OCR
Oxford Cambridge and RSA

Cambridge Technicals

Engineering

Unit **2:** Science for engineering

Level 3 Cambridge Technical Certificate/Diploma in Engineering
05822 - 05825

Mark Scheme for June 2016

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

1. **Annotations**

Annotation	**Meaning**
tick	Correct response worthy of a mark. **Number of ticks = no of marks awarded**
cross	incorrect
omission mark (carat)	Missing something
ecf	Error carried forward
bod	Benefit of doubt
nbod	Not benefit of doubt
pot	Power of ten error
con	contradiction
re	Rounding error
sf	Significant figure error

2. **Subject-specific marking instructions**

In all numerical calculation questions a correct response will gain all marks unless specified otherwise. You do not need to see all the workings if the answer is correct.

<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>
<table>
<tr><th>Quantity</th><th>Unit</th></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td>kilogram</td></tr>
<tr><td>inductance</td><td></td></tr>
<tr><td>temperature</td><td></td></tr>
<tr><td></td><td>second</td></tr>
</table>
</td><td>4</td><td>Award one mark for each correct response.

ACCEPT kg for kilogram (not kgs)
ACCEPT s for second.
No other abbreviations allowed.</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>Absolute Correction = True value – Indicated value / 12 – 11.7

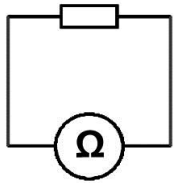
= 0.3 (V)</td><td>1

1</td><td>EOR (evidence that correct rule is being used)

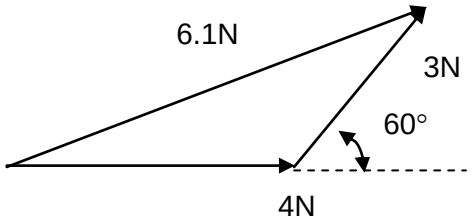
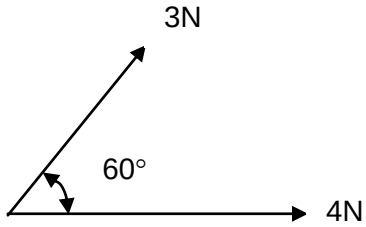
Negative value maximum one mark.
Unit V is not required, but an incorrect unit here would lose the second mark.</td></tr>
<tr><td></td><td>(b)</td><td>(ii)</td><td>Relative Correction = Absolute correction/True Value / 0.3/12

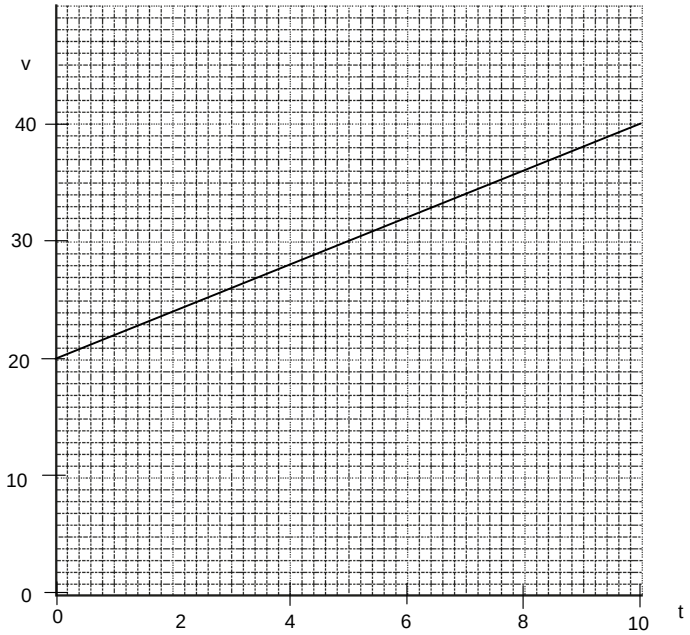
= 0.025 or 2.5%</td><td>1

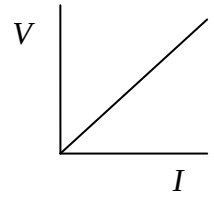
1</td><td>EOR. Allow ecf from incorrect answer in b)i)

Correct answer has no units. If a unit is included one mark maximum.</td></tr>
<tr><td></td><td>(c)</td><td></td><td>  </td><td>2</td><td>Award one mark for the use of a labelled multi-meter or ohm-meter.

Award one mark for the correct positioning of the instrument and nothing else.</td></tr>
<tr><td></td><td></td><td></td><td>Question total</td><td>10</td><td></td></tr>
</table>

Question			Answer	Marks	Guidance
2	(a)	(i)	Examples of scalar quantities are area, volume, time, speed, electric charge, temperature, length, distance, density, pressure, energy, work, power.	1	If there is a list they must all be correct for the mark to be awarded in both cases.
		(ii)	Examples of vector quantities are velocity, displacement, acceleration, force, momentum, lift, drag, thrust and weight.	1	
	(b)	(i)	Force diagram, drawn to scale: 		The space diagram is shown for information. 
			Two forces <u>with arrows</u> drawn at 60° (or labelled) to one another.	1	Accept space diagram as above. Vector triangle can be any orientation – ie rotated/mirror image etc.
			Force lines drawn to scale eg 3cm and 4cm long. Lengths can be ± 2mm.	1	
		(ii)	6.1(N)	1	Award one mark for a magnitude of 6.1 ± 0.5N. Do not accept error carried forward.
		(iii)	25(°)	1	Accept 25 ± 3°. Do not accept error carried forward.

