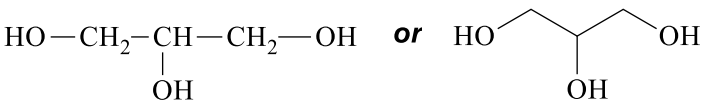
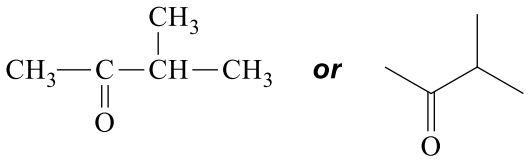
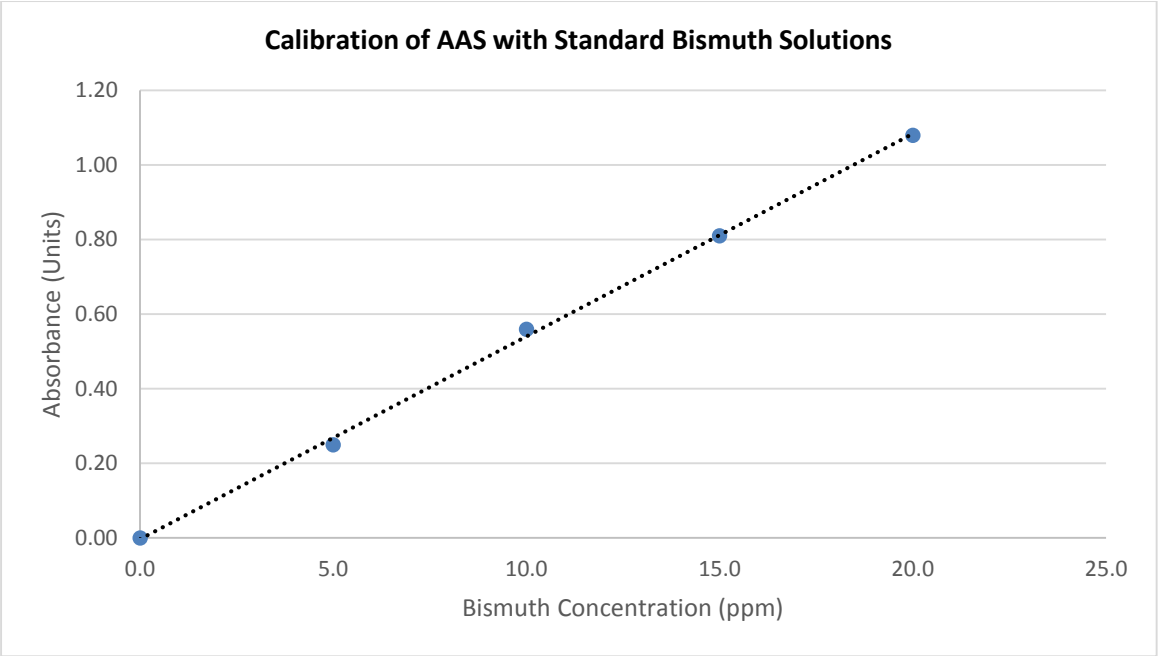
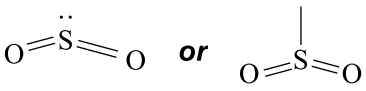
Suggested Stage 2 Chemistry 2014 SACE Board of SA Exam Solutions

Question 1		Marks	Comments
(a)	Ester	1	
(b)	Esterification *or* Condensation	1	
(c) (i)	Ethane-1, 2-diol *or* 1, 2-ethanediol	2	
(ii)	More than one hydroxyl group	1	
(iii) (1)	 **or**	2	**Note:** • Take care when drawing or copying structures. • Be careful with the positioning of the bonds
(2)	**[Any one point:]** • Increase in rigidity • Less flexible • Higher m pt • Increase in hardness	1	**Note:** Must be a physical change.
(d)	Ethanal	2	
(e) (i)	**[Any two points:]** • Plants are renewable resource whereas petroleum is a finite resource • More plants grown (use CO_2) therefore reducing CO_2 levels in the atmosphere • Saves on petroleum consumption therefore petroleum available for other uses • Saves on petroleum consumption therefore conservation of finite reserves	2	**Note:** Must be benefit
(ii)	• Polymer being made is still PET (i.e. same compound with the same chemical and physical properties • Therefore no effect as PET is non-biodegradable	2	
	Total	**14**	

