



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2015

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 2015

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 2015

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) Four parts, 1 @ 4 3 @ 3 (13)
(c) Three parts @ 4 each (12)
(d) Two parts @ 4 each (8)

Question 3 Total - 45 Marks
(a) Two parts @ 8 each (16)
(b) Two parts, 1 @ 8 1 @ 7 (15)
(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) Three parts @ 3 each (9)
(b) Three parts @ 3 each (9) Three parts @ 3 each (9)
(c) Three parts @ 4 each (12)
(d) Two parts @ 3 each (6)

Question 5 Total - 45 Marks
(a)(i) Three parts @ 3 each (9) (ii) One part @ 9 marks (9)
(b) Two parts @ 3 each (6)
(c) Three parts @ 5 each (15)
(d) One part @ 6 marks (6)

Question 6 Total - 45 Marks
(a) Three parts @ 5 each (15)
(b) Three parts @ 5 each (15)
(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

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) Wear protective gloves when handling hot plastic sheet.
(ii) Be careful not to overheat the acrylic sheet.
- (b) Metals are excellent conductors of electricity, which means an electrical current can pass through metals easily.
- (c) Two operations for a centre lathe tailstock are:
(i) Drilling the centre of round bars.
(ii) Supporting the end of long bars when machining.
- (d) (i) Machine parts can be designed, drawn and edited on computer before manufacture.
(ii) Computers can be used to control the manufacturing process, providing accuracy and very high levels of finish.
- (e) (i) To establish if the final product operates as required.
(ii) To identify design aspects which might be improved.
- (f) (i) To ensure the product is safe to use.
(ii) To improve the overall appearance / presentation of the final product.
- (g) Cam and Follower.
- (h) (i) Engineering machine vice – Buttress / Square thread.
(ii) Machine screw – Vee form / ISO Metric thread.

3 + 2 Marks

5 Marks

3 + 2 Marks

3+2 Marks

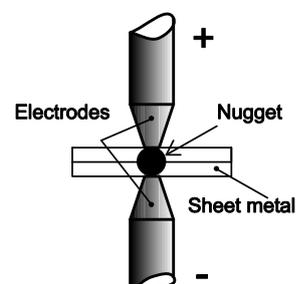
SECTION B – 35 MARKS

(i) Any one:

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

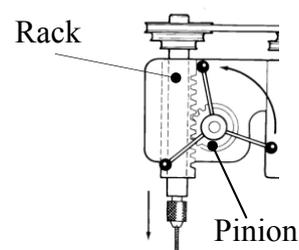
Spot welding machine:

A spot welding machine has two copper electrodes which clamp the sheet metals to be welded. When the spot welding machine is turned on, a current flows from one electrode through the two sheet metal parts to the other electrode. A resistance to the flow of current builds up between the two sheets causing both pieces to heat up and melt at a point. The process only takes a few seconds and a nugget is formed at the weld area.



Rack and pinion mechanism:

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.



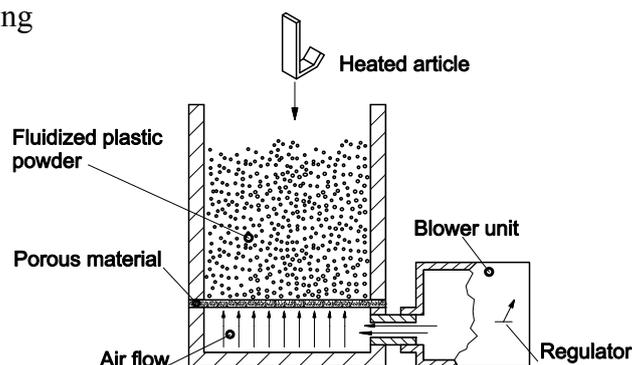
Plastic dip coating tank:

The plastic dip coating tank consists of a fluidizing unit (tank) 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 component 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. 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.



(j) Any two:

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

Software:

Software is a programme or instruction which tells a computer to perform certain tasks. Computers which control CNC machines need software loaded to allow the computer communicate with the CNC device. Common software includes MS word, Solidworks, PowerPoint etc.

