# Trade of Plumbing 

# Module 1: Thermal Process and Mild Steel Pipework 

Unit 4: Basic Engineering Phase 2



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## Document Release History

| Date | Version | Comments |
| :--- | :--- | :--- |
| June 2006 | V.1.0 |  |
| $14 / 02 / 14$ | 2.0 | SOLAS transfer |
|  |  |  |
|  |  |  |

## Module 1 -Thermal Process and Mild Steel Pipework

## Unit 4 - Basic Engineering

Duration - 13 hours

## Learning Outcome

By the end of this unit each apprentice will be able to:

- Apply the SI system of measurement to simple formulae and calculations.
- Fabricate basic engineering exercise using hand tools and pedestal drill.

Describe the physical properties of metals and alloys.

## Key Learning Points:

M S.I. Units, basic units, derived units.
M Conversion of values - metres to millimetres etc.
M Formula and calculations - area, volume and capacity.
M Ratios.
M Percentage.
SK Interpretation of drawings.
SK Marking out, dimensioning.
P Planning, communication.
SK Use of hand tools, cutting, filling.
SK Use of pedestal drill, clamping speeds, eye protection.
H Hazards of Metal Swarf.
P Good working practice, working independently.
SC Properties of metals/materials.
SC Properties of metals/alloys used in plumbing.

## Training Resources:

- Classroom facilities, workshop facilities, information sheets.


## Key Learning Points Code:

$\mathrm{M}=$ Maths $\quad \mathrm{D}=$ Drawing $\quad \mathrm{RK}=$ Related Knowledge $\mathrm{Sc}=$ Science
$\mathrm{P}=$ Personal Skills
$\mathrm{Sk}=$ Skill
H = Hazards

## Volume

Volume is the amount of space in any container, no matter it's shape.
Note: VOLUME IS ALWAYS IN CUBIC METRES M ${ }^{3}$.
The volume of a rectangular tank is:
Length X Width X Height.

To find the volume of a rectangular tank which is 2 m long, 3 m wide and 1 m high:
$2 \mathrm{mX} 3 \mathrm{mX} 1 \mathrm{~m}=6 \mathrm{~m}^{3}$

Volume is always in $\mathrm{m}^{3}$, so the measurements you use must always be in metres, before you do any calculations.

Find the volume of the rectangular container, length 2 m , width 450 mm , height 750 mm .
Two of the measurements are in mm (millimetres). These must be converted into metres. Since every 1000 mm makes up a metre, divide the number of mm by 1000 to give metres.
So $450 \mathrm{~mm} \div 1000=0.450 \mathrm{~m}$
And $750 \mathrm{~mm} \div 1000=0.750 \mathrm{~m}$
Now the calculations are as before:
Volume is $2 \mathrm{~m} \mathrm{X} 0.450 \mathrm{~m} \mathrm{X} 0.750 \mathrm{~m}=0.675 \mathrm{~m}^{3}$

## Capacity

Capacity is the amount of liquid which the container can hold.
This is very simple to work out.
$1 \mathrm{~m}^{3}$ holds 1000 litres of liquid.
So if the volume of the container is $5 \mathrm{~m}^{3}$, since each cubic metre holds 1000 litres, the capacity of this container must be
$5 \mathrm{~m}^{3}$ X $1000=5000$ litres
A tank with a volume of $1.175 \mathrm{~m}^{3}$ will have a capacity of
$1.175 \mathrm{~m}^{3}$ X $1000=1175$ litres
Note: Find volume as before, making sure that all dimensions are in metres before you start, and multiply your answer by 1000 .

## Example 1:

Find the capacity in litres of a rectangular tank 1 m long X 250 mm wide X 300 mm high.
First, convert all measurements into metres:
$1 \mathrm{mX} .25 \mathrm{mX} .3 \mathrm{~m}=0.075 \mathrm{~m}^{3}$
This figure is less than 1 cubic metre, but the principle remains the same.
Multiply the volume in cubic metres by 100 to get the capacity in litres.
$0.075 \times 1000=75$ litres

## Example 2:

Find the capacity in litres of a rectangular tank 1.5 m long X 750 mm wide X 1250 mm deep.
Note: This time not all the measurements are given in metres. Since volume is always required in $\mathrm{m}^{3}$, all measurements are must be converted into metres before any calculations are done.
To convert mm into metres, just divide by 1000 . We can now say that the tank measures 1.5 m X .75 X 1.25 m .

