SAFETY

Manufacturing

Toronto District School Board

MANUFACTURING SAFETY

ACKNOWLEDGEMENTS

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SAFETY CONTRACT

Shop Safety Rules

These rules must be read and signed by both the student and parent or guardian.

- ✓ If in doubt **ask** the instructor.
- ✓ Students **must never** enter the shop unless the teacher is present.
- ✓ Students **must** be familiar with fire exits in each classroom.
- ✓ Students **must** be familiar with fire extinguishers in each classroom.
- ✓ Students **must** be familiar with the emergency stop buttons in each classroom.
- ✓ All machinery must be operated only after safety training, instructor demonstration and student demonstration has been completed.
- ✓ Power equipment **must never** be operated unless a qualified teacher is in the shop.
- ✓ Students **must** ask permission before operating any machine,
- ✓ Proper eye protection **shall** be worn in the shop.
- ✓ **No** coats, sweaters, ties or lose clothing are permitted in the shop. Long sleeves **must** be rolled up to the elbows.
- ✓ **No jewellery** of any kind is to be worn in the shop (some examples may include: rings, bracelets, earrings, nose rings, necklace, and watches.
- ✓ Long hair **must** be tied back.
- ✓ While welding, leather apron, gloves and appropriate eye protection **shall** be worn at all times.
- ✓ **All** injuries **must** be reported to the instructor immediately.
- ✓ When performing any operations where dust or fumes are present, **make sure** the area is well ventilated.
- ✓ Any spilled product on the floor or work area, such as oil **must** be cleaned up immediately and the instructor notified.
- ✓ Oily rags or flammable materials **must** be stored in proper metal containers.
- ✓ Horseplay of any sort is **not permitted** and will **not be tolerated** in the shop.

SAFETY CONTRACT (Continued)

- ✓ Follow proper procedures to dispose or store hazardous materials.
- ✓ Use compressed air with caution- wear eye protection, direct air away from eyes, skin and any cuts in the body. Be aware of flying chips.
- ✓ Respect yourself, others, and the school property and take responsibility for your actions.
- ✓ Students agree that they will participate in cleaning the shop and putting away all tools daily after use and at the end of classes.
- ✓ Students must report any damaged or defective tools or machines to the teacher immediately.
- ✓ Students understand that they must not abuse machinery, tools or materials in the shop.

This form must be returned to the instructor after being read by the student and parent or guardian.

Date:_____

Student Name:_____
(Please print)

Student Signature:_____

Parent/Guardian Name:_____
(Please print)

Parent/Guardian Signature:_____

TAPE MEASURE

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Apron/coverall

Operating Procedures

- Wear safety glasses at all times even when measuring.
- Use the tape measure only after you have received instruction.
- Never place measuring tools in chips or where other tools may be dropped on them.
- Always wipe measuring tools clean after use and give them a light dressing of oil to prevent rusting.
- Measuring tools should be stored in separate cases or areas to avoid scratches that can obscure the graduation lines.
- The safest way to retract the tape measure's blade is to hold the tape in one hand and use the thumb of your opposite hand to apply pressure onto the center of the blade as it retracts.
- You can prolong the life of the tape measure by preventing dirt, dust, or water from entering the spool. To clean the blade, pull it out only to the point where you see dirt or water. From this point use a rag to clean both the top and bottom of the blade as it retracts. If water is involved, it is recommended that you wipe the blade as many times as it takes to remove any moisture.

Specific Hazards

- Keep measuring tools away from moving parts of any machine.
- Never slow down the blade of the tape measure with the same hand holding the tape measure. Over time, the edges of the blade can get sharp, which increases the possibility of slicing a finger.
- Caution should be used to protect fingers from pinching when retracting the blade.

STEEL RULERS

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Apron/coverall

Operating Procedures

- Wear Safety glasses at all times even when measuring.
- Use the ruler after you have received instruction.
- Use the rule tilted slightly so the graduations touch the work.
- A steel ruler can also be used to measure or check a flat surface.
- Never place measuring tools in chips or where other tools may be dropped on them.
- Always wipe measuring tools clean after use and give them a light dressing of oil to prevent rusting.
- Measuring tools should be stored in separate cases or areas to avoid scratches that can obscure the graduation lines.

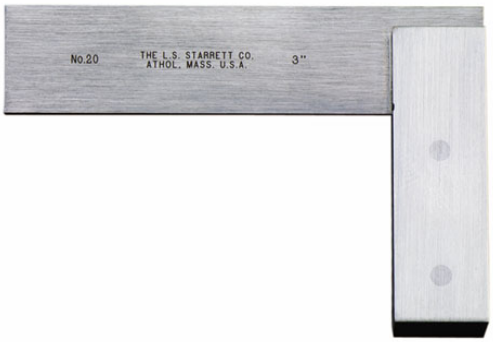
Specific Hazards

- Do not use steel rule for prying or scraping they could snap and cause serious injury.
- Do not use steel rules as a screw driver.
- Never strike or hammer a rule on any surface.
- Keep measuring tools away from moving parts of any machine.

SOLID SQUARE

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Apron/coverall



Operating Procedures

- Wear Safety glasses at all times even when measuring.
- Use the square only after you have received instruction.
- The solid square is used to check surfaces for flatness, to determine if two surfaces are at right angles to each other, and to check accuracy of other squares.
- Solid squares must be treated with great deal of care and not abused; otherwise its accuracy will be damaged.
- Never place measuring tools in chips or where other tools may be dropped on them.
- Always wipe measuring tools clean after use and give them a light dressing of oil to prevent rusting.
- Measuring tools should be stored in separate cases or areas to avoid scratches that can obscure the graduation lines.

Specific Hazards

- Remove jewellery, eliminate loose clothing, and confine long hair.
- Keep the work area and floor clean and free of oil and grease.
- Do not use square for prying or scraping it could snap and cause serious injury.
- Never strike or hammer a square this could cause injury and also damage the accuracy of the square.
- Keep measuring tools away from moving parts of any machine.

OUTSIDE / INSIDE CALIPERS

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Apron/coverall

Operating Procedures

- Wear Safety glasses at all times even when measuring.
- Use the calipers only after you have received instruction.
- Outside calipers are used to measure the outside surface of either round or flat work.
- Inside calipers are used to measure the diameters of holes, or the width of keyways and slots.
- Outside Calipers must be treated with great deal of care and not abused; otherwise its accuracy will be damaged.
- Never drop a caliper; always place it down gently.
- Never place measuring tools in chips or where other tools may be dropped on them.
- Always wipe measuring tools clean after use and give them a light dressing of oil to prevent rusting.
- Measuring tools should be stored in separate cases or areas to avoid damage.

Specific Hazards

- Keep measuring tools away from moving parts of any machine.
- Never attempt to use a caliper on moving work.
- Be aware of handling tools properly when walking to prevent personal injury.

MICROMETERS

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Apron/coverall

Operating Procedures

- Wear Safety glasses at all times even when measuring.
- Gloves should not be worn when operating equipment.
- Operate the micrometer only after you have received instruction.
- Micrometers must be treated with great deal of care and not abused; otherwise its accuracy will be damaged.
- Never drop a micrometer; always place it down gently.
- Never place measuring tools in chips or where other tools may be dropped on them.
- Always wipe measuring tools clean after use and give them a light dressing of oil to prevent rusting.
- Micrometers should be stored in separate cases or areas to avoid scratches and damage to moving parts.

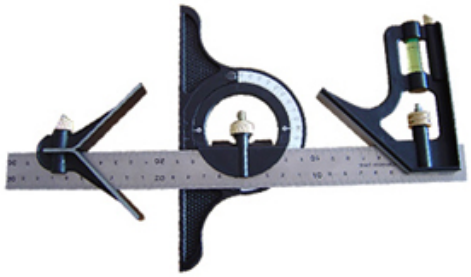
Specific Hazards

- Keep measuring tools away from moving parts of any machine.
- Never attempt to use a micrometer on moving work.

COMBINATION SET

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Apron/coverall



Operating Procedures

- Wear Safety glasses at all times even when measuring.
- Use the combination set only after you have received instruction.
- Use the steel rule with square head to layout lines parallel and at right angles to an edge
- The square head may be used to check 45 and 90 degree angles.
- The steel rule may also be used to measure or check a flat surface.
- The bevel protractor is used to layout and check angles.
- The centre head is used to locate centres of round, square, and octagonal stock.
- Never place measuring tools in chips or where other tools may be dropped on them.
- Always wipe measuring tools clean after use and give them a light dressing of oil to prevent rusting.
- Measuring tools should be stored in separate cases or areas to avoid scratches that can obscure the graduation lines.

Specific Hazards

- Do not use the steel rule for prying or scraping, it could snap and cause serious injury.
- Do not use the steel rule as a screw driver.
- Never strike or hammer a rule on any surface.
- Keep measuring tools away from moving parts of any machine.

DIAL INDICATORS

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Apron/coverall

Operating Procedures

- Wear Safety glasses at all times even when measuring.
- Operate only after you have received instruction.
- Measuring an item - this involves first zeroing the dial indicator where you are seeking to measure. When you then measure the item the dial indicator will provide a measure of how far off the item is from the desired measurement. Dial indicators can be outfitted with a variety of tips that enable them to be used for a variety of applications, and a variety of fixtures for a variety of purposes.
- Dial Indicators must be treated with great deal of care and not abused; otherwise its accuracy will be damaged.
- Never drop a dial indicator; always place it down gently.
- Never place dial indicator in chips or where other tools may be dropped on them.
- Keep the indicator clean. A single dial indicator can be used for a variety of measuring tasks. It is important that you take care of the dial, making sure to keep it clean and free from chips and debris. A small of piece of metal or wood can cause damage to the sensitive internals of the indicator and throw off the measurement.
- Always wipe dial indicators clean after use and give them a light dressing of oil to prevent rusting.
- Dial indicators tools should be stored in separate cases or areas to avoid scratches or damage to tip.

Specific Hazards

- Keep dial indicators away from moving parts of any machine.
- Never attempt to use a dial indicator on moving work.
- Do not pick up the indicator by the lens face.

PROTRACTOR / DEPTH GAUGE

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Apron/coverall

Operating Procedures

- Wear Safety glasses at all times even when measuring.
- Operate only after you have received instruction.
- The bevel protractor is used to layout and check angles.
- The rule is used to layout or measure depth.
- Never place measuring tools in chips or where other tools may be dropped on them.
- Always wipe measuring tools clean after use and give them a light dressing of oil to prevent rusting.
- Measuring tools should be stored in separate cases or areas to avoid scratches that can obscure the graduation lines or damage to moving parts.

Specific Hazards

- Do not use steel rule for prying or scraping they could snap and cause serious injury.
- Do not use the steel rules as a screw driver.
- Never strike or hammer measuring tools on any surface.
- Keep measuring tools away from moving parts of any machine.

VERNIER CALIPERS

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Protective Footwear
- Apron/coverall

Operating Procedures

- Wear Safety glasses at all times even when measuring.
- Operate only after you have received instruction.
- Vernier Calipers must be treated with great deal of care and not abused; otherwise its accuracy will be damaged.
- Never drop a vernier; always place it down gently.
- Never place measuring tools in chips or where other tools may be dropped on them.
- Always wipe the vernier clean after use and give it a light dressing of oil to prevent rusting.
- Measuring tools should be stored in separate cases or areas to avoid scratches that can obscure the graduation lines or damage to moving parts and tips.

Specific Hazards

- Keep measuring tools away from moving parts of any machine.
- Never attempt to use a vernier caliper on moving work.
- Be aware of sharp edges when handling the vernier and when walking to prevent personal injury.