Question 2		Marks	Comments
(a)	p	1	**Note:** Must be lower case letter
(b)	$Bi_2O_3 + 6H^+ \rightarrow 2Bi^{3+} + 3H_2O$	2	**Note:** 1 mark for correct species 1 mark for balancing
(c)	 ***or***	2	**Note:** • Take care when drawing or copying structures. • Be careful with the positioning of the bonds
(d) (i)	**See graph below on following page**	5	
(ii)	Scatter of the points above and below the trend line.	1	**Note:** • regular and suitable scales on both axes • correct plotting of points • line of best fit
(iii)	9.3 – 9.6	1	**Note:** Units not needed
(iv)	• Bi^{3+} absorbs **unique / specific / characteristic** wavelengths / frequencies of light (to excite its electrons to higher energy levels). • Bismuth lamp emits specific wavelengths / frequencies capable of being absorbed by the Bi^{3+} ions only. • Other trace elements present would require different energies and thus absorb different wavelengths / frequencies of light	3	**Note:** Must refer to electron energy levels in bismuth / unique electron configuration for full marks
	Total	**15**	



Question 3		**Marks**	**Comments**
(a)	 *or*	2	
(b) (i)	• decrease in pH means $[H^+]$ increases • equilibrium shifts to right to counter change (Le Châtelier's principle) • therefore $[SO_2]$ increases	3	
(ii)	Endothermic	1	
(c) (i)	Distilled water	1	
Significant Figure mark	Answers to parts (ii) and (iii) must be 3 significant figures	1	**Note:** Significant figures mark *only* applies to parts (ii) and (iii)
(ii)	n_{SO_2} = c x v = 4.76 x 10^{-3} x 0.0200 mole ratio SO_2 : I_2 is 1 : 1 n_{I_2} = 4.76 x 10^{-3} x 0.0200 = 9.52 x 10^{-5} $V_{I_2} = \frac{n}{C}$ $= \frac{9.52\times10^{-5}}{0.0120}$ = 7.933333 x 10^{-3} L = 7.93 mL	4	**Note:** • Should show full working in calculations. • Units must be shown in final answer as not specified in question.

(iii)	4.76×10^{-3} mol L^{-1} = $4.76 \times 10^{-3} \times M_{SO_2}$ g L^{-1} = $4.76 \times 10^{-3} \times (32.06 + 2 \times 16.00)$ = 0.3049256 g L^{-1} = 305 mg L^{-1} which is > 250 mg L^{-1}	3	**Note:** • Should show full working in calculations.
	Total	**15**	

Question 4		**Marks**	**Comments**
(a)	$C_2H_5SH_{(l)} + \frac{9}{2}O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)} + SO_{2(g)}$ ΔH = -2173 kJ	4	**Note:** 1 mark for correct species 1 mark for balancing 1 mark for states 1 mark for ΔH
(b) (i)	• Rate increases • Increased frequency of successful collision	2	**Note:** Must mention rate increases for full marks
(ii) (1)	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^7, 4s^2$	2	**Note:** correct convention: (s, p, d etc and superscripts)
(2)	• lowers activation energy for reaction, **[Any two points:]** • Provides an alternative reaction pathway • More particles with E > Ea • Higher frequency of successful collisions	3	**Note:** Must mention lower activation energy for full marks
(3)	**[Any two points:]** • Same rate can be achieved at a lower Temperature • Less fuel / energy needed to attain or maintain reaction system • Reduced cost as less energy required	2	
(iii)	$CH_3NH_2 + H_2S \rightarrow CH_3NH_3^+ + HS^-$ or $2CH_3NH_2 + H_2S \rightarrow 2CH_3NH_3^+ + S^{2-}$	2	**Note:** 1 mark for correct species 1 mark for balancing
(iv)	$SO_2 + 2H_2S \rightarrow 2H_2O + 3S$	2	**Note:** 1 mark for correct species 1 mark for balancing
	Total	**17**	

