Welding Technology Institute of Australia

INTERNATIONAL WELDING PRACTITIONER (IWP)
INCORPORATING
AS 1796 CERTIFICATES 1 TO 8

AND
OTHER NATIONAL/INTERNATIONAL QUALIFICATIONS

SAMPLE QUESTIONS AND ANSWERS BANK

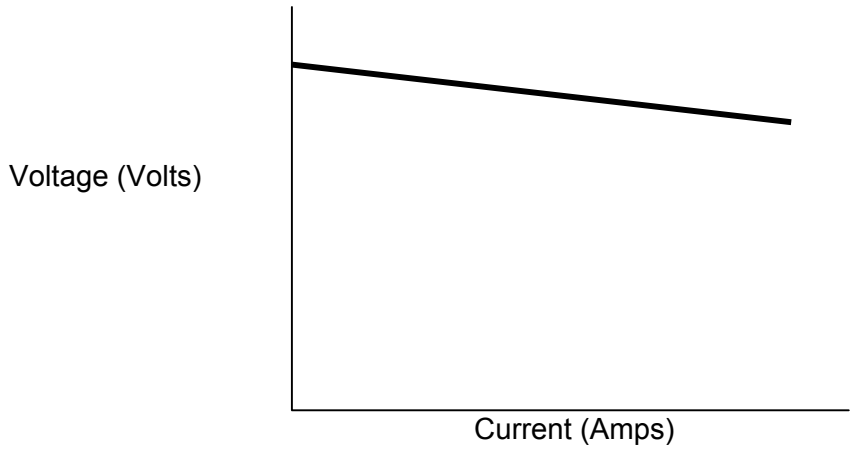
PAPER PA1
WELDING PROCESSES AND EQUIPMENT

QUESTION 1

1.1 What are the four modes of metal transfer in GMAW process? **8 marks (Ref: 1.9)**

- Short circuit
- Globular
- Spray
- Pulsed

1.2 Draw below a typical "Voltage vs Current" graph for a constant voltage (potential) welding power source **12 marks (Ref: 1.9, 1.6)**



QUESTION 2

2.1 What is "duty cycle" with reference to a welding power source? What does 25% duty cycle at 250A mean? **10 marks (Ref: 1.6)**

Duty cycle is the amount of time a welding machine can be used at a particular output. Expressed as a percentage of a ten minute cycle, a 250 A machine with a 25% duty cycle set at maximum will allow 2.5 minutes of use for every ten.

2.2 What is meant by an "electrical stickout" for GMAW welding? What are the effects of increasing the electrical stickout on welding? **10 marks (Ref 1.9)**

Electrical stickout is the term used to describe the distance of the wire from the contact tip to the workpiece.

An increase in electrical stickout increases the preheat of the wire, reduces heat to the arc pool, slows the melting of the parent metal and decreases penetration

QUESTION 3

3.1 List three possible causes for tungsten inclusion in welds. **6 marks (Ref: 1.8)**

- Current too high for the size of electrode
- Poor electrode preparation
- Touching the workpiece with the electrode
- Welding with a badly contaminated electrode

3.2 List three types of welding currents available for the GTAW process. Which type is most commonly used? **8 marks (Ref: 1.8)**

- DC – electrode negative
- DC – electrode positive
- AC – high frequency

DC electrode is the most commonly used

3.3 State three limitations of the GTAW process **6 marks (Ref: 1.8)**

- Thorough cleaning of the part is essential
- Welding close to an air draught or the slightest breeze can cause loss of gas shield resulting in porosity
- Manual GTAW is slow compared to other processes.

QUESTION 4

4.1 What are the functions of the flux used in Submerged Arc Welding? **10 marks (Ref: 1.11)**

Submerged Arc Welding (SAW) shields the weld arc using a granular flux fed into the weld zone forming a thick layer that completely covers the molten zone and prevents spatter and sparks. It also acts as a thermal insulator, permitting deeper heat penetration. The flux close to the arc melts and intermixes with the molten weld metal and helps purify and fortify it.

