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Background

The Tools4Work resource and delivery materials are based on the most appropriate Unit Standards for schools.

Other Unit Standards are required to complete the Mechanical Engineering Level-2 National Certificate.

- US 2430 **Draw and Interpret Sketches**
- US 2432 **Construct Engineering Plane Geometric Shapes**
- US 20917 **Demonstrate Basic Knowledge of Engineering Materials**
- US 21905 **Demonstrate Knowledge of Trade Calculations and Units for Mechanical Engineering Trades**
- US 21908 **Demonstrate Knowledge of Basic Mechanics for Mechanical Engineering Trades**

- US 2387 ***Assemble Mechanical Components Under Supervision***
- US 2395 ***Select, Use and Care for Engineering Hand Tools***
- US 2396 ***Select, Use and Maintain Portable Handheld Engineering Power Tools***
- US 4433 ***Select, Use and Care for Simple Measuring Devices Used in Engineering***
- US 4435 ***Select, Use and Care for Engineering Dimensional Measuring Equipment***
- US 4436 ***Select, Use and Care for Engineering Marking-out Equipment***
- US 21911 ***Demonstrate Knowledge of Safety on Engineering Sites***



Special thanks to Chevpac Machinery for supplying the tooling and machinery pictures used in the Tools4Work Information Sheets and other delivery resources.

Resource Delivery Material

The Tools4Work Mechanical Engineering Level 2 resource and delivery materials include the following types of documents;

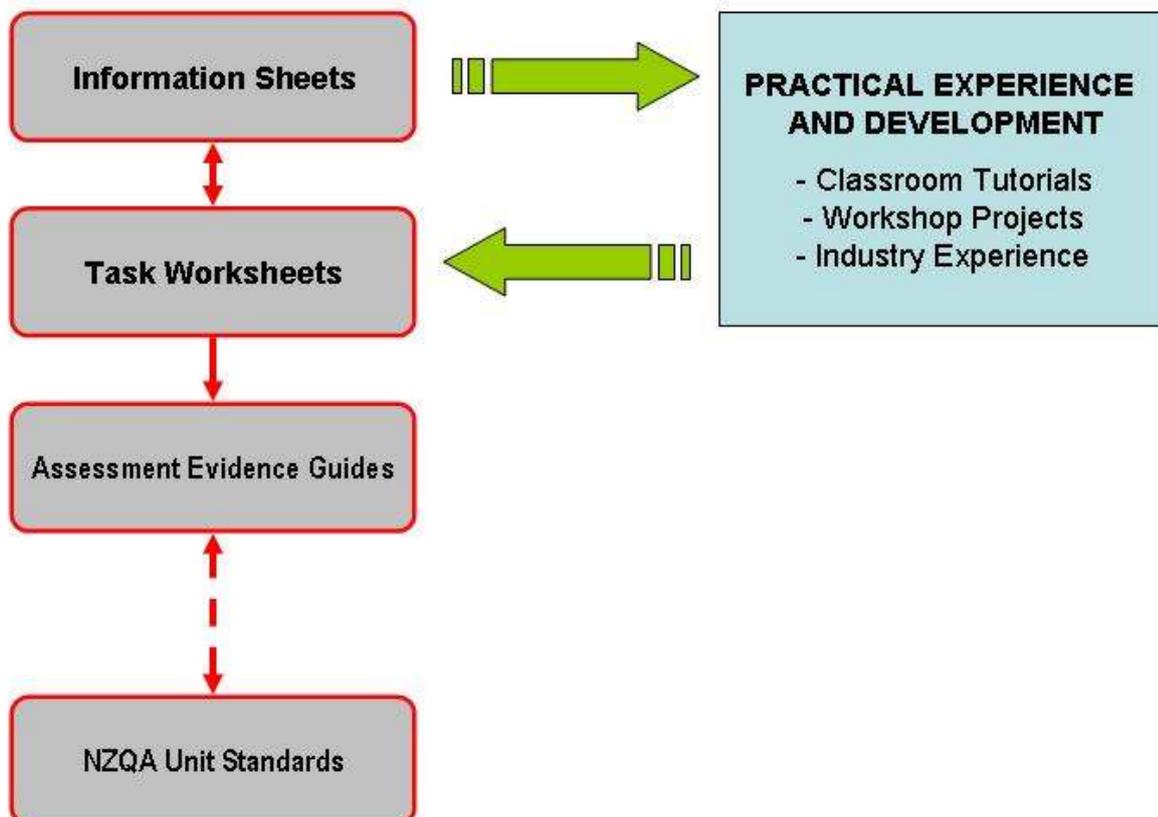
Information Sheets are provided as a starting point for gaining essential technical information for your investigations and learning experiences.

