



Coimisiún na Scrúduithe Stáit  
State Examinations Commission

**LEAVING CERTIFICATE 2010**

**MARKING SCHEME**

**ENGINEERING**

**ORDINARY LEVEL**



**LEAVING CERTIFICATE 2010**

**MARKING SCHEME**

**Written Examination and Practical Examination**

***ENGINEERING –  
MATERIALS AND TECHNOLOGY***

**ORDINARY LEVEL**

**LEAVING CERTIFICATE**  
**ENGINEERING - Materials and Technology**

(Ordinary Level – 200 marks)

**Written Examination Marking Scheme 2010**

**Answer Question 1, Sections A and B and Three other questions.**

**Question 1 - 65 Marks.**

**Section A – 30 Marks**

Any six @ 5 marks each.

Two part answers 3 + 2

**Section B – 35 Marks**

Any three parts @ 12 + 12 + 11 marks

Two part answers 6 + 6 or 6 + 5

**Question 2 - 45 marks**

- (a) One part @ 8 marks  
Two parts @ 3 each (14)
- (b) Three parts @ 6 each (18)
- (c) Three parts @ 3 each (9)
- (d) Two parts @ 2 each (4)

**Question 3 - 45 marks**

- (a) Two parts @ 8 each (16)
  - (b) One part @ 12 marks (12)
  - (c) Two parts @ 4 each (8)
  - (d) Two parts @ 5 + 4 (9)
- OR**
- (d) Two parts @ 5 + 4 (9)

**Question 4 - 45 marks**

- (a) Two parts @ 5 each  
Two parts @ 3 each (16)
- (b) Three parts @ 4 each (12)
- (c) Three parts @ 4 each (12)
- (d) One part @ 5 marks (5)

**Question 5 - 45 marks**

- (a) One part @ 4 marks  
One part @ 14 marks (18)
- (b) Two parts @ 3 each (6)
- (c) Three parts @ 5 each (15)
- (d) Two parts @ 3 each (6)

**Question 6 - 45 marks**

- (a) Three parts @ 6 each (18)
  - (b) Three parts @ 5 each (15)
  - (c) One part @ 8 marks  
One part @ 4 marks (12)
- OR**
- (c) Three parts @ 4 each (12)

**Question 7 - 45 marks**

- (a) Two parts @ 5 each (10)
  - (b) Four parts @ 5 each (20)
  - (c) Three parts @ 5 each (15)
- OR**
- (c) Three parts @ 5 each (15)

## Sample Answers *and* Marking Scheme

*Note:* The solutions presented are examples only.  
All other valid solutions are acceptable and are marked accordingly.

### Question 1

(65 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) (i) Work in a well ventilated area.  
(ii) Always secure a hot soldering iron in a stand when not in use.
- (b) A Light Emitting Diode can be used to indicate that current has been turned on in a project.
- (c) A Vee block can be used to support round bars while marking out or drilling.
- (d) A metal is ductile if it can be stretched permanently without breaking.
- (e) An interference fit results when a shaft is bigger than the hole.
- (f) (i) Square thread. (ii) Buttress thread.
- (g) (i) 3D Computer Aided Drawing can be used to help visualise design ideas.  
(ii) Computer Aided Manufacture can be used to produce high quality products.
- (h) (i) A rack and pinion mechanism is commonly used on drilling machines to bring down the drill into the work.  
(ii) A rack and pinion can also be used as part of the steering mechanism in cars.

3 + 2 Marks

5 Marks

5 Marks

5 Marks

5 Marks

3 + 2 Marks

3 + 2 Marks

3+2 Marks

## Section B - 35 Marks

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

(i) Any one:

### Strip heater

A strip heater is used to form straight or small curvature bends in thermoplastic sheet material. An electric element or hot wire is enclosed in a channel which has an opening at the top. Thermoplastic sheet is placed across supports above the opening. By adjusting the height of the supports the width of strip to be heated can be altered. The supports are set to a low height for tight bends. If a more gradual bend is required the heated area is widened by setting the supports higher. Different thicknesses of sheet may be formed by thermostatically controlling the heating temperature.

