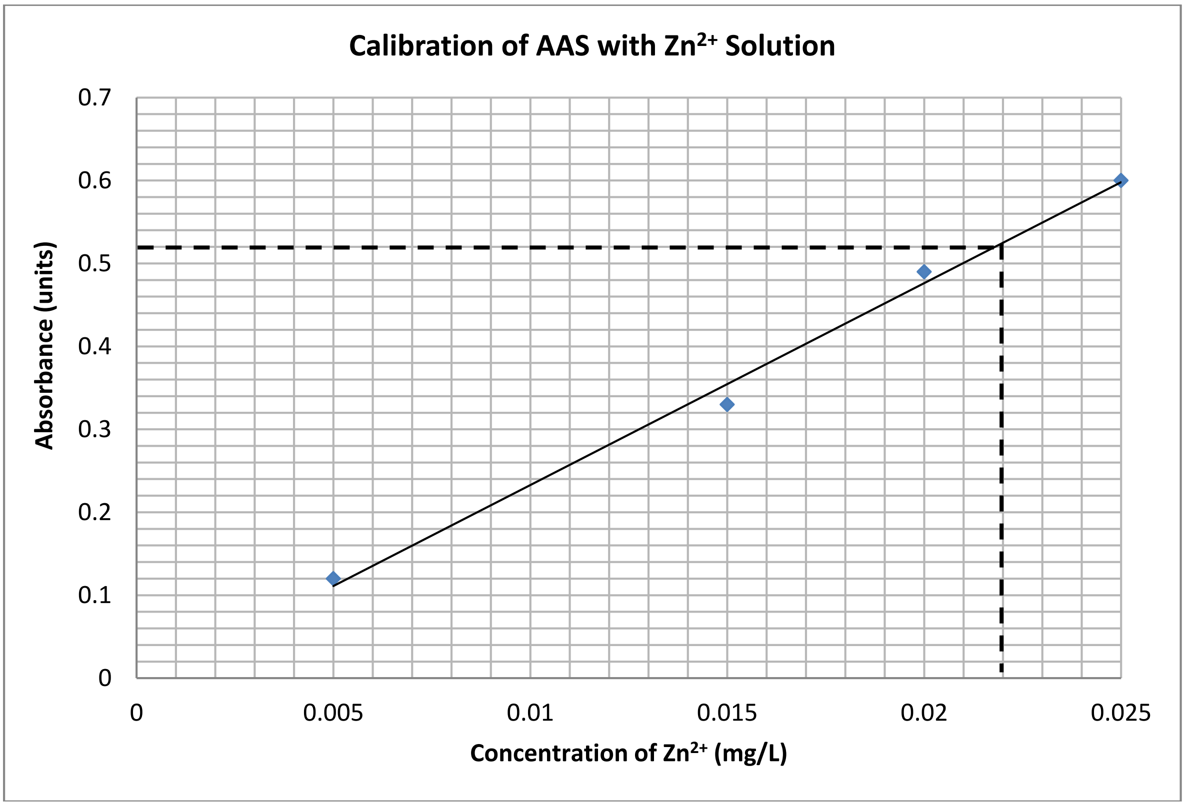
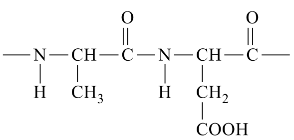
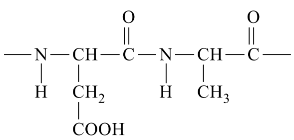
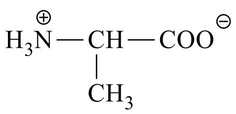
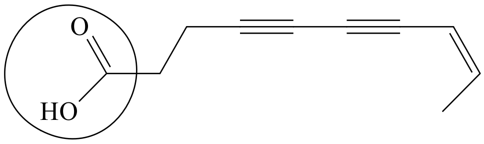
Suggested Stage 2 Chemistry 2013 SACE Board of SA Exam Solutions

