



Coimisiún na Scrúduithe Stáit State Examinations Commission

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Scrúduithe Ardteistiméireachta, 2005

*Innealtóireacht – Ábhair agus
Teicneolaíocht*

Gnáthleibhéal

Marking Scheme

Leaving Certificate Examination, 2005

*Engineering – Materials and
Technology*

Ordinary level



Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2005

ENGINEERING MATERIALS AND TECHNOLOGY

(ORDINARY LEVEL – 200 marks)

SAMPLE ANSWERS AND MARKING SCHEME

Required: Answer Question 1 and 3 others

QUESTION No. 1 - 65 MARKS

Marks

SECTION A - 30 MARKS

**6 parts @ 5 marks each
For two part answers award 3 + 2**

SECTION B - 35 MARKS

**2 parts @ 12 marks each
1 part @ 11 marks
Award 6 + 6 or 6 + 5 as Appropriate**

SECTION A – 30 MARKS

MARKS

- (a) Use all safety guards and wear visor for eye and face protection. Ensure work is securely held before machining.

3 + 2 Marks

- (b) Light Emitting Diode (L.E.D.).

5 Marks

- (c) Ferrous metals contain iron while non-ferrous metals contain no iron.

3 + 2 Marks

- (d) Polystyrene

5 Marks

- (e) (i) Square thread.
(ii) Buttress Thread.

3 + 2 Marks

- (f) Monitor (VDU), Printer, Plotter, CNC lathe, Speaker.

3 + 2 Marks

- (g) (i) A tapping size hole is smaller than the required thread size. This is to allow the tap to cut the thread into the wall of the drilled hole.
(ii) A clearance size hole is slightly larger than the screw that passes through it. The clearance enables machine screws to be inserted quickly. Washers have clearance holes.

3 + 2 Marks

- (h) Computer Aided Manufacture (CAM) refers to the use of computers for controlling machines in the manufacture of products. The CNC lathe is an example of Computer Aided Manufacturing system.

5 Marks

SECTION B – 35 MARKS (continued)

MARKS

(i) Any one:

(i) **Variable resistor:** A variable resistor can facilitate the flow of more or less current in a circuit. Depending on its application the resistance of a variable resistor can be changed in a number of ways. Mechanical adjustment may be achieved by the rotation of a spindle while variable resistors which respond to light or heat levels are also available.

(ii) **Strip Heater:** A strip heater is used to bend thermoplastic strip or sheet material. Utilising an electrical bar element the strip heater heats the thermoplastic sheet, softening it along a line. When the correct temperature is reached the sheet can be quickly bent to the required angle. A former is often used to ensure a uniform bend.

Good clear description
Award 12 (11) Marks
Total (12,11)

(iii) **Thermostat:** A thermostat is a device used to control the temperature of a system, e.g. a central heating system, a cooling system in a motor car, etc. The thermostat operates by switching on / off or otherwise regulating the supply of heat from the source so as to maintain the temperature of the system within a predetermined level.

(j) Any two

(i) **DVD:** Digital Versatile Disc or Digital Video Disk is a type of CD – ROM that holds a minimum of 4.7GB of data, enough for a full-length movie. A DVD player or drive is required to read the contents of a DVD.

(ii) **Desktop:** The 'Desktop' is the homepage of a computer's operating system. The desktop screen can contain many icons such as 'My Computer', 'Recycle Bin', 'My Documents', shortcuts, files and folders. The desktop can be changed to facilitate user access to required files or programs in a fast and convenient way, providing an alternative to using the Start menu.

(iii) **Broadband:** Broadband provides high speed internet access by delivering multiple channels of data over single communication mediums such as DSL, Wireless or Satellite. Providing an always on

Good clear description
Award 6+6(5) Marks
Total (12,11)

connection, broadband facilitates fast access to data, voice or video.

- (iv) **CPU:** Refers to the **central processing unit** of the computer where the instructions of the computer program are used to process the data and change them into the required form or information.

(k)

- (i) The use of pure metals may not satisfy the demands of certain engineering applications. By mixing metals or other elements to form alloys, special metals with particular properties such as hardness, machinability and low melting points are produced.
- (ii) High Carbon Steel / Brass / Solder.

