



**Coimisiún na Scrúduithe Stáit
State Examinations Commission**

LEAVING CERTIFICATE EXAMINATION, 2013

ENGINEERING – MATERIALS AND TECHNOLOGY

(Higher level – 300 marks)

THURSDAY, 6 JUNE

MORNING 9:30 – 12:30

INSTRUCTIONS

1. Answer **Section A** and **Section B** of **Question 1** and **FOUR** other questions.
2. All answers must be written in ink on the answer book supplied.
3. Diagrams should be drawn in pencil.
4. Squared paper is supplied for graphs, as required.
5. Please label and number carefully each question attempted.

Question 1.

(100 marks)

Section A – 50 marks

Give **brief answers** to **any ten** of the following:

- (a) Identify **two** common lubricating materials used in engineering machines.
- (b) State the purpose of **any two** of the safety signs shown.



(i)

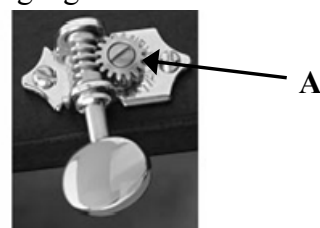


(ii)



(iii)

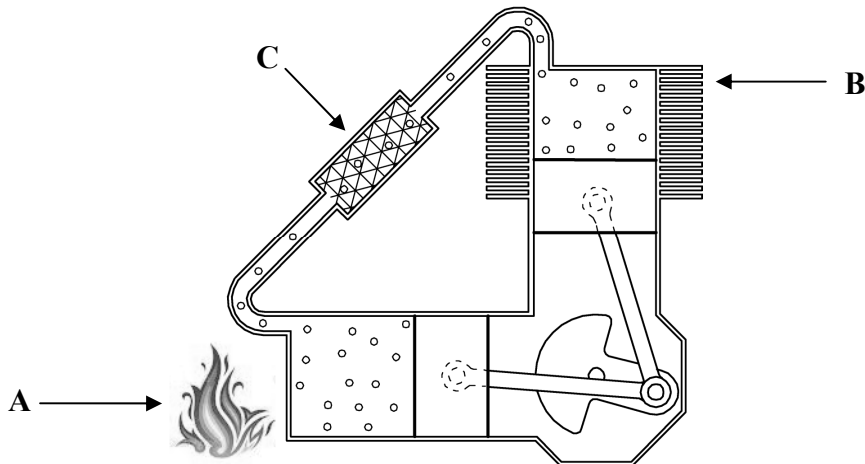
- (c) Name **two** methods of ore dressing.
- (d) Outline **two** environmental factors that increase the rate of corrosion in steel fixings.
- (e) Compare the process of metal alloying and the process of co-polymerisation of plastic materials.
- (f) The inventor, James Dyson, has developed this innovative design of a room heater. Explain the function of the *thermostatic control* device in this heater.
- (g) Differentiate between systemic and narcotic effects of toxic materials.
- (h) Discuss the contribution that **any one** of the following has made to technology:
(i) Nicolaus Otto (ii) Frank Whittle (iii) Dugald Clerk.
- (i) Identify **three** applications for pneumatic control in engineering.
- (j) Explain **one** reason for the *anodising* of aluminium.
- (k) Describe the constituents of the *carburising* flame used in oxy-acetylene welding.
- (l) Explain the meaning of **any two** of the following abbreviations:
(i) IC (ii) LCD (iii) GRP (iv) CAM.
- (m) Name the mechanism shown at **A** used in tuning a guitar.



Section B – 50 marks

Answer **all** of the following:

- (n) A key element of the Stirling engine is an effective heat source.
Identify **three** heat sources that can be used to run a Stirling engine.
- (o) A simplified Stirling engine is shown.
- (i) Identify the zones **A**, **B** and **C**.
- (ii) Describe the principle of operation of this engine.



- (p) Outline the main advantages and disadvantages of the Stirling engine with reference to:
- engine efficiency
 - range of applications.

