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Centre number

Candidate number

Surname \_\_\_\_\_

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# 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	
<b>TOTAL</b>	



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

IB/M/Jan19/E6

**F/506/5952**

**Section A**Answer **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**  $\text{kg m}^2$ ☐**B**  $\text{kg m}^{-3}$ ☐**C**  $\text{N m}^{-2}$ ☐**D**  $\text{N m}$ ☐**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☐

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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 \_\_\_\_\_

\_\_\_\_\_

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

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

[7 marks]

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**1 3 . 1** Explain the function of an electronic transistor.

**[5 marks]**

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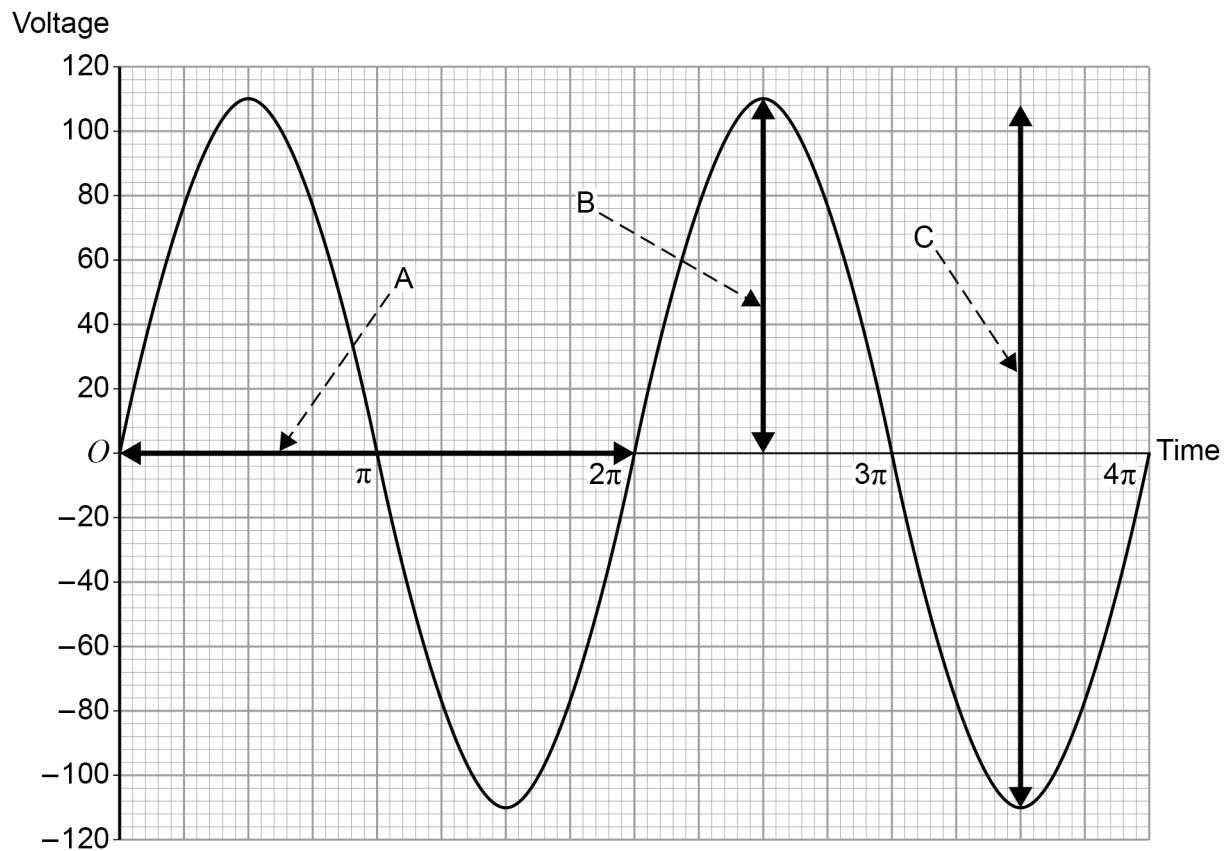
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1 3 . 2

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 \_\_\_\_\_

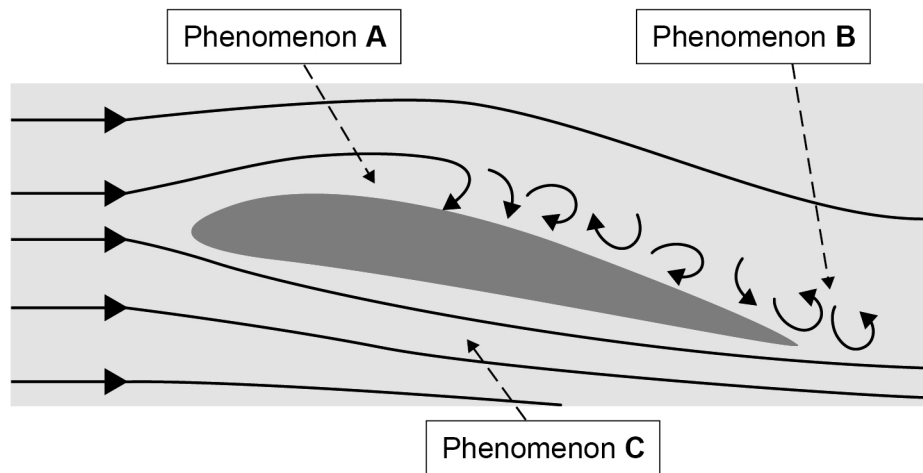
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1 4

**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]**

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\_\_\_\_\_

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Describe how to calculate the efficiency of a simple machine.

**[3 marks]**

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

**[2 marks]**

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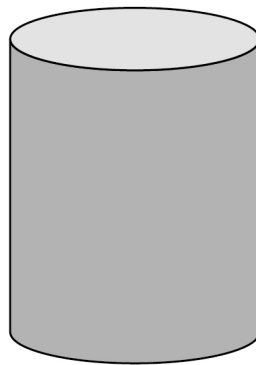
**Turn over for the next question****Turn over ►**

**Section B**Answer **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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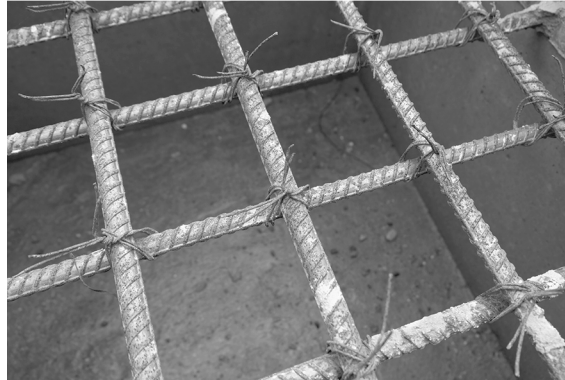


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A tie-bar is to be used in a construction project.

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

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

**[5 marks]**

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

**[5 marks]**

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

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

**[3 marks]**

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

**[2 marks]**

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

**[5 marks]**

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**10**

**END OF QUESTIONS**



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