VERNIER HEIGHT GAUGE

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Protective Footwear
- Apron/coverall

Operating Procedures

- Wear Safety glasses at all times even when measuring.
- Operate only after you have received instruction.
- Vernier Height gauges must be treated with a great deal of care and not abused; otherwise its accuracy will be damaged.
- Never drop a vernier height gauge; always place it down gently.
- Never place measuring tools in chips or where other tools may be dropped on them.
- Always wipe measuring tools clean after use and give them a light dressing of oil to prevent rusting.
- Measuring tools should be stored in separate cases or areas to avoid scratches or damage to moving parts.

Specific Hazards

- Keep measuring tools away from moving parts of any machine.
- Never attempt to use a vernier height gauge on moving work.
- Be aware of sharp edges of vernier height gauge or attachments when handling.
- Be aware of handling tools properly when walking to prevent personal injury.

SURFACE TABLE AND SURFACE PLATE

Used to accurately layout and inspect work pieces.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Apron/Coveralls
- Safety Shoes

Surface Table

Surface Place

Operating Procedures

- Ensure you are dressed properly.
- Avoid horseplay.
- Housekeeping - always keep your workspace clean.
- Ensure your surface table or surface plate is clean and free from dust, oil and grease.
- Always gently place your work piece on the surface table or surface plate.
- Care must be taken when placing tools on the surface table or surface plate.
- Hammers, and files must not be placed on the surface table or surface plate; these tools must be placed on the workbench.
- Never strike your work piece on the surface table or surface plate with a hammer.

Specific Hazards

- Remove all burrs from the work piece before placing on the surface table or surface plate.
- Always keep the surface table or surface plate clean and covered when not in use.
- Remember, the surface table or surface plate is used for layout or inspection work, so tools not in use must be placed in an orderly fashion on the work table.
- Care must be taken when using the surface plate to avoid dropping.

REVIEW QUESTION (Example)

Fill in the blanks with the best answer

1. The _____ _____ is used for layout and inspection work.

   a) centre punch c) oddleg caliper

   b) layout dye d) surface plate

LAYOUT SOLUTION

The most common type of layout solution is layout dye and bluing. The surface of the work piece must be coated with a layout solution so the layout lines can be visible.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Apron/Coveralls
- Safety Shoes

Operating Procedures

- Ensure you are dressed properly.
- Avoid horseplay.
- Housekeeping - always keep your workspace clean.
- Ensure your work piece surface is clean and free from oil and grease.
- Using a cloth, brush, or dauber, coat the surface lightly with the layout solution.
- After it has dried the work piece is ready to be marked out.

Specific Hazards

- The layout solution can stain your hands, clothes and everything it comes into contact with; therefore place a piece of cardboard under the work piece to protect the immediate surfaces.
- Ensure the area is well ventilated.
- Remove all jewellery, eliminate loose clothing and confine long hair.
- Care must be taken when using the layout solution to avoid spilling.

REVIEW QUESTION (Example)

Fill in the blanks

1. Layout solution is applied to the surface of the work piece so that the _____ can be _____.

SCRIBER

Used to draw straight lines on metal. The point of the scriber is always kept sharp and, ground to an angle between 30 and 40 degrees.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Apron/Coveralls
- Safety Shoes

Operating Procedures

- Ensure you are dressed properly.
- Avoid horseplay.
- Housekeeping - always keep your workspace clean.
- The scribing point must always kept sharp.
- Scribers usually have a knurled grip suitable for gripping.
- Straight lines are marked on a surface with a steel rule or a square.

Specific Hazards

- Never point a scriber at anyone.
- Always carry the scriber at your side with the point facing the floor.
- Remove all jewellery, eliminate loose clothing and confine long hair.
- Care must be taken when using this tool, to avoid dropping or throwing.

REVIEW QUESTION (Example)

Circle the correct answer - True (T) or False (F)

1. The scriber is used to draw straight lines on metal. (T) (F)

DIVIDERS

There are 2 types, spring and firm joint dividers.. Used to scribe arcs, circles, to divide layout lines into a number of equal parts and to transfer measurements.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Apron/Coveralls
- Safety Shoes

Operating Procedures

- Ensure you are dressed properly.
- Avoid horseplay.
- Housekeeping - always keep your workspace clean.
- The scribing points must always kept sharp.
- To ensure correct dimension, place one point on the 1 cm mark of a steel rule and open the divider until the other leg is set to the proper distance.
- Place one of the points into the indentation mark made by the prick punch and scribe your arc.

Specific Hazards

- Never point a divider at anyone.
- Always carry the divider at your side with the point facing the floor
- Remove all jewellery, eliminate loose clothing and confine long hair
- Remove all burrs from the work piece.
- Care must be taken when using this tool to avoid dropping or throwing.

REVIEW QUESTION (Example)

Fill in the blank

1. The _____ is used to draw arcs and circles on metal.

ODDLEG CALIPER

The oddleg caliper is also known as the hermaphrodite caliper. Used to layout lines parallel to an edge and to locate the center of round material.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Apron/Coveralls
- Safety Shoes

Operating Procedures

- Ensure you are dressed properly. Avoid horseplay.
- Housekeeping - always keep your workspace clean.
- The scriber point must always be kept sharp.
- To ensure correct dimension, place the bent leg at the end of the rule and adjust the straight leg to the desired dimension.
- Transfer the measurement by scribing a line using the bent end on the edge and the point on the work piece.
- Be careful to keep the point at 90 degrees to the edge; then, scribe the line.

Specific Hazards

- Never point a divider at anyone.
- Always carry the divider at your side with the point facing the floor.
- Remove all jewellery, eliminate loose clothing and confine long hair.
- Remove all burrs from the work piece.
- Care must be taken when using this tool, do not drop or throw this tool.

REVIEW QUESTION (Example)

1. What is the other name for the oddleg caliper? _____ caliper.

LAYOUT OR PRICK PUNCH

Used to make small indentation on a metal surface to indicate layout lines. The point of the layout or prick punch is always kept sharp, and, ground to an angle between 30 and 60 degrees.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Apron/Coveralls
- Safety Shoes

Operating Procedures

- Ensure you are dressed properly.
- Avoid horseplay.
- Housekeeping - always keep your workspace clean.
- Hold the knurled finger-grip at 45 degrees angle and place the point on the layout line.
- The layout or prick punch must then be brought to a vertical position, so the punch makes 90 degrees with the work piece.
- Strike the punch lightly with a ball peen hammer, then examine the indentation to make sure it is in the correct position.
- If the indentation is inaccurate, incline and tap the punch towards the correct position; then strike gently with the ball peen hammer.
- The layout lines that have been scribed in the work piece is made visible by prick punch marks; these can be placed every 6 mm apart in lines or on the quadrants for circles; this ensures the lines are not rubbed off during handling of the work piece.
- Gently place the prick punch on your workbench when not in use.

Specific Hazards

- Never point the prick punch at anyone.
- Always carry the prick punch at your side with the point facing the floor.
- Remove all jewellery, eliminate loose clothing and confine long hair.
- Care must be taken when using this tool, do not drop or throw this tool.

REVIEW QUESTION (Example)

Underline the best answer to the question.

1. With safety in mind:

   a) Remove all burrs from the work piece before scribing layout lines.
   b) Layout tools with sharp points should be covered when not being used.
   c) Layout tools with sharp points must not be carried in the pocket.
   d) The prick punch can be used as a centre punch.

CENTRE PUNCH

Used to mark the location of the center of a hole for drilling .The point of the centre punch is always kept sharp, and, ground to an angle f 90 degrees.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Apron/Coveralls
- Safety Shoes

Operating Procedures

- Ensure you are dressed properly.
- Avoid horseplay.
- Housekeeping - always keep your workspace clean.
- Hold the knurled finger-grip at 45 degrees angle and place the point on the prick punch indentation.
- The centre punch is then brought to a vertical position, so the punch makes 90 degrees with the work piece.
- Strike the punch with a ball peen hammer, and then examine the indentation to make sure it is in the correct position.
- If the punch mark is inaccurate, use a chisel and strike the mark to eliminate the punch mark; scribe over the layout lines. Prick punch, then centre punch in the correct position.
- Gently place the centre punch on your workbench when not in use.

Specific Hazards

- Never point the centre punch at anyone.
- Always carry the centre punch at your side with the point facing the floor.
- Remove all jewellery, eliminate loose clothing and confine long hair
- Care must be taken when using this tool, do not drop or throw this tool.

REVIEW QUESTION (Example)

Fill in the blanks.

1. The _____ _____ has a point that has an angle of 90 degrees.

ANGLE PLATE

The angle plate has 2 surfaces that form a perfect right angle. It is used as a reference point and to support the work piece for layout work.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Apron/Coveralls
- Safety Shoes

Operating Procedures

- Ensure you are dressed properly.
- Avoid horseplay.
- Housekeeping - always keep your workspace clean.
- Ensure your angle plate is clean and free from dust, oil and grease.
- Gently place the angle plate on the surface table or surface plate.
- The plate is used for supporting work when marking or supporting work while it is being tested for squareness.

Specific Hazards

- Remove all jewellery, eliminate loose clothing and confine long hair
- Remove all burrs from the work piece.
- Always keep the angle plate clean and covered when not in use.
- Remember, the angle plate is used for layout or inspection work, so tools not in use must be placed in an orderly fashion on the work bench.
- Care must be taken when using this tool, do not drop or throw this tool.

REVIEW QUESTIONS (Example)

Circle the correct answer - True (T) or False (F)

1. When moving heavy angle plates, you should ask for assistance. (T) (F)
2. Layout tools not in use should be placed on the angle plate? (T) (F)
3. Irregular shaped work pieces should be clamped to the angle plate (T) (F)

V-BLOCKS

Used to support round work for layout and inspection; and to support round work for drilling.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Apron/Coveralls
- Safety Shoes

Operating Procedures

- Ensure you are dressed properly.
- Avoid horseplay.
- Housekeeping - always keep your workspace clean.
- Ensure your V-blocks are clean and free from dust, oil and grease.
- When marking round work on the surface table or surface plate, V blocks are used.
- They are also used to find the centre of round work by scribing two lines as the round bar is turned through 90 degrees between the lines.
- V-blocks are used with clamps when a hole is to be drilled; the V-blocks, can be held in a vice while drilling operations are performed on round bars.

Specific Hazards

- Remove all jewellery, eliminate loose clothing and confine long hair
- Remove all burrs from the work piece.
- Always keep the V-blocks clean and covered when not in use.
- Remember, the V- blocks are used for layout or inspection work, so tools not in use must be placed in an orderly fashion on the work bench.
- Care must be taken when using this tool, do not drop or throw this tool.

REVIEW QUESTION (Example)

Fill in the blanks

1. Round work piece is supported on _____ _____ for layout and inspection.

BALL PEN HAMMER

The ball peen hammer is the hammer that is commonly used in machine shop work. The bottom is known as the face and the rounded top is known as the peen. Ball-peen hammers are manufactured in a variety of sizes, with the weight of the hammer head ranging from approximately 55g to 1400g. The hammer heads are hardened and tempered. The smaller size hammers are used for layout work and the larger ones are used for general bench type work.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

- Safety glasses shall be worn when using the hammer.
- Before using a hammer ensure that it is in good working condition.
- When using a hammer ensure that there is no one or any obstructions in your working area.
- Never strike a hammer with another hammer, this could cause serious injuries.
- To avoid injury to yourself or others concentrate on the work being done.
- Only use a hammer on the type of surface or material that it is intended for.
- When using a hammer, it should be held at the end of the handle; this allows for a greater pounding force.
- Proper use of the hammer helps to keep the hammer face flat on the work area being struck. This in turn reduces the chance of damaging the face of the hammer.

