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PRE-LEAVING CERTIFICATE EXAMINATION, 2006

MARKING SCHEME

ENGINEERING

HIGHER AND ORDINARY LEVEL

Higher Level

Marking Scheme

Question 1 — 100 Marks				
Section A = 50 Marks any 10 = 5 marks each				
Section B = 50 Marks				
N	**O**	**P**	**Q**	**R**
(i) 1 + 3 (ii) 1 + 3 (iii) 2 + 2	2 × 4	14	(i) 3 (ii) 3 (iii) 2	(2 + 2) × 2

Question 2 — 50 Marks		
A	**B**	**C**
3 + 3 + (1 + 1 + 1) 2	(3 × 2) + (3 × 2) + 3 + 6	4 + 4 + 4 + (3 + 3)

Question 3 - 50 Marks		
A	**B**	**C (any two)**
(2 + 2) + (1 + 1) + 3 + 3	2 × 8	(6 + 5) + (4 + 4 + 3) + (2 + 3 + 6)

Question 4 — 50 Marks		
A	**B**	**C**
4 × 4	3 + 8 + (5 + 5)	7 + 6

Question 5 — 50 Marks			
A	**B**	**C**	**C**
6 + 6	(1 + 4 + 8) + 4 + (3 + 3)	15	15

Question 6 — 50 Marks		
A	**B**	**C**
(2 + 3) × 3	(2 + 2) × 3 + (1 + 1) × 3 + 3	3 + 4 + 7

Question 7 — Marks			
A	**B**	**C**	**C**
(3 × 3) + 5	4 + 4 + 4 + (2 × 3)	(2 + 2) × 2 + 5 + 5	(3 × 6)

Question 8 — 50 Marks			
A	**B**	**C**	**C**
(3 × 3) + (3 × 3)	4 + 4 + (5 + 4)	5 × 3	15

Higher Level

Question 1

Section A

(a) Narcotic effects result from inhaling fumes, vapours etc. produce drowsiness, headache, instability even death. Prevention: Good ventilation and masks, clothing.

(b) Perspex – secondary bonding, aluminium – metallic bond, diamond – covalent bond.

(c) Can bond variety of materials, non corrosive, structure of parent metal not affected.

(d) Tank, foaming agent, air, material stick to bubble, rise to top, skimmed off into settling tank.

(e) Don't direct it at or allow to come in contact with any part of body, never mix or allow it come in contact with combustible materials.

(f) It will be hard and brittle — known as martensite.

(g) Ensures that the stresses which a structure is designed for will not be exceeded in practice either through deterioration in materials or fluctuation in applied loads.

(h) Plug gauge – check hole size Gap gauge – check shaft size.

(i) Impact test – tests for toughness.

(j) Failure of a metal under a repeatedly applied stress. The stress required to cause failure if applied many times, is much less than that required to break the material with a single application.

(k) Car body – pressed and spot welded, Bearing body – cast, bicycle – extruded pipe. Then TIG welded (TAGS).

(l) Good design to prevent moisture traps, anodising, galvanising, dip coating.

(m) Dugald Clerck – 2 stroke engine, William Shockley – invented the transistor (1947).
Robert MacGhee – multi legged robot for use by US army.

Section B

(n) **(i)** The valve has 3 main ports and two states. As on diagram B – when the valve is operated at the left hand end port 1 (main air) is connected to port 2, and when reset to the normal state at the right hand end port 1 is connected to nothing.

(ii) This has 5 main ports and 2 states. When the valve is operated at the left hand side main air is connected to port 4 (also port 2 is connected to port 3, exhaust). When reset to the normal at the 'spring side' port 1 (main air) is connected to port 2 (also port 4 is connected to port 5 – exhaust).

(iii) X is a flow control valve and its function is to regulate the outstroke and instroke speed. A uni-directional flow regulator has free flow in one direction and adjustable restricted fl ow in the other direction.
Y is an FRL which stands for filter, regulator and lubricator. They form a unit which will prepare the condition of compressed air just before delivering it to pneumatic equipment or machinery.

