Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2018

Marking Scheme

ENGINEERING –
Materials and Technology

Higher 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 2018

MARKING SCHEME

Written Examination and Practical Examination

ENGINEERING –
Materials and Technology

HIGHER LEVEL

LEAVING CERTIFICATE

ENGINEERING - Materials and Technology

(Higher Level – 300 marks)

Written Examination Marking Scheme 2018

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

Question 1 Section A – 50 marks
Any ten @ 5 marks each.

(a) 5
(b) 5
(c) 3 + 2
(d) 5
(e) 3 + 2
(f) 5
(g) 5
(h) **Any one** @ 5
(i) 5
(j) 5
(k) 3 + 2
(l) 3 + 2
(m) 3 + 2

Question 1 Section B – 50 marks
Answer **all** of the following.

(n) (i) 3 + 2
(ii) 3 + 2

(o) (i) 5
(ii) 5

(p) **Any two** @ 5 + 5

(q) **Any two** @ 5 + 5

(r) 5 + 5

Question 2 – 50 marks

(a) (i) 8
(ii) 8

(b) (i) 1 + 1 + 1
(ii) 9
(iii) 6

(c) (i) 4 + 4
(ii) 8

Question 3 – 50 marks

(a) (i) 8
(ii) 4 + 4

(b) (i) 3 + 3
(ii) 6
(iii) 6

(c) 16

Question 4 – 50 marks

(a) (i) 4 + 4 + 4
(ii) 4

(b) (i) 10
(ii) 2 + 2 + 2
(iii) 2

(c) Any **two** @ 8 + 8

Question 5 – 50 marks

(a) (i) 10
(ii) 2 + 2 + 2

(b) **Any three** @ 6 + 6 + 6

(c) 16
OR
(c) (i) 4 + 4
(ii) 8

Question 6 – 50 marks

(a) (i) 8
(ii) 4 + 4

(b) **Any three** @ 6 + 6 + 6

(c) (i) 4
(ii) 8
(iii) 2 + 2

Question 7 – 50 marks

(a) (i) 4 + 4
(ii) 4 + 4

(b) **Any three**@ 6 + 6 + 6

(c) (i) 8
(ii) 8
OR
(c) (i) 4 + 4
(ii) 4 + 4

Question 8 – 50 marks

(a) (i) 8
(ii) 8

(b) **Any three** @ 6 + 6 + 6

(c) (i) 8
(ii) 4 + 4
OR
(c) (i) 2 + 2
(ii) 4
(iii) 4 + 4

Sample Answers *and* Marking Scheme

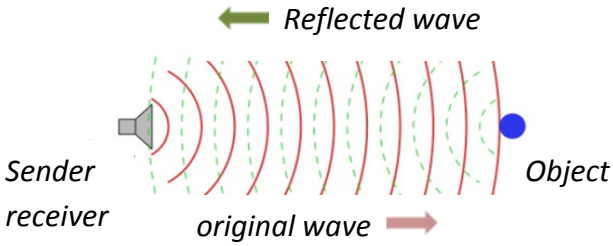
Note: **The solutions presented are examples only.**

All other valid solutions are acceptable and are marked accordingly.

Question1 **(100 Marks)**

Section A – 50 marks

(a) An ultrasonic wave is emitted from a sensor and reflections from nearby objects are received. Detection of the received field indicates an object within a certain distance.



5

(b) The degree of structural capacity beyond applied loads, e.g. if a load of 10kN is the maximum applied to a structure capable of withstanding 30kN, the Factor of Safety is 3.

5

(c) Titanium benefits include: lightweight, strong, corrosion resistant, non-toxic, biocompatible (not toxic and not rejected by the body), long-lasting, osseo-integrated (the joining of bone with artificial implant), flexibility and elasticity rivals that of human bone, etc.

3 + 2

(d) Cast iron, ceramic coated aluminium, stainless steel, etc.

5

(e) Reduce weight of disk, allow the heat generated by braking to dissipate, allows air to circulate cooling the disk, increases disk life, improves grip etc.

3 + 2

(f) 22.15 mm

5

(g) Izod or Charpy impact tests are suitable to test the helmet.

Izod Test

- 167 joules striking energy.
- Test specimen is vertical.
- Test piece is clamped at one end.
- Test piece notch is facing the pendulum.
- The distance the pendulum travels after breaking the piece will give the toughness value.

Charpy Test

- 300 joules striking energy.
- Test specimen is horizontal.
- Test piece is clamped at both ends.
- Test piece notch is facing away from the pendulum.
- The distance the pendulum travels after breaking the piece will give the toughness value.

5

(h) **(i)** **James Dyson**

Born in Norfolk in England in 1947, he invented the use of cyclone technology in vacuum cleaners. This bagless system does not clog or lose suction. The Dyson Airblade hand dryer was launched in 2006. Dyson continue to invent a range of technological products.

(ii) **Charles Parsons**

Irish engineer (1854 –1931) who is credited as the inventor of the steam turbine. He worked as an engineer on dynamo and turbine design and power generation, with great influence on the naval and electrical engineering fields. He also developed optical equipment for searchlights and telescopes.

(iii) **Eileen Gray**

Irish-born architect and influential furniture designer, Eileen Gray was a pioneer of the modern Movement in Architecture since the 1920's with furniture designs in a range of materials. Her furniture is still in great demand with her Bibendum chair still in production.

Any one @ 5

(i) Creep is the slow deformation of a material over time resulting from a constant force acting on the material. It occurs as a result of long term exposure to high levels of stress that are below the yield strength of the material. Temperature and time are contributing factors.

5

(j) Elastic memory in thermoplastics is the ability of the polymer to return to its original state from a deformed state. If a thermoplastic has been bent to a specific shape, when reheated it will return to its original shape.

5

(k) Aluminium is suitable for use as outdoor TV antennas because it is:

- Conductive material
- Structurally strong
- Light
- Cost effective
- Ductile metal

3 + 2

(l) **Cast Iron** is used in garden ornaments because of its structural capacity, heavy material, ability to resist corrosion and its ability to be cast into intricate shapes.

3 + 2

(m) **Advantages of electric vehicles:**

- No CO_2 emissions.
- Limited effect on the ozone layer.
- Cleaner air quality.
- Less noise pollution.

Disadvantages of electric vehicles:

- Limited range.
- Availability of charging points.
- Silent vehicles may be dangerous to other road users.
- Electricity is not free.

3 + 2

Section B – 50 marks

(n) **(i)** **Sporting and recreational activities**

- Aerial photography of sporting events.
- Drone racing.
- Used to assist with security and safety at large sporting events to monitor crowds and their movement.
- Recording family events such as weddings, birthdays or holidays.
- Data is gathered using video clips of team players using drone technology, etc.

Two applications @ 3 + 2

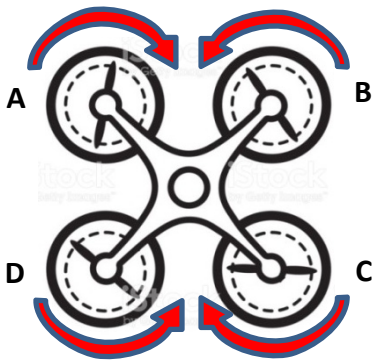
(ii) **Agriculture and the environment**

- Soil and field analysis.
- Planting.
- Crop spraying.
- Crop monitoring.
- Irrigation.
- Herd Monitoring.
- Health assessment of the crop, etc.

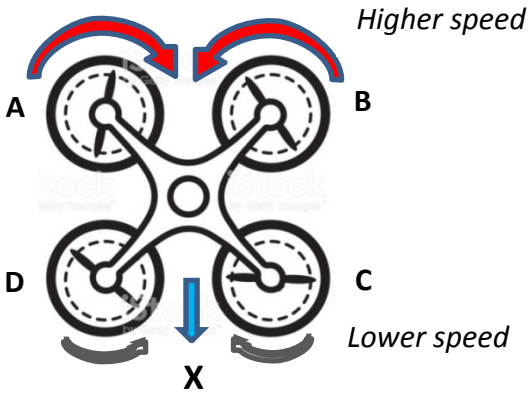
Two applications @ 3 + 2

(o) **(i)** **Hovering in a fixed elevated position:**

The quadcopter hovers by applying equal thrust to all four rotors therefore ensuring that they rotate at the same speed. This is achieved by having two opposite propellors (A,C or B,D) rotating in the same direction while the other two rotate in the counter direction.



