



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2012

Marking Scheme

**ENGINEERING – MATERIALS AND
TECHNOLOGY**

Ordinary Level

LEAVING CERTIFICATE 2012

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 2012

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) Three parts @ 3 each
One part @ 9 (18)
- (c) Three parts @ 3 each (9)
- (d) Two parts @ 3 each (6)

Question 3 Total - 45 Marks.

- (a) Two parts @ 7 each (14)
 - (b) Two parts @ 6 each
One part @ 5 (17)
 - (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 @ 5 each (15)
- (b) Three parts @ 4 each (12)
- (c) Three parts @ 4 each (12)
- (d) Two parts @ 3 each (6)

Question 5 Total - 45 Marks.

- (a) One part @ 4 marks
One part @ 12 marks (16)
- (b) Two parts @ 3 each (6)
- (c) Three parts @ 5 each (15)
- (d) Two parts @ 4 each (8)

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)

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) Ensure the safety guard is down before machining.
(ii) Always run a simulation of the part program before final output. | 3 + 2 Marks |
| (b) | An L.E.D. (Light Emitting Diode). A suitable application would be in a laptop to indicate the power has been turned on. | 3 + 2 Marks |
| (c) | A brittle material can easily be fractured by an impact force. | 5 Marks |
| (d) | To stop the flow of electrical current. | 5 Marks |
| (e) | Injection moulding is used for the manufacture of plastic buckets. | 5 Marks |
| (f) | A rack and pinion used to raise or lower the table of a pillar drilling machine. | 3 + 2 Marks |
| (g) | (i) A printer used to provide hardcopies of documents such as a design folio.
(ii) A robot arm used on car assembly lines to spray paint car bodies. | 3 + 2 Marks |
| (h) | A micrometer. | 5 Marks |

SECTION B – 35 MARKS

(i) Any one:

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

Four Jaw Independent Chuck:

The four jaw independent chuck can be used for eccentric turning and for gripping square, round, rectangular and irregular shapes. The four jaw independent chuck allows the work to be centered more accurately than a three jaw, but takes longer.

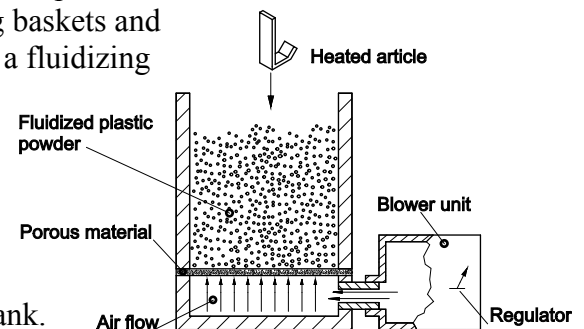
The jaws can be moved independently of one another, each being actuated by its own screw. The jaws are also reversible and therefore only one set is required.

Plastic dip-coating tank

A plastic dip coating tank is used to put a more socially acceptable finish on components made from steel, such as shopping baskets and kitchen utensils. The plastic dip coating tank consists of a fluidizing unit and a blower unit. The fluidizing unit has two compartments which are separated from each other by a porous material. The upper compartment contains the plastic powder and the air supply is connected to the lower one. Air passes up through the porous material and causes the plastic powder to act like a fluid.

The component is heated to 180°C and dipped into the tank.

The plastic close to the component 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 component in a protective coating.



Sprocket and chain mechanism

Sprocket and chain mechanisms are usually made of alloy steels and provide direct positive drives. Their main advantages are high torque transmission with no slippage. A good example of a sprocket and chain drive is on a bicycle. The pedal sprocket (driver) is larger than the wheel sprocket (driven). Both sprockets have 'vee' shaped teeth which a specially designed chain made up of links fits over. Each link contains two pivot pins which allow the chain to move around the sprockets. A sprocket and chain mechanism requires lubrication to function successfully. Other applications are on motorcycles, go-karts and camshaft drives of some engines.

(j) Any two

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

Webcam

A webcam is a video camera that feeds its images in real time to a computer or computer network, often via USB, ethernet, or Wi-Fi. Their most popular use is the establishment of video links, permitting computers to act as videophones or videoconference stations. The common use as a video camera for the World Wide Web gave the webcam its name. Other popular uses include security surveillance, computer vision, video broadcasting and for recording social videos.