(o) Cylinder A goes positive and rotates the table through part of a rotation. Cylinder B goes positive and the shaft engages in a hole in the base of the table. Cylinder A goes negative disengaging from the table. Cylinder B goes negative unlocking the table to allow further movement

(p) The signal given by the completion of each movement will initiate the next movement.. i.e. the signal given by completion A+ is a1. Therefore the limit switch initiating B+ will be labelled a1. This will continue such that b1 will return cylinder A and a0 will return cylinder B.

(q) **(i)** Used for the control and sequencing of applications. If the sequencing is complicated. One or more of the cylinders may be used several times in a cycle and where accuracy is required. The PLC operates by monitoring input signals from such sources as proximity, heat, pressure or level sensors etc..

(ii) To overcome the problem of opposing signals the cascade system was devised. The basis of the system is the division of movements into groups. These groups are then provided with air supplies, only one of which is pressurised at any one time.

(iii) Take the sequence and apply the cascade technique of splitting into groups. If the sequence is not very complicated it will result in a two or three group pneumatic cascade system. If there are only a few time delays and no long counting procedures cost will be much lower.

(r) Uses: Rock drilling, dentist drilling, paint spraying, pneumatic machine tools etc..
Advantages: Safe, Speed control much easier to achieve, Lighter tools, Linear motion easier to achieve.

Question 2

(a) **Destructive tests** – hardness, tensile and impact tests.
Non-destructive tests – ultrasonic, magnetic particle and x-ray.

(b) **(i)** stress = force/c.s.a. – The load (force) per unit of cross sectional area of material.
strain = extension/original length. The amount of extension produced in unit length of material Youngs Modulus = stress/strain. Within the elastic range of a material stress $\propto$ strain. Stress/Strain will be constant for each material. Measure of the stiffness of a material.

(i) A – yield point or limit of proportionality.
B – is the ultimate tensile strength.
C – is the breaking (fracture) strength.

(ii) Tensile strength of mild steel as shown is 400 N/mm².

(iii) Youngs modulus is obtained by the slope of the straight line part of the graph in maths terms:

$$\frac{Y^2 - Y^1}{X^2 - X^1}$$

(c) **(i)** X-ray testing.

(ii) A high voltage discharge tube produces x-rays. Heating the cathode to a high temperature

releases electrons. These electrons are then speeded up by a high DC voltage and are aimed at the anode. Some electrons penetrate the atoms of the metal anode and this causes energy to be released as x-rays. The anti cathode is angled so that the x-rays are aimed towards the work. x-rays will penetrate materials that ordinary light will not. The x- ray image can be viewed on a fluorescent screen or be printed onto photographic film.

(iii) Used to test welds, gas pipe lines, etc.

(iv) Penetrant test or ultrasonic test magnetic particle test, etc.

Question 3

(a) **(i)** Face centred cubic (fcc) and Body centred cubic (bcc).

(ii) FCC = 14 atoms; BCC = 9 atoms.

(iii) Slippage is more likely to occur in face centred cubic structures as the atoms are more tightly packed in the FCC structure meaning that the energy required for each row to rise over the top of each atom is less than that required for BCC as the atoms are further apart.

(iv) This is very important particularly when heat treating steels. When heated above the upper critical temperature its structure changes from BCC to FCC and all the carbon is dissolved in the austenite. Depending on the method of cooling will depend on the properties that the steel will have. This is why allotropy is important for steels.

(b)

Microstructure	Numbered position	Name of Microstructure
A	1	Ferrite
B	7	Pearlite
C	6	Pearlite + Cementite
D	3	Pearlite + Ferrite

(c) **(i)** Both are methods of surface hardening. **Carburising** involves heating the component in a carbon rich material (solid, liquid or gas) at a temp of 900 – 950º C. Depending on the time allowed, carbon diffuses into the surface of the component to a particular depth. The component can then be heat treated in the normal way.
Nitriding is used to produce hard nitrides in the surface of components by diffusing atomic nitrogen into the surface from a surrounding atmosphere of ammonia. The process takes about 36 hours at a temp of 500ºC to produce a case of 0.2mm thick.

