



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

**Leaving Certificate 2013**

**Marking Scheme**

***ENGINEERING –***  
***Materials and Technology***

**Ordinary Level**

## **Note to teachers and students on the use of published marking schemes**

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. This training involves, among other things, marking samples of student work and discussing the marks awarded, so as to clarify the correct application of the scheme. The work of examiners is subsequently monitored by Advising Examiners to ensure consistent and accurate application of the marking scheme. This process is overseen by the Chief Examiner, usually assisted by a Chief Advising Examiner. The Chief Examiner is the final authority regarding whether or not the marking scheme has been correctly applied to any piece of candidate work.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates' work and the feedback from all examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination and the need to maintain consistency in standards from year to year. This published document contains the finalised scheme, as it was applied to all candidates' work. In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when in doubt.

### **Future Marking Schemes**

Assumptions about future marking schemes on the basis of past schemes should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination in a given year. The Chief Examiner in any given year has the responsibility to determine how best to ensure the fair and accurate assessment of candidates' work and to ensure consistency in the standard of the assessment from year to year. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination are subject to change from one year to the next without notice.

# **LEAVING CERTIFICATE 2013**

## **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 2013**

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

**Question 1:**

**Total - 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 Total - 45 Marks.

- (a) Three parts @ 4 each (12)
- (b) Two parts @ 4 each  
One part @ 10 (18)
- (c) Three parts @ 3 each (9)
- (d) Two parts @ 3 each (6)

Question 3 Total - 45 Marks.

- (a) Three parts @ 6 each (18)
  - (b) One part @ 8 each  
One part @ 5 (13)
  - (c) Two parts @ 3 each (6)
  - (d) Two parts @ 4 each (8)
- OR**
- (d) Two parts @ 4 each (8)

Question 4 Total - 45 Marks

- (a) Two parts @ 4 each  
Two parts @ 2 each (12)
- (b) Three parts @ 5 each (15)
- (c) Three parts @ 4 each (12)
- (d) Two parts @ 3 each (6)

Question 5 Total - 45 Marks.

- (a) Two parts @ 3 marks  
One part @ 12 marks (18)
- (b) Three parts @ 5 each (15)
- (c) Two parts @ 3 each (6)
- (d) Two parts @ 3 each (6)

Question 6 Total - 45 Marks.

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

Question 7 Total - 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

Any 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

MARKS

#### SECTION A – 30 MARKS

- |   |             |
|---|-------------|
| (a) (i) Ensure the safety guard is down before drilling.<br>(ii) Always hold work securely when drilling.   | 3 + 2 Marks |
| (b) Copper & Brass.   | 3 + 2 Marks |
| (c) (i) Safer process. (ii) Higher accuracy achieved.   | 3 + 2 Marks |
| (d) A DC Motor used to provide rotary input for class projects i.e. model car.  | 3 + 2 Marks |
| (e) To judge if the final solution functions as required and to identify if all required work is completed.   | 3 + 2 Marks |
| (f) (i) A countersunk hole is one which has its mouth enlarged to accommodate countersunk head screws or rivets.<br>(ii) A tapping size hole is one which is drilled prior to cutting an internal thread. It must be smaller than the tap to allow for the depth of the thread. | 3 + 2 Marks |
| (g) (i) An acme thread is used on a lathe leadscrew.<br>(ii) A square thread is used for the operation of a car jack.   | 3 + 2 Marks |
| (h) Mobile phones / I Pads contain Printed Circuit Boards.  | 5 Marks     |

## SECTION B – 35 MARKS

(i) Any one

Good clear description <b>Award 12 (11) Marks</b> <b>Total (12, 11) Marks</b>
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### **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.

### **Worm and wheel mechanism**

A worm and wheel mechanism is a gear arrangement in which a worm, in the form of a screw, drives a wheel similar to a spur gear. A worm and wheel mechanism is used to change the direction of rotation through  $90^\circ$ , reduce rotational speed and increase output torque. This gear system is often used in project work to change the high speed of DC electrical motors into more useful speeds and torques. The worm drives the wheel, if the wheel tries to drive the worm, the system is designed to lock.