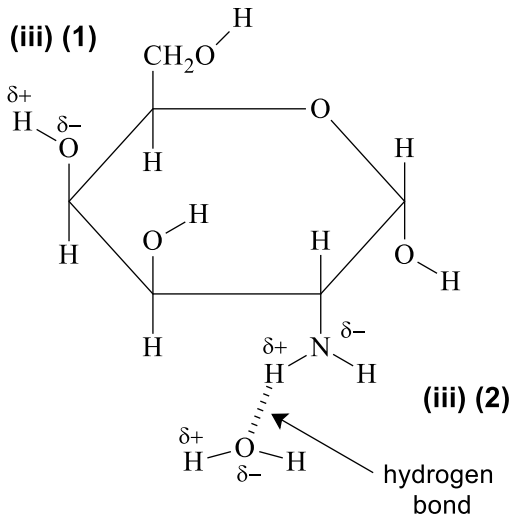
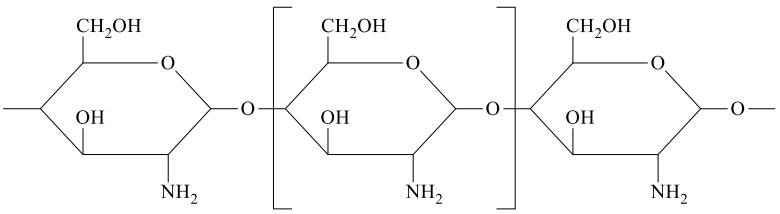
Question 5		Marks	Comments
(a) (i)	$C_6H_6Cl_6$	2	
(ii) (1)	**[Any one point:]** • Carbon and chlorine have different electronegativities • Chlorine has a higher electronegativity than carbon • Chlorine and carbon have different electron attracting powers *And* **[Any one point]** • Electrons are not shared equally • Chlorine has greater control of bonded electrons • Electrons spend more time around Chlorine atom	2	**Note:** 1 mark for comment on electronegativity *and* 1 mark for discussing position of electrons
(2)	**[1 mark for:]** • molecule is symmetrical and polar bonds are arranged so that … **[Any one point:]** • bond dipoles / polarities cancel out • there is an even distribution of charge • there is no separation of charge • the centre of positive charge coincides with centre of negative charge • vector sum of dipoles is 0	1 + 1	**Note:** Need to make reference to symmetry and arrangement of bonds
(3)	14 ng per kg ∴ 14 x 70 ng in 70 kg = 980 ng = 980 x 10^{-3} μg = 0.98 μg	2	**Note:** • Should show full working in calculations. • Units not needed as given in the question
(b) (i)	**Chromatography Principles:** • Chromatography separates substances according to polarity • components in mixture to be separated have different attraction to /adsorption to stationary phase • components have different attraction to / solubility in mobile phase **Polarity Differences:** • attraction to SP/MP depends on polarity of molecule • components have different polarities **Separation:** • components move at different rates over stationary phase • components separate • movement of components can be compared to a known standard • identification of components based on their R_f values / retention times	4	**Note:** Must refer to all three headings, and at least two points in one heading for full marks

(ii) (1)	4.5 — 4.8 mins *or* 4:30 – 4:50 minutes and seconds	1	**Note:** • Units must be shown in answer as not specified in question.
(2)	Aldrin is less polar than lindane	1	
	Total	**14**	