- (q) A miniature Stirling engine can be used in the electronic circuit of a computer.

Explain the function of the Stirling engine in this application.



- (r) Describe **any two** of the following:
- (i) Beta Stirling engine;
- (ii) **One** reason for using an internal combustion engine rather than a Stirling engine in motor car design;
- (iii) The role of the *displacer* in a Stirling engine.

Question 2.

(50 marks)

(a) (i) Distinguish clearly between *fatigue* and *creep* with reference to deformation of metals.

(ii) Mechanical tests are carried out to determine metal properties.

These include:

A - Tensile test;

B - Vickers test;

C - Izod test.

For **each** of the tests **A**, **B** and **C**, identify and describe the metal properties under examination.

(b) The results shown below were obtained from a tensile test on a non-ferrous alloy with a 10 mm diameter and 50 mm gauge length.

Load (kN)	15	25	40	60	80	100	107	108	105	96
Extension (mm)	0.06	0.10	0.16	0.26	0.38	0.65	0.90	1.00	1.20	1.40

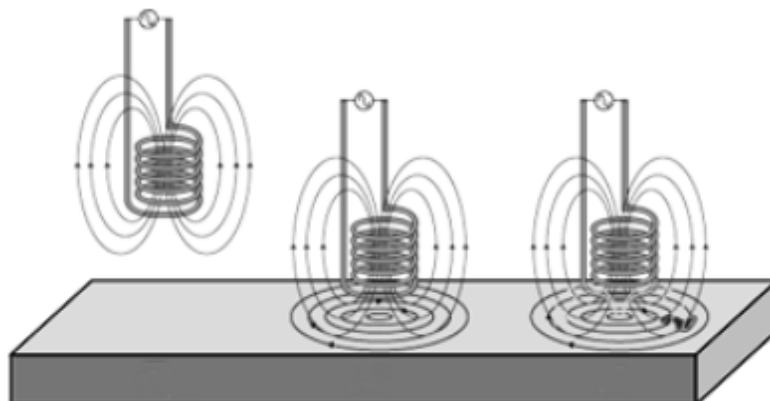
Using the graph paper supplied, plot the load-extension diagram and determine:

(i) The ultimate tensile strength (UTS);

(ii) The 0.1% proof stress.

(c) (i) Outline **three** advantages of using non-destructive tests (NDT) in industrial engineering.

(ii) Name the NDT shown below. Describe the principle of operation and the applications of this NDT.



Question 3.

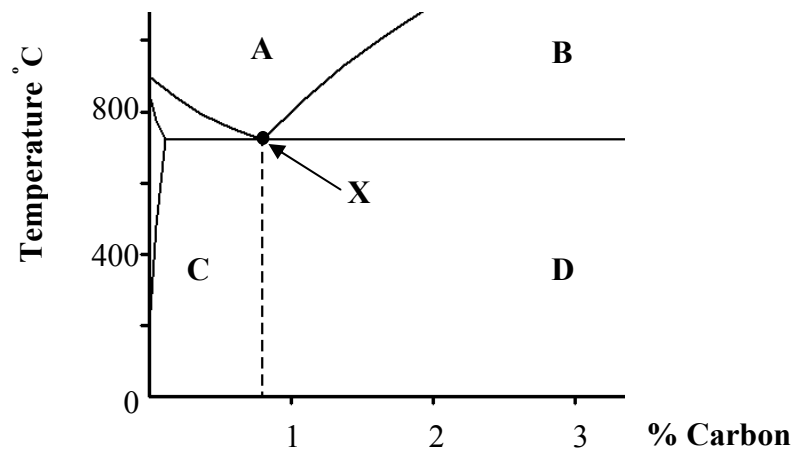
(50 marks)

- (a) The table below describes heat treatments which have been applied to each of the medium-carbon steel screwdrivers **A** and **B**.

