OCR
Oxford Cambridge and RSA

SAMPLE ASSESSMENT MATERIAL

Level 3 Cambridge Technical in Engineering

Unit 2: Science for engineering

Date – Morning/Afternoon

Time allowed: 1 hour 30 minutes

You must have:
- the formula booklet for Level 3 Cambridge Technical in Engineering (inserted)
- a ruler (cm/mm)
- a protractor
- a scientific calculator

First Name						Last Name				
Centre Number						Candidate Number				
Date of Birth	D	D	M	M	Y	Y	Y	Y		

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number, candidate number and date of birth.
- Answer **all** the questions.
- Write your answer to each question in the space provided. Additional space may be used if required, but you must be clearly show your candidate number, centre number and the question number(s) .
- The acceleration due to gravity is denoted by g m s^{-2}. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Where appropriate, your answers should be supported with working.
- Marks may be given for a correct method even if the answer is incorrect.
- An answer may receive no marks unless you show sufficient detail of the working to indicate that a correct method is being used.
- Final answers should be given to a degree of accuracy appropriate to the context.
- This document consists of **11** pages.

Answer **all** questions.

1 (a) State what is meant by the term ‘measurement’ in the context of engineering.

…… **[1]**

(b) In an electronics circuit an ammeter is indicating a value of 4.4 amperes when the true value is known to be 4.5 amperes.

Determine the:

(i) relative error

relative error = ……..**[2]**

(ii) relative correction.

relative correction = ……..**[2]**

(c) The sample values 200 kN, 300 kN, 400 kN, and 500 kN are taken from a destruction test on a low carbon steel bar. The mean value (M) of the sample is 350 kN.

(i) Complete the table below.

Sample X	X - M	$(X - M)^2$
200 kN		
300 kN		
400 kN		
500 kN		
		$\Sigma =$

[3]

(ii) Calculate the standard deviation of the sample using the information from the completed table.

Standard deviation = …… **[2]**

Turn over

2 (a) State what is meant by the term 'kinetic energy'.

……

……

……

……**[2]**

(b) A car with mass 1500 kg moving at 90 km h^{-1} is brought to a standstill over a distance of 100 m.

(i) Calculate the average braking force on the car.

Average braking force = …….. N **[6]**

(ii) Explain what has happened to the original kinetic energy.

……

……

……

…….**[2]**

3 (a) Explain what is meant by the term ‘resistivity’.

……

……

……

……**[2]**

(b) Sketch in the space provided in Fig. 1 a graph to show the relationship between the resistance and the length of a conductor.

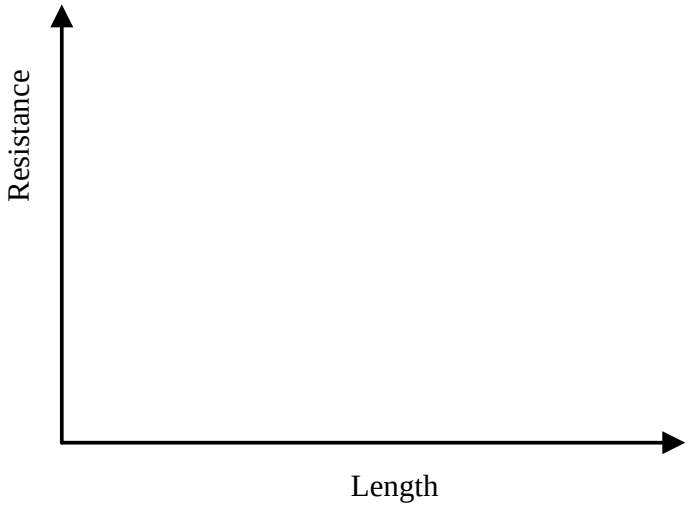


Fig. 1

[1]

(c) A coil is carrying a current of 6 A from a 120 V d.c. supply.

(i) Calculate the resistance of the coil.

Resistance = …….. Ω **[2]**

(ii) The same coil is wound with 500 turns of wire. The mean length of each turn is 200 mm. The resistivity of the coil material is 0.02 μΩ m.

Calculate the cross-sectional area of the wire in mm^2.

