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Pacific Community
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EDUCATIONAL QUALITY AND ASSESSMENT PROGRAMME

EQAP

Scoring Rubric 2020

South Pacific Form Seven Certificate

CHEMISTRY

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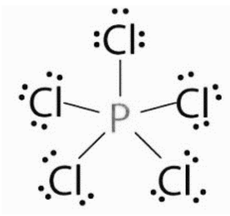
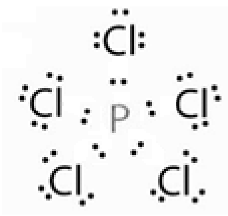
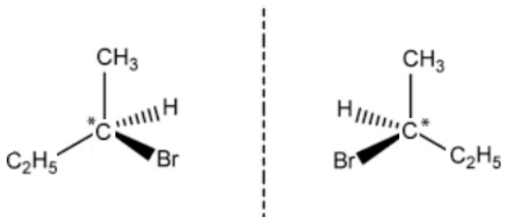
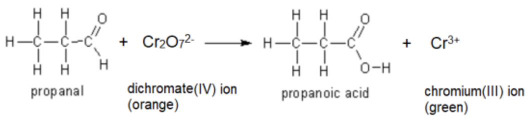
SLO	Q. No.	SL	Evidence	Student Response Level			
				Extended Abstract 4	Relational 3	Multistructural 2	Unistructural 1
Strand 1: Atomic Structure, Bonding and Related Properties							
CHE1.1.1.1	1.1	1	It is the representation of the arrangement of electrons distributed among the orbital shells and subshells.				Any reasonable response defining the concept of electron configuration.
CHE1.1.1.2	1.2	1	$[Ar]3d^6 4s^2$				Also accept $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$
CHE1.1.2.2	1.3	2	The atomic radius of atoms generally decreases from left to right across a period. The atomic radius of atoms generally increases from top to bottom within a group.			Two correct ideas are given.	One correct idea is given.
CHE1.1.1.3	1.4a	1	The shape is trigonal pyramidal.				The only correct answer is trigonal pyramidal.
CHE1.1.3.4	1.4b	3	 OR 		Lewis structure has all the following: - P as central atom - Five Cl atoms are well spaced around the P atom and connected with single bonds or a pair of electrons - 3 lone pairs of electrons clearly present around each of the five Cl atoms	Lewis structure has any of the two ideas correct.	Lewis structure only has one correct idea.
CHE1.1.1.4	1.5a	1	Weak van der Waals forces or instantaneoues dipole-induced dipole forces or London disperson forces				Any response close to the evidence.
CHE1.1.3.8	1.5b	3	Both, Compound B and Compound C are polar molecules with permanent dipoles, and have dipole-diploe attractions between their molecules. However, the presence of the more electronegative oxygen atom on Compound C means that it will exhibit stronger dipole-dipole interactions (known as hydrogen bonds) as compared to Compound B. Stronger the intermolecular forces between the liquid particles, the more energy needed to convert it from liquid to the vapour phase, in other words, higher its boiling point. As a result, Compound C has greater boiling point than Compound B.		The response should clearly relate the higher boiling point of Compound C to its ability to form stronger intermolecular forces as compared to Compound B, due to the presence of more electronegative oxygen atom.	At least two correct ideas are given but not linked.	Only one correct idea is given.
CHE1.2.1.1	1.6a	1	Radioactivity is the spontaneous emission of radiation in the form of particles or high energy photons resulting from a nuclear reaction.				Any reasonable response defining the concept of radioactivity.
CHE1.2.2.1	1.6b	2	• $^{232}_{90}\mathrm{Th} \rightarrow ^{228}_{88}\mathrm{Ra} + ^{4}_{2}\mathrm{He}$ • Alpha particle			Balanced equation and name of nuclear particle is correct.	Only one idea is correct.
CHE1.2.1.3	1.6c	1	Any one of: - A beta particle is emitted - a high-energy electron or positron is emitted				Any one property is stated correctly.