Specific Hazards

- Never stand behind or close to anyone using a hammer. If you need to watch someone using a hammer, stand at a safe distance to the side of the person using the hammer.
- Proper eye protection shall be worn to avoid metal chips or other debris from entering the eye and causing serious injuries.
- Unsafe use of the hammer will cause injury to yourself and others around you.
- Ensure that the head is tight on the handle and is secured with a proper wedge to keep the handle secured into the head.
- Never use a hammer with a greasy handle or if your hands are greasy.

SOFT FACED HAMMER

The soft face hammer is used when assembling or setting-up work. This type of hammer has a surface that is made of brass, hard rubber, plastic or rawhide.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

- Safety glasses shall be worn when using the hammer.
- Before using the soft-faced hammer ensure that it is in good working condition.
- When using the hammer ensure that there is no one or any obstructions in your working area.

Specific Hazards

- Never stand behind or close to anyone using a hammer. If you need to watch someone using a hammer, stand at a safe distance to the side of the person using the hammer
- Never use the soft-face hammer for heavy duty hammering; this will damage the face of the hammer.

SCREWDRIVERS

Screwdrivers are made in a variety of lengths, sizes and styles to fit a wide range of screws. A screwdriver consists of three parts, the handle, shank and the blade which is hardened and tempered to prevent wear. Most shanks are round; however, those on heavy duty screwdrivers are normally square so that a wrench can be used when extra torque is needed.

Types of screwdrivers

Standard

Robertson

Phillips

Torx

Personal Protection Equipment (PPE) Requirements

- Safety glasses

Operating Procedures

- Safety glasses shall be worn when using any type of screwdriver.
- Avoid holding the screwdriver in one hand and the work in the other hand. If the screwdriver slips, serious injury can result.
- Choose the correct size of screwdriver for the job. If a screwdriver that is too small is used, both the screwdriver tip and the screw slot may become damaged.
- Do not use the screwdriver as a chisel, pry bar or a wedge.
- To avoid injury to yourself or others concentrate on the work being done.
- Always select the correct screwdriver for each application and use it properly to avoid accident or injury.

Specific Hazards

- Screwdrivers should never be used as a pry bar; if they bend under heavy load they will no longer be useful and may be unsafe to use.
- Do not carry screwdrivers in your pockets.
- Only use a screwdriver for its intended use. Misuse will damage the screwdriver and may cause an accident.

WRENCHES

Many types of wrenches are used in machine shop work, each wrench being suited for a specific purpose. The name of a wrench is derived from either it use, its shape or its construction. A wrench is used to tighten or loosen nuts and bolts. Some wrenches are used in plumbing work to assemble and dismantle pipes. Most wrenches have a fixed opening; however, some are made with adjustable openings to fit a variety of nut and bolt sizes.

Types of wrenches


Open End


Combination


Box


Adjustable

Monkey Wrench


Pipe


Single End

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

- Safety glasses shall be worn when using any wrench.
- Whenever possible, it is always advisable to pull rather than push on a wrench in order to avoid an injury if the wrench should slip off the nut or bolt.
- When tightening or loosening a nut or bolt a sharp jerk is more effective than a steady pull.
- When assembling a nut and bolt it is advisable to put a drop of oil on the threads to make it easier for removal at a later date.
- Always use a wrench in the same plane as the nut or bolt.
- Before using a wrench ensure that it is in good working condition and is safe to use.

Specific Hazards

- Always ensure that the wrench is properly seated on the nut or bolt before attempting to loosen or tighten it.
- To avoid accidents always select a wrench that fits the nut or bolt properly. A wrench that is too large may slip off the nut or bolt and cause an accident.
- Proper stance or balance is necessary when using a wrench to avoid an injury.

WRENCHES (Continued)

Single-ended Wrench

- A single-ended wrench is used to tighten and loosen one size of nut and bolt.
- The opening of the wrench is normally offset at a 15 degree angle to allow complete rotation of a hexagon nut in only 30 degrees by “flopping” the wrench.

Double-ended Wrench

- A double-ended wrench has a different size opening at each end.
- This wrench is used in the same manner as a single-end wrench.

Combination Wrench

- A combination wrench has an opening at one end and a box at the other end.
- Both ends are the same size.

Double-box End Wrench

- A double box-end wrench has different size at each end.
- The box-end wrench has six or twelve notches cut around the inside of the face of the wrench.
- This type of wrench is capable of operating in confined space.
- The box-end wrench completely surrounds the nut or bolt head and will not slip.

Adjustable Wrench

- The adjustable wrench can be adjusted to fit various sizes of nuts and is notably useful for odd size nuts.
- However, if this type of wrench is not properly adjusted to fit the flats of the nut, the corners of the nut will be damaged.
- Adjustable wrenches should not be used on nuts which are very tight on the bolt because, when excess force is applied to the handle, the jaws of the wrench tend to spring and this causes damage to the wrench and the corners of the nut.
- When adjustable wrenches are used, the direction of the force applied should always point towards the solid or fixed jaws.

Allen Wrench

- The Allen wrench is commonly known as the socket set screw wrench.
- This is a hexagonal shaped tool and fits into the holes of socket-head cap screws or safety set screws.
- Allen wrenches are made in various sizes to fit a variety of screw sizes.
- Allen wrench sizes are identified by the distance across the flats, this distance is normally one-half the outside diameter of the screw thread in which it is used.

WRENCHES (Continued)

Socket Wrench

- A socket wrench is a tool that is used to tighten and loosen nuts and bolts easier than using a regular wrench.
- A socket wrench has a cylindrical socket that fits over a nut or bolt of a specific size and shape.
- Avoid overloading the capacity of the wrench by using a pipe extension on the handle of the wrench or by striking the handle of the wrench with a hammer. Striking the handle of the wrench with a hammer will weaken it and cause the tool to break.
- Special heavy duty wrenches are available with extended handles up to 3 feet in length.
- A socket wrench will include three basic parts: the socket, the lever and the switch.
- Choosing the proper size and type of wrench for the job at hand is crucial, since using a socket wrench with too large a reach will damage the points of the tool.

Pipe Wrench

- Pipe wrenches are used to tighten and dismantle pipes particularly in the plumbing trade.
- Pipe wrenches are available in various styles and sizes to suit the job that they are designed for.
- Serious injury can occur if the pipe wrench is not used properly.
- Do not use a pipe wrench that is not properly maintained. The wrench should be inspected frequently for damaged or worn parts.

PLIERS

Pliers are made in a variety of shapes and sizes and for a wide range of uses. Some are made for gripping objects that are round such as a pipe or a rod, some are used for twisting wires and others are designed to be used for multiple tasks including cutting wire.

Pliers fall into two main categories - solid joint pliers and slip joint pliers, either of these may have cutters. Pliers vary in length from 4" to 20" (10cm – 51cm).

Slip-joint pliers are of two designs-multiple hole and tongue and groove. The slip or adjustable joint enables the tool to adjust to the size of the object being held. Solid-joint pliers have a joint fixed with a solid pin or rivet and are not adjustable.

Cutting pliers are of three types - side, end and diagonal cutters.

Types of pliers


Multiple Slip-joint


Linesman


Vice Grip


Needle Nose


Diagonal

Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

- Safety glasses shall be worn when using pliers.
- Cut material at right angles, never rock the cutting tool from side to side or bend the wire back and forth against the cutting edges.
- Before using a pliers ensure that they are in good working condition.
- Oil pliers and wire cutters regularly. A drop of oil on the hinge will make the tools easier to use.
- Make sure that the toothed jaws are clean and sharp. Greasy or worn jaws can result in compromised safety.

PLIERS (Continued)

Specific Hazards

- Pliers cannot grip nuts and bolts securely and will slip, damaging the nut and may cause an injury.
- Make sure that the cutting edges are sharp. Dull and worn down cutting edges require a greater force is needed for cutting.
- If jaws are worn they will require increased force to hold the work-piece which, in turn, increases the risk of muscular fatigue and repeated strain injuries.
- To avoid injury, pull on the pliers. Do not push away from yourself when applying pressure.
- Maintain your balance when using pliers to avoid injury.
- Pliers used for electrical work must be insulated to avoid electrical shock.

Linesman Pliers

- Linesman or electrical pliers are heavy-duty, side-cutting pliers designed for all regular wire-cutting needs.
- They have gripping jaws in addition to cutting edges.
- High leverage lineman's pliers have a rivet placed closer to the cutting edges to provide 50 percent more leverage.

Needle-nose Pliers

- Long-nose or needle-nose pliers have a pointed nose designed for reaching places with restricted clearance.
- This tool is a standard item for all electrical and electronics work.

Diagonal Pliers

- Diagonal pliers are sometimes called wire cutters or diagonal cutting pliers. They are used for cutting wire.
- Cutting pliers with cutters positioned diagonally to the handle are used to provide leverage when pulling cotter pins. They are also used for general cutting by electricians, mechanics.
- Instead of using a shearing action much like scissors, cutting pliers cut by indenting and wedging the wire apart.
- Cutting pliers have blades on the end and are used to make sharp, clean cuts close to the surface on wires, bolts and rivets.

Multiple Slip-joint Pliers

- Slip joint pliers can be adjusted to allow for different sizes of objects to be gripped.
- A slot in the neck allows the pivot to slide between a series of positions.
- The adjustable pivot point in slip joint pliers is usually one of two types of construction, either it will have two or more preset holes, or it will have a tongue and groove construction.
- Sometimes called water pump or pipe pliers, this type of plier often has larger handles, to deal with the larger items they are used to grip.
- Slip joint pliers maybe used in special cases to turn a nut.

PLIERS (Continued)

Vice-grip Pliers

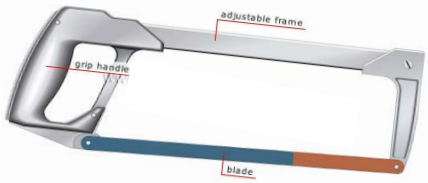
- Vice-grip pliers are special lever-action adjustable pliers they are designed to grip various shapes and sizes of components such as nuts and cap-head screws.
- Do not use a hammer to strike the wrench or an extension bar on the handle to increase the force to remove a nut or bolt.
- These types of pliers should not be used to replace wrenches, however, may be used to remove a rounded nut or bolt.
- Vice grip pliers can sometimes be used as a vice, clamp, or pipe wrench.

HACKSAWS

The hacksaw is a hand tool used to cut metal to length or shape. The four main parts that make up a hacksaw are: handle, adjustable frame, blade and adjusting wing nut. The frame on most hacksaws can be tubular or flat and some are adjustable to suit various lengths of hacksaw blades. Common lengths of blades are 8 in., 10 in., and 12 in.(20cm, 25cm, and 30cm)

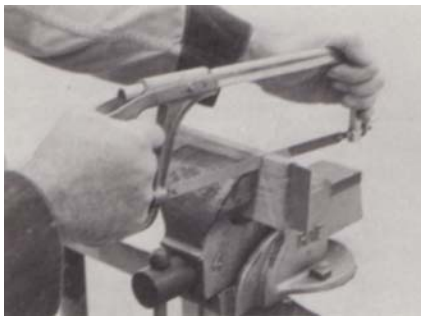
Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear



Operating Procedures

- Safety glasses shall ***always*** be worn when using the hacksaw.
- Use the proper blade for the size and shape of the material to be cut.
- The location of the cut should me marked on the work-piece.
- The work-piece should be mounted in a vise.
- It is important that the teeth of the blade point away from the handle of the hacksaw.
- Hold the hacksaw firmly and assume a comfortable stance.
- Adjust the tension so that the blade is a tight fit.
- Apply pressure on the forward stroke when cutting release it on the return stroke.
- Care should be taken when nearing the end of the cut to slow down and control the saw as it breaks through the material.
- Start the saw by drawing back on the handle using the right hand and guiding the blade with the left thumb.
- When sawing a thin piece of metal, clamp the metal between two pieces of wood. Use a very fine teeth blade and saw through the wood and the metal.