Question 1	Possible Solution	Marks	Comments
(a) (i)	Electrolytic	1	
(ii)	From left to right in external circuit	1	
(iii)	Left electrode	1	
(b) (i)	d block	1	**Note:** Must be lower case letter
(ii) (1)	$Cr_2O_7^{2-}$ = +6 Cr = 0	2	
(2)	Reduction	1	
(iii)	$Cr_2O_3 + 6HCl \rightarrow 2\,CrCl_3 + 3H_2O$ ***or*** $Cr_2O_3 + 6H^+ \rightarrow 2Cr^{3+} + 3H_2O$	2	**Note:** 1 mark for correct species 1 mark for balancing
(c) (i)	**[Any three points]** • Al^{3+} highly charged cation • Attracts negatively charged silicate(clay) particles • Flocculation occurs where clay particles come close together • Gravity pulls flocculated particles to bottom	3	**Note:** Must have three distinct points
(ii) (1)	**[Any two points]** • Zeolite has negative surface charge, will attract cations • Large surface area for exchange of ions • Porous allows large volumes of water through in quick time • Solid structure will not dissolve / break-up in water	2	**Note:** Must have two distinct points
(2)	50 ppb ≡ 50 nanograms (ng) Therefore in 250 mL $= \frac{50\times250}{10^9}$g = 1.25^{-5} g = 0.0125 mg ***or*** 50 ppb ≡ 50 μg per litre = 0.05 mg per litre = 0.0125 mg in 250 mLs	2	**Note:** Units not needed as given in the question
	Total	**16**	

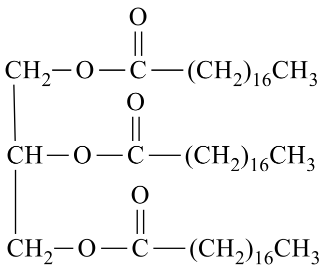
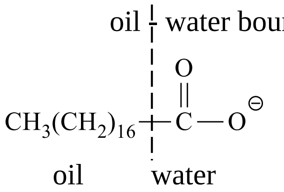
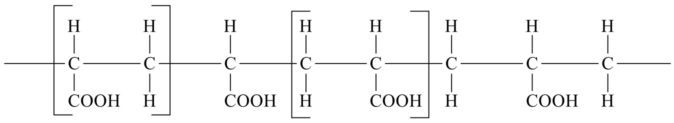
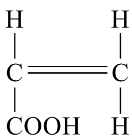
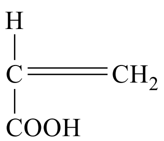
Question 2	Possible Solution	Marks	Comments
(a) (i)	Crushing	1	
(ii)	**Evidence for metallic nature of zinc:** • Zn^{2+} ion in hemimorphite • Reaction of zinc oxide with sulfuric acid **Evidence for non-metallic nature of zinc:** • Formation of zincate ion.	2	**Note:** Must have two distinct points one from metallic / other from nonmetallic
(iii)	Reducing agent ***or*** reductant	1	
(b)	$Na_2ZnO_2 + H_2O \leftrightharpoons ZnO + 2NaOH$ ***or*** $ZnO_2^{2-} + H_2O \leftrightharpoons ZnO + 2OH^-$	2	**Note:** 1 mark for correct species 1 mark for balancing
(c) (i)	**See graph below**	2	**Note:** • regular and suitable scales on both axes • correct plotting of points • line of best fit
(ii)	Scatter of the points above and below the trend line.	1	
(iii)	See dashed line on graph 0.022 mg L^{-1}	2	**Note:** • Working must be shown for full marks as per instructions • Must include units
	Total	**14**	