Wireless technology:

Wireless technology allows computers / phones / audio devices share information without the use of connecting cables. Information data is moved between computers by radio waves allowing laptops to move about within wireless networks. The cost and complexity of cable connections is removed.

Computer simulation:

A computer simulation provides a computer generated animation of a procedure or process. Utilised in many fields from training of aircraft pilots to safety checks on machining operations, CNC software provides a simulation facility to trial run programs before manufacture.

USB port:

A USB port is a standard cable connection hardware device on personal computers and consumer electronics. USB ports allow stand-alone electronic devices to be connected via cables to a computer (or to each other). USB stands for Universal Serial Bus, an industry standard for short-distance digital data communications. USB allows data to be transferred between devices. USB ports can also supply electric power across the cable to devices without their own power source.

(k)

Brittleness:

A brittle material can be fractured easily by an impact. Brittleness is the opposite to toughness.

Glass / Hardened Steel is an example of a brittle material.

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

(l) Any two:

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

Printed circuit board (PCB):

Printed circuit boards are used to connect electric components together. A printed circuit board (PCB) is usually a plastic board about 1.6mm thick with a thin layer of copper on one side. Unwanted portions of the copper are routed or etched away to leave pads and strips which form electrical connections between the components. The components are soldered to the pads. The strips allow the current to move from component to component.

Metal alloy:

A metal alloy is a material composed of two or more metals or a metal and a nonmetal such as carbon. High speed steel and stainless steel are examples of alloy steels where the addition of various elements such as tungsten or chromium improve the properties or give new properties such as resistance to corrosion or the ability to retain hardness and strength.

Knurling:

Knurling is the operation of impressing serrations on articles to enable them to be gripped securely by hand. The knurl can be of diamond or straight patterned. Usually performed on a centre lathe where the work is rotated at a slow speed and a pair of wheels are pressed against it. The wheels rotate with the work.

Worm and worm wheel:

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

(m)

(i) Plug Tap

(ii) Counter sink drill

Name Award 6 + 6 (5) Total (12, 11) Marks

Question 2

(45 Marks)

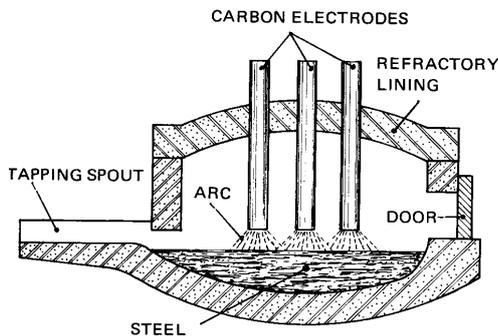
(a) Furnaces:

- (i) Electric arc furnace
- (ii) Basic oxygen furnace
- (iii) Blast furnace

Name
Award 3 @ 4 Marks
Total (12) Marks

Any furnace
Award 1 @ 4 Marks
Award 3 @ 3 Marks
Total (13) Marks

(b) (i)

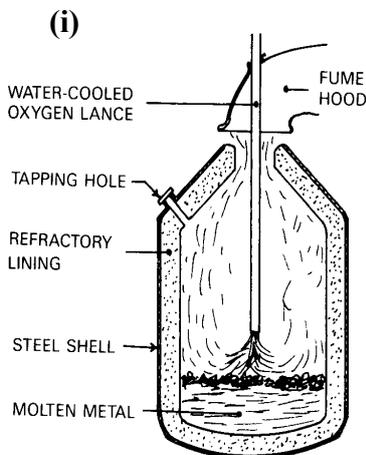


(ii) Pig iron, Scrap steel & Lime.

(iii) Heat for this furnace is produced by an electric arc created by current flowing between the carbon electrodes and the charge.

