

# **Trade of Sheet Metalwork**

**Module 6: Decorative Metalwork**

**Unit 1: Hollowing and  
Planishing**

**Phase 2**



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## Document Release History

Date	Version	Comments
15/01/07	First draft	
09/04/14	2.0	SOLAS transfer

## Module 6 – Decorative Metalwork

### Unit 1 – Hollowing and Planishing

Duration – 7 Hours

#### Learning Outcome:

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

- Complete design and fabricate a dish
- Hollow and planish using appropriate equipment
- Demonstrate annealing process to relieve work hardening in metal
- Use pickle solution to clean metal
- Solder legs to copper bowl
- Describe the creative/natural forms of designing

#### Key Learning Points:

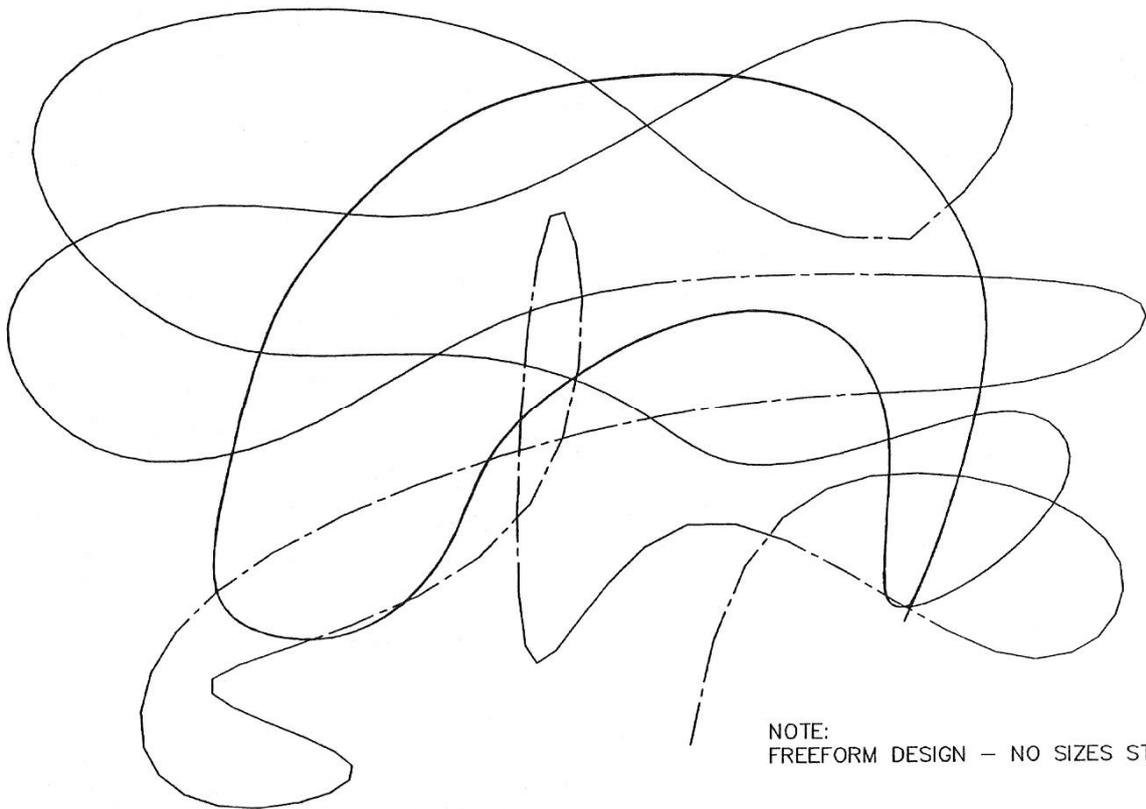
P D	Creative design.
Rk Sc	Heat treatment for annealing/knowledge of work hardening.
Sk Rk	Production of shallow bowl stages.
Rk Sc	Dissolution of oxides/pickling.
H Sc	Use of brass tongs in acid bath (sulphuric acid).
Sk	Shaping curves in metals by hand, double curvature.
H	Dangers in quenching. Protective clothing and equipment.
M	Formulae for estimating blank size.