### **Box and pan folding machine**

A box and pan folding machine is used to form and bend light gauge sheet metal. It consists of an upper jaw which can be adjusted to accommodate different material thicknesses and different bend radius. The lower jaw is fixed but split to allow a hand operated lever lift the outer half of the lower jaw and bend the clamped material to the required angle.

(j) Any two

Good clear description <b>Award 6 + 6(5)</b> <b>Total (12, 11) Marks</b>
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### **Skype**

Skype is software downloadable from the internet. Skype software allows internet users communicate with peers by voice using a microphone, video by using a webcam, and instant messaging by text. Skype also offers file transfer, and videoconferencing facilities. Phone calls can also be coordinated within Skype but standard landline telephones and mobile phones on the traditional telephone networks are charged.

## VDU

A VDU is a visual display unit or **monitor** used to output visual data on a computer. The monitor comprises the display device circuitry and enclosure. The technology used for the display device continues to evolve but is typically a thin film transistor liquid crystal display thin panel. Their aspect ratio of 16:9 allows high quality picture display for entertainment purposes.

## Virus

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

## Social networks

Social networks offer online services, platforms, or sites that focus on the sharing of information such as interests, activities, backgrounds, or real-life connections between people. A social network service consists of a representation of each user, often a profile, his / her social links, and a variety of additional services. Most social network services are web-based and provide a means for users to interact over the Internet by e-mail and or instant messaging

(k)

### Electrical conductivity:

Electrical conductivity is the ability of a material to allow electric current to pass through. Metals are excellent electrical conductors.

### Example:

Copper / Gold / Brass

Definition

**Award 6**

Example

**Award 6(5)**

**Total (12,11) Marks**

(l) Any two

### Variable resistor

A variable resistor is a resistor which can have the resistance between the central terminal and the end terminals changed by turning the spindle. The resistance can be set between zero and the value marked on its case.

An LDR or Thermistor can also behave as a variable resistor.

Good description

**Award 6 + 6 (5)**

**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.

### Compressive force

A compressive (squashing) force occurs 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.

### Hand vice

A hand vice is used for holding metal while it is being drilled. Small work which has to be drilled and that cannot be held in a machine vice i.e. small pieces of sheet or strip is held in a hand vice for safety.

(m)

**Name:**

Ratchet and pawl

**Application:**

A ratchet and pawl is used in mechanisms such as ratchet spanners, fishing reels, ratchet screwdrivers, micrometers and the winding mechanisms of watches.

Name

**Award 6**

Application

**Award 6(5)**

**Total (12,11) Marks**

## Question 2

(45 Marks)

(a) Metal alloys

- |                                |              |
|--------------------------------|--------------|
| (i) <b>Stainless steel:</b>    | Kitchen sink |
| (ii) <b>Brass:</b>             | Door hinges  |
| (iii) <b>High speed steel:</b> | Twist drills |
| (iv) <b>Bronze:</b>            | Church bell  |

Name

**Award 3 @ 4 Marks**

**Total (12) Marks**

(b) (i) Furnaces

- |                              |           |
|------------------------------|-----------|
| <b>Blast furnace:</b>        | Pig iron  |
| <b>Cupola furnace:</b>       | Cast iron |
| <b>Electric arc furnace:</b> | Steel     |

