



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2017

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 2017

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 2017

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) (i) Three parts @ 4 each (12)
- (ii) One part @ 10 (10)
- (b) (i) Three parts @ 3 each (9)
- (ii) Three parts @ 2 each (6)
- (c) Two parts @ 4 each (8)

Question 3 Total - 45 Marks.

- (a) Two parts @ 6 each (12)
 - (b) (i) Two parts @ 6 each (12)
 - (ii) One part @ 7 (7)
 - (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) (i) Three parts @ 3 each (9)
- (ii) Three parts @ 3 each (9)
- (b) Three parts @ 3 each (9)
- (c) Three parts @ 4 each (12)
- (d) Two parts @ 3 each (6)

Question 5 Total - 45 Marks.

- (a) (i) Two parts @ 3 each (6)
- (ii) Two parts @ 3 each (6)
- (iii) Two parts @ 3 each (6)
- (b) Three parts @ 5 each (15)
- (c) Two parts @ 3 each (6)
- (d) One part @ 6 (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) (i) Three parts @ 3 each (9)
 - (ii) Three parts @ 2 each (6)

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) Search and rescue.
(ii) Aerial photography.

3 + 2 Marks

- (b) A non-ferrous metal is a material that does not contain iron.

5 Marks

- (c) Coal.

5 Marks

- (d) **Name:** Knurling tool.
Application: Used to put a grip on round bars in lathe work.

3 + 2 Marks

- (e) A clearance fit is achieved when the largest shaft fits into the smallest hole.

5 Marks

- (f) (i) Printer. (ii) CNC lathe.

3 + 2 Marks

- (g) The injection moulding process is used to produce components such as lunch boxes, phone covers, irregular shapes made from thermoplastic.

5 Marks

- (h) (i) Slippery surface. (ii) Flammable.

3 + 2 Marks

SECTION B – 35 MARKS

Description Award 12 (11) Marks Total (12, 11) Marks
--

(i) Any one:

Hydraulic lifting platform

The hydraulic lifting platform consists of a hydraulic ram attached to one side of a scissor/parallel linkage mechanism. The other side of the linkage mechanism is attached to a fixed pivot. When hydraulic oil is compressed inside the hydraulic ram, the scissor arms either move closer together or further apart. As one side of the scissor arm is secured to a fixed pivot at the bottom, movement of the hydraulic arm opens or closes the scissor mechanism resulting in lifting or lowering the platform.

Ratchet and pawl mechanism

A ratchet and pawl mechanism is used when rotation is required in one direction only. As the ratchet is rotated clockwise the pawl pushes outwards as it lifts over the ratchet's teeth. However, if the ratchet tries to rotate anti-clockwise the pawl does not release thereby preventing rotation.

Scroll saw

A scroll saw includes an electric motor and a crank mechanism. The crank mechanism converts the rotary motion of the motor into reciprocating motion of a thin blade. The up and down motion of the thin blade can be used to cut intricate shapes in wood or metals. A small rubber bellows, fixed to the crank mechanism, is used to produce a small air flow which is directed at the cutting face to remove waste material as it is cut. A guard is attached to the top of the scroll saw arm and should always be used when cutting.

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

(j) Any two:

Bluetooth

Bluetooth is a wireless technology which allows mobile devices to be connected over short distances. Used as a short-range wireless interconnection of mobile phones, computers, and other electronic devices.

3D printer

3D printing is an additive manufacturing process where 3D objects are produced from a digital file. Components are produced by laying down successful layers of material until the object is produced. Each layer can be seen as a thinly sliced horizontal cross-section of the eventual object. Plastics and metals are commonly used as materials.

Cloud technology

Cloud technology is computing over the internet. Cloud technology provides shared processing and resources to other computers and other devices. Storing of information, photographs etc. is a popular use of cloud technology i.e. One Drive, Google Drive, Dropbox etc.

GPS

GPS is a global positioning system. GPS allows detailed navigation using satellite technology to find out one's position. GPS can be used to plan how best to travel between two locations providing direction, travel time, fuel consumption etc.

