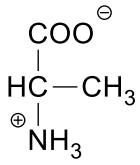
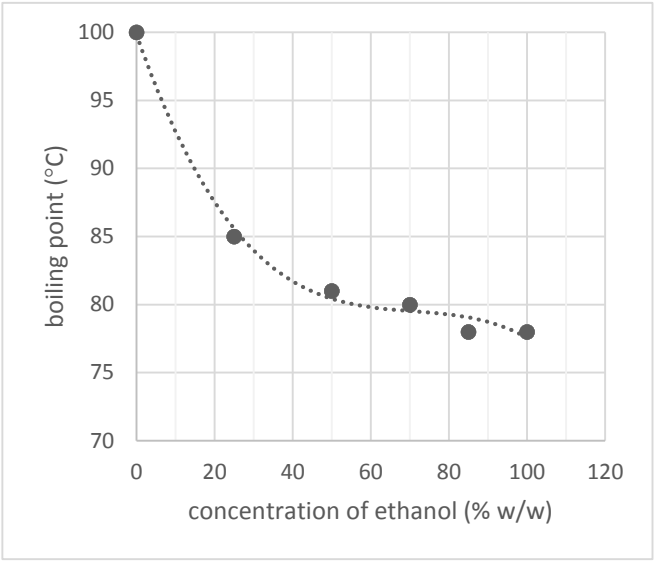
The following pages offer suggested solutions to the 2012 SACE Stage 2 Chemistry final examination. These solutions are not the official set of solutions used by the examiners of the SACE Board.

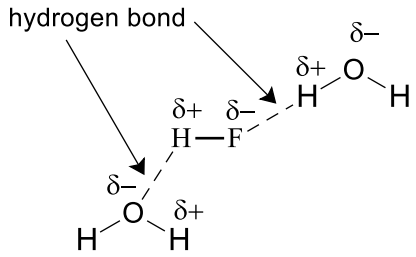
Suggested Stage 2 Chemistry 2012 SACE Board of SA Exam Solutions

Question 1	Possible Solution	Marks	Comments
(a) (i)	Carbon monoxide or CO	1	**Note:** Name or formula acceptable
(ii)	29	1	
(iii)	Location B It has a higher concentration of NO_2	2	**Note:** Must have two distinct points
(iv) (1)	NO_2 photodissociates in bright sunlight due to UV ($NO_2 \rightarrow NO + O$) O atom highly reactive and reacts with O_2 ($O + O_2 \rightarrow O_3$ End result is lower atmosphere (tropospheric) ozone	1	**Note:** Full marks possible without equations
(2)	**[Any One:]** causes rubber to perish causes respiratory problems causes leaves to turn yellow sore eyes oxidises living tissue	1	
(b)	NO_2 reacts with water to form HNO_3 HNO_3 ionises and release NO_3^- ions rain falls and enters soil	3	**Note:** Must have three distinct points
(c) (i)		2	**Note:** Take care when drawing or copying structures. Be careful with the positioning of the bonds
(ii)	Amide *or* Peptide	1	
(iii)	Ammonia or NH_3	1	**Note:** Name or formula acceptable
	Total	**15**	

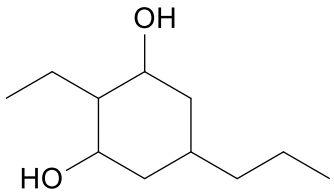
Question 2	Possible Solution	Marks	Comments
(a) (i)	Secondary	1	
(ii)(1)	It is a polyhydroxy ketone	2	**Note:** Must have two distinct points
(2)	**Observation:** No observable change **Reason** There is no aldehyde group present	2	**Note:** Must have observation *and* reason
(b) (i)	**A:** hydrogen bond **B:** covalent bond	2	
(ii)	**B**	1	
(iii)	Change in pH will affect **A** (hydrogen bond) May change shape of protein	2	**Note:** Must have two distinct points
(c) (i)	$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$	2	**Note:** 1 mark for correct species 1 mark for balancing
(ii)	–2816	2	**Note:** Units not necessary as given
	Total	**14**	