The correct method of holding a hand hacksaw – courtesy Kostel Enterprises Ltd.

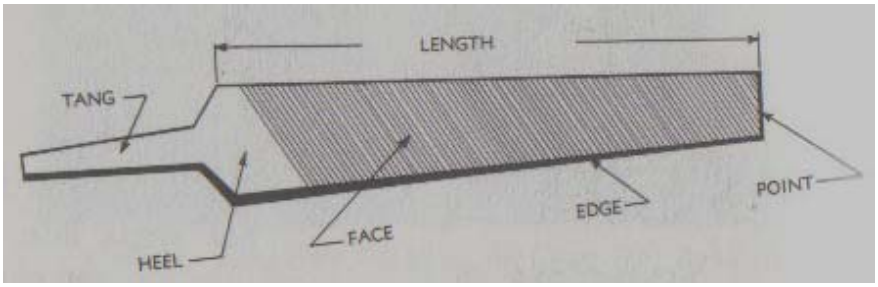
Specific Hazards

- Do not apply too much tension on the saw blade when adjusting. Too much pressure will bend the frame and damage the blade. Not enough tension will cause the blade to bend and break.
- When using a new saw blade on an old cut, do not apply pressure until the saw is at the bottom of the old cut.

FILES

A file is a hand-cutting tool which is made of high carbon-steel with many teeth cut on its face. Files are used to remove surplus material and to produce finished surfaces. Files are manufactured in a variety of shapes, sizes and types, each for a specific purpose.

Files may be divided into two categories: single cut and double cut files.



The parts of a file

Single-cut Files
Single-cut files have a single row of parallel teeth running diagonally across the face of the file. Single cut files are used when a smooth surface is needed or when harder metals are to be finished.

Double-cut Files
Double-cut files have two intersecting rows of teeth crossing each other; one row is finer than the other. The finer row is called the ***upcut*** and the coarser cut is called the ***overcut.*** These intersecting rows create hundreds of cutting teeth which allow for fast removal of metal and easy clearing of metal fillings.

Personal Protection Equipment (PPE) Requirements

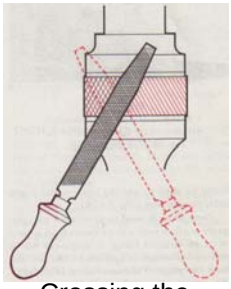
- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

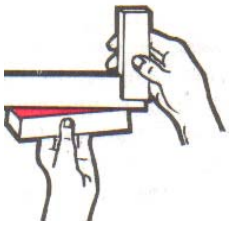
- Safety glasses shall be worn when using a file.
- Proper care, selection and use of the file are very important to achieve good results.
- The work to be filed should be held in a vise at about elbow level as show in the diagram.
- Apply pressure only on the forward stroke or action when filing. If pressure is applied on the return stroke this will dull the file.
- Do not rock the file when filing, but push it across the work surface in a straight line.

FILES (Continued)

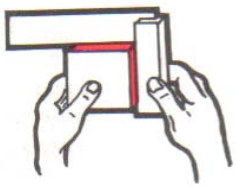
- Do not press too hard on a file; too much pressure tends to break off the cutting edges and shorten the life of the file.
- When rough filing, use a double-cut file and cross the stroke at regular intervals to help keep the surface flat and straight.
- When finishing, a single-cut file should be used and short strokes in order to keep the surface flat.
- The work piece should be tested intermittently for flatness by placing a straight edge across its surface and steel square should be used to test squareness of one surface to another.



Crossing the stroke



Testing for flatness



Testing for squareness

Draw Filing

- Use draw filing to produce a straight, square surface with a finer finish than straight filing.
- A single-cut file is used and gripped firmly at both ends and is successively pulled and pushed lengthwise along the surface of the work.
- Ensure the file is flat and apply pressure only on the forward stroke when draw filing.

Draw filing

Courtesy – Nicholson File Co. of Canada, Ltd.

Specific Hazards

- Never use a file without a handle.
- Always ensure that the handle is tight on the file.
- Do not store files where they will rub against each other. They should be hung or stored separately to avoid damage to the file.
- Do not use the file as a pry bar or hammer. A file is made of hard brittle steel that will break easily. This can cause small pieces to fly and cause a serious injury to the eye.
- Never knock a file on a vise or any other hard surface to clean it.
- Always use a file card to keep the file clean and free of iron filings and debris.

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SAMPLE REVIEW QUESTIONS ON FILES

Study the questions below and place **"True** or **"False"** in the space provided.

1. _____ Files are divided into two categories.

2. _____ Double-cut files have two parallel rows of teeth.

3. _____ Do not use the file as a pry bar or hammer.

4. _____ Safety glasses should be worn only when working on a machine in the machine shop.

5. _____ When filing, pressure should be applied both on the forward stroke and also on the return stroke.

6. _____ The work to be filed should be held in a vise.

7. _____ When a file is new it will need more pressure to operate because the teeth will remove more material.

8. _____ Only small files can be used without a handle.

Answer key:
1. True
2. False
3. True
4. False
5. False
6. True
7. False
8. False.

HAND TAPS

Taps are cutting tools used to produce internal threads. They are made from high quality steel, that is hardened and ground. Taps are manufactured in metric units and imperial units. Taps are available in various sizes and pitches. The most common taps are manufactured with three or four flutes cut lengthwise across the threads to form cutting edges, provide clearance for the chips and allow cutting fluid to lubricate the tap. The end of the shank is square so that a tap wrench can be used to hold the tap and turn it into a hole. Hand taps are usually made in sets of three, consisting of a taper, plug and bottoming tap.

Bottoming Plug Tapered

Taper Tap
A taper tap is tapered from the end of the tap for approximately six threads and is used to start the thread more easily. It can be used for tapping a hole that goes through the work-piece, as well as starting a hole that does not go through the work (a blind hole).

Plug Tap
A plug tap is tapered from the end of the tap to approximately three threads. The plug tap is sometimes the only tap used to cut a thread going through the work piece.

Bottoming Tap
A bottoming tap is not tapered but has a chamfer at the end for one thread. It is used to cut a thread that does not go through the work-piece. Normally all three taps would be used to cut a thread that does not go through the work-piece.

Tap wrenches
Tap wrenches are available in two styles and in various sizes to accommodate the tap being used.

T-handle tap wrench

Double ended adjustable wrench

HAND TAPS (Continued)

Adjustable T-handle Tap Wrench
The adjustable T-handle tap wrench is generally used for holding small taps or for working in confined areas where it is not possible to use a double-ended tap wrench.

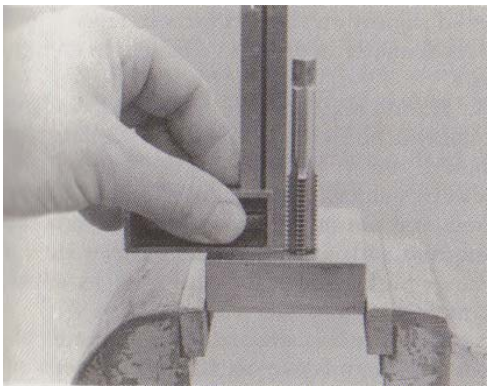
Double-Ended Adjustable Tap Wrench
The double-end tap wrench is made in several sizes but is normally used to hold larger taps when working in open places where there is adequate space to turn the tap wrench.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

- Safety glasses shall be worn when using a hand tap.
- Before a tap is used, the hole must be drilled to the correct tapping drill size.
- The tapping drill is always smaller than the tap so that enough material is left in the hole for the tap to cut a thread.
- A chart can be used to find the appropriate tapping size for each tap.
- Select the correct tap and tap wrench for the job.
- When smaller size taps are being used with the adjustable T-handle type wrench, the body of the wrench should be turned with the thumb and forefinger to advance the tap into the work-piece.
- The handle part of the adjustable T-handle wrench is used to turn the wrench for larger taps, which will not break as easily as the smaller ones.
- Apply a suitable tapping compound for the material being tapped.
- Hold work-piece in a vise and place the tap in the hole at $90^{0.}$ Apply an equal down pressure on the tap wrench while turning it clockwise for approximately two turns for a right hand thread.
- Remove the tap wrench from the tap and check the tap for squareness. Check at two positions 90^{0} apart.
- If the tap did not enter the hole squarely, remove the tap from the hole and restart it by applying pressure in the direction that the tap is leaning.
- When the tap is square feed it into the work-piece by turning the tap wrench.
- When tapping blind holes use all three taps: the taper tap first, then the plug and then the bottoming tap



Checking tap for squareness at two positions 90^{0} apart.
Courtesy of Kostel Enterprises Ltd.

HAND TAPS (Continued)

Specific Hazards

- To avoid breaking the tap, it is important not to use a large tap wrench to hold a small tap.
- When checking the squareness of the tap be careful not to exert too much pressure in straightening the tap, otherwise the tap may break.
- To avoid breaking the tap, turn the tap clockwise one-quarter of a turn and then turn the tap backwards one-half of a turn to break the chips.
- When tapping a blind hole, before using the bottoming tap ensure the hole is clear of chips.
- Care must be taken to avoid hitting the bottom of the hole and breaking the tap.

THREADING DIES

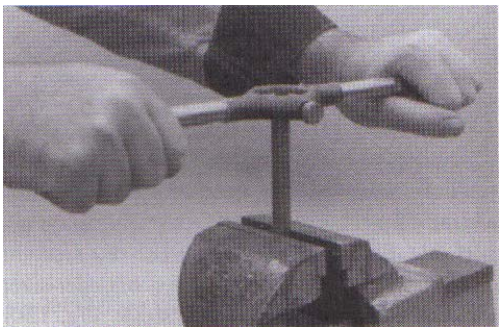
Threading dies are used to cut external threads on round work. The adjustable and the solid type dies are the most common types of dies. The round adjustable die is split on one side and can be adjusted to cut slightly over or under-sized threads. The solid die cannot be adjusted and normally is used for finishing purposes. The dies are mounted in a die holder which makes it possible to turn the die on the work-piece.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

- Safety glasses shall be worn when using a threading die.
- Ensure that the work piece has a chamfer at the end so that the die can locate over the work-piece to start the thread.
- Hold the work piece firmly in a vise or in the chuck on a lathe.
- Select and setup the proper die and holder and lubricate the tapered end of the die.
- Place the tapered end of the die over the work-piece so that the die is square on the work-piece.
- Press down on the die holder handles and turn the holder clockwise for several turns.
- Check the die to see if it is square with the work piece.
- If the die is not square remove the die and restart it square with the work-piece.
- Turn the die forward one turn and then backwards one-half of a turn to break the chips.



Start the tapered end of the die on the work.

THREADING DIES (Continued)

Specific Hazards

- Ensure that the work piece is held securely before threading.
- Care should be taken to ensure that he die is seated squarely and firmly in the holder.
- It is important that the die is located squarely on the work piece.
- Do not hit the die with any metal object, this may damage the die.
- Even pressure should be applied to the die during the threading operations.
- Avoid handling the chips that are generated from the threading operation. Use a brush to remove the chips from the die.

CENTRE DRILLS AND TWIST DRILLS

Twist Drill

A twist drill is a cutting tool used to produce various sizes of holes in a piece of metal, wood or any other material. The most common types of drills have two cutting edges and two helical or straight flutes. The flutes are important because they provide the cutting edges, allow cutting fluid to the work piece and also allow the chips to escape during the drilling operation. Twist drills are manufactured from carbon tool steel, high-speed steel and cemented carbides. The high-speed steel drills are the most commonly used in the manufacturing shop.

