Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2014

ENGINEERING – MATERIALS AND TECHNOLOGY

(Higher level – 300 marks)

THURSDAY, 5 JUNE **MORNING 9:30 – 12:30**

INSTRUCTIONS

1. Answer **Question 1**, **Section A** and **Section B**, 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. Graph 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** hazards associated with using adhesives on plastics.

(b) The occasional table shown opposite was designed by the celebrated Irish designer Eileen Gray. Describe **two** design features associated with this table.

(c) Discuss the advantages of *upcycling* the inner tubes of tyres to produce designer bags.

(d) Outline **two** reasons for the use of tubular steel in the roof structure of modern sport arenas, such as Croke Park in Dublin and Thomond Park in Limerick.

(e) The screen of the portable computer tablet shown is made from glass. Outline **one** advantage and **one** disadvantage of using glass screens.

(f) Describe the importance of *allotropy* in carbon steel.

(g) Differentiate between *amorphous* and *crystalline* structures.

(h) Discuss the contribution that **any one** of the following has made to technology:
(i) Jack Kilby **(ii)** Marie Curie **(iii)** John Dunlop.

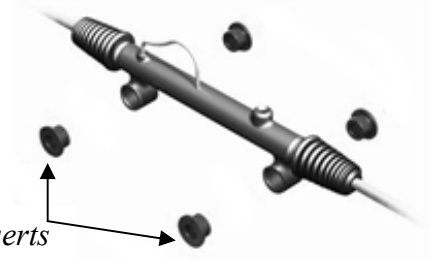
(i) A prosthetic hand is shown opposite.
Outline **two** reasons why *research* is important at the design stage of prosthetic devices.

(j) Describe **two** important properties of a material which is suitable for the manufacture of a prosthetic hand.

(k) Discuss **two** advantages of using pneumatics in industry.

(l) Explain the association between *conductivity* and the *metallic bond*.

(m) Nylon inserts are used in the steering column mounting of a car, as shown. Outline **two** reasons for using nylon in the steering column mounting.



Section B – 50 marks

Answer **all** of the following:

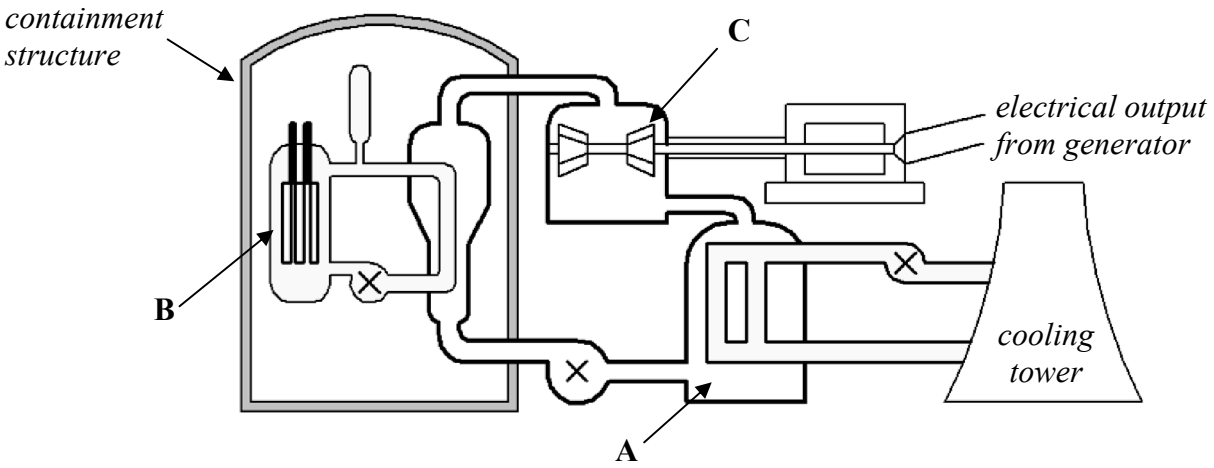
(n) Nuclear power plants provide some of the energy in many modern industrialised economies.
Discuss this energy source with reference to:

- Efficiency
- Environmental impact.