Good clear description

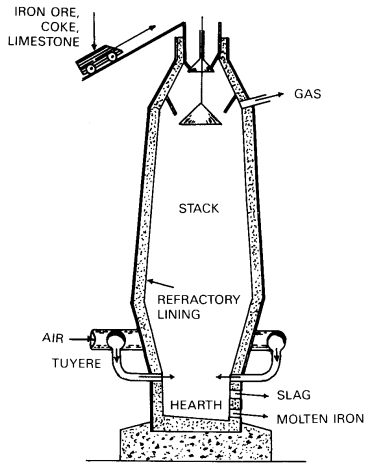
**Award 2 @ 4 Marks**

**Award 1 @ 10 Marks**

**Total (18) Marks**

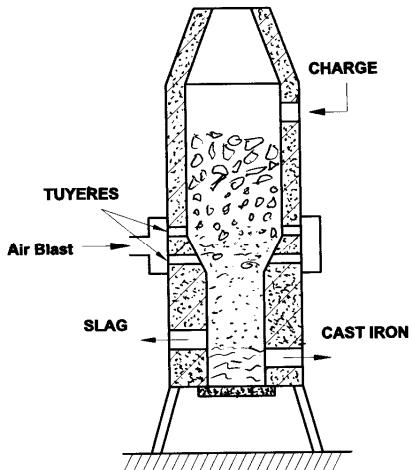


**(b) (ii) Any one description**



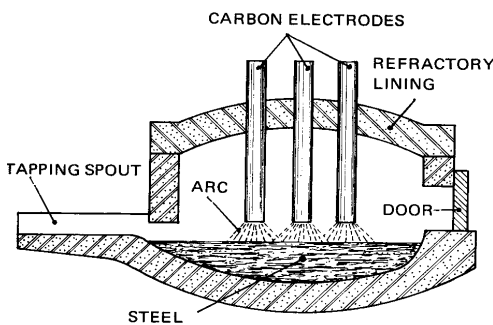
**Blast Furnace**

Iron ore, coke and limestone provide the charge and are fed in through the top of the furnace. 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.



**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.



**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.

**(c) Parts**

- A:** Aluminium
- B:** Fiber Glass
- C:** Stainless steel
- D:** Leather

Name <b>Award 3 @ 3 Marks</b> <b>Total (9) Marks</b>
--

**(d) Two methods**

- (i)** Spray painting
- (ii)** Dip coating

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

**Question 3**

**(45 Marks)**

**(a) Any two descriptions**

**(i)**

**Hardening**

Hardening is carried out to produce the hardest condition possible of a metal. Hardening produces a brittle metal which resists wear, indentation and scratching. It is achieved by heating the metal to a red color and quenching immediately.

**Annealing:**

Annealing is carried out to produce the softest condition possible of a metal and to relieve internal stresses. The metal is heated to the required temperature and allowed to cool down as slow as possible.

Difference <b>Award 2 @ 6 marks</b> Name <b>Award 6 marks</b> <b>Total (18)</b>
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**(ii) Case hardening**

- (b) (i) **Hardening**  
To harden the twist drill is it first heated in a tube or a crucible of red-hot lead until it is a low red, and then quenched in a bath of lukewarm water or brine. Small drills may be dipped in a bath of oil.

Hardening  
Award 8 marks  
Name  
Award 5 marks  
Total (13)

- (ii) Tempering

- (c) **Two safety precautions**

Wear protective clothing to protect from hot water splashes or rising steam.

Plunge the component vertical into the water and move about in a circular direction to ensure uniform cooling.

Good Description  
Award 2 @ 3 Marks  
Total (6) Marks

- (d) **Any two terms:**

- (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.

Description  
Award 2 @ 4 Marks  
Total (8)

- (ii) **Brittleness:**

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

- (iii) **Tempering:**

Tempering is a heat treatment process used to reduce the hardness level of components which have been hardened and are too hard to use.

**OR**

- (d) (i) Suitable applications: assembly lines /operation of screwdriver heads, component placing, dentist drill or robot gripper operation.

Award 2 @ 4 Marks  
Total (8) Marks

- (ii) Once equipment is installed pneumatics provides a relatively cheap form of energy for doing work also pneumatic equipment operates at a relatively quiet level.

## Question 4

(45 Marks)

(a) (i) **Gas welding**

In gas welding the heat source is a flame of acetylene burning in an atmosphere of pure oxygen. This produces a flame which can reach a temperature of 3250° C. Gas welding requires a filler rod fed in by hand and is suitable for welding light gauge material.