**Training Resources:**

- Toolkit
- Job card
- 0.7mm half-hard copper
- Tools and machinery/equipment (including bossing mallets, planishing hammers, sandbags, stakes)
- Drawing and design equipment
- Safety equipment and protective clothing
- Bench

**Key Learning Points Code:**

**M** = Maths      **D** = Drawing      **RK** = Related Knowledge      **Sc** = Science  
**P** = Personal Skills      **Sk** = Skill      **H** = Hazards



NOTE:  
FREEFORM DESIGN – NO SIZES STIPULATED

**Figure 1 - Freeform Bowl**

## Hollowing

Hollowing is a method of forming double curvature work by beating the metal to shape by means of hammering. The shaping is generally carried out on a sandbag or a suitably recessed wooden block. The type of blow struck in hollowing is often termed an "elastic" blow. This is a blow struck when either the tool, or support, or both is of a resilient material such as wood.

Use a sandbag, in conjunction with a wooden or rubber bossing mallet on light gauge sheet steel, where a minimum amount of stretching is required, or for soft materials such as aluminium.

Before use check that sandbag is free from cuts and stitching of seam is good order.

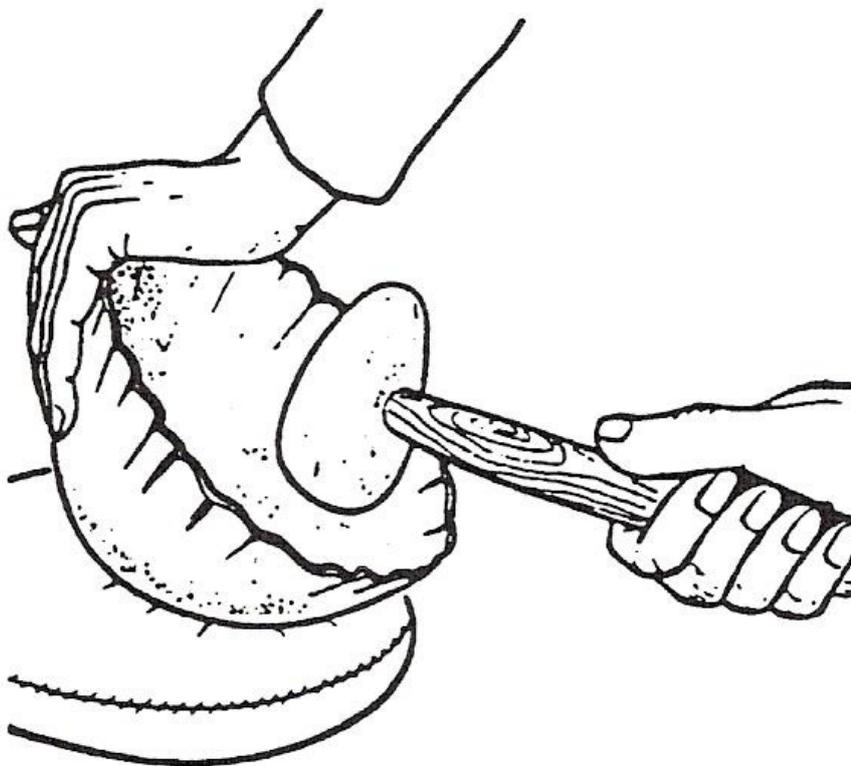


Figure 2 - Hollowing

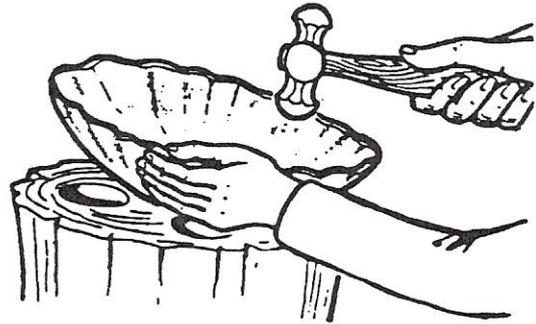
### Safety

Ensure that mallet head is secure on shaft and free from splits.

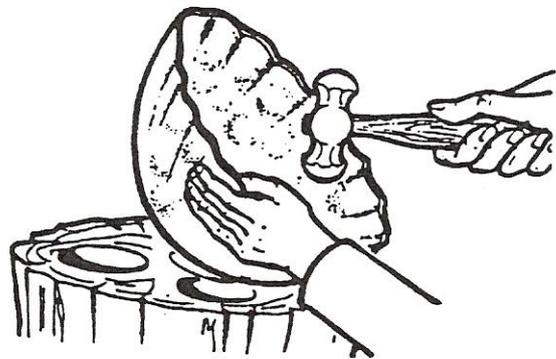
Check that faces are smooth and free from blemishes.