### Vernier height gauge

A Vernier height gauge is a precision measuring instrument used for accurately measuring heights and testing for parallel. The gauge consists of a heavy base and a fixed main scale rule with a sliding vernier scale attached. When used on the surface plate, the relationship between the main scale and vernier scale has the potential to provide limits of 0.02 mm. A finger or knife edge made of hardened steel, fixed to the sliding vernier scale, is used to scribe lines when marking out. The use of lock and fine adjustment screws helps the user to achieve accurate settings.

### Cam and follower

A cam is a specially shaped piece of material which is fixed to an axle or shaft. A follower is a device designed to move up and down as it follows the shape or profile of the rotating cam. The shape of the cam controls the movement of the follower. Depending on design, a cam and follower can be used to convert one type of motion into another. The most common design is based on a rotary cam which changes the rotary motion of the cam into reciprocating motion of the follower. The follower is kept in contact with the cam by its own weight or by pressure exerted on it.

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

**(j) Any two:**

**(i) Network**

A computer network is a collection of computers, printers and other equipment, which are connected together so that they can communicate with each other. The linking of computers by special cables or radio waves known as wireless networks allow data and resources to be shared among users.

**(ii) DVD-R**

Digital Versatile Disc or Digital Video Disk is a type of CD that can have a potential storage capacity of up to 8GB of data, enough for a full-length movie. DVD-R is a DVD recordable format only which means that data, once written to a DVD-R, cannot be changed, whereas a DVD-RW can be rewritten multiple times.

A DVD-R provides portable memory in the form of a compact disk, however, a DVD player or drive is required to read its contents.

**(iii) External hard drive**

An external hard drive is a portable magnetic disk which can be connected externally to a PC or Laptop by way of a USB socket. The term 'hard' is used to distinguish it from a soft, or floppy disk. Hard disks hold more data, are faster than floppy disks and allow large amounts of information to be transferred between computers. Many users now use external hard drives to backup important data.

**(iv) Broadband**

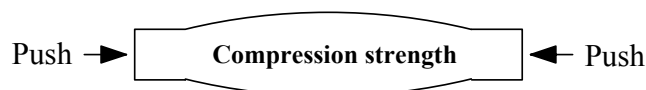
Broadband provides high speed internet access by delivering multiple channels of data over single communication mediums such as DSL, Wireless or Satellite. Providing an always on connection, broadband facilitates fast access to data, voice or video.

**(k)**

**(i) Compressive strength**

The compressive strength of a metal is the metal's ability to support a heavy weight or withstand large equal and opposite push forces.

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



Tubular metal legs of chairs need to have good compressive strength to support the weight of the person sitting down.

**(l) Any two:**

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

**Worm and wheel drive**

A worm and wheel drive is a gear system which consists of a worm gear and a wormwheel. The worm gear, which looks like a screw thread, is fixed to a drive shaft or motor axel. It meshes with the wormwheel which is fixed to the driven shaft. The worm gear runs at 90° to the wormwheel. A worm and wheel drive provides large speed reduction while increasing output torque. This gear system only allows drive from worm to wormwheel.

**Electrical fuse**

An electrical fuse generally consists of a thin wire inside a glass or ceramic tube and is commonly found inside electrical plugs. The fuse prevents too much electricity flowing into the appliance if a fault occurs. It's purpose is to protect the low voltage electronics found inside all electrical appliances. The fuse acts as a deliberate weak link in a circuit. When the fuse 'blows' the thin wire melts and the electricity supply to the appliance is cut off.

**Morse taper sleeve**

A morse taper sleeve can be used to hold tools such as taper shank drills and reamers in drilling machines and in lathe tailstocks. The morse taper sleeve is used when the taper shank of a tool is too small for the machine socket in which it is to be used. The shank of the tool is inserted into the sleeve, which is then inserted into the tapered socket of the machine. The morse taper sleeve maintains the frictional drive between the machine spindle and the cutting tool being used.

