Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2016

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 2016

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 2016

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 @ 5 each (15)

(b) Three parts @ 4 each (12)

(c) One part @ 10 (10)

(d) Two parts @ 4 each (8)

Question 3 Total - **45 Marks**

(a) Two parts @ 8 each (16)

(b) Three parts @ 5 each (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 @ 4 each (12)

(b) (i) Three parts @ 3 each (9)
(ii) Three parts @ 2 each (6)

(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 @ 12 (12)

(b) Two parts @ 3 each (6)

(c) Two parts @ 4 each (8)

(d) Two parts @ 5 each (10)

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 goggles.
(ii) Ensure the work is secured tightly. — **3 + 2 Marks**

(b) Solder. — **5 Marks**

(c) Polyvinylchloride (PVC). — **5 Marks**

(d) **Name:** Stepped cone pulley.
Application: Pillar drilling machine. — **3 + 2 Marks**

(e) **(i)** To avoid unnecessary mistakes such as material choice, sizes etc.
(ii) To have a scheme of work to follow such as processes for each piece, assembly techniques etc. — **3 + 2 Marks**

(f) **(i)** CAD is used to produce accurate drawings of components for manufacture.
(ii) CAM is used to make the components according to the CAD drawings. — **3 + 2 Marks**

(g) **(i) Name:** A square thread.
(ii) Application: A car jack. — **3 + 2 Marks**

(h) **(i)** To cool down the cutting tool and work piece.
(ii) To act as a lubricant between the cutting tool and work piece. — **3 + 2 Marks**

SECTION B – 35 MARKS

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

(i) Any one:

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°, 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.

Tailstock
The tailstock is part of a centre lathe which can be moved along the bed slideways of the lathe and may be clamped in any desired position. The bore of the tailstock barrel is tapered to take a lathe centre, which is used to support the outer end of long work. The tailstock barrel can also accommodate drill chucks, taper shank drills and reamers.

Vacuum forming machine
A vacuum forming machine is used to heat a plastic sheet before pulling the air out from below it, causing a vacuum. Because of the vacuum, the soft plastic sheet is pressed down over a pattern by atmospheric pressure. In school a vacuum forming machine is used to form / shape thin sheets of plastic, usually polystyrene into 3D hallow shapes such as dishes or box like shapes. To achieve this a vacuum forming machine includes electrical heating elements to soften the plastic sheet which has been clamped, a movable table to allow the pattern to be raised up into the sheet and a vacuum pump to extract the air.

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

(j) Any two:

Drone
A drone may be explained as any unmanned robot either preprogrammed or remotely controlled. This includes robots designed for water, land and air use. The most common drone is an aerial one, either an RPA (remote piloted aircraft) or UAV (unmanned/unpiloted aerial vehicle). A remote-piloted aircraft, RPA, is controlled remotely either by a short-range remote control or from a more sophisticated remote base station. Used in both commercial and military applications, these drones are often similar to a helicopter and can come with more than one rotor blade. An unmanned aerial vehicle, UAV, is preprogrammed prior to flight to do a specific set of tasks on a specific flight path.

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 subdivied 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.

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.

High definition (HD)
High definition (HD) is a system for screen display or resolution of images that are sharper and more detailed than normal. Expressed in pixels, HD is achieved by having many more than the standard number of scanning lines per frame. High definition television (HDTV) has a resolution of approx. 1080 lines which offers approx. 2.07 mega pixels per frame, thus providing a much sharper and clearer image.

(k)

Malleability:
Malleability is the ability of a material to be hammered / flattened out in all directions without breaking.

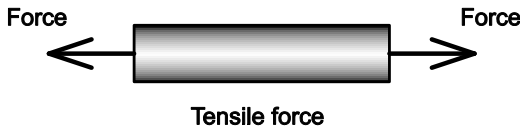
Example:
Lead / Gold

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

(l) Any two:

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

Tensile force
A tensile force is a pulling force acting from opposite ends of a piece away from each other. A tensile force tries to stretch the component.