(k)

Compressive strength

Compressive strength is the ability of a material to be squashed or pushed together without breaking.

Application: The legs of a chair need to be strong in compression as does the cast iron base and column of a pillar drilling machine.

Definition

Award 6

Application

Award 6(5)

Total (12,11) Marks

(l) Any two:

Carbon footprint

Carbon footprint is the total amount of greenhouse gas emissions by an individual or business. Usually expressed in equivalent tons of carbon dioxide (CO₂).

Self-locking nut

A self-locking nut has a nylon insert which will tighten on a thread and prevent the nut from loosening.

Pop riveting

Pop riveting is a permanent assembly technique using a pop riveting gun and rivets. The gun will pull the tail part of the rivet, deforming the other end around the pieces being assembled.

Light emitting diode (LED)

A light emitting diode is a small light which will only give out light if connected in the correct way. Popular use of a light emitting diode is a power on indicator in devices such as laptops, phones, cookers etc. As they require low energy to operate, uses now include car lights, TV screens and household lighting.

Description

Award 6 + 6 (5)

Total (12, 11) Marks

(m)

Name: Worm and wheel mechanism.

Application: Lifting mechanism for a toy crane.

Name

Award 6

Application

Award 6(5)

Total (12, 11) Marks

Question 2

(45 Marks)

- (a) (i) **Blast furnace:**
Cupola furnace:
Electric arc furnace:

Pig iron
Cast iron
Steel

Name of metals

Award 3 @ 4 Marks

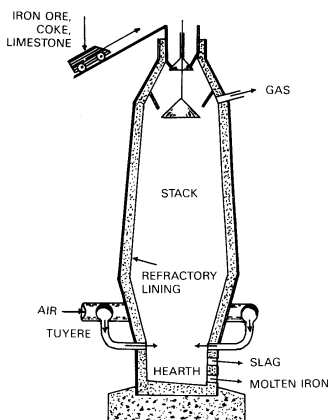
Total (12) Marks

- (ii) Any one description:

Description

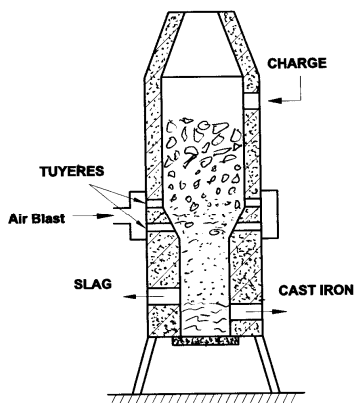
Award 1 @ 10 Marks

Total (10) Marks



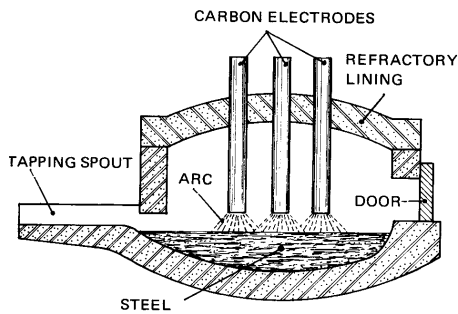
Blast Furnace

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.

(b) (i)

Frame: Steel

Wheel rim: Aluminium

Mud guard: PVC (Thermoplastic)

Name of material
Award 3 @ 3 Marks
Total (9) Marks

(ii)

Steel: Strong

Aluminium: Light / will not rust

PVC: Light / easy to clean / flexible

Reason
Award 3 @ 2 Marks
Total (6) Marks

(c) Any two metal alloys:

Copper and Zinc: Brass

Lead and Tin: Solder

Copper and Tin: Bronze

Name of alloy
Award 2 @ 4 Marks
Total (8) Marks

Question 3

(45 Marks)

(a)

(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.

Description

Award 2 @ 6 marks

Total (12)

(ii) Annealing

The metal is heated to a cherry red colour, approx. 900° and allowed to cool down as slowly as possible. This can be achieved by leaving the metal in the furnace while the furnace is cooling down.