Task Worksheets are provided as a place to document your activities and to record the knowledge and skills you have gained. The Task Worksheets can be used to provide teachers and tutors with detailed evidence for competency assessment. The student, and in some cases the teacher, tutor or workshop supervisor must sign-off each completed Task Worksheet prior to submission for assessment.

Assessment Evidence Guides are provided as an aid the teacher or tutor when they assessing learning outcomes and the evidence of competency against the requirements listed the Unit Standards. The student and the teacher or tutor must sign-off each of the completed Assessment Evidence Guides, prior to the unit standard credits being reported.

Unit Standards are provided for reference and assessment purposes.

Tools4Work Resource Map



Using the Tools4Work Resources as a Work and Learning Guide

During your time in the classroom, in the workshop and out in industry there will be opportunities to;

- ask questions
- use tools and equipment
- observe and perform engineering processes
- investigate work methods, tools and techniques, and
- explore machinery and equipment

The Tools4Work **Information Sheets** provide the basic information you need to get started. From there, you can use teachers, tutors, engineers, technical books and even the Web as sources of information to help with your work.

The Tools4Work **Task Worksheets** will help to guide you when gathering and recording evidence of the skills and knowledge you have gained from practical engineering tasks and learning experiences.

After completion and sign-off, the **Task Worksheets** can be assessed and used for gaining Unit Standard credits.

The evidence you need to complete the unit standards can be gathered from a variety of sources including;



- Classroom Tutorials



- School Workshop Projects and Activities



Getting Started and Keeping Going

To assist you with planning, organizing and completing your work, the Tools4Work resource materials can be clustered into five basic groups. To help you keep on track, use the **Tools4Work Progress Tracker** on page 10 to mark-off each of your completed unit standards.

DRAWING AND DESIGN

Unit Standard 2430 requires the completion of a range of work involving engineering sketches. The Engineering Sketching Information Sheets (**MEL02INF2430**) provide basic instructions which can be used for completing engineering sketches. The instructions can be applied to jobs in an engineering workshop or used in the classroom during exercises.

Your sketches can be of small or large engineering components or assemblies, and may include hydraulic cylinders, mounting brackets, guards, jigs, duct transitions, pipe joints, bolted flanged joints, turned components, and assemblies of typically not more than five major parts.

Your sketching activities can be recorded using **five or more** Engineering Sketch Worksheets (**MEL02TWS09**), and the worksheets need to be checked and signed-off by your supervisor.

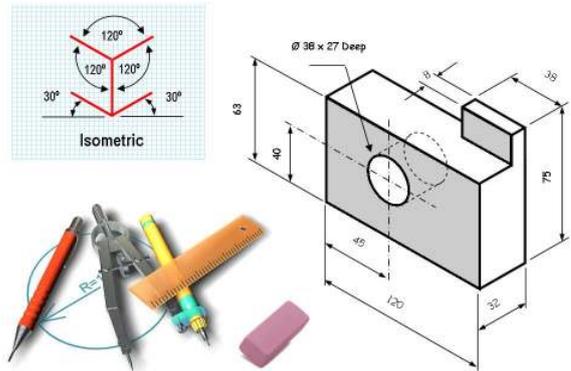
The sketches need to be two-dimensional, and you will need to complete at least **three freehand sketches**, as well as **two aided sketches**, using instruments such as a rule, compass and set squares. The aided sketches need to include the precise calculation of angles and dimensions.

The Engineering Mechanics Task Worksheet (**MEL02TWS04**) and the Engineering Tool Task Worksheet (**MEL02TWS01**) can also be used for your sketching activities.