4.2 Explain the electrode classification system of AS/NZS 1553 Part 1,which deals with low carbon steel electrodes for manual metal-arc welding of carbon steels and carbon-manganese steels, for a typical electrode class shown below: **10 marks (Ref: 1.10)**
E xxxx (Explain the meaning of each of the characters in the classification)

E = Electrode

First two numbers = 1/10 of the weld metal's tensile strength in MPa

Second two numbers = flux type, welding position and current type.

QUESTION 5

5.1 Briefly explain the principles of plasma arc cutting **12 marks (Ref: 1.14)**

The basic principle is that the arc formed between the electrode and the workpiece is constricted by a fine bore, copper nozzle. This increases the temperature and velocity of the plasma emanating from the nozzle. The temperature of the plasma is in excess of 20000°C and the velocity can approach the speed of sound. When used for cutting, the plasma gas flow is increased so that the deeply penetrating plasma jet cuts through the material and molten material is removed.

5.2 List four safety precautions that you would take when handling oxygen cylinders during oxy-acetylene welding **8 marks (Ref: 1.2)**

- Oxygen cylinders should not be stored with combustible substances
- Oxygen under pressure should never be directed at a person. It could cause serious injury
- Store oxygen cylinders in a cool place.
- Oxygen under pressure reacts with oils and grease. Don't handle equipment with oily hands or store cylinders with oil, grease etc

PAPER PA2
MATERIALS AND THEIR BEHAVIOUR DURING WELDING

QUESTION 1

1.1 Which space lattice do the crystals of vanadium have at room temperature?

2 marks (Ref: 2.4)

- Body-centred cubic

1.2 Which space lattice do the crystals of aluminium have at room temperature?

2 marks (Ref: 2.4)

- Face-centred cubic

1.3 Which space lattice does the crystals of magnesium have at room temperature?

2 marks (Ref: 2.4)

- Close packed hexagon

1.4 What is alpha iron? **8 marks (Ref: 2.5)**

Ferrite or alpha iron is a materials science term for iron, or a solid solution with iron as the main constituent, with a body centred cubic crystal structure. It is the component which gives steel and cast iron their magnetic properties, and is the classic example of a ferromagnetic material.

1.5 Give the range of carbon content (in percentage) for the following steels:

6 marks (Ref: 2.5)

- Low carbon steels: 0.1% to 0.3%
- Medium carbon steels: over 0.3% to 0.5%
- High carbon steels: over 0.5%

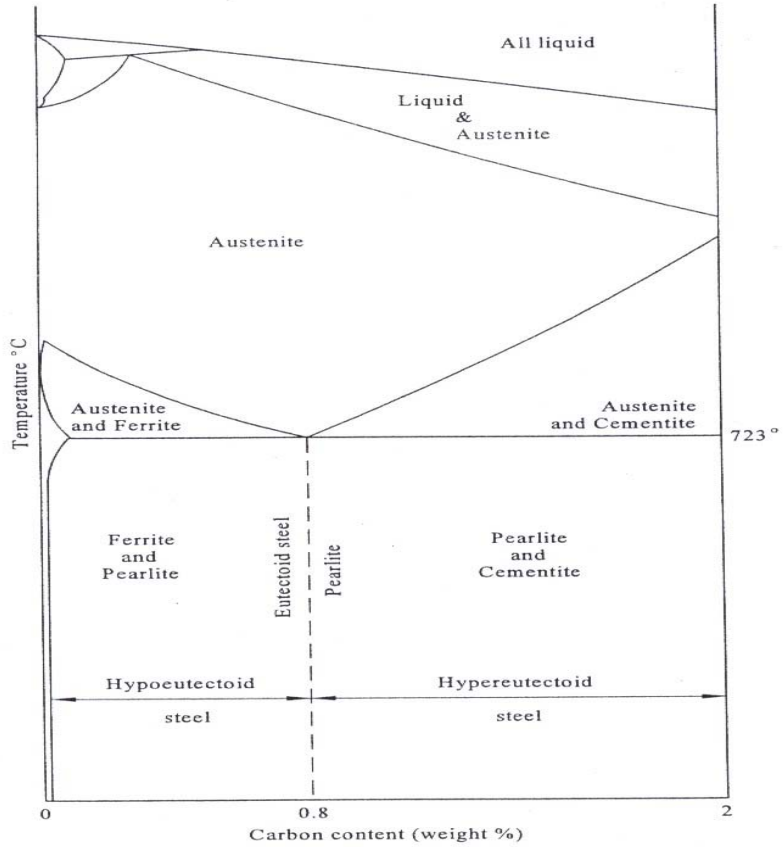
QUESTION 2

2.1 What is a phase or equilibrium diagram? What information does it provide?

It is a two-dimensional graph which indicates the phases present at a given temperature and composition. **8 marks (Ref: 2.4)**

- To get some idea of the conditions of temperature and pressure that are most likely to produce a gas, a liquid, or a solid.
- To find the combinations of temperature and pressure at which two states are in equilibrium.