(ii) **Forward movement in the direction of arrow X:**
This is achieved by increasing the speed of propellors A and B relative to D and C. Propellors A and C must rotate in the opposite direction to B and C. The faster the rotational speed, the faster the lateral movement.



5 + 5

(p) **(i)** **Function of accelerometer**
An accelerometer sensor is designed to measure acceleration in the X, Y and Z axes. Inside this tiny sensor is a small system that bends when a momentum or gravity force is applied. The amount of bend has a proportional value of the output signal. These measurements detect small movements quickly, which is critical for in flight control.

(ii) **Function of gyroscope**
The gyroscope deals with the rotational movements of pitch, roll and yaw. It measures angular velocity and orientation. This movement is converted into electrical signals that can be read by the inertial measurement unit (IMU) and used by the flight control system for stabilisation.

(iii) **Function of electronic speed controller.**
The electronic speed controller is an electronic circuit that varies the speed and direction of each motor. It also acts as a dynamic brake to the motor system.

Any two @ 5 + 5

(q) **(i)** **Trilateration**
This process is used to pinpoint the exact location of the drone. Accurate navigation/guidance is dependent on the availability of at least three satellites. Each satellite transmits information about its position and time. The GPS receiver on the drone intercepts these signals and calculates the distance and time taken for the signal to travel from each satellite. Once calculated, the drone can pinpoint its location. Spheres are used to establish the distances as both the drone and satellite deal in 3D space.

(ii) Autonomous flight

This is where the flight path is programmed with GPS co-ordinates or tracked to a signal and the drone then makes its way to the destination. Passenger drones are a good example where the co-ordinates are in-putted on the navigation screen before the drone takes off. On board sensors detect for obstacles to avoid collisions. Other examples are parcel delivery and air ambulance, which tracks emergency mobile calls and uses GPS to navigate to the exact location.

(iii) Auto return home

One critical safety use of GPS is Auto Return Home. When a drone takes off, it saves the location. If the drone loses contact with the receiver, or the battery goes dangerously low, the drone will return back at its take off point.

(iv) FPV flying

First-person view (FPV) is a method used to control a drone from the driver or pilot's viewpoint. It allows the operator to see the drone in real time, control is viewed on a portable monitor rather than by sight. This means that the operator need not have to see the drone allowing the user to fly further and faster.

Any two @ 5 + 5

(r) Security and privacy issues

In order to guard privacy of firms or individuals and ensure that security is not compromised, the following techniques are used:

- Radio jamming technology starves the craft of communication with user.
- Netting drones can be employed to protect intrusion.
- No-fly zones are enforced around airports and prisons.
- Trained birds have been used to intercept drones.
- Restrictions on use of drones such as the 5km exclusion zone around aerodromes, max. height of 120m and fly only within 300m of the operator are in place in Ireland.
- Legislation on data collection storage and protection may lead to prosecution.
- Drone blinding lasers can be used to interfere with drone cameras.

Two methods @ 5 + 5

Question 2 (50 Marks)

(a) (i) **Galvanising** is the most effective way of protecting the steel cable from corrosion. This involves coating the steel with zinc.

8

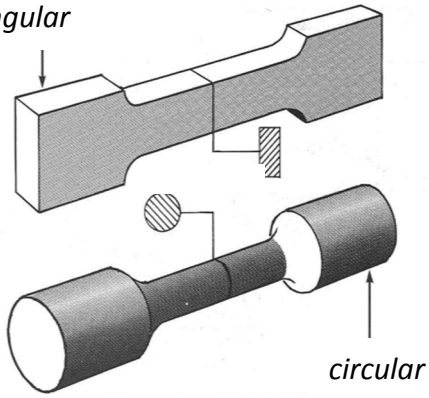
Extensometer

(ii) **Tensile testing**

- Extensometer tensile testing machine is used.
- Specimen (rectangular or circular cross section) is clamped at both ends.
- Machine is turned on and begins to apply a tensile force on the specimen.
- The specimen will continue to stretch until it fractures.
- A graph readout will be produced from the tensile test.
- Further calculations can be determined from the graph produced.

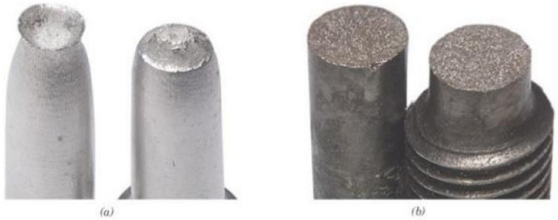
Tensile test specimens

rectangular



circular

Ductile fracture *Brittle fracture*



(cup and cone)

8

(b) (i) **A** – copper
B – stainless steel
C – low carbon steel

1 + 1 + 1

(ii) Graph A has a relatively short elastic phase where it will return to its original shape and length with the removal of the strain. The metal has very ductile properties where it extends with a relatively small addition of force before fracture. It will stretch for a long time before necking and breaking. Metal A has low tensile strength yet is ductile.
Graph C has an extended elastic range where the metal stays strong and will return to its original shape. The shape of graph C shows clearly defined upper and lower yield points. This

is followed by a ductile stage until the metal reaches ultimate tensile strength in advance of necking and fracture. Metal C is strong, good in tension and is less ductile than metal A.

9

(iii) 250 N/mm^2

6

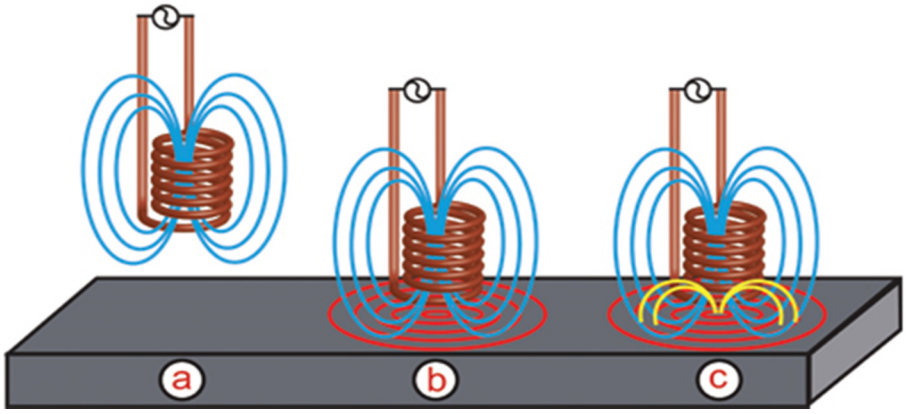
(c) **(i)** Economic benefits of NDT: Non-destructive testing allows materials to be tested to ensure conformity, metals are not rejected. Tested specimens are not discarded. The test specimens are not broken. **4**

Safety benefits of NDT: Internal and external flaws are examined using NDT. Well-designed objects will not fail as objects are tested for conformance by NDT. Objects are not weakened by the testing process.

4

(ii) Eddy Current Testing is the most suitable NDT for non-ferrous metals where the flaw is near the surface.

The alternating current flowing through the coil at a chosen frequency generates a magnetic field around the coil (a). When the coil is placed close to an electrically conductive material, eddy currents are induced in the material (b). If a flaw in the conductive material disturbs the eddy current circulation (c), the magnetic field with the probe is changed and a defect signal can be read by measuring the variation.

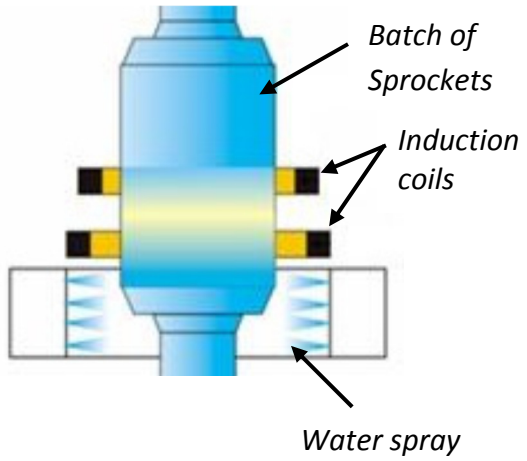


8

Question 3 (50 Marks)

(a) (i) Induction hardening:

A coil carries high frequency currents which are induced on the surface of the component causing a rapid rise in temperature. This allows a change to austenite in the surface layers of the component. Water jets then cool the steel transforming the austenite to martensite. This leaves the outer surface hard while the inner core is tough. The frequency of the current and duration of heating determines the depth of heating and the depth of hardening.



