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Candidate number

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Forename(s) _____

Candidate signature _____

Level 3 Technical Level DESIGN ENGINEERING MECHATRONIC ENGINEERING

Unit 1 Materials Technology and Science

Wednesday 16 January 2019 Afternoon Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- pens
- pencils
- simple drawing instruments
- a scientific calculator (non-programmable)
- the formula sheet, which is provided as an insert inside this paper.

Instructions

- Use black ink or black ball-point pen. Use pencil only for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this answer book. Cross through any work you do not want to be marked.
- Answer to 3 significant figures unless otherwise instructed.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80. There are 50 marks for **Section A** and 30 marks for **Section B**.
- Both sections should be attempted.

Advice

- Do not spend too long on one question.
- Read all questions thoroughly before starting your answer.
- Show all working in the spaces provided.

For Examiner's Use	
Question	Mark
1–10	
11	
12	
13	
14	
15	
16	
17	
TOTAL	



J A N 1 9 F 5 0 6 5 9 5 2 0 1

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Section AAnswer **all** questions in this section.**Total for this section: 50 marks**Tick (✓) the box next to the correct answer for questions **01** to **10**.**0 1**

What are the units of compressive strength?

[1 mark]**A** kg m^2 ☐**B** kg m^{-3} ☐**C** N m^{-2} ☐**D** N m ☐**0 2**Identify which **one** of the following is a thermosetting polymer.**[1 mark]****A** Acrylic☐**B** Polycarbonate☐**C** Polyethylene☐**D** Urea formaldehyde☐

0 3

Identify which of the following best describes a dislocation in a metal.

[1 mark]**A** A line defect.☐**B** A buckling stress.☐**C** A normalising effect.☐**D** A physical property.☐**0 4**

Identify the unit of electrical capacitance.

[1 mark]**A** Ampere☐**B** Farad☐**C** Henry☐**D** Ohm☐**Turn over for the next question****Turn over ►**

0 5

Which class of materials are generally the best heat conductors?

[1 mark]**A** Ceramics☐**B** Composites☐**C** Metals☐**D** Polymers☐**0 6**

Name the property that is represented by the linear gradient on a stress-strain graph.

[1 mark]**A** Plastic deformation☐**B** Tensile strength☐**C** Yield point☐**D** Young's modulus☐**0 7**

Identify the material that a lathe cutting tool would generally be manufactured from.

[1 mark]**A** High carbon steel☐**B** Low carbon steel☐**C** Medium carbon steel☐**D** Stainless steel☐

0 8

What effect would annealing have on an aluminium alloy?

[1 mark]**A** Harden it☐**B** Strengthen it☐**C** Soften it☐**D** Normalise it☐**0 9**

Which of the following is the unit of frequency?

[1 mark]**A** Amplitude☐**B** Hertz☐**C** Period☐**D** Phase☐**1 0**

What is the unit of gravitational force?

[1 mark]**A** Joule☐**B** Kelvin☐**C** Newton☐**D** Watt☐

10**Turn over ►**

1 1 . 1 Complete **Table 1** by entering the material class and typical use.

The top row has been completed for you as an example.

[6 marks]

Table 1

Material	Class	Typical use
Brass	Non-ferrous metal	Ornaments, bullet cartridges, bells, plumbing application, door knobs, electrical applications etc.
High impact polystyrene (HIPS)		
Cast iron		
Silicon carbide		

1 1 . 2 **Figure 1** shows a wheelbarrow suitable for use by adults.

Figure 1



State **two** materials that Component **A** is commonly manufactured from.

[2 marks]

Material 1 _____

Material 2 _____



1	1	.	3
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Give **two** reasons why these materials can be used.**[2 marks]**

Reason 1 _____

Reason 2 _____

10**Turn over for the next question****Turn over ►**

1	2	.	1
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Explain briefly what is meant by an alkane structure.

Give an example of **one** in your answer.

[3 marks]

Explanation _____

Example _____

1	2	.	2
---	---	---	---

Explain what is meant by crosslinking in polymers and how it affects the property of the material.