Therefore, volume is $1.406 \mathrm{~m}^{3}$.
Now that we have the volume in cubic metres, we multiply by 1000 to find out the capacity of the tanks in litres: $1.406 \mathrm{X} 1000=1,406$ litres.

## Volume/Capacity of Rectangular Cisterns

## Example 3:

If you know the capacity of a rectangular cistern and two of it's measurements. You need to find out the third measurement.
Firstly, capacity must be converted into volume.
For example, if the capacity is 3000 litres, the volume is $3000 \div 1000=3 \mathrm{~m}^{3}$
Volume is got by the formula Volume $=\mathrm{L} \times \mathrm{W} \times \mathrm{H}$

Writing this in reverse, $\mathrm{L} \times \mathrm{W} \times \mathrm{H}=$ Volume
Then:

$$
\begin{aligned}
\mathrm{L} & =\frac{\text { Volume }}{\mathrm{W} \times \mathrm{H}} \\
\mathrm{~W} & =\frac{\text { Volume }}{\mathrm{L} \times \mathrm{H}} \\
\mathrm{H} & =\frac{\text { Volume }}{\mathrm{W} \times \mathrm{L}}
\end{aligned}
$$

Note: all measurements must be in metres.

## Example 4:

The capacity of a rectangular cistern is 162,000 litres. Its length is 6 m and its width is 3 m . Find its height.

$$
\begin{aligned}
\text { Capacity } & =162000 \text { litres. } \\
\text { Volume } & =162000 \div 1000 \\
& =162 \mathrm{~m}^{3} \\
\mathrm{~L} \times \mathrm{W} \times \mathrm{H} & =162 \\
6 \times 3 \times \mathrm{H} & =162 \\
18 \times \mathrm{H} & =162 \\
\mathrm{H} & =\underline{162} \\
\mathrm{H} & =9 \mathrm{~m}
\end{aligned}
$$

If, instead of height, you were looking for the width, the procedure is similar.

| Volume | $=162^{3}$ |
| ---: | :--- |
| $\mathrm{~L} \times \mathrm{W} \times \mathrm{H}$ | $=162$ |
| $6 \times \mathrm{W} \times 9$ | $=162$ |
| $54 \times \mathrm{H}$ | $=162$ |
| W | $=\frac{162}{54}$ |
| W | $=3 \mathrm{~m}$ |

If you were looking for the length:

$$
\begin{aligned}
\mathrm{L} \times \mathrm{W} \times \mathrm{H} & =162 \\
\mathrm{~L} \times 3 \times 9 & =162 \\
27 \times \mathrm{L} & =162 \\
\mathrm{~L} & =\frac{162}{27} \\
\mathrm{~L} & =6 \mathrm{~m}
\end{aligned}
$$

## The Circle

An important mathematical constant is used when solving area and perimeter calculations of a circle. This constant is called 'Pi' and is represented by the symbol п. The numerical value of the constant is 3.142 and is the number of times that the diameter of the circle will go into the circumference length of the same circle. This constant applies to all circles, whatever their size.

The area of a circle is calculated using the formula $n r^{2}$ :

| Area of a circle | $=\pi \times \mathrm{r}^{2}$ |
| :--- | :--- |
| where $\pi$ | $=3.142$ |
| r | $=\quad$ radius of circle |

Note: To square a figure you have to multiply it by itself, ie:

| $4^{2}$ | $=$ | $4 \times 4$ |
| :--- | :--- | :--- |
| $4^{2}$ | $=$ | 16 |

Therefore, the surface area of a circle:

$$
\begin{aligned}
& =\quad \pi \mathrm{x} \mathrm{r}^{2} \\
& =\quad \pi \times \text { radius } \times \text { radius }
\end{aligned}
$$

## Overview

The area of a circle is calculated using the formula:
Area of circle $=\pi \times \mathrm{r}^{2}$
Where $\pi=3.142$ and $r=$ radius
$\mathrm{r}^{2}$ means radius x radius

## Example 1:

Find the area of a circle with radius 2 m :

$$
\begin{aligned}
\text { Area of circle } & =\pi \mathrm{r}^{2} \\
& =\pi \times \mathrm{rrr} \\
& =3.142 \times 2 \times 2 \\
& =12.568 \mathrm{~m}^{2}
\end{aligned}
$$

## Example 2:

Find the area of a circle with diameter 3 m .