Twist Drill

Centre Drills

The centre drill is used to prepare holes for drilling when using the drill press. Centre drills are available in various sizes to suit different diameter work.

Centre Drill

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

- When drilling a hole safety glasses shall be worn.

<u>Set-up for using a twist drill</u>

- Centre drilling holes in preparation for drilling with a twist drill
- Centre punch the location of the holes if drilling the hole on a drill press.
- Locate the work piece accurately in a vise and secure it firmly.
- Select the correct size centre drill to suit the diameter of hole needed and secure it in the drill chuck.
- Select the correct speed to suit the diameter of the drill and the material being drilled.
- Switch on the machine and use the hand lever to carefully feed the centre drill into the work-piece until the correct depth is reached.
- Intermittently raise the drill from the work-piece and apply cutting fluid.
- Repeat the operations for other holes if necessary.

<u>Setup for drilling centre holes with a twist drill</u>

- Select the correct size drill and firmly secure the drill in the drill chuck.
- Secure the work piece in a vise fastened to the table.
- Choose the speed to suit the material and size of drill being used.
- Switch on machine and use the hand lever to accurately and carefully drill the required holes in the work-piece to the specified depth.
- Lower the drill slowly into the material.
- Intermittently raise the drill from the work piece and apply cutting fluid.

CENTRE DRILLS AND TWIST DRILLS (Cont'd)

Specific Hazards

- To avoid accidents or injury secure the work piece and vise before drilling.
- Remove the chuck key from the chuck before switching on the drill.
- Ensure that all guards are in place before switching on the machine
- To remove any chips, switch off the machine and use a brush to clean chips from the work piece.
- Lower the drill slowly into the work piece to avoid breaking the drill.

REAMERS

A reamer is used to finish a drilled or bore hole to size and shape, and to produce a good surface finish in the reamed hole. Speed, feed and the reaming allowance are three of the main factors that can affect the accuracy of a reamed hole.

There are two types of reamer used in machine shop work: hand reamers and machine reamers. Hand reamers are used to remove no more that 0.005 in (0.12 mm) from a hole. The machine reamers are made with a straight or tapered end and are used under power.

Allowances

- Approximately 0.4 mm (0.016 in) is left remaining for reaming holes up to 12.5 mm (0.492 in) in diameter; 0.8 mm (0.031in) is recommended for holes over 12.5 mm diameter.
- The speed for reaming is normally about one-half of the drilling speed.

Machine Reamer & Hand Reamers

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

- Safety glasses shall be worn when using reamers.
- Care should be taken to select the correct drill to suit the reamer.
- Ensure that the drill and reamer are sharp and in good working condition.
- The work piece should be held firmly in a vise, or secured to the machine table.
- Select the proper spindle speed for the material being used.
- Locate the position of the hole to be drilled, centre drill and drill the hole, applying a suitable lubricant.
- Ensure that the alignment of the work piece and the machine spindle is maintained.
- Select the proper speed for the reamer being used (half the drilling speed).
- Locate the reamer in the spindle and slowly feed reamer through hole. Apply a suitable lubricant.

Specific Hazards

- Ensure that the correct tool is being used for the job.
- Avoid leaving too much material for the reamer to remove. This will affect the accuracy of the reamed hole.
- Ensure that the work-piece is properly secured.
- Select the proper speed for the reamer being used. If speed is too fast the reamer will loose its accuracy.
- The work-piece should be aligned to the machine spindle to maintain accuracy.

SAMPLE REVIEW QUESTIONS FOR REAMING

Review the questions and place “True” or “False” in the space provided.

1. _____ There are two types of reamers used in machine shop work.

2. _____ Machine reamers have a square on one end.

3. _____ Machine reamers have a straight or tapered end and are used under power.

4. _____ The accuracy of a reamed hole is affected by: speed, feed and reaming allowance.

5. _____ The speed for reaming is normally about two times that of the drilling speed.

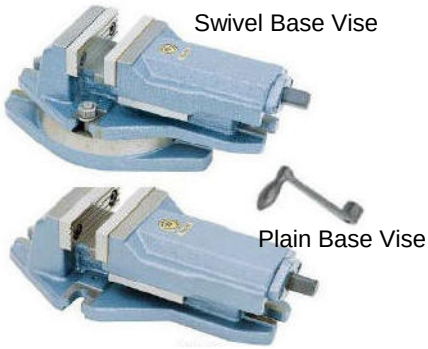
6. _____ Approximately 0.08 mm is left remaining for reaming holes up to 12.5 mm diameter.

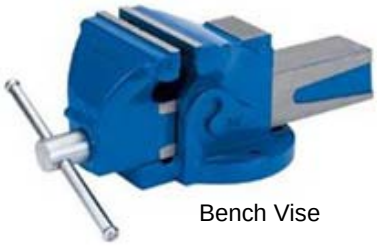
Answer Key

1. True
2. False
3. True
4. True
5. False
6. False

BENCH VISE AND MILLING MACHINE VISE

The bench vise or machinist's vise is a material holding device that is used to hold work for various operations such as: sawing, filing, tapping, threading, polishing and drilling. When holding finished work soft jaw covers are used over the regular jaws to protect the work piece. Vises are available in a variety of sizes and styles.





Milling machine vises are the most commonly used work holding devices for milling. They are manufactured in three styles, plain, swivel and universal as shown above.

The **plain vise** may be bolted to the table of the machine so that its jaws are parallel to the axis of the spindle. The vise can be positioned quickly and accurately by location keys on the bottom of the vise that fits into the T-slot of the machine table.

The **swivel vise** is very similar to the plain vise, except that it has a swivel based which makes it possible to swivel the vise through 360 degrees in a horizontal plane.

The **universal vise** may be swiveled through 360 degrees in a horizontal plane and may also be tilted from zero to 90 degrees in a vertical plane. This type of vise is used mainly by mould-makers, tool-makers and die-makers, because it allows the setting of compound angles for milling.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

- Safety glasses shall be worn in the shop area.
- When using the bench vise it should be securely clamped on a bench or table.
- When clamping a previously machined part in a vise, place soft jaws made of brass, aluminum or copper over the regular jaws to protect the work.
- Ensure that the work piece is properly secured in the vise before attempting to carry out any operations.

BENCH VISE AND MILLING MACHINE VISE

- Locate the work piece in the center of the vise. This equalizes the pressure on the vise jaws.
- The work piece should always be supported by the bottom of the vise or by parallels.
- When clamping a work piece in the vise keep it as low as possible in the vise.

Specific Hazards

- Striking the vise handle with a hammer can cause the vise to become over-tightened or cause the vise handle to break.
- Holding the work piece off centre in the vise puts unequal pressure on the vise jaws. This can cause the piece to loosen up and cause and injury or damage to the work piece.
- Work pieces that are not supported in the vise properly will move under the pressure of the cutting forces and may cause damage of injury.
- Avoid using the swivel base vise when doing heavy rough cutting operations.

HORIZONTAL MILLING MACHINE

Used mainly for facing, end milling and drilling operations. This type of machine is very versatile and its spindle is normally in a horizontal plane.

Operating the horizontal milling machine is not much different from operating the vertical milling. However, when using the over-arm support and arbor driven cutters, a new set of operating principles needs to be taken into consideration to ensure good work practice and a safe working environment.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

- Safety glasses shall be worn when operating the milling machine.
- Before operating the horizontal milling machine you should be properly trained in its safe use operation.
- Ensure that all guards are in place before attempting to operate the machine.
- Ensure that the milling machine has a start/stop button within easy reach of the operator.
- Make sure that the work holding device is mounted firmly to the machine table and the work piece is held solidly.
- Care should be taken to make sure the cutter is mounted securely to the spindle or arbour before making a cut.
- When setting up or removing a milling cutter from its holder or arbor, proper precautions should be taken to avoid injury.
- To avoid injury to you hands move the machine table to a safe distance from the cutter while setting up the work.
- Always use a coarse tooth cutter instead of a fine tooth when possible. A coarse tooth cutter has a larger clearance area for the chips and will not clog up quickly.
- When setting up a cutter on the arbor always make sure that the cutter is keyed to the arbor.
- When assembling or disassembling a tool on the arbor setup using the over-arm support, always leave the support in place when loosening or tightening the arbor nut.
- Tighten the arbor nut by hand with a wrench never use a hammer to strike the wrench to tighten the arbor nut.

Specific Hazards

- Do not move the operating levers without knowing what they control and what action is going to take place.
- Do not use a blunt or chipped cutter to machine work-piece.
- Keep hands, brushes and rags away from the rotating milling cutter.
- Keep floor around the milling machine free of oil and grease.

HORIZONTAL MILLING MACHINE (Cont'd)

- Do not use excessively heavy cuts or feeds as it can cause the cutter to break.
- Never attempt to make any adjustments or measurements to the work piece set-up until the milling machine is completely stopped.
- Always ensure that the cutting tool is sharp, in good working condition and is safe to use.
- Never reach over or near a rotating cutter.
- Over tightening the arbor nut can crack the nut or strip the threads.
- Tightening the arbor nut without the over arm in place will ruin the arbor.
- Do not leave the machine unattended while it is running.
- While the machine is in operation keep hands away from the rotating cutter.
- Use a brush ***only*** to clean metal cuttings from work piece once the cutter has stopped rotating.

SAMPLE REVIEW QUESTIONS

▪ always ▪ off ▪ sharp ▪ hands ▪ rotating	▪ trained ▪ keyed ▪ stopped ▪ mounted ▪ knowing

Fill in the blanks with the appropriate words from the list above.

1. Turn the power _____ before you make any measurements or adjustments.

2. Safety glasses should _____be worn when operating the milling machine.

3. Make sure that the work holding device is _____firmly to the machine table and the work-piece is held solidly.

4. Use a brush ***only*** to clean metal cuttings from work-piece once the cutter has _____rotating.

5. Always ensure that the cutting tool is sharp, in good working condition and is _____ to use.

6. While the machine is in operation keep _____ away from the rotating cutter.

7. When settings up a cutter on the arbor always make sure that the cutter is _____ to the arbor.

8. Never reach over or near a _____ cutter.

9. Do not move the operating levers without _____what they control and what action is going to take place.

10. Before operating the horizontal milling machine you should be properly _____in its safe use operation.

Answer key for review questions

1. Off
2. Always
3. Mounted
4. Stopped
5. Safe
6. Hands
7. Keyed
8. Rotating
9. Knowing
10. Trained

VERTICAL MILLING MACHINE

Used mainly for facing, end milling and drilling operations.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

- Safety glasses shall be worn when operating the vertical milling machine.
- Gloves should not be worn when operating the milling machine.
- Before operating the milling machine you should be properly trained in its safe operation.
- Ensure that the milling machine has a start/stop button within easy reach of the operator.
- Ensure that the work piece and cutter are mounted securely before making a cut.
- When setting up or removing a milling cutter from its holder, proper precaution should be taken to avoid getting injured.
- To avoid injuring your hands move the machine table as far as possible away from the cutter while setting up or measuring work
- Do not attempt to setup, measure or adjust work-piece until the cutter is completely stopped.
- Do not use excessively heavy cuts or feeds as it can cause the cutter to break.

Specific Hazards

- Use a brush ***only*** to clean metal cutting from work-piece once the cutter has stopped rotating.
- Do not move the operating levers without knowing what they control and what action is going to take place.
- Do not use a blunt or chipped cutter to machine work-piece.
- Keep hands, brushes and rags away from the revolving milling cutter.
- Keep floor around the milling machine free of oil and grease.
- Make sure the cutting tool is properly tightened in the holder.
- Do not leave machine unattended while it is running.
- Ensure that all guards are in place before attempting to operate the machine.

