



Coimisiún na Scrúduithe Stáit  
State Examinations Commission

**LEAVING CERTIFICATE 2009**

**MARKING SCHEME**

**ENGINEERING -  
MATERIALS AND TECHNOLOGY**

**ORDINARY LEVEL**





**Coimisiún na Scrúduithe Stáit**  
*State Examinations Commission*

# **LEAVING CERTIFICATE 2009**

## **MARKING SCHEME**

**Written Examination and Practical Examination**

### ***ENGINEERING - MATERIALS AND TECHNOLOGY***

## **ORDINARY LEVEL**

**LEAVING CERTIFICATE EXAMINATION**  
**ENGINEERING – MATERIALS and TECHNOLOGY**  
**ORDINARY LEVEL – 200 marks**

**Written Examination Marking Scheme 2009**

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

<b>Question 1:</b>	<b>Total - 65 Marks</b>
Section A – <b>30 Marks</b> Any six @ 5 marks each.	Two part answers 3 + 2
Section B – <b>35 Marks</b> Any three parts @ 12 + 12 + 11 Marks	Two part answers 6 + 6 or 6 + 5

<b>Question 2.</b>	<b>Total - 45 Marks</b>
(a) Two parts @ 6 each One @ 8	(20)
(b) One part @ 3 Two parts @ 3	(9)
(c) Three parts @ 4	(12)
(d) One part @ 4 marks	(4)

<b>Question 3.</b>	<b>Total - 45 Marks</b>
(a) Two parts @ 8 marks	(16)
(b) Two parts @ 6 each	(12)
(c) Two parts @ 4 each	(8)
(d) Two parts 5 & 4	(9)
<b>OR</b>	
(d) Two parts 5 & 4	(9)

<b>Question 4.</b>	<b>Total - 45 Marks</b>
(a) Three parts @ 5 each	(15)
(b) Three parts @ 4 each	(12)
(c) Three parts @ 4 each	(12)
(d) Two parts @ 3 each	(6)

<b>Question 5.</b>	<b>Total - 45 Marks.</b>
(a) Two parts @ 5 each Explanation @ 8 marks Component @ 3 marks	(10) (11) (11)
(b) Two parts @ 3 each	(6)
(c) Two parts @ 6 each	(12)
(d) Two parts @ 3 each	(6)

<b>Question 6.</b>	<b>Total - 45 Marks.</b>
(a) Three parts @ 6 each	(18)
(b) One part @ 10 One part @ 5	(15)
(c) Two parts @ 6 each	(12)
<b>OR</b>	
(c) Two parts @ 6 each	(12)

<b>Question 7.</b>	<b>Total - 45 Marks.</b>
(a) Two parts @ 5 each	(10)
(b) Four parts @ 5 each	(20)
(c) Three parts @ 5 each	(15)
<b>OR</b>	
(c) Three parts @ 5 each	(15)

**LEAVING CERTIFICATE EXAMINATION 2009**  
**ENGINEERING - MATERIALS and TECHNOLOGY**  
**ORDINARY LEVEL – 200 Marks**

**Sample Answers and Marking Scheme**

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

**QUESTION No. 1 – Total 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**

- |            |  |                    |
|------------|--|--------------------|
| <b>(a)</b> | Always use adhesives in a well ventilated area to allow fumes dissipate. Wear protective clothing.   | <b>3 + 2 Marks</b> |
| <b>(b)</b> | A single pole single throw electrical switch.  | <b>5 Marks</b>     |
| <b>(c)</b> | To provide guidance to a larger drill when drilling a large hole.  | <b>5 Marks</b>     |
| <b>(d)</b> | A countersink drill  | <b>5 Marks</b>     |
| <b>(e)</b> | To check if a machined hole is within stated limits.   | <b>5 Marks</b>     |
| <b>(f)</b> | The term Computer Aided Drawing refers to the use of computers in the production of 2D or 3D drawings. 2D dimensioned drawings can be used for manufacturing while 3D drawings can be used to help visualise design ideas.                 | <b>3 + 2 Marks</b> |
| <b>(g)</b> | (i) Vee form thread (ii) Square thread   | <b>3 + 2 Marks</b> |
| <b>(h)</b> | A ratchet and pawl mechanism is used to allow a shaft, axle or pin to rotate in one direction only. It is used in mechanisms such as ratchet spanners, fishing reels, ratchet screwdrivers, micrometers and winding mechanisms of watches. | <b>5 Marks</b>     |

## SECTION B – 35 MARKS

MARKS

(i) Any one:

### Electric soldering iron

An electric soldering iron is used to apply solder. It can be used when soldering electrical wires or components together. A fine tip electric soldering iron is used when soldering electronic components to circuit boards such as printed circuit boards (PCB).