Use a hollowing block in conjunction with a blocking hammer or a hollowing hammer. Ensure block is clean and free from grit and is secure on its base.

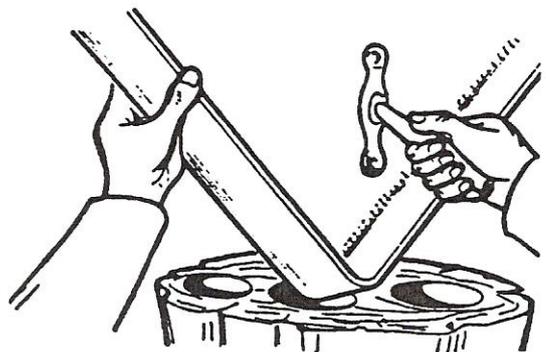
Use a blocking hammer for shallow work or for smoothing work prior to planishing. The blocking hammer has convex faces and is obtainable in various weights and various curvatures of the faces.



Use a hollowing hammer for deep or sharply curved work. The hollowing hammer has hemispherical faces and is obtainable in various weights and face radii.

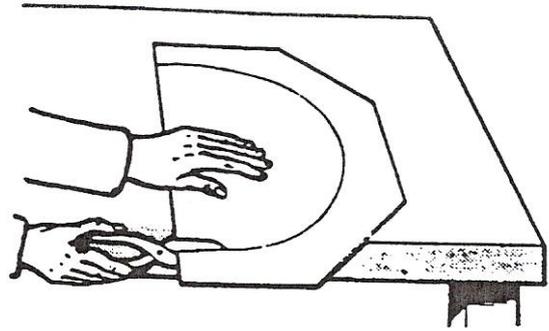


Use a small hollowing or bullet hammer for small hollowing work, or where sharp curvatures are required.

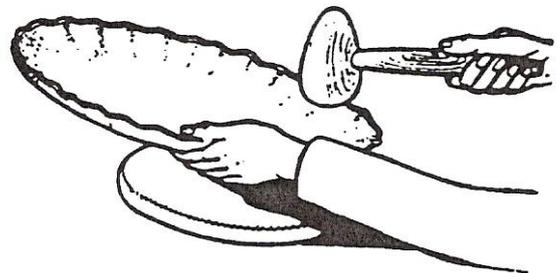


Examples of forming mild steel hemispherical cover plate.

- a) Mark off and cut a cross sectional template from dimensions given on drawing.
- b) Mark off and cut disc of required diameter. Allow for flange when calculating diameter of disc.

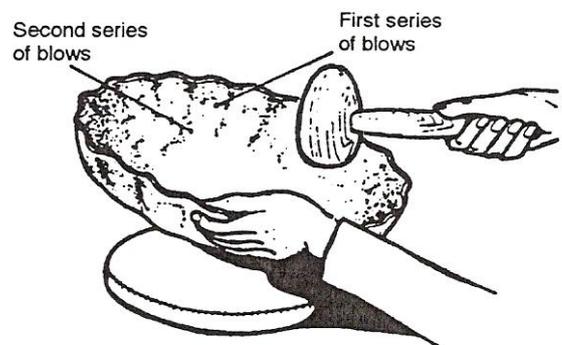


- c) Check that the sandbag and mallet to be used are in good condition.
- d) Position disc on centre of sandbag holding plate at slight angle.

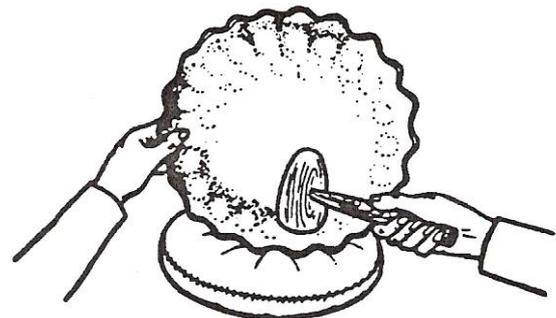


- e) Strike a series of blows round disc edge. Use forearm and wrist movement turning work with left hand as mallet is rising. Maintain a smooth strike and turn movement, keeping weight of blows equal. Repeat striking and turning movement to complete a ring of blows around edge.