(ii) **(a)** **Stress relieving:** Component heated and held at that temp. for a long time. It is then cooled slowly. The time and the temp. depend on the component.

(b) **Normalising:** Component heated to the prescribed temp. and allowed to soak until it is heated uniformly. It is then allowed to cool in air. This gives the material a finer grain size and removes internal stresses. A forged chisel would be normalised in this way.

(c) **Annealing:**This process softens the material. The steel is heated up above the UCT. It is then allowed to cool very slowly by switching off the furnace. Steel which is deep drawn requires this treatment.

(iii) This works on the principle that if one of the wires is hot, heat will flow from the hot side to the cold side. This movement will create a small voltage. The pyrometer uses a couple of different wires i.e. iron and constantin to create a manageable electric flow, which can be metered and then calibrated into temperature readings.

Question 4

(a) (i) **Dendrite:** The unit cell forms and grows to form a dendrite similar to how ice crystallises and freezes. It is a tree like structure which characterises the growth of a crystal from molten metal during the solidification process. Depending on the unit cell arrangement atoms from a nucleus which grow in a preferred direction and branch out in typical dendritic form.

(ii) In a eutectic alloy system the two metals are completely soluble in each other in the liquid state but completely insoluble in each other in the solid state. After cooling, crystals are formed which are made up of two separate metals.

(iii) When one atom is missing, a **vacant** site is present. This distorts the lattice

(iv) A **dislocation** is where a row of atoms is incomplete.

(b) (i) Liquidus — above the liquidus line the alloy is completely liquid;
Solidus — below the solidus line the alloy is in the solid state;
Solvus — lines representing the range of temperatures where solid to solid transformation of structure takes place.
Eutectic point : represents the change point from liquid to solid for a composition of the alloy which takes place at constant temperature, i.e. without a pasty stage.

(ii) Tinmans solder occurs at 183ºC and at a composition of 38% lead, 62% tin;

(c) (i) Solid phase: 87% lead and 13% tin
Liquid phase: 62% lead and 38% tin;

(ii) Ratio of the phases:

$$\frac{30 - 10}{38 - 30} = \frac{20}{8}$$

Answer = 2.5

Question 5

(a) **Arc welding** is a fusion welding process in which an electric arc maintained between the electrode and the joint provides a concentrated heat source necessary for welding. The arc is also the vehicle whereby weld metal is transferred from the consumable electrode to the joint.

Resistance welding is essentially a solid state process in which parts are clamped between two electrodes through which a large current is passed. The pressure and heat produced by the electrical resistance at the joint raises the temperature to the point where the pressure of the electrodes on the joint achieves coalescence between the parts.

(b) (i) Diagram should be labelled to include transformer, rectifier, capacitor and resistor. Diodes must be facing correct direction.

(ii) Direction of current flow – arrows going from A down through diode (on right of parallelogram) down through resistor, parallel to A up to intersection of rectifier (on left) over to B.

(iii) X is a capacitor – absorbs excesses or peaks in current flow and emits current when dips or a lack of current are experienced. Results in a smooth current output.
Y is a resistor – slows down the flow of current – particularly for diodes.

(c) Submerged arc welding – this is a fully automatic process in which a bare wire electrode provides an electric arc to the joint. A granular flux is fed from a hopper and spread over the joint, just ahead of the moving electrode. The heat from the unseen arc causes local melting of the flux, the joint and the electrode. Welding speeds and currents are high and the heat is concentrated beneath the flux so that thick sections are easily welded.

OR

(c) Robots offer the following possibilities:

i. An increase in output of 2 – 4 times that of manual operation.

ii. 24 hour continuous production.

iii. Increased quality assurance and consistency of product.

iv. Improved working conditions and work practices.

Question 6

(a) (i) Bakelite is produced by condensational polymerisation. The starting monomers for the reaction include unwanted groups of atoms which are given off as a by-product, usually water.

(ii) Vinyl-chloride – vinyl acetate is produced by means of co-polymerisation, which involves two different monomers in the reaction. Successive monomers of vinyl chloride and vinyl acetate line up to form the molecular chains.