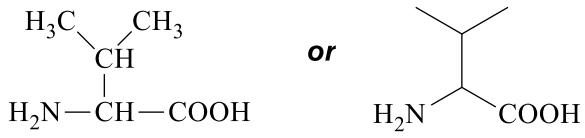
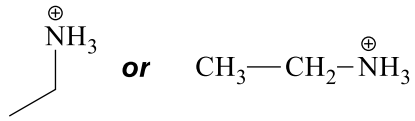
Question 6		**Marks**	**Comments**
(a) (i)	**Nature of CO_2:** • CO_2 is s nonmetallic oxide and therefore is acidic • CO_2 reacts with water in atmosphere to produce carbonic acid H_2CO_3 • $CO_2 + H_2O \rightarrow H_2CO_3$ **Acidity of H_2CO_3:** • Carbonic acid is weak acid ionizes • H^+ is produced • $CO_2 + H_2O \rightarrow H^+ + HCO_3^-$	2	**Note:** • Answer must include minimum of one sentence. • Acid formed needs to be named. • Equations not necessary for full marks,
(ii)	Burning coal / fossil fuels containing sulfur releases sulfur dioxide (SO_2) and sulfur trioxide (SO_3). These are acidic oxides which react with water forming sulfurous (H_2SO_3) and sulfuric acid (H_2SO_4) *or* Roasting sulfide ores releases sulfur dioxide (SO_2) and sulfur trioxide (SO_3). These are acidic oxides which react with water forming sulfurous (H_2SO_3) and sulfuric acid (H_2SO_4) *or* Combustion of refined fuels petrol / diesel releases nitrogen oxides (NO_x in particular nitrogen dioxide NO_2) NO_2 is an acidic oxide which reacts with water forming a mixture of nitrous and nitric acid	3	**Note:** Must identify the activity, the gas involved and the explanation for the effect for full marks
(b) (i)	carbon dioxide (CO_2) methane (CH_4)	2	**Note:** • Name or formula acceptable.

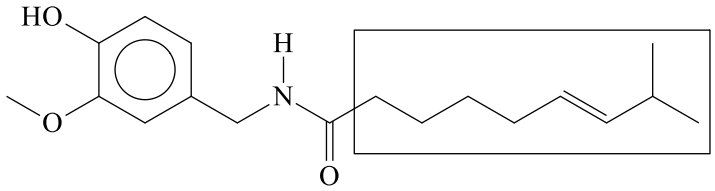
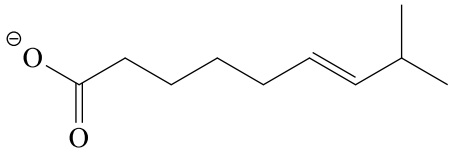
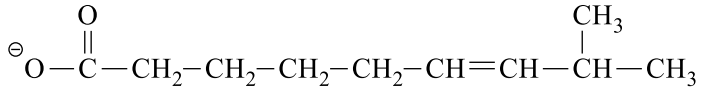
(ii)	• Burning fossil /C-based fuels releases more CO_2 • Deforestation causes release of more CO_2 • Landfill causes release of more CH_4 • Keeping more sheep cattle causes release of more CH_4 • Growing more rice causes release of more CH_4 • Coal mining causes release of more CH_4	2	**Note:** Must identify the human activity, and the gas involved for full marks
(c)	**Human activity (Any One):** • Increased combustion by cars / power stations • Land clearing by fire **Explanation:** • High temperatures causes N_2 to react with O_2 to form nitric oxide (NO) • NO reacts further with O_2 to form NO_2 **Possible Equations:** $N_2 + O_2 \rightarrow 2NO$ $2NO + O_2 \rightarrow 2NO_2$ **Action to reduce (Any One):** • Catalytic converters on cars, which convert NOx to N_2 • Greater use / better public transport system therefore less NO_x released	7	**Note:** 1. Be careful to answer the question *ie two parts need to be addressed*: (1) Human activity and how human activity contributes to increase in NO_x (2) One action to reduce NO_x 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	**16**	