2.2 Given the steel section of the simplified iron-iron carbide phase diagram below, identify and mark the structures which exist, on the diagram, for different carbon contents and at different temperatures. **12 marks (Ref: 2.4)**



QUESTION 3

3.1 What are the three factors that determine the pre-heating temperature for carbon steel? **8 marks (Ref: 2.6, 2.11)**

- The welding process
- Chemical composition of the consumables and the parent metal
- Material thickness & geometry of the joint

3.2 What is meant by the "carbon equivalent" of a commercial steel? **5 marks (Ref: 2.6)**

The carbon equivalent is a calculation used to determine the weldability of a low alloy steel compared to the weldability of plain carbon steel

3.3 Wrought aluminium alloys are classified into **2 marks (Ref: 2.23)**

- 7 groups

3.4 The major alloying element in the 7000 series of wrought aluminium alloy is **2 marks (Ref: 2.23)**

- Zinc

3.5 Comment on the weldability of the 2000 series of wrought aluminium alloy and give a typical application example **6 marks (Ref: 2.23)**

The weldability of these alloys ranges from fair to not recommended. Some grades with low copper contents can be welded but these alloys not been designed for fabrication by welding.

Eg. Truck frames/panels, aircraft fittings, rivets and fastners

QUESTION 4

4.1 Define "stainless steel". How is the "stainless" property achieved? List the four main groups of stainless steel. **10 marks (Ref: 2.15)**

It is a ferrous alloy with a minimum of 10.5% chromium content. Stainless steel has higher resistance to oxidation (rust) and corrosion in several environments.

High oxidation resistance in air at ambient temperature is normally achieved with additions of more than 12% (by weight) chromium. The chromium forms a layer of chromium oxide (Cr_2O_3) when exposed to oxygen. The layer is too thin to be visible. It is, however, impervious to water and air, protecting the metal beneath.

- Austenitic
- Ferritic
- Martensitic
- Duplex

4.2 What is creep? Give an example of creep resistant material. **10 marks (Ref: 2.14)**

Creep is the term given to the material deformation that occurs as a result of long term exposure to levels of stress that are below the yield or ultimate strength. The rate of this damage is a function of the material properties and the exposure time, exposure temperature and the applied load (stress).

Eg: stainless steels, refractory metal alloys

QUESTION 5

5.1 Why is hydrogen a concern in welding? **10 marks (Ref: 2.11)**

Hydrogen contributes to delayed weld and/or heat affected zone cracking. Hydrogen combined with high residual stresses and crack-sensitive steel may result in cracking hours or days after the welding has been completed.

5.2 Why is preheat sometimes required before welding? **10 marks (Ref: 2.23)**

Preheating the steel to be welded slows the cooling rate in the weld area. This may be necessary to avoid cracking of the weld metal or heat affected zone. The need for preheat increases with steel thickness, weld restraint, the carbon/alloy content of the steel, and the diffusible hydrogen of the weld metal. Preheat is commonly applied with fuel gas torches or electrical resistance heaters

PAPER PA3
CONSTRUCTION AND DESIGN

QUESTION 1

1.1 Explain the following terms with reference to a metal:

a) Fatigue strength **8 marks (Ref: 3.8)**

The maximum stress that can be sustained for a specified number of cycles without failure, the stress being completely reversed within each cycle unless otherwise staled.

b) Fatigue life **8 marks (Ref: 3.8)**

The number of cycles of stress that can be sustained prior to failure under a stated test condition.