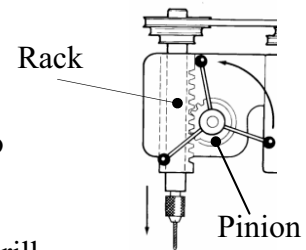
When the electric iron is plugged in, its tip heats up and can reach temperatures of over 200°C. The tip heats the metal and melts the solder so that it flows round the lead of the component and the track on the board.

Heat is produced when electricity flows through a heating element inside the soldering iron. The element is made of a material which electricity finds difficult to pass through. The resistance of the material to the flow of electricity causes the element to heat up, heating the tip.

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

### Rack and pinion

A rack and pinion is used to convert between rotary (circular) and linear (straight line) motion. The rack is the flat, toothed part, the pinion is the gear. A rack and pinion can convert from rotary to linear or from linear to rotary. Rack and pinions are commonly used on drilling machines to bring down the drill into the work. The feed lever rotates the pinion and moves the rack, causing the drill spindle to move down in a straight line.



### Plastic dip coating tank

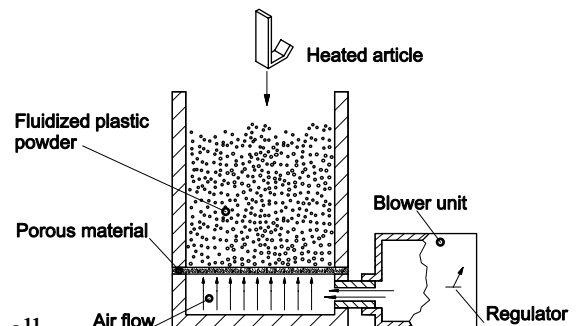
A plastic dip coating tank is used to put a more socially acceptable finish on articles made from steel, such as shopping baskets and kitchen utensils. The plastic dip coating tank consists of a fluidizing unit and a blower unit.

The fluidizing unit has two compartments which are separated from each other by a porous material.

The upper compartment contains the plastic powder and the air supply is connected to the lower one.

Air passes up through the porous material and causes the plastic powder to act like a fluid.

The article is heated to 180°C and dipped into the tank. The plastic close to the article melts and sticks to the component providing an even coating all over. The component is then removed and the molten plastic is allowed to cool and harden covering the article in a protective coating.



**(j) Any two:**

**(i) Hardware**

All the physical parts of a computer system are classified as hardware. Keyboard, mouse, VDU and printers are examples of computer hardware. Hardware can be further subdivided into either input or output devices. A keyboard is an example of a computer input device and a VDU / monitor is an example of a computer output device. Many hardware devices are connected to PCs via USB ports.

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

**(ii) Browser**

A browser is a piece of software that is used to view and download the content of webpages. Browsers provide users with a graphical interface to explore the web by translating HTML pages into various types of files such as text, audio, video and graphics. Mozilla Firefox and Microsoft's Internet Explorer are two common browsers in use.

**(iii) Virus**

A virus is a program or piece of code that operates by attaching itself to some other program or downloaded file. When the program starts the virus code runs, replicates itself and infects other programs or documents on the computer without the user's knowledge. Written with the deliberate intention of corrupting files, a computer virus can seriously damage or completely destroy files of software on a computer.

**(iv) CPU**

A CPU is the central processing unit of a computer where the instructions of a computer program are used to process input data and change them into the required form or information before output.

**(k)**

**(i) Compressive force**

A compressive force is when a bar is subjected to a push. If the push on one end results in an equal and opposite push on the other end then the bar is said to be in compression.



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

**Tensile force**

A tensile force is when a bar is subjected to a pull. If the pull on one end results in an equal and opposite pull on the other end then the bar is said to be in tension.



**(l) Any two:**

**Self-locking nut:**

A self locking nut contains a nylon insert which the screw thread cuts into thus holding the nut secure. The nylon insert prevents loosening due to vibration.