Screwdriver A	Heat to 900°C and allow to cool slowly
Screwdriver B	Heat to 900°C and quench in cold water

- (i) Describe the effect of applying maximum torque to both screwdriver **A** and screwdriver **B** after the above heat treatments.
- (ii) Outline the most effective heat treatment process that should be applied to a screwdriver.

- (b) A simplified portion of the iron-carbon equilibrium diagram is shown.



- (i) Name the regions **A**, **B**, **C**, **D** and the point **X** shown.
- (ii) Describe in detail, the point **X** with reference to the following:
- phase change
 - composition
 - temperature.
- (c) Answer **any two** of the following:
- (i) Describe the process and applications of induction hardening.
- (ii) Name **three** quenching media used in heat treatment.
- (iii) Outline the operating principles of an optical pyrometer.
- (iv) Explain the properties of *18/10 stainless steel* and outline a suitable use for this steel.

Question 4.

(50 marks)

(a) Explain in detail **any two** of the following:

- (i) Age hardening;
- (ii) The differences between *eutectic alloy* and *partial solubility alloy*;
- (iii) **Three** crystal point defects;
- (iv) Intermetallic compound.

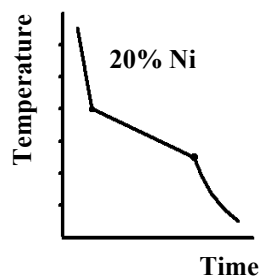
(b) The table shows the solidification temperatures for various alloys of metal A and metal B.

% of metal B in alloy	0	20	40	60	80	100
Start of solidification (°C)	270	400	492	552	603	630
End of solidification (°C)	270	280	318	368	449	630

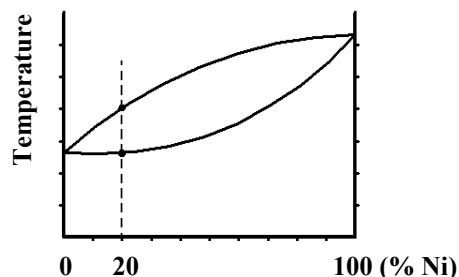
- (i) Using the graph paper supplied, draw the thermal equilibrium diagram according to the given data.
- (ii) Label and describe the main features of the diagram.
- (iii) Determine the composition of the phases present at **450 °C** for the alloy containing **60%** of metal B.

(c) (i) Outline the stages of metal solidification from the liquid phase.

(ii) Explain the relationship between cooling curves and the formation of alloy equilibrium diagrams as shown below.



Cooling curve



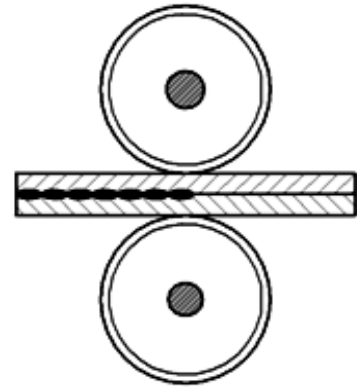
Equilibrium diagram

Question 5.

(50 marks)

- (a) Answer **any three** of the following:
- (i) Describe **three** hazards associated with the use of manual metal arc welding in a school engineering room.
 - (ii) Outline the functions of the *transformer*, *capacitor* and *rectifier* in manual metal arc welding.
 - (iii) State **two** functions of the electrode coating in manual metal arc welding.
 - (iv) State specific uses for **each** of the following welding processes:
 - Tungsten inert gas (TIG) welding
 - Submerged arc welding (SAW)
 - Oxy-acetylene welding.

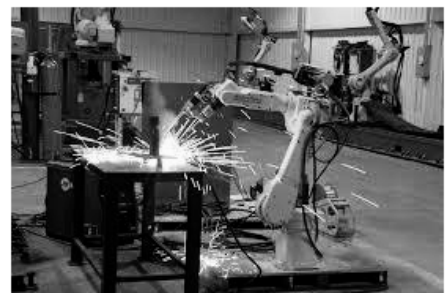
- (b) A resistance welding process is illustrated.
- (i) Name this resistance welding process.
 - (ii) Identify **one** application for this process.
 - (iii) Describe in detail, the key principles of resistance welding.