1.2 What is the difference between a weld and a joint? **4 marks (Ref: 3.4)**

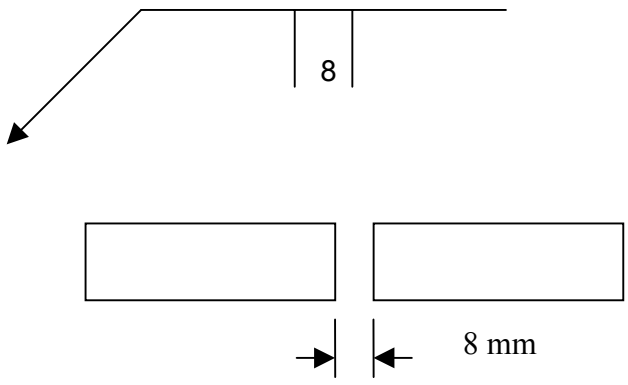
A joint represents the type of mating of parts to be welded whereas a weld is the fusion of parent material at the joint

QUESTION 2

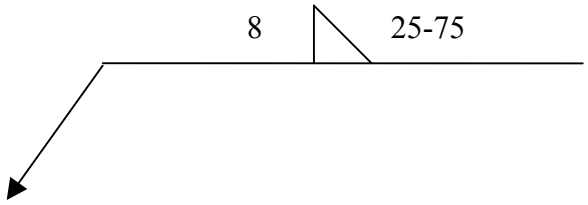
2.1 Draw the sketch of the joint for the welding symbols shown below:

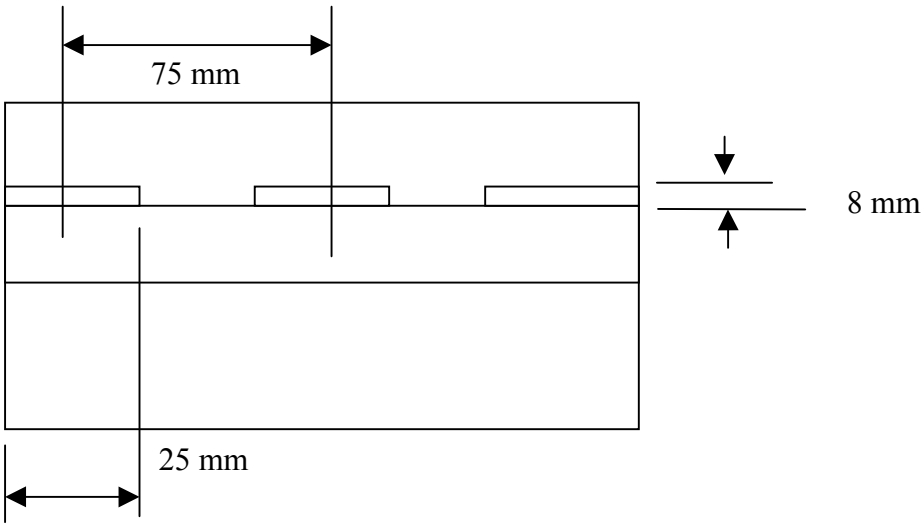
10 marks (Ref: 3.4)

a)