Differences

**Award 2 @ 4 Marks**

Applications

**Award 2 @ 2 Marks**

**Total (12) Marks**

**Manual arc welding**

In manual arc welding the heat source is produced by an electrical discharge between the electrode (filler rod) and the work piece. The electric arc produced has a temperature of about 4000° C. and is suitable for welding heavy gauge material.

(ii) **Application:**

**Gas welding:**

Box section / tubular steel - table / chairs

**Manual arc welding:**

Gates / farm machinery

(b)

(i) **Name:** Carburising flame

**Description:** Excess acetylene

(ii) **Name:** Oxidising flame

**Description:** Excess oxygen

(iii) **Name:** Neutral flame

**Description:** Equal amounts of oxygen & acetylene

Name & Describe

**Award 3 @ 5 Marks**

**Total (15) Marks**

(c) **Any three**

(i) Quick and easy to achieve a permanent joint.

Can join different types of materials.

(ii) Wing nut.

Easy to remove by hand.

(iii) Clean joint and correct temperature.

(iv) Easy to apply / will clamp sheet material tight together.

Good explanation

**Award 3 @ 4 Marks**

**Total (12) Marks**

(d) **Two safety precautions**

Welding goggles must be worn to protect the eyes from molten splatter.

Use the correct brazing flux.

Safety

**Award 2 @ 3 Marks**

**Total (6) Marks**

## Question 5

(45 Marks)

(a) (i) Processes

- A: Vacuum forming
- B: Blow moulding

Name  
Award 2 @ 3 Marks  
Total (6) Marks

(ii) Any one process

**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 vacuumed formed sheet can be removed for finishing.

Process  
Award 9 Marks  
Component  
Award 3 Marks  
Total (12) Marks

Vacuum forming is used to produce plastic baths / bins / containers.

**Blow Moulding**

Used to produce articles from a heated thermoplastic tube called a parison. The article is moulded by the internal shape of a split mould. The mould closes around the extruded parison and air is blow inside forcing the parison out against the wall of the mould. The component is allowed to cool before being removed from the opened mould.

Blow moulding is used to produce plastic bottles

(b) Any three

(i) Thermoplastic

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

Explanation  
Award 3 @ 5 Marks  
Total (15) Marks

(ii) Dip coating

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 the tank where fluidized power particles of polyethylene melts and adheres to its surface. When removed, the particles fuse together and cool, providing an attractive and protective coating.

(iii) 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.

**(iv) Elastic memory**

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

**(c) Name:**

**DVDs:** Polycarbonate

**Mobile phones:** Polypropylene

Name

**Award 2 @ 3 Marks**

**Total (6) Marks**

**(d) Two safety precautions**

- Do not hold hot plastic sheet by hand, always wear protective gloves.
- Do not over heat the plastic as it can ignite or produce toxic fumes.

Safety precautions

**Award 2 @ 3 Marks**

**Total (6) Marks**

**Question 6**

**(45 Marks)**

**(a) Any three operations**

**(i) Facing**

**(ii) Knurling**

**(iii) Parting off**

**(iv) Drilling**

Name

**Award 3 @ 4 Marks**

**Total (12) Marks**

**(b) Any three lathe parts**

**(i) Four jaw independent chuck**

Used to hold square or hexagonal material.

**(ii) Tool post**

Used to hold different cutting tools on a centre lathe

**(iii) Tailstock**

Used for drilling and supporting long bars on the centre lathe.

**(iv) Fixed steady**

Used to provide extra support to long bars on the centre lathe.

Name

**Award 3 @ 4 Marks**

Use

**Award 3 @ 2 Marks**

**Total (18) Marks**

**(c) Turning process**

- (i) Name:** Taper turning.
- (ii) Part A:** Top / compound slide.
- (iii) One safety precaution:**  
Ensure the top slide is securely tightened before use.

