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General Certificate of Education (A-level) Applied
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Applied Science SC05

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Unit 5: Choosing and Using Materials

Final

Mark Scheme

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Question	Part & subpart	Marking guidance	AO/Mark	Total Mark	Comment
1	(a)	Brittle: fractures /shatters / snaps / cracks / only deforms elastically / no (or little) plastic deformation Ductile: can be drawn out into wires (or pipes) / undergoes(both elastic and) plastic deformation	(1)(AO1) (1)(AO1)	**2**	
1	(b)	Brittle: straight line through origin Ductile: straight line through origin followed by a curved section – curving towards the horizontal	(1)(AO1) (1)(AO1)	**2**	Brittle: allow a <u>small</u> amount of plastic deformation shown on the graph
1	(c)	any metal example of desirable application e.g. making wires / pipes / crumple zone of cars	(1)(AO1) (1)(AO1)	**2**	do not accept rubber do not accept examples of moulding or malleable behaviour
1	(d)	malleable box circled	(1)(AO1)	**1**	
1	(e)(i)	maximum stress / force material can withstand (before fracture) / breaking stress / force	(1)(AO1)	**1**	
1	(e)(ii)	materials can be chosen / tested to prevent collapse of bridge	(1)(AO2)	**1**	
1	(f)(i)	random arrangement / irregular / no pattern / non-crystalline	(1)(AO1)	**1**	
1	(f)(ii)	regular arrangement / repeating patterns	(1)(AO1)	**1**	

Total: 11 Marks

2	(a)	2·1 (mm)	(1)(AO1)	**1**	
2	(b)(i)	0 to 16(N)	(1)(AO1)	**1**	

2	(b)(ii)	extension goes up in even steps / constantly / uniformly or extension is (directly) proportional to force or at value >16 extension is not proportional to weight / extension at 20 should be 3·5 / weight at 4·6 should be 26·3	(1)(AO1)	**1**	allow load / mass / weight / tension as alternative for force
2	(c)(i)	returns to original length /shape / state or extension is zero	(1)(AO1)	**1**	not length is zero
2	(c)(ii)	does not (fully) return to original length / shape / state or length stays the same / nothing happens to length	(1)(AO1)	**1**	
2	(d)	1·2 (mm) or 8 (N) or (c)(i) not past elastic limit / undergoing elastic deformation 4·6 (mm) or 20 (N) or (c)(ii) has passed elastic limit / undergoing plastic deformation	(1)(AO2) (1)(AO2)	**2**	Not reached elastic limit

Total: 7 Marks

3	(a)	a mixture of elements containing at least one metal	(1)(AO1)	**1**	accept a mixture of metals not a combination
3	(b)	alloy is stronger / harder / more resistant to corrosion	(1)(AO1)	**1**	Not cheaper
3	(c)	heat to high temperature / below mp / heat strongly cool slowly / allow to cool / cool in air / controlled cooling	(1)(AO1) (1)(AO1)	**2**	not heat 'quickly' or just 'heat'
3	(d)	can be formed more easily into different shapes / easier to work / less energy is required	(1)(AO1)	**1**	
3	(e)	prevents corrosion / rusting / reaction / contamination of drink or improved chemical resistance	(1)(AO2)	**1**	
3	(f)(i)	reduce thickness of metal sheets	(1)(AO2)	**1**	accept needs less metal / alloy

3	(f)(ii)	reduce temperature / recycle heat / heat exchangers	(1)(AO2)	**1**	

Total: 8 Marks

4	(a)(i)	insulator <u>of electricity</u> (1) then any one from : stiff / strong / tough / low density (light)	(1)(AO1) (1)(AO1)	**2**	accept 'heat resistant' allow corrosion resistant

4	(a)(ii)	ceramic	(1)(AO1)	**1**	allow polymer / glass

4	(b)(i)	in any order : (electrical) resistance, length, cross – sectional area	(1)(AO1) (1)(AO1) (1)(AO1)	**3**	accept 'conductance' instead of resistance

4	(b)(ii)	for each part accept either one reason (1) with associated explanation (1) or two reasons (2) <u>not made entirely from aluminium</u> : • low tensile strength therefore cable might break • high cost therefore expensive <u>not made entirely from steel</u> : • high density therefore cable very heavy / might sag too much / might snap • conductivity low therefore not as good a conductor	 (1)(AO2) (1)(AO2) (1)(AO2) (1)(AO2)	**4**	