* Remember to halve the diameter to find the radius.

| Area of circle | $=\pi \mathrm{r}^{2}$ |
| ---: | :--- |
|  | $=\pi \times \mathrm{rxr}$ |
|  | $=3.142 \times 1.5 \times 1.5=7.0695 \mathrm{~m}^{2}$ |

## The Cylinder

The volume of a cylinder is calculated using the formula:
VOLUME $=\pi r^{2} h$
The answer must always be in cubic metres.
Therefore all measurements must be in metres to start with.

## Example 1:

Find the volume of a cylinder with a radius of 1.25 m and a height of 2 m .

$$
\begin{aligned}
\text { Volume } \quad & =\pi \mathrm{r}^{2} \mathrm{~h} \\
& =3.142 \times 1.25 \times 1.25 \times 2 \\
& =9.189 \mathrm{~m}^{3}
\end{aligned}
$$

## Example 2:

Find the volume of a cylinder with a diameter of 450 mm and a height of 750 mm .
In this case the measurements are not in metres.
$450 \mathrm{~mm}=0.45 \mathrm{~m} \quad 750 \mathrm{~mm}=0.75 \mathrm{~m}$
Since the diameter is 0.45 m , the radius is 0.225 m .

$$
\begin{aligned}
\text { Volume } & =\pi \mathrm{r}^{2} \mathrm{~h} \\
& =3.142 \times 0.225 \times 0.225 \times 0.75 \\
& =0.1193 \mathrm{~m}^{3}
\end{aligned}
$$

## Capacity of a Cylinder

The CAPACITY of a cylinder is found by multiplying the volume by 1000 .

## Example:

Find the capacity of a cylinder 1.25 m high, with a diameter of 700 mm .

$$
\begin{aligned}
\text { Volume } & =\pi \mathrm{r}^{2} \mathrm{~h} \\
& =3.142 \times 0.35 \times 0.35 \times 1.25 \\
& =0.4811 \mathrm{~m}^{3} \\
\text { Capacity } & =\text { Volume } \times 1000 \\
& =0.4811 \times 1000 \\
& =481.1 \text { litres }
\end{aligned}
$$

## Cylinder Height

The method of finding the height of a cylinder when you know the capacity or volume and the radius, is very similar.
Remember: $\quad$ capacity $\div 1000=$ volume
$\pi \mathrm{xr}^{2} \times \mathrm{H}=\quad$ volume
therefore

$$
\mathrm{H}=\frac{\underline{\text { volume }}}{\pi \times \mathrm{r}^{2}}
$$

The capacity of a cylinder is 157,100 litres. The radius is 10 m . Find the height.

$$
\begin{aligned}
\text { Volume } & =157,100 \div 1000 \\
& =157.1 \mathrm{~m}^{3} \\
\pi \mathrm{r}^{2} \mathrm{~h} & =157.1 \\
3.142 \times 10 \times 10 \times \mathrm{h} & =157.1 \\
3.142 \times \mathrm{h} & =157.1 \\
\mathrm{~h} & =\frac{157.1}{314.2} \\
\mathrm{~h} & =0.5 \mathrm{~m}
\end{aligned}
$$

## Alloys

An element is a substance made up of atoms, all of one kind. Lead, copper, zinc and aluminium are all elements. Each is composed entirely of atoms of lead, copper, zinc or aluminium.

It is possible to melt down and mix together copper and zinc but the mixture, when set, would not be an element, because it would contain atoms of both copper and zinc. Such a mixture of metals is called an alloy, and in this case, if the proportions were right, by alloying copper and zinc together brass would be made. The properties of the mixed metal would be different from those of either the copper or the zinc which were added together to make it.

