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Centre number

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Candidate number

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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.

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

#### 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.



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

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**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** kg m<sup>2</sup>**B** kg m<sup>-3</sup>**C** N m<sup>-2</sup>**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 2

**0 3**

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

**[1 mark]**Do not write  
outside the  
box**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 3

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**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 steelDo not write  
outside the  
box

0 4

**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  
10Do not write  
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0 5

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**

Give **two** reasons why these materials can be used.

**[2 marks]**

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Reason 1 \_\_\_\_\_

Reason 2 \_\_\_\_\_

10

**Turn over for the next question**

**Turn over ►**



0 7

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**1 2. 1** 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]

10



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ANSWER IN THE SPACES PROVIDED**

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

[5 marks]

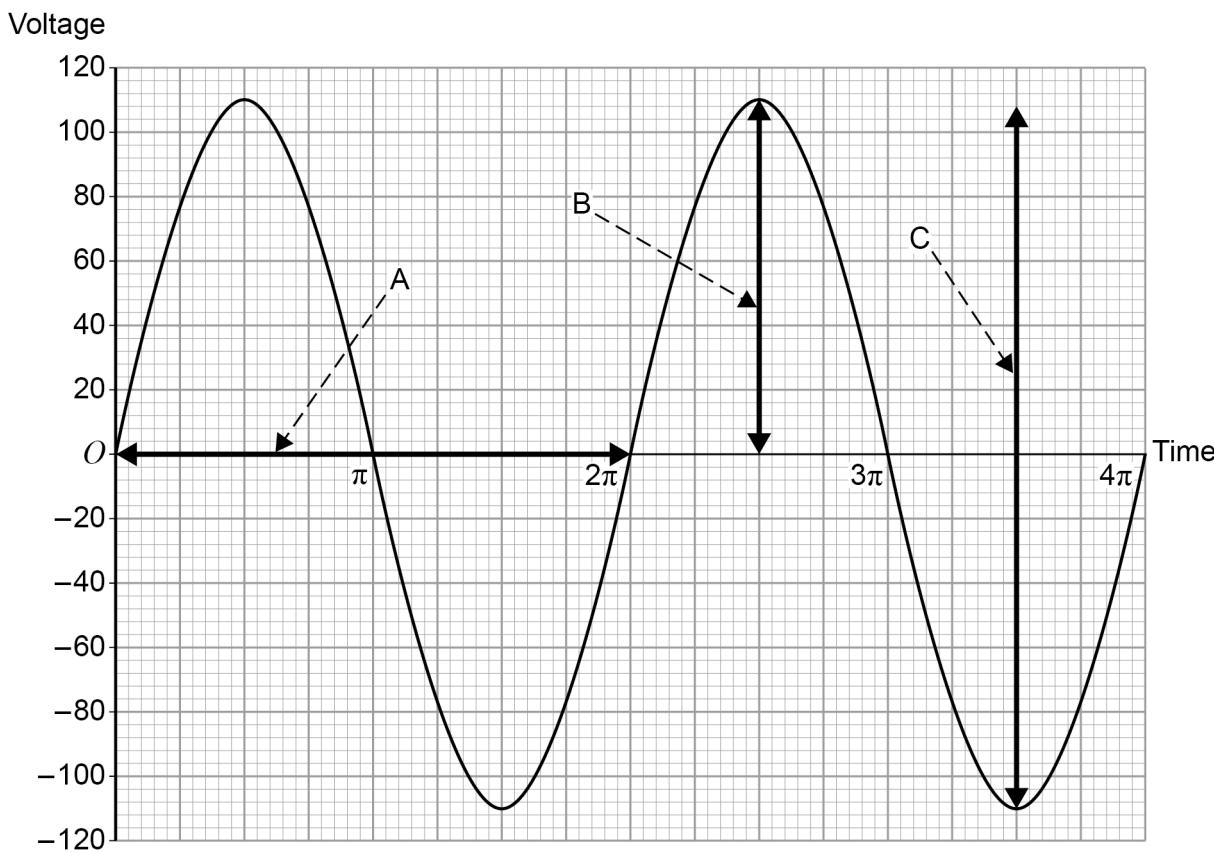
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1 3 . 2

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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 \_\_\_\_\_

10

Turn over ►



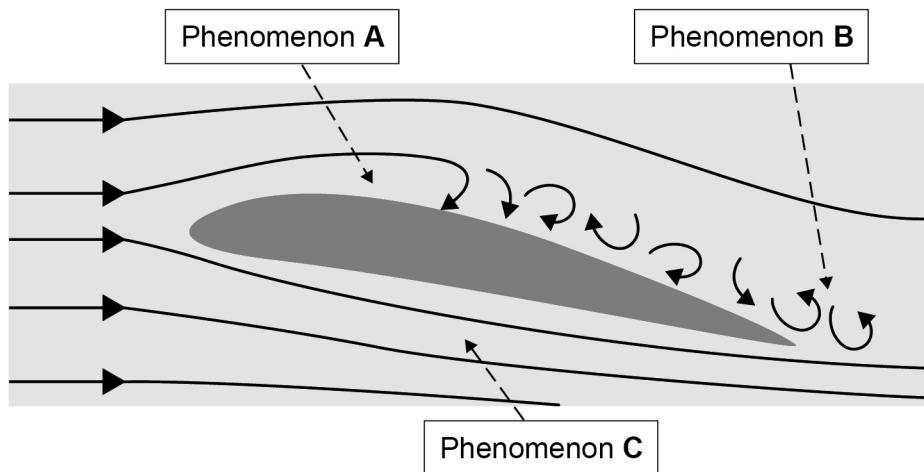
1 1

1 4

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

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**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 2

**1 4 . 3** Describe how to calculate the efficiency of a simple machine.

**[3 marks]**

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

**[2 marks]**

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**10**

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1 3

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## Section B

Answer **all** questions in this section.

**Total for this section: 30 marks**

1 | 5

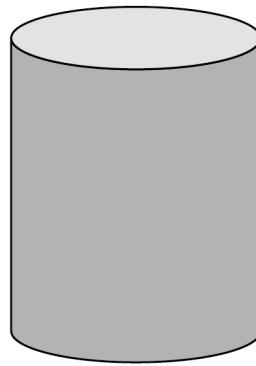
An engineer is designing a compressed gas storage cylinder – **Figure 4.**

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]

1 5 . 2

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.

$$pV = mRT \text{ where:}$$

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

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

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

*m* = mass

[6 marks]

10

**Turn over for the next question**

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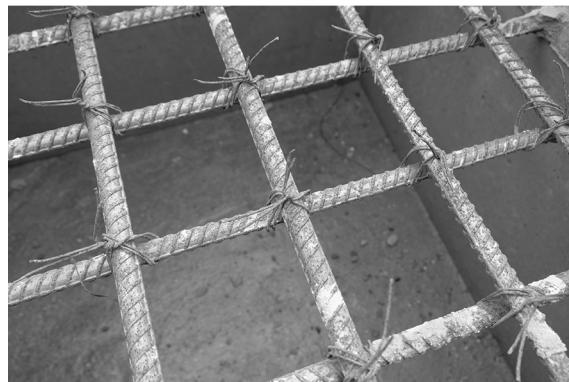
1 6

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

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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]**

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1 6

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

[5 marks]

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**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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END OF QUESTIONS



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