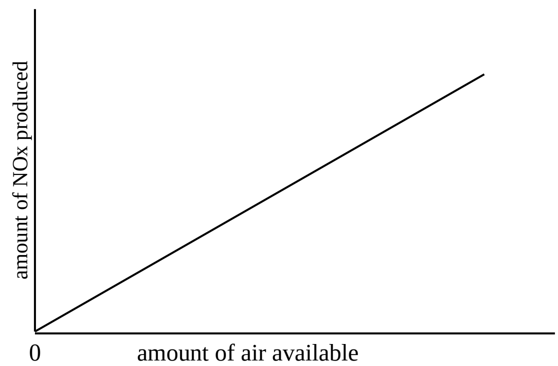
Question 3	Possible Solution	Marks	Comments
(a) (i)	disaccharide	1	
(ii)	hydrolysis	1	
(iii)	$C_6H_{12}O_6$	1	
(b) (i)	**[Any three points]** • secondary interactions in the protein are affected • three-dimensional arrangement of protein is changed • shape change affects the enzyme property • shape change affects the active site of enzyme	3	**Note:** • Must have three distinct points • Must make link between shape *and* function for full marks
(ii)	**[Any one points]** • change does not affect the three dimensional arrangement • new amino acid has similar side chain so secondary interactions unaffected • change does not affect shape • change does not alter the active site	1	**Note:** Must have one distinct point
(c) (i)	peptide ***or*** amide	1	
(ii)	 ***or*** 	2	**Note:** *Must* be open ended (ie a section of the lactase chain)
(iii)	pentane-1,5-diamine ***or*** 1,5-pentanediamine	2	
(iv)		2	
	Total	**14**	

Question 4	Possible Solution	Marks	Comments
(a)		1	
(b)	[**Any one point]** • Formation of bubbles • Dissolves/forms one layer	1	**Note:** Must be an observation
(c) (i)	Higher proportion of particles have enough energy to exceed the activation energy required for the reaction (i.e. E_k > E)$_a$ Therefore higher proportion of collisions successful	2	**Note:** Must have two distinct points
(ii)	Same quantities of oleic acid and DHMA Add Br_2 solution in small amounts Observe when loss of colour does not occur One that decolourises more Br_2 solution is DHMA ***or*** Bromine solution reacts with C=C and C≡C bonds Decolourises / turns from brown to colourless DHMA has more unsaturated bonds DHMA is the liquid that requires larger molar amounts of bromine solution	4	**Note:** Must have four distinct sequential points
(iii)	• Chromatography separates substances according to polarity • DHMA has a smaller non polar hydrocarbon chain than oleic acid • DHMA is more polar than oleic acid • DHMA will be more dissolved in the polar mobile phase/less attracted to the non-polar stationary phase • DHMA will have a shorter retention time • Therefore DHMA is peak A ***or*** • Chromatography separates substances according to polarity • Oleic acid has a larger non polar hydrocarbon chain than DHMA • Oleic acid is less polar than DHMA • Oleic acid adsorb more strongly than DHMA to the non-polar stationary phase • Oleic will have a longer retention time • Therefore DHMA is peak A	8	**Note:** 1. Be careful to answer the question *ie two parts need to be addressed*: (1) how chromatography achieves separation (2) which peak is DHMA 2. Plan your answer on scrap paper before writing. 3. Six marks are allocated for chemical content. 4. Two marks are allocated for communication skills including grammar, spelling and writing in sentences.
	Total	**16**	

Question 5	Possible Solution	Marks	Comments
(a)	$K_c = \frac{[C_2H_5OH]}{[C_2H_4][H_2O]}$	1	**Note:** Must have square brackets.
(b) (i) (1)	$K_c = \frac{\frac{0.05}{2.00}}{\frac{1.0}{2.00}\times\frac{1.2}{2.00}} = \frac{0.025}{0.50\times0.60} = 0.083$	2	**Note:** Should show full working in calculations
(2)	[**Any one point]** • K_c very small therefore not much ethanol produced at equilibrium • K_c <<1 therefore more reactants than products therefore not much ethanol	1	**Note:** Must refer to ethanol in the answer.
(ii)	Moles — C_2H_4 — H_2O — C_2H_5OH Equil^{m} — 1.0 — 1.2 — 0.05 Change — -0.05 — - 0.05 — +0.05 Initial — 1.05 — 1.25 — 0	3	**Note:** Should show full working in calculations
(c)	[Decrease Temperature] • Decrease in temperature stresses the equilibrium • Le Châtelier's Principle states equilibrium will oppose the stress • forward exothermic reaction favoured • therefore equilibrium moves to right ***or*** [Increase Pressure] • Increase in pressure stresses the equilibrium • Le Châtelier's Principle states equilibrium will oppose the stress • less moles of gas (1) on RHS compared to LHS (2) • therefore equilibrium moves to right	4	**Note:** • Must have four distinct points for full marks. • Answer must refer to *one* change only.
(d)	[**Any two points]** • Increase Pressure • Lower Temperature • Removal of ethanol • Addition of water (H_2O) / ethene (C_2H_4)	2	**Note:** • Must have two distinct points for full marks • Must not use answer from (c)
(e)	Increases reaction rate	1	
(f)	[**Any one point]** • Maintain 350 °C operating temperature • Preheat materials • Generate electricity • Generate steam	1	
	Total	**15**	