Your sketches need to use a variety of shapes such as rectangles, circles, ellipses, cylinders, cones and pyramids.

You will need to interpret and make pictorial sketches from orthographic projections, and you will need to interpret and make orthographic sketches from pictorial projections. Your pictorial sketches need to include isometric, oblique and single-point perspective projections. Your completed sketches need to include dimensions and related notes to meet job requirements. To be signed-off, your sketches need to be unambiguous, in proportion, clear, and in compliance with the job requirements.

Unit Standard 2432 requires the construction of a range of geometric plane shapes as well as the bisection of angles and lines. The Geometric Plane Construction Information Sheets (**MEL02INF2432**) provide basic instructions which can be used in the construction of geometric plane shapes. The instructions can be applied in the workshop for lofting or marking-out jobs or in the classroom during exercises



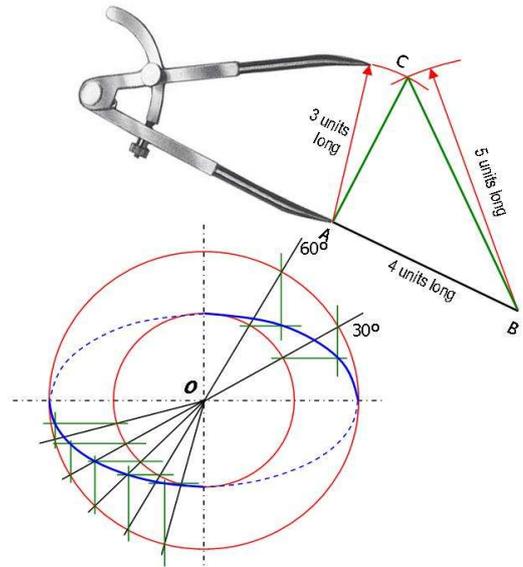
The construction of geometric plane shapes and the related calculations can be recorded on the Geometric Construction Task Worksheet (**MEL02TWS07**).

Any inspections and measurements carried out to check and validate your work can be recorded on the Engineering Measurement Task Worksheet (**MEL02TWS03**).

Any non-conformances and corrective actions taken need to be recorded on the Geometric Construction Task Worksheet (**MEL02TWS07**).

Your geometric plane constructions need to include a variety of shapes such as rectangles, squares, circles, ellipses, tangential arcs, triangles, polygons, and parts thereof.

You will also need to include work involving the bisection of angles and lines, and the division of lines into equal parts.



MATH AND MECHANICS

Unit Standard 21905 requires you to carry out arithmetic, algebraic and trigonometric operations, use tables and graphs, and define and use quantities and units of measure common to mechanical engineering trade calculations.

The Mechanical Engineering Calculations Information Sheets (**MEL02INF21905**) provide basic technical information relating to the fundamental principals of engineering mathematic functions.

The information sheets are the starting point for your investigations and can be applied in industry and the engineering workshop, or in the classroom during exercises.

The Mechanical Engineering Calculations Task Worksheet (**MEL02TWS06**) can be used to record the progress of your work as you investigate the principles and practices of mechanical engineering calculations. The Engineering Mechanics Task Worksheets (**MEL02TWS04**) can also be used to record your learning and to gather evidence for unit 21905.



Unit Standard 21908 requires you to demonstrated knowledge of simple machines, friction and Pascal's Law.

The Engineering Mechanics Information Sheets (**MEL02INF21908**) provide basic technical information relating to the fundamental principals of engineering mechanics.

The information sheets are the starting point for your investigations and can be applied in industry and the engineering workshop when working on machinery and equipment, or in the classroom during exercises.



Seven or more Engineering Mechanics Task Worksheets (**MEL02TWS04**) can be used as a learning guide and to record the progress of your work as you investigate the mechanical principles of engineering machinery. The Engineering Calculations Task Worksheet (**MEL02TWS06**) can also be used to record your learning and to gather evidence for unit 21908

You will need to investigate a range of simple machines including a lever, a wedge, a screw, a pulley, a wheel and axel, and a hydraulic system. The Engineering Mechanics Task Worksheet can be used to record calculations for the machine system, including forces, moments, torque, work and power, and hydraulic pressure. The Engineering Mechanics Task Worksheet for each machine will need to include information on forces and the types of friction in the machine system.