An alloy is sometimes described as a metal composed of two or more metals. This of course quite true, but an alloy can be made by alloying a metallic element with a non-metallic element. A better way of describing an alloy, therefore, is as follows: "An alloy is a metallic substance made by mixing two or more elements, one of which is metal".
As has already been shown, copper and zinc when mixed together correctly will make brass. Lead and tin, two more metallic elements, can be blended to make solder, which, incidentally, has a lower melting point than either the lead or tin of which it is composed. This is but one of many strange changes of physical properties which occur when alloys are formed.

Steel, used for making tools, pipes etc is also an alloy. It is a mixture of iron and carefully controlled amounts of carbon. Carbon is an element but is not a metal. So steel is one example of an alloy composed of metallic and non-metallic elements.

Some alloys may be improved by the addition of other elements.
For example:

- Chromium added to steel increases its resistance to corrosion.
- Magnesium increases the toughness of steel.
- Silicone added to steel destroys its magnetic properties.
- Vanadium added to steel makes it more resistant to damage by shock.

If you have a spanner or pair of pliers made of chrome-vanadium steel, such tools will not only resist corrosion, they will also withstand sudden wrenching shocks without fracture.

## Alloys Used In Plumbing Work

Table 1. Alloys used in Plumbing

| Alloy | Components | Uses |
| :--- | :--- | :--- |
| Brass | $70 \%$ Copper $-30 \%$ Zinc | Pipe Fittings |
| Gunmetal Bronze | $90 \%$ Copper $-10 \%$ Tin | Underground Pipes and Fittings |
| Cast Iron | $2-4 \%$ Carbon $-98 \%$ Iron | Boilers, Rainwater, Pipes and <br> Fittings |
| Mild Steel | $0.5 \%$ Carbon $-99.5 \%$ Iron | Pipes and Fittings |
| Soft Solder | $40 \%$ Tin $-60 \%$ Lead | Blowpipe Soldering |
| Hard Solder | $2 \%$ Silver $-98 \%$ Copper | Cuprotectic Joints |
| Lead Free Solder | $2 \%$ Silver $-98 \%$ Tin | Blowpipe Soldering |

## Properties of Plumbing Materials

Many of the materials used by the plumber have different characteristics which must be considered before their use.

## Fusibility

This is the melting point of a material and indicates the temperature at which a solid changes to a liquid. Metals being welded have to be heated to the melting point of the material in order to "fuse" together with the filler rod. Mild steel has the highest melting point of all the plumber's metals. Although unyielding at normal temperatures, when heated to red heat it can easily be bent.

## Malleability

The ability of a metal to be worked (bossed or hammered) into a new shape without breaking. Lead has this property to a remarkable degree. Most metals become more malleable when their temperature is increased.

## Ductility

This denotes the ability of a metal to be stretched without breaking. A good example of a ductile metal would be copper which can be drawn out to form tubes and wires.

## Tenacity

A material's ability to resist being pulled apart or pulled from its present position.

## Tensile Strength

This is a measure of the tenacity contained by a material. A sample piece of material is bolted between two clamps in a special tensile strength testing machine. The clamps are then made to pull apart in opposite directions, thus imposing a pulling load on the sample. The sample slowly stretches and eventually breaks. The force at which the material breaks is a measure of its tensile strength and is expressed in $\mathrm{N} / \mathrm{m}^{2}$.

## Elasticity

The ability of a material to return to normal after being pulled and pushed out of shape. Rubber is an excellent example of a material which is elastic. Metals are basically not elastic, although some steels, hard brass and hard copper can be made into spring shapes which possess certain characteristics of elasticity.

## Durability

This represents the ability of a material to resist wear and tear. A durable material is one which is long-lasting and non-perishable.

## Annealing and Tempering

Annealing is the treatment of a metal or alloy to reduce its brittleness and improve its ductility. Annealing is often referred to as the softening of a metal. If a metal becomes work hardened it may require softening before work is continued, otherwise it might fracture.
Annealing is achieved by the application of heat.
Copper pipes are annealed before spring bending. The pipe is heated to a dull red colour and then allowed to cool or quenched in cold water.
Tempering or hardening, is a process of improving the characteristics of a metal, especially steel. Tempering is carried out by heating the metal to a high temperature and then cooling it, usually by quenching it in oil or water.
Cold chisels, screwdrivers, bending springs and the jaws of stilsons are examples of tools which are tempered.