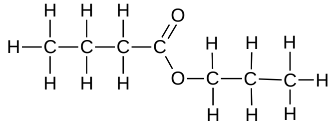
			- a high-speed electron or positron is emitted - a particle bearing negligible mass is emitted				
CHE1.3.1.1	1.7a	1	Transition elements or transition metals				Either option in evidence.
CHE1.3.1.2	1.7b	1	Tetraamminezinc(II) ion				Spelling should be correct.
CHE1.3.2.3	1.7c	2	At this introductory level, it is sufficient to represent the system as follows: $Cu^{2+}{}_{(aq)} + 2OH^{-}{}_{(aq)} \rightleftharpoons Cu(OH)_{2\,(s)}$ $Cu^{2+}{}_{(aq)} + 4NH_{3\,(aq)} \rightleftharpoons [Cu(NH_3)_4]^{2+}{}_{(aq)}$			Both balanced equations are given with the correct formula of reactants and products.	Correct formula of reactants and/or product are given but equations are not balanced OR Only one balanced and correct equation is given
Strand 2: Energy Changes in Chemical and Physical Processes							
CHE2.1.1.1	2.1	1	It is the energy required to break one mole of a particular bond (when the reactants and products are in gaseous state).				Any reasonable response close to the given definition.
CHE2.1.1.3	2.2	1	Standard enthalpy of formation				Only symbols not to be accepted.
CHE2.1.2.2	2.3	2	Any two of: - Usually includes oxygen - Usually accompanied by the generation of heat (exothermic) and light in the form of flame - The speed at which the reactants combine is high - Is a type of redox reaction			At least two correct are ideas given.	Any one correct idea given.
CHE2.1.4.1	2.4	4	The heat or enthalpy of the reaction is calculated using Hess's Law, which is equal to the energy released per mole of glucose: $\Delta H^{o}_{rxn} = \sum\Delta H^{o}_{f}\,(\text{products}) - \sum\Delta H^{o}_{f}\,(\text{reactants})$ $= \{6\Delta H^{o}_{f}\,[CO_{2(g)}] + 6\Delta H^{o}_{f}\,[H_2O_{(g)}]\} - \Delta H^{o}_{f}\,[C_6H_{12}O_{6(s)}] + 6\Delta H^{o}_{f}\,[O_{2(g)}]\}$ $= [6(-393.5\text{ kJ mol}^{-1}) + 6(-285.8\text{ kJ mol}^{-1})] - [-1273.3 + 6(0\text{ kJ mol}^{-1})]$ $= -2802.5\text{ kJ mol}^{-1}$ The energy released by 1 gram of glucose: No. of moles of glucose $= m_{glucose}/M_{glucose}$ $= 1\text{ g} / 180\text{ g mol}^{-1}$ $= 5.56 \times 10^{-3}\text{ mol}$ Energy released $= n \times \Delta H^{o}_{rxn}$ $= 5.56 \times 10^{-3}\text{ mol} \times 2802.5\text{ kJ mol}^{-1}$ $= 15.6\text{ kJ}$	The following should be correctly and clearly demonstrated: - That the enthalpy change can be calculated by subtracting the sum of heat of formation of reactants from the sum of heat of formation of products OR the same is demonstrated with a formula - The heat of formation data is clearly related to the chemical equation (moles of each react and product) and the standard enthalpy change of the reaction equation during calculation. - Standard enthalpy change of the reaction is calculated and expressed with appropriate sign and unit.	The standard heat of formation data is correctly related to the reaction equation and the standard enthalpy change of the reaction equation during the calculation, but the final answer is not correct or without correct sign/unit OR At least two correct ideas are given, which are properly linked.	The standard heat of formation data is not correctly related to the reaction equation and/or the standard enthalpy change of the reaction equation during the calculation. OR At least two correct ideas are given but unlinked.	Only one correct idea is given.

				- Heat released is calculated from moles of glucose in one gram.			
Strand 3: Aqueous Equilibrium Systems							
CHE3.1.1.1	3.1a	1	Anyone of: The large equilibrium constant value indicates that the equilibrium concentration of the products is large. OR The reaction lies to the far right. OR The forward reaction is favoured.				Any one of the correct options in evidence.
CHE3.1.2.1	3.1b	2	$K_c = [N_2].[CO_2]^2 / [NO]^2.[CO]^2$			- Expression is correct. - Correct terms with symbols are used.	Expression has $[H_2O]$. OR Expression given with some incorrect symbols.
CHE3.1.1.5	3.2	1	A strong electrolyte is a substance that completely dissociates/ionises in solution.				Any reasonable response close to the given definition.
CHE3.1.1.3	3.3a	1	It is a solution that can resist pH change upon the addition of an acidic or basic component.				Any reasonable response close to the given definition.
CHE3.1.1.4	3.3b	1	It is an acidic buffer OR The buffer will have pH < 7 OR The buffer is made from a weak acid and its basic salt				Any correct idea from evidence.
CHE3.1.3.6	3.3c	3	Addition of sodium ethanoate to acetic acid adds lots of extra ethanoate ions, which shifts the position of the following equilibrium even further to the left. $CH_3COOH_{(aq)} \rightleftharpoons CH_3COO^-_{(aq)} + H^+_{(aq)}$ The buffer will thus resist a pH change as follows: • When an acid, which is a source of hydrogen ions, is added, the buffer solution removes most of the new hydrogen ions by combining with the ethanoate ions to make ethanoic acid as follows: $CH_3COO^-_{(aq)} + H^+_{(aq)} \rightleftharpoons CH_3COOH_{(aq)}$ • When a base, which is a source of hydroxide ions, is added, the buffer solution removes most of the hydroxide ions by combining with ethanoic acid molecules as follows: $CH_3COOH_{(aq)} + OH^-_{(aq)} \rightleftharpoons CH_3COO^-_{(aq)} + H_2O_{(l)}$		The response should explain how the buffer will resist change in pH for both, when an acid or a base is added to it. The response should relate this to the buffer solution equilibrium with suitable equations.	The response has at least two correct but unlinked ideas.	The response has only one correct idea.