(b)

(i) Hardening and tempering the point of a center punch:

Hardening:

The point of the centre punch is hardened by heating the point to approx. 800 °C i.e. a cherry red color. The point is then immediately quenched in water.

Describe - Hardening

Award 1 @ 6 marks

Describe -Tempering

Award 1 @ 6 marks

Total (12)

Tempering:

Tempering the point is achieved by heating the point again to approx. 230 °C – 350 °C (a light brown color) and then cooling in oil or water.

(ii) Why temper the point of the centre punch?

The point of the centre punch is tempered to reduce the brittleness and increase the toughness of the point.

Explanation

Award 1 @ 7 marks

Total (7)

(c) **Any two items of protective clothing:** Goggles, Gloves.

Identify

Award 2 @ 3 Marks

Total (6) Marks

(d) Any two terms:

(i) **Malleability:**

Malleability is the ability of a material to be hammered / formed into a flat sheet without breaking.

(ii) **Tensile strength:**

Tensile strength is the ability of a material to withstand being pulled apart or stretched.

(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.

Description

Award 2 @ 4 Marks

Total (8)

OR

(d)

(i) Robotics offer precision placement of components in manufacturing.

(ii) Robots are expensive and need qualified personnel to service and programme.

(i) Advantage

Award 1 @ 4 Marks

(ii) Disadvantage

Award 1 @ 4 Marks

Total (8) Marks

Question 4

(45 Marks)

(a) (i)

- A: Oxidising flame
- B: Carburising flame
- C: Neutral flame

Name

Award 3 @ 3 Marks

Total (9) Marks

(ii)

A: (Oxidising flame)

An oxidising flame has more oxygen than acetylene.

B: (Carburising flame)

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

C: (Neutral flame)

A neutral flame has equal proportions of acetylene and oxygen.

Proportions

Award 3 @ 3 Marks

Total (9) Marks

(b) Description, any three:

Description
Award 3 @ 3 Marks
Total (9) Marks

(i) Electric soldering iron

An electric soldering iron is used to heat up the materials and melt the solder when producing a soldered joint. The soldering iron contains an electric element which heats up the soldering tip when electricity is allowed to pass through it.

(ii) A sweated joint

A sweated joint is produced when two pieces of material which have a thin layer of solder on their outside are brought together and heated. The solder melts on both pieces allowing the solder to fuse (sweat) together. When the joint is allowed to cool, a permanent joint between both materials is produced.

(iii) Flux

Flux is used to clean the materials being soldered. Flux also protects the joint from oxidation during soldering.

(iv) Oxides

Oxides (rust) form on a metal when exposed to oxygen. This can prevent a soldering joint forming correctly.

(c) Any three

Explanation
Award 3 @ 4 Marks
Total (12) Marks

(i) Spot welding is performed by placing the electrodes either side of the two pieces and when an electric current flows between the electrodes the joint in the middle of the two pieces heats up and melts creating a nugget weld.

(ii) A tapping size hole is drilled smaller than the size of the tap which is used to thread the hole i.e. for a M6 threaded hole the tapping size hole would be drilled 4.8mm dia.

(iii) The function of a flashback arrester is to prevent the flame travelling back from the torch to the gas cylinder.

(iv) Ventilation is required, Avoid contact with hands / skin.

(d) Two reasons:

- To protect the eyes from light and heat damage.
- To protect the eyes from sparks and debris.

Reasons
Award 2 @ 3 Marks
Total (6) Marks

Question 5

(45 Marks)

(a) (i) Name

- A: - Vacuum forming
B: - Blow moulding

Name of process
Award 2 @ 3 Marks
Total (6) Marks

(ii) Main differences:

In process A, the thermoplastic is heated, the mould is lifted up into the softened plastic sheet and a vacuum is then applied to suck the plastic sheet around the shape of the mould.

In process B, a soft hot thermoplastic tube (parison) is fed in between two half moulds. Hot air is then forced into the tube causing the plastic to stretch out and fill the shape of the mould.