VERTICAL MILLING MACHINE
SAMPLE REVIEW QUESTIONS

Multiple Choice Review Questions

1. Before leaving any machine that is in operation you must:
   a) reduce the speed
   b) slow down the feed
   c) reverse the feed
   d) stop the machine

2. The safest way to clean metal cuttings from a milling machine is:
   a) with a brush
   b) pick the chips up with your hands
   c) with compressed air
   d) with a clean cloth

3. When measuring the work-piece on a milling machine, the cutter must at a safe distance away from the work piece in order to prevent:
   a) damage to the milling cutter
   b) damage to the work-piece
   c) injury to your arm or hand
   d) damage to the measuring instruments

4. You should remove rings and wrist watches before operating any machine because they may:
   a) damage the work-piece
   b) get damaged
   c) get caught on moving parts
   d) all the above

5. You should not attempt to operate any machine until you have had:
   a) the drawing checked
   b) your tools checked
   c) proper instructions
   d) the material checked

6. Safety glasses shall be worn at all times to protect your eyes from:
   a) flying chips
   b) dangling hair
   c) strong light
   d) eye strain

Answer key to review questions.

1. d
2. a
3. c
4. c
5. c
6. a

ENGINE LATHE

ENGINE LATHE:
Used mainly for turning cylindrical shaped work-pieces.

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures:

- Safety glasses shall be worn when operating the lathe.
- Do not operate the lathe without proper instructions from your instructor.
- Do not operate the lathe until you are familiar with all the controls and levers.
- To avoid injury only one person should operate a machine at anytime. Observers should be at a safe distance.
- Ensure that the lathe has a start/stop button within easy reach of the operator.
- Remove the chuck key before turning on the lathe.
- Ensure that the headstock, tailstock, tool and tool holder are properly secured before operating.
- Ensure your material is secure in the chuck before switching on the machine.
- Ensure all tool bits are sharp and properly secured at the correct height and location before attempting to remove any material from the work piece.
- Do not operate the lathe until you have obtained the proper speeds and feeds for the type of material to be machined.
- Ensure you have the proper cutting tool for the type of material and type of machining operation to be performed.
- Do not lean on the lathe while it is in operation
- Ensure that your body is located to the side of the cutting tool while it is in operation.
- Be sure to have a firm footing or stance when operating the lathe.
- Do not attempt to remove a large depth of cut from material at a single pass.
- When turning a small diameter work piece over a long length, use a work steady attachment and a rotating centre.
- When turning a work piece that overhangs 4 inches or more from the chuck, a rotating centre must be used to secure the work piece to avoid it from slipping out of the chuck.

Specific Hazards

- To avoid any injury no loose clothing, rings, watches or any other jewelry should be worn when operating the lathe.
- To avoid any injury stop the lathe and move the tool to a safe location before taking any measurements on the work piece.
- Keep the floor around the lathe clean and clear of tools, oil and metal chips.
- Turn the lathe off immediately if you hear any unusual sound or if there is excessive vibration.
- Remove cut off material or metal chips with a brush ***never*** use your hands.
- Compressed air should ***never*** be used to clean the lathe.

ENGINE LATHE REVIEW QUESTIONS

1. When checking the work-piece on a lathe, the point of the tool bit must be at a safe location in order to prevent:
   a) damage to the tool bit
   b) damage to the work-piece
   c) injury to your arm or hand
   d) damage to the measuring instruments

2. To avoid injury the safest way to clean a lathe is:
   a) with a brush
   b) pick the chips up with your hands
   c) with compressed air
   d) with a piece of cloth

3. Never leave the chuck key in the chuck because; if the machine is switched on the key will fly out and:
   a) damage the work-piece
   b) damage the chuck and key
   c) may cause injury to yourself and others
   d) all of the above

4. To avoid serious injury, never wear loose clothing, rings, and watches when operating a lathe because, they may:
   a) get damage by the rotating part
   b) get caught by the rotating part
   c) damage the work-piece
   d) all of the above

5. You should wear safety glasses when machining on the lathe in order to:
   a) prevent injury to the eye
   b) keep smoke out of the eyes.
   c) keep dust out of the eyes
   d) all of the above

6. You should never attempt to operate any machine until you have had:
   a) the speed and feed checked
   b) your tools checked
   c) proper instructions
   d) the material checked

Answer key to the review questions.

1. c
2. a
3. c
4. b
5. a
6. c

CNC MILLING MACHINE

CNC: *Computer Numerical Control (Milling) - Computerized controlled and used for facing, end milling and drilling operations.*

Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

- Safety glasses shall be worn when operating the CNC milling machine.
- Ensure that the work-piece, the work holding device and cutting tool are securely mounted before taking a cut.
- Before operating the CNC milling machine you should be properly trained in it's safe setup and operation.
- Ensure that the CNC milling machine has a start/stop button within easy reach of the operator.
- Keep the working area clean and clear of tools and metal chips.
- Do not attempt to take large depths of cuts from the material at one pass.
- Consideration should be given to the type of materials used for work-pieces.
- Make sure that the work-piece size is within the limits of the machine traverse.
- When setting up or removing a milling cutter from its holder, proper precaution should be taken to avoid any injury.
- Never attempt to make any adjustments or measurements to the work-piece set-up until the CNC milling machine has completely stopped.
- Move table as far as possible from cutter while setting up work to avoid injuring your hands.
- Do not attempt to setup, measure or adjust work-piece until the cutter is completely stopped.
- Do not use excessively heavy cuts or feeds as it can cause the cutter to break.

Specific Hazards

- Use a brush ***only*** to clean metal cutting from work-piece once the cutter has stopped rotating.
- While machine is in operation keep hands away from the rotating cutter.
- Do not use a blunt or chipped cutter to machine work-piece.
- Keep hands, and rags away from the rotating milling cutter.
- Keep floor around the milling machine free of oil and grease.
- Make sure the cutting tool is properly tightened in the holder.
- Make sure that the work is properly secured in place before attempting to remove any material from the work-piece
- Do not leave the machine unattended while it is running.
- Ensure that all guards are in place before operating the machine.

CNC LATHE

CNC: *Computer Numerical Control (Lathe) - Computerized controlled and used mainly to turn cylindrical shaped work-pieces.*

Personal Protection Equipment

- Safety glasses
- Coverall/Apron
- Protective footwear

Operating Procedures

- Safety glasses shall be worn when operating the CNC lathe.
- Do not attempt to operate the CNC lathe without proper instructions from your instructor.
- Ensure that the CNC lathe has a start/stop button within easy reach of the operator.
- Do not operate the CNC lathe until you are familiar with all the controls.
- Ensure your material is secure in the chuck before switching on the machine.
- Ensure all tool bits are sharp and properly secured at the correct height and location before attempting to remove any material from the work-piece.
- Do not operate the CNC lathe until you have obtained the proper cutting speeds and feeds for the type of material to be machined.
- Ensure you have the proper cutting tool for the type of material and type of machining operation to be performed.
- Do not lean on the lathe while it is in operation and ensure that your body is located to the side of the cutting tool while it is in operation.
- Be sure to have a firm footing or stance when operating the lathe.
- Do not attempt to remove large depth of cut from material at a single pass.
- When turning a work piece that overhangs 4 inches or more from the chuck, a rotating centre must be used to secure the work-piece to avoid it from slipping out of the chuck.

Specific Hazards

- To avoid any injury no loose clothing, rings, watches or any other jewelry should not be worn when operating the CNC lathe.
- To avoid any injury stop the lathe and move the tool to a safe location before attempting to take any measurements on the work-piece.
- Keep the floor around the machine clean and clear of tools, oil and metal chips.
- Turn off the machine immediately and inform the teacher if you hear any unusual sound or if there is excessive vibration**.**
- Remove metal chips with a brush ***never*** use your hands.
- Compressed air should ***never*** be used to clean the CNC lathe.

MACHINERY SAFETY SHEET

CONTRACT SIGNATURES

I have my copy of the safety contract and operation guidelines for the following machine:

_____

I was present for the lesson, understand its meaning and will operate the above mentioned machine in the safe manner described and taught in the lesson.

Date_____ Grade _____ Course: _____

STUDENT SIGNATURES

1.	12.
2.	13.
3.	14.
4.	15.
5.	16.
6.	17.
7.	18.
8.	19.
9.	20.
10.	21.
11.	22.

ABSENT STUDENTS

1.	4.
2.	5.
3.	6.

ANGLE GRINDER

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Hearing Protection
- Dust Mask
- Face Shield
- Protective Footwear
- Apron/coverall

Operating Procedures

- Safely glasses shall be worn when using the grinder.
- Gloves should not be worn when operating equipment.
- Only one person operates the grinder; observers at a safe distance.
- Operate only after you have received instruction.
- Make sure the guards are in place and operating properly before you begin work.
- Always disconnect power when mounting new disc wheel.
- Always stand to one side when starting the grinder, especially with a newly mounted wheel.
- Keep all cords clear of the cutting area during use.
- Inspect cord for damage before each use.
- Use light pressure when starting the grinder, especially with a cold wheel.
- Keep a solid grip of the grinder at all times, especially when starting up, the high speed motor has a tendency to ”torque” out of your hands.

Specific Hazards

- Remove jewellery, eliminate loose clothing, and confine long hair.
- Keep the work area and floor clean and free of oil and grease.
- Don’t use grinders in the vicinity of flammable materials.
- Be aware of the direction of the sparks from the grinder.
- Be aware of sparks and bits of metal that fly off as you grind.

BANDSAW

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Push Stick
- Protective Footwear
- Apron/coverall

Operating Procedures

- Safety glasses shall be worn when operating the bandsaw.
- Be sure that all guards are in place.
- Gloves should not be worn when operating equipment.
- Operate only after you have received instruction.
- One person at a time operates the machine, observers at a safe
- distance.
- The blade guard must not be more than ¼" (6mm) above the work.
- Ensure blade is under proper tension.
- Ensure the correct blade is being used for the job.
- Keep hands on either side of the blade never in front of the blade.
- Keep work flat on the table.
- Wait for the band saw to come to full speed before starting a cut.
- Always use a push stick to feed work into blade.
- Do not force a cut; always use a smooth, slow feed into the blade.
- Do not make small radius cuts, if necessary make relief cuts first.
- If the blade breaks, shut off the power and stand clear until the wheels stop turning.

Specific Hazards

- Any exposed saw blade can cause serious injury.
- Keep the work area and floor clean and free of oil and grease.
- Remove jewellery, eliminate loose clothing, and confine long hair.
- Covers must be closed over rollers and moving parts.
- Excessive force when pushing work into blade may cause you to slip into saw blade and cause serious injury. Maintain your balance in all circumstances.
- Turn the power off to remove scrap or wedged pieces from the saw block area.
- Never leave the machine running unattended.

BANDSAW SAFETY QUIZ

1. When operating a bandsaw you should always wear _____.
2. The bandsaw blade must not be more than ¼" above the _____.
3. Ensure the bandsaw blade is under proper _____ before starting.
4. Keep hands on either side of the blade never in _____.
5. Never use _____ force when pushing the work into the blade this may cause serious injury.
6. Always use a _____ _____ to feed work into blade.
7. Do not attempt to remove _____ from around the blade while bandsaw is running.
8. Never leave machine running _____.
9. Keep floor area _____ and free of _____ or _____.
10. If the blade breaks shut off the _____ and stand clear.