- f) Raise angle of disc, and repeat striking and turning (operation e), positioning second series of blows to overlap inner edge of first series. Edge of disc will now be wrinkled due to hammering operations. These must be gentle worked out to prevent overlapping and subsequent cracking of edges.



- g) Work out wrinkles by striking on peak, or high spot of wrinkle. Work from apex, or inner edge of wrinkle, towards outer edge with a series of light blows.



h) Repeat operation (f), positioning each series of blows to overlap previous series. Work inwards in series until middle of disc is reached, removing wrinkles, as each series is completed.

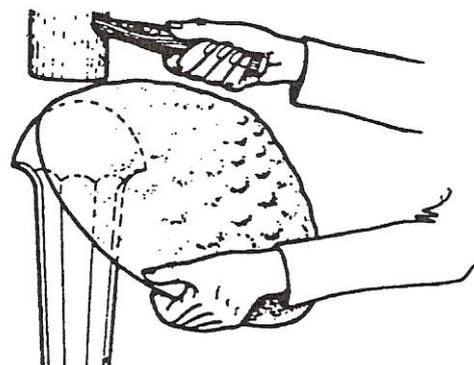
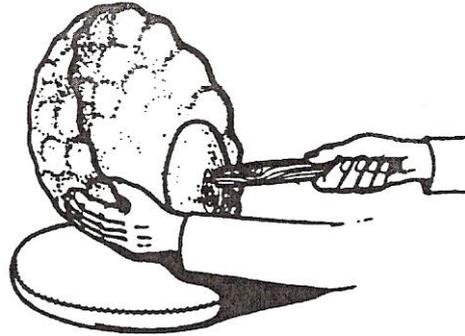
i) Check curvature of work using template, positioning template across diameter from different points on circumference.

j) Examine fit of template, marking points of contact with blow, using chalk.

k) Return work to sandbag and repeat operation over area indicated by chalk marks. Check frequently with template until correct curvature is obtained.

l) Select a suitable dome head stake. Ensure head curvature is slightly less than curvature of work. Check head is clean and free from blemishes. Select a standard flat mallet and check faces are clean and free from marks. Check head is free from splits and secure on shaft.

m) Place work on stake and strike lightly all over to remove high spots on surface. Ensure curvature is not altered by working in series as for hollowing operations, starting from edge and working towards centre of bowl. Work is now ready for planishing operation.

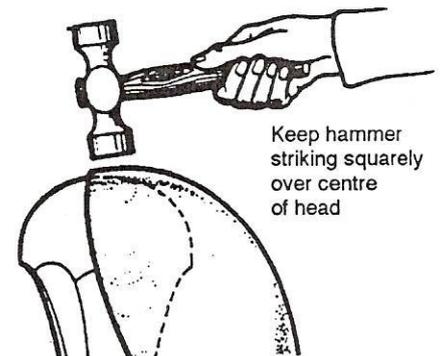


## Planishing

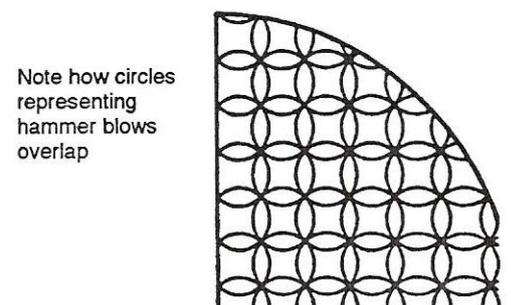
Planishing is the finished process in forming double curvature work, in which the workpiece is smoothed off and finally set to its correct shape. All hammers and stakes used in planishing must be maintained in a highly polished condition, as any blemishes on the working faces would be reproduced on the surface of the work. Planishing hammers are available in a wide variety of weights and shapes. As a general rule, flat faced hammers are used on convex work and convex-faced hammers are used on flat or slightly concave work.

### Planishing a Hemispherical Bowl

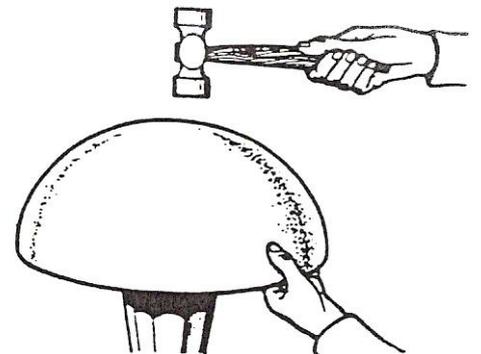
- (a) Select a suitable dome head stake.  
The stake must have a curvature slightly less than curvature of work. Fit stake securely in bench socket and wipe head with cloth to ensure it is free of dust or grease. Select suitable flat-faced hammer and ensure face is clean.