Computer network

A computer network is a collection of computers, printers and other equipment, which are connected together so that they can communicate with each other. The linking of computers by special cables or radio waves know as wireless networks allow data and resources to be shared among users.

Search engine

The World Wide Web, contains hundreds of millions web sites and pages waiting to present information on many topics. Search engines such as ‘Google’ are special sites on the Web that are designed to help people find information stored on other sites. Search engines perform three basic tasks:

- They search the Internet or select pieces of the Internet based on important words.
- They keep an index of the words they find, and where they find them.
- They allow users to look for words or combinations of words found in that index.

Today’s search engines can index hundreds of millions of pages and respond to tens of millions of queries each day.

Mobile application (app)

A mobile application (app) is application software which is developed for small low-power handheld devices such as mobile phones or personal digital assistants. These applications are either pre-installed on phones during manufacture, downloaded by customers from various mobile software distributors, or web applications. There is a vast range of mobile app available from games, business, travel to educational applications.

(k)

Tensile strength:

The ability of a metal to withstand a pulling force is know as it’s tensile strength.

Example:

Fishing line / a tow bar requires a high degree of tensile strength as does a crane hook.

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

(l) Any two

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

Pulley drive system

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

Ratchet and pawl

A ratchet and pawl is used to allow a shaft, axle or pin to rotate in one direction only. The teeth on the ratchet wheel are so shaped that the pawl slides over them in one direction and engages with them so as to restrict movement in the other direction. A ratchet and pawl can be used in ratchet spanners, fishing reels, ratchet screwdrivers, micrometers and winding machines etc.

Pop riveting

Pop riveting is used for joining light gauge material. A special tool is used to draw a pin through the rivet enlarging one end of the rivet until the pin breaks leaving its head behind. A pop rivet has an advantage in that it can be used to join hollow sheet metal articles where only one side of the joint is accessible.

Enameling

Enameling involves fusing enamel, which is basically coloured glass, onto metal surfaces. The enamel is mostly applied in powder form and then fired. The firing can be done with a blow torch but a kiln is more suitable. The enamel can be transparent, translucent or opaque and can be confined to certain areas of the surface if desired. A number of metals can be enameled, e.g. copper, silver, gold and steel.

(m)

Name:

Circular split die / button die

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

Function:

A circular split die is used for cutting external threads on round bars and on pipes. The circular die is fitted into a stock, placed on top of the bar and rotated forward and backward to cut the thread. The split permits a small amount of opening and closing of the die to aid in the cutting of the thread.

Question 2

(45 Marks)

(a) Suitable material

- | | |
|--------------------|--------------------------|
| (i) Scribe: | High carbon steel |
| (ii) Radiator: | Steel |
| (iii) Step ladder: | Steel / Aluminium / Wood |

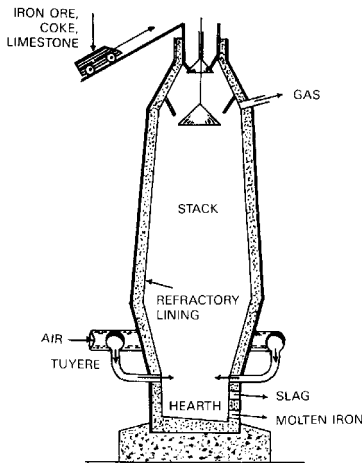
Name
Award 3 @ 4 Marks
Total (12) Marks

(b) (i) Furnaces

- | | |
|--------------------|----------------------|
| Pig iron: | Blast furnace |
| Cast iron: | Cupola furnace |
| High carbon steel: | Electric arc furnace |

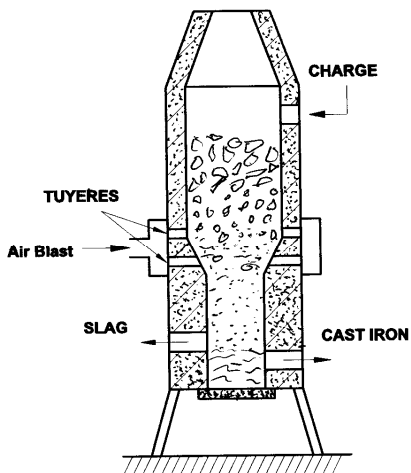
Good clear description
Award 3 @ 3 Marks
Award 1 @ 9 Marks
Total (18) Marks