8

(ii) Incorrect heat settings, incorrect speed, not enough time for heat treatment to penetrate, inappropriate quenching, too much heating time for the sprockets to become brittle, etc.

Two faults @ 4 + 4

(b) (i) A = Upper Critical Temperature Line (UCT) - Austenite to ferrite and austenite transformation. **3**

B = Lower Critical Temperature Line (LCT) - Austenite and cementite to pearlite and cementite transformation. **3**

(ii) Point C is called the eutectoid point. At this point solid Austenite changes to solid pearlite at approximately 723°C at 0.83% carbon.

6

(iii) Annealing 1.2% carbon steel:

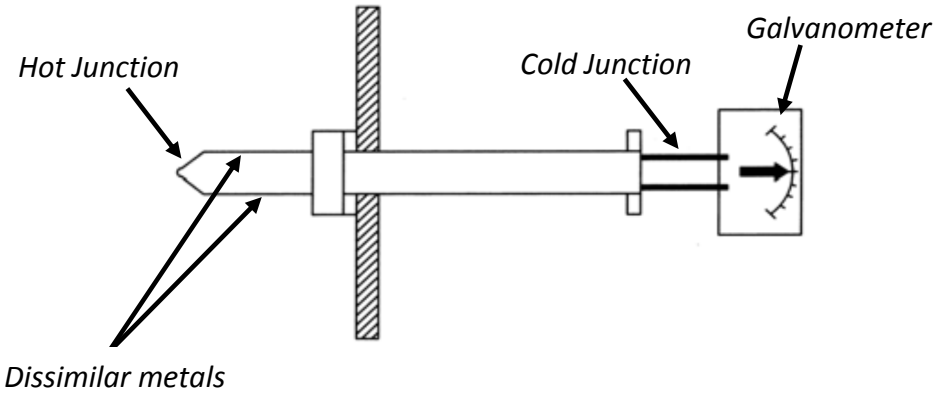
For 1.2% steel the piece is heated 25˚-50˚ above the LCT (approx. 800°C). It is then soaked at this temperature allowing the whole of the piece to be at the same temperature. It is then allowed to cool gradually in the furnace by reducing the temperature.

During full annealing new grains are formed and this is called recrystallisation and this makes the metal soft, improves ductility, refines the grain size and removes internal stresses.

6

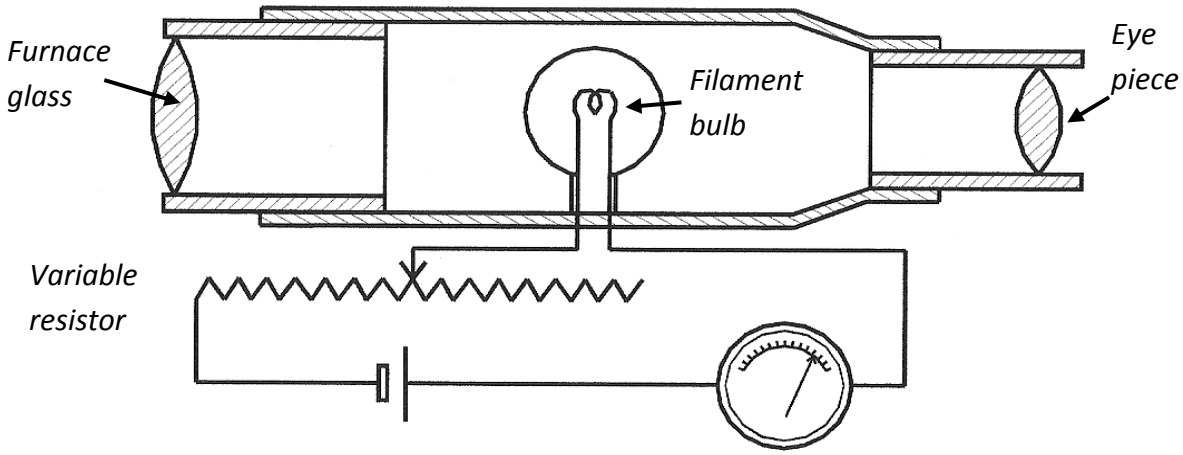
(c) Thermocouple Pyrometer:

Principle of operation: Two dissimilar metals are joined together with a galvanometer placed at the cold junction. A rise in temperature at the hot junction produces an electrical current which is recorded by the galvanometer. This galvanometer is calibrated to read in degrees of temperature rather than indicating electrical units. This is a very accurate way to measure furnace temperature.



OR

Optical pyrometer: this method compares the intensity of light from the filament of a lamp. Current flow from the lamp can be adjusted, using a variable resistor, to match the light from the furnace. When the filament seems to 'disappear', a temperature reading can be taken. Accuracy will depend on the visual accuracy of the operator.



Temperature reading: *Too low* *Correct* *Too high*

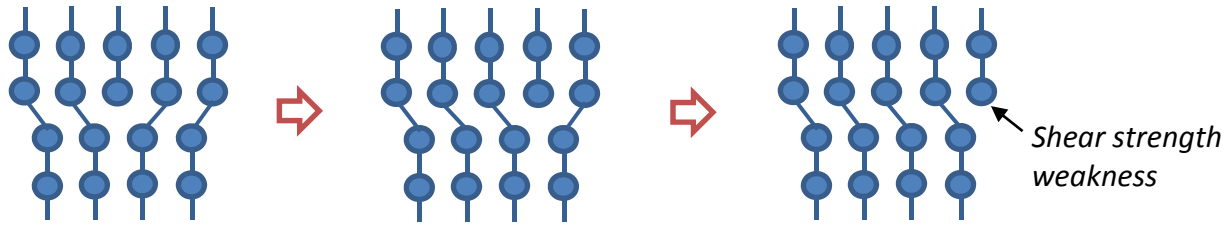
16

Question 4 (50 Marks)

(a) (i) Defect A - Substitution
Atoms from another material replace atoms of the base metal
Defect B - Interstitial
An additional atom embeds into the metal structure, some distortion is a consequence.
Defect D - Self interstitial atom
Atom of parent material distorts the atomic structure.
Defect E - Vacancy
Atom missing from lattice, density of metal is reduced. A vacancy can result in a weaker metal under compression or other forces. It will also have reduced thermal conductivity as a result of the missing atom.

Name and describe three crystal point defects @ 4 + 4 + 4

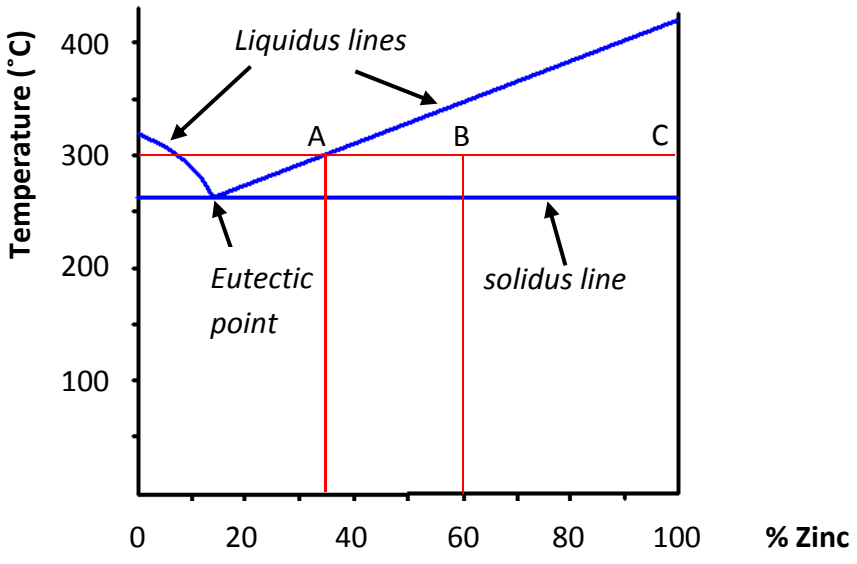
(ii) Line defects, such as dislocations, are rows of atoms that are spaced irregularly. Line defects can weaken or strengthen solids. Dislocations can move along the densest planes of atoms to the edge of the material, shear strength is reduced. Dislocations may move easily to improve ductility. Work hardening can occur when dislocations impede movement.