- (b) Place bowl on stake with edge head.  
Strike a light ring of blows around edge of bowl. Do not strike heavily or metal may be stretched. Allow each blow to overlap previous one and keep weight of blow equal. Each blow produces a small flat spot and these should blend into each other.



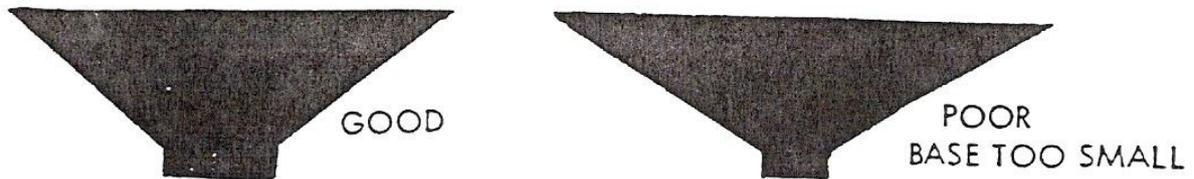
- (c) Repeat operation (b) in successive rings around bowl until whole surface has been planished.
- (d) Check with template to ensure curvature has not been altered.



## Designing Projects

Observation will help in design. Look at designs and shapes all around you. Examine different countries. Take note of ancient design features and contemporary features. Use books and magazines for examples. Not everything you will see can be classed as good design. Learn to be objective and critical.

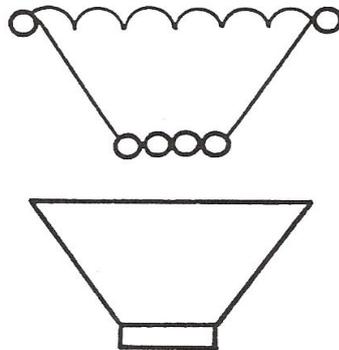
When you have decided on a form for your piece consider the size and proportion of it. It should be the right size to fulfil its function. Proportion is critical and appeals to the customer. The Greeks used the ratio 3:5. If a vessel was 5 inches high it was 3 inches wide. German and French metal workers use 2:5 and 5:8.



**Figure 3- Examples of Good and Poor Proportion**

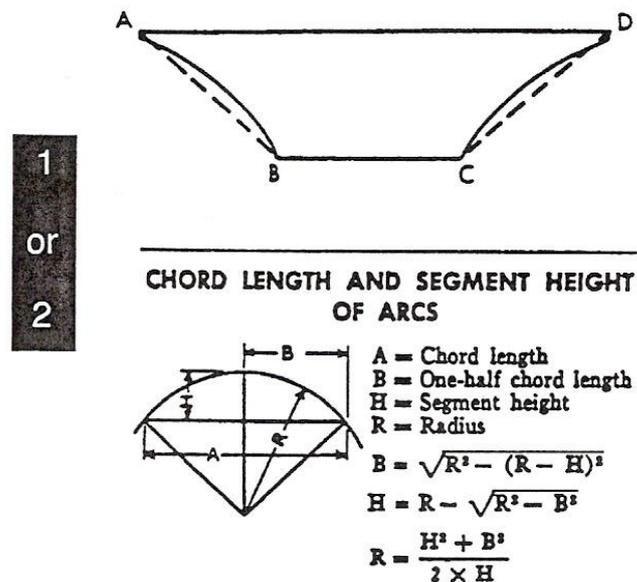
## Simplicity

Modern design favours simplicity of shape. Some ancient period designs included a rich tapestry of design. Works that are both engraved and in-laid with different metals were in tune with those elaborate times. Beauty was placed before function. Now it is the other way around. Decoration should be kept simple and should not interfere with function.



**Figure 4 - Simplicity is More Attractive in Contemporary Design**

To estimate amount of metal needed for a domed shape add lengths AB + BC + CD.