Cross sectional area = …….. mm^2 **[5]**

4 (a) Explain the difference between elastic and plastic deformation of a material.

……

……

……

……**[2]**

(b) A tie bar has a cross-sectional area of 200 mm^2 and carries a load of 50 000 N. Under this load its length increases by 2 mm over an initial length of 2 m.

Calculate:

(i) the stress in the bar

stress = ……. $N\ m^{-2}$ **[2]**

(ii) the strain in the bar

strain = ……...……...…. **[2]**

(iii) the modulus of elasticity.

modulus of elasticity = ……. $N\ m^{-2}$ **[2]**

(c) A test on a steel wire gave the following results:

Force/N	25	50	75	100	125	150
Extension/mm	0.20	0.40	0.60	0.65	0.69	0.80

(i) Using the results above, draw a graph of force against extension on the grid in Fig. 2.

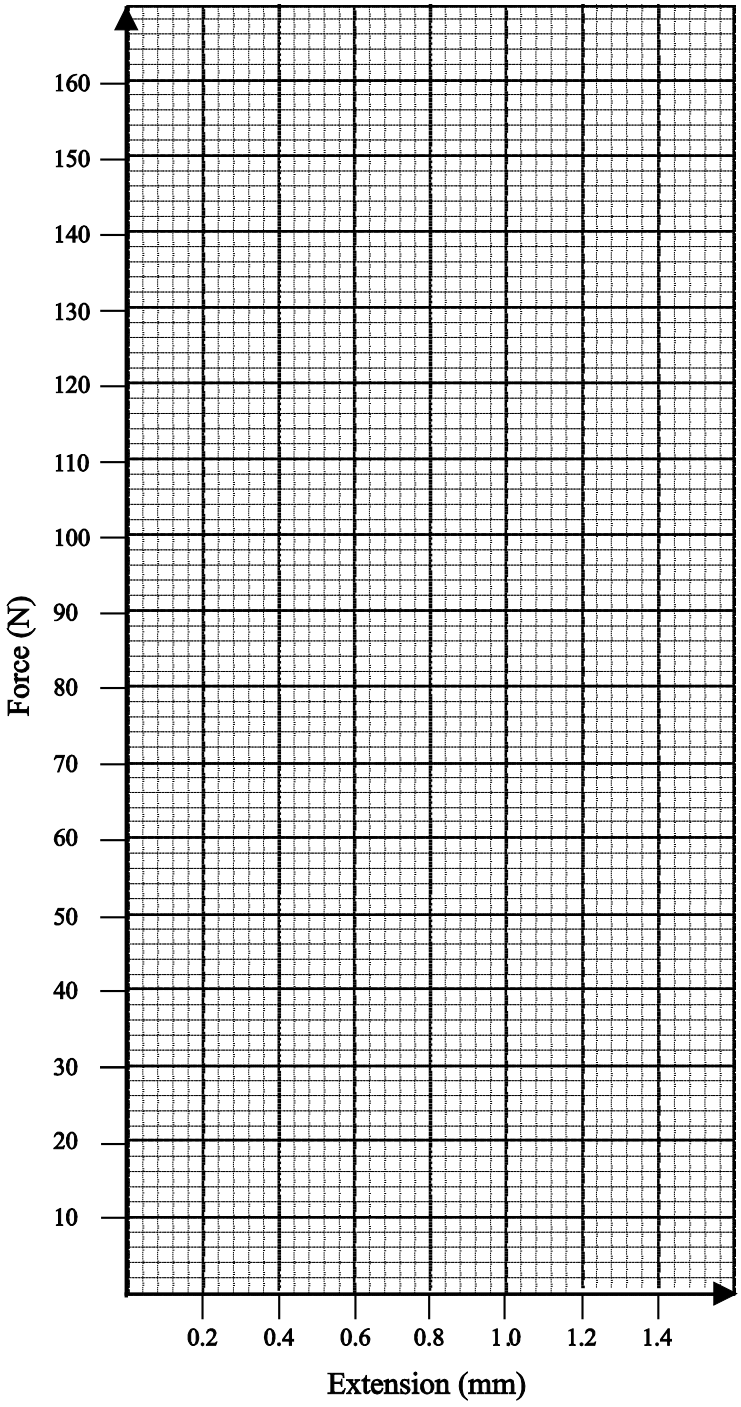


Fig. 2 **[1]**

(ii) From the graph identify the approximate elastic limit point.

