



Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

Level 3 Technical Level

DESIGN ENGINEERING

MECHATRONIC ENGINEERING

Unit 1 Materials technology and science

Friday 8 June 2018

Morning

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- pens
- pencils
- simple drawing instruments
- scientific calculator (non-programmable)
- formula sheet.

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.
- There are 80 marks available on this paper. There are 50 marks for **Section A** and 30 marks for **Section B**.
- Both sections should be attempted.
- The gravitation constant: $g = 9.81 \text{ ms}^{-2}$
- Conversion from bar g to Pascal's bar $g \times 101 \times 10^3 \text{ N M}^{-2}$

Advice

- Do not spend too long on one question.
- Read all questions thoroughly before starting your answer.

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



J U N 1 8 F 5 0 6 5 9 5 2 0 1

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ANSWER IN THE SPACES PROVIDED**



0 2

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Section AAnswer **all** questions in this section.In the multiple choice questions, only **one** answer per question is allowed.

For each question completely fill in the circle alongside the appropriate answer.

CORRECT METHOD



WRONG METHODS



If you want to change your answer you must cross out your original answer as shown.



If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown.

You may do your working in the blank space around each question but this will not be marked.
Do **not** use additional sheets for this working.**0 | 1**

Steel is an alloy of

[1 mark]**A** tin and iron.**B** iron and carbon.**C** aluminium and iron.**D** iron and brass.**0 | 2**Which of the following is **not** a composite material?**[1 mark]****A** Reinforced concrete**B** CRP**C** GRP**D** Polyethylene

Turn over ►



0 3

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0 3

Photochromic materials

[1 mark]

A change colour with different lighting conditions.

B lose density with different lighting conditions.

C change shape with change of lighting conditions.

D gain strength with change in lighting conditions.

0 4

QTC stands for

[1 mark]

A quantum-temperature controller.

B quantum-temperature composite.

C quantum-tensile component.

D quantum-tunnelling composite.

0 5

The SI unit of capacitance is the

[1 mark]

A pascal.

B ohm.

C farad.

D henry.

0 6

Which of the following is a thermosetting polymer?

[1 mark]

A Polyester resin

B PVC

C Polypropylene

D PTFE



0 4

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0 7

The UTS of a material is better known as its

[1 mark]

- A ultimate thermal stress.
- B unique thermal strength.
- C ultimate tensile strength.
- D unique tensile stress.

0 8

Plasticity is a material's ability to be

[1 mark]

- A easily cast or forged.
- B easily shaped or moulded.
- C easily welded or soldered.
- D easily drawn or extruded.

0 9

Which of the following does a belt drive rely on to operate?

[1 mark]

- A Acceleration
- B Pressure
- C Work
- D Friction

1 0

Which **one** of the following engineering materials is the **most** ductile at room temperature?

[1 mark]

- A High carbon steel
- B Tungsten
- C Aluminium
- D Medium carbon steel

10

Turn over ►



0 5

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Complete **Table 1** by entering the class of material and an application.

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

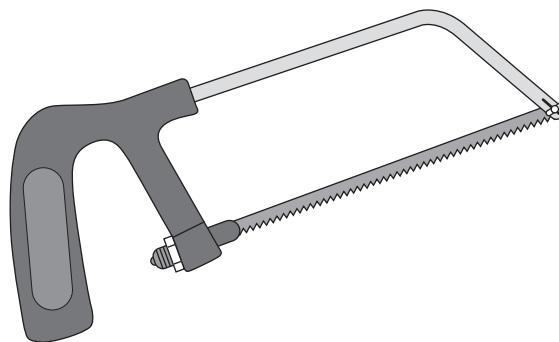
[6 marks]

Table 1

Material	Class of material	Application
Stainless steel	Ferrous alloy	Sinks, knives, forks, washing machines, food preparation equipment etc.
Acrylonitrile butadiene styrene (ABS)		
Brass		
Reinforced concrete		



Figure 1



1 1 . 2 What material is the blade of the hacksaw shown in **Figure 1** made from?

[1 mark]

1 1 . 3 Explain why this material is used.

[3 marks]

10

Turn over for the next question

Turn over ►



0 7

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1 2 . 1 Describe how cold working changes the structure of a metal.

[4 marks]

1 2 . 2 Name **two** benefits of cold working on metals.

[2 marks]

1	<hr/> <hr/>
2	<hr/> <hr/>

1 2 . 3 Explain what is meant by crosslinking within polymers.

[4 marks]



1 **3** . **1** **Figure 2** shows a bar magnet.

Describe the magnetic field with the aid of a sketch around the bar magnet.

[5 marks]

Figure 2



Question 13 continues on the next page

Turn over ►



1 3 . 2 Describe **two** applications where magnets are typically used.

[4 marks]

Application 1 _____

Application 2 _____

1 3 . 3 State the function of a transistor.

[1 mark]

10



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1 4 . 1 Describe what is meant by thermal radiation.