**Figure 5 – Simplicity**

To sum up, good design is centre on the following points:

- The article should be functional, i.e. it should perform the use for which it was intended
- For, the form should be practical for the use intended
- Size and proportion, the item should look good
- Simplicity, function before decoration

## Annealing

If metals are hammered, bent or rolled they become work hardened. If they are not softened they may crack or tear. Annealing is done to prevent this. The metal is heated slightly above the recrystallisation temperature. It is then allowed to cool slowly. This recrystallisation temperature is where the grains in the metal increases in size. A low annealing temperature or a short annealing time will usually give a small grain size. A higher temperature or longer annealing time gives a larger grain size which is the preferred choice for decorative metalwork.

Temperatures for annealing vary. Factors such as the three listed below affect the temperature.

1. How hard the metal was worked.
2. How long the metal was held at the annealing temperature.
3. The chemical composition of the metal.

Some metals may be cooled in the air at room temperature, while others may be quenched in water.

<i>Alloy</i>	<i>Annealing temp.</i>	<i>Melting point</i>
Aluminium		
Alloy 1100	650° F	1220° F
Alloy 3003	750° F	
Alloy 5052	650° F	
Yellow brass	1100-1300° F	1751° F
Jeweller's bronze	1100-1300° F	1886° F
Copper	1100°	1981° F
Monel	1600-1800° F	2370-2460° F
Nickel silver (65-18)	1100° F	2030° F
Pewter	250-300° F	440-500° F
Sterling silver	1100-1500° F	1640° F
Zinc based allows	250-270° F	830° F
Stainless steel (302)	1850-2050° F	2550-2590° F

**Table 1 - Annealing**

Colours which indicate the temperature of the metal are best viewed in a dark corner of the shop.

Approximate temperatures that are indicated by the various colours are:

Red heat	975° F
Dark red	1290° F
Dull cherry red	1470° F
Cherry red	1650° F
Bright cherry red	1830° F
Dull orange red	2010° F

The heat for annealing can be obtained from a gas plate soldering furnace or torch. Heat the metal slowly moving the heat or metal in a circular motion.

### **Annealing Procedure for Following Metals**

**Aluminium:** Heat the metal slowly and occasionally touch the metal with a piece of white pine. When the pine leaves a brown char mark remove the metal from the heat and allow it to cool at room temperature.

**Brass:** Heat the metal to a dull cherry red and allow the metal to cool slowly at room temperature.

**Zinc-based alloys:** Coat the alloy with a thin coating of oil. Heat slowly and evenly until the oil smokes, then remove the metal from the heat and allow it to cool slowly.

**Stainless steels:** Heat the metal to a dull orange colour, place in sand and allow it cool slowly.

**Copper:** Heat the metal to a dark red and quench in water.

Decorative metals anneal better if you maintain them at the annealing temperature for five minutes.

## Removing Oxides

Metals usually oxidise on the surface when heated. This colour scale is removed by chemicals called pickles. If not removed the scale is forced into the metal and will disfigure the surface. The chemical used (normally acid) are called pickling solutions.

Pewter, aluminium and zinc-based alloys can be cleaned with pumice and water. They do not need to be pickled.

The lowest concentration of chemicals possible should be used. If the solution is too strong or you leave the workpiece in for too long pitting of the metal can occur. If the metal has a heavy scale use a more concentrated and hotter pickling solution. Remove all traces of the pickling solution by rinsing with water (the workpiece).

## Pickling Solutions

1. A pickling solution for brass, bronze, copper and nickel silver consists of one-part sulphuric acid, nine parts water. Dip the article into a solution and let it remain for about 10 minutes. Wash it in water before drying. By heating the acid solution in a Pyrex container to 150°F the metal will clean quicker. Sparex No.2 can also be used to pickle these alloys. This solution is safer to use than acids.
2. For stainless steel: Dip your metal in a 40% nitric acid solution (acid 40%, water 60%) at 120-140°F temperature. Allow the metal to remain in the solution for 30 minutes, then rinse in clean running water and dry.

### **SAFETY**

Always mix pickling solutions in acid-proof containers such as Pyrex glass, earthenware crocks, enamelled steel or rubber containers. When mixing chemicals, wear a rubber apron and rubber gloves. Goggles should be worn to protect your eyes.

Remember - when mixing acids always add the acid to the water slowly. Mix the solution with a stick as you add the acid. Do not drop your project into the pickling solution; slide it in to prevent splashing. Handle the metal to be pickled with tongs made of plastic, wood or copper.