**Plastic dip coating**

Plastic dip coating is used to put a more socially acceptable finish on articles made from steel, such as shopping baskets and kitchen utensils etc. The article is heated to 180 ° C in an oven and dipped into a tank where fluidised power particles of polyethylene melts and adheres to its surface. When removed, the particles fuse together and cool, providing an attractive and protective coating.

**(m)**

**Name:**

A ratchet and pawl mechanism

**Operation:**

A ratchet and pawl mechanism is used to allow a shaft, axle or pin to rotate in one direction only. The diagram shows a ratchet and pawl mechanism which will only rotate in an anticlockwise direction. As the ratchet rotates anticlockwise, the curved surface on the ratchet lifts the pawl, allowing the ratchet to rotate. When the ratchet rotates in a clockwise direction, the spring pulls the pawl in behind a tooth, stopping rotation. A ratchet and pawl can be used in mechanisms such as ratchet spanners, fishing reels, ratchet screwdrivers, micrometers and winding mechanisms of watches

Name  
**Award 6 (5) Marks**  
Operation  
**Award 6(5) Marks**  
**Total (12,11)**

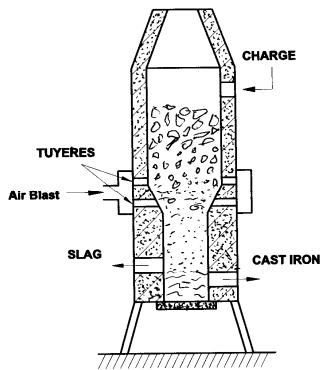


## Question 2

(45 Marks)

(a)

(i) Any one:



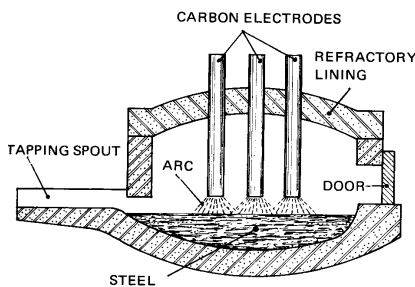
### Cupola Furnace

Pig iron and scrap steel or cast iron, together with other elements are the raw materials. 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.

(i) Sketch & Operation  
Award 8 Marks

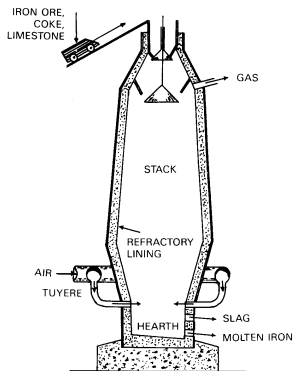
(ii) Name & Application  
Award 6 Marks

**Total (14) Marks**



### 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 generated 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.



### 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.

(ii) Any one:

**Cupola Furnace** : Cast Iron - Castings for machine frames/beds, lathe slide ways.

**Electric Arc** : High Carbon/Alloy Steels - Metal cutting tools/hammer heads

**Blast Furnace** : Pig Iron - Production of Cast Iron / Steel

**(b) Any three alloys:**

- |              |                 |   |                           |
|--------------|-----------------|---|---------------------------|
| <b>(i)</b>   | Soft solder     | - | Lead & Tin                |
| <b>(ii)</b>  | Stainless Steel | - | Steel & Chromium / Nickel |
| <b>(iii)</b> | Brass           | - | Copper & Zinc             |
| <b>(iv)</b>  | Bronze          | - | Copper & Tin              |

Alloy  
**Award 3 @ 6 Marks**  
**Total (18) Marks**

**(c) Any three materials:**

- |              |                |   |                   |
|--------------|----------------|---|-------------------|
| <b>(i)</b>   | Centre punch   | - | High Carbon Steel |
| <b>(ii)</b>  | Satellite dish | - | Aluminium         |
| <b>(iii)</b> | Cutlery        | - | Stainless Steel   |
| <b>(iv)</b>  | Bench Vice     | - | Cast Iron         |

Materials  
**Award 3 @ 3 Marks**  
**Total (9) Marks**

**(d) Any two non-ferrous metals:**

Copper / Brass / Tin / Aluminium / Bronze / Lead etc.