CHE3.1.2.2	3.3d	2	pH = $-\log_{10}[H^+]$ $[H^+]$ can be found using the K_a expression: Note: Since a dilute solution of ethanoic acid is used, the assumption of $[CH_3COOH] = c_{CH3COOH}$ is made here. $K_a = [CH_3COO^-][H^+] / [CH_3COOH]$ $1.8 \times 10^{-5} = 0.090 [H^+] / 0.050$ $[H^+] = 1.0 \times 10^{-5}$ mol L^{-1} pH = $-\log_{10} 1.0 \times 10^{-5} = 5.0$ (2 s.f.)			The following are provided: -Correct calculation of $[H^+]$ - Correct calculation of pH (Note that this value will depend on the $[H^+]$ calculated above – do consistent scoring in this case)	Any one correct idea given.
CHE3.2.2.2	3.4a	2	If x is moles of $PbCl_2$ that dissolves, then $[Pb^{2+}]$ = x and $[Cl^-]$ = 2x according to the following equation: $PbCl_{2\,(aq)} \rightleftharpoons Pb^{2+}_{(aq)} + 2Cl^-_{(aq)}$ 1 : 1 : 2 (mole ratio) x : x : 2x Therefore: $K_s (PbCl_2) = [Pb^{2+}][Cl^-]^2 = (x)(2x)^2 = 4x^3$ $1.7 \times 10^{-5} = 4x^3$ $x = 1.6 \times 10^{-2}$ or 0.016 mol L^{-1} (2 s. f.)			- Correct expression used - Correct concentrations of $[Pb^{2+}]$ and $[Cl^-]$ used for K_s calculation	Only one idea is correct.
CHE3.2.1.1	3.4b	1	Common ion effect				Common ion effect is the only correct response.
Strand 4: Oxidation–Reduction Reactions							
CHE4.1.3.4	4.1	3	For the cell to be spontaneous, $E°_{cell}$ should be positive. $Zn^{2+}_{(aq)} + 2e^- \rightarrow Zn_{(s)}$ $E° = -0.76$ V $Ag^+_{(aq)} + e^- \rightarrow Ag_{(s)}$ $E° = +0.80$ V Ag^+ will undergo reduction since the $E°_{Ag+/Ag}$ is more positive. Zn will therefore undergo oxidation. For overall reaction, reverse the first half-equation and sign on $E°$, multiply the second half equation by 2 and add both: $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$ $E° = +0.76$ V $2Ag^+_{(aq)} + 2e^- \rightarrow 2Ag_{(s)}$ $E° = +0.80$ V ——— $Zn_{(s)} + 2Ag^+_{(aq)} \rightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)}$ $E° = +1.56$ V Since $E°_{cell}$ is positive, the cell will be spontaneous. Note that candidates may also have used the following equation for $E°_{cell}$ calculation: $E°_{cell} = E°_{red} - E°_{oxd} = E°_{Ag+/Ag} - E°_{Zn2+/Zn}$ $= +0.80\text{ V} - (-0.76\text{V}) = +1.56$ V		The response has the following: - Correct identification of the reducing and oxidising half cells from the $E°$ values - Determination of $E°_{cell}$ and overall equation. - Correct relation of the $E°_{cell}$ to cell spontaneity	At least two correct ideas are given but not linked.	Any one correct idea given.

