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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	Marking guidance		Mark	Comment
1	(a)(i)	strength	(AO1)	**1**	
1	(a)(ii)	stiffness	(AO1)	**1**	
1	(a)(iii)	brittleness	(AO1)	**1**	
1	(b)	undergoes plastic deformation / deforms permanently / will not return to original length (or shape) when force removed	(AO1)	**1**	
1	(c)(i)	mass per unit volume / mass ÷ volume	(AO1)	**1**	
1	(c)(ii)	2 from: balance displacement can measuring cylinder	(AO1) (AO1)	**2**	NOT: 'scales' alone - must be qualified accept eureka can
1	(c)(iii)	mass = density × volume volume = mass ÷ density mass of aluminium = 2.75 × 80 = 220g mass of lead is also 220g volume of lead = 220 ÷ 11 = 20(cm^3)	(AO2) (AO2) (AO2)	**3**	3 marks for correct answer (allow answer obtained by ratio) 2 compensation marks for: • M = D × V / V = M ÷ D / correct substitution of either • mass = 220g
2	(a)	• nylon • glass reinforced plastic(GRP) • tile	(AO1) (AO1)	**2**	2 marks if all three answers are correct 1 mark if 1 or 2 answers are correct
2	(b)(i)	a long chain molecule / a long chain of monomers / a long chain of repeating units	(AO1)	**1**	do not accept 'a long chain <u>of</u> molecules'
2	(b)(ii)	made of more than one material	(AO1)	**1**	

2	(c)	alloy	(AO1)	**1**	
2	(d)(i)	can be hammered (or pressed) into shape	(AO1)	**1**	do not accept 'can be shaped'
2	(d)(ii)	• in iron the layers / atoms can slide past each other • the different sized atoms / irregular structure (of steel) • prevents the layers / atoms sliding past each other (as easily)	(AO1) (AO1) (AO1)	**3**	The second marking point can be obtained from a diagram
2	(e)	stainless steel does not corrode (or rust) / ordinary steel corrodes (rusts) / stainless steel is resistant to chemicals / stainless steel does not react with water	(AO1)	**1**	ignore aesthetic qualities
3	(a)	• elastic deformation • (to push refill back into pen) the spring must return to its original length	(AO2) (AO2)	**2**	
3	(b)(i)	• correct label and units added to each axis (1) • all points plotted correctly (to within ± ½ a small square) (1) • straight line of best fit through points and origin (1)	(AO2) (AO2) (AO2)	**3**	
3	(b)(ii)	3.2(N)	(AO1)	**1**	allow 3.1 to 3.3(N)
3	(b)(iii)	new force = ½ of original force / 1·6N (allow ecf)	(AO2)	**1**	
4	(a)(i)	man made / not natural	(AO1)	**1**	
4	(a)(ii)	any 2 from: • lightweight • waterproof / doesn't absorb so much water • more flexible / soft / stretchy • leather changes shape	(AO2) (AO2)	**2**	ignore ethical comments

4	(b)	metal or polymer or composite (no mark) metal: 2 from: • strong / doesn't break • durable / tough / long lasting / hard wearing • hard polymer: 2 from: • lightweight • durable / long lasting / hard wearing • strong composite: • 2 from a combination of above	(AO2) (AO2)	**2**	no marks for reasons if haven't stated a material or have stated ceramic / wood 2 correct materials each with 1 reason = 2 marks
4	(c)	any 3 from: • low density / lightweight • strong / doesn't break • durable / long lasting / hard wearing • hard • does not corrode • rigid / stiff / not flexible	(AO2) (AO2) (AO2)	**3**	
5	(a)	can be drawn out into wires (or pipes) / shows (both elastic and) plastic behaviour (or deformation)	(AO1)	**1**	
5	(b)	• electrons are delocalised / free in structure / sea of electrons • these electrons can move in an organised way (or WTTE) / electrons carry the charge through the material	(AO1) (AO1)	**2**	
5	(c)(i)	the higher the copper content, the higher the thermal conductivity / as one increases so does the other	(AO1)	**1**	accept converse accept positive correlation NOT: proportional

5	(c)(ii)	equation or description i.e. heat conducted per second ÷ (cross-sectional area × temperature gradient) or rate of flow of heat per unit area per unit temperature gradient	(AO1)	**1**	