Countersink drill
A countersinking drill is a cutter which widens the mouth of a hole to accommodate a CSK screw. Countersinking drills have point angles of either 60° or 90°.

Thermal conductor
A thermal conductor is a material that allows energy in the form of heat, to be transferred within the material, without any movement of the material itself. Heat travels quickly through thermal conductors, like metals i.e. copper.

Solar panel
Solar panels are devices that convert light into electricity. They are called solar panels because the most powerful source of light available is the Sun, called Sol by astronomers. Solar panels are often called photovoltaic panels which means "light-electricity." Solar panels are now used to power / charge many devices such as calculators and mobile phones.

(m)

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

Name:
Morse tapered sleeve

Function:
A Morse tapered sleeve is used to fit onto a smaller Morse taper drill or sleeve so as to be fitted into the spindle of a drilling machine or tailstock.

Question 2 (45 Marks)

(a) (i) Seat: Acrylic
Steering Column: Brass
Wheel rim: Aluminium

Part (a) (i) & (ii)
Name & Reason
Award 3 @ 5 Marks
Total (15) Marks

(ii) Acrylic: Easy to manufacture and bend into shape. Provides a good finish.

Brass: Strong with good bearing properties. Can be soldered / threaded easily.

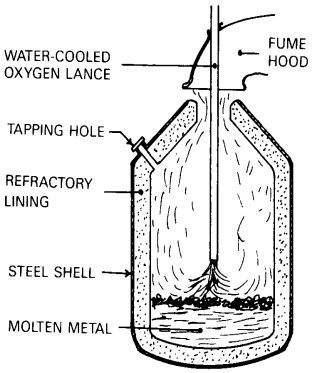
Aluminium: Good strength to weight ratio, will not rust.

(b) Furnaces:
(i) Steel Basic oxygen furnace
(ii) Pig iron Blast furnace
(iii) Cast iron Cupola furnace

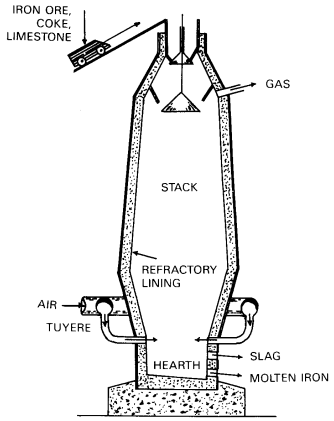
Name
Award 3 @ 4 Marks
Total (12) Marks

(c) Any one description:

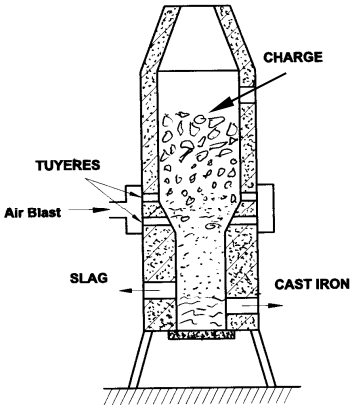
Good clear description
Award 1 @ 10 Marks
Total (10) Marks



Basic Oxygen Furnace.
The charge consists of scrap iron and steel together with lime and molten pig iron. Oxygen is blown at the surface of the molten charge from a water cooled lance which is lowered through the mouth of the furnace. Impurities in the charge are oxidized and form a slag on the surface. At the end of the blow, the steel is poured off through a tapping hole followed by emptying the slag through the mouth of the furnace.



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.

(d) Ferrous & Non-ferrous Metals:

Two ferrous metals: Steel & Cast Iron

Two non-ferrous metals: Copper & Aluminium

Name
Award 2 @ 4 Marks
Total (8) Marks

Question 3 (45 Marks)

Part (a)(i)
Difference @ 8 marks
Part (a)(ii)
Describe @ 4 + 4 marks
Total (16)

(a) (i) Hardening
Hardening a piece of metal creates a hard material which will resist wear, indentation and scratching. Hardening will also increase brittleness.