- (c) Describe, with the aid of suitable diagrams, the main features of **one** of the following:
- (i) Metal inert gas (MIG) welding;
 - (ii) Electro-slag welding.

OR

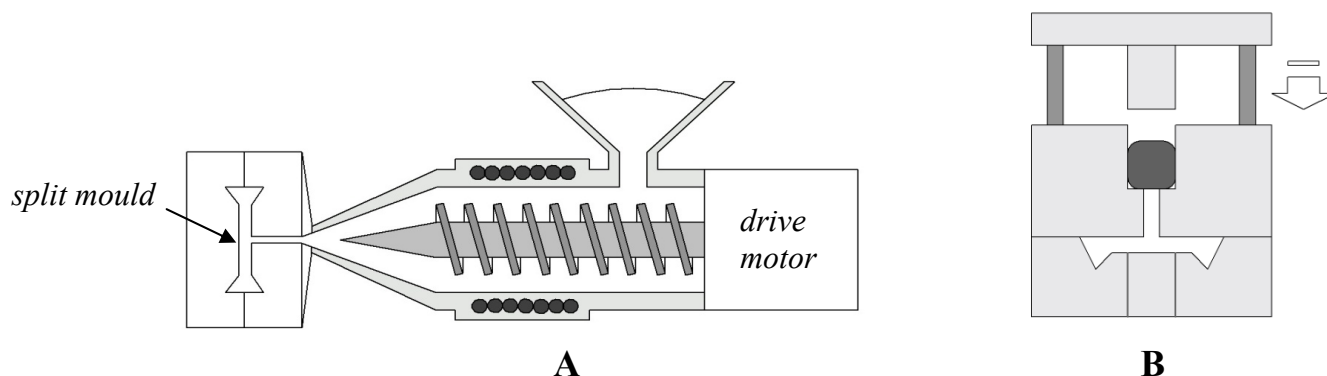
- (c) The use of robotic welding has increased steadily over the past 25 years and now accounts for approximately 20% of all industrial robotic applications.
- (i) Name **two** types of welding suitable for robotic control.
 - (ii) Identify **two** other industrial processes that can be controlled by robotic techniques.



Question 6.

(50 marks)

- (a) Two polymer manufacturing processes are shown at **A** and **B** below.

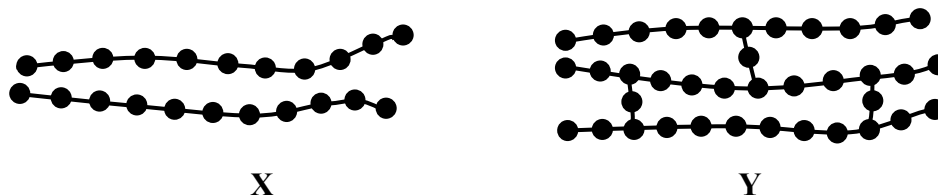


- (i) Which of the processes shown at **A** and **B** is most suitable for the manufacture of an electrical plug casing?
- (ii) Outline the reasons why the process selected is the most suitable for the manufacture of an electrical plug casing.
- (iii) Explain **one** reason for using the split mould in manufacturing process **A**.

- (b) Select **any three** of the following and distinguish between:

- (i) Condensation polymerisation and addition polymerisation;
- (ii) Plasticiser and stabiliser;
- (iii) Extrusion and compression moulding;
- (iv) Natural and synthetic rubber.

- (c) Two internal polymer structures **X** and **Y** are represented below.



With reference to the two polymer structures at **X** and **Y**:

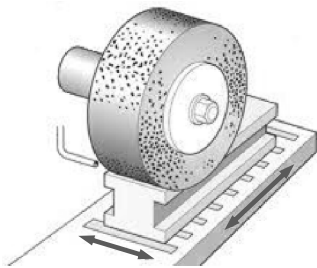
- (i) Name each structure;
- (ii) Identify **one** polymer associated with each structure;
- (iii) State **two** properties associated with each structure.