(o) A simplified diagram of a nuclear power plant is shown.

(i) Identify the parts labelled **A**, **B** and **C**.

(ii) Describe the principles of operation of a nuclear power plant.



(p) Describe briefly the nuclear fission process with reference to: the *reactor fuel*, the *enrichment process* and the *exponential increase*.

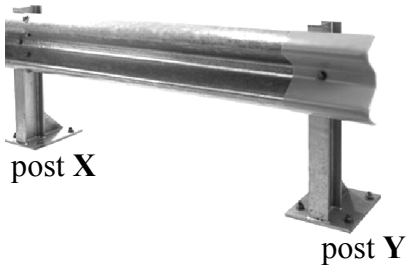
(q) Chernobyl in 1986 and Fukushima Daiichi in 2011 are widely considered to have been the worst nuclear power plant accidents in history.
Outline **three** consequences of nuclear accidents.

(r) Safety is a primary concern in the design, construction and operation of any modern nuclear power plant. Describe how **any two** of the following contribute to overall safety:

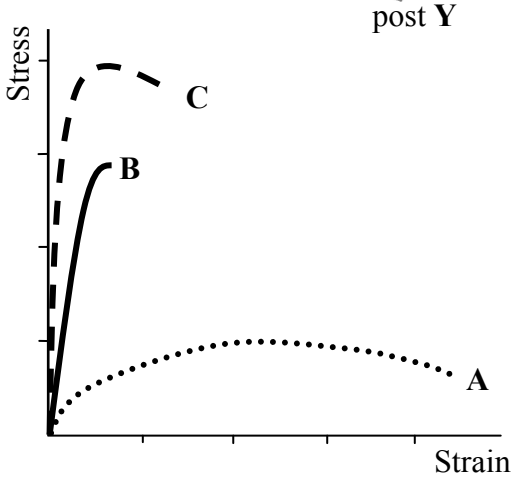
(i) Modern safety regulations;
(ii) Containment building;
(iii) Back-up power supply.

Question 2. **(50 marks)**

(a) Following an analysis of a road accident black-spot, it has been decided to reinforce the crash barrier shown with an additional post. The post is to be centered between the posts **X** and **Y** shown opposite.



Tensile test results on three metals **A**, **B** and **C**, which may be suitable for the additional post, are shown.



(i) Analyse the main properties of metals **A**, **B** and **C**.

(ii) Select the most suitable metal from **A**, **B** and **C** for the additional post and outline **two** reasons for your selection.

(b) The results shown below were obtained from a tensile test on a non-ferrous alloy.

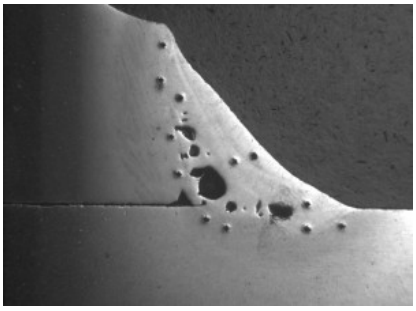
Stress (N/mm^2)	45	90	135	200	275	308	335	345	340
Strain (× 1000)	0.50	1.00	1.50	2.25	3.25	4.00	5.00	6.50	7.50

Using the graph paper supplied, plot the Stress-Strain diagram for the alloy and determine:

(i) Young's modulus of elasticity;

(ii) The 0.1% proof stress.

(c) **(i)** A sample of a weld is shown. Evaluate the quality of this weld.



(ii) Describe, with the aid of a diagram, a non-destructive test suitable for testing weld quality.