Annealing:
Annealing is carried out to produce the softest condition possible of a metal and to relieve internal stresses. Annealing increases the ductility and malleability of a metal.

(ii) Hardening
High carbon steel is heated to a cherry red colour, approx. 900^{0}C and quenched immediately in cold water.

Annealing
The metal is heated to a cherry red colour, approx. 900^{0}C 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) Scriber:	Hardening & Tempering
(ii) Copper dish:	Annealing
(iii) Screwdriver point:	Case hardening

Process
Award 3 @ 5 marks
Total (15)

(c) Two safety precautions:

- Wear protective clothing to protect from hot water splashes or rising steam.
- When using oil as a coolant, use appropriate ventilation to allow extraction of fumes.

Precautions
Award 2 @ 3 Marks
Total (6) Marks

(d) Any two terms:

(i) Brittleness:
Brittleness is the inability of a material to withstand impact i.e. a brittle material will fracture if subjected to an impact or blow.

Description
Award 2 @ 4 Marks
Total (8)

(ii) Ductility:
Ductility is the ability of a material to be stretched without breaking. A metal must be ductile to be drawn into wire.

(iii) Toughness:
Toughness is the ability of a material to withstand blows or an impact.

OR

(d) Two applications:

- Changing tyres on cars / lorries / buses
- Tightening of machine screws on assembly lines.

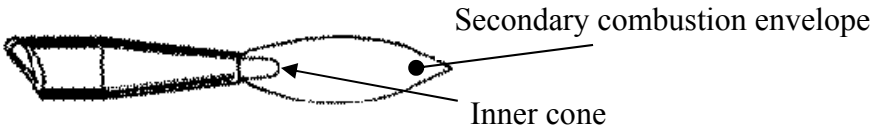
Applications
Award 2 @ 4 Marks
Total (8) Marks

Question 4 (45 Marks)

Description
Award 3 @ 4 Marks
Total (12) Marks

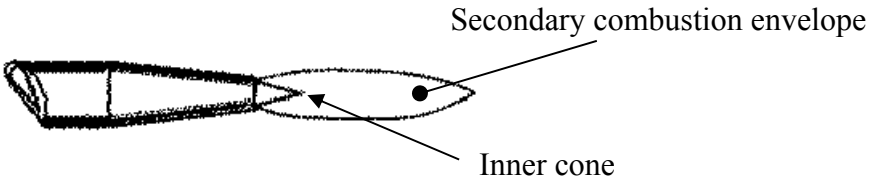
(a) (i) Neutral flame

A neutral flame has equal proportions of acetylene and oxygen. Can be identified by a rounded inner cone. The neutral flame is used for general welding.



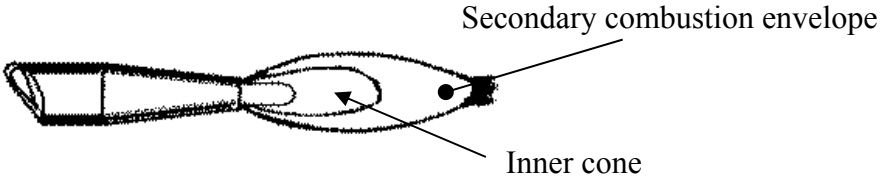
(ii) Oxidising flame

An oxidizing flame has more oxygen than acetylene. Can be identified by a pointed inner blue cone. Used for brazing and welding of brasses.



(iii) Carburising flame

A carborising flame contains a greater ratio of acetylene than oxygen. It can be identified by an additional feather on the inner cone. The extra acetylene may be used to add carbon to a mild steel welded joint to improve hardness.



(b) **(i) Function:**

Function
Award any 3 @ 3 Marks
Total (9) Marks

Electrode
The electrode creates the arc between the work piece and the welder. The electrode melts and fills up the joint while also creating a high temperature to melt the piece.

Welding mask
A welding mask is required to protect the user from the bright light and heat of the welding process affecting both the eyes and the skin on the face.