…… **[1]**

5 (a) Explain the meaning of the term 'ideal fluid'.

……

……**[1]**

(b) State the difference between gauge pressure and absolute pressure

……

……

……

……..……..……..…**[2]**

(c) Calculate the pressure at the base of a column of liquid of height 400 mm and density 1000 kg m^{-3}.

Pressure = …… **[3]**

(d) During a non-flow thermodynamic process, the internal energy of the system was increased from 25 kJ to 50 kJ while 40 kJ of work was done in the system.

Calculate the magnitude and direction of the heat energy transferred across the system boundary during the process.

Magnitude of energy transferred = ……..…… kJ

Direction ……

[4]

Turn over

6 (a) Explain the meaning of the term 'sensible heat'.

.....

.....**[1]**

(b) Fig.3 represents a temperature–time graph for the heating of a block of ice which has an initial temperature of −10 °C.

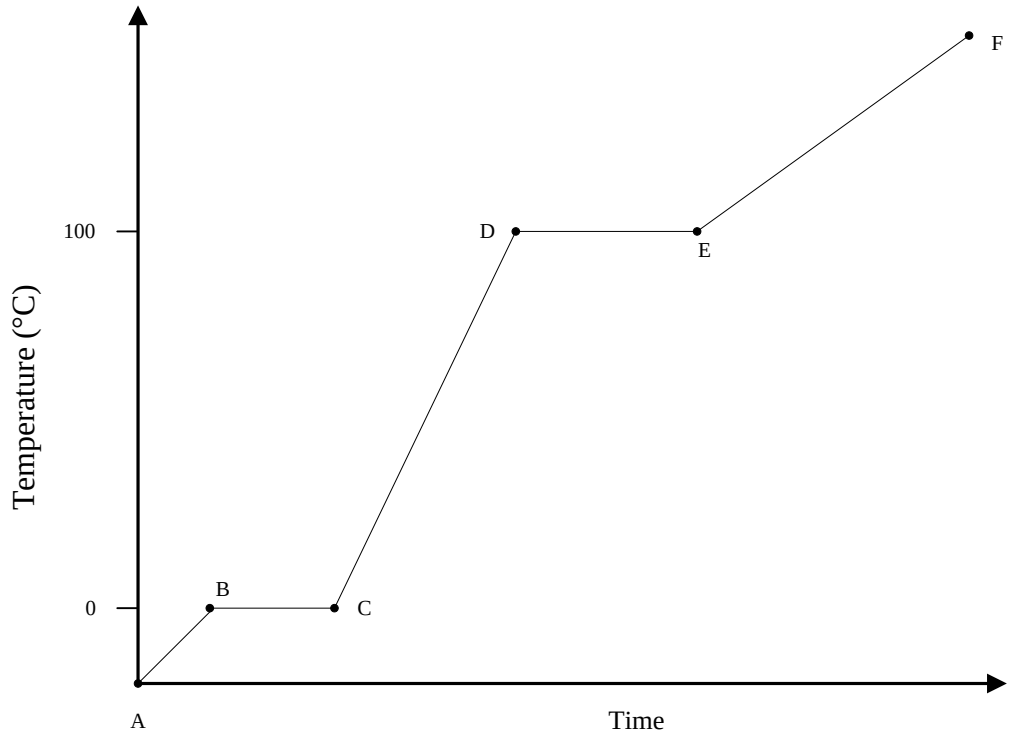


Fig. 3

(i) Complete the table with a ✓ (tick) to indicate which parts of the graph are showing sensible heat and which latent heat.

Graph	Sensible heat	Latent heat
A to B		
B to C		
C to D		
D to E		
E to F		

[2]

(ii) Name the **five** states that the block of ice goes through.

1……

2……

3……

4……

5…….

[5]

(c) The latent heat of fusion of ice is 334 kJ kg^{-1}.

Calculate the amount of heat required to melt 10 kg of ice at its freezing point.