Question 3. **(50 marks)**

(a) Answer **any two** of the following:

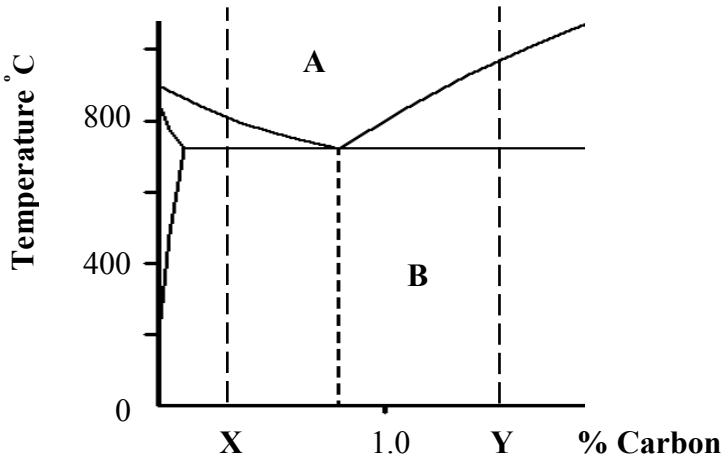
(i) Describe the heat treatment process of normalising.

(ii) Distinguish between eutectic point and eutectoid point.

(iii) Explain the term *re-crystallisation*.

(iv) Outline the effects of adding **any two** elements to iron and carbon in the production of alloy steels.

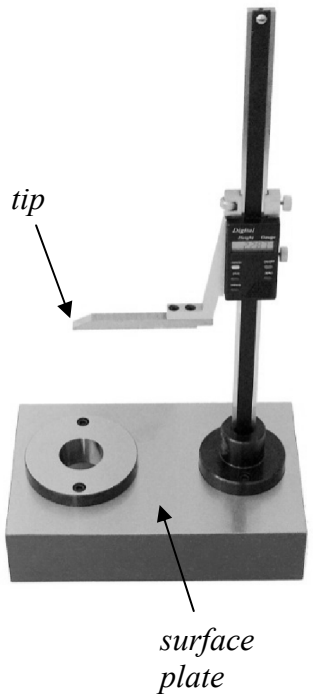
(b) A simplified portion of the iron-carbon equilibrium diagram is shown.



(i) Identify the regions **A** and **B**.

(ii) Compare the main properties of the steel at **X**, which has 0.3% carbon, and the steel at **Y**, which has 1.5% carbon.

(c) The tip of the height gauge shown is to be made from carbon steel. A cast iron surface plate is also shown.



(i) Compare the different heat treatment requirements for the carbon steel tip and the cast iron surface plate.

(ii) Describe, with the aid of a diagram, a suitable heat treatment process for the surface plate.

Question 4. **(50 marks)**

(a) **(i)** Describe **any two** *factors* that should be considered during the design of a weather vane in order to prevent corrosion.

(ii) Describe **any two** suitable *methods* that could be used to protect the metal weather vane shown, from the corrosive effects of the environment.

(b) The table shows the solidification temperatures for various alloys of Cadmium and Zinc.

% of Zinc in alloy	0	10	14	20	30	40	50	60	70	80	90	100
Start of solidification (°C)	321	290	266	275	293	310	328	345	362	380	401	419
End of solidification (°C)	266	266	266	266	266	266	266	266	266	266	266	266

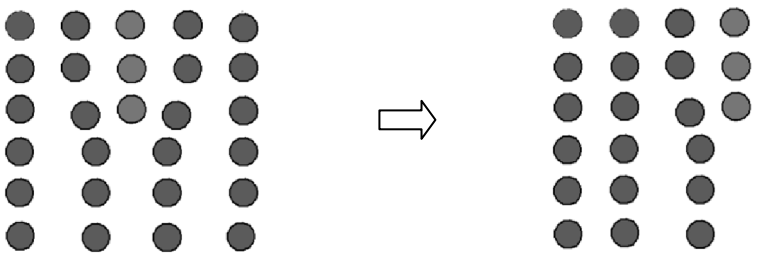
(i) Using the graph paper supplied, draw the thermal equilibrium diagram according to the given data.

(ii) Label and describe the main features of the diagram.

(iii) State the melting point of Cadmium and the melting point of Zinc.