5	(c)(iii)	• zinc is the harder metal • the higher the zinc content the harder the brass	(AO2) (AO2)	**2**	

5	(d)	In any order: • annealing (1). Heat to high temperature and cool slowly / cool in air / allow to cool / controlled cooling (1) • quenching (1). Heat to high temperature and cool quickly / cool in water / cool in oil (1)	(AO1) (AO1) (AO1) (AO1)	**4**	

5	(e)(i)	increase in temperature of 80°C causes 25cm to expand 0.025mm increase in temperature of 80°C causes 1cm to expand 0.001mm increase in temperature of 1°C causes 1cm to expand 0.001 ÷ 80mm =0.0000125(mm) or 1.25×10^{-5}	(AO2) (AO2)	**2**	2 marks for correct answer 1 compensation mark for correct answer to intermediary stage

5	(e)(ii)	coefficient of linear expansion / linear expansivity	(AO1)	**1**	

5	(e)(iii)	• any correct example e.g. metal bridges (1) • description e.g. bridge on rollers + expansion gap (2)	(AO1) (AO1) (AO1)	**3**	for description allow either 2 precautions or 1 precaution plus explanation

6	(a)	a plastic made from plant products	(AO1)	**1**	

6	(b)	• decomposes / decays / rots • monomer turned into polymer	(AO1) (AO1)	**2**	

6	(c)	less of the traditional plastics are needed / less crude oil is used to make traditional plastics	(AO1)	**1**	
6	(d)	lactic acid	(AO1)	**1**	
6	(e)(i)	covalent (bonding)	(AO1)	**1**	NOT convalent
6	(e)(ii)	electrons are shared	(AO1)	**1**	if 'ionic' is given in (d)(i) allow 'electrons are transferred' / 'force of attraction between ions'
6	(f)	any one of: • both are long chain molecules • both contain carbon • both contain hydrogen	(AO1)	**1**	
6	(g)	any one of: • PLA contains oxygen, (poly(ethene) doesn't) • PLA contains double (covalent) bonds, (poly(ethene) contains only single (covalent) bonds) • PLA contains a CH_3 group	(AO1)	**1**	accept 'it' for PLA
7	(a)(i)	strain = extension ÷ original length	(AO1)	**1**	
7	(a)(ii)	stress = force ÷ cross-sectional area	(AO1)	**1**	
7	(b)(i)	any 2 of: • micrometer screw gauge • vernier callipers • digital vernier • travelling microscope • metre rule • balance	(AO1) (AO1)	**2**	

7	(b)(ii)	• diameter of wire • mass / load / force • extension of wire • <u>original</u> length of wire all 4 scores 2 marks 2 or 3 scores 1 mark	(AO3) (AO3)	**2**	

7	(b)(iii)	any 4 from: • diameter using a micrometer • in several places and calculate average value • weight on a balance • several weights used • extension using vernier scale or travelling microscope • original length using metre rule • repeat readings on <u>unloading</u>	(AO3) (AO3) (AO3) (AO3)	**4**	

7	(b)(iv)	any 4 from: • force / load is given by *mg* • diameter gives area using $\pi d^2 \div 4$ (or diameter gives radius which gives area using πr^2) • for each value of force / load, calculate stress and strain • plot a graph of stress against strain (or force against extension) • gradient of graph = Young modulus (or YM = {gradient × length}÷ area)	(AO3) (AO3) (AO3) (AO3)	**4**	

7	(b)(v)	hazard / risk identified and appropriate precaution given e.g. snapping wires and safety glasses e.g. falling weights and toe protection / sand bucket / stand back	(AO1)	**1**	

7	(c)	stress = 35 ÷ $1{\cdot}64 \times 10^{-7}$ = $2{\cdot}13 \times 10^{8}$ strain = $1{\cdot}25 \times 10^{-3}$ ÷ 1·84 = $6{\cdot}79 \times 10^{-4}$ YM = stress ÷ strain = $2{\cdot}13 \times 10^{8}$ ÷ $6{\cdot}79 \times 10^{-4}$ = $3{\cdot}14 \times 10^{11}$ Nm^{-2} (Pa) 3 marks for correct answer 1 mark for units	(AO2) (AO2) (AO2) (AO1)	**4**	2 compensation marks as follows: • 1 mark for correct formula for Young modulus • plus 1 mark for correct value for either stress or strain • or 1 mark for correct substitution for either stress or strain accept N/m^2 for units