Impact of line defect as it moves to the edge of metal

4

(b) (i) **Draw the thermal equilibrium diagram** **10**



(ii) **Labels on diagram** **2 + 2 + 2**

(iii) Ratio of the phases at 300°C for 60% Zinc:
A = 34
B = 60
C = 100
|AB|/|BC| = 26/40

2

(c) **(i)** Partial Solubility alloy: An alloy of two metals will dissolve in each other to a limited degree, the lead-tin alloy is an example.
Solid solution alloy: When two metals are completely soluble in each other in both the liquid and solid states. When viewed under a microscope, a solid solution appears like a pure metal. Copper-nickel and iron-chromium are examples.

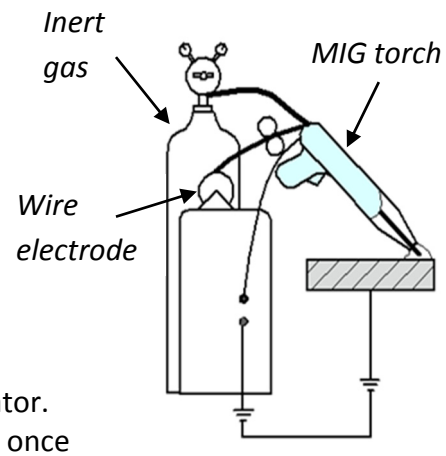
(ii) Work hardening is the internal stressing of a material due to processes such as hammering, filing, drilling etc.
Age hardening: Aluminium alloyed with copper and cooled from a high temperature will increase in hardness over time at room temperature. This is due to the precipitation of $CuAl_2$. Age hardening is a feature of a range of alloys, especially non-ferrous combinations.

(iii) Ductility in BCC and FCC structures: In the BCC structure, the structure is arranged with an atom at the corner of a cube and an atom in the centre of the cube. This structure is associated with brittleness. In the FCC structure atoms are at the corners of a cube and a single atom in the centre of each face of the cube. Atoms are more tightly packed which allows metals to be more ductile.

Any two @ 8 + 8

Question 5 (50 Marks)

(a) **(i)** **Metal inert gas welding** (MIG), MAGS – *other appropriate methods accepted.*
MIG is an effective method of welding mild steel even in light tubular form.
It is relatively easy to set up and use.
Mild steel welding wire is commonly used.
MIG welding torch can be manoeuvred easily.
A semi-automatic process.
A consumable bare wire electrode is fed continuously into the weld pool area through the welding torch.
An inert gas, such as Argon, creates a protective shield around the weld pool giving a fluxing action.
The feed rate and flow rate of the gas are set by the operator.
This allows the operator to guide the torch along the weld once the arc is generated between the electrode and the work. MIG welding does not produce a slag on the weld.



10

(ii) MIG welding is a semi-automated process with a predetermined wire feed, this eliminates the need for adjustment during welding.
The wire feed is shielded by the torch.
MIG welders are supplied with an appropriate mask to protect against uv light, heat and hot metal.
Welding booths are designed to be ventilated and protect others.
Anti-spatter compound on the nozzle and gun will reduce spatter.
Gas cylinders are secured at the machine.

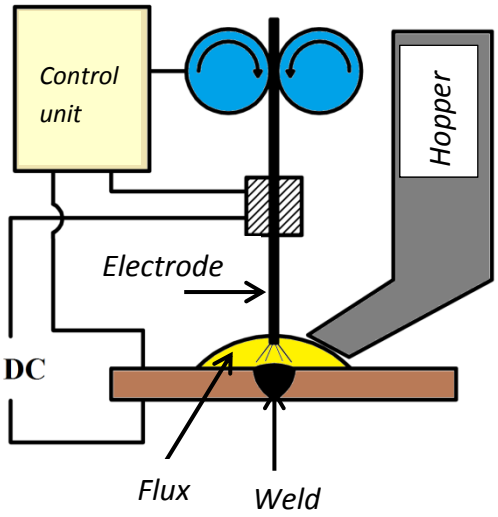
Three safety features @ 2 + 2 + 2

(b) **(i)** **Multi-run welds:**

- Multi-runs produce a superior quality weld which is more refined than a single run weld.
- Multi-run welds have a post heating effect on the previous weld which will improve its quality.

(ii) **Submerged Arc Welding:**

In submerged arc welding, a bare wire electrode is used. It is fed automatically from a spool and generates an electric arc to heat the metal. The flux, in powder form, is fed from a hopper to completely cover the joint and the tip of the electrode. The arc creates the heat to melt the joint, flux and electrode. A slag is formed to provide a protective coating for the weld. The excess flux powder can be collected and used again.
Submerged arc welding is a fully automated process.
Applications: used for large scale straight line welds such as steel reinforcing beams, shipbuilding and bridge construction.



(iii) **Two benefits of the formation of a slag:**

- It minimises impurities in the weld.
- To form a coating which protects the weld from oxidation.
- It ensures a slow cooling rate for the weld.
- It prevents cracking and brittleness.

(iv) **Hazards associated of spot welding:**

- Flying sparks can cause fire and explosion.
- Electric shock from wiring is a possible hazard.
- Hot metal and parts can cause burns.
- Moving parts, such as tongs, tips and linkages, can injure fingers and hands.
- Fumes from spot welding on parts coated with cleaners.

(v) Three ways oxidation can be prevented during welding:

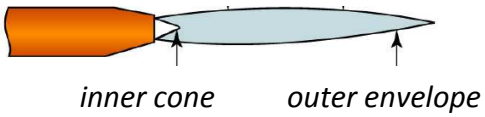
- Inert gas
- Flux coating on electrode
- Granulated flux
- Secondary combustion envelope
- Formation of a slag coating.

Any Three @ 6 + 6 + 6

(c) (i) Oxy-acetylene flame types

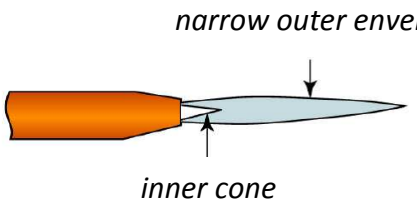
Neutral flame:

- A balanced proportion of oxygen and acetylene.
- Maximum combustion as all carbon from the acetylene is used.
- Has a working temperature of up to 3300°C.
- The most extensively used flame for oxy-acetylene welding.



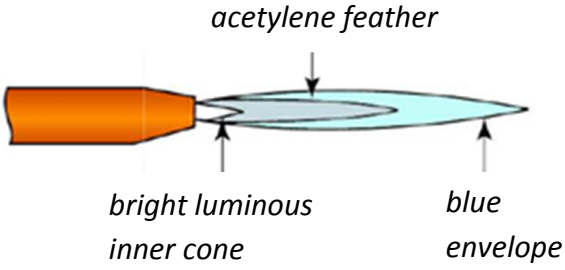
Oxidising flame:

- Contains excess oxygen.
- Has a working temperature of up to 3500°C.
- Used to weld copper and brass, it would oxidise steel.
- Flame appears smaller.



Carburising flame:

- Contains excess acetylene.
- It has a working temperature of 3150^{o}C.
- Used to weld aluminium and alloy steel where it gives protection against oxidation.
- Flame is bigger with the distinctive acetylene feather.



16

OR

(i) Self-docking: When power is needed, the robotic lawnmower finds its way back to the charging station by using its sensors and GPS location technology.

4

Robotic sensors: When the robotic lawn mower meets an obstacle, it stops and redirects itself because the sensors detect the objects in its path. It also knows when it needs to be charged and will find its docking by sensing surroundings based on the boundary wire.