Word Bank

excessive	push	scrap	front
clean	power	work	unattended
safety glasses	grease	stick	oil
tension			

HORIZONTAL BAND SAW

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Gloves for material handling only.
- Protective Footwear
- Apron/coverall

Operating Procedures

- Safety glasses shall be worn when operating the horizontal band saw.
- Operate only after you have received instruction.
- Be sure that all guards are in place and operating correctly.
- Gloves should not be worn when operating equipment.
- One person at a time operating the machine, observers at a safe distance.
- If the material requires coolant, be sure that the system is working and that the correct coolant is used.
- Place material in the vise, supporting long pieces with a floor stand.
- Lower the saw blade until it just clears the work. Keep it in this position by closing the hydraulic valve.
- Adjust the roller guide brackets until they just clear both sides of the material to be cut.
- Hold a steel rule against the edge of the saw blade and move the material until the correct length is obtained.
- Tighten the vise and recheck the length from the blade to the end of the material to make sure work has not moved. Always allow 1.5mm for each 25mm thickness you are cutting.
- Raise the frame slightly so the blade is off the work, open the hydraulic feed lever and then start the machine.
- Lower the blade slowly until it just touches the work, adjust feed rate so blade does not bounce or plunge into work when starting the cut.
- Keep hands away from cutting area and brush away chips only when the machine is turned off.
- When the cut has been completed, the machine will shut off automatically.

Specific Hazards

- Remove jewellery, eliminate loose clothing, and confine long hair.
- Keep the work area and floor clean and free of oil and grease.
- Never attempt to mount, measure, or remove work unless the saw is stopped.
- Guard long material at both ends to prevent anyone from coming in contact with it or tripping over it.
- When sawing thin pieces, hold the material flat in the vise to prevent the saw teeth from breaking.
- When holding short work in a vise, be sure to place a short piece of the same thickness in the opposite end of the vise. This will prevent the vise from twisting when it is tightened.

BENCH AND PEDESTAL GRINDER

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Protective Footwear
- Apron/coverall
- Respiratory protection may be required depending on work.

Operating Procedures

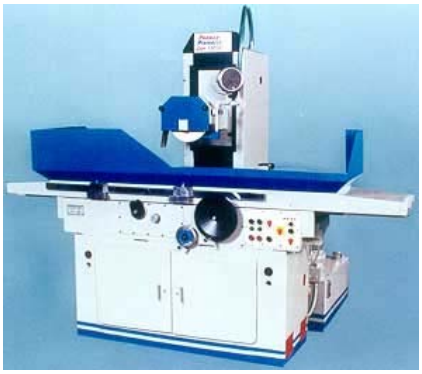
- Safety glasses shall be worn when using a grinder.
- Gloves should not be worn when operating equipment.
- One person at a time operates the machine, observers at a safe distance
- Operate only after you have received instruction.
- Adjust tools rests so they are within 1/16” of an inch of the wheel.
- Always stand to one side of the wheel when starting a grinder. Never in line with the grinding wheel.
- Allow a new wheel to run for about one minute before grinding.
- Make sure eye shields are in place.
- Bring work slowly into contact with grinding wheel.
- Move the work back and forth across the face of the wheel to prevent grooves in the wheel.
- Dress the wheel frequently to keep the wheel smooth.
- Ensure there is ample water for cooling material located at the machine.

Specific Hazards

- Remove jewellery, eliminate loose clothing, and confine long hair.
- Keep the work area and floor clean and free of oil and grease.
- Never leave the machine running unattended
- Keep your head well back from revolving parts to prevent your hair from being caught.
- Excessive gap between grinding wheel and tool rest could cause serious injury to fingers or hands.
- When grinding metal it will get hot you will need to cool metal in water to prevent burns.
- Be aware of sparks that may ignite a fire if contacted with a flammable or combustible material (e.g., paper, oil).
- Do not grind non metal materials as they will clog up the grinding wheel.
- Do not grind on the side of the wheel.

HORIZONTAL SPINDLE RECIPROCATING SURFACE GRINDER

Uses: For grinding flat surfaces.



Personal Protection Equipment (PPE) Requirements

- Safety glasses
- Apron/Coveralls
- Safety Shoes

Operating Procedures

- Ensure you are dressed properly. (PPE – safety glasses, apron/coveralls and safety shoes).
- Avoid horseplay.
- Housekeeping – maintain a clean workspace.
- Safety glasses (with side shields) shall be worn.
- Never run a grinder faster than the recommended speed.
- Ensure the wheel guard is in place and it covers 1/2 of the wheel.
- Clean the magnetic chuck.
- Dress the wheel.
- Remove all burrs from the work piece using a file.
- Ensure the magnetic chuck is on and it holds the work piece.
- The work piece must clear the grinding wheel by 3 cm at each end. This is done by positioning the table reverse dog.
- Position the wheel so that it is 1 mm above the work piece.
- Move the table so that the grinding wheel overlaps the work piece.
- Start the wheel and bring it into contact with the work piece until sparks can be seen.
- Raise the grinding wheel 0.1 mm and move the table so the work piece clears the grinding wheel.
- Lower the grinding wheel by 0.1 mm.
- Engage the automatic feed.
- Rough grind, then use a dress grinding wheel and a finish grinding wheel.

Specific Hazards

- Test the wheel to see it is not cracked.
- Select the proper wheel for the job.
- Always use the correct speed.
- Check the magnetic chuck for nicks and burrs.

HORIZONTAL SPINDLE RECIPROCATING SURFACE GRINDER (Continued)

Websites for more information on safety
www.fttweb.com
www.TheMarlinCompany.com
www.centurymachinery.com

REVIEW QUESTIONS (Example)

1. How can you test that the work is secured on the magnetic chuck?

_____
_____
_____
_____

DRILL PRESS

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Protective Footwear
- Apron/coverall

Operating Procedures

- Safety glasses shall be worn when operating the drill press.
- Gloves should not be worn when operating equipment.
- One person at a time operates the machine, observers at a safe distance
- Operate only after you have received instruction.
- Measure the drill to be sure that it is the correct size especially if the hole is to be reamed or tapped.
- Clamp the work properly to prevent inaccurate work and accidents.
- Always use a sharp drill correctly ground for the material being drilled.
- Remove the chuck key before starting the drill press.
- Set the drill press to the proper speed and feed. Forcing or trying to feed too quickly can cause drills to break with the chance of serious injuries.
- If the drill sticks in the work, stop the motor and rotate the drill by hand to free it from the work.
- Always ensure that the machine has come to a **COMPLETE STOP** and has been switched off before you attempt to change the belt for speed regulation.
- File or scrape all burrs from drilled holes.
- Always clear away chips and curls with a **HAND BRUSH** – not your hands.

Specific Hazards

- Remove jewellery, eliminate loose clothing, and confine long hair.
- Never attempt to set speeds, adjust or measure the work until machine is completely stopped.
- Keep the work area and floor clean and free of oil and grease.
- Never leave a chuck key in the drill chuck at anytime.
- Always use a brush to remove chips only when the machine is off.
- Never leave machine running unattended.
- Never attempt to hold work by hand. Use a clamp or table stop to prevent work from spinning.
- Keep your head well back from revolving parts to prevent your hair from being caught.
- Ease up on the drilling pressure as the drill breaks through the work piece.
- Always remove burrs with a file from a hole that has been drilled.

DRILL PRESS SAFETY QUIZ

1. When operating a drill press you should always wear _____.
2. While operating a drill press you should confine _____.
3. The work piece should be _____ before drilling to prevent any accidents.
4. Forcing a drill into the work can cause the drill to _____.
5. Before changing speeds or drills always make sure the drill press comes to a complete _____.
6. Never clear metal chips with your _____ always use a _____.
7. Never attempt to hold your work piece by _____ when drilling.
8. Never leave the _____ _____ in the spindle.
9. Keep your _____ back from revolving parts.
10. Always remove _____from a hole that has been drilled.

Word Bank

Brush	Break	Stop	Clamped
Head	Chuck	Burrs	Key
Safety glasses	Hand	Long Hair	Hands

POWER DRILL AND CORDLESS DRILL

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Hearing Protection
- Protective Footwear
- Apron/coverall

Operating Procedures

- Safety glasses shall be worn when operating a drill.
- Gloves should not be worn when operating equipment.
- One person at a time operates this tool, observers at a safe distance
- Operate only after you have received instruction.
- Select the proper drill bit or attachment suitable for the size of the drill and
- the work being done.
- Always disconnect power when mounting or changing drill bits.
- Ensure the drill bit or attachment is properly seated and tightened in the chuck.
- Keep drill bits sharp.
- Tighten the chuck securely and remove the chuck key before starting the drill.
- Keep all cords clear of the cutting area during use. Inspect cord for damage
- before each use.
- Secure work piece being drilled to prevent movement.
- Operate the drill at the correct speed for the diameter of the drill bit.
- Slow down the rate of feed before breaking through the surface.
- Always centre punch location of the hole when drilling into metal.
- Always drill a small pilot hole before drilling large holes.

Specific Hazards

- Remove jewellery, eliminate loose clothing, and confine long hair.
- Keep the work area and floor clean and free of oil and grease.
- Keep a solid grip of the drill at all times, especially when starting up, the high speed motor has a tendency to" torque" out of your hands.
- High speed steel (H.S.S.) drill bits may require cooling or lubrication.
- Do not attempt to free a jammed drill bit by starting and stopping the drill. Unplug the drill and then remove the bit from the work piece.
- Always maintain proper footing and balance.
- Do not raise or lower or carry the drill by its power cord.
- Avoid wet or damp areas with the power cord.
- Use less force to drill into hard metal and reduce drill speed.

RADIAL DRILL PRESS

Personal Protection Equipment (PPE) Requirements

- Safety Glasses
- Protective Footwear
- Apron/coverall

Operating Procedures

- Safety glasses shall be worn when operating the radial drill press.
- Gloves should not be worn when operating equipment.
- One person at a time operates the machine, observers at a safe distance.
- Operate only after you have received instruction.
- Measure the drill to be sure that it is the correct size especially if the hole is to be reamed or tapped.
- Clamp the work properly to prevent inaccurate work and accidents.
- Always use a sharp drill correctly ground for the material being drilled.
- Align the drill bit to your spot mark on work piece by moving the arm and the drill head.
- Clamp the radial arm and drilling head before starting to drill.
- Set the drill press to the proper speed and feed.
- If the drill sticks in the work, stop the motor and rotate the drill by hand to free it from the work.
- Always ensure that the machine has come to a **COMPLETE STOP** and has been switched off before you attempt to change the belt for speed regulation.
- File or scrape all burrs from drilled holes.
- Always clear away chips and curls with a **HAND BRUSH** – not your hands.