ENGINEERING PRACTICE

Unit Standard 2395 requires you to select, use and care for engineering hand tools.

The Engineering Hand Tools Information Sheets (**MEL02INF2395**) provide basic technical information relating to the selection, use and care of engineering hand tools. The information sheets are a starting point for your practical experiences and investigations.

The information can be applied in industry and the engineering workshop when working on machinery and equipment, or in the classroom during exercises.



Six or more Engineering Tool Task Worksheets (**MEL02TWS01**) can be used as a learning guide and to record the progress of your work as you investigate the range of hand tools used in mechanical engineering. You need to record information relating to **at least three assembly hand tools** and **at least three cutting hand tools**. Measuring and inspection information related to your use of assembly and cutting hand tools can be recorded on **MEL02TWS03**.

Unit Standard 2396 requires you to create a safe worksite and to select, use care for and maintain portable handheld engineering power tools.

The Handheld Engineering Power Tool Information Sheets (**MEL02INF2396**) provide basic technical information relating to the selection, use, care and maintenance of portable handheld engineering power tools, and creating a safe worksite.

The information sheets are a starting point for your practical experiences and investigations. The information can be applied in industry and the engineering workshop when working on components, machinery and equipment, or in the classroom during exercises.



Four or more Engineering Power Tool Task Worksheets (**MEL02TWS13**) can be used as a learning guide and to record the progress of your work as you investigate the range of handheld engineering power tools. Power tools used should include drills, grinders, sanders, brushes, buffs, wrenches (including impact type). Power sources may include mains electric and battery, as well as pneumatic, and/or hydraulic. You should also use the Engineering Measurement Task Worksheet (**MEL02TWS03**) to record the results of measurements taken while using handheld engineering power tools. The inspection records will help to validate your use of the power tools.

Unit Standard 4433 requires you to select, use and care for simple engineering measuring devices.

The Simple Measuring Devices Information Sheets (**MEL02INF4433**) provide basic technical information relating to the selection, use and care of simple measuring devices and tools used in engineering. The information sheets are a starting point for your practical experiences and investigations.

The information can be applied in industry and the engineering workshop when working on components, machinery and equipment, or in the classroom during exercises.



Six or more Engineering Tool Task Worksheets **MEL02TWS01** can be used as a learning guide and to record the progress of your work as you investigate the range of simple measuring devices used in mechanical engineering. You need to record information relating to **at least 6 simple measuring devices** on **MEL02TWS01** and you should also record the results of measurements you take on the Engineering Measurement Task Worksheet (**MEL02TWS03**). These inspection records will help to validate your use of the measuring devices.

Unit Standard 4435 requires you to select, use and care for engineering dimensional measuring equipment.

The Measuring Equipment Information Sheets (**MEL02INF4435**) provide basic technical information relating to the selection, use and care of measuring equipment and instruments used in engineering.

The information sheets are a starting point for your practical experiences and investigations. The information can be applied in industry and the engineering workshop when working on components for machinery and equipment, or in the classroom during exercises.

Four or more Engineering Tool Task Worksheets (**MEL02TWS01**) can be used as a learning guide and to record the progress of your work as you investigate the range of engineering measuring equipment and instruments. You need to record information relating to an external micrometer or depth micrometer and at least three other instruments, such as an internal micrometer, a vernier caliper, dial gauges or dial test indicators (DTI's) or height gauges and surface tables.

You should also record the results of measurements you take on the Engineering Measurement Task Worksheet (**MEL02TWS03**). These inspection records will help to validate your use of the measuring instruments and equipment.



Unit Standard 4436 requires you to select, use and care for engineering marking-out equipment.

The Marking-out Information Sheets (**MEL02INF4436**) provide basic technical information relating to the selection, use and care of marking-out equipment and instruments used in engineering.

The information sheets are a starting point for your practical experiences and investigations. The information can be applied in industry and the engineering workshop or in the classroom during exercises.