(iv) High Quality Steel

OR

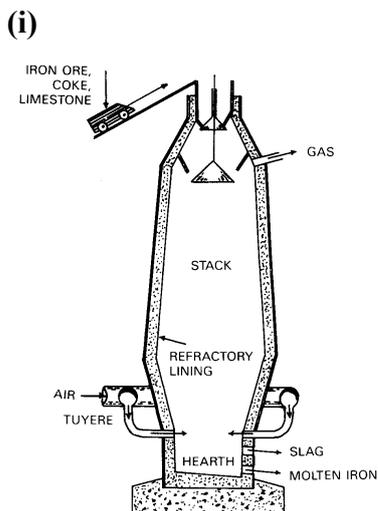


(ii) Pig iron & scrap metal

(iii) Oxygen blown onto the surface of the molten metal produces intense heat which burns unwanted impurities from the charge.

(iv) Steel.

OR



(ii) Iron ore, coke and limestone provide the charge

(iii) As the coke burns it provides heat to melt the charge.

(iv) Pig iron.

(c) Components:

- (i) Frying pan - Aluminium / Cast iron / Copper
- (ii) Engineering square - High carbon steel
- (iii) Hot water cylinder - Copper

Suitable material
Award 3 @ 4 Marks
Total (12) Marks

(d) Metal alloys:

- (i) Brass - Copper / Zinc
- (ii) Solder - Lead / Tin

Metals
Award 2 @ 4 Marks
Total (8) Marks

Question 3

(45 Marks)

(a) Any two descriptions:

Clear descriptions
Award 2 @ 8 marks
Total (16)

(i) 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.

(ii) Annealing:

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

(iii) Work hardening:

Work hardening is the buildup of stresses inside a metal due to hammering or shaping a metal cold. When a metal is hammered or shaped when cold it can become hard and brittle. Some metals are prone to work hardening. Copper and aluminium are typical examples where hardness values can be increased by working on the metal when cold.

(b)

Hardening

The head of the hammer is hardened by heating the head to a dark red colour and then cooling rapidly in clean water / oil.

Description
Award 1 @ 8 Marks
Award 1 @ 7 Marks
Total (15)

The head will become non-magnetic on reaching the required temperature. It must be dipped vertically and moved about in the water / oil to achieve proper cooling.

Tempering

To temper the hammer head, first polish with emery cloth so that the tempering colours can appear. Heat the head slowly to allow the colours to appear as the temperature rises. When the correct colour is achieved i.e. dark brown, cool it in oil or water.

(c) Safety precautions:

- (i)** Do not hold hot metals in your hand, always use tongs to secure.
- (ii)** Use protective equipment to guard against steam / hot splashes.

Reasons
Award 2 @ 3 Marks
Total (6) Marks

- (d) (i)** Water causes the component to lose heat much quicker than if were quenched in oil. This results in the steel having an increased hardness. Care needs to be taken in its use as distortion can occur.

Difference
Award 2 @ 4 Marks
Total (8) Marks

- (ii)** Oil is less drastic than water in quenching and presents less risk of distortion and cracking. Oil gives better control of hardening with slightly less brittleness. Care needs to be taken in its use as fumes are given off by the oil.

OR

(d) Two applications:

- Welding of car frames.
- Spray painting car bodies.

Robotics
Award 2 @ 4 Marks
Total (8) Marks

Question 4

(45 Marks)

(a) Any three:

Description Award 3 @ 3 Marks Total (9) Marks

(i) Flux

A flux is used to remove oxides from the surface of the parts being soldered and to prevent further oxidation when the parts are heated. A flux can be active or passive.

(ii) Sweating

Sweating is a process used when joining two pieces together by soldering. When sweating, both surfaces are coated separately with solder then placed together and heated until the solder on both melts and unites. When the solder cools, both parts are held together.

(iii) Cored solder

Cored solder, supplied in wire form, contains flux inside small holes which run the length of the solder wire. This allows the flux to be deposited as soon as the solder is melted. Cored solder is used when joining electrical components together or when populating PCB's.

(iv) Tinning

Tinning is the process used when a thin layer of solder is required to cover components before sweating. The tip of a soldering iron is often tinned to ensure good heat transfer when soldering.

(b) (i) Three flames

Neutral flame, Oxidising flame, Carbursing flame.