4

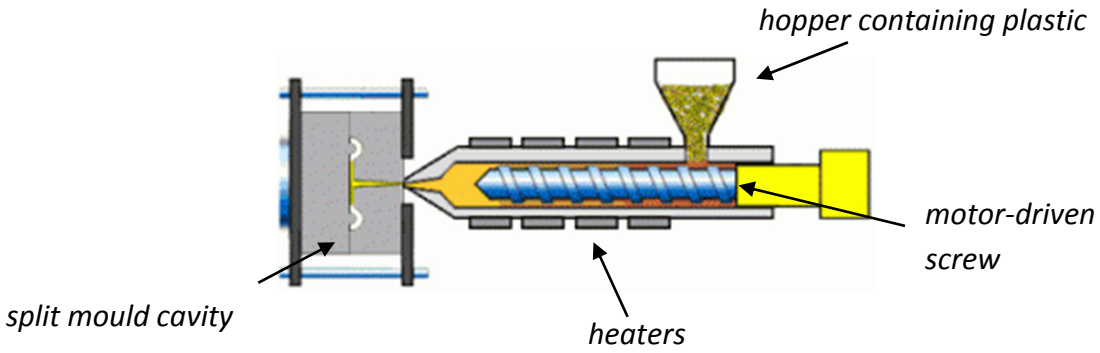
(ii) Environmental impact of robotic lawnmowers:
The robotic lawn mower is electrically powered therefore the robotic mower produces less harmful emissions. It can also use the suns energy to power itself via the solar cells too.

8

Question 6 (50 Marks)

(a) (i) Injection Moulding

This is an efficient method of shaping thermoplastics of complicated shapes and various cross sections in large quantities.



The mould has a hollowed out shape of the roof box.
With the split mould firmly clamped under pressure, plastic granules are fed from the hopper. These plastic granules are then made into a molten plastic liquid using heat, friction and force.
Pressure is applied after the molten plastic material has been injected into the mould to make sure that all of cavities and spaces have been filled.
In the final stage of the process as the screw begins moving back for the next moulding the mould is opened.
The opening of the mould allows the finished plastic moulding of the casing to be ejected.

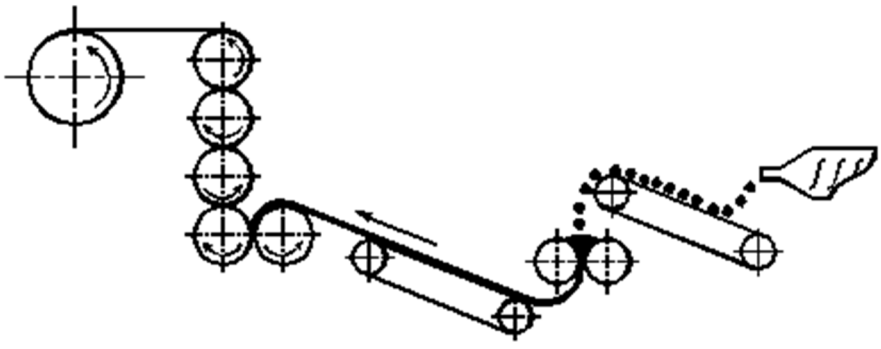
8

(ii) **Plasticisers** are added to make products softer and more flexible. Some plasticisers evaporate and tend to concentrate in an enclosed space; the "new car smell" is caused mostly by plasticisers evaporating from the car interior.
UV stabilizers: Used for the protection of the polymers mechanical properties by absorbing selective UV rays resulting in less degradation.

4 + 4

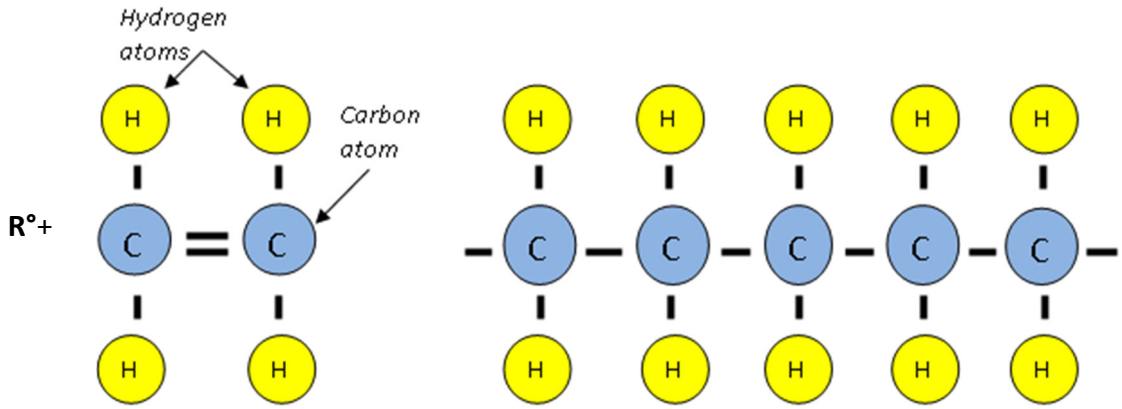
(b) (i) Calendering:

Continuous lengths of thermoplastic sheets are produced by calendering. The material passes through a series of heated rollers to gradually produce the desired thickness of material. These sheets may then be cut to size or collected in a roll.



(ii) Additional Polymerisation:

Polyethylene is produced by addition polymerisation. Long chainlike molecules are formed by the addition of large numbers of mers. The ethylene molecule (or mer) consists of a strong and a weak bond between the carbon atoms. A catalyst or a free radical, which has an unpaired electron in its outer shell, is released to the ethylene molecule. The weak bond is attacked and one of its electrons is taken by the radical leaving the other free. Then that ethylene molecule behaves like a radical and the process is continuously repeated until termination takes place. Addition polymerisation contains bonds held together by weak van der Waals forces which can be overcome by heat or pressure.



(iii) Glass Transition Temperature:

Glass transition temperature describes the temperature at which a solid glassy amorphous polymer changes to a rubbery, viscous polymer. It is engineered by altering the degree of branching or cross-linking in the polymer by the addition of plasticisers.

(iv) Van der waal forces:

These are the bonding forces between polymer chains produced by addition polymerisation. They are weak, secondary covalent bonds that may be disrupted by heat or pressure.

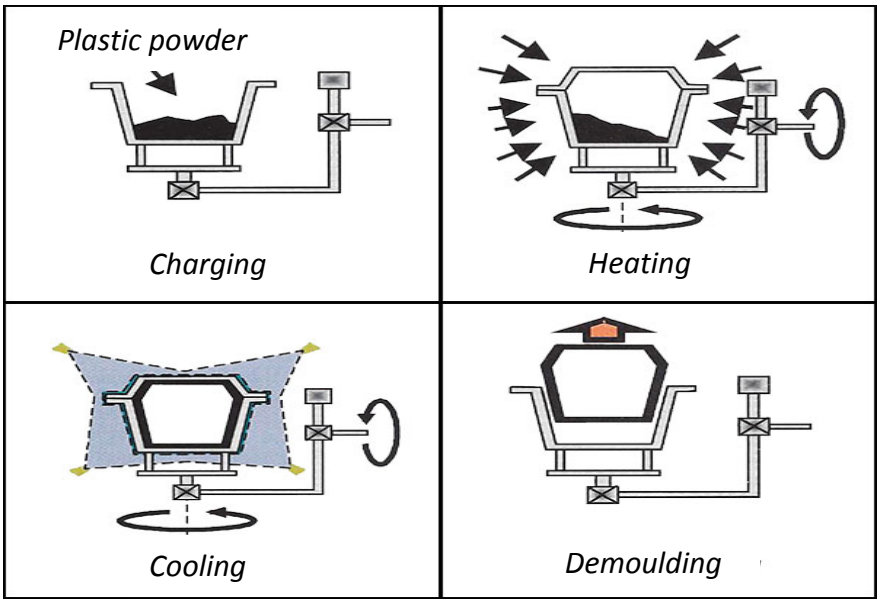
(v) Rotational Moulding

Rotational Moulding involves a heated hollow mould which is filled with a charge of thermoplastic material.

The charge is heated and softened and then slowly rotated (usually around two perpendicular axes) causing the softened material to disperse and stick to the walls of the mould.

In order to maintain even thickness throughout the part, the mould continues to rotate at all times during the heating phase.