Non-ferrous metals  
**Award 2 @ 2 Marks**  
**Total (4) Marks**

### Question 3

(45 Marks)

(a)

(i) **Name:** Annealing

**Description:**

Annealing is carried out to soften metal and to relieve internal stresses. When annealing copper it is heated to a dull red color and allowed to cool in air or water.

Good clear description  
Award 2 @ 8 Marks  
Total (16)

(ii) **Name:** Tempering

**Description:**

To temper the point of a centre punch, first polish with emery cloth so that the tempering colours can appear. Heat slowly behind the hardened portion and allow the heat to travel gradually to the point. The tempering colours will appear as the temperature rises. When the correct colour reaches the point i.e. brown, cool it in oil or water.

(b)

**Case hardening:**

Case hardening is a method of making low carbon steel very hard on the outside while leaving its centre tough. The shaft of the screwdriver may be case hardened by first increasing the amount of carbon in the outer surface by 'carburising'. Carburising is carried out by heating the steel to a cherry red and allowing it to cool in a carbon rich material. The steel part will now have a skin or 'case' rich in carbon. The part is then heated to a cherry red and quenched, producing a hardened skin with a tough core.

Good clear description  
Award 12 Marks  
Total (12)

(c) **Reasons include:**

- To protect the body against steam or oil flashback
- To protect the body against burns resulting from high temperatures.

Reasons  
Award 2 @ 4 Marks  
Total (8)

(d) **Main differences include:**

- Percentage content of carbon
- High carbon steel can be hardened throughout.

Description  
Award 1 @ 5 Marks  
Award 1 @ 4 Marks  
Total (9)

OR

(d) **Two applications:**

- Welding of car frames
- Spray painting car bodies.

Description  
Award 1 @ 5 Marks  
Award 1 @ 4 Marks  
Total (9)

## Question 4

(45 Marks)

(a)

**(i) Manual metal arc welding:**

Metals are melted and fused using high temperatures. The joint produced is very strong. Special equipment and a high skill level is required to weld. Only similar metals can be joined using this process.

**Adhesive bonding:**

Process can be performed cold, joint based on surface attachment. No special equipment or high level skill is required. Adhesive bonding can join a broad range of materials which can be dissimilar. When used on metals the joint is generally not as strong as arc welding.

**(ii) Manual metal arc welding – Gates / Steel table and Chair frames**

**Adhesive bonding - Footwear, attaching outsole to upper / bathroom tiles**

Differences

**Award 2 @ 5 Marks**

Application

**Award 2 @ 3 Marks**

**Total (16) Marks**

(b) **Any three:**

(i) Any one - Oxygen / Acetylene.

(ii) Positioned on both gas supply lines between the hose and regulator. Purpose is to prevent the return of the flame through the hose into the regulator and gas cylinders.

(iii) Neutral flame.

(iv) Special goggles must be worn to protect the user from hot metal particles, harmful light rays and or high temperatures.

Explanation

**Award 3 @ 4 Marks**

**Total (12) Marks**

(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) Vapours produced by adhesives can often be dangerous to breath. Working in a well ventilated area ensures a clean air supply, diluting any vapours which may be present.

Reason

**Award 5 Marks**

**Total (5) Marks**

## Question 5

(45 Marks)

(a) (i) Any one:

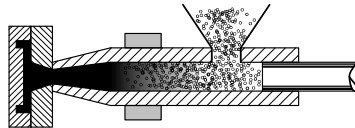
Golf tee	-	Injection molding
Model car body	-	Vacuum Forming
Water Bottle	-	Blow Molding

Name  
Award 4 Marks  
Total (4)

(ii) Description of any one:

### Injection Moulding

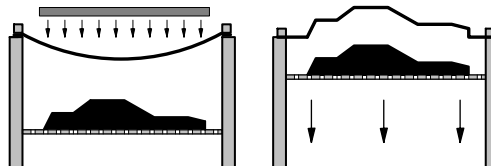
Thermoplastic is softened by heating it inside an injection nozzle. The softened plastic is forced by a plunger into a cold mould where it hardens rapidly and is then ejected. Injection molding is used for the rapid moulding of components.