Question 3	Possible Solution	Marks	Comments
(a) (i)	**[Any One:]** • fluctuation in balance when taking mass of sample • parallax error when reading meniscus	1	**Note:** Should give specific example
(ii)	absorbance	1	
(iii)	**[Any Two:]** • systematic error present • some Na^+ in the distilled water • meter not zeroed	2	**Note:** Need to give example of systematic error for full marks
(iv)	Particular wavelength used to measure Na Ca does not absorb this wavelength Different wavelengths related to different electron energy levels	3	**Note:** Must have three distinct points
(v)	[acceptable range 336–339] $= 336 \times \frac{500.0}{25.00}$ = 6720 mg L^{-1} [within range 6720–6780]	2	**Note:** Should show full working in calculations Units not needed
(b) (i)	non-spontaneous	1	
(ii)	**B**	1	
(iii) (1)	$2H_2O \rightarrow O_2 + 4H^+ + 4e^-$	2	**Note:** 1 mark for correct species 1 mark for balancing
(2)	**[Any Two:]** • Na is a very active metal • Na^+ ions are not readily reduced • H_2O is reduced more readily than the Na^+	2	**Note:** Must have two distinct points
	Total	**15**	

Question 4	Possible Solution	Marks	Comments
(a)		3	**Note:** regular and suitable scales on both axes correctly plot of points curved line of best fit
(b)	Moles ethanol $= \frac{1.25}{(2\times12.01+6\times1.008+16.00)} = = \frac{1.25}{46.068}$ $= 0.0271338$ Heat released = 0.0271338 x 1367 = 37.091908 kJ 50% to heat water = 18.545954 kJ E = m C ΔT $\Delta T = \frac{E}{mC} = \frac{18.545954\times1000}{170\times4.18} = 26.099006°C$ = 26°C	4	**Note:** Should show full working in calculations Units not needed
(c)	**Describe reaction**: reactants (e.g. glucose and water) catalyst (e.g enzymes must be present) products (e.g. ethanol and carbon dioxide) **Possible equation**: $C_6H_{12}O_6 \rightarrow 2C_2H_5O_2 + 2CO_2$ **State and explain any 2 conditions:** • yeast required supplies enzyme(s) needed • Suitable temperature 15 - 25°C needed for yeast growth • anaerobic conditions otherwise ethanol oxidized to ethanoic acid • mildly acidic as optimum pH for enzyme	8	**Note:** Be careful to answer the question *ie two parts need to be addressed*: (1) Fermentation process (2) Explanation of two reaction conditions (3) An equation may be included but you will not be penalized if you do not include an equation Plan your answer on scrap paper before writing. Two marks are allocated for communication skills including grammar, spelling and writing in sentences.
	Total	**15**	

Question 5	Possible Solution	Marks	Comments
(a)	**[Any One:]** • Tantalum is too reactive • Tantalum is easily oxidised	1	**Note:** Use metal activity series given.
(b)	Crushing increases surface area Exposes mineral to separating process Allows greater rate of reaction in froth flotation process.	2	**Note:** Must have two distinct points for full marks
(ii)	**[Any One:]** • FeF_2, FeF_3, $FeSO_4$, $Fe_2(SO_4)_3$, • MnF_2, $MnSO_4$, • TiF_2, $TiSO_4$, TiF_4, $Ti(SO_4)_2$,	1	
(iii) (1)	$Ta_2O_5 + 14HF \rightarrow 2H_2TaF_7 + 5H_2O$	1	**Note:** 1 mark for correct species 1 mark for balancing
(2)	H and F have a large difference in electronegativity H—F bond highly polar Strong attraction between $H^{\delta+}$ of one molecule and $F^{\delta-}$ or $O^{\delta-}$ of another molecule  	4	**Note:** • Diagram needed as stated in question • Must show δ+ / δ– • Must clearly indicate hydrogen bond
(iv)	potassium fluoride *or* KF	1	**Note:** Name *or* formula acceptable.
(v) (1)	$1s^2, 2s^2, 2p^6, 3s^2, 3p^1$	2	**Note:** correct convention: (lower case s, p, d etc and superscripts)
(2)	**[Any Two:]** • Al is a more reactive metal than Ta • Al loses electrons more readily • Al displaces Ta from its compounds • Al causes reduction of Ta ions	2	**Note:** Must state Ta ions *or* Ta compounds ***not*** Ta metal when mentioning displacing / reduction.
	Total	**14**	