Describe difference
Award 2 @ 3 Marks
Total (6) Marks

- (iii) Vacuum forming: Biscuits trays
Blow Moulding: Bottles

Identify Component
Award 2 @ 3 Marks
Total (6) Marks

(b) Any two descriptions:

(i) Thermoplastic

Thermoplastic is a plastic which can soften over and over again.
Thermoplastic can also be recycled.

(ii) Elastic memory

Elastic memory is where a thermoplastic product will return to its original manufactured state if heated a second time.

Description
Award 3 @ 5 Marks
Total (15) Marks

(iii) Thermosetting plastic

Thermosetting plastic is a plastic which cannot be re-softened a second time. It is difficult to recycle a thermosetting plastic.

(iv) Plastic dip coating tank

A plastic dip coating tank is a container which holds powdered thermoplastic material. A metal piece is heated to approx. 180°C and dipped into the powder which needs to be aerated (fluidized). The plastic powder sticks to the hot metal and melts forming a protective coating around the piece. The metal piece is removed and allowed to cool.

(c) Any two applications:

Polyethylene:	Shopping bags / bottles
Polystyrene:	Disposable cups / packaging
PVC:	Gutter down pipes / Insulation on electrical wires

Application
Award 2 @ 3 Marks
Total (6) Marks

(d) Process:

To bend the acrylic cab a strip heater is used to heat the acrylic on the bend line. This softens the acrylic and when soft enough, the acrylic can be bent over a former of the required angle and allowed to cool and set in position. The angle can be measured with a protractor.

Description
Award 1 @ 6 Marks
Total (6) Marks

Question 6

(45 Marks)

(a) (i) Cutting fluids:

Cutting fluids are used to help lubricate the cutting process, reduce the production of heat and wash away swarf.

1 reason for each part
Award 3 @ 5 Marks
Total (15) Marks

(ii) Speed of the chuck:

Reasons for changing the speed of the chuck include, the diameter of the workpiece, diameter of drill piece and machining operation.

(iii) Lathe cutting tool on centre:

If the cutting tool is on-centre it will cut to the middle with the minimum force. If it is below centre, a small piece will remain uncut at the centre and climbing can be an issue. While if above centre, rubbing and a poor finish will result.

(b) Any three:

- (i) Centre drill
- (ii) Tailstock
- (iii) Parting off tool
- (iv) Chuck

Identify
Award 3 @ 5 Marks
Total (15) Marks

(c) Lathe chuck:

- (i) **Name:** 3-jaw self-centering chuck.
- (ii) **Work holding:** 4-jaw independent chuck, faceplate.
- (iii) **One safety precaution:** Remove chuck key before use.

(i) Name
Award 1 @ 5 Marks
(ii) Name two methods
Award 2 @ 3+2 Marks
(iii) Safety precaution
Award 1 @ 5 Marks
Total (15) Marks

OR

(c) CNC Lathe:

- (i) **CAD / CAM:** Computer Aided Design / Computer Aided Manufacture
- (ii) **Advantages:** Precision of product. Easy to make alterations
- (iii) **Safety:** Perform a simulation of the machining process to ensure no collisions.

(i) Explanation
Award 1 @ 5 Marks
(ii) Advantages
Award 2 @ 3+2 Marks
(iii) Safety precaution
Award 1 @ 5 Marks
Total (15) Marks

Question 7

(45 Marks)

(a) Any two:

(i) Interference fit

Interference fit results when the smallest shaft is bigger than the largest hole. Force is needed to assemble the parts together.

Description
Award 2 @ 5 Marks
Total (10)

(ii) Tolerance

Tolerance is the difference between the upper and lower limits of a component to be manufactured.

$$15 \pm 0.07\text{mm} \quad \text{Tolerance} = 0.14\text{mm}$$

(iii) **Lower Limit**

The lower limit is the smallest size a component can be manufactured to and still be acceptable.