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

**Electrical insulator:**

An electrical insulator is a material which offers very high resistance to current flow. Plastic is an example of an electrical insulator as it will not allow electricity pass through.

**Bevel gear:**

Bevel gears transmit rotary motion where shafts are at an angle to one another. Hand operated drills use bevel gears.

**Cam and follower:**

A rotary cam changes rotary motion into reciprocating motion. A follower in contact with the edge of the cam moves up and down or in and out as the cam rotates. The shape of the cam controls the motion of the follower. The follower is kept in contact with the cam by its own weight or by pressure exerted on it.

**(m)**

**Name:**

A belt and pulley drive system.

**Application:**

Household machines such as sewing machines, spin driers and washing machines are often driven by round grooved pulleys. Machine tools such as drilling machines and lathes use vee pulleys and vee belts. Belt and pulley drive systems can also be used to transfer rotary motion from a motor spindle to a drive axle on class projects.

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



## QUESTION NO.2

Total 45 Marks

(a)

- (i) Any two  
Pig Iron  
High Carbon Steel  
Cast Iron

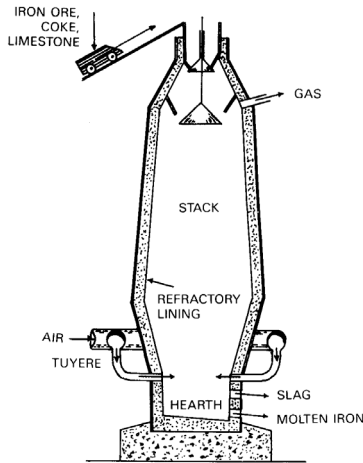
- Blast furnace
- Electrical arc furnace
- Cupola furnace

(ii) Any one

(i) Name furnace  
Award 2 @ 6 Marks

(ii) Sketch & Operation  
Award 8 Marks

**Total (20) Marks**

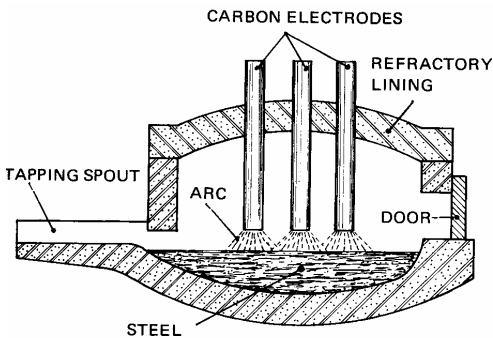


Pig Iron is produced in the **Blast Furnace**.

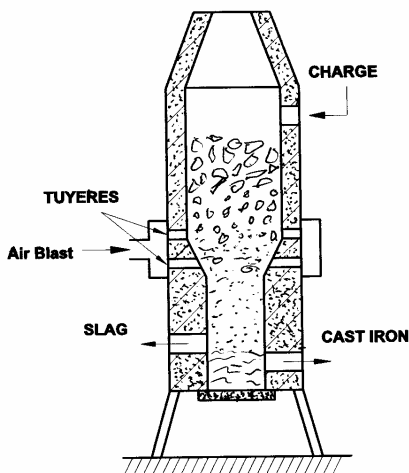
Fed in through the top of the furnace, iron ore, coke and limestone provide the charge.

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.



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.



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.

(b)

- (i) An alloy is a combination of metals or other elements. Alloys produce metals with improved properties such as resistance to corrosion and the ability to retain hardness and strength at high temperatures. The metals and or elements added depend on the properties required.

(i) Alloy  
**Award 1 @ 3 Marks**  
(ii) Identify alloy  
**Award 2 @ 3 Marks**  
**Total (9) Marks**

- (ii) Solder - Lead & Tin  
Brass - Copper & Zinc

(c) Application for **any three:**

- (i) Tungsten - Cutting tools  
(ii) Aluminium - Soft drinks can  
(iii) Lead - Chimney flashing  
(vi) Stainless Steel - Kitchen sink

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

(d) **Difference between ferrous & non-ferrous metal.**

A ferrous metal contains iron, a non-ferrous metal does not.

Difference  
**Award 1 @ 4 Marks**  
**Total (4) Marks**

### QUESTION NO. 3

Total 45 Marks

(a) Explain any two:

(i) **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.

(ii) **Case hardening:**

Case hardening is a method of making low carbon steel very hard on the outside while leaving its centre tough. Low carbon steel 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.