b) **10 marks (Ref: 3.4)**

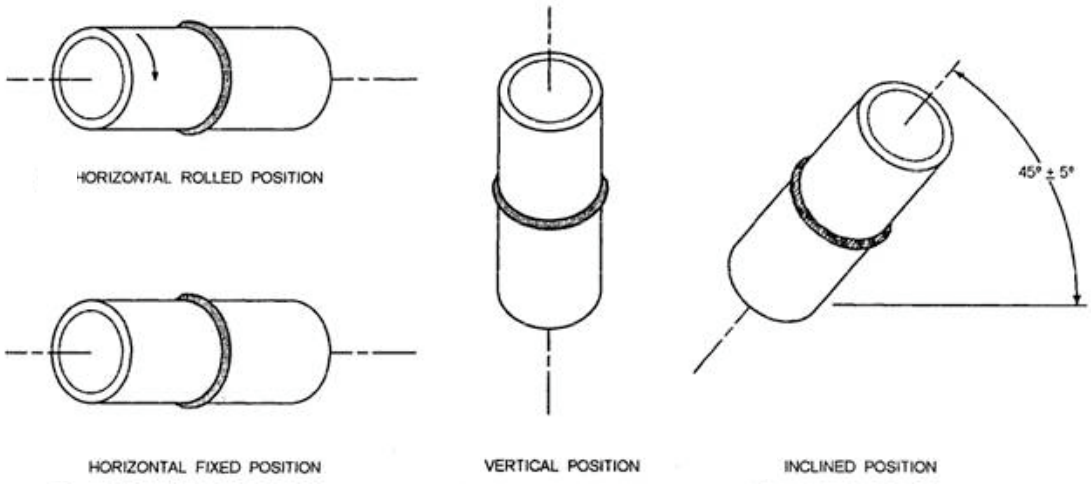




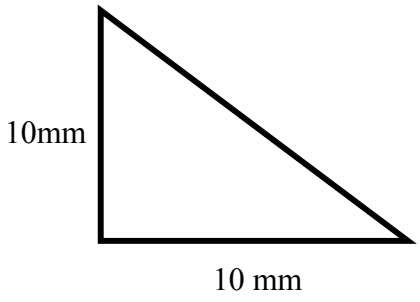
QUESTION 3

3.1 Under each of the diagrams below, write the ISO designation of the positional welding.

i.e _G **12 marks (Ref: 3.4)**



3.2 Calculate the throat length of the fillet weld which has the leg lengths as shown below:
8 marks (Ref: 3.4)



Throat length = 0.707 x Leg length = 0.707 x 10 = 7.07 mm

QUESTION 4

4.1 List three detrimental effects of notches in a welded structure. **6 marks (Ref: 3.8)**

- Reduce tensile strength
- Reduce impact strength
- Reduce ductility
- Reduce toughness

4.2 List three weld defects that create significant notch effects. **6 marks (Ref:3.8)**

- Undercut
- Overroll
- Convex-shaped weld beads

4.3 What factors (give at least four) are taken into account when selecting and designing a joint for a welding application? **8 marks (Ref: 3.7)**

- Strength
- Accessibility for welding
- Mimimise distortion
- Cost of welding
- Accessibility for inspection

QUESTION 5

5.1 What are the "axial stress" and "hoop stress" in a pressure vessel? **8 marks (Ref: 3.10)**

Hoop stress is the circumferential stress in a material of cylindrical form subjected to internal pressure.

Axial stress is the longitudinal stress in a material of cylindrical form subjected to internal pressure.

5.2 Explain the "GTAW dressing" technique to improve the fatigue life of welded components. **12 marks (Ref: 3.8)**

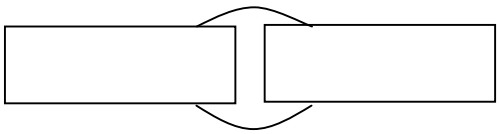
GTAW dressing is a technique that can be used to improve the fatigue life of a transversely loaded tee and butt joint. In this case, metal at the toe is not removed, only redistributed. A GTAW arc is run along the toe of the weld to remelt both the base material and weld cap. No filler metal is used. The GTAW bead should have a width of approximately 6 mm and a current of 150 to 200 A is generally required.

PAPER PA4
FABRICATION AND APPLICATIONS ENGINEERING

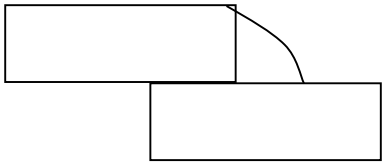
QUESTION 1

1.1 What are the five basic types of welded joints? Give an example of each with a neat sketch.

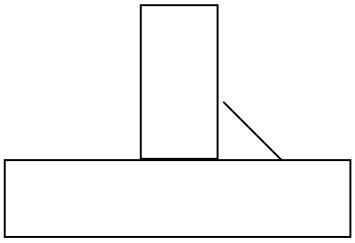
20 marks (Ref: 4.8)



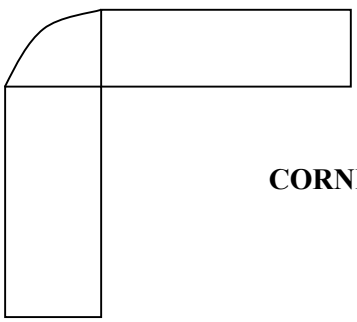
BUTT JOINT



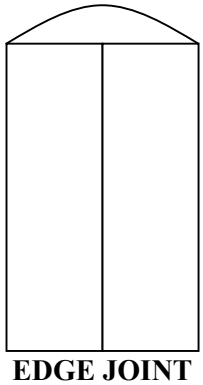
LAP JOINT



T-JOINT



CORNER JOINT



EDGE JOINT

QUESTION 2

2.1 What is a welding procedure specification (WPS)? **7 marks (Ref: 4.2)**

The WPS is a written document that provides direction to the welder for making production welds in accordance with Code/Standard requirements.