Question 7.

(50 marks)

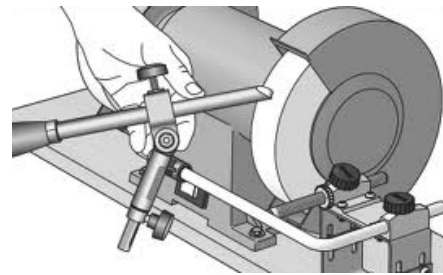
- (a) Answer **any three** of the following:
- (i) Identify **three** safety features incorporated in the design of a centre lathe.
 - (ii) Describe the purpose of a plug gauge.
 - (iii) Distinguish between **any two** types of chip formed when machining.
 - (iv) Outline **three** methods of machining flat surfaces on metals.
 - (v) Identify **one** advantage and **one** disadvantage of using carbide tipped cutting tools when machining.

- (b) Two common grinding processes are illustrated at **A** and **B**.



A

Surface grinding a steel machine slide.



B

Sharpening a cutting tool on a bench grinder.

- (i) Outline the main features of a surface grinding machine.
 - (ii) Describe **three** hazards associated with using a bench grinder.
- (c) Describe, with the aid of suitable diagrams, the differences between *gang milling* and *straddle milling*.

OR

- (c) CNC machining is used in a variety of industrial engineering applications.
- (i) Describe **two** features that reduce CNC machining cycle time.
 - (ii) Outline the advantages of using stepper motors in CNC machines.

Question 8.

(50 marks)

- (a) Name and describe the operation of **any one** of the mechanisms shown.



(i)

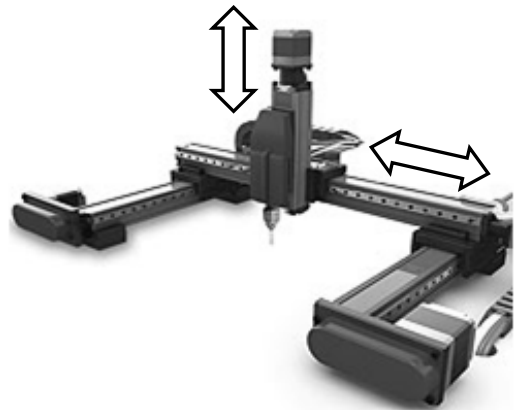


(ii)

- (b) Describe **any three** of the following:

- (i) The advantages of toothed pulley belts;
- (ii) The operation and **one** application of a solenoid;
- (iii) **One** application for a resistor;
- (iv) **One** mechanical device used to convert rotary motion into linear motion;
- (v) A pneumatic flow regulator.

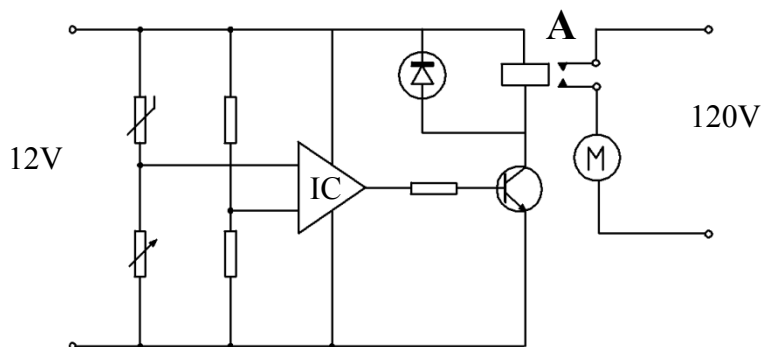
- (c) The computer-controlled machine shown moves the cutter in the directions shown. Describe clearly, with the aid of diagrams, suitable drive mechanisms to control the cutter movement.



OR

- (c) With reference to the IC circuit shown below:

- (i) Name the input and output components in the circuit.
- (ii) Name and describe the functions of component **A** in this circuit.



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