## Self Assessment

Questions on Background Notes – Module 6.Unit 1

1. For which kind of work would you use hollowing?

2. Why is it important for the tools to be in very good condition when hollowing?

3. How do you work out wrinkles when hollowing?

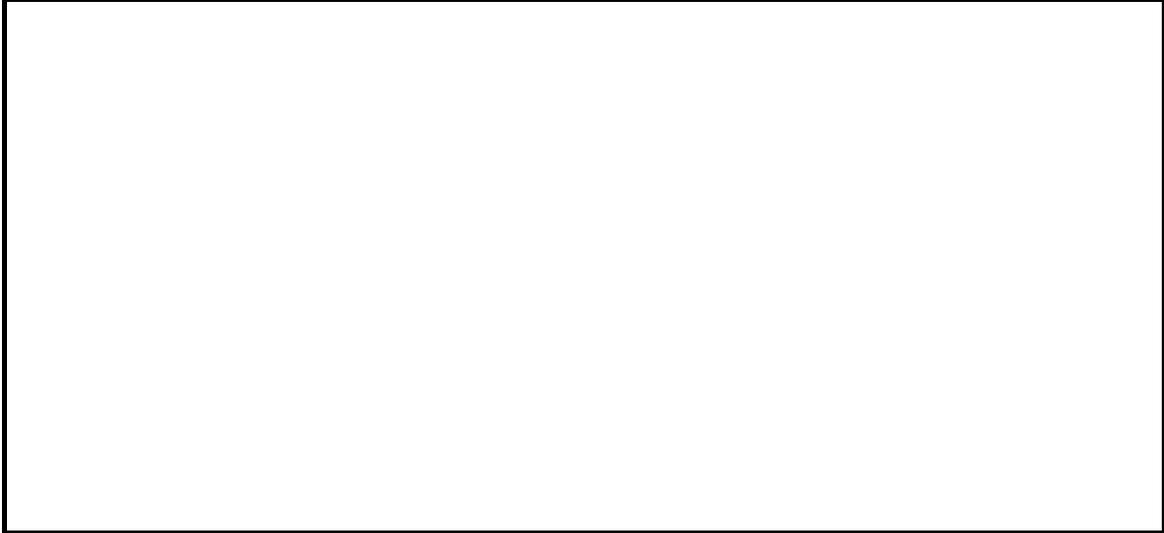
4. When hollowing do you start at the centre or at the outside edge?

5. When planishing where would you use:

- a. Flat-faced hammer
- b. Convex-faced hammer

6. List two ratios used when designing a project.

7. Why anneal metal and what is annealing?



8. What is the annealing temperature of:

- a. Aluminium
- b. Copper



9. What three metals can be cleaned using pumice and water?

10. Do you add acid to the water slowly or the water to acid?

## Answers to Questions 1-10. Module 6. Unit 1

1.

**Hollowing:**

Hollowing is a method of forming double curvature work by beating the metal to shape by means of hammering. Hollowing is usually used on ornamental work such as dishes, bowls and any spherical work.

2.

Any imperfection on the tools will transfer itself onto the work resulting in unwanted blemishes.

3.

Work out wrinkles by striking on peak or high spots of wrinkles. Work from apex or inner edge of wrinkle towards outer edge with a series of light blows.

4.

Strike a series of blows around the disc edge and work your way in towards the centre.

5.

A flat - faced hammer would be used for convex work and convex-faced hammers used on flat or slightly concave work.

6.

Greeks use the ratio 3:5 where as German and French metal workers use 2:5 and 5:8.

7.

Annealing:

When metals are bent, rolled or hammered they become work hardened. If they are not softened they may crack or tear.

Annealing is done to prevent this.

Annealing metal is achieved by heating the metal slightly above the recrystallisation temperature. It is then allowed to cool slowly.

This causes the grains in the metal to increase in size.

A low annealing temperature or a short annealing time will usually give a small grain size. A higher temperature or longer annealing time will give a larger grain size which is the preferred choice for decorative metalwork.

8.

The annealing temperature for:

<b>Aluminium</b>	650°F for alloy 1100
	750°F for alloy 3003
	650°F for alloy 5052

<b>Copper</b>	1100°F
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9.

- Pewter
- Aluminium
- Zinc-based alloys

10.

Always add the acid to the water slowly, mix the solution with a stick as you add the acid.

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