## Hand Tools

There are far too many accidents in the construction industry. Many of them could be avoided with a little thought and common sense. Accidents are generally caused by people disregarding recommended safety procedures. They feel that accidents can only happen to other people and that, in any case, they have done that operation many times without any problem.
One area where accidents frequently occur is in the incorrect use and care of hand tools. The basic principles to follow when using hand tools are set out below:

- Make sure you use the right tool for the job.
- Wear unbreakable goggles when chipping welds, using chisels, drilling, using cartridge guns etc.
- When using stilsons and wrenches make sure the pull forces the jaws together, otherwise the tool might slip.
- Never leave a defective tool about for others to use.


## Hammers and Mallets



Mallets are used when the use of a hammer would damage the metal. Many metals are softer than the hammer face. Hard rubber mallets can be used for most purposes and replace the hide and boxwood mallets. Nyion striking faces are also used instead of the hide in the hide-faced hammer.

Figure 1. Hammers \& Mallets

## Screw Drivers



## Bradawl



Figure 2. Screw Drivers

## Files



Figure 3. Files

## Hack Saws



Junior hacksaw


Figure 4. Hack Saws

## Spanners



Adjustable spanner


Open ended spanner


Ring spanner
Figure 5. Spanners

## Pliers



Engineer's pliers


Gland nut pliers


Gas pliers


Self grip wrench or mole wrench

Figure 6. Pliers

## Specialist Plumbing Tools



Hand operated ratchet dies


Copper tube cutter

Internal bending spring


Figure 7. Specialist Plumbing Tools

## Pipe Wrenches



Stilson type pipe wrench.


Footprint wrench.

AS WITH A STILSON WRENCH, THE CORRECT SIZE OF WRENCH MUST BE CHOSEN FOR THE SIZE OF PIPE BEING USED

CHAIN WRENCHES CAN BE USED WHERE STILSONS OR
FOOTPRINTS CANNOT BE USED DUE TO LACK OF SPACE
Chain wrench.
Figure 8. Pipe Wrenches

## Mild Steel Pipe \& Fittings

Mild steel pipe, also known as low carbon steel pipe, is available either painted black or galvanised. Black steel pipes should be used for hot water heating systems and gas supplies only. If it were used where freshwater is continuously being drawn off through the pipeline it would soon become liable to corrosion problems.

Steel tube for water and gas services is usually joined by means of screwed joints or by welding. Galvanised tube, however, must not be welded as the heat would remove the zinc coating and leave the steel unprotected against corrosion attack. There is also a health risk, in that, when galvanised pipe is heated it gives off fumes that can be injurious to health. It should be noted that all welding processes produce fumes and care must be taken to minimise exposure to this hazard.
A comprehensive range of pipe fittings as available both for screwed and welded joints, the latter type having no threads but the outer edge bevelled to provide the necessary joint preparation.

## Bending Mild Steel Pipe

Mild steel pipe is manufactured to BS 1387 and is also known as low carbon steel pipe. Mild steel is an alloy of iron and up to $0.2 \%$ carbon, hence the term "LOW CARBON STEEL".

There are two methods used to bend mild steel pipe:

- Machine Bending.
- Heat Bending.


## Machine Bending

For bending mild steel pipe by machine a method known as hydraulic press bending is used. The pipe is placed in the machine using the correct size former. Tube stops and pins are also located in the correct holes. A hydraulic ram is operated by a lever, which forces oil from one chamber to another. This exerts tremendous power which moves the ram forward forcing the pipe against the stops. As the lever is pumped the pipe is forced to bend. By using care and attention to detail mild steel pipes can be bent accurately using this method of pipe bending. Because of their thickness the walls of mild steel pipes do not have to be fully supported during the bending process.

## Setting up a Hydraulic Bending Machine

When using a hydraulic bending machine ensure that:

- The correct size inside former is attached to the hydraulic ram.
- The two back formers are located in the correct holes in the base plate.


Figure 9. Hydraulic Bending Machine Setup
Position the bending line on the pipe in line with the centre line of the inside former. To obtain accurate bends the diameter of the pipe is subtracted from the measurement to obtain the bending line.