Heat required = ……. **[2]**

END OF QUESTION PAPER

OCR
Oxford Cambridge and RSA

SPECIMEN

Sample Assessment Material

CAMBRIDGE TECHNICALS

Unit 2: Science for engineering

MARK SCHEME

Duration: 1 hour 30 minutes

MAXIMUM MARK 60

SPECIMEN

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1</td><td>(a)</td><td></td><td>A system of measures based on a particular standard</td><td>1</td><td>Accept reasonable answer.</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>Absolute error = indicated value – true value
= 4.4 – 4.5
= – 0.1

Relative error = absolute error/true value
= – 0.1/4.5
= – 0.02</td><td>1

1</td><td></td></tr>
<tr><td></td><td>(b)</td><td>(ii)</td><td>Absolute correction = true value – indicated value
= 4.5 – 4.4
= 0.1

Relative correction = absolute correction/true value
= 0.1/4.5
= 0.02</td><td>1

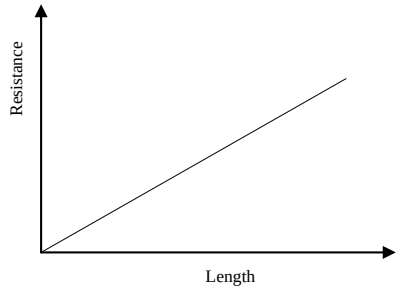
1</td><td></td></tr>
<tr><td></td><td>(c)</td><td>(i)

(ii)</td><td><table><tr><th>Value X</th><th>X - M</th><th>$(X - M)^2$</th></tr><tr><td>200</td><td>200 – 350 = – 150</td><td>22500</td></tr><tr><td>300</td><td>300 – 350 = – 50</td><td>2500</td></tr><tr><td>400</td><td>400 – 350 = 50</td><td>2500</td></tr><tr><td>500</td><td>500 – 350 = 150</td><td>22500</td></tr><tr><td></td><td></td><td>Σ= 50000</td></tr></table>SD = √ (50000/4)
= 111.8</td><td>3

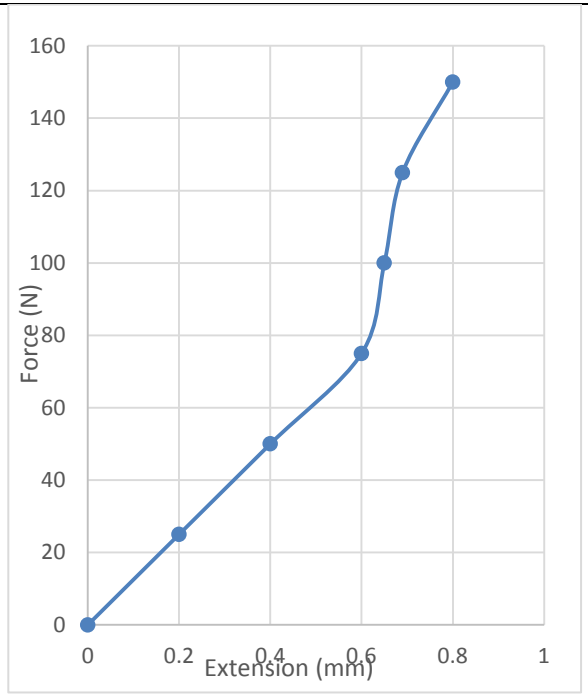
1
1</td><td>Award one mark for each correct column and one mark for Σ = 50000

Accept error carried forward for 50000</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Question			Answer	Marks	Guidance
2	(a)		Kinetic energy is the ability to do work which a body possesses by virtue of its motion	1 1	
	(b)	(i)	Conversion of 90 km h^{-1} = (90 x 1000)/(60 x60) = 25 ms^{-1} Kinetic energy (KE) = ½mv^2 = ½ x 1500 x 25^2 = 468750 J Work done in stopping the car when the force is applied must equal the original kinetic energy. Work done = F d = F x 100 where F is the average braking force on the car so F x 100 = 468750 F = 468750/100 = 4687.5 N	1 1 1 1 1 1	Converting speed to m s^{-1}. Use of kinetic energy equation. Value of KE. Conservation of energy Accept answer correct to 2 sf (4.7 x 10^4 N)
	(b)	(ii)	Most KE is converted in to heat energy; Dissipated through the brake drums of the car.	1 1	