(b) (ii) Any one description



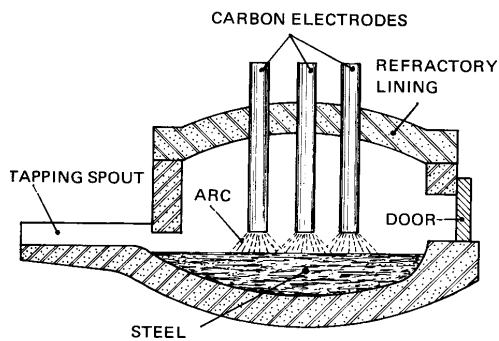
Blast Furnace

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) Ferrous / Non ferrous

- | | | |
|-------|-------------------------|-------------|
| (i) | Stainless steel: | Ferrous |
| (ii) | Zinc: | Non-ferrous |
| (iii) | Tungsten: | Non-ferrous |
| (iv) | Lead: | Non-ferrous |

Name
Award 3 @ 3 Marks
Total (9) Marks

(d) Two copper alloys

- Brass
- Bronze

Name
Award 2 @ 3 Marks
Total (6) Marks

Question 3

(45 Marks)

(a) Any two descriptions

Description Award 2 @ 7 marks Total (14)
--

(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 relieve internal stresses. The metal is heated to the required temperature and allowed to cool down as slow as possible.

(iii) **Work hardening:**

When a metal is hammered or shaped when cold it becomes hard and brittle at the point where the cold - working occurs. Some metals are prone to work hardening, copper and aluminium are typical examples where hardness values can be increased by cold working.

(b)

(i) **Hardening**

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

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

Tempering

To temper point A of the chisel, first polish with emery cloth so that the tempering colours can appear. Heat slowly behind the hardened portion and allow the heat to travel gradually to the cutting edge. The tempering colours will appear as the temperature rises. When the correct colour reaches the point i.e. dark straw, cool it in oil or water.

(b) (ii) **Reason for tempering**

After hardening point A of the chisel, it is too brittle for use. Some of the hardness must be removed from the cutting point. Tempering is used to reduce the hardness level of components which have been hardened.

Reason Award 5 Marks Total (5) Marks
--

(c) Two safety precautions

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

Perform the hardening process in a well protected area away from busy environments.

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

(d) Any two material properties

(i) Toughness:

This is the ability of a material to withstand an impact or hammering load.

(ii) Ductility:

Ductility is the ability of a metal to be drawn into wire. A material is ductile when it can be permanently stretched by a tensile force without fracture.

(iii) Melting point:

The melting point of a material is the temperature at which a material changes from a solid state to a liquid state.

Description
Award 2 @ 4 Marks
Total (8)

OR

(d)

(i) Suitable applications are welding, component placing or spray painting.

(ii) Using robots to perform repetitive tasks, helps to increase productivity.

Safety
Award 2 @ 4 Marks
Total (8) Marks

Question 4

(45 Marks)

(a)

(i) **Excess oxygen:**

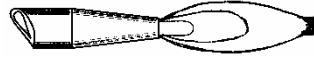
Name: Oxidising flame **Sketch:**



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

(ii) **Excess acetylene:**

Name: Carburising flame **Sketch:**



(iii) **Equal balance:**

Name: Neutral flame **Sketch:**



(b) **Any three**

- (i) Quick and easy to achieve a permanent joint.
Suitable for joining light gauge sheet material.
- (ii) Ensure both surfaces are clean and free from liquids
Maximise surface contact between both joining faces.
- (iii) Pop riveting / machine screws.
- (iv) As the thread on the machine screw cuts into the nylon insert it provides a grip holding / locking the nut in place, stopping the nut from loosening by vibration.

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

(c)

(i) **Purpose of a flux**

To remove oxides from metal and / or prevent the formation of new oxides.

To reduce surface tension allowing the solder to flow easily i.e. capillary attraction.

To assist the alloying action of the solder with the work.