Figure 10. Hydraulic Bending Machine Setup
Check the angle of the bend frequently during the bending process. Mild steel pipes should be overbent slightly to allow for contraction. This allowance for contraction will be determined by experiment.


Figure 11. Hydraulic Bending Machine Setup

## Parts of a Circle



CIRCUMFERENCE $=\Pi \times$ Diameter
$T=3.142$


Figure 12. Parts of a Circle
DIAMETER is a straight line drawn across a circle and passing through its centre.
RADIUS is a straight line drawn from the centre of a circle to its circumference. It is equal to half its diameter.
TANGENT is a straight line which touches the circumference or arc of a circle.
ARC is a section of the circumference of a circle.


Screw to Wall (STW)

## PVC Pipe Clip

Figure 13. PVC PipeClip, STW, Holderbat

## Mild Steel Pipe Identification

Mild steel piping is supplied in 6.4 m lengths. Finished in Black or hot dipped galvanised for extra corrosion resistance.

These lengths can have either:

1. PLAIN ENDS: When they are to be welded together on site.

2. THREADED ENDS: When threaded joints are to be used on site.

On threaded lengths, one socket is supplied with each length.
 sizes, all in mm .
$8,10,15,20,25,32,40,50,65,80,100,150,200$ etc.
Mild steel pipes are supplied in different grades for different applications: -

- MEDIUM GRADE:

Marked with blue band. Suitable for low pressure hot water heating and gas installations.

- HEAVY GRADE:

Marked with a red band. Suitable for steam and high temperature hot water heating installations.

- SCHEDULE 40 \& 80:

The particular schedule is stamped on the outside of the pipe. These are very heavy walled pipes and are used in process industries.
Actual size:


Figure 14. Pipe Grades

## Mild Steel Pipe Cutting

The teeth on a hacksaw blade are set at a slight angle to enable the blade to produce a cut wide enough so that the rest of the blade does not bind or break.

It is important that the hacksaw blade being used is suitable for the type of material being cut.


Figure 15. Hacksaw Blade
For rapid cutting of mild steel pipes a pipe cutters is used. It consists of cutting wheel, two guide rollers and an adjusting screw. The cutting wheel should be replaced periodically as a blunt wheel tends to crush rather than cut the pipe.
Pipe cutters with three cutting wheels are available for applications where the cutters can not be turned completely around by the pipe.


A pipe reamer is used to remove the internal burr left by the pipe cutter.

If this burr is not removed it causes an increased restriction to the flow of water in the pipeline.


Figure 17. Pipe Reamer

## Thread Cutting

The type of thread normally used for connecting mild steel pipes is called a British Standard Pipe Thread or B.S.P.T.


To cut threads on mild steel pipes a "stocks and dies" is used. This consists of a set of four dies in a holder. This holder fits into a ratchet stock which is fitted with a handle.


Figure 19. Stocks and Dies
To cut a longscrew thread the normal thread cutting procedure is continued until the backnut and socket can be threaded completely on to the pipe.

Barrel nipples can be cut with a special attachment on the electric powered threading machine.


Figure 20. Longscrew Connector and Barrel Nipple

Mild Steel Pipe Cutting


Figure 21. Mild Steel Pipe Cutting

## Thread Cutting



Figure 22. Thread Cutting

Mild Steel Pipe Identification


Figure 23. Mild Steel Pipe Identification




 BACKNUT

SOCKET

뭉


Figure 24. Mild Steel Pipe Identification

The threads on malleable iron pipe fittings are referred to as either male or female. The male thread is the one where the threads are external and visible. The female thread is the one where the threads are internal and hidden.


Figure 25. Malleable Pipe Fitting Threads
When ordering malleable iron tees with unequal outlets quote the size in the order shown in the figure opposite. So the correct way to quote the tees piece shown is: 25 mm X 15 mm X 20 mm .


Figure 26. Iron Tees
The Z dimension is the distance from the centre of the fitting to the point reached by the end of the pipe when it has been screwed the proper distance into the fitting.

When piping runs are being prefabricated it is essential to know this dimension and it can be obtained from the fitting manufactures catalogue.