Definition Award 6 Example Award 6(5) Total (12,11)

(l) Any two

- (i) **Self-locking nut:** A special nut used to prevent loosening by movement or vibration. On assembly, the screw thread cuts through a nylon or fiber insert within the nut, holding it in position.

- (ii) **Light Dependent Resistor (LDR):**
An electrical component, whose resistance changes with light levels. Suitable for use in light controlled circuits.

Good clear description Award 6 + 6(5) Total (12,11)

- (iii) **Gearbox:** A structure containing a combination of gears in mesh. The particular gear arrangement can change the ratio of input to output speed, the direction of drive rotation and the relative position of the input to the output shaft. A reduction in output to input speed increases turning power or torque, while an increase in output to input speed reduces turning power or torque of the output shaft.

- (vi) **Countersink drill:**
A special drill made from high-speed steel, used to cut a large chamfer of the correct angle, usually 90 degrees, in the top of a hole. The use of a countersink drill provides seating for countersink – head screws. The seating allows the screw head to sit flush with the material face.

- (m) (i) Worm and wheel. (ii) Rack and pinion.

For names Award 6 +6(5) Total (12,11)

QUESTION NO.2

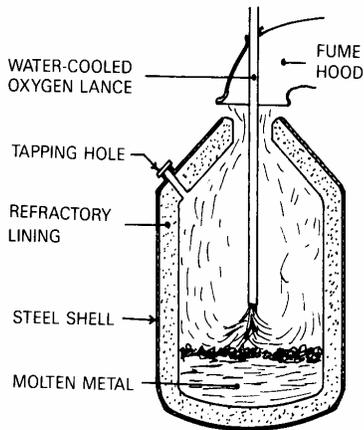
Total 45 Marks

(a) Any three:

- (i) Basic Oxygen furnace.
- (ii) Electrical Arc furnace.
- (iii) Blast furnace.
- (vi) Cupola furnace.

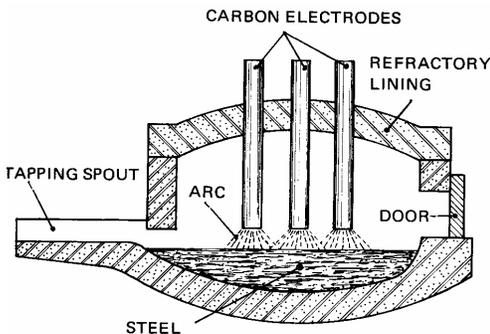
Name furnaces
Award 3 @ 6 Marks
Total (18)

(b) Any One

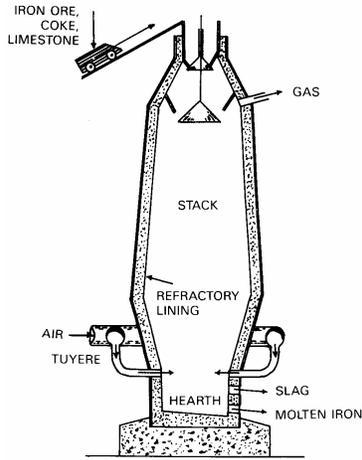


- (i) Mild Steel is produced in the **Basic Oxygen Furnace**. The charge consists of scrap iron and steel together with lime and molten pig iron. Oxygen is blown at the surface of the molten charge from a water cooled lance which is lowered through the mouth of the furnace. Impurities in the charge are oxidized and form a slag on the surface. At the end of the blow, the steel is poured off through a tapping hole followed by emptying the slag through the mouth of the furnace.

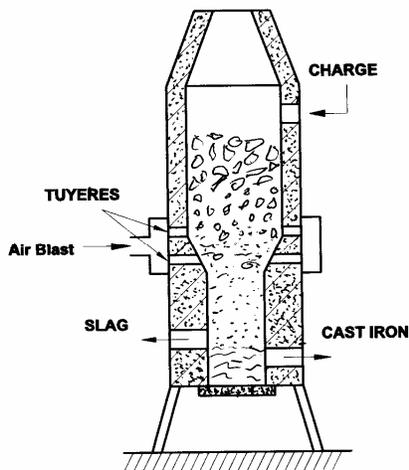
For furnace selected
Award:
Diagram: 6 Marks
Description: 3 Marks
Total (9)



- (ii) High Carbon Steel is produced in the **Electric Arc Furnace**. Cold scrap iron or steel make up the majority of the charge together with small amounts of lime and carbon. Heat for this furnace is by an electric arc created between carbon electrodes and the charge. The lime combines with impurities producing slag. When the correct composition of steel is achieved the slag is removed and the steel tapped from the furnace.