Six or more Engineering Tool Task Worksheets (**MEL02TWS01**) can be used as a learning guide and to record the progress of your work as you investigate the range of engineering marking-out tools.

You need to record information relating to **six items** of marking-out equipment, and your work needs to include tasks marking-out the positions of between five and ten equally spaced holes on a given pitch circle diameter (PCD), marking-out relative to a datum, and marking-out from templates. You should also use the Engineering Measurement Task Worksheet (**MEL02TWS03**) to record the results of measurements you take when checking and verifying the marking-out process. The inspection records will help to validate your use of the marking-out tools and equipment.



Unit Standard 2387 requires you to prepare for assembly of mechanical components, assemble mechanical components, and test and store completed assemblies.

The Mechanical Component Assembly Information Sheets (**MEL02INF2387**) provide basic technical information relating to the assembly of mechanical components. The information sheets are a starting point for your practical experiences and investigations.

The information can be applied in industry and the engineering workshop while working on components,



machinery and equipment, or in the classroom during exercises.

The Engineering Assembly Task Worksheets (**MEL02TWS15**) can be used as a learning guide and to record the progress of your work as you assemble mechanical components. Typically this will include levers, bearings, seals, shafts, motors, chains, belts, pulleys, sprockets, frames, fasteners and keys. This could be achieved while working on engine over-head cam drives, and water pump or alternator assemblies. The Engineering Measurement Task Worksheet (**MEL02TWS03**) can also be used to record the results of measurements you take while completing assembly tasks. The inspection records will help to validate your work.

ENGINEERING MATERIALS

Unit Standard 20917 requires you to identify a range of engineering materials types, including their performance characteristics, as well as the criteria for their selection and use.

Five or more Engineering Materials Task Worksheets (**MEL02TWS05**) can be used as a learning guide and to record the progress of your work.

The Engineering Materials Information Sheets (**MEL02INF20917**) provide some technical data and information relating to the basic types of materials used in engineering. The information provided is a starting point for your investigations and can be applied in the workshop for jobs or in the classroom during exercises.

You will need to cover at least **five** common materials such as wood, polymers (rubber and plastic), metal and concrete which are used in common engineering applications such as boat building, bridge construction, precision tools, casts and moulds, and roofing.



HEALTH AND SAFETY

Unit Standard 21911 requires you to demonstrate knowledge of hazards, personal safety, and safety procedures and equipment on engineering worksites.

The Engineering Worksite Safety Information Sheets (**MEL02INF21911**) provide basic information relating hazards, personal safety, and safety procedures and equipment typically used on engineering worksites.

The information sheets are a starting point for your practical experiences and investigations. The information can be applied in industry and the engineering workshop or in the classroom during exercises.

13 or more Engineering Worksite Safety Task Worksheets (**MEL02TWS02**) can be used as a learning guide and to record the progress of your work as you investigate the range of hazards, personal safety requirements, and the safety procedures and equipment used on engineering worksites. You can use the health and safety icon sheets (**MEL02TWS10**) and Safety Information Sheets (**MEL02INF21911**) to help complete your Worksite Safety Task Worksheets.



Planning Your Learning Using the Tools4Work Resources

The table shown below can be used for planning your learning when using the Tools4Work resources.

The resources can be clustered as either complimentary subjects, as a combination of one or more complementary unit standards, or as a series of practical tasks or assignments in the classroom, in the workshop and/or on-the-job;