Question 7		Marks	Comments
(a)	• increases surface area / subdivision / smaller particles • increases reaction rate	2	
(b)	oxygen *or* O_2	1	**Note:** Name or formula acceptable.
(c)	**[Any one point:]** • Ions compete for oxygen / oxidised in preference to Au • Ions other than Au react with O_2 • Less O_2 is available for Au	1	
(d)	$H-C\equiv N$	2	
(e) (i)	negative	1	
(ii)	**[Any one point:]** • Mg^{2+} is attracted to the carbon. • Mg^{2+} more strongly attracted to the carbon than $MgAu(CN)_2^+$ • Mg^{2+} competes with the $MgAu(CN)_2^+$ to bind with the carbon. • Mg^{2+} is more highly charged than $MgAu(CN)_2^+$ **[Any one point:]** • Mg^{2+} displaces the $MgAu(CN)_2^+$. from the carbon. • Equilibrium is set up between Mg^{2+} and the $MgAu(CN)_2^+$ • Mg^{2+} higher preference than $MgAu(CN)_2^+$	2	
(f) (i)	negative	1	
(ii) (1)	$Au(CN)_2^- + e^- \rightarrow Au + 2CN^-$	1	**Note:** Must be completely correct for mark.
(2)	reduction	1	
(3)	+1	1	**Note:** Must include + sign for mark.
(g) (i)	$Zn + 2Au^+ \rightarrow Zn^{2+} + 2Au$	2	**Note:** 1 mark for correct species 1 mark for balancing
(ii)	**[Any one point:]** • reducing agent • Zn donates electron/s	1	
	Total	**16**	

Question 8		Marks	Comments
(a) (i)	hydroxyl *or* hydroxy *or* alcohol *or* alkanol *and* amino *or* amine	2	
(ii)	Polyhydroxyl Aldehyde or ketone group present in other (chain) form	2	
(iii) (1)		1	Both δ- and δ+ must be shown for mark
(2)		2	
(b) (i)		1	
(ii) (1)	enzyme	1	
(2)	• Secondary interactions (e.g. dispersion forces / dipole-dipole and H-bonding) affected at high temperature as weak forces • Protein's 3D shape changes • Ability to catalyse reaction is reduced by change in shape of active site	3	
(3) A	Gives out heat	1	
(3) B	Less than 0	1	
	Total	**14**	

Question 9		**Marks**	**Comments**
(a) (i)	M_{Butane} = 4 x 12.01 + 10 x 1.008 = 58.12 Therefore 2874000 J produced by 58.12 g $\therefore$ 600000 J produced by $58.12 \times \frac{600000}{2874000}$ = 12.1336 g	3	**Note:** Each error -1.
(ii)	600 kJ = 6 x 10^5 J $\Delta T = 100 - 27 = 73°C$ Energy change (or q) = m_{H_2O} x C x ΔT 6 x 10^5 = m_{H_2O} x 4.18 x 73 $m_{H_2O} = \frac{600000}{4.18\ x\ 73}$ = 1966 g	3	**Note:** Units required as not mentioned in the question.
(iii)	**[Any two reasons with relevant explanation:]** • Heat lost to surroundings and equipment. Therefore not all heat goes into the water. • Incomplete combustion of butane. Therefore not all heat released from the fuel. • Heat lost from water surface as it is heated. Therefore less heat remains in water. • Evaporation of some fuel. Therefore no heat generated from evaporated fuel.	4	
(b)	$C_6H_{12}O_6 \rightarrow 2CH_3CH_2OH + 2CO_2$	2	**Note:** 1 mark for correct species 1 mark for balancing
(c)	• Ethanol is a polar molecule capable of forming hydrogen bonds with other ethanol molecules • Butane molecules are non polar and only weaker dispersion forces occur between butane molecules. • Therefore more energy required to separate ethanol molecules from each other than butane molecules due to stronger secondary interactions.	3	
	Total	**15**	