Description Award 2 @ 8 marks Total (16)
--

(iii) **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.

(b)

Good Description Award 2 @ 6 Marks Total (12) Marks
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**Hardening**

Part A of the centre punch is hardened by heating the point to a cherry red and then cooling rapidly in clean water. The point will become non-magnetic on reaching the required temperature. It must be dipped vertically and moved about in the water to achieve proper cooling.

**Tempering**

To temper point A, 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, cool it in oil or water.

(c) **Two safety precautions**

- (i) Hold the component securely.
- (ii) Wear protective clothing in case of steam or oil flashback.

Precautions  
Award 2 @ 4 Marks  
**Total (8)**

(d) **Any two:**

(i) **Malleability:**

This is the capacity to which a metal can be extended in all directions by hammering or rolling without causing the material to rupture.

(ii) **Elasticity:**

Elasticity enables a metal to return to its original shape after external forces which cause distortion are removed.

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

(iii) **Brittleness:**

A brittle material will fracture if subjected to an impact or blow. Glass is an example of a brittle material.

**OR**

(d)

- (i) Single acting spring return pneumatic cylinder
- (ii) Opening and closing a glasshouse window.

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

## QUESTION NO. 4

**Total 45 Marks**

- (a) (i) Neutral flame (ii) Carburising flame (iii) Oxidising flame

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

(b)

- (i) Heat is produced by an electrical arc formed between the welding electrode and the metal being welded.
- (ii) Flux is required at the joint to remove oxides, keep the weld pool clean from impurities and allow the weld to cool slowly by producing a slag covering.
- (iii) The earth clamp is required to complete the circuit for current flow through the metal being welded and back to the welding unit.
- (iv) Leather gloves must be worn to protect the user from hot metal particles, UV light and or high temperatures.

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

(c) **Any three:**

- (i) Tinsplate - Soft solder
- (ii) Mild steel plate - Gas welding / Spot welding
- (ii) Acrylic - Adhesives / Plastic Welding
- (iv) Light gauge aluminium - Pop rivets / Adhesives

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

- (d) To protect the user from hot metal particles.  
To protect the user from bright light produced by the gas flame.

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

## QUESTION NO. 5

Total 45 Marks

(a) (i) Any two plastic molding processes shown:

- A - Injection moulding
- B - Compression moulding
- C - Blow moulding

Name
<b>Award 2 @ 5 Marks</b>
<b>Total (10)</b>

(ii) Description of any one

### (A) 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 moulding is used for the rapid moulding of components such as **buckets** or the **casings** for a wide range of computer hardware devices.

### (B) 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**.

Good description
<b>Award 1 @ 8 Marks</b>
Component
<b>Award 1 @ 3 Marks</b>
<b>Total (11)</b>

### (C) 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**.

(b) Two safety precautions

- (i) Control the heating temperature, do not overheat.
- (ii) Wear protective gloves when handling hot plastic sheet.

Precautions
<b>Award 2 @ 3 Marks</b>
<b>Total (6) Marks</b>

(c) **Differences:**

Good description  
**Award 2 @ 6 Marks**  
**Total (12) Marks**

**Thermoplastic**

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

**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.

- (d)
- (i) Nylon - Gears / toothbrush handles
  - (ii) Polystyrene - House insulation sheets / beads

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

## QUESTION NO. 6

**Total 45 Marks**

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

Knurling  
Drilling  
Parallel turning  
Facing / surfacing  
Taper turning

Operations <b>Award 3 @ 6 Marks</b> <b>Total (18)</b>
---

(b) **Any one:**

### **Four jaw independent chuck**

The jaws on a four jaw independent chuck can move independently of one another, each being operated by its own screw. This chuck is used for gripping square, round, rectangular and irregular shapes.

Do not use excessive speeds when machining on a four jaw chuck.

### **Fixed Steady**

The fixed steady is clamped to the bed of the lathe and has three fingers which can be adjusted to accommodate different shaft diameters. A fixed steady is used for supporting long shafts which need to be machined on their end.

Always ensure the supporting fingers and work is lubricated and adjusted correctly to reduce overheating.

### **Faceplate**

The faceplate is a large circular plate containing a number of machined slots. The faceplate is fitted to the nose of a lathe spindle and is used to hold work whose shapes do not permit gripping in a chuck. The work piece is bolted to the faceplate or to a fixture on the faceplate.