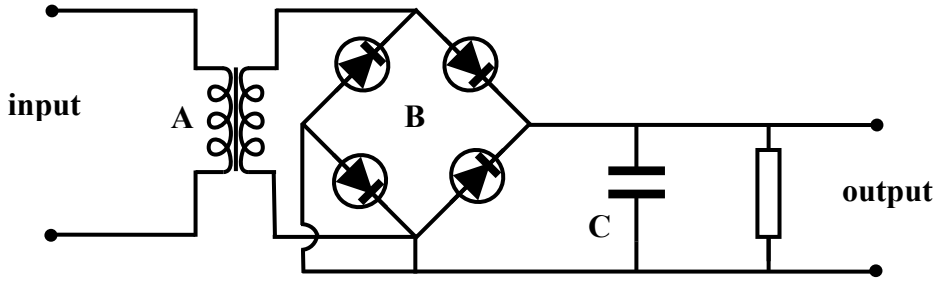
(c) **(i)** Distinguish clearly between a *substitutional solid solution* and an *interstitial solid solution*.

(ii) Describe **one** effect of the movement of the line defect shown below.



Question 5. **(50 marks)**

(a) With reference to manual metal arc welding, answer **any three** of the following:



(i) Name the components **A**, **B** and **C** in the welding circuit shown above.

(ii) Describe the operation of **each** of the components **A**, **B** and **C** in this welding circuit.

(iii) Outline **three** safety precautions to be observed during manual metal arc welding.

(iv) Discuss **two** advantages of multi-run welds.

(b) High performance car exhaust pipes are often manufactured in stainless steel and joined by welding.

(i) Name a suitable welding process for an exhaust pipe.

(ii) Describe, with the aid of a suitable diagram, the main features of this welding process.

(c) Describe **each** of the following:

(i) The composition and uses for **each** of the **three** principal flames in oxy-acetylene welding.

(ii) **Any three** methods of joint protection when welding.

OR

(c) **(i)** Outline **two** reasons why robotic welding is suitable for large scale industrial production.

(ii) Identify **two** methods to control the movement of industrial robots.

Question 6. **(50 marks)**

(a) The casing for the games controller shown is to be manufactured in a large scale production run, using a thermoplastic material.

(i) Select a manufacturing process suitable for making the casing and state **one** reason why the manufacturing process selected is suitable.

(ii) Describe, with the aid of a suitable diagram, the operation of this process.

(b) Describe how polymer properties may be enhanced by **any three** of the following:

(i) Plasticisers;

(ii) Stabilisers;

(iii) Glass or carbon fibre;

(iv) Lamination.

(c) A thermosetting plastic is used in the manufacture of the electric kettle shown.
Most thermosetting plastics are produced by condensation polymerisation.

(i) Outline **two** reasons for choosing thermosetting plastics for this application.

(ii) Describe the process of condensation polymerisation.

Question 7. **(50 marks)**

(a) Answer **any three** of the following:

(i) Identify **three** safety features integrated into a milling machine.

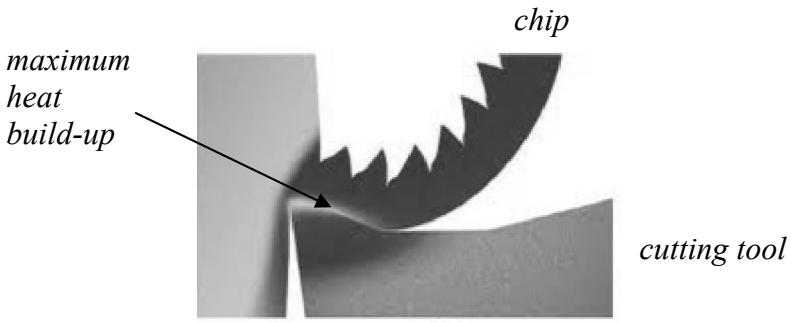
(ii) Describe the formation of a *built-up edge* on a cutting tool.

(iii) Outline the purpose of *dressing* a grinding wheel.

(iv) Differentiate between *forming* and *generating* when machining.

(v) Discuss **two** reasons why inaccuracies may occur during precision measurement.

(b) Many factors have to be considered for effective metal cutting and machinability.



(i) Describe **two** factors that influence metal machinability.

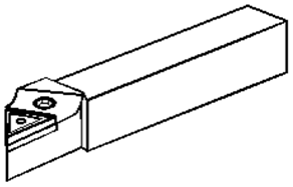
(ii) Outline **three** functions of cutting fluids in effective metal cutting.