2.2 How is the Procedure Qualification Record (PQR) different from the WPS (Welding Procedure Specification)? **7 marks (Ref: 4.2)**

Procedure Qualification Record certifies that test welds performed in accordance with the WPS meet Code requirements and summarizes the specific test results.

2.3 What is a "Weld Map" and how is it used? **6 marks (Ref: 4.1)**

It is an isometric drawing showing the location and numerical identification of each weld used in the construction of a process piping system. Each weld, when completed, is labelled with the weld number indicated on the weld map, the date completed, and the welder/welding operator identification number or code.

QUESTION 3

3.1 Give two methods for minimising residual stresses **6 marks (Ref: 4.3)**

- Preventing overwelding: The more material that is placed in a weld preparation, the greater the shrinkage force will be
- By placing weldments as close to the neutral axis of the fabrication

3.2 Give two causes for the following weld imperfections and two methods of preventing them.

6 marks (Ref: 4.6, 4.3)

a) Lack of fusion

Causes:

The principal causes are too narrow a joint preparation, incorrect welding parameter settings, poor welder technique and magnetic arc blow. Insufficient cleaning of oily or scaled surfaces can also contribute to lack of fusion.

Prevention:

- use a sufficiently wide joint preparation
- select welding parameters (high current level, short arc length, not too high a welding speed) to promote penetration into the joint side wall without causing flooding

- ensure the electrode/gun angle and manipulation technique will give adequate side wall fusion
- use weaving and dwell to improve side wall fusion providing there are no heat input restrictions
- if arc blow occurs, reposition the current return, use AC (in MMA welding) or demagnetise the steel

b) Porosity **6 marks (Ref: 4.6, 4.3)**

Causes:

- Poor welding techniques, contaminated base material or electrode, lack of proper gas shielding
- Porosity is caused by the absorption of nitrogen, oxygen and hydrogen in the molten weld pool which is then released on solidification to become trapped in the weld metal.

Prevention:

- seal any air leak
- avoid weld pool turbulence
- use filler with adequate level of deoxidants
- reduce excessively high gas flow
- avoid draughts
- dry the electrode and flux
- clean and degrease the workpiece surface
- clean the joint edges immediately before welding

QUESTION 4

4.1 List three types of weld imperfections that can be detected by the following NDT methods. **(Ref: 4.7)**

a) Magnetic particle **6 marks**

Magnetic particle inspection (MPI) is used for the detection of surface and near-surface flaws in ferromagnetic materials.

b) Ultrasonic **7 marks**

Ultrasonic method is used for the detection of surface and sub-surface flaws in ferromagnetic materials.

c) State two limitations of the radiography method of non-destructive testing **7 marks**

Access to both sides of the part is needed in order to produce a radiograph
Interpretation of film takes much training and experience

QUESTION 5

5.1 What does "open circuit voltage" mean? **8 marks (Ref: 4.4)**

A welding machine that is turned on but not being used for welding at the moment will have an open-circuit voltage applied to the cables attached to the output terminals of the welding machine. No current flows in the circuit because the circuit is open. The voltage is impressed upon the circuit, however, so that when the circuit is completed, the current will flow immediately.

5.2 List six important check points that you would use to prevent electrical shocks while welding with GMAW welding equipment. **12 marks (Ref: 4.5)**

- The use of dry, hole-free welding gloves on both hands while welding
- Turn off the power at end of each shift or when taking a break.
- Do not drag live leads to the work.
- Use dry, fire resisting insulation eg. Wooden duckboards, leather covered cushions, leather aprons, leather jackets, heat resisting blankets.
- In hot conditions the risk of electrocution is increased because of clothing and equipment being soaked in perspiration. Take frequent rest periods, during which time dry off equipment and clothing.
- Either a voltage limited welding power source should be used, or the power should be controlled by a contractor switch on the torch.