It is important to counter-balance the work piece to prevent vibration during the machining operation

Good description <b>Award 10 Marks</b> Safety precaution <b>Award 1 @ 5 Marks</b> <b>Total (15)</b>
---



(c) **Any two:**

**(i) Rake angle**

The purpose of the rake angle is to make an easy escape for the chip / swarf being cut. A large rake angle reduces the amount of force required when cutting.

Good description  
**Award 2 @ 6 Marks**  
**Total (12)**

**(ii) Coolant:**

The use of a coolant helps to keep the cutting tool and work piece cool when machining. Coolant also helps to reduce friction between the cutting tool and work piece reducing wear and improving surface finish.

**(iii) Tailstock**

The tailstock stands on the lathe bed opposite the headstock. It can be clamped to the bed at any point. The tailstock is used to hold cutting tools such as drills and reamers. A centre can be fitted into the tailstock barrel and used to support long work pieces. The tailstock can also be adjusted from side to side on its base to facilitate taper turning.

**OR**

(c) **Any two:**

**(i) Safety switch**

Located on CNC lathes to check if the safety guard is in the correct position before manufacturing. The CNC lathe will not start if the guard is opened.

CNC Terms  
**Award 2 @ 6 Marks**  
**Total (12)**

**(ii) G Codes**

Determine the tool path. The cutting tool will move in a particular way depending on the number following the letter G. G01, for example, will cause the tool to travel in a straight line.

**(iii) CAD/CAM**

Stands for Computer Aided Design and Computer Aided Manufacture. Such a system enables us to design and draw the part on the computer screen. Then by selecting the appropriate command the computer will write the part program for output to a CNC lathe for manufacture.

**QUESTION NO. 7**

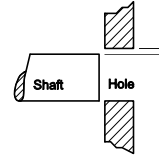
**Total 45 Marks**

Good description  
Award 2 @ 5 Marks  
**Total (10)**

**(a) Any two:**

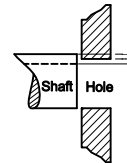
**(i) Clearance fit**

A clearance fit results in the assembly of a shaft and hole where the upper limit of the shaft is smaller than the lower limit of the hole.



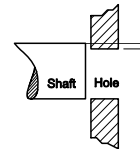
**(ii) Transition fit**

This fit can either be a clearance or interference fit.



**(iii) Interference fit**

An interference fit results where the lower limit on the shaft is always greater than the upper limit on the hole



**(b)**

- (i) Nominal diameter of shaft: - 24.00 mm
- (ii) Maximum diameter of the shaft: - 24.08 mm
- (iii) Minimum diameter of the shaft: - 23.92 mm
- (iv) Tolerance on the shaft: - 00.16 mm

Calculations  
Award 4 @ 5 Marks  
**Total (20)**

**(c) Any three:**

- (i) Micrometer - for the accurate measurement of shafts
- (ii) Angle plate - for supporting work while marking out
- (iii) Feeler gauges - for checking the gap between two surfaces i.e. spark plug gap or car tappets
- (iv) Vee block - for holding round bars when marking out / drilling

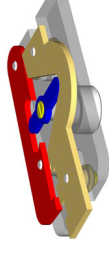
Name  
Award 3 @ 3 Marks  
Application  
Award 3 @ 2 Marks  
**Total (15)**

**OR**

**(c) Any three:**

**A:- Motor, B:- LED, C:- Fixed resistor, D:- Battery.**

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



Subjective Grading 1 - 20		17 - 20 Excellent		13 - 16 Very Good		9 - 12 Good		5 - 8 Poor		1 - 4 Very Poor	
Section	Part Number	Pictorial Sketch / Description				Concept		Mark	Mark		
1	All Parts of Mechanism					Assembly, Function & Finish Subjective Grade 1-20		20	20		
2	Part 1					Marking Out 10mm Radii 10.5mm Slots 11mm Slot Drill 10.5mm Holes		4	20		
3	Parts 2					Marking Out 10mm Radii M5 Tapped Holes 90° Angle and Slot Profile General Profile		4	20		
4	Part 3					Marking Out Vee Slot 9mm Slots M5 Tapped Holes 25mm Radius General Profile		4	20		
5	Parts 4, 5 and 6					Part 4 Lathe Work Part 5 x 4 Lathe Work Part 6 Bench Work		6	20		
								4			
								10			