4	(c)	**Must be present** • connect wire to (variable) power supply (1) • measure <u>current</u> through wire (not measure 'amps') (1) • measure <u>voltage</u> across wire (not measure 'volts') (1) **Then 5 from the following** • (current) measured with an ammeter (accept multimeter) • (voltage) measured with a voltmeter (accept multimeter) • repeat using different values of current / voltage • calculate the conductance in each case • take an average value of the conductance (In place of last 2 bullet points : • plot a graph of current against voltage • calculate gradient of graph)	(8) × (AO3)	**8**	allow a <u>correct</u> circuit diagram to give the marks for : power supply ammeter voltmeter

Total: 18 Marks

5	(a)(i)	sample B	(1)(AO1)	**1**	

5	(a)(ii)	smallest range of data / range is 0.02 / results cluster about the mean	(1)(AO2)	**1**	If (a)(i) is incorrect then a correct statement about the sample chosen scores 1 mark

5	(b)(i)	means in order are 0·44, 0·42	(1)(AO1)	**1**	Both must be correct to 2 d.p.

5	(b)(ii)	samples A and D (in any order)	(1)(AO1)	**1**	allow ecf from (b)(i)

5	(c)	expansion = coefficient × length × temperature change = $1{\cdot}2 \times 10^{-5} \times 50 \times 10$ = 0·006 m (6×10^{-3}) length = 50·006 m (5000·6 cm)	(1)(AO2) (1)(AO2) (1)(AO2) (1)(AO1)	**4**	3 marks for correct answer 1 compensation mark for correct rearrangement / substitution 1 compensation mark for expansion = 0·006 1 mark for unit

5	(d)	mass - does not change volume - increases density - decreases	(1)(AO1) (1)(AO2)	**2**	all 3 correct = 2 marks 2 correct = 1 mark 1 correct = zero
5	(e)	density = mass ÷ volume = 3400 ÷ 0·42 = 8095·24 kg m^{-3}	(1)(AO2) (1)(AO2) (1)(AO1)	**3**	2 marks for correct answer Accept 8095 / 8095.2 1 compensation mark for correct formula / substitution 1 mark for unit (accept kg / m^3)
5	(f)	thermal expansion of concrete and steel might not match causes concrete to break up / crumble / be damaged	(1)(AO2) (1)(AO2)	**2**	

Total: 15 Marks

6	(a)	inflexible / does not extend easily / resistance to bending / rigidity /a stiff material has a high Young modulus	(1)(AO1)	**1**	
6	(b)(i)	stress = force ÷ cross-sectional area	(1)(AO1)	**1**	
6	(b)(ii)	strain = extension ÷ original length	(1)(AO1)	**1**	
6	(b)(iii)	it is a ratio of two lengths / idea that units cancel out	(1)(AO1)	**1**	not just 'it is a ratio'
6	(c)(i)	axes labelled correctly (name and unit) points plotted correctly (± 1 small square) – allow 1 error best fit straight line through origin	(1)(AO2) (1)(AO2) (1)(AO2)	**3**	
6	(c)(ii)	As read from candidate's graph (± 0.2) (should be 10×10^{-5})	(1)(AO1)	**1**	

6	(c)(iii)	Young modulus = stress ÷ strain = 14 ÷ 10×10^{-5} = $1{\cdot}4 \times 10^{5}$ M Nm^{-2} ecf from (c)(ii)	(1)(AO2) (1)(AO2) (1)(AO1)	**3**	2 marks for correct answer 1 compensation mark for correct formula / substitution 1 mark for unit (accept M Pa or M N/m^2)

6	(c)(iv)	a less steep <u>straight</u> line drawn through origin	(1)(AO1) (1)(AO1)	**2**	

6	(d)	any 2 from ductility, <u>tensile</u> strength, elasticity, density	(1)(AO1) (1)(AO1)	**2**	

Total: 15 Marks

7		non composite material scores zero composite named (1) matrix and fibre named (1) drawbacks of both (1) useful properties of both (1) advantage of composite (1) correct use for the named composite (1) <u>Example</u> glass reinforced plastic (GRP) (1) glass fibres in a resin matrix (1) resin is tough but is weak in tension (1) glass is not tough but is strong in tension (1) GRP combines the useful properties of glass and resin (1) used in making canoes (1)	 (1)(AO1) (1)(AO1) (1)(AO1) (1)(AO1) (1)(AO1) (1)(AO1)	**6**	not alloy

Total: 6 Marks