(iii) Pig Iron is produced in the **Blast Furnace**. Fed in through the top of the furnace, iron ore, coke and limestone provide the charge. As the coke burns, carbon monoxide is produced, and combines with the oxygen in the ore, leaving iron. The limestone combines with impurities to form slag. The molten iron falls to the bottom of the furnace where it is tapped off from time to time. The slag floats above the molten iron and is tapped off as required.



(iv) Cast Iron is produced in the **Cupola Furnace**. Pig iron and scrap steel or cast iron, together with other elements are the raw materials. Similar to the blast furnace, the cupola furnace is coke-fired with limestone acting as a flux to trap the impurities into slag. The molten cast iron is tapped from the bottom of the furnace and cast into moulds of different shapes and sizes as required.

(c) **Any two:**

- | | | |
|-------|---------|------------------------|
| (i) | Brass: | Ornamental work. |
| (ii) | Lead: | Lead – acid batteries. |
| (iii) | Bronze: | Bearings. |

Materials
Award 2 @ 6 Marks
Total (12)

(d) **Any two methods:**

Explanation
Award 3 + 3
Total (6)

Plastic dip coating / Painting / Galvanising /
Electroplating / Enamelling.

QUESTION NO. 3

Total 45 Marks

(a) **Any one:**

(i) **Work hardening:**

When a metal is hammered or shaped when cold it becomes hard and brittle at the point where the cold - working occurs. Some metals are prone to work hardening, copper and aluminium are typical examples where hardness values can be increased by cold working.

(ii) **Case hardening:**

Case hardening is a method of making a steel part very hard on the outside while leaving its centre tough. Mild Steel may be case hardened by first increasing the amount of carbon in the outer surface by 'carburising'. The steel part will now have a skin or 'case' rich in carbon, which can be hardened leaving a tough core.

(ii) **Annealing:**

Annealing is carried out to soften metal and to relieve internal stresses. The metal is heated to the required temperature and allowed to cool down as slow as possible.

Explanation
Award 1 @ 12 Marks
Total (12)

(b) **Any two:**

- (i) Hand file: High Carbon Steel.
- (ii) Twist drill: High Speed Steel.
- (iii) Screwdriver point: High Carbon Steel / Silver Steel.

Name
Award 2 @ 4 Marks
Total (8)

(c)

(i) **Hardening:**

The cutting edge of a cold chisel is hardened by heating to a cherry red colour, 750 degrees to 850 degrees centigrade, and immediately quenched in a container of oil, brine or tepid water.

(ii) **Tempering:**

The chisel is polished to show up the oxide colours. Heat is then applied well back from the cutting edge.

Hardening:
Award 1 @ 8 Marks
Tempering:
Award 1 @ 7 Marks
Total (15)

When the required colour reaches the cutting edge (brown) the chisel is quenched in water.

- (d) (i) **Malleability:**
The property that allows a metal to be hammered or rolled without breaking.

Good description
Award 2 @ 5 Marks
Total (10)

- (ii) **Ductility:**
The property of a metal, which allows it to be drawn out long and fine.

OR

- (d) (i) 'Double Acting' pneumatic cylinder.
(ii) 'Single Acting Spring Return' pneumatic cylinder.

Name
Award 2 @ 5 Marks
Total (10)

QUESTION NO. 4

Total 45 Marks

- (a)
- | | | |
|-------|-------------------|--------------------|
| (i) | Equal balance: | Neutral flame. |
| (ii) | Excess acetylene: | Carburising flame. |
| (iii) | Excess oxygen: | Oxidising flame. |

Identify three
Award 3 @ 5 Marks
Total (15)

(b) **Any three:**

(i) A **Flux** is used to help a weld joint to form by first producing a gas shield to protect the weld pool from the oxidizing effects of the atmosphere. The slag-forming agents then unite with impurities in the weld pool which float to the top, cool and form a coating, protecting the freshly formed weld from oxidation. This slag coating also helps to slow down the rate at which the weld cools, preventing weld brittleness.