Arc
The arc is the jumping of current from the electrode to the work piece
The arc creates the heat which melts both the electrode and work piece.

Generator
A generator is used to produce the electricity required by the manual metal arc welding process when a mains electricity supply is not available.

Steps
Award 3 @ 2 Marks
Total (6) Marks

(ii) Three steps:

- Welding joint must be prepared and cleaned before welding.
- The correct power setting must be selected to match the materials.
- A good earth connection must be established to ensure a continuous arc.

(c) **Any three:**

Good explanation
Award 3 @ 4 Marks
Total (12) Marks

(i) Locknut
Used on a shaft / axel where movement / vibration takes place.
The locknut remains on the axle holding a wheel in place.

(ii) Passive flux prevents oxidation but does not corrode the material i.e. it is non-active. A passive flux is required when soldering electrical circuits to prevent damage to the soldered joint.

(iii) - Provides a spot welded joint on light gauge metals.
- Very suitable for automation.

(iv) A permanent joint cannot be taken apart without cutting i.e. welding, soldering, gluing etc.
A temporary joint can be taken apart easily i.e. machine screw and nut.

(d) **Two safety precautions:**

Safety
Award 2 @ 3 Marks
Total (6) Marks

- Light the torch facing away from the user.
- Ensure the bottles are securely held in place prior to use.

Question 5 (45 Marks)

(a) (i) Processes:

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

Name
Award 3 @ 3 Marks
Total (9) Marks

(ii) Any one process from 5(a)(i):

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

(A) 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, drums.**

(B) 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.

(C) 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**.

(b) Two safety precautions:

- Use protective equipment when handling hot plastic i.e. gloves.
- Be careful not to overheat plastic, causing it to ignite.

Safety
Award 2 @ 3 Marks
Total (6) Marks

(c) Suitable plastic:

(i) Plastic water bottle: Low density polyethylene
(ii) Plug casing: Bakelite

Plastic
Award 2 @ 4 Marks
Total (8) Marks

(d) Recycling:

(i) Thermoplastic is more suitable for recycling.

(ii) Thermoplastic can be re-softened by heat over and over again.

Part (d)(i)
Name @ 5 marks

Part (d)(ii)
Reason @ 5 marks

Total (10)

Question 6 (45 Marks)

(a) Any three operations:

(i) Taper turning

(ii) Drilling

(iii) Parting off

(iv) Parallel turning.

Name
Award 3 @ 5 Marks
Total (15) Marks

(b) Any three:

(i) Four jaw independent chuck
The jaws in this chuck can be moved independently of one another, each being controlled by its own screw. They are also reversible and therefore only one set is required. The four jaw independent chuck is used for eccentric turning and for gripping square, round, rectangular and irregular shapes. The work can be centered more accurately in this chuck than in the self-centering one, but it takes longer. The concentric circles on the face of the chuck serve as a guide when positioning the work.

Description
Award 3 @ 5 Marks
Total (15) Marks

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

(iii) Pilot hole
A pilot hole must be drilled before using a large drill. This keeps the large drill central, and it also means that the chisel edge of the large drill does not have to do any cutting.

(iv) Swarf
Swarf is the waste material produced when the chip is cut from the workpiece. Swarf is produced when drilling on a drilling machine or turning on the centre lathe.

Part (c)(i)
Name @ 5 marks
Part (c)(ii)
Two Things @ 3 + 2 marks
Part (c)(iii)
One Precaution @ 5 marks
Total (15)

(c) Machining tool:

(i) Process: Knurling.

(ii) Setting up:
- Make sure it is on centre and square to work.
- Make sure it is well secured in the tool post.

(iii) One safety precaution: Ensure the tool does not collide with the chuck.

OR

(c) Three Advantages:

Advantages
Award 3 @ 5 Marks
Total (15) Marks

- Better accuracy achieved due to precise movement of the cutting tool.
- Self-contained work area, safer for the user.
- Consistent replication of pieces.