Good description  
Award 14 Marks  
Total (14)

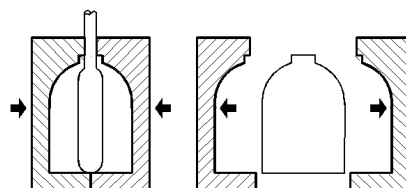
### Vacuum forming

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.



### 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.



**(b) Two safety precautions:**

- Ensure the acrylic sheet is secured in a vice and does not project too high above the clamping jaws.
- Be careful not to exert too much pressure when cross filing.

Precautions  
**Award 2 @ 3 Marks**  
**Total (6) Marks**

**(c) Any three:**

**Thermosetting plastic**

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.

Terms  
**Award 3 @ 5 Marks**  
**Total (15) Marks**

**Elastic memory**

Elastic memory is the ability of a thermoplastic to return to its original shape when heated.

**PVC**

The term PVC refers to the plastic Polyvinylchloride.

**Former**

When a thermoplastic sheet is heated, it becomes soft and flexible. Formers are used to retain the shape of the soft plastic sheet until it cools and is capable of maintaining the required shape.

- (d)**
- |                                   |   |             |
|-----------------------------------|---|-------------|
| <b>(i)</b> Wall cavity insulation | - | Polystyrene |
| <b>(ii)</b> Gear wheel            | - | Nylon       |

Material  
**Award 2 @ 3 Marks**  
**Total (6)**

## Question 6

(45 Marks)

(a) **Any three lathe parts:**

- (i) Four jaw independent chuck
- (ii) Knurling tool
- (iii) Four way tool post
- (iv) Tailstock

Operations Award 3 @ 6 Marks Total (18)
---

(b) **Any three:**

**Chuck key**

The chuck key is used to open and close the jaws on a lathe chuck. A spring is often fitted to ensure the chuck key is removed from the lathe chuck before operating.

Operations Award 3 @ 5 Marks Total (15)
---

**Feed**

Feed refers to the distance the cutting tool moves during each revolution of the workpiece. It is expressed in millimeters per revolution. The smaller the feed rate, the smoother the surface finish.

**Swarf**

Swarf is the waste material produced when the chip is cut from the workpiece.

**Clearance angle**

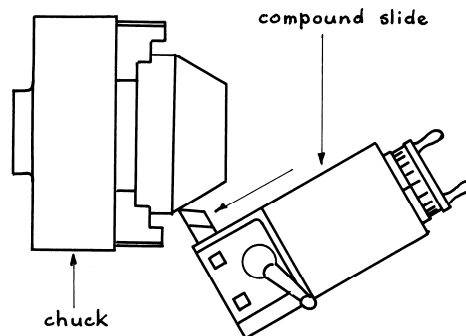
The clearance angle ensures that only the cutting edge of the tool comes into contact with the work. Without clearance, the tool would just rub against the work without cutting.

(c) **Taper turning**

**Description:**

Setting the angle on the top / compound slide:  
Here the compound slide is swiveled on its base, locked at the required angle and the tool fed by hand using the slide handle.

Good description  
**Award 8 Marks**  
Safety precaution  
**Award 4 Marks**  
**Total (12)**



Cutting a taper with the compound slide set at an angle

**Safety precaution:**

Ensure the cutting tool does not run into the chuck when rotating the compound slide handle.

**OR**

(c) **Any three advantages:**

- Safer machining
- Higher accuracy achieved
- Faster production output
- Uniformity of end product
- Less operational involvement in production
- Improved quality control.

Advantages  
**Award 3 @ 4 Marks**  
**Total (12)**



## Question 7

(45 Marks)

**(a) Advantages include:**

- Clear visual display of the measurement is provided
- No calculations required.