Flames Award 3 @ 3 Marks Total (9) Marks
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(ii) Proportions of oxygen and acetylene

A neutral flame contains equals amounts of oxygen and acetylene.

An oxidising flame contains more oxygen than acetylene.

A carburising flame contains a greater ratio of acetylene then oxygen.

Proportions Award 3 @ 3 Marks Total (9) Marks

Descriptions
Award 3 @ 4 Marks
Total (12) Marks

(c) **Any three:**

- (i) Heat is produced by an electric current passing from the electrode to the work piece in the form of an arc. The electrode touches the piece to start the arc and then withdrawn slightly to maintain it.
- (ii) Pop riveting / machine screws can be used to join light gauge aluminium sheet.
- (iii) Always return the soldering iron back into its stand when soldering is completed. Be careful not to burn the electrical cable on the soldering iron.
- (iv) Countersunk machine screw. Used when the screw head needs to fit flush with material being joined.

(d) **Two reasons:**

- To protect the face and eyes from the intense heat produced.
- To protect against UV light thus reducing damage to eyes and skin.

Safety
Award 2 @ 3 Marks
Total (6) Marks

Question 5

(45 Marks)

(a) (i) **Manufacturing process:**

- Ice cube tray:** - Vacuum forming
Sports bottle: - Blow moulding / Injection moulding (cap)
Tooth brush: - Injection moulding / Caldering / Extrusion

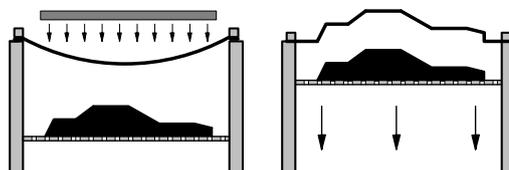
Name
Award 3 @ 3 Marks
Total (9) Marks

(ii) **Any one process:**

Vacuum forming:

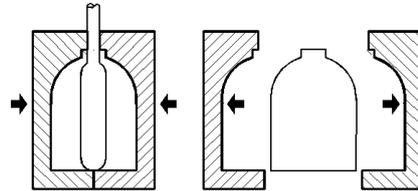
Vacuum forming is used to make articles from thermoplastic sheet. The sheet is clamped and a heater raises the temperature of the sheet until it becomes soft and flexible. The mould table is raised and air is removed from beneath the sheet allowing atmospheric pressure to push down, forcing the sheet 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
Total (9) Marks



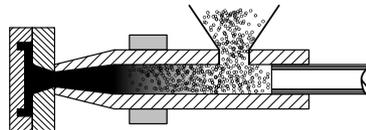
Blow Moulding:

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.



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. The mould opens and ejects the part.



(b) **Any two:**

- Acrylic can shatter and break easily, always ensure the correct cutting speed and feeds are selected when turning on a centre lathe.
- When drilling, ensure the acrylic sheet is supported underneath and reduce feed to help the drill cut through successfully.

Safety
Award 2 @ 3 Marks
Total (6) Marks

(c) **Any three:**

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

Fibreglass

Fibreglass is a fiber reinforced plastic where the reinforcement fiber is made of glass. The glass fiber may be randomly arranged but is commonly woven into a mat. The plastic matrix may be a thermosetting plastic- most often epoxy / polyester resin. Fibreglass is strong as resists impact.

Thermoforming

Thermoforming is a manufacturing process where a plastic sheet is heated until the plastic becomes soft and pliable. A strip heater can be used to heat acrylic sheet for thermoforming. The sheet can then be formed to a specific shape and then trimmed to create a usable product.

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) **High finished edge on acrylic sheet**

- Draw file edge to remove saw cut or cross file marks.
- Use wet and dry emery paper to remove draw file marks.
- Finish with a plastic polish.

Description

Award 1 @ 6 Marks

Total (6) Marks

Question 6

(45 Marks)

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

- (i) Knurling tool
- (ii) Centre drill / Slocombe drill
- (iii) Parting off cutting tool
- (iv) Fixed steady

Name

Award 3 @ 5 Marks

Total (15) Marks

(b) **Any three terms:**

(i) **Taper turning**

A turning process used on a centre lathe to produce a taper or angled finish on a round bar.