(iii) Polyethylene is produced by additional polymerisation breaking the double bond between the carbon atoms in the ethylene monomers causing them to link up additively, producing the long chain molecules of polyethylene.

(b) (i) The three structures are linear, branched and cross-linked

Linear – produced by additional polymerisation. Chain molecules bonded together along their length by weak van der waals forces. These bonds are weak and can be easily overcome by heat or pressure. Properties include low melting point and low tensile strength.

Branched chain — produced by additional polymerisation. Chain molecules bonded together along their length by weak van der waals forces. The presence of side branching means that each chain has a greater surface area and consequently more van der waals forces resulting in the polymer being stiffer and stronger. Higher melting point than a polymer with linear chains e.g. polyethylene

Cross-linked chain – This type of chain results from condensation polymerisation. The bond between adjacent molecular chains are covalent bonds called cross links. These cross links are much stronger than van der waals forces operating in thermoplastic materials. This results in high tensile strength, rigidity and resistance to heat. Phenol formaldehyde is an example.

(c) **Electric switch cover** – phenol formaldehyde / phenolic resin resists high temperatures good insulator of electricity and heat, hard.

Compression moulding – condensational polymerisation.

Nylon gears – made from nylon (polyamides). Resists abrasion, hard and strong

Injection moulding – nylon is formed by a condensational polymerisation process.

Acrylic bath – Acrylic sheet (poly methylmethacrylate). Can be coloured, fine smooth finish, hard, resistance to water, good electrical insulator.

Vacuum formed – base reinforced with wood.

Question 7

(a) (i) **Continuous chip** – formed when machining ductile materials such as aluminium.

Discontinuous chip – formed when machining brittle materials, such as brass.

Chip with built up edge – very rough surface on the underside of the chip and also on the machined surface of the work. Use of coolant will prevent 'welding' of particles of the work onto the tool face.

(b) (i) Dividing head worked by means of worm and wormwheel.

(ii) In general it can be used with a vertical milling machine for a variety of accurate work.

(iii) Ratio of worm to wormwheel is 40:1. Variety of pitch hole circles on the front of dividing head. This will mean that if a chuck is attached to the wormwheel shaft then it can be turned through any angle. The work can then be rotated and the vertical milling cutters will machine the surface.

(iv) Ideal for cutting spur gears, drilling holes evenly on the surface of a cylindrical bar. Producing helical grooves and helical gears.

(c) (i) Negative rake tools. Positive rake tools.

Negative rake tools: Tangential force is taken on a more well supported part of the tool. The force is transmitted down into the machine foundation. This increases the strength of the tool.

Positive rake tools: have a more reduced volume of metal at the point of the tool where the main cutting forces are acting. This force is unsupported.

(ii) **Negative rake tools** – Tungsten carbide tipped tools. Positive rake tools – High speed steel

(iii) **Negative rake tools** can be run at much higher speeds. Depth of cut can be increased also.

Positive rake tools cannot be run at higher speeds. More suitable for finishing cuts. Slow speed and slow feed for best finish.

OR

(c) **(i)** CNC – computer numerical control. Automatic lathe process where the cross slide and top slide are moved by stepper motors (electric pulses). Computer programmes can be written to incorporate the various operations, processes and parameters in the order required to complete the particular part. A variety of accurate work can be produced on CNC lathes and CNC milling machines.

(ii) CAD – computer aided design. A systems approach to designing for a wide variety of applications in mechanical engineering design. Individual parts can be designed and assembled, moved about, observed from different viewpoints and modified if necessary. Hard copies can be produced by outputting programmes to printers and plotters.

(iii) CAM – concerns the execution of individual manufacturing tasks using control by computers. CNC machining is one example of CAM; other examples are the use of a robot for welding or spray painting operations.

Question 8

(a) **(i)** Bull wheel and slotted link for a shaping machine – quick return mechanism.
The slotted link mechanism allows the ram to return on its idle stroke quicker than it takes to complete its cutting stroke. Moving the crankpin location relative to the centre of the slotted wheel alters the length of stroke. Locating the pin at the farthest point from the centre sets the maximum stroke. Provides a return stroke, which is faster than the cutting stroke.

