of a flat piece of metal
- ☐ Use a caliper to measure diameter of a hole
- ☐ Other:

Notes/Comments:

Micrometers

Overview & Safety

Overview

Micrometers are precision measuring tools used to measure small dimensions with extremely high accuracy, typically down to 0.001 inches or 0.01 millimeters. They are widely used in machining, metalworking, quality control, and mechanical maintenance to measure thickness, diameter, and depth.

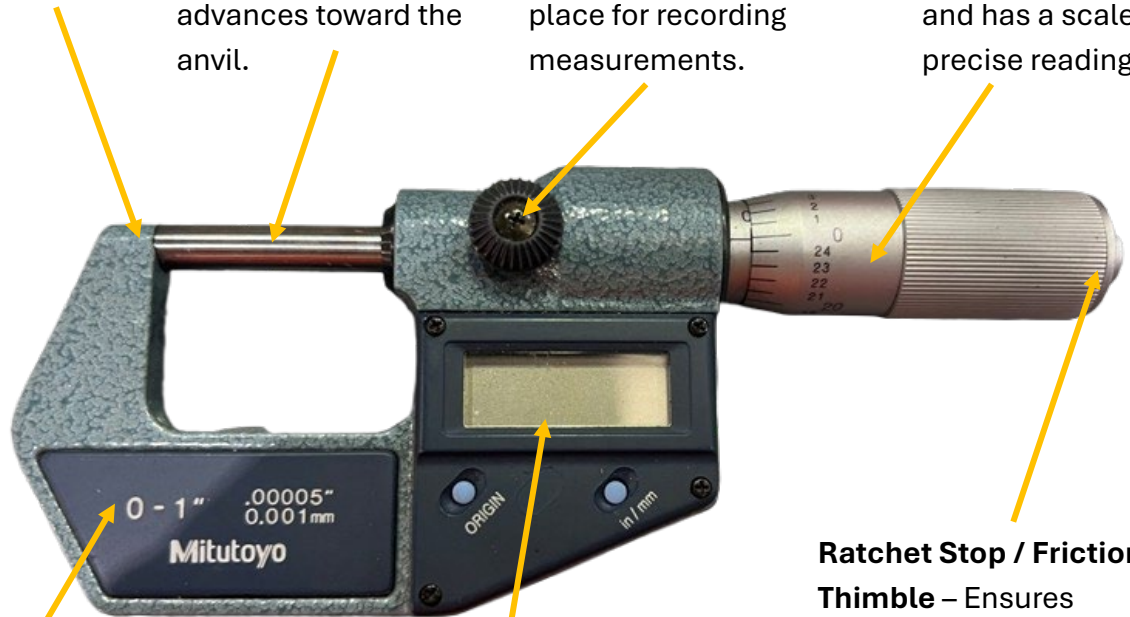
Key Components: Micrometers

Anvil – Stationary measuring surface.

Spindle – Movable measuring face that advances toward the anvil.

Lock Nut / Spindle Lock – Holds the spindle in place for recording measurements.

Thimble – Rotates to move the spindle and has a scale for precise readings.



Frame – The rigid, C-shaped body of the micrometer.

Digital Display (Digital Micrometers only) – Provides direct numerical readout.

Ratchet Stop / Friction Thimble – Ensures consistent measuring pressure.

Carbide Measuring Faces (on high-end models) – Hardened surfaces for durability.

Sleeve (Barrel) – Fixed scale engraved with measurement markings. (underneath thimble)

Safety Considerations

Personal Protective Equipment (PPE):

- Safety glasses (if working around sharp or machined parts)
- Gloves (optional, but avoid heavy gloves that reduce tactile feedback)

General Safety:

- Handle micrometers carefully — they are precision tools, sensitive to drops or impacts.
- Use gentle, consistent pressure—excess force will damage the tool or part.
- Ensure the part being measured is clean and free of burrs.
- Do not measure rotating parts or use micrometers near moving machinery.
- Avoid over-tightening — always use the ratchet or friction thimble for the final measurement.

Standard Operating Procedures

Pre-Operation

- Inspect micrometer for cleanliness, rust, or physical damage.
- Verify zero calibration by closing the spindle and checking the zero reading.
- Clean both measuring faces (anvil and spindle) and the workpiece.
- Select the correct micrometer size range (0-1", 1-2", etc.).