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

(ii) **Passive and active flux**

A passive flux is non-corrosive and resin based. It prevents oxidation during soldering. Suitable for electrical work and other applications where it is not possible to wash away the flux from the joint afterwards.

An active flux is corrosive and removes oxides from the surface and prevents further oxidation during soldering. When using an active flux, the joint must be thoroughly washed afterwards.

(d) **Two safety precautions**

A welding mask must be worn to protect the eyes from UV rays and welding spatter. Always work in a spacious and well ventilated area.

Reasons
Award 2 @ 3 Marks
Total (6)

Question 5

(45 Marks)

(a) (i) Any one process

- Clothes hanger - Injection moulding
- Container - Blow moulding
- Socket - Compression moulding

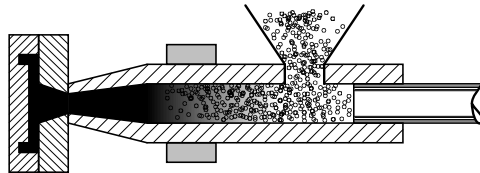
Name
Award 1 @ 4 Marks
Total (4)

(ii) Any one process

Injection Moulding:

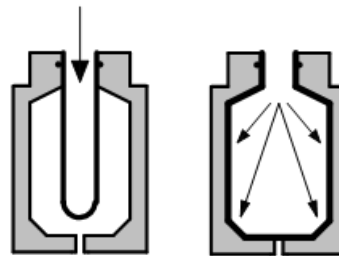
Thermoplastic is softened by heating it inside an injection nozzle. The softened plastic is forced by a plunger into a cold mould where it hardens rapidly and is then ejected. Injection moulding is used for the rapid moulding of components.

Good description
Award 12 Marks
Total (12)



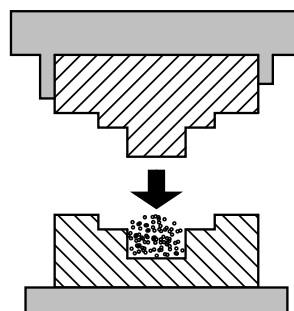
Blow Moulding

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 blown inside forcing the parison out against the wall of the mould. The component is allowed to cool before being removed from the opened mould.



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.



(b) Two safety precautions

- Do not hold acrylic sheet by hand when drilling, always use a hand vice or machine vice to secure.
- Use a slow feed when drilling and use a wooden block to support the acrylic sheet underneath.

Safety precautions
Award 2 @ 3 Marks
Total (6) Marks

(c) Any three

(i) 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.

(ii) Elastic memory

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

(iii) Thermoplastic

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

(iv) PVC

The term PVC refers to the plastic Polyvinylchloride

Explanation
Award 3 @ 5 Marks
Total (15) Marks

(d) Any two

- A plastic cup takes up to 50-80 years to decompose. Plastic bags and other plastic waste which makes its way into the sea kills as many as 1 million sea creatures every year. Always separate plastic waste into biodegradable and non- biodegradable.
- Careless disposal of plastics by burning / incineration can release poison gases into the environment. Identification of plastic types before incineration can help reduce air pollution.

Good description
Award 2 @ 4 Marks
Total (8) Marks

Question 6

(45 Marks)

(a) Any three operations

Name Award 3 @ 5 Marks Total (15) Marks

Knurling

Knurling is the operation of impressing serrations on components to enable them to be gripped securely by hand. Produced by a knurling tool pressed into the surface of the knob. The knurl used for the knob is a diamond pattern.

Taper turning

Produced by offsetting the lathe top-slide. The cutting tool is fed into the work by hand.

Drilling

The tailstock is used for drilling on the lathe. Drills are located in the tailstock chuck which is fed into the material by rotating the tailstock handwheel.

Countersinking

Used to provide a recess for a locating screw. The centre or slocombe drill can be used in the tailstock to provide a countersink finish.

Parallel turning / Sliding

The cutting tool moves parallel to the work axis producing a cylindrical form.

Facing / Surfacing

The cutting tool moves at right angles to the axis or rotation of the work by means of the cross slide. This movement produces flat surfaces and finishes shoulders.