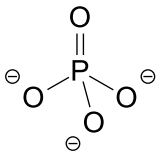
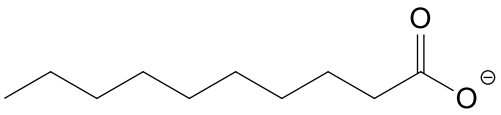
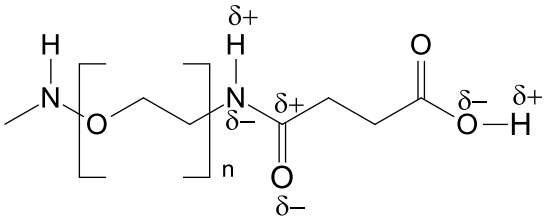
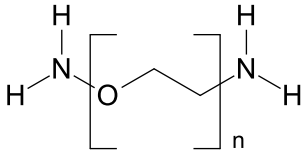
Question 6	Possible Solution	Marks	Comments
(a)	2-methylbut-1,3-diene 2-methyl-1,3-butadiene	2	
(b) (i)	M = (5 x 12.01) + (8 x 1.008) = 68.114 Number of units = $\frac{750000}{68.114}$ = = 11010.952 = 11000	2	**Note:** Should show full working in calculations.
(ii)	2	1	
(c) (i)	**[Any Two:]** • Lower CO_2 footprint as trees remove CO_2 • Uses renewable resources as trees can be regrown • Does not deplete finite resources as not using petroleum feedstock • Can be decomposed by living organisms as no non-biodegradable materials	2	**Note:** Advantage must relate to description for full marks
(ii)	**[Any Two:]** • Greater variety of structures therefore greater variety of properties or uses • Varying composition varies properties therefore can be modified to suit purpose • Does not destroy natural habitat therefore reduced need for rubber plantation	2	**Note:** Advantage must relate to description for full marks
(d)	Thermoplastic	1	
(e) (i)	**[Any Three:]** • Greater cross-linkage means polymer chains are held in position more strongly • Now strong primary bonds between chains rather than weaker secondary bonds • Chains cannot slide past each other as chains now fixed in position • Does not soften on heating as chains now fixed in position • Less flexible as chains now fixed in position • Strong linkages in 3-D rather than 1-D • Harder	3	**Note:** Must have three distinct points for full marks
(ii)	**[Any Two:]** • Needs to be heated more strongly • Decomposes rather than melts • Chars rather than softens • Heating causes chemical change rather than physical • 1° bonds broken rather than 2° • Cannot be reused for similar purpose	2	**Note:** Must have two distinct points for full marks
	Total	**15**	

Question 7	Possible Solution	Marks	Comments
(a)	$C_{11}H_{18}O_2$	2	
(b)	orange *or* brown colour	1	
c) (i)		2	**Note:** Take care when drawing structures. Be careful with the positioning of the bonds.
(ii)	acidified potassium dichromate solution *or* acidified dichromate ions	2	**Note:** Must be name *not* formula
(d) (i)	**Compound:** C is more polar **Reason:** Chiloglottone-1 has two polar ketone groups Compound C has an additional O atom that would also be δ- because it is bonded to C atoms which are less electronegative	2	**Note:** Must have two distinct points for full marks: Compound identified *and* reason
(ii)	**Retention Time of Compound C**: Longer **Reason:** Compound C will be more attracted to the polar phase than will chiloglottone-1 Therefore Compound C will be more attracted to the stationary phase Therefore Compound C will move more slowly	3	**Note:** Must have three distinct points for full marks: Retention time identified *and* two reasons
(e) (i) (1)	isomer	1	
(2)	chiloglottone-3	1	
(ii)	5-ethyl-2-methylcyclohexan-1,3-dione	2	
	Total	**16**	