Operation

- Place the part between the spindle and anvil.
- Rotate the thimble until the spindle lightly contacts the part.
- Use the ratchet stop or friction thimble to apply consistent pressure.
- Lock the spindle if needed to hold the measurement.
- Read the measurement carefully from the sleeve and thimble (or digital display).
- Record the measurement and release the lock.



Inspection & Maintenance

Inspection and maintenance for micrometers involves regular care and upkeep to ensure that the tool remains in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect for damage, burrs, or contamination on measuring faces.
- Check zero reading to ensure calibration.
- Confirm smooth spindle movement with no rough spots.

Calibration (Annually or As Needed):

- Perform calibration check using certified reference standards.
 - Adjust zero setting as needed (many micrometers have an adjustment wrench).
- Record calibration results if used in quality-controlled environments.

Quick Tips for Users:

- ✓ Always use the **ratchet stop or friction thimble** for consistent measuring pressure.
- ✓ Clean both the **measuring faces and the part** before measuring.
- ✓ Use a micrometer **only for measuring**—never as a clamp, pry tool, or caliper substitute.
- ✓ If the micrometer **sticks or feels gritty**, clean and lightly lubricate the spindle threads.
- ✓ Regularly check calibration, especially if the micrometer is dropped or used heavily.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of a micrometer:

- ☐ Measure the thickness of a piece of metal
- ☐ Other:

Notes/Comments:

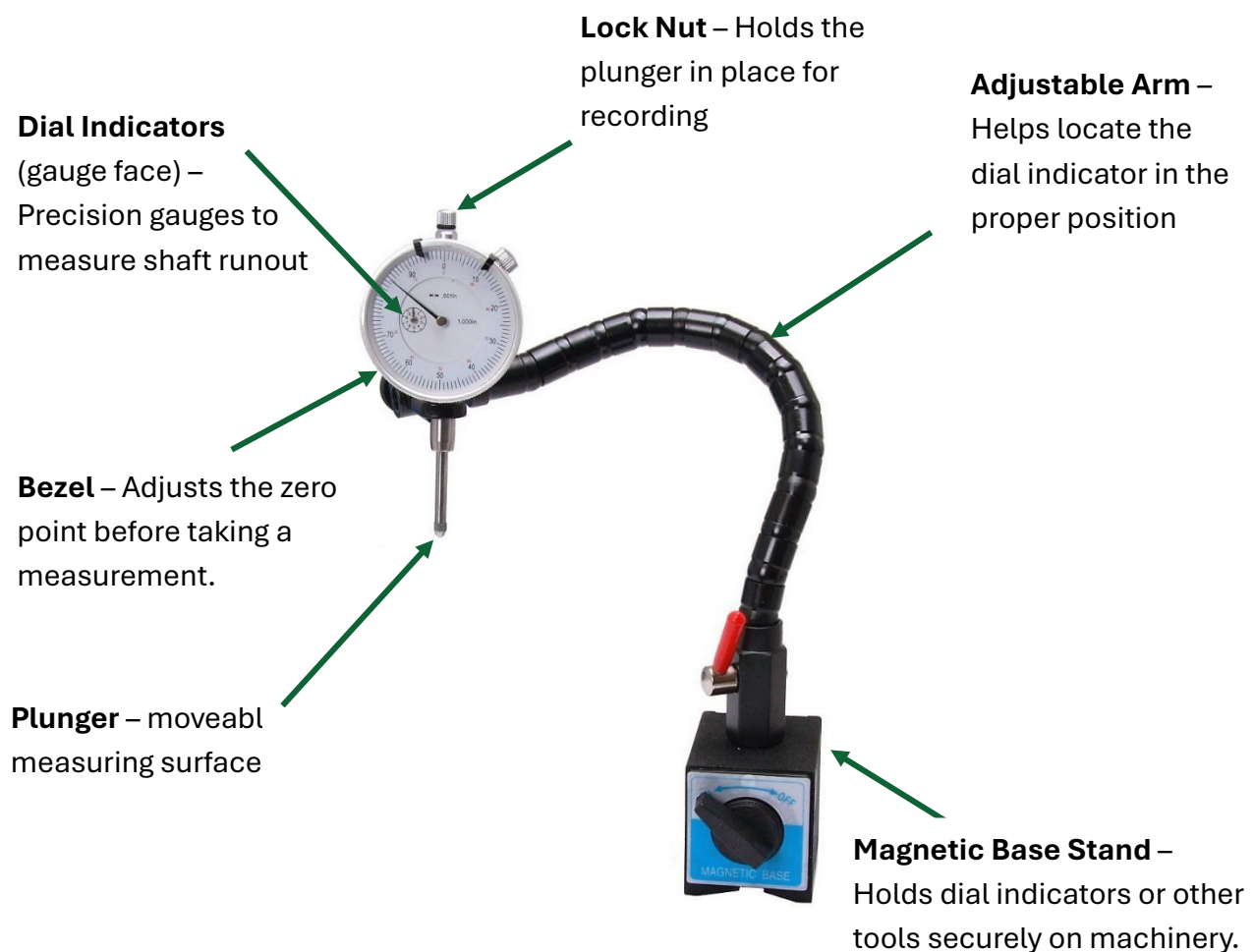
Dial Indicators

Overview & Safety

Overview

Dial indicators are a measurement device used to measure flatness, alignment, radial runout, inclination, etc. A dial indicator consists of a series of gears and levers. The dial indicator offers a dependable and efficient way in mechanical and industrial work to assess and verify everything from surface flatness to machine alignment. The heart of the dial indicator is a spring-loaded plunger, a rod that lengthens and rescinds as it comes into contact with the surface being measured.

Key Components: Dial indicator with stand



Safety Considerations

Personal Protective Equipment (PPE):

- Safety glasses
- Gloves (when handling heavy machinery or shimming)
- Steel-toe boots (if working around heavy equipment)

General Safety:

- If applicable, ensure all equipment is **locked out and tagged out (LOTO)** before starting alignment.
- Remove rotating equipment from service before measurement.
- **Use the right alignment tool for the accuracy needed**—improper tools can cause damage.
- Keep hands clear of pinch points when adjusting equipment or inserting shims.
- Do not force or over-tighten mounts or bolts during realignment.

Standard Operating Procedures

Pre-Operation

- **Review the equipment manual** for alignment specifications.
- Inspect all tools for wear, damage, and calibration.
- **Lockout/tagout (LOTO)** all machinery involved in the alignment process.
- Clean measurement surfaces—dirt or rust affects accuracy.



Operation

- **Zeroing:** Before each measurement, ensure the dial indicator is set to zero by gently brushing the plunger against a flat reference veneer and modifying the zero point on the dial.
- **Mounting:** Secure the dial indicator (with the use of a stand or fixture) for optimal equilibrium and minimize measurement errors caused by oscillation.
- **Alignment:** Align the plunger perpendicular to the measured surface for the most authentic reading. Use shims, adjust mounts, or reposition components to achieve correct alignment. Tighten fasteners in sequence while monitoring for alignment shift.
- Record **angular and parallel misalignment** readings.
- **Re-measure** after each adjustment to confirm changes.

Types of Dial Indicators

Commonly Used Dial Indicators

Plunger Dial Indicator	Dial Indicator Stand	Digital Dial Indicators
		
Often referred to as Dial Indicators. They use a plunger that moves in a straight line up and down to magnify and convert the force applied to the contact point (at the bottom of the plunger) into a measurement. Used for measuring shaft misalignment, runout, and vibration.	Secures dial indicators in place for added flexibility	Digital readouts simplify the measuring process. Requires a battery

Inspection & Maintenance

Inspection and maintenance for dial indicator tools involves regular care and upkeep to ensure that any tools remain in optimal working condition, extends its lifespan, and maintains safety and efficiency during use.

Daily / Before Use:

- Inspect dial indicators for smooth movement and zero calibration.
- Verify that magnetic bases hold securely.

Quick Tips for Users:

- ✓ Always protect the spindle by keeping it clean
- ✓ Ensure the indicator hand is able to move freely. It must be able to move to its fullest extent as well as to the zero end of the scale in one fluid movement.
- ✓ Use the indicator correctly by securely affixing it to the holding device or magnetic base.
- ✓ Use it often to prevent the spindle from sticking or test periodically to ensure the spindle continues to move freely.
- ✓ Store dial indicators correctly in a dry place and try to keep them covered to minimize dust and moisture getting into the dial.
- ✓ Clean the dial with warm soapy water.
- ✓ Don't use an indicator that has been hit with something heavy or dropped.
- ✓ Don't over-tighten contact points or adapters. This can cause a distortion in the measurements or cause the spindle to bind or the mechanism to stick.