(ii) Labelled diagram should include cam, compression spring, spark plug, valve, head of engine
One correction to the drawing would be that since the cam is at its max – the valve should be in the open position

(b) **(i)** A is straddle milling. When the cutters are mounted on the arbour of a horizontal milling machine and are separated by spacing collars – this is known as straddle milling.
B is known as gang milling. When the cutters are mounted adjacently on the arbour as shown. Each cutter is performing a machining operation.

(ii) **(i)** **Strain gauge:** It is a device for measuring the changes in the distance between points on a component, which occurs when the component is deformed. The principle of the strain gauge is based on the fact that when an electric conductor is stretched it gets longer and thinner and these effects cause the electrical resistance of the conductor to increase.

(ii) **A non–return valve:** It allows fluid/air to flow in one direction only similar to a diode in electrical terms. Pressure on one side of the valve overcomes the pressure provided by the spring and opens the valve allowing fluid/air to flow through. Pressure on the other side assists the spring and the valve remains closed preventing the fluid/air from returning.

(iii) **Integrated circuit**: This is an electronic circuit containing transistors, resistors, capacitors, etc. produced integrally in a small piece of semi–conductor material (chip).

(c) **(i)** Transformer
(ii) Turbine
(iii) Shock absorber
(iv) Thermistor
(v) Flow regulator

OR

(c) The automatic feed mechanism is operated from the headstock through the feed shaft to produce movement of the carriage along the lathe bed or movement of the cross slide across the carriage. A gear which is mounted on the feed shaft and rotates with it, is also capable of sliding along the feed shaft keyway. As the feedshaft gear rotates it can be connected to a gear train which provides power to the cross slide leadscrew by moving a lever on the apron. Alternatively it can be connected to a gear system which provides power to the carriage drive pinion engaged with the rack running along the lathe bed. In this case the feedshaft gear slides along the feedshaft which drives it simultaneously.

Ordinary Level

Marking Scheme

Question 1 — 65 Marks			
Section A — 30 Marks any 6 = 5 marks each			
Section B — 35 Marks any 3 at 12, 12, 11			
Question 2 — 45 Marks			
A	**B**	**C**	**D**
5 + 4	3 + 3 + 3 + 3	3 + 3 + 3 + 3	(2 + 2) × 3
Question 3 — 45 Marks			
A	**B**	**C**	
5 + 10	15	(3 + 2) ×3	
Question 4 — 45 Marks			
A	**B**	**C**	**C**
(4 + 4) + (4 + 3)	5 + 5 + 5	8 + 7	(3 + 2) × 3
Question 5 — 45 Marks			
A	**B**	**C**	
7 + 7	(2 + 2) × 4	4 + 4 + 4 + 3	
Question 6 — 45 Marks			
A	**B**	**C**	
3 + 3 + 3	5 + (4 × 3) + 2 + 2	4 + 4 + 4 + 3	
Question 7 — 45 Marks			
A	**B**	**C**	**C**
5 + 5 + 5	(4 + 3) × 2	8 + 8	16

Ordinary Level

Question 1
Section A

(a) Goggles must be worn, no jewellery and long hair tied back and covered.
(b) **(i)** Iron **(ii)** Aluminium.
(c) Production of baths.
(d) **(i)** Blast furnace and **(ii)** Cupola furnace.
(e) To improve the mechanical properties of a metal.
(f) Buttress and acme threads.
(g) Extrusion.
(h) The combined friction between both surfaces of the belt and the pulley wheel ensures that there is better grip, better alignment.

Section B

(i) Software – Instructions that come on disk and tell your computer what to do and how to do it.
VDU – Visual Display unit.
WWW – World Wide Web.
CPU – The brain of the computer. Stands for central processing unit. The chip that processes all of the data that flows through the system unit.

(j) **(i)** Plastic Dip coating unit – used to blow air into granular plastic to fluidise it so that hot metal can be dipped into the plastic easily. The air being blown through the plastic ensures an even adhesion of the plastic to the hot metal.