[7 marks]



Turn over for the next question

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ANSWER IN THE SPACES PROVIDED**

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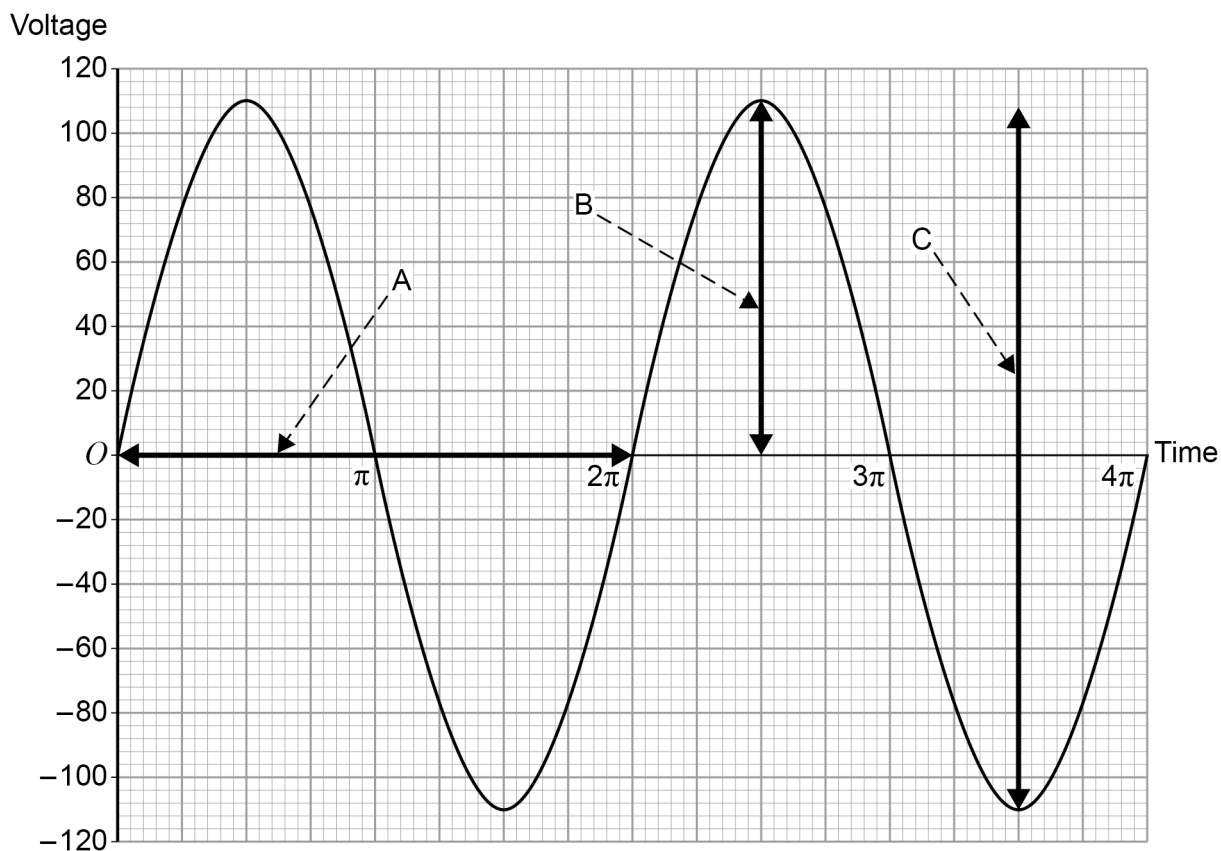
Explain the function of an electronic transistor.

[5 marks]



1 3 . 2

Figure 2



Give the correct terms for the properties of the waveform indicated by **A**, **B** and **C** on **Figure 2**

[3 marks]

Point A _____

Point B _____

Point C _____

1 3 . 3

Give **two** engineering examples of where sine waveforms can be found.

[2 marks]