Question 6	Possible Solution	Marks	Comments
(a) (i)	Propane-1, 2, 3-triol ***or*** propan-1, 2, 3-triol	2	
(ii)		2	**Note:** • Take care when drawing or copying structures. • Be careful with the positioning of the bonds
(iii) (1)		2	
(2)	Anions give the oil droplets an overall negative charge Micelles have overall negative charge Micelles repel each other therefore stay suspended	2	**Note:** Must mention charge and repulsion for full marks
(b) (i)	$CH_3(CH_2)_{11}OCH_2CH_2OH$	1	
(ii)	Carboxylate ion has greater attraction to H^+ than OH group of the non-ionic surfactant therefore effectiveness of the carboxylate anion more affected than non-ionic surfactant	3	**Note:** Must have three distinct points for full marks
(c) (i)	 ***or***	1	
(ii)	 ***or*** 	2	**Note:** • Take care when drawing or copying structures. • Be careful with the positioning of the bonds
	Total	**15**	

Question 7	Possible Solution	Marks	Comments
(a)	$C_{10}H_{18}O$	2	
(b)	$C_{10}H_{18}O_{(l)} + 14O_{2(g)} \rightarrow 10CO_{2(g)} + 9H_2O_{(l)}$ $\Delta H = -6121\ kJ\ mol^{-1}$	4	**Note:** 1 mark for correct species 1 mark for balancing 1 mark for states 1 mark for ΔH
Significant Figure mark		1	**Note:** Significant figures mark *only* applies to parts (i) and (ii)
(c) (i)	$m_{H_2O} = 100.0$ g $\Delta T = 42.5\ ^oC$ Energy change (or q) = m_{H_2O} x C x ΔT = 100.0 x 4.18 x 42.5 = 17765 J = 17.8 kJ	3	**Note:** • Must have **three** significant figures • Must have units for full marks • Should show full working in calculations
(ii)	Mass of cineole = 124.8 - 123.6 = 1.2 g $n_{cineole} = \frac{m_{cineole}}{M_{cineole}} = \frac{1.2}{154.244}$ = 0.007779881 = 7.8×10^{-3}	2	**Note:** • Must have **two** significant figures • *No units* required • Should show full working in calculations
(iii)	$\Delta H_c = \frac{q}{n_{cineole}}$ $= \frac{18800}{7.77957 \times 10^{-3}}$ = 2416607.8 J mol^{-1} = 2400 kJ mol^{-1}	3	**Note:** • Should show full working in calculations • Must have units for full marks
	Total	**15**	

Question 8	Possible Solution	Marks	Comments
(a) (i)	Primary	1	
(ii)	CO is due to incomplete combustion (i.e. lack of O_2) As more O_2 is available combustion is more complete	2	**Note:** Must have two distinct points for full marks
(iii)	[**Any one point]** • soot (carbon) • methane (CH_4)	1	
(b) (i)	[**Any two points]** • High temperature needed • High temperature breaks N≡N bond • nitrogen reacts with oxygen → NO • NO reacts with more $O_2 \rightarrow NO_2$	3	**Note:** • Must have three distinct points for full marks • Equations may be included
(ii)		1	
(iii)	[**Any two points]** • bright / intense sunlight • no wind / still air • thermal inversion (to trap pollutants)	2	**Note:** Must have two distinct points for full marks
(c)	[**Any two points Activity / Effect]** Activities: Effect on Atmosphere • burning fossil fuels → CO_2 increases in atmosphere • deforestation → decreases removal of CO_2 by P/S • increased number of cattle → CH_4 increases in in atmosphere Conclusion: • global warming increases • climate change increases • enhanced greenhouse effect increases	5	**Note:** Must have two activities and two points on the effect on greenhouse gase(s) for full marks
	Total	**15**	