Subjects	Unit Standard	Unit Credits	Subject Information Resource	Student Worksheets Recommended for Recording Learning and Gathering Assessment Evidence	Assessment Tool
Drawing and Design	2430 Level-2	4	Engineering Sketching MEL02INF2430	5x Engineering Sketching Worksheet MEL02TWS09 <i>Also consider using;</i> - Engineering Mechanics Task Worksheet MEL02TWS04 - Engineering Tool Task Worksheet MEL02TWS01 - Engineering Power Tool Task Worksheet MEL02TWS13 - Engineering Assembly Task Worksheet MEL02TWS15	MEL02AEG2430
	2432 Level-2	3	Geometric Plane Construction MEL02INF2432	>1 Geometric Construction Worksheet MEL02TWS07 <i>Also consider using;</i> - Engineering Measurement Task Worksheet MEL02TWS03	MEL02AEG2432
Math and Mechanics	21905 Level-2	4	Engineering Trade Calculations MEL02INF21905	>1 Engineering Calculations Task Worksheet MEL02TWS06 <i>Also consider using;</i> - Engineering Mechanics Task Worksheet MEL02TWS04	MEL02AEG21905
	21908 Level-2	2	Basic Engineering Mechanics MEL02INF21908	7x Engineering Mechanics Task Worksheet MEL02TWS04 <i>Also consider using;</i> - Engineering Calculations Task Worksheet MEL02TWS06	MEL02AEG21908
Engineering Materials	20917 Level-2	2	Engineering Materials MEL02INF20917	5x Engineering Materials Task Worksheet MEL02TWS05	MEL02AEG20917
Engineering Practice	2387 Level-2	2	Mechanical Component Assembly MEL02INF2387	>1 Engineering Assembly Task Worksheet MEL02TWS15 <i>Also consider using;</i> - Engineering Measurement Task Worksheet MEL02TWS03	MEL02AEG2387
	2395 Level-2	4	Engineering Hand Tools MEL02INF2395	6x Engineering Tool Task Worksheet MEL02TWS01 <i>Also consider using;</i> - Engineering Measurement Task Worksheet MEL02TWS03	MEL02AEG2395
	2396 Level-2		Engineering Power Tools MEL02INF2396	4x Engineering Power Tool Task Worksheet MEL02TWS13 <i>Also consider using;</i> - Engineering Measurement Task Worksheet MEL02TWS03	MEL02AEG2396
	4433 Level-1	2	Simple Measuring Devices MEL02INF4433	6x Engineering Tool Task Worksheet MEL02TWS01 <i>Also consider using;</i> - Engineering Measurement Task Worksheet MEL02TWS03	MEL02AEG4433
	4435 Level-2	3	Engineering Measuring Equipment MEL02INF4435	4x Engineering Tool Task Worksheet MEL02TWS01 <i>Also consider using;</i> - Engineering Measurement Task Worksheet MEL02TWS03	MEL02AEG4435
	4436 Level-2	4	Engineering Marking-out Tools MEL02INF4436	6x Engineering Tool Task Worksheet MEL02TWS01 <i>Also consider using;</i> - Engineering Measurement Task Worksheet MEL02TWS03	MEL02AEG4436
	21907 Level-2	3	Safe Welding under Supervision MEL02INF21907	8x Welding Application Worksheets MEL02TWS08 <i>plus 3x</i> Welding Task Worksheets MEL02TWS12	MEL02AEG21907
Health & Safety	21911 Level-2	1	Engineering Worksite Safety MEL02INF21911	13x Worksite Safety Task Worksheet MEL02TWS02	MEL02AEG21911

Tools4Work Progress Tracker

To help you keep on track use this handy **Progress Tracker** to record each completed unit;

		Start Date	Finish Date	Competent (✓)	
2430	Draw and Interpret Sketches				4
2432	Construct Engineering Plane Geometric Shapes				3
20917	Demonstrate Basic Knowledge of Engineering Materials				2
21905	Demonstrate Knowledge of Mechanical Engineering Trade Calculations				4
21908	Demonstrate Knowledge of Basic Mechanics for Mechanical Engineering				2
2387	Assemble Mechanical Components Under Supervision				2
2395	Select, Use and Care for Engineering Hand Tools				4
2396	Select, Use and Maintain Portable Handheld Engineering Power Tools				4
4433	Select, Use and Care for Simple Measuring Devices Used in Engineering				2
4435	Select, Use and Care for Engineering Dimensional Measuring Equipment				3
4436	Select, Use and Care for Engineering Marking-out Equipment				4
21911	Demonstrate Knowledge of Safety on Engineering Sites				1
21907	Demonstrate and apply knowledge of safe welding procedures under supervision				3

Class:

Date Completed

Total Credits Achieved

Student Name:

Student Signature

Tutors/Assessors Signature:

Comments:

Assessor Stamp

Glossary of Common Terms

Bisect	<i>To divide a line or angle into two equal parts</i>
Burr	<i>A raised edge on a metal part usually created by machining and metal working or repeated mechanical impact</i>
Calibration	<i>The process of using measurement standards to determine the accuracy of a measuring instrument by comparing the output of a measuring instrument against the input value, quantity or attribute</i>
Carbon Steel	<i>Carbon steel is a metal alloy containing mostly iron and quantities of carbon ranging from 0.1 % to 1.3%</i>
COF	<i>Coefficient of Friction is a dimensionless quantity which is used to calculate the force of friction</i>
Datum	<i>A specific point, line or surface of an object used as a primary reference for orientation during measurement, marking-out, drawing or machining operations</i>
DTI	<i>Dial Test Indicator, also known as a dial-gauge or "clock". Used to measure the "run-out" of a flat or circular surface</i>
Elastomer	<i>The scientific definition for rubber material</i>
Ferrous metal	<i>Ferrous metals contain iron and are usually magnetic</i>
Hardened	<i>Hardened steel is used to describe medium or high carbon steel which has been heat treated by quenching and tempering</i>
Imperial	<i>The imperial measurement system is based on the Imperial Units of foot, pound and seconds</i>
Lofting	<i>The practice of marking-out or laying down the form of a mechanical object using an expansive area such as a workshop floor</i>
Moment	<i>Turning effect of a force on a lever</i>
Non-ferrous metal	<i>Non Ferrous metals do not contain iron and are usually non-magnetic</i>
OOS	<i>Occupational Overuse Syndrome- also known as Repetitive Strain Injury (RSI), includes a range of disorders causing pain, discomfort and other sensations</i>
PCD	<i>Pitch Circle Diameter is the common circular centerline used when plotting an array of holes in a flange or other flat surface</i>
Perpendicular	<i>A situation where intersecting lines or surfaces are located at right- angles (90°) to each other.</i>
Pinnings	<i>Small particles of metal which accumulate and clog the cutting surfaces of files</i>
Pitch	<i>The distance between two points, such as the tips of a screw thread i.e. thread pitch</i>
Polymer	<i>Polymer is the scientific name used to describe plastic material and includes a wide range of natural and synthetic materials with a variety of properties and purposes.</i>
PPE	<i>Personal Protective equipment that is used in the workplace to protect a person from harm</i>
Procedure	<i>A procedure is the specification of the series of actions, acts or operations which must be executed in the same manner in order to obtain the same result in the same circumstances</i>
Prohibition Notice	<i>A notice issued by a Health and Safety Inspector prohibiting the use of a machine, process or other source of a hazard</i>
Ratchet	<i>A ratchet is a mechanical device to prevent or restrict motion in one direction while allowing motion in another direction</i>
Swarf	<i>Swarf is the waste shavings and chippings of metal produced during metalworking operations</i>
Tang	<i>The tang is the part of a file or other bladed tool which extends into the handle</i>
Tempered	<i>Tempering is the technique of toughening metals and alloys by a process of heat treatment</i>
Template	<i>A template is an overlay, usually made from metal, plastic or wood, which is used to replicate shapes of mechanical components for repetitive small-run production</i>
Thermoplastic	<i>A thermoplastic is a material which becomes deformable or melts into a liquid when heated, and returns to a solid state when cooled</i>
Thermosetting	<i>Thermosetting plastics are polymer materials which cure to a stronger form with the addition of energy, usually heat</i>
Torque	<i>Torque is measured in newton meters and is another name for a turning moment.</i>

© Competenz - N Z Engineering Food & Manufacturing Industry Training Organisation Inc
Torque is defined by the linear force multiplied by the radius

- Transposition** *The practice of moving a term of the formula from one side of an equation to the other, reversing the sign to maintain equality*
- Vector** *A vector is a quantity that possesses size and direction. Often used to establish the result of more than one force acting on a object*
- Wrench** *A wrench or spanner is a tool used to provide a mechanical advantage in applying torque to turn fasteners such as bolts and nuts or other hard-to-turn items*