Example 1 _____

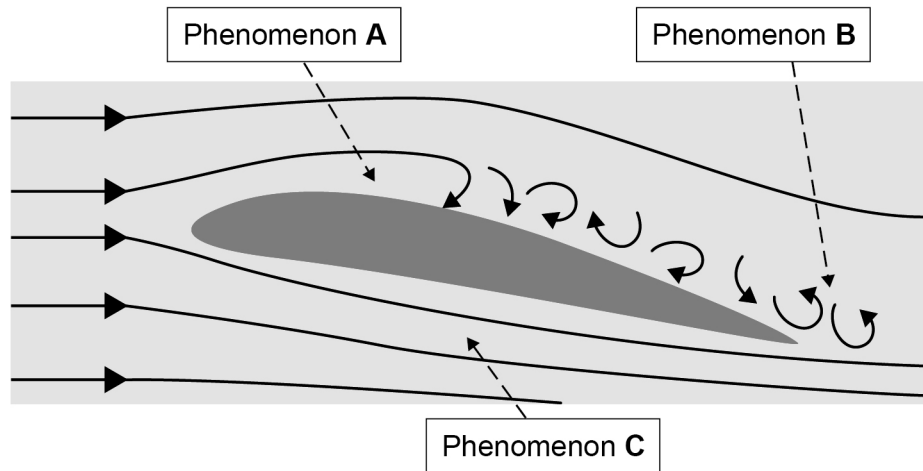
Example 2 _____



1 4

Figure 3 shows the cross section of an aircraft's wing in flight.

Figure 3



1 4 . 1

Identify the **three** phenomena listed in **Figure 3**

[3 marks]

Phenomenon **A** _____

Phenomenon **B** _____

Phenomenon **C** _____

1 4 . 2

Explain what is meant by the stagnation point in a two-dimensional fluid flow system.

[2 marks]



1	4	.	3
---	---	---	---

Describe how to calculate the efficiency of a simple machine.

[3 marks]

1	4	.	4
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Briefly explain what is meant by friction in a mechanical power transmission system.

[2 marks]

10

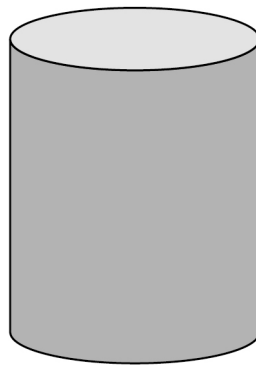
Turn over for the next question**Turn over ►**

Section BAnswer **all** questions in this section.**Total for this section: 30 marks****1 5**An engineer is designing a compressed gas storage cylinder – **Figure 4**.

The dimensions of the cylinder are:

Diameter = 1.2 m

Height = 1.75 m

Figure 4**1 5 . 1**

Calculate the volume of the cylinder.

Give your answer to 3 decimal places using the correct engineering units.

[4 marks]



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1	5	.	2
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The engineer needs to know the mass of air that the cylinder will contain under certain operating parameters.

Use the characteristic gas equation and the volume calculated in question **15.1** to calculate the mass of air.

$pV = mRT$ where:

$$p = 1.25 \text{ MPa}$$

$$R = 287.05 \text{ J kg}^{-1} \text{ K}^{-1}$$

$$T = 75\text{ }^{\circ}\text{C}$$

$m = \text{mass}$

[6 marks]

[illegible]

10

Turn over for the next question

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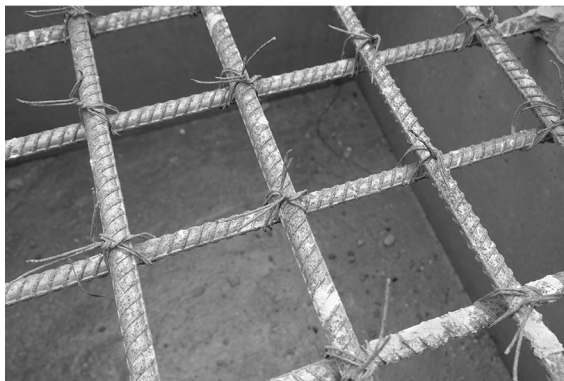


1	6
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A tie-bar is to be used in a construction project.

This is shown in **Figure 5**

Figure 5



The following data applies:

Young's Modulus, $E = 200 \text{ GNm}^{-2}$

Length = 2.0 m

Diameter = 20.0 mm

Load, $F = 50\,000 \text{ N}$ applying tension across the axis of the tie-bar

1	6
---	---

.	1
---	---

Calculate the tensile stress in the tie-bar to 3 significant figures.

[5 marks]



1	6	.	2
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Calculate the extension in the tie-bar in millimetres to 1 decimal place.

[5 marks]

10

Turn over for the next question**Turn over ►**

1 7 . 1 Explain the process of corrosion in metals.

[3 marks]

1 7 . 2 Explain how different metals, used together, can inhibit corrosion.

[2 marks]



1 7 . 3 Give **five** benefits of corrosion protection.

[5 marks]

10

END OF QUESTIONS



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