Question 9	Possible Solution	Marks	Comments
(a)	hexanal	2	
(b) (i)	1 : 1	1	
(ii)	n_{KOH} = C x V = 0.1 x 0.25 = 0.025 mol m_{KOH} = n x M = 0.025 x (39.10 + 16.00 + 1.008) = 0.025 x 56.108 = 1.4027 g = 1.4 g	3	**Note:** • Should show full working in calculations. • Units must be shown as not specified in question.
(iii)	Propan-2-ol has a nonpolar carbon chain which will mix with the essentially non-polar oleic acid Water is highly polar and will not mix with essentially non-polar oleic acid	2	**Note:** Must have two distinct points for full marks
(iv) (1)	$n_{KOH} = c \times V$ $= 0.108 \times 6.45 \times 10^{-3}$ $= 6.966 \times 10^{-4}$ $n_{\text{oleic acid}} = 6.966 \times 10^{-4}$ $m_{\text{oleic acid}} = 6.966 \times 10^{-4} \times 282.46$ = 0.1967616 g = 0.197 g	3	**Note:** • Should show full working in calculations. • Units must be shown in final answer as not specified in question.
(2)	% oleic acid (w/w) = $\frac{Mass\ of\ Oleic\ acid}{Mass\ of\ Olive\ oil}$ x 100 = $\frac{0.1967616}{9.543}$ x 100 = 2.062%	2	**Note:** Should show full working in calculations
(3)	ordinary virgin (olive oil)	1	
(4)	$C_{20}H_{12}O_4^{2-}$	1	
	Total	**15**	

<table>
<tr><th>Question 10</th><th>Possible Solution</th><th>Marks</th><th>Comments</th></tr>
<tr><td>(a) (i)</td><td>$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^9$</td><td>2</td><td>Note:
correct convention:
(s, p, d etc and superscripts)</td></tr>
<tr><td>(ii)</td><td>$2Cu^{2+} + 2e^- + H_2O \rightarrow Cu_2O + 2H^+$
or
$2Cu^{2+} + 2OH^- + 2e^- \rightarrow Cu_2O + H_2O$</td><td>2</td><td>Note:
1 mark for correct species
1 mark for balancing</td></tr>
<tr><td>(b) (i)</td><td>[Any one point]
mercury or Hg
silver or Ag</td><td>1</td><td>Note:
Use metal activity series given.</td></tr>
<tr><td>(ii)</td><td>Heat of the flame raises electrons to higher energy level
When excited electrons drop back to original energy level light is emitted
Wavelengths for copper appears blue-green
Other metals emit different wavelengths unique for each element</td><td>4</td><td>Note:
Must have four distinct points for full marks</td></tr>
<tr><td>(iii) (1)</td><td>m_{Cu} = 4.921 – 4.625 = 0.296 g
n_{Cu} = m/M = 0.296 / 63.55 = 4.65774 x 10^{-3}
= 4.66 x 10^{-3}</td><td>2</td><td>Note:
Should show full working in calculations.</td></tr>
<tr><td>(2)</td><td>m_{oxygen} = 4.996 – 4.921 = 0.075
$n_{oxygen} = \frac{m}{M} = \frac{0.075}{16.00} = 4.6875 \times 10^{-3}$
Mole ratio Cu:O = 4.66 x 10^{-3} : 4.6875 x 10^{-3}
= 1:1</td><td>3</td><td>Note:
Should show full working in calculations.</td></tr>
<tr><td>(iv)</td><td>[Any one error + corresponding explanation]
<table><tr><th>Systematic Error</th><th>Explanation of Effect</th></tr><tr><td>• Loss of Cu in flame</td><td>Final mass too low
Proportion of O too high</td></tr><tr><td>• Not all oxide reduced by H_2</td><td>Final mass too low
Proportion of O too high</td></tr><tr><td>• Copper oxide impure, will not react</td><td>Final mass too low
Proportion of O too high</td></tr><tr><td>• Copper oxide impure, impurity lost</td><td>Final mass too high
Proportion of O too low</td></tr></table></td><td>3</td><td>Note:
Must have linked systematic error to calculated formula for full marks</td></tr>
<tr><td></td><td align="right">Total</td><td>17</td><td></td></tr>
</table>