Question 8	Possible Solution	Marks	Comments
(a) (i)	water or H_2O	1	**Note:** Name *or* formula acceptable.
(ii)	condensation	1	
(iii)	Both oil and the surface of the silicate are nonpolar Nonpolar compounds form similar intermolecular attractions (dispersion forces)	2	**Note:** Must have two distinct points for full marks
(iv)	The detergent has a nonpolar hydrocarbon chain This is attracted to the nonpolar silicate. The detergent has a polar (or ionic) end Polar (or ionic) end attracted to polar water	3	**Note:** Answer must make clear why detergent attracted to water
(b)	***How sodium zeolites soften water:*** • Hard water due to presence of Ca^{2+} or Mg^{2+} • Ca^{2+} / Mg^{2+} ions more strongly attracted to aluminosilicate due to increased charge. • Ca^{2+} / Mg^{2+} ions replace Na^+ on aluminosilicate thereby removed (softening) water. ***Possible Equation (not essential):*** $2Na^+_{(zeolite)} + Ca^{2+}_{(aq)} \rightleftharpoons 2Na^+_{(aq)} + Ca^{2+}_{(zeolite)}$ ***or*** $2Na^+_{(zeolite)} + Mg^{2+}_{(aq)} \rightleftharpoons 2Na^+_{(aq)} + Mg^{2+}_{(zeolite)}$ ***How Zeolite can be recharged*** • High $[Na^+]$ equilibrium forced to left. • Ca^{2+} / Mg^{2+} on silicate replaced by Na^+. • Waste water higher $[Ca^{2+} / Mg^{2+}]$.	8	**Note:** 1. Be careful to answer the question *i.e. two parts need to be addressed*: (1) How sodium zeolites soften water (2) How sodium zeolite can be recharged 2. An equation *may be* included but you will not be penalized if you do not include an equation 3. Plan your answer on scrap paper before writing. 4. Two marks are allocated for communication skills including grammar, spelling and writing in sentences.
	Total	**15**	

Question 9	Possible Solution	Marks	Comments
(a) (i)	$2H_2O_2 \rightarrow 2H_2O + O_2$	2	**Note:** 1 mark for correct species 1 mark for balancing
(ii)	Decomposition requires E_a At a higher temperature more molecules have E_a Therefore higher proportion of collisions exceed E_a (i.e. more rapid reaction)	3	**Note:** Must have three distinct points for full marks
(b) (i)	6.0% of 1 L = 60 g L^{-1} $c = \frac{60}{(22.99+35.45+16.00)} = \frac{60}{74.44}$ = 0.806018 = 0.81 mol L^{-1}	3	**Note:** Should show full working in calculations
(ii)	$ClO^- + 2H^+ + 2e^- \rightarrow Cl^- + H_2O$	2	**Note:** 1 mark for correct species 1 mark for balancing
(c) (i)	Cl_2 or diatomic chlorine	1	**Note:** Name or formula acceptable
(ii)	At a high pH the acids would react as equilibrium under stress System responds to counter stress (Le Châtelier's Principle) System moves to RHS therefore $[Cl_2]$ decreases	3	**Note:** Must have three distinct points for full marks
(iii)	pH + pOH = 14 pOH = 14 – 12.4 = 1.6 $[OH^-]$ = antilog (-pOH) = antilog (-1.6) = 0.025 mol L^{-1} *or* pH = -log $[H_3O^+]$ = 12.4 $[H_3O^+] = 10^{-12.4} = 3.98 \times 10^{-13}$ $[H_3O^+][OH^-] = 10^{-14}$ $[OH^-] = \frac{10^{-14}}{3.98\ x\ 10^{-13}}$ = 0.025 mol L^{-1}	2	**Note:** Should show full working in calculations
	Total	**16**	