[4 marks]

1 4 . 2 Describe **two** applications where heat transfer is influenced by thermal radiation. **[4 marks]**

Application 1 _____

Application 2 _____

Question 14 continues on the next page

Turn over ►

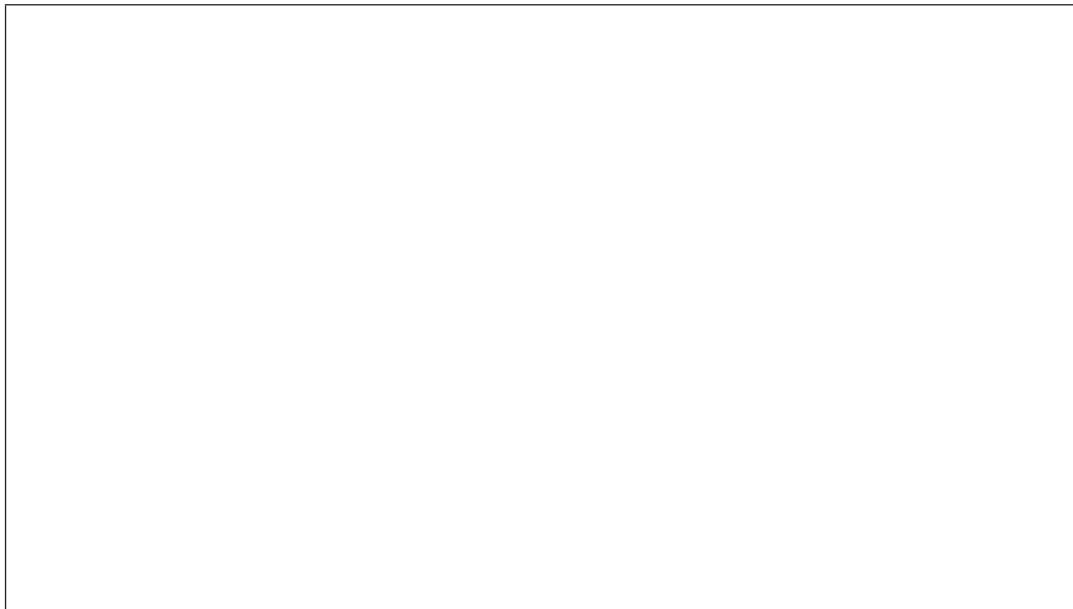


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1 4 . 3 Describe the term 'potential energy'.

Use a diagram to support your answer.

[2 marks]



10



1 2

Turn over for Section B

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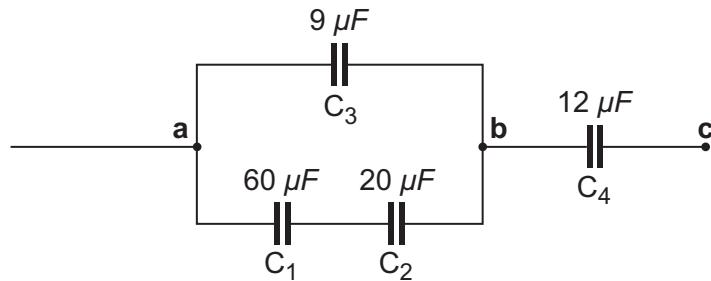


1 3

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Section BAnswer **all** questions in this section.

1 5

Figure 3

In the circuit, in **Figure 3**, if the potential difference between points **a** and **c** is $V_{ac} = 120$ V, find the charge on capacitors C_1 and C_2 .

Use the following formulae:

$$\frac{1}{C_{\text{total}}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \quad \text{capacitors in series}$$

$$C_{\text{total}} = C_1 + C_2 + C_3 \quad \text{capacitors in parallel}$$

$$V = \frac{Q}{C} \quad \text{where } V = \text{voltage, } Q = \text{charge (coulombs) and } C = \text{capacitance}$$

[10 marks]

1 4

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1 5

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1 6

Figure 4 shows a fitter applying a force to a nut. The force is equivalent to a mass of 5 kg.

Figure 4



1 6 . 1 The radius of the applied force is 250 mm.

Calculate the torque the fitter is applying to the nut.

Show your answer to 2 decimal places.

[5 marks]



1 6

1 6 . 2

As a result of tightening the nut, a 10 mm diameter bolt now has a force of 1 kN applied to it.

Determine the stress in the bolt once tightened. Show your answer in engineering units.

[5 marks]

10

Turn over for the next question

Turn over ►



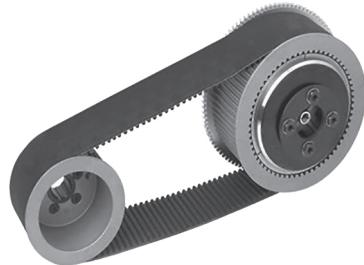
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1	7
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A belt drive is pictured in **Figure 5**.

Figure 5



1	7	.	1
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Describe **two** advantages of using a belt drive as a means of power transfer in engineering systems.

[4 marks]

Advantage 1

Advantage 2



1 8

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1 7 . 2

Describe **two** disadvantages of using a belt drive as a means of power transfer in engineering systems.

[4 marks]

Disadvantage 1 _____

Disadvantage 2 _____

1 7 . 3

Figure 5 shows a belt drive system that maintains the direction of both pulleys, whilst working.

Show a belt drive arrangement that can change the direction of each pulley.

[2 marks]**10****END OF QUESTIONS**

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