CHE4.1.2.4	4.2	2	• Energy conversion: A galvanic cell converts chemical energy to electrical, while an electrolytic cell does the opposite.			At least two correct ideas are given.	One correct idea given.
Strand 5: Organic Chemistry							
CHE5.1.1.1	5.1a	1	Enantiomers are pairs of chiral molecules that are non-superimposable mirror images of each other.				Any reasonable response close to the given definition.
CHE5.1.3.9	5.1b	3	The molecule has a chiral or asymmetric carbon center (four different groups attached to the carbon atom marked by a star). Therefore, the molecule is chiral. $CH_3\overset{*}{C}HCH_2CH_2CH_3$ (Br on the starred carbon) The molecule will have two enantiomers as follows:  		The response should include the following: - Identification of structural feature in 2-bromopentane - 3D structures of the two enantiomers on other side of a mirror line. The mirror images of the molecule should show the correct relative positions of the four groups and their bonds to the chiral carbon atom.	At least two correct ideas are demonstrated but not linked.	Any one correct idea given.
CHE5.1.4.1	5.2c	4	Enantiomers are optically active i.e. they can rotate a plane of polarised light. The (–) enantiomer rotates the plane anticlockwise (to the left), while the (+) enantiomer rotates the plane clockwise (to the right). Enantiomers have similar properties, except for when they interact with other chiral compounds. They have identical chemical and physical properties in an achiral environment, but interact with other chiral molecules differently. An important area of consideration for chirality and enantiomerism is in biochemistry. Enantiomers may have very different biological properties. The reason is that one enantiomer can be the useful in the body while the other can be harmful. The two enantiomers of an optically isomeric drug can have very different effects administered separately. There is an emphasis on the testing of all the optical isomers of drugs for effects to ensure that they are safe. Therefore, in the synthesis of drugs, it is highly desirable, if not easily achievable, to produce drugs of a chiral nature, containing only the single and most effective enantiomer.	The response should have correctly and clearly described the properties of enantiomers and discussed the relevance, consideration and implication of it to a real life situation using a suitable example.	At least two correct ideas are given, which are clearly linked.	At least two correct ideas are given, which are not linked.	Any one correct idea is given.

			One such example is the case of drug thalidomide and its administration in pregnant women. One enantiomer alleviated morning sickness, which is what the drug had been originally designed for. Unfortunately, with tragic results, the other mirror image enantiomer caused genetic damage in the fetus resulting in physical deformities of the limbs. Furthermore, even if the 'safe' isomer can be separated to high degree of purity, it has also been found later that an isomerisation reaction occurs forming the harmful mirror image enantiomer in vitro i.e. in situ in the body.				
CHE5.1.2.1	5.2a	2	- Chain isomers - Positional isomers - Funcitonal group isomers Accept metamers and tautomers, if given in the response, but this is not expected of the candidates.			At least two correct ideas/groups are given.	Any one correct idea/group is given.
CHE5.2.3.4	5.2b	3	Propanal reacts with acidified potassium dichromate solution and changes the reaction mixture from orange to green. However, propanone does not react with acidified potassium dichromate solution. It does not cause any colour change. The reaction with propanal is a redox reaction, whereby propanal is oxidised to propanoic acid and dichromate(IV) ions are reduced to chomium(III) ions. 		Response should have the following: - correct observation for both compounds - correct identification of the reaction for propanal with reactants and products - correct relation of the chemical equation to the observation for propanal	At least two correct ideas are given but unlinked.	Any one correct idea is given.
CHE5.2.1.2	5.3a	1	Reduction reaction				The only correct option is reduction.
CHE5.2.2.2	5.3b	2	• Halolalkanes OR halogenoalkanes OR alkyl halides • 1-bromopropane			At least two correct ideas given.	Any one correct idea given.
CHE5.2.2.3	5.3c	2	• Elimination or dehydration reaction • Concentrated sulphuric acid and heat is used			At least two correct ideas given.	Any one correct idea given.
CHE5.2.2.10	5.3d	2	• Esterification reaction • Product structure (propyl butanoate)			At least two correct ideas given.	Any one correct idea given.

						(Also accept condensed structural formula.)	(Also accept condensed structural formula.)
CHE5.2.1.4	5.4	1	A water molecule is removed. OR It is a condensation reaction. OR It undergoes step growth polymerisation.				Any one correct idea given.
CHE5.2.2.12	5.5	2	• Low heat capacity or heat conductivity, therefore used as an insulator eg. styrofoam used for disposable coffee cups. • Very low coefficient of thermal expansion, therefore low expansion or contraction when heated or cooled e.g. used as a sealant. • High resistance to electric current, therefore used as an insulator eg. insulation pipes for electrical wires. • High resilience, therefore good ability to resist abrasion and wear e.g. used as ball bearings. • High stability, therefore very resistant to chemicals e.g. used for packaging corrosive chemicals. • High elasticity, therefore stretchable in different directions without breaking easily e.g. plastics wraps for packaging.			At least two correct ideas given.	Any one correct idea given.