Hands-on Learning Activities

Overview and Instructions

Hands-on learning bridges the gap between theory and practice, helping learners develop problem-solving skills, reinforce complex concepts, and build confidence while enhancing retention and task accuracy. Hands-on activities should complement written materials by providing opportunities to practice and retain content. With guidance and feedback from experienced instructors, this approach ensures learners build the confidence and competence needed to be skilled and job-ready.

Hands-on Learning Activities

Suggested hands-on learning activities for use of dial indicators:

- ☐ Use a dial indicator to measure runout on a piece of metal or brake rotor
- ☐ Other:

Notes/Comments:

Appendix

**Hands-On Learning Activity
Template (Sample)**

**Hands-On Assessment Form
Template (Sample)**

**Hands-On Learning Activity
Template (Blank)**

**Hands-On Assessment Form
Template (Blank)**

Hands-on Learning Activity Template (Sample)

Topic:	Inspection of an Air Brake System				
Hands on Learning Objective(s):	Demonstrate practical inspection and troubleshooting strategies for diagnosing and repairing an air brake system for a transit bus.				
Courseware Reference:	Foundational Skills – Mechanical Tools				
Preparation: Make sure the bus is properly parked above the load lifting mechanism so the participants can inspect underneath the bus. Have the appropriate PPE and tools nearby or in the shop for quick access.					
Tools, Equipment and Materials Required (including PPEs): Bus; Docking area/depot, Lift and lifting mechanism, any required safety PPE and diagnostic equipment					
Instructional Method					
☐	Role Play	☒	Demonstration	☐	Critical Incident
☒	Drills	☒	Simulations	☐	Case Study
Application Feedback Level					
☐	Full Class	☒	Small Group	☒	Individual
The instructor will perform the following task lists and then ask participants to perform the tasks. Task Steps for Air Brake System Inspection: - Pre-Inspection - Identify any affected high voltage areas and perform any lock-out/tag-out (LOTO) procedures - Inspection of bus under - Perform visual inspection of bus brake system - Visually examine brake systems: chambers, hoses, fittings, etc. - Perform air pressure and leak tests. Check the system response timing. - Repair, remove and/or replace as needed - Document any repair work performed and appropriate entry information into catalog. The instructor will perform the following task lists and then ask participants to perform the tasks and document the responses on the Hands-On Assessment Form.					
Maximum Time Allowed:		<i>Up to 2 hours per person (total time may change depending of number of participants, availability of time and materials/bus, etc.)</i>			

Other Notes:

Hands-on Learning Assessment Form Template (Sample)

Participant Name	John Doe		
Date of Assessment	8-15-25		
Topic:	Air Brake System Inspection		
Hands on Learning Objective(s):	Demonstrate air brake system inspection techniques and troubleshooting strategies.		
Courseware Reference:	N/A		
Task Steps	S	U	
1. Identify any affected high voltage areas and perform any lock-out/tag-out (LOTO) procedures.			
2. Perform visual inspection of bus brake system.			
3. Visually examine brake systems: chambers, hoses, fittings, etc.			
4. Perform air pressure and leak tests. Check the system response timing.			
5. Repair, remove and/or replace as needed.			
6. Document any repair work performed and appropriate entry information into catalog.			
7.			
8.			
9.			
10.			
Comments:			

Hands-on Learning Activity Template (Blank)

Topic:			
Hands on Learning Objective(s):			
Courseware Reference:			
Preparation:			
Tools, Equipment and Materials Required (including PPEs):			
Instructional Method			
☐	Role Play	☐	Demonstration
☐	Drills	☐	Simulations
☐		☐	Critical Incident
☐		☐	Case Study
Application Feedback Level			
☐	Full Class	☐	Small Group
☐		☐	Individual
The instructor will perform the following task lists and then ask participants to perform the tasks. Task Steps: 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.			
Maximum Time Allowed:			
Other Notes:			

Hands-on Learning Assessment Form Template (Blank)

Participant Name			
Date of Assessment			
Topic:			
Hands on Learning Objective(s):			
Courseware Reference:			
Task Steps		S	U
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
Comments:			