(ii) A **Filler rod** provides additional filler metal when welding. In the form of a rod or wire, the end of the filler rod is held very close to the weld pool. The intense heat melts the rod causing a globule to drop into the weld pool, thus providing extra metal to the welded joint.

Purpose
Award 3 @ 4 Marks
Total (12)

(iii) A **pressure gauge** indicates the pressure in the oxygen or acetylene cylinders as used in gas welding. Often referred to as 'gas pressure regulators' pressure gauges can also indicate the pressure in the supply pipe to the torch.

(iv) The purpose of a **generator** is to produce electricity for DC welding. Powered by an electric motor, petrol or diesel engine the generator provides sufficient current for the arc.

(c) **Three steps:**

- (i) The surfaces to be joined must be perfectly clean and coated with flux.
- (ii) The joint should fit tightly together as any large gaps weaken the joint to the strength of the solder at that point.
- (iii) A good flow of heat to the joint is essential. Before applying the solder, the joint must be brought to the temperature at which the solder melts.

Steps
Award 3 @ 4 Marks
Total (12)

(d) **Two reasons:**

- (i) The face shield protects the eyes from extreme bright light produced by the electric arc.
- (ii) The face shield also protects the operator from the UV rays emitted by the electric arc.

Reasons
Award 2 @ 3 Marks
Total (6)

QUESTION NO. 5

Total 45 Marks

- (a) (i) Blow Moulding;
(ii) Compression Moulding;
(iii) Vacuum Forming.

Name Award 3 @ 5 Marks Total (15)

- (b) **One from above:**

Blow Moulding:

In blow moulding a heated thermoplastic tube called a parison is extruded between the two halves of a split mould. The mould closes around the parison and air is blown into it forcing the parison out against the wall of the mould. The component is allowed to cool before being removed from the opened mould. Using blow moulding thermoplastic materials like polythene can be moulded into **bottles** and **drums**.

Description Award 1 @ 7 Marks Component Award 1 @ 3 Marks Total (10)

Compression Moulding:

A raw thermosetting plastic, in powder form, is placed in a mould and subjected to heat and pressure for a given period of time, during which the material solidifies (cures). After this stage the mould is opened and the component ejected. Using this process thermosetting materials can be moulded into **screw top lids, plug tops** or **light fittings**.

Vacuum Forming:

Vacuum forming is used to make articles from thermoplastic sheet. The sheet is clamped and a heater raises the temperature of the sheet until it becomes soft and flexible. The mould table is raised and air is removed from beneath the sheet allowing atmospheric pressure to push down, forcing the sheet to take up the shape of the mould. When the mould table is lowered the vacuum formed sheet can be removed for finishing. Using this process thermoplastic sheet can be formed into **baths, interior panels of lorry cabs** or for **biscuit tin liners**.

(c) **Any two:**

(i) **Thermoplastic:**

Thermoplastics are linear chain type polymers and are relatively soft and flexible, they melt easily and can be repeatedly softened and remoulded.

(ii) **Elastic memory:**

The ability of a thermoplastic to return to its original shape when heated.

Good description
Award 2 @ 7 Marks
Total (14)

(ii) **Thermosetting:**

Thermosetting plastics are three dimensional in structure with strong cross-links between molecules. They are therefore rigid and hard, they cannot be reset once they have hardened in the mould.

(d)

(i) Many adhesives produce toxic fumes; always work in a well ventilated area.

(ii) Select the appropriate adhesive for the materials being joined.

Precautions
Award 2 @ 3 Marks
Total (6)

QUESTION NO. 6

Total 45 Marks

(a) **Any three turning operations used:**

- (i) Parallel turning;
- (ii) Facing / Surfacing;
- (ii) Taper turning;
- (iii) Knurling.

Name
Award 3 @ 6 Marks
Total (18)

(b) (i) **Name:** Tailstock.

(ii) **Use: Any Two:**

May be used for drilling / reaming the end of round bars on a centre lathe.

The tailstock can be offset for taper turning and also used to support the end of long bars when machining.

Name
Award 1 @ 5 Marks
Uses
Award 2 @ 5 Marks
Total (15)

(c) **Any two:**

(i) **Rake angle:** The purpose of the rake angle on a lathe cutting tool is to make an easy escape for the chip/swarf being cut. The size of the rake angle contributes to the size of the tool angle, determined by the type of material being cut.