Specific Hazards

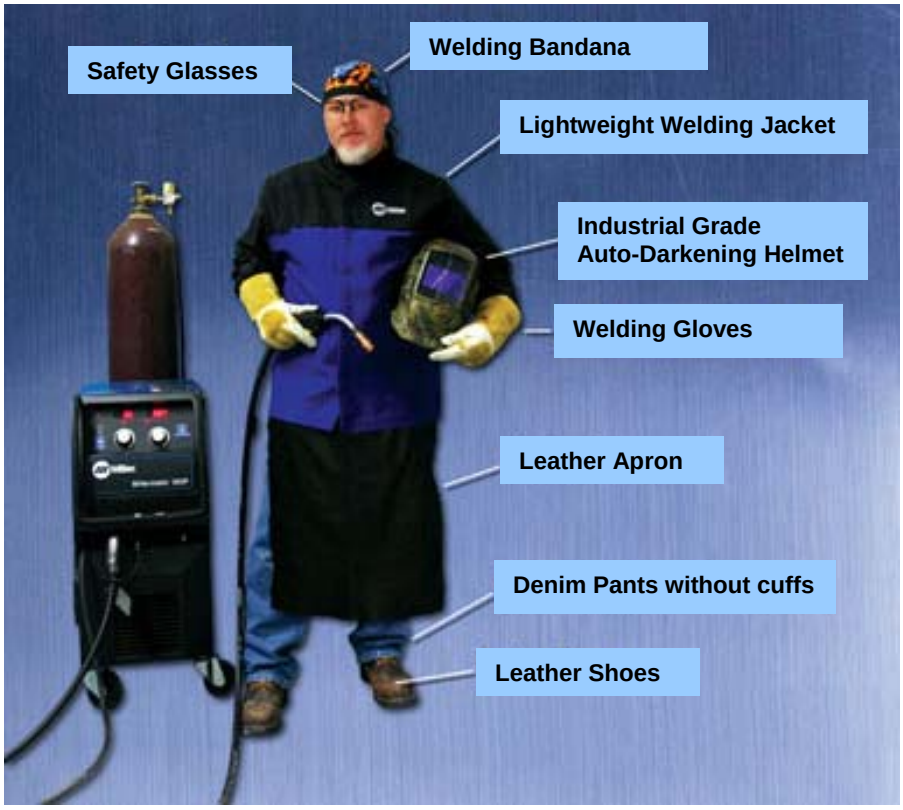
- Remove jewellery, eliminate loose clothing, and confine long hair.
- Never attempt to set speeds, adjust or measure the work until machine is completely stopped.
- Keep the work area and floor clean and free of oil and grease.
- Never leave a chuck key in the drill chuck at anytime.
- Always use a brush to remove chips only when the machine is off.
- Never leave machine running unattended.
- Never attempt to hold work by hand. Use a clamp or table stop to prevent work from spinning.
- You must clamp the radial arm and the drill head before drilling to prevent drill or work from breaking. The head will vibrate and chatter and may cause operator injury.
- Keep your head well back from revolving parts to prevent your hair from being caught.
- Ease up on the drilling pressure as the drill breaks through the work piece. This will prevent the drill from pulling into the work and breaking.
- Always remove burrs with a file from a hole that has been drilled.

WELDING

Personal Protection Equipment (PPE) Requirements

- Always wear cotton clothing; the shirts should be buttoned up to the neck, long sleeves and no open pocket.
- Welding helmet, with proper lens shade for the process.
- Safety glasses should be worn under the helmet.
- Welder's cap or bandana, to protect the welder from sparks that can get behind the welding helmet and into the welder's hair.
- Gloves, of strong leather, with long gauntlets to protect the hands and wrists from arc rays.
- Fire resistant leather apron, jacket or coveralls, should be worn to protect the welder from sparks, heat and light, that is given off during the welding process.
- High safety shoes with steel toes should be worn.

SAFETY WEAR



Courtesy ww.millerwelds.com/educational/articles/images

WELDING (Continued)

Operating Procedures

Start-up Procedures

- Obtain instructions and the teacher's permission before operating any Welding Equipment.
- Check the condition of the workstation, welding equipment, and personal protective equipment.
- Put up adequate screening to protect people in the immediate area.
- Ensure proper ventilation.
- Make sure all connections are correctly attached.
- Check for gas leakage

Shut-down Procedures

- Carefully remove and cool all hot welding materials.
- Turn off power supply to the welding unit.
- Hang all cables and store away all equipment.
- Clean up work station.
- Turn off gas lines.

ALWAYS KNOW THE LOCATION OF THE NEAREST FIRE EXTINGUISHER, FIRE EXIT, FIRE BLANKET, AND FIRE ALARM, BEFORE YOU START WORKING

Websites for more information on safety:
www.lincolnelectric.ca
www.aws.org
www.naddonline.org

REVIEW QUESTION (Example)

List 4 pieces of safety equipment a welder should wear, by filing in the blanks.

a) Welding h _ _ m _ t

b) S _ fe _ _ gl _ s _ es

c) Welder's c _ p or b _ nd _ n _

d) L _ at _ er ap _ _ n

OXYACETYLENE WELDING (OAW)

OAW is also known as **oxyfuel welding** or **gas welding.**

Personal Protection Equipment (PPE) Requirements

- Safety glasses shall be worn at all times and must fit under your welding tinted safety goggles
- Welding tinted safety goggles (welding goggles with flip-up cover)
- Welder's cap or bandana
- Leather gloves
- Leather apron, jacket or coverall
- High safety boots

Operating Procedures

- Obtain instructions and the teacher's permission before operating any welding equipment.
- Insure you are dressed properly. [PPE – welding helmet and cap or bandana, safety glasses, leather gloves, leather apron, and safety shoes).
- Ensure your workspace is dry.
- Remove all flammable materials from around your workspace.
- Ensure fire fighting materials are close at hand (fire extinguisher, water, and fire blanket)
- Know the location of all exits and fire alarms.
- Remove the protective cap from the oxygen and acetylene cylinders and crack the cylinder valve (ensure the outlet is facing away from you) to clear dust or moisture.
- Check the threads on the oxygen and acetylene cylinders, and the regulator nuts.
- Oxygen regulators have right-hand threads and plain nuts; while, acetylene regulators have left-hand thread and grooved nuts.
- The oxygen hose is green with right-hand threads and plain nuts; and, the acetylene hose is red with left-hand threads and grooved nuts. Connect the hoses to the regulator and blow them out to remove dust by opening the valves 1½ turns for 5 seconds.
- Assemble the torch to the hose.
- Check for leaks. (Use soap and water and apply with a brush)
- Turn on the acetylene valve 1/4 turn and light and with a flint lighter.
- Adjust the needle valve of the acetylene regulator by turning in a counter-clockwise direction until a red flame can be seen that is free from smoke.
- Adjust the needle valve of the oxygen regulator by turning in a counter-clockwise direction until the flame changes from a red to blue.

Specific Hazards

- Ensure proper ventilation.
- Never cut into a sealed container
- Oil or grease should never come in contact with oxygen cylinders.
- Compressed oxygen should never, be used as compressed air to blow out dirt or clean clothing.
- Defective equipment must be reported to the instructor immediately and should not be used.

OXYACETYLENE WELDING (Continued)

- Always chain oxygen and acetylene cylinders in an upright position; and, in a safe location when not in use. Ensure the protection caps are on to protect the valves and keep them clean.
- The caps must not be taken off when moving from one location to another.
- Oxygen cylinders should be stored away from cutting, welding tools and electrical equipment.
- Store and mark empty and full cylinders separately.

ALWAYS KNOW THE LOCATION OF THE NEAREST FIRE EXTINGUISHER, FIRE EXIT, FIRE BLANKET, AND FIRE ALARM, BEFORE YOU START WORKING.

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REVIEW QUESTIONS (Example)

Fill in the blanks by writing the technical terms on the right in the correct spaces.

1. The hose used for oxygen is _____. (red / left-hand)
2. The regulator nut for the acetylene valve is _____. (plain / green)
3. Acetylene regulators have _____ _____ threads. (counter-clockwise / right)

SHIELDED METAL ARC WELDING (SMAW)

SMAW is also known as arc welding, stick welding, and stick electrode welding.

Personal Protection Equipment (PPE) Requirements

- Welding helmet
- Safety glasses
- Welder's cap or bandana
- Leather gloves
- Leather apron, jacket or coveralls
- High safety shoes

Operating Procedures

- Obtain instructions and the teacher's permission before operating any welding equipment.
- Ensure you are dressed properly. (PPE – welding helmet and cap or bandana, safety glasses, leather gloves leather apron, and safety shoes).
- Locate the welding power supply and know where the power switch to the unit is located. In case of an emergency the machine can be shut off.
- Ensure the area around the machine and your workspace is dry.
- Remove all flammable materials from around your workspace.
- Ensure fire fighting materials are close at hand (fire extinguisher, water, and fire blanket).
- Set the welding polarity and current on the welding machine.
- Set out the welding cable and attach the lead to the work securely.
- Make sure you have an empty container at hand for the stubs.
- Select the electrode for your job.
- Turn on the machine, then insert the electrode in the holder; flip down your helmet, strike an arc and begin to weld.

Specific Hazards

- SMAW should not be done in rain or snow; or when the base metal is below -20 degrees Celsius.
- Remove all jewellery from your person before welding.
- Never strike an arc on a compressed gas cylinder.
- Never weld where gas cylinders are stored.
- Never weld while standing on a wet floor.
- Don't use defective welding equipment.
- Don't work in areas with poor ventilation.
- Don't weld parts that are coated with zinc or aluminum.
- Remove all combustible materials from your workspaces before welding.
- Do not weld on any container suspected of holding flammable substances.

ALWAYS KNOW THE LOCATION OF THE NEAREST FIRE EXTINGUISHER, FIRE EXIT, FIRE BLANKET, AND FIRE ALARM, BEFORE YOU START WORKING

SHIELDED METAL ARC WELDING (Continued)

Websites for more information on safety
www.lincolnelectric.ca
www.aws.org
www.naddonline.org

REVIEW QUESTIONS (Example)

Underline the best answer below each question.

1. How can a person receive an electric shock while welding?

   a) Welding without gloves
   b) Holding the electrode]
   c) Standing in water
   d) Touching the welding machine

GAS METAL ARC WELDING (GMAW)

GMAW is also known as MIG or wire feed welding

Personal Protection Equipment (PPE) Requirements

- Welding helmet
- Safety glasses
- Welder's cap or bandana
- Leather gloves
- Leather apron, jacket or coveralls
- High safety shoes

Operating Procedures

- Obtain instructions and the teacher's permission before operating any welding equipment.
- Ensure you are dressed properly. (PPE – welding helmet and cap or bandana, safety glasses, leather gloves leather apron, and safety shoes).
- Locate the welding power supply and know where the power switch to the unit is located. In case of emergency the machine can be shut off.
- Ensure the area around the machine and your works pace are dry.
- Remove all flammable materials from around your workspace.
- Ensure fire fighting materials are close at hand.
- Set the power supply and adjust the voltage and current
- Check the wire feeder, and the wire feeding gun; ensure you are using the proper shielding gas, and, electrode filler wire.
- Turn on the power switch on the welding machine and squeeze the button on the gun for a few seconds, to remove any air from the hose and fill it with the shielding gas.
- Feed the wire and ensure the proper tension on the feed rolls. (Manufacturer's information on data sheet attached to the machine)
- Adjust the shielding gas
- Attach the lead on the work piece.
- Set the wire speed by adjusting the amperage control, the arc voltage and amperage can be fine tuned by running a bead on a piece of scrap metal.
- The electrode must not stick out more than 1 cm from the gun.
- Aim the gun and put your welding helmet on; touch the work piece hold the gun at an angle between 5 and 10 degrees, from the vertical position.
- Squeeze the trigger on the gun, and begin to weld

Specific Hazards

- SMAW should not be done in rain or snow; or when the base metal is below -20 degrees Celsius.
- Remove all jewellery from your person before welding.
- Never strike an arc on a compressed gas cylinder.
- Never weld where gas cylinders are stored.

GAS METAL ARC WELDING (Continued)

- Never weld while standing on a wet floor.
- Don't use defective welding equipment.
- Don't work in areas with poor ventilation.
- Don't weld parts that are coated with zinc or aluminum.
- Remove all combustible materials from your workspaces before welding.
- Do not weld on any container suspected of holding flammable substances.

ALWAYS KNOW THE LOCATION OF THE NEAREST FIRE EXTINGUISHER, FIRE EXIT, FIRE BLANKET AND FIRE ALARM, BEFORE YOU START WORKING

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REVIEW QUESTIONS (Example)

Write **T** (True) or **F** (False) in the space provided next to each question.

1. All exposed skin must be covered because ultraviolet rays can burn the skin. (___)

2. Lens shade #8 is worn for GMAW. (___)