Question 7 (45 Marks)

Explanation
Award 2 @ 5 Marks
Total (10)

(a) Any two:

(i) Clearance fit
A clearance fit results when the largest shaft is smaller than the smallest hole hence giving a fit which will go together without using force.

(ii) Upper limit
The upper limit is the largest measurement the piece can be i.e.

$15 \pm 0.07mm$ Upper limit = 15.07 mm

(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.

Calculations
Award 4 @ 5 Marks
Total (20)

(b)

(i)	Nominal diameter of the shaft;	15.00 mm
(ii)	Minimum diameter of the shaft;	14.93 mm
(iii)	Maximum diameter of the shaft;	15.07 mm
(iv)	Tolerance on the shaft;	0.14 mm

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

(c) Any three:

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

(ii) Depth gauge - for measuring the depth of holes/slots/shoulders.

(iii) Radius gauges - comparing a radius for size / shape
(iv) Dial gauge - can be used to check the concentricity of a rotating bar in a centre lathe.

OR

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

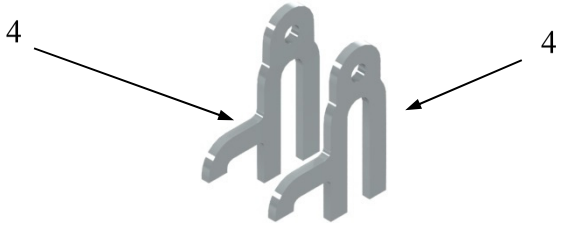
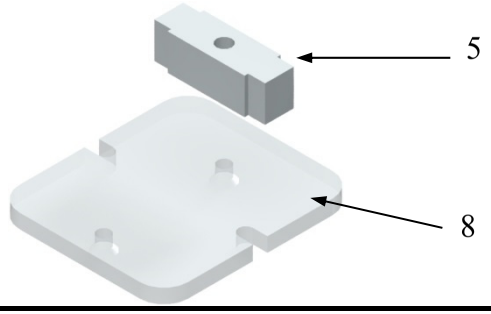
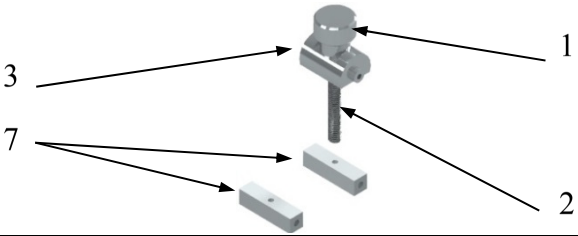
(c) Electronic components:

Name:	**Use:**
(i) LED:	Can be used as a power on indicator in circuits.
(ii) Toggle switch:	Used to turn circuits on or off.
(iii) Fixed resistor:	Prevents too much current getting to components and damaging them.

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate - Engineering Practical - Marking Scheme 2016

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 Project**		Assembly, Function & Finish Subjective Mark 1 – 20		**20**	**20**
2	**Parts 4**		**Parts 4** 20 Marks	Marking Out	**4**	**20**
				External Profiles	**8**	
				12 mm Slots	**6**	
				Ø8 mm Holes	**2**	
3	**Parts 6**		**Parts 6** 20 Marks	Marking Out	**2**	**20**
				External Profiles	**8**	
				15 mm × 12 mm Slots	**6**	
				Ø5.5 mm Holes	**4**	
4	**Parts 5 and 8**		**Part 5** 10 Marks	Mark Out	**2**	**20**
				M8 Tapped Hole	**2**	
				12 mm Spigots	**6**	
			Part 8 10 Marks	Marking Out	**2**	
				Profile and 6 mm Slots	**6**	
				Ø5.5 mm CSK Holes	**2**	
5	**Parts 1, 2, 3 and 7**		**Parts 1, 2 and 3** 10 Marks	Lathe Work	**6**	**20**
				Marking Out and Bench Work	**4**	
			Parts 7 10 Marks	Marking Out and Lengths	**4**	
				6 × M5 Tapped Holes	**6**	

100 Marks (× 1.5 = 150 Total)

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