Figure 27. $Z$ Dimension

## Mild Steel Pipe Assembly



Figure 28. Mild Steel Pipe Assembly
Thread seals and taps are always applied in a clockwise direction when facing the threaded end of the pipe.

Polishing brass and chrome plated threads such as radiator valve tailpieces and bib taps may need to be slightly serrated with a hacksaw blade to give the flax or thread tape a grip.
If this is not done the flax of tape will move along the threads as the fitting is tightened leaving none in the joint and probably causing the joint to leak.

## BOSS WHITE AND FLAX

Is suitable for hot and cold water services and low pressure hot water heating.

## P.T.F.E TAPE

Is suitable for all the above mentioned applications as well as joints on oil and gas lines and oxygen and acetylene.

## STAG JOINTING COMPOUND

Is especially suitable for oil and gas lines.

## Self Assessment

## General Exercises

1. State the SI units for the following:
a) Capacity
b) Pressure
c) Energy
2. Describe what is meant by the terms:
a) Fusibility,
b) Malleability
c) Ductility of a metal
3. List three alloys used in the plumbing trade, their applications and their component parts.
4. Calculate the floor area of the rooms shown in Exercise No. 2.1.4a. in the Curriculum document.
5. Fabricate basic engineering exercise.

## Volume

## Exercises 1:

Find the volume of each of the following rectangular tanks.

1. Length 2 m , height 3 m , width 4 m .
2. Length 1 m , height 2 m , width 3 m .
3. Length 1.5 m , height 2 m , width 2.5 m .
4. Length 1 m , height 3.5 m , width 1.75 m .
5. Length 1.25 m , height 2.25 m , width 1.75 m .
6. Length 3.6 m , height 0.65 m , width 2.1 m .

## Exercises 2:

Find the volume of the following rectangular tanks:

1. Length 2 m , height 650 mm , width 800 m .
2. Length 1250 mm , height 1 m , width 450 mm .
3. Length 3.5 m , height 750 mm , width 500 mm .
4. Length 4 m , height 300 mm , width 200 mm .
5. Length 2.25 m , height 1200 mm , width 0.65 m .
6. Length 1.1 m , height 1400 mm , width 2250 mm .

## Capacity

## Exercises:

Find the capacity of the following tanks:

1. Length 2.25 m , height 1250 mm , width 350 mm .
2. Length 1200 mm , height 450 mm , width 2500 mm .

## Volume/Capacity of Rectangular Cisterns

## Exercise 1:

Find the capacity of a rectangular cistern 650 mm X $1,750 \mathrm{~mm} \times 2,250 \mathrm{~mm}$.

## Exercise 2:

Find the capacity of a cistern 950 mm X $1,350 \mathrm{~mm}$ X 800 mm .

## Exercise 3:

Find the volume and capacity of a cistern 3 m X 2.5 m X 2.5 m .

## Exercise 4:

Find the volume / capacity of a cistern 4.5 m X 3.25 m X 1.25 m .

## Exercise 5:

Find the volume / capacity of a cistern 300 mm X 300 mm X 500 mm .

## Exercise 6:

Find the volume / capacity of a cistern 250 mm X 175 mm X 750 mm .

## Questions:

1. Calculate the volume and capacity of a rectangular cistern 3.45 m wide, 2.67 m long and 565 mm high.
2. A tank is 450 mm wide, 1505 mm long and 25 mm high. How much water will it hold?
3. A storage cistern is 4555 mm long, 2343 mm wide and 655 mm high. If the water level in the cistern is 105 mm below the top how much water does the cistern contain?
4. A cold water cistern is 2 m long, 4.5 m wide and 6.25 m high. Calculate it's volume and capacity.
5. Find the volume of a rectangular cistern 1.25 m long, 550 mm wide and 720 mm high. If the cistern is filled to 50 mm below the top, how much water will it hold?