(ii) Drill bits greater than 13mm have a tapered shank. If the taper shank of the drill or reamer is to small to fit the machine in which it is to be used a 'sleeve' is used to bring the taper up to the correct size. It is not uncommon for a 'small drillbit' to require two sleeves. Sleeves will fit into drills and tailstock of lathes.

(iii) Electric soldering irons are used to solder electrical components in electronic circuits and are rated from 15W to 100W. The advantage of a high wattage is that heat can flow quickly into a joint. Electric soldering heat the special metal tip by means of an element. Hold the heated iron next to the component to be soldered and melt the solder quickly on the joint. In order to cut down and ensure a steady current many of the soldering irons have transformers.

(k) Sketch should show tank, water, ballcock. A further sketch should show what happens when water level falls – releasing piston, and allowing water pressure to push piston back and allowing water to enter tank. As water level rises flow of water is restricted until finally a level is reached where piston valve blocks off flow of water and pressure restricts opening valve.

(l) Multimeter: Used to measure voltage, current and resistance and continuity in electronic components and circuits. Used for fault finding by electricians.
A stripheater is a plastic heating machine which allows the operator to heat a defined line of plastic which can then be bent to the required angle.
A solar panel is used to trap the suns energy using special photo cells which convert the solar energy into electrical energy.

(m) A = Battery, B = Resistor, X = LDR.
Component C is a diode and this device allows current flow in one direction only.

Question 2.

(a) Bauxite is the ore of aluminium (raw material). Cryolite is a material which has a lower melting point than alumina. Used to reduce and melt the alumina since alumina has a high melting point. The cryolite reduces the electricity required to melt the alumina.

(b) Casting = pistons, Bending = aluminium windows.

(c) **(i)** Copper. Excellent conductor of heat. Good to allow heat to flow. Solder will adhere to the iron following tinning.

(ii) Cast Iron. Good Damping properties, good wear resistance, can be cast and machined, scraped to a high standard of finish.

(d) Soft solder = lead and tin. Brass = Copper + zinc. Bronze = copper and tin.

Question 3

(a) Heat treatment is annealing. Component is heated in a muffle furnace and allowed soak at a temperature for a short period of time. Furnace is then switched off. Component is allowed to cool in the furnace. Component will now be in a soft workable condition.

(b) Case hardening. Low carbon steel does not contain sufficient carbon to enabled it to be hardened in the normal way. Component is packed in a box and surrounded with a substance rich in carbon. Box is sealed with clay. Furnace is preheated to 950 degrees component is placed in furnace and allowed soak in it. 24 hours will give a skin of 1mm carbon case. Further heat treatments will have to be carried out to refine the core and harden the case.

(d) Air, brine (salt + water), oil and water.
Fastest is brine followed by water, next is oil and slowest is air.

Question 4

(a) Sketches of fixed steady and travelling steady to accompany description. Fixed steady is used to support pipe while drilling, boring or centering operation is taking place. Travelling steady will prevent bar from bending and oppose forces of cutting tool.

(b) **(i)** Mandrel – used to support a machined component when further work needs to be done on its external surface and it is unable to be held in a chuck.

(ii) Faceplate – used to grip irregular work which cannot be held or centred in a 3 or 4 jaw chuck. Work is normally bolted onto the suface of the face plate and is balanced centrifugally by means of balance weights.

(iii) Turning down – moving the cutting tool along the workpiece parallel to the axis of the work therefore producing a smaller cylindrical surface.

(c) **Rake Angle** – The angle ground at the top of a cutting tool sloping away from the cutting point therefore facilitating the removal of the chips.
Clearance Angle – The front and sides of the cutting tool are angled back from the cutting point to ensure that the cutting tool is touching the work at one point.

OR

(c) Perspex Guard on CNC lathe – automatic process. No hands near chuck or cutting tool during cutting process. CNC lathe will automatically cut off if safety guard is lifted. Manual lathe will work without guard in place. The CNC lathe ensures that the programme will be test run before manufacture. This is not the case for conventional lathes.
Speeds and feeds can be predetermined during programming. Making of the component is automatic making is safe for semi-skilled operators.