Question			Answer	Marks	Guidance
3	(a)		The resistivity of a material is defined as the resistance of unit length and unit cross-sectional area	 1 1	
	(b)		 	1	Straight line with positive gradient through the origin.
	(c)	(i)	Given V =120 V and I = 6 A Resistance = V/I = 120/6 = 20 Ω	 1 1	Use of correct equation.
	(c)	(ii)	Total length of wire = 500 x 0.2 = 100m $\rho = 0.02\ \mu\Omega\ m = 0.02 \times 10^{-6}\ \Omega m$ R = ρl/A so Area A = ρl/R $A = (0.02 \times 10^{-6} \times 100)/20$ $= 0.0000001\ m^2$ $= 0.1\ mm^2$	1 1 1 1 1	Calculating total length of wire Conversion of resistivity units (POT) Rearrange equation to calculate A Calculation of area and conversion to mm^2.

Question			Answer	Marks	Guidance
4	(a)		Elastic deformation is when a material is stretched and released it will go back to its original form; plastic deformation is when a material is stretched and released it will NOT go back to its original form.	1 1	
	(b)	(i)	Stress = force/cross-sectional area = 50 000/200 x 10^{-6} = 250 x 10^{6} Nm^{-2}	1 1	Correct conversion of mm^2 to m^2.
	(b)	(ii)	Strain = change in length/original length = (2 x 10^{-3})/2 = 1 x 10^{-3} or 0.001	1 1	Do **not** award if unit added.
	(b)	(iii)	Modulus of Elasticity = stress/strain = (250 x 10^{6})/1 x 10^{-3} = 250 x 10^{9} Nm^{-2}	1 1	Allow ecf of values for stress and strain from (i) and (ii)

Question			Answer	Marks	Guidance
4	(c)	(i)		1	Award one mark for a correct graph
	(c)	(ii)	75 N	**1**	Accept answers between 60 and 85 N

Question			Answer	Marks	Guidance
5	(a)		An ideal fluid is one which is assumed to have zero viscosity	1	
	(b)		Gauge pressure is pressure indicated above that due to the atmosphere; Absolute pressure is the sum of the gauge pressure and the atmospheric pressure	1 1	
	(c)		Pressure due to a column of liquid is $p = h\ g\ \rho$ $= 400 \times 10^{-3} \times 9.81 \times 1000$ $= 3.9 \times 10^{3}$ Pa	1 1 1	Use of correct equation. Conversion of height to m. Unit must be stated.
	(d)		Heat energy transferred across the system $Q = (U_2 - U_1) + W$ $= (50 - 25) + 40$ $= +65$ kJ Magnitude is 65kJ Direction: into the system/supplied to the system	1 1 1 1	Use of correct equation Except suitable alternative wording e.g. Direction is + which means heat is supplied to the system

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>(a)</td><td></td><td>Heat which produces a change in temperature is called sensible heat</td><td>1</td><td></td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>
<table>
<tr><th>Graph</th><th>Sensible heat</th><th>Latent heat</th></tr>
<tr><td>A to B</td><td>✓</td><td></td></tr>
<tr><td>B to C</td><td></td><td>✓</td></tr>
<tr><td>C to D</td><td>✓</td><td></td></tr>
<tr><td>D to E</td><td></td><td>✓</td></tr>
<tr><td>E to F</td><td>✓</td><td></td></tr>
</table>
</td><td>2</td><td>Award one mark for each correct column</td></tr>
<tr><td></td><td>(b)</td><td>(ii)</td><td>Sensible heat
Latent heat of fusion
Sensible heat
Latent heat of vaporisation
Sensible heat</td><td>1
1
1
1
1</td><td></td></tr>
<tr><td></td><td>(c)</td><td></td><td>Q = mL
= 10 x 334
= 3340 kJ</td><td>
1
1</td><td>

Final value must include the unit.</td></tr>
</table>

[Paper Total: 60]