Products that can be manufactured using rotational moulding include storage tanks, toys, bins and refuse containers, footballs, helmets and canoes.



Any three @ 6 + 6 + 6

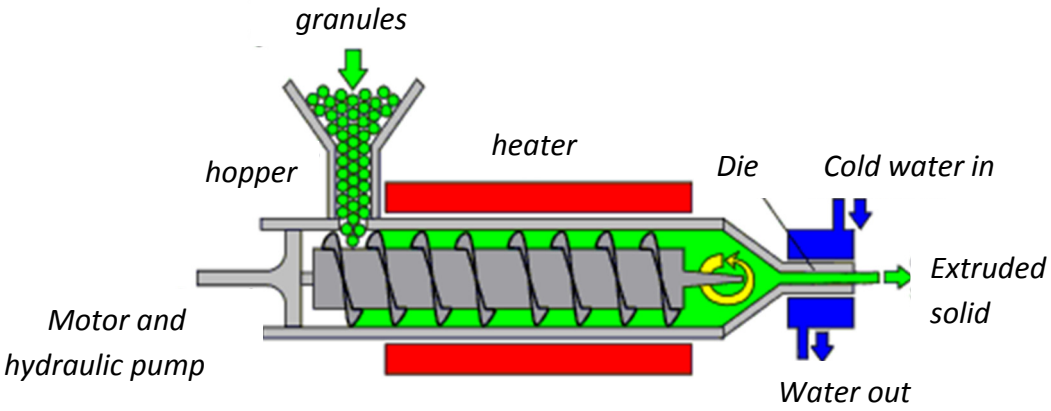
(c) (i) Elastomer:

A group of polymers consisting of linear chains that are coiled, entangled and are subject to minimal cross-linking. This irregular internal structure and bonding arrangement allows these materials to be very elastic at room temperature.

4

(ii) Extrusion:

Granulated thermoplastic polymer is fed into the barrel from the hopper.
The screw moves the polymer forward.
Heaters melt the polymer to liquid.
As the screw continues to rotate, the polymer is pushed out through the die to give the required shape.
Typical products include gutters, fascia, pipes and rods.



Explain: 6

Reason: extrusion gives a long continuous product which can be cut to length. **Reason: 2**

(iii) **Two reasons for using elastomer seals:**

- Flexibility/softness
- Easy to fit
- Dampening effect on vibrations
- Cushion between two hard surfaces.

Two reasons @ 2 + 2

Question 7 (50 Marks)

(a) **(i)** Materials which give continuous chip formation

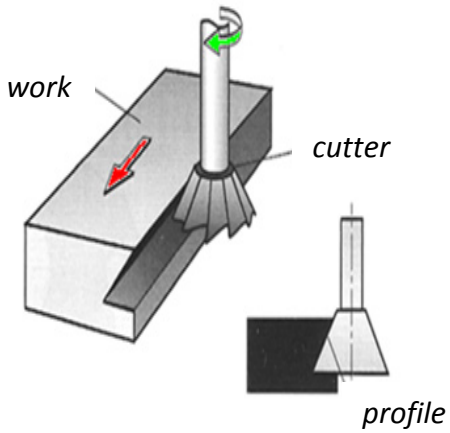
- Aluminium
- Copper
- Steel
- Nylon
- Acetal

Two materials @ 4 + 4

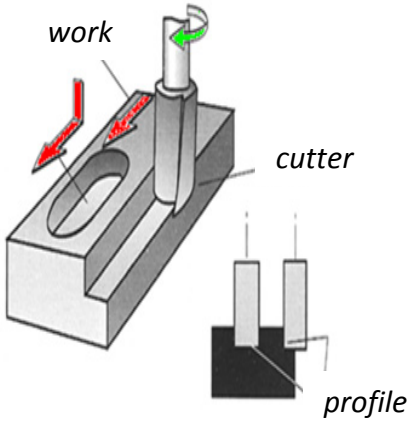
(ii) A continuous chip will leave a smooth finish on soft ductile materials, such as aluminium or copper. Continuous chips are more likely to produce a stable cutting action which results in a good surface finish.
For automated machinery, continuous chip formation is a problem for the cutting tool and the piece being machined as the chip can wrap around the workpiece and get in the way of the cutting process.

4 + 4

(b) **(i)** **Dovetail cutter** will machine an angled profile suitable for dovetail joints.
Slot drill will machine a slot in the middle of a piece to a certain depth or it can also machine an edge profile.



Dovetail cutter



Slot drill

(ii) If a grinding wheel is out of balance the spindle will vibrate and a poor surface finish will result. This has consequences for machine safety.
A wheel is placed on a balancing stand and weights are moved around the flange to balance the wheel. This is similar to balancing a car wheel.

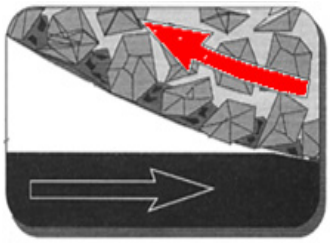
(iii) A three-jaw chuck has its jaws at 120° whereas a square bar has it sides at 90° therefore the square bar will not be held on center in a three-jaw chuck.

(iv) A magnetic chuck is traditionally associated with grinding machines, it has been adapted for use with other machines.
Used for holding ferromagnetic workpieces, a magnetic chuck consists of an accurately centered permanent magnet face. Electromagnets or permanent magnets are brought into contact with fixed ferrous plates, or pole pieces, contained within a housing. These pole pieces are usually flush with the housing surface. The part (workpiece) to be held forms the closing of the magnetic loop or path, onto those fixed plates, providing a secure anchor for the workpiece.

(v) The fixed steady provides support for lengthy work which needs an intermediate support to prevent whip or wobble. This is useful where long lengths of bar are being machined at either end and need to be securely supported.

Any three @ 6 + 6 + 6

(c) **(i)** Loading: a grinding wheel becomes loaded with small particles when grinding debris becomes trapped in the space between the abrasive grains and the wheel. This will cause overheating of the work piece.
Glazing: the grinding wheel has a shiny appearance as the abrasive particles have lost their edge and failed to break away from the wheel. The grinding wheel will not cut effectively.
These faults are caused by inappropriate choice of grinding wheel for the material being ground.



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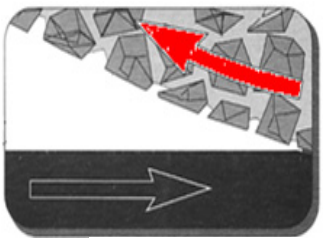


Glazing

8

(ii) In the grinding process, wheel dressing is used to restore the cutting surface of any irregularities. Grinding wheels are designed to have a self-dressing action in which grains should break free and expose sharp edges. Wheel dressing will renew a sharp cutting face and correct irregularities such as wheel concentricity and any undulations in the wheel.

A wheel dressing tool, such as the star dresser shown, is a long handled tool with a row of free running, hardened and serrated, wavy discs or star-shaped cutters running at right angles to the handle. These are presented to the grinding wheel as it is turned off and slows down. Force is applied to the face of the slowing wheel with the result that the hardened disk knocks the abrasive grains out and expose sharp edges.

8

OR

(c) **(i)** **Machine tool envelope:** area that includes all axes, spindles, chucks, turrets, tool holders, tailstocks, fixtures, clamps and stock.

Software simulation: Simulation software is essentially a program that allows the user to observe an operation through simulation without actually performing that operation. Simulation software is used widely to design equipment so that the final product will be as close to design specs as possible without expensive in-process modification.

Closed Loop Control: On commercial metalworking machines, closed loop controls are standard and required in order to provide the accuracy, speed and repeatability demanded. In a closed loop system, feedback is provided to the controller so that it can correct for errors in position, velocity and acceleration, which can arise due to variations in load or temperature.