Advantages  
Award 2 @ 5 Marks  
Total (10)

**(b)**

- |              |                                |          |
|--------------|--------------------------------|----------|
| <b>(i)</b>   | Nominal diameter of hole -     | 40.00 mm |
| <b>(ii)</b>  | Maximum diameter of the hole - | 40.07 mm |
| <b>(iii)</b> | Minimum diameter of the hole - | 39.93 mm |
| <b>(iv)</b>  | Tolerance on the hole -        | 00.14 mm |

Calculations  
Award 4 @ 5 Marks  
Total (20)

**(c) Any three**

- |              |                      |  |
|--------------|----------------------|--|
| <b>(i)</b>   | Vernier calipers     | - for the accurate measurement of inside, outside and depth sizes. |
| <b>(ii)</b>  | Plug gauge           | - for checking the size of holes.                                  |
| <b>(iii)</b> | Outside calipers     | - for checking the diameter of shafts.                             |
| <b>(iv)</b>  | Engineers protractor | - used for measuring or marking out angles.                        |

Illustrations  
Award 3 @ 5 Marks  
Total (15)

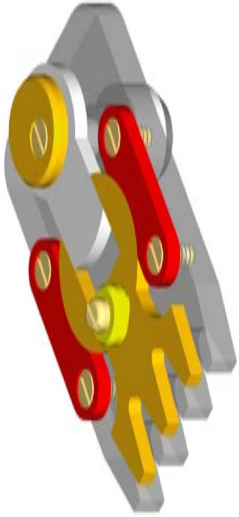
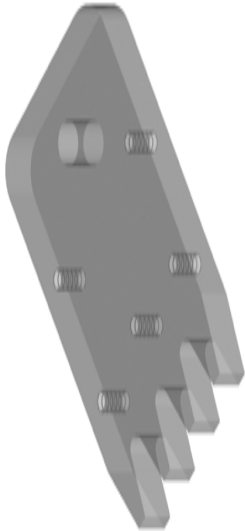

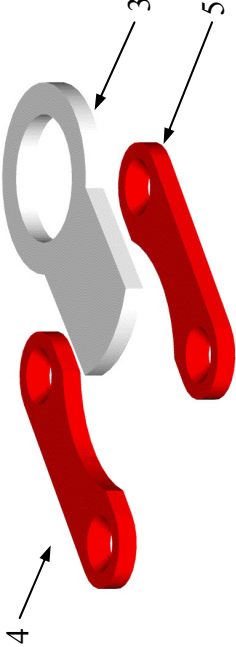
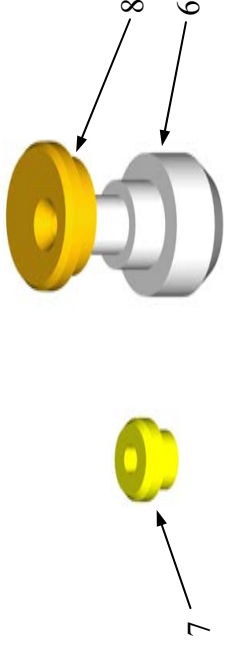
**OR**

**(c) Any three**

- A- Push to make switch
- B- Battery
- C- Motor
- D- Bulb

Symbols  
Award 3 @ 5 Marks  
Total (15)



Section	Part Number	Pictorial Sketch / Description	Concept	Mark	Mark
1	All Parts of Project		Assembly, Function & Finish: Subjective Grade 1-20	20	20
2	Part 1		Marking Out 10mm Radii M5 Tapped Holes Ø10mm Hole Tooth Profile	4 2 5 1 8	20
3	Part 2		Marking Out 20mm Radii 9mm Slot 20mm Rectangular Slot Tooth & 11mm Radius Profile	4 3 2 3 8	20
4	Parts 3, 4 and 5		Part 3 Marking Out Ø20mm Hole External Profile Parts 4 & 5 Marking Out 5mm CSK Holes External Profile	2 2 4 4 4 4	20
5	Parts 6, 7 and 8		Part 6 Lathe Work Part 7 Lathe Work Part 8 Lathe Work	8 4 8	20