Explanation

Award 3 @ 5 Marks

Total (15) Marks

(ii) **Spindle speed**

This is the speed at which the chuck is rotating in RPM. Spindle speed can be altered by selecting various gear or pulley options.

(iii) **Cutting fluids**

Cutting fluids are used when machining i.e. on a centre lathe or band saw.

They help reduce heat and provide a lubricant at the cutting face between the cutting tool and material.

(iv) **Feed**

Feed is the amount per revolution which the drill moves into the material being drilled.

(c) **Lathe chuck:**

- (i) **Name:** Four jaw chuck
- (ii) **Operations:** Holding square bar when turning.
Eccentric turning.
- (iii) **One safety precaution:** When eccentric turning do not select a high spindle speed.

Centre lathe part
Award 3 @ 5 Marks
Total (15) Marks

OR

(c) **Any three terms:**

- (i) Computer Aided Design / Drawing
- (ii) Distances perpendicular to a CNC lathe centre line.
- (iii) Motors used on a CNC lathe which allows the cutting tool to move in a number of predetermined steps. Steps are controlled by electrical pulses.
- (iv) The safety switch is operated by the acrylic guard. If the acrylic guard is not closed the CNC lathe will not operate.

Explanation
Award 3 @ 5 Marks
Total (15) Marks

Question 7

(45 Marks)

(a) **Any two terms:**

- (i) **Lower limit**
The lower limit is the smallest dimension allowed when machining.
- (ii) **Interference fit:**
Interference fit results when the size of the shaft is larger than the size of the hole diameter. No clearance exists and a force is required to force the shaft into the hole.
- (iii) **Allowance:**
The allowance is the difference between the dimensions of a shaft and hole when assembled. In a clearance fit there is always a space between the shaft and hole which is called the allowance.

Description
Award 2 @ 5 Marks
Total (10)

(b)

- (i) Nominal diameter of the hole: 20
- (ii) Largest diameter of the hole: 20.06
- (iii) Smallest diameter of the shaft: 19.92
- (iv) Clearance fit

Calculations
Award 4 @ 5 Marks
Total (20)

(c) **Any three:**

- (i) Engineering protractor - for checking and marking angles
- (ii) Vee block and clamp - for holding round bars when marking out or drilling.
- (iii) Digital micrometer - for accurate measurement of machine parts
- (iv) Digital vernier height gauge - for accurate marking out of machine parts.

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

OR

(c)

Name:

(i) **DC electrical motor:**

(ii) **Light Bulb:**

(iii) **Transistor:**

Use:

To provide rotary movement to whatever is connected to its shaft i.e. gears, wheels, pulleys.

Provides light, converts electrical energy into light and heat energy.

Operates as an electrical switch or can be used to amplify an electrical signal.

Name & function Award 3 @ 5 Marks Total (15)
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Leaving Certificate Engineering - Practical Marking Scheme 2015

Subjective Marking 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	Mark	
1	All Parts of Project					Assembly, Function & Finish Subjective Mark 1 – 20		20	20	20	
2	Parts 1 and 2					Part 1 12 Marks	Marking Out	3	20	20	
							25 mm × 4 mm Steps	6			
							M8 Tapped Hole	2			
							Ø5.5 mm Hole	1			
						Part 2 8 Marks	Marking Out	2	20		
							8 mm × 4 mm Steps	5			
							Ø9 mm Hole	1			
3	Part 3 × 2					Part 3 × 2 20 Marks	Marking Out	4	20	20	
							Rear Profiles	6			
							6 mm Slots	4			
							Lengths & Heights	4			
							Ø9 mm Holes	2			
4	Parts 6 and 7					Part 6 8 Marks	Marking Out	2	20	20	
							26 mm × 4 mm Slots	6			
							Marking Out	4			
							Drill, CSK & Profile	8			
5	Parts 4, 5, 6, 8 and 9					Part 4 8 Marks	Mark Out	2	20	20	
							3 × M5 Tapped Holes	6			
							Lathe Work	12			

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