Question 10	Possible Solution	Marks	Comments
(a) (i)	photochemical	1	
(ii)	$CO_2 \rightarrow CO + O$	2	**Note:** 1 mark for correct species 1 mark for balancing
(b)	$3FeS_2 + 8O_2 \rightarrow 6SO_2 + Fe_3O_4$	2	**Note:** 1 mark for correct species 1 mark for balancing
(c) (i)	High pressure imposes stress on the equilibrium system System responds to counter stress (Le Châtelier's Principle) Less moles on RHS therefore system moves to RHS	3	**Note:** Must have three distinct points for full marks
(ii)	**[Any One:]** • More costly • More expensive equipment needed • Increase in yield not worth extra cost • High pressure more dangerous to workers	1	
(iii)	If T > 450°C rate faster *but* yield lower If T < 450°C rate slower *but* yield higher	4	**Note:** Must mention *both rate and yield for both temperatures* for full marks
(iv)	V_2O_5 lowers the activation energy by providing an alternative reaction pathway with a lower activation energy barrier therefore reaction is faster All of the V_2O_5 is present at the end of the reaction (not used up by the reaction)	2	**Note:** Must have two distinct points for full marks
	Total	**15**	

Question 11	Possible Solution	Marks	Comments
(a)	p	1	**Note:** Must be lower case
(b)	Two carbon atoms have the same electronegativity Electrons shared equally	2	**Note:** Must have two distinct points for full marks
(c) (i) (1)		2	**Note:** Take care when drawing structures. Be careful with the positioning of the bonds.
(2)	+5	2	**Note:** Sign must be included
(ii)		1	**Note:** Take care when drawing structures. Be careful with the positioning of the bonds.
(d) (i)	**[Any one labelled pair of δ+ / δ- bonds:]** 	1	**Note:** Correct polar bond in diagram Only portion of published polymer chain shown
(ii)	Contains many polar groups which attract polar water molecules	2	**Note:** Must have two distinct points for full marks
(iii)	butan-1, 4- dioic acid	2	
(iv)		2	**Note:** Take care when drawing structures. Be careful with the positioning of the bonds.
	Total	**15**	

Question 12	Possible Solution	Marks	Comments
(a)	Diesel has larger molecules Therefore more secondary forces to overcome Therefore diesel higher b pt as more energy needed to overcome secondary forces	3	**Note:** Must have three distinct points for full marks
(b) (i)	Soybean molecules have kinked chains therefore cannot pack closely together Therefore less secondary forces compared to palm oil molecules which are unkinked molecules and can pack closely Less secondary forces present, means less energy needed to separate (therefore lower m pt)	3	**Note:** Must have three distinct points for full marks
Significant Figure mark		1	**Note:** Significant figures mark *only* applies to part (ii)
(b) (ii)(1)	n_{KOH} = C V = 0.01017 x 0.2500 = 0.0025425 mol m_{KOH} = n M = 0.0025425 x 56.108 = 0.142665459 = 0.1427 g	3	**Note:** Must have **4** significant figures *and* Must have units for full marks Should show full working in calculations
(2)(A)	volumetric pipette	1	
(2)(B)	moles KOH = c V = 0.01017 x 4.2 x 10^{-3} = 4.2714 x 10^{-5} moles acid = moles KOH = 4.2714 x 10^{-5} In *diluted* biodiesel $C_{(acid)} = \frac{4.2714 \times 10^{-5}}{0.02000}$ = 2.1357 x 10^{-3} mol L^{-1} In *undiluted* biodiesel $C_{(acid)}$ = 2.1357 x 10^{-3} x 50 = 0.106785 = 0.11 mol L^{-1}	4	**Note:** Must have **2** significant figures *and* Must have units for full marks Should show full working in calculations
	Total	**15**	