(c) Answer part **(i) or** part **(ii)**:

(i) Describe, with the aid of suitable diagrams, **each** of the following:

- a single point cutting tool
- a multi-point cutting tool
- an abrasive cutting tool.

(ii) Describe how carbide cutting tools are manufactured and state **two** advantages of using carbide cutting tools.



OR

(c) Describe **each** of the following with reference to CNC machining:

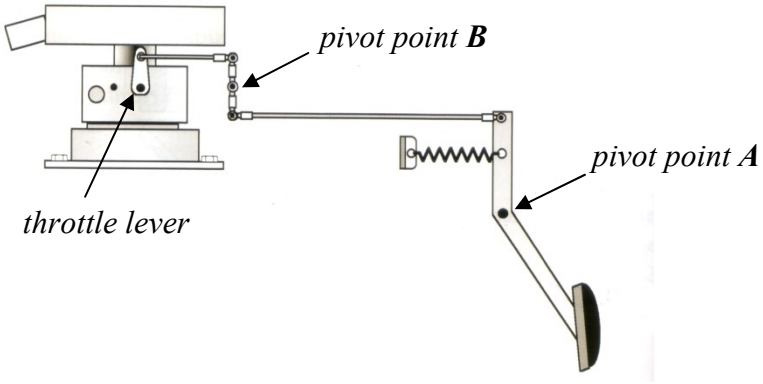
(i) The advantages of CNC machining in industrial engineering.

(ii) **Two** safety features integrated into CNC software.

(iii) The role of simulation in CNC machining.

Question 8. **(50 marks)**

(a) Describe how the linkage system controls the throttle lever of the carburettor, as shown opposite.



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

(i) The differences in operation between a single-acting cylinder and a double-acting cylinder in pneumatic control.

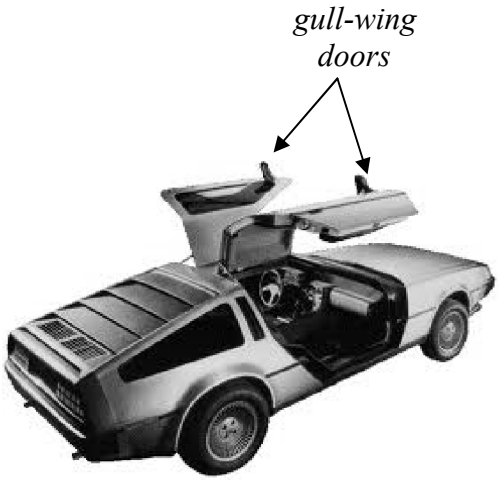
(ii) The operation and application of a rack and pinion system.

(iii) **One** application of reciprocating motion.

(iv) A toggle mechanism.

(v) The function of idler gears.

(c) It is proposed to design a model based on the DeLorean DMC-12 sports car shown. Describe, with the aid of a suitable diagram, a mechanism that would allow the *gull-wing doors* in the model to open and close.

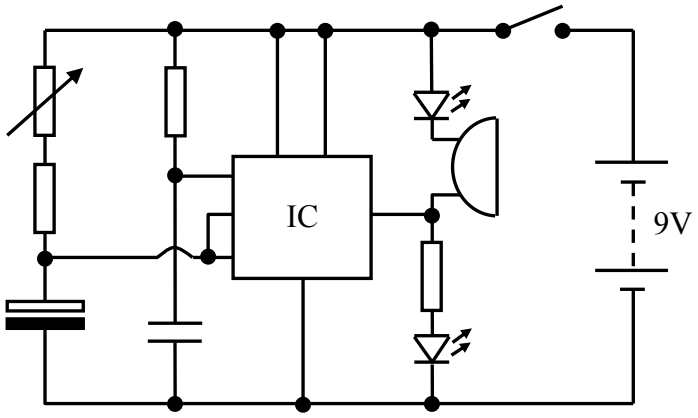


OR

(c) With reference to the timer circuit shown below:

(i) Name the components that determine the timing of the circuit.

(ii) Outline **two** advantages of using an integrated circuit (IC).



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