## Exercise 7:

Find the required measurement in the following examples:
Table 2. Exercise: Find Measurement

| Exercise | Length | Width | Height | Capacity |
| :--- | :--- | :--- | :--- | :--- |
| 1. | 8 m | 9 m | $\boldsymbol{?}$ | 504,000 litres |
| 2. | 2.5 m | 4 m | $\boldsymbol{?}$ | 15,000 litres |
| 3. | $\boldsymbol{?}$ | 1.5 m | 2.25 m | 4219 litres |
| 4. | 750 mm | $\boldsymbol{?}$ | 550 mm | 392 litres |
| 5. | 3.25 m | 6.5 m | $\boldsymbol{?}$ | 16,900 litres |
| 6. | $\boldsymbol{?}$ | 1.25 m | 1.25 m | 1953 litres |
| 7. | 7.5 m | $\boldsymbol{?}$ | 0.5 m | 3750 litres |
| 8. | 5500 mm | 1.2 m | $\boldsymbol{?}$ | 6930 litres |
| 9. | 6.25 m | 7.5 m | $\boldsymbol{?}$ | 4687.5 litres |
| 10. | 200 mm | 110 mm |  | 1.1 litres |

## The Circle

## Exercises:

Find the area of the following circles:

1. Radius 3 m .
2. Radius 2.5 m .
3. Radius 1200 mm .
4. Diameter 2 m .
5. Diameter 4.5 m .
6. Diameter 300 mm .
7. Radius 100 mm .
8. Diameter 25 mm .
9. Diameter 20 mm .
10. Diameter 15 mm .

## The Cylinder

## Exercises:

Find the volume of the following cylinders:

1. Radius 1.3 m Height 4 m .
2. Radius 1575 mm Height 2.3 m .
3. Radius 950 mm Height 1600 mm .
4. Diameter 1440 mm Height 1.8 m .
5. Diameter 1.6 m Height 500 mm .
6. Diameter 100 mm Height 6 m .
7. Diameter 50 mm Height 4.2 m .
8. Diameter 25 mm Height 0.5 m .
9. Diameter 20 mm Height 300 mm .
10. Diameter $15 \mathrm{~mm} \quad$ Height 5.5 m .

## Volume and Capacity

## Exercise 1:

Find the volume and the capacity of a pipe 420 mm in diameter and 975 mm long

## Exercise 2:

Calculate the quantity of water contained in a circular storage cistern 950 mm high and 1.12 m in diameter.

## Exercise 3:

Calculate the capacity of a copper pipe 25 mm in diameter and 2 m long.

## Cylinder Height

## Exercises:

Find the height of the following cylinders:
Table 3. Exercise: Height of Cylinders

| Exercise | Radius | Capacity | Height |
| :--- | :--- | :--- | :--- |
| 1. | 4 m | 150,816 litres |  |
| 2. | 2.5 m | 49093.75 litres |  |
| 3. | 1.5 m | 10604.25 litres |  |
| 4. | 0.5 m | 78.55 litres |  |
| 5. | 15 mm | 70.695 litres |  |

## Questions:

1. A pipe is 80 mm in dimension and is 12.5 metres long. How much water will it hold?
2. A cylinder is 120 mm in dimension and is 1.25 metres high. Calculate it's volume and capacity.
3. A cylindrical C.W.S. cistern has a diameter of 5.25 metres. If it is 12.55 metres high how much water will it hold?
4. A vertical pipe is 2450 mm long. Its diameter is 65 mm .Calculate:

- The volume of the pipe
- The capacity of the pipe

5. A barrel is 1.05 metres in diameter and is 1.05 metres high. How much water will it hold?
6. A barrel has a radius of 1.05 meters and is 1.05 metres high. How much will it hold?
7. A cylindrical is 2 metres high and 855 mm in diameter. If the water level is 125 mm below the top, what is the amount of liquid that it contains?
8. An underground water pipe is 450 mm in diameter and 25.25 metres long. State:

- The volume of the pipe.
- The capacity of the pipe.
- The weight of the water in the pipe.

9. A 15 mm diameter copper pipe is supplying a wash basin. If the pipe run is 5.5 metres long how much water does the pipe hold?
10. A 75 mm diameter drainage pipe is half full of water. If it is 20.5 metres long, how much water is in the pipe?

## Stag Jointing Compound

Is especially suitable for oil and gas lines.

## Exercise:

Each apprentice will pressure test sample pipe-work to 6 bar pressure:


Figure 29. Unit Exercise/Procedure No. 2.1.8.A

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