Question 11	Possible Solution	Marks	Comments
(a)	**[Any *one* hazard + corresponding precaution]** **Hazard** — **Hazard minimisation** Flammable — Keep away from open flames Flammable — Keep in enclosed container	2	**Note:** Must have *linked* hazard to hazard minimisation for full marks
(b)	Sulfur the central atom has: • 2 single covalent bonds, a double covalent bond and an unbonded pair of electrons • Arranged on the surface of a sphere • Maximum repulsion gives tetrahedral shape but only three bonding regions therefore shape trigonal pyramid	3	**Note:** Must have three distinct points for full marks
(c) (i)	$CH_3-\overset{\overset{\large O}{\|\|}}{C}-O-CH_2-CH_3$	2	**Note:** • Take care when drawing structures. • Be careful with the positioning of the bonds.
(ii)	• DMSO is a more polar molecule • therefore has stronger secondary interactions • need more heat energy to separate molecules	3	**Note:** Must have three distinct points for full marks
(d) (i)	positive ***or*** +ve	1	
(ii) (1)	**[Any two points]** • Coats the cathode • Prevents flow of electrons • Prevents ion flow ***or*** • Breaks the circuit • Ions cannot contact the anode	2	**Note:** Must have two distinct points for full marks
(2)	–1	1	
	Total	**14**	

Question 12	Possible Solution	Marks	Comments
(a) (i)	4– ***or*** SiO_4^{4-}	1	
(ii)	$MgFeSiO_4$	2	
(b)	Rain is slightly acidic ***either*** H^+ ions in water can exchange with Mg^{2+} adsorbed on the silicate surface ***or*** $Mg^{2+}{}_{(silicate)} + 2H^+{}_{(aq)} \rightleftharpoons Mg^{2+}{}_{(aq)} + 2H^+{}_{(silicate)}$ plants can absorb $Mg^{2+}{}_{(aq)}$ through their roots	3	**Note:** Must have three distinct points for full marks.
(c)	Equation **[Any five points]** 1. *How olivine decreases acidity* Crushing olivine increases surface area silicate anion can absorb H^+ Mg^{2+}, Fe^{2+} ions on silicate surface can exchange with H^+ Mg^{2+} essential mineral for green (algae) plants 2. *How atmospheric CO_2 levels reduced* CO_2 reacts with water to form H_2CO_3 $CO_2 + H_2O \rightleftharpoons H_2CO_3$ H_2CO_3 is weak acid (<10% ionization) $H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$ less $H^+{}_{(aq)}$ raises pH (if adsorbed on surface of silicate) less $H^+{}_{(aq)}$ more H_2CO_3 can ionise lower $[H_2CO_3]$ lowers $[CO_2]$ in water more CO_2 in atmosphere can dissolve in ocean lowers CO_2 concentration in atmosphere	8	**Note:** 1. Be careful to answer the question *ie two parts need to be addressed*: (1) how olivine decreases acidity (2) how atmospheric CO_2 levels reduced and (3) one equation (at least) must be included in your answer (Does not have to be balanced and is worth one mark) 2. Plan your answer on scrap paper before writing. 3. 6 marks are allocated for chemical content (including one mark for the equation). 4. Two marks are allocated for communication skills including grammar, spelling and writing in sentences.
	Total	**14**	