Question 5

(a) Thermoplastics are plastic materials which can be reheated and reshaped. Examples are acrylic, PVC and nylon. Thermosetting plastics once heated and set cannot be reheated. Examples are Fibreglass, epoxy resin and urea formaldehyde.

(b) **(i)** Polystyrene – Thermoplastic **(ii)** PVC – Thermoplastic **(iii)** Bakelite – Thermosetting
(iv) acrylic – Thermoplastic.

(c) **(i)** Labelled diagram

(ii) Compression moulding, extrusion, injection moulding.

(iii) Compression moulding — A polymer powder is placed in the mould and subjected to heat and pressure causing it to be forced into the shape of the mould. When cooled and set, mould opened and article removed.
Extrusion — The thermoplastic, in granular form is fed continuously Through the heating zone and die by means of a rotating screw. The shape of the die will determine the shape of the section produced.
Injection Moulding — The material in granular form is fed along a heated barrel and when the granules become plastic, the plunger forces them into mould. A thermoplastic material is used.

(iv) **(i)** Distributor caps, bottle tops, cups; (ii) PVC pipes; (iii) Refuse bins.

Question 6

(a) **(i)** Welding goggles, gloves, leather apron, steel toe-capped boots, flashback arrestors on bottles, ensure hoses not frayed/damaged, gauges working, bottles secure, well ventilated area.

(b) **(i)** Transformer

(ii) C = Primary coils B = Secondary coils. Alternating current flowing in coil C will create a magnetic field and will induce an alternating current in B. Depending on the number of coils in C and B will determine whether it is a step up or step down transformer.

(iii) D is a soft Iron core. The primary and secondary coils are wound around the iron core.

(c) **(i)** Copper + zinc **(ii)** 850 – 950 degrees **(iii)** Spelter between the two surfaces. An alloy of spelter and metal, then the two pieces of metal. Capillary action takes place.

(iv) Borax. Borax is a powder flux. Mixed with water to form a paste. Applied to joint.

Question 7

(a) **(i)** **Clearance fit** – When the limits of size of both the hole and the shaft are such that the shaft is always bigger than the hole.

(ii) **Interference fit** – When the limits of size of both hole and shaft are such that the shaft is always smaller than the hole.

(iii) **Transition fit** – When the limits of size of both the shaft and the hole are such that the condition may be of clearance or interference.

(b) Sketch should show a plug gauge (i) used for measuring holes. Go and No Go to be shown
Sketch should show a gap gauge (ii) used for measuring shafts. Go and No Go to be shown.

(c) Maximum clearance = largest hole – smallest shaft:-
0.059 = X (largest hole) – 49.971 implies X = 0.059 +49.971 = 50.03
Tolerance on hole = largest hole – smallest hole
Tolerance on hole = 50.03 – 50.00 = **<u>0.03mm</u>**

Minimum clearance = smallest hole – largest shaft
0.010 = 50.00 – Y (largest shaft)
–Y = – 50.00 + 0.010 – Y = – 49.990 implies Y = 49.990
Tolerance on shaft = largest shaft – smallest shaft
Tolerance on shaft = 49.990 – 49.971 = **<u>0.019mm</u>**

OR

(c) **Dial Gauge :** Used to check if surfaces are flat, parallel or when used in conjunction with a four jaw chuck to ensure a workpiece is 'clocked' true.
A spring loaded plunger protrudes out of the body of the dial indicator. Linear movement of this plunger is converted into angular movements of the pointer by a rack and pinion mechanism. A sensitive gearing system is used to convert small movements of the plunger into angular movements of the pointer.
Solenoid : In a solenoid the current in the coil causes a magnetic field which pulls the soft bar inwards. A spring is used to return the soft iron bar to its original position after the current is switched off.
Transistor : A transistor acts as a switch in an electric circuit. When a small current 0.6V flows into the base, resistance across the collector – emitter is low allowing current to flow. Transistor is now on. It can also be used as an amplifier in a circuit (gain from 20 – 800).