Question			Answer	Marks	Guidance
	(c)	(i)	Sensible scales and labelled axes. Should use at least 4cm in x direction. Straight line (by eye) from (0,20) to (10,40).  	1 1	Do not allow reversed axes. End points should be correct to one small square in both x and y direction. Ignore extensions to the line beyond (0,20) to (10,40).
		(ii)	Acceleration = gradient of graph Acceleration = dv/dt = (40-20)/10 = 2 (m s^{-2})	1 1	Accept use of v = u + at to give a = (v-u)/t for first mark.
			Question total	**10**	

Question			Answer	Marks	Guidance
3	(a)		Opposition to flow / movement of electrons/charge/current.	1 1	NOT resistance. ACCEPT restriction/prevention IGNORE slow down/more difficulty ALLOW resistance = voltage/current for both marks. If V/I used V and I must be defined.
	(b)		Straight line (by eye) with positive gradient. Beginning at the origin.  	1 1	A curve at the end is incorrect so can only score the second marking point.
	(c)		$R = R_1 + R_2$, so $R_2 = R - R_1$ $R_2 = 900 - 680$ $= 220\ \Omega$	1 1 1	No mark for quoting formula – rearrangement required. Must include unit. A raw answer of 220 with no unit or an incorrect unit maximum 2 marks.
	(d)		P = VI, so I = P/V I = 400/230 I = 1.7(4) A	1 1 1	No mark for quoting formula – rearrangement required. Must include unit and at least 2 sf..
			Question total	**10**	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>4</td><td>(a)</td><td></td><td>Force is proportional to the extension/change in length

Provided the material is within its elastic limit</td><td>1

1</td><td>Accept F α Δx in symbols provided it is obvious that it is a <u>change</u> in length.
Accept stress is proportional to strain.

wtte.</td></tr>
<tr><td>4</td><td>(b)</td><td></td><td>Strain energy = Area under the straight line graph / (180 x 80 x 10^{-3})/2
= 7.2 (J)</td><td>1
1</td><td>
Max 1 mark for POT error</td></tr>
<tr><td>4</td><td>(c)</td><td></td><td><table><tr><th>Definition</th><th>Property of material</th></tr><tr><td></td><td>ductility</td></tr><tr><td></td><td>hardness</td></tr><tr><td></td><td>toughness</td></tr></table></td><td>
1
1
1</td><td>Award one mark for each crrect response.</td></tr>
<tr><td>4</td><td>(d)</td><td></td><td>Maximum/greatest/largest (tensile) <u>stress</u> the material can withstand

before rupture/breaking/failure.</td><td>1

1</td><td>NOT maximum force. ACCEPT force per unit area for stress.

‘Stress at failure’ scores both marks.</td></tr>
<tr><td>4</td><td>(e)</td><td></td><td>It is used to test a material without causing damage to the material.</td><td>1</td><td>Accept so it does not break the material.
Accept so the material/component can be reused/re-tested.</td></tr>
<tr><td></td><td></td><td></td><td>Question total</td><td>10</td><td></td></tr>
</table>

Question			Answer	Marks	Guidance
5	(a)		particles move in (very) irregular/haphazard/random paths	1 1	ACCEPT molecules Allow this second marking point to be awarded for labelled diagram.
	(b)		absolute pressure = atmospheric pressure + gauge pressure /100 + 350 = 450 kNm^{-2}	1 1	Award one mark for transposing formula correctly. Must have correct unit. If incorrect or no unit then max one mark.
	(c)		Pressure = force / area / = 120/2.5 = 48 Nm^{-2} or 48 Pa	1 1	One mark for use of correct substitution into formula. Must include unit. If incorrect or no unit then max one mark.
	(d)		Resistance / ability to resist to flow / to shear forces.	1 1	
	(e)	(i)	decreases	1	
	(e)	(ii)	increases	1	
			Question total	**10**	

Question			Answer	Marks	Guidance
6	(a)		Convert temperature to Kelvin 80°C = 273 + 80 = 353 K	1	
			$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ / $T_2 = \frac{T_1 V_2}{V_1}$ / = (353 x 0.1)/0.05	1	Award one mark for rearranging formula correctly.
			= 706 (K)	1	Accept 700 K. Conversion to 433°C is aso acceptable. If used °C (which gives 160°C), maximum one mark awarded.
	(b)		$P_1V_1 = P_2V_2$ rearranged to give $V_2 = (P_1V_1)/P_2$	1	Award one mark for rearranging formula correctly.
			= (250 x 0.004)/500	1	
			= 0.002 m^3	1	Must include correct unit.
	(c)		<u>Heat / energy</u> (absorbed or emitted) during a change of state / does not cause a change in temperature	1	
	(d)		Q = mCΔT		No mark for quoting formula.
			ΔT = 70 – 10 = 60 °C	1	
			Q = 0.5 x 4000 x (70 – 10)	1	Substitution mark. Allow incorrect ΔT ecf.
			= 120000 J or 120 kJ	1	Must include unit.
			Question total	**10**	
			Paper total	**60**	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

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Head office
Telephone: 01223 552552
Facsimile: 01223 552553