Any two @ 4 + 4

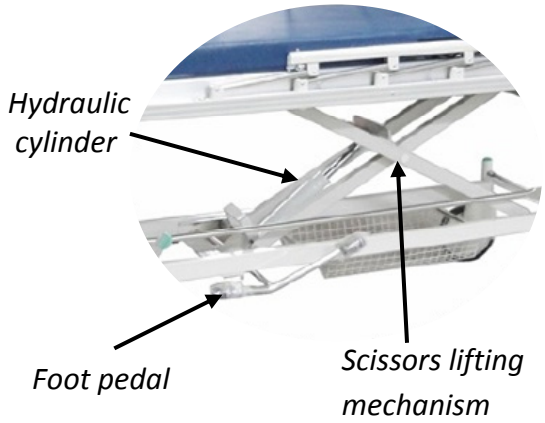
(ii) Safety features incorporated into CNC machines include:

- Work area covered with clear guard.
- Emergency stop buttons.
- Test-run software.
- Interlocking guard.

Two safety features @ 4 + 4

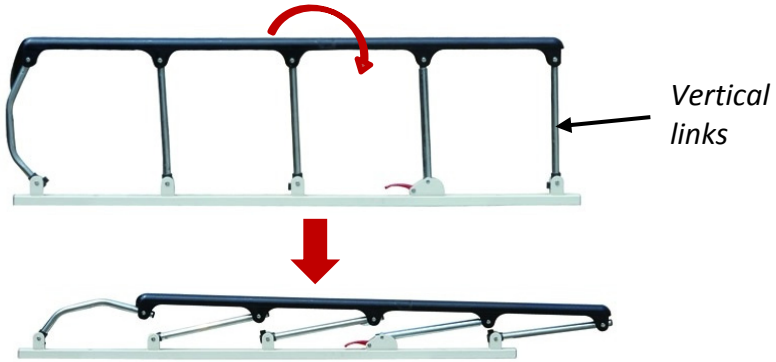
Question 8 (50 Marks)

(a) **(i)** The bed lift design incorporates a hydraulic cylinder and a foot pedal pump to actuate the scissor lifting mechanism.
As the cylinder extends, the scissor arm is pushed upwards raising the bed.
The opposite happens when the foot pedal is pressed in the opposite direction and the bed lowers.



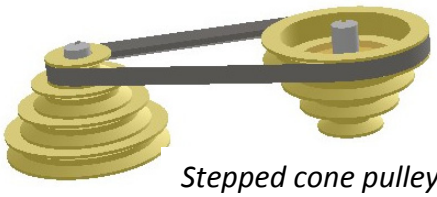
8

(ii) The side rails of the bed can easily be collapsed using a parallel linkage mechanism. This will allow all the parallel vertical links to fall to one side thus lowering the side rails.



8

(b) **(i)** A stepped cone pulley mecahnism allows for various speeds of a machine. If the belt is on the smallest driving pulley, then it will have to be on the largest driven pulley and this gives a slow speed. If the belt is on the largest driving pulley, then it will have to be on the smallest driven pulley and this gives a fast speed.

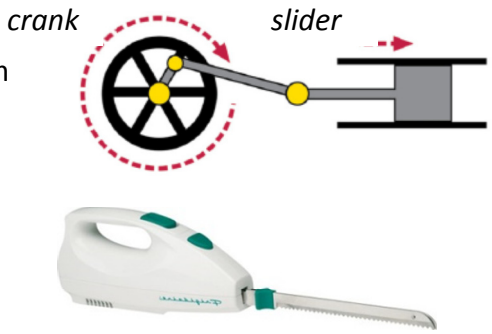

Stepped cone pulleys

(ii) The cam and follower converts rotary motion into reciprocating motion. In the caterpillar example shown, the rotating cams are positioned at different centres on the rotating shaft which then moves the followers up/down thus giving the caterpillar a moving body effect.

(iii) Uses for a universal joint:

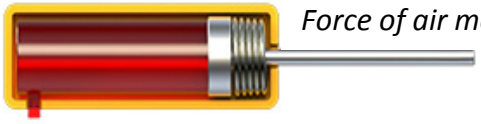
- Steering mechanisms
- Socket sets
- Shafts connecting machinery to tractors
- Shafts that are not in line.

(iv) A crank and slider mechanism converts rotary motion from a motor into reciprocating motion. For the electric knife this reciprocating motion is applied to the blades which then have a cutting action.



(v) A single acting cylinder is a pneumatic output device that requires compressed air to make the piston move. If the air is removed the piston will return because of the spring.

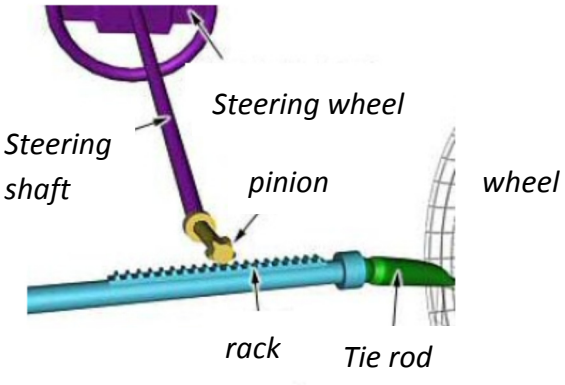
No compressed air



Compressed air applied

Any three @ 6 + 6 + 6

(c) **(i)** The use of a linkage system or rack and pinion mechanism would be suitable solutions for the steering mechanism of the golf cruiser. The steering wheel can be connected to the pinion and when rotated it will move the rack in a linear manner either left or right. The wheels in turn are connected via a linkage to the rack and this will allow the wheels turn.



8

(c) **(ii)** Advantages of single rear wheel design over single front wheel design:

- Greater stability for the vehicle
- Better under braking as weight is to the front.
- Better aerodynamics
- No chance of "nosedive" when cornering

Two advantages @ 4 + 4

OR

(c) **(i)** Benefits of using IC chips include:

- Can be programmed
- ICs are cheap
- ICs are very small in size
- They are reusable, dependable, cost effective and energy efficient.

Two benefits @ 2 + 2

(ii) Using a heat sink in soldering the microcontrollers will take away the heat from the microcontroller which will prevent it from overheating and possibly being damaged by the heat of the soldering iron.

4

(iii) Output components include LED, bulbs, motors, LCD display, servo, etc.

Two output components @ 4 + 4

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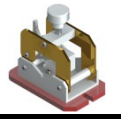
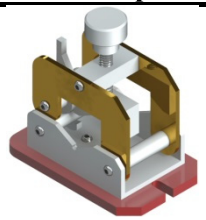
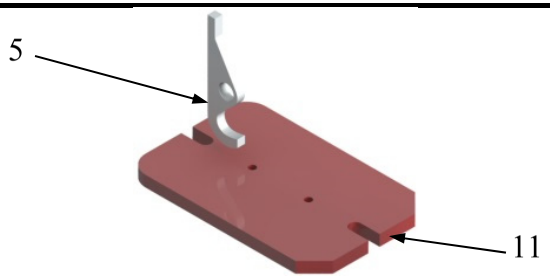
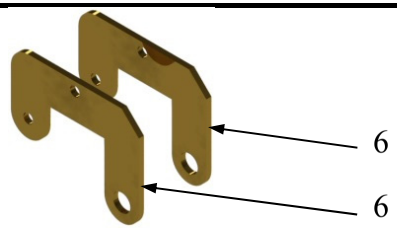
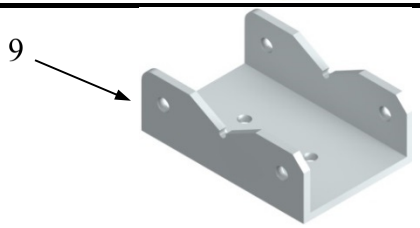
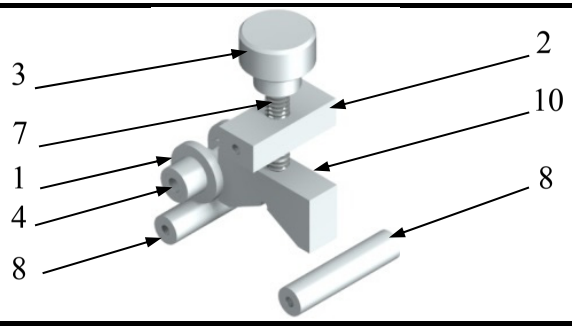