(b)

- | | | |
|-------|---------------------------------|----------|
| (i) | Nominal diameter of the shaft; | 40.00 mm |
| (ii) | Smallest diameter of the shaft; | 39.95 mm |
| (iii) | Largest diameter of the hole; | 39.05 mm |
| (iv) | Interference fit. | |

Calculations/Name
Award 4 @ 5 Marks
Total (20)

(c) **Any three**

- (i) **Outside calipers** - for gauging the outside diameter of round bars.
- (ii) **Vee block & clamp** - used for holding round bars when drilling or marking out.
- (iii) **Digital calipers** - used to accurately display the inside, outside and depth measurements of components.
- (iv) **Feeler gauges** - used to accurately set the gap / distance between two Surfaces i.e. spark plug.

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

OR

(c) **Electronic components**

- (i) **Name:** A:Battery, B:Switch, C:Variable resistor, D:Motor.

Name
Award 3 @ 3 Marks
Total (9)

- (ii) **Battery:** Provides electricity energy.

Switch: Turns on or off a circuit.

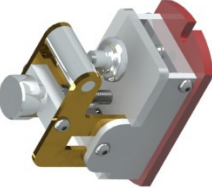
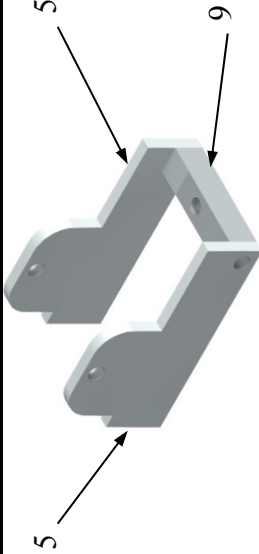
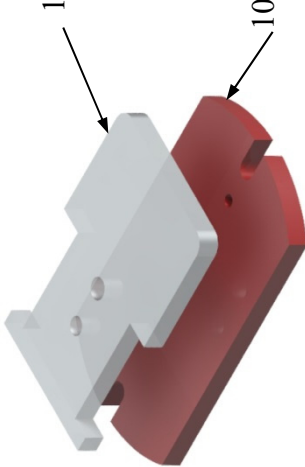
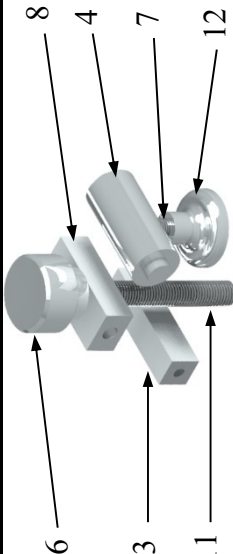
Variable resistor: Slows down the flow of current in a circuit.

Motor: Converts electricity energy into mechanical energy (rotary).

Function
Award 3 @ 2 Marks
Total (6)



Leaving Certificate – Engineering Practical – Marking Scheme 2017

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																										
1	All Parts of Test-piece											Assembly, Function & Finish Subjective Mark 1 – 20																				20	20																										
2	Parts 2											Parts 2 20 Marks										Marking Out										4	20																										
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																						10 mm Slots										6																											
																						Ø8 & Ø5.5 mm Holes										4																											
3	Parts 5 and 9											Parts 5 16 Marks										Marking Out										4	20																										
																						External Profiles										8																											
																						Ø5.5 mm Holes										4																											
																						2 × M5 Holes & Length Ø5.5 mm Hole										3 1																											
4	Parts 1 and 10											Part 1 10 Marks										Marking Out										2	20																										
																						M8 Tapped Hole & Ø5.5 mm Hole										2																											
																						7 mm × 38 mm Slots										6																											
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												Part 10 10 Marks										M5 Tapped Holes										2																											
																						Profile and 6 mm Slots										6																											
5	Parts 3, 4, 6, 7, 8, 11 and 12											Parts 4, 6 and 12 10 Marks										Lathe Work										6	20																										
																						Marking Out and Bench Work										4																											
												Parts 3, 7, 8 and 11 10 Marks										Marking Out and Lengths										5																											
																						4 × M5 Holes & Ø10 mm Hole										5																											

100 Marks (× 1.5 = 150 Total)

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