Question 10		Marks	Comments
(a)	Amide *or* peptide	1	
(b)		2	**Note:** • Take care when drawing structures. • Be careful with the positioning of the bonds.
(c)	C-terminal has more polar groups (e.g., many more NH_2)	1	
(d) (i)		2	**Note:** • Take care when drawing structures. • Be careful with the positioning of the ⊕, must be over N atom
(ii) (1)	• C- terminal positively charged in acidic environment. • Therefore attracted to negatively charged phosphate in phospholipid.	2	
(2)	• Less amino groups means less positive charge in acid environment. • Therefore less strongly attracted to negatively charged phosphate in phospholipid.	2	
(e) (i)	Synthetic polymers reduce the effects of toxic mellitin on mice *or* Synthetic polymers reduce the effects of bee venom (which contains toxic mellitin) *or* Synthetic polymers help mice to survive bee venom (which contains toxic mellitin)	2	**Note:** • Need to mention polymer *and* mice (effects on / survival)
(ii)	Recovery rate of mice *or* Rate of survival of mice *or* Death rate of mice	1	
(iii)	**[Any one point:]** • Size of dose / concentration of melittin • Size of dose / concentration of synthetic polymer • Strain of mice • All mice injected at same time	1	
	Total	**14**	

Question 11		Marks	Comments
(a) (i) (1)		1	
(2)	Capsaicin has a large non-polar end Nonpolar end soluble in nonpolar fatty component of milk	2	
(ii)	 ***or*** 	2	**Note:** • Take care when drawing structures. • Be careful with the positioning of the bonds. • Make sure correct number of carbon atoms.
(b)	Vanillin contains aldehyde group Therefore will silver mirror observed with Tollens'reagent Capsaicin contains no aldehyde group therefore no reaction with Tollens' reagent	4	
(c) (i)	$Rf = \frac{distance\ travelled\ by\ B}{distance\ travelled\ by\ mobile\ phase} = \frac{41\ mm}{48\ mm} = = 0.85$	2	
(ii)	**Identity:** A is vanillin **Reasons:** A has travelled the shortest distance *or* A has been most attracted to the polar stationary phase A must be the most polar constituent *or* Vanillin has the greatest number of polar groups	3	
	Total	**14**	

Question 12		Marks	Comments
(a) (i)	increases	1	
(ii)	4.6	1	
(iii)	From the graph at pH = 5.5 Al^{3+} = 9%, $Al(OH)_2^+$ = 65% Al^{3+} + $Al(OH)_2^+$ = 74% Therefore $Al(OH)^{2+}$ = 100 – 74 = 26%	2	**Note:** • Ensure all working clearly shown • Ensure correct line is used at pH = 5.5.
(iv)	$Al(OH)^{2+} + H^+ \rightleftharpoons Al^{3+} + H_2O$ *or* $Al(OH)^{2+} + H_3O^+ \rightleftharpoons Al^{3+} + 2H_2O$	2	
(v) (1)	85% of Al is present as Al^{3+} $[Al^{3+}]$ = 0.85 x 43 µmol L^{-1} = 36.55 µmol L^{-1}	2	
(2)	pH = - log $[H^+]$ $[H^+] = 10^{-pH}$ $= 10^{-4.2}$ $= 6.3 \times 10^{-5}$ mol L^{-1}	2	**Note:** Units required as not mentioned in the question.
(3)	reduces concentration of Al^{3+} *or* less Al^{3+} present therefore less damage to crop	2	
(b) (i)	Covalent *or* polar covalent	1	
(ii)	+3 + (3 x +4) + (*x* x -2) = -1 +3 + 12 -2*x* = -1 -2*x* = -1 -3 – 12 = -16 *x* = 8	1	
(iii)	$K_3Na(AlSi_3O_8)_4$	2	
	Total	**16**	