Day 1 - Leaving Certificate Engineering - Practical Marking Scheme 2018

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	5 10 5	**20**	**20**
2	**Parts 5 and 11**		**Part 5** 10 Marks	Marking Out	**4**	**20**
				Ø8.1 mm Hole	**1**	
				External Profile	**5**	
			Part 11 10 Marks	Marking Out	**2**	
				2 × 6 mm Slots	**2**	
				2 × M5 Holes	**2**	
				10 mm Radii and Chamfers	**4**	
3	**Parts 6**		**Parts 6** 20 Marks	Marking Out	**6**	**20**
				External Profiles	**4**	
				Internal Profiles	**4**	
				4 × Ø5.5 mm Holes	**4**	
				2 × Ø10 mm Holes	**2**	
4	**Part 9**		**Part 9** 20 Marks	Marking Out	**4**	**20**
				6 × Ø5.5 mm Holes	**6**	
				Vee Slots	**6**	
				5 mm Radii and Chamfers	**4**	
5	**Parts 1, 2, 3, 4, 7, 8 and 10**		**Parts 1, 3, 4, 7 & 8** 10 Marks	Lathe Work	**6**	**20**
				Marking Out and Bench Work	**4**	
			Parts 2 & 10 10 Marks	Marking Out, Lengths & Profile	**6**	
				6 × M5 Holes & 1 × M8 Hole	**2**	
				Ø3, 6 & 8 mm Holes	**2**	

100 Marks (×1.5 = 150 Total)

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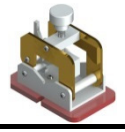
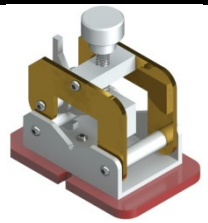
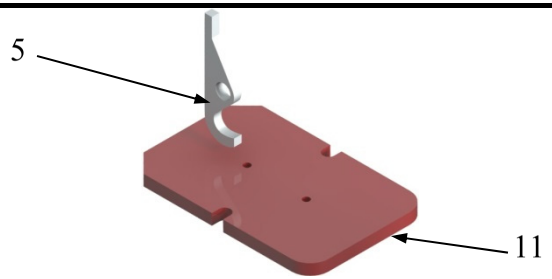
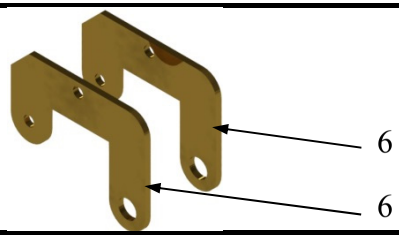
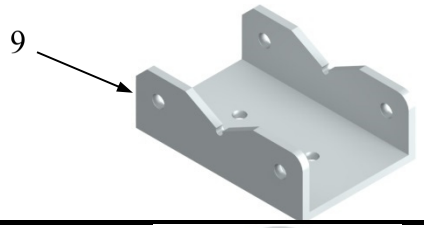
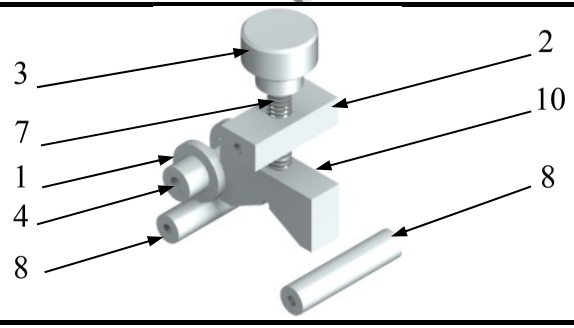
State Examinations Commission



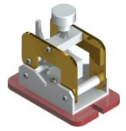
Day 2 - Leaving Certificate Engineering - Practical Marking Scheme 2018

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	5 10 5	**20**	**20**
2	**Parts 5 and 11**		**Part 5** 10 Marks	Marking Out	**4**	**20**
				Ø8.1 mm Hole	**1**	
				External Profile	**5**	
			Part 11 10 Marks	Marking Out	**2**	
				2 × 6 mm Slots	**2**	
				2 × M5 Holes	**2**	
				10 mm Radii and Chamfers	**4**	
3	**Parts 6**		**Parts 6** 20 Marks	Marking Out	**6**	**20**
				External Profiles	**4**	
				Internal Profiles	**4**	
				4 × Ø5.5 mm Holes	**4**	
				2 × Ø10 mm Holes	**2**	
4	**Part 9**		**Part 9** 20 Marks	Marking Out	**4**	**20**
				6 × Ø5.5 mm Holes	**6**	
				Vee Slots	**6**	
				5 mm Radii and Chamfers	**4**	
5	**Parts 1, 2, 3, 4, 7, 8 and 10**		**Parts 1, 3, 4, 7 & 8** 10 Marks	Lathe Work	**6**	**20**
				Marking Out and Bench Work	**4**	
			Parts 2, & 10 10 Marks	Marking Out, Lengths & Profile	**6**	
				6 × M5 Holes & 1 × M8 Hole	**2**	
				Ø3, 6 & 8 mm Holes	**2**	

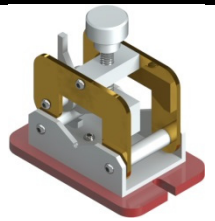
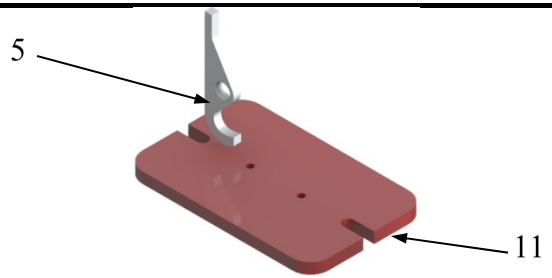
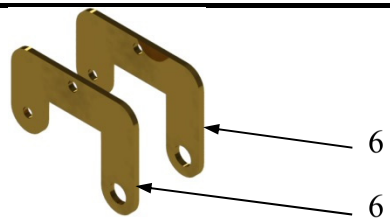
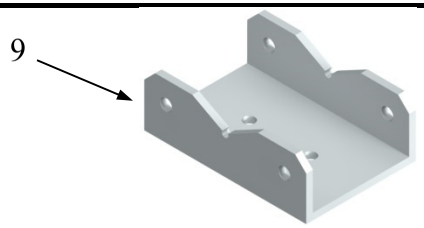
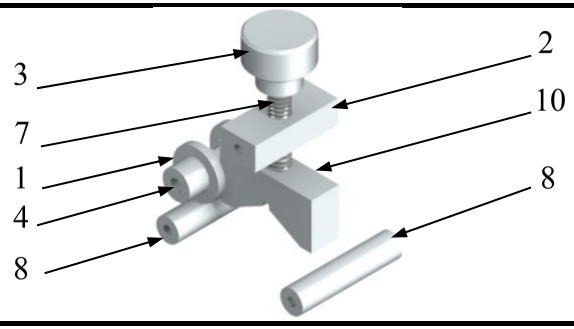
100 Marks (×1.5 = 150 Total)

Coimisiún na Scrúduithe Stáit
State Examinations Commission



Day 3 - Leaving Certificate Engineering - Practical Marking Scheme 2018

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	5 10 5	**20**	**20**
2	**Parts 5 and 11**		**Part 5** 10 Marks	Marking Out Ø8.1 mm Hole External Profile	**4** **1** **5**	**20**
			Part 11 10 Marks	Marking Out 2 × 6 mm Slots 2 × M5 Holes 10 mm Radii	**2** **2** **2** **4**	
3	**Parts 6**		**Parts 6** 20 Marks	Marking Out External Profiles Internal Profiles 4 × Ø5.5 mm Holes 2 × Ø10 mm Holes	**6** **4** **4** **4** **2**	**20**
4	**Part 9**		**Part 9** 20 Marks	Marking Out 6 × Ø5.5 mm Holes Vee Slots 5 mm Chamfers	**4** **6** **6** **4**	**20**
5	**Parts 1, 2, 3, 4, 7, 8 and 10**		**Parts 1, 3, 4, 7 & 8** 10 Marks	Lathe Work Marking Out & Bench Work	**6** **4**	**20**
			Parts 2, & 10 10 Marks	Marking Out, Lengths & Profile 6 × M5 Holes & 1 × M8 Hole Ø3, 6 & 8 mm Holes	**6** **2** **2**	

100 Marks (×1.5 = 150 Total)

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