(b) Any three

Cutting fluids Award 3 @ 5 Marks Total (15) Marks

(i) Cutting speed

Cutting speeds for tools are given in meters per minute. To calculate spindle speeds or rotational speeds for a lathe a formulae is applied. This calculation provides the revolutions per minute (rev/min) of the lathe spindle.

(ii) Depth of cut

When parallel turning the depth of cut is the distance the cutting tool is moved in at right angles to the axis of rotation. The depth of cut will determine how much the diameter of the material is reduced on each pass.

(iii) Feed

Feed refers to the distance the cutting tool moves parallel to the axis of rotation during each revolution of the workpiece. It is expressed in millimeters per revolution. The smaller the feed rate, the smoother the surface finish.

(iv) 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 just rub against the work without cutting.

(c) Workholding

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

- (i) Name:** Turning between centres
- (ii) Two other methods:** Three jaw chuck, Four jaw independent chuck
- (iii) Two safety precautions:**
Ensure all components i.e. driving plate / dog carrier / live & dead centres are secured and tightened correctly.
Stay clear of all rotating parts.

OR

(c) Any three

Explanation Award 3 @ 5 Marks Total (15) Marks
--

(iv) CAD/CAM

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

(ii) Z Axis

A CNC lathe controls the movement of the cutting tool along two axes identified as the 'X' and 'Z' axis. The Z axis runs parallel to centre line of the work billet.

(iii) G Codes

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

(iv) Canned cycle

A canned cycle enables a number of repetitive operations to be carried out by a single block of program. Peck drilling (G83) is an example of a canned cycle.

Question 7

(45 Marks)

(a) Any two

Good description
Award 2 @ 5 Marks
Total (10)

(i) Tolerance

The tolerance is the amount by which a dimension is allowed to deviate from the nominal size. Tolerance can be obtained by subtracting the lower limit from the upper limit.

(ii) Interference fit

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

(iii) Upper limit

The upper limit refers to the largest size of a hole or shaft.

(b)

- | | |
|--------------------------------------|---------------|
| (i) Nominal diameter of the hole: | 51.00 |
| (ii) Smallest diameter of the hole: | 50.81 |
| (iii) Largest diameter of the shaft: | 50.06 |
| (iv) Type of fit: | Clearance fit |

Calculations
Award 4 @ 5 Marks
Total (20)

(c) Any three

- | | |
|--------------------------|---|
| (i) Engineers protractor | - for accurate marking out of angles |
| (ii) Depth gauge | - for accurate measuring the depth of holes/slots/shoulders |
| (iii) Radius gauges | - for checking internal & external radii |
| (iv) Vee block & clamp | - for holding round bars when drilling or marking out |

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

OR

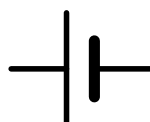
(c) Any three

Symbols
Award 3 @ 5 Marks
Total (15)

(i) Bulb



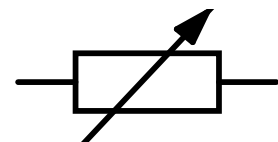
(ii) Battery



(iii) Switch

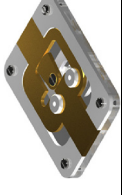


(iv) Variable resistor





Leaving Certificate Engineering Practical Marking Scheme 2012



Subjective Marking 1 - 20		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 3					Part 1 12 Marks	Marking Out	2	20
							10mm Radii	2	
							M5 Tapped Holes	2	
							Ø10 mm Hole	2	
							8 mm Slots	4	
3	Part 2					Part 3 8 Marks	Marking Out	2	20
							Ø5.5 mm CSK	2	
							External Profile	4	
							Marking Out	4	
							Internal Profile	6	
4	Parts 4 and 5					Parts 4 & 5	57 × 60 mm with 12 mm Radii	4	20
							34 × 26 mm Bolt End	3	
							21 × 26 mm Bolt End	3	
							Marking Out	4	
							Ø5.5 mm Holes	4	
5	Parts 6, 7 and 8					Parts 4 & 5	10 mm Radii	4	20
							12 mm Radii	4	
							Internal Profile	4	
							Marking Out	4	
							Lathe Work	8	
							Bench Work	8	
							Lathe Work	4	

100 Marks (× 1.5 = 150 Total)