(ii) **Centre drill:** The Centre drill is used first when drilling round material on the centre lathe. Use of a Centre drill ensures accurate location of the twist drill size required. The Centre drill or 'Slocomb' drill is also used for drilling holes for lathe centers, which are used for supporting the ends of work pieces.

Good description
Award 2 @ 6 Marks
Total (12)

(ii) **Clearance angle:** This ensures that only the cutting edge of the tool comes into contact with the work. Without clearance the tool would just rub against the work without cutting.

OR

(c) **Any Two:**

- (i) Safer machining;
- (ii) Higher accuracy achieved;
- (iii) Faster production output;
- (iv) Uniformity of end product;
- (v) Less operational involvement in production;
- (vi) Improved quality control.

Advantages
Award 2 @ 6 Marks
Total (12)

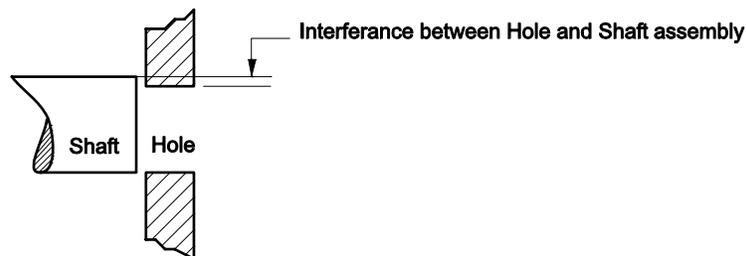
QUESTION NO. 7

Total 45 Marks

- (a) (i) Nominal Diameter - 20mm
- (ii) Upper Limit - $20 + 0.04 = 20.04\text{mm}$
- (iii) Lower Limit- $20 - 0.04 = 19.96\text{mm}$
- (iv) Tolerance- $20.04 - 19.96 = 0.08\text{mm}$

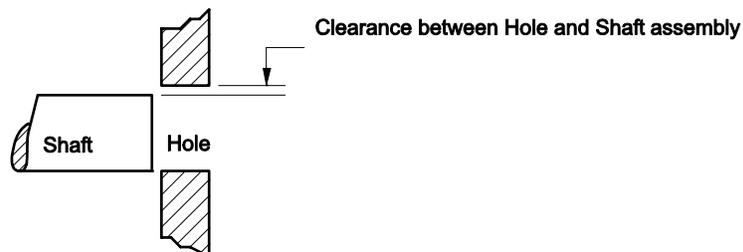
Calculations
Award 4 @ 5 Marks
Total (20)

- (b) (i) **Interference fit:**
An interference fit results in the assembly of a hole and shaft when the shaft is bigger than the hole.



Explanation
Award 7 + 6 Marks
Total (13)

- (ii) **Clearance fit:**
A clearance fit results in the assembly of a hole and shaft when the shaft is smaller than the hole.



(c) **Any three:**

Description Award 3 @ 4 Total (12)

(i) **Plug gauge:**

A plug gauge is used to determine if a hole is within its specified limits. If the 'GO' end of the gauge passes through the hole and the 'NO GO' end does not then the hole is within its specified limits.

(ii) **Vernier height gauge:**

A vernier height gauge is a precision marking out instrument which utilises the vernier scale principle. Enabling a greater degree of accuracy, 0.02mm, it is used to measure or mark off vertical distances relative to a datum surface such as a surface plate.

(iii) **Gap gauge:**

A Gap gauge is used to determine if a shaft is within its specified limits. If the shaft fits into the 'GO' opening and will not fit into the 'NO GO' opening then it is within its specified limits.

(iv) **Feeler gauge:**

Used to estimate, by sense of touch, the clearance between two separate components by inserting different blades or combination of blades until the thickness is found that will just go between the surfaces i.e. spark plugs, car tappets.

OR

(c) (i) Closing switch 'A' will complete the circuit, allowing current to flow, activating the 'motor' and 'power on' indicator.

(ii) **Any two:**

- A: Fixed Resistor.
- B: Motor.
- C: Switch.

Operation Award 4 Marks Name Award 2 @ 4 Marks Total (12)