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

**OR**

**(c) Any three**

- A:** Chuck
- B:** Jog Keys
- C:** Stepper motor
- D:** Cutting tool

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

**Question 7**

**(45 Marks)**

**(a) Any two**

**(i) Clearance fit**

A clearance fit results when the largest shaft is smaller than the smallest hole.

**(ii) Interference fit**

Interference fit results when the size of the shaft is larger than the size of the hole

**(iii) Transition fit**

Depending on the size of the hole and shaft selected, a transition fit can produce a clearance fit or an interference fit.

Name & description  
**Award 2 @ 5 Marks**  
**Total (10)**

**(b)**

- (i)** Nominal diameter of the shaft: 30.00
- (ii)** Smallest diameter of the shaft: 29.94
- (iii)** Largest diameter of the shaft: 30.06
- (iv)** Tolerance of the shaft: 0.12

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

(c) Any three

**Name:**

(i) Vernier height gauge - for accurate marking out.

(ii) Micrometer - for accurate measuring.

(iii) Plug gauge - for checking the diameter of internal holes.

(iv) Outside calipers - for checking the outside diameter of round bars.

**Application:**

Name & application  
Award 3 @ 5 Marks  
Total (15)

**OR**

(c) Any three

**Name:**

(i) LED:

(ii) Toggle switch:

(iii) Variable resistor:

(iv) Battery:

**Use:**

Can be used as a power on indicator in circuits.

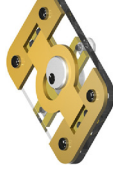
Used to turn circuits on or off.

Can be used to control the flow of current in circuits.

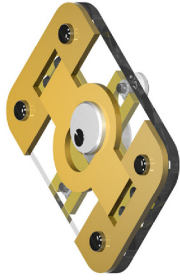
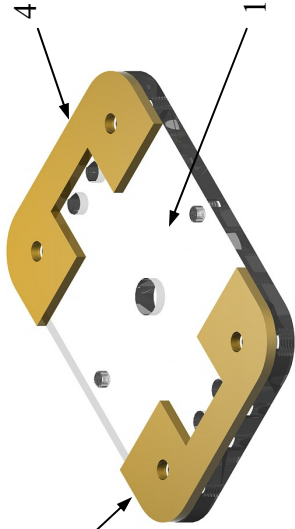


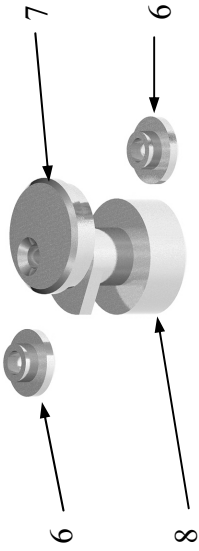
Provides electrical energy to circuits.

Name & use  
Award 3 @ 5 Marks  
Total (15)





Leaving Certificate Engineering - Practical Marking Scheme 2013

Subjective Marking 1 – 20		9 – 12 Good		5 – 8 Poor		1 – 4 Very Poor	
Section	Part Number	Pictorial Sketch / Description	Concept	Mark	Mark		
1	All Parts of Project		Assembly, Function & Finish Subjective Mark 1 – 20	20	20		
2	Parts 1, 3 & 4		Part 1 8 Marks	Marking Out 10 mm Radii Drilled & Tapped Holes	1 2 5		
			Parts 3 & 4 12 Marks	Marking Out 24 mm × 17 mm Slots Ø5.5 mm Holes External Profile	2 4 2 4		
3	Part 2		Part 2	Marking Out 22 mm Slot Profile 20 mm Radii 24 mm Bolt End Right Side 24 mm Bolt End Left Side	4 6 4 3 3		
4	Part 5		Part 5	Marking Out 18 mm Slot 6 mm Slots 8 mm Slots External Profile	4 4 4 4 4		
5	Parts 6, 7 and 8		Part 6	Lathe Work	4		
			Part 7	Lathe Work	4		
			Part 8	Lathe & Bench Work	12		

100 Marks (× 1.5 = 150 Total)

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