No. 103/2

EDUCATIONAL QUALITY AND ASSESSMENT PROGRAMME

CHEMISTRY

Scoring Rubric 2019

South Pacific Form Seven Certificate

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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							
CHE1.1.1.2	1.1a	1	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$ or [Ar]$4s^2$				$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$ or [Ar]$4s^2$ is the only correct answer.
CHE1.1.1.1	1.1b	1	Monoatomic ion is an ion which consists of only one atom.				An ion which consists of only one atom OR an ion made from a single atom OR it is a single atom that has a different number of proton(s) and electron(s)
CHE1.1.3.1	1.1c	3	The trend is due to an additional shell added to the elements going down the group, which increases the distance of the valence shell electron from the positive nucleus. **Due to decreasing attraction/pull or increasing shielding effect, lesser energy is required to remove the valence electron going down the group.**		The trend is explained with clear relation (in bold) of the increasing number of shells down the group/increasing distance of the valence electron from the nucleus **and** decreasing attraction/pull or increasing shielding effect.	Any two ideas are stated correctly.	Only one idea is stated correctly.
CHE1.1.1.3	1.2a	1	The shape is trigonal pyramidal.				The only correct answer is trigonal pyramidal.
CHE1.1.2.7	1.2b	2	• H_2O molecule is overall polar. • It has polar bonds due to electronegativity difference between the oxygen and hydrogen atoms. • It has a net dipole moment since the dipoles do not cancel out. • It has unequal sharing of electrons between the oxygen and hydrogen atoms. • It has a slight positive charge on each hydrogen atom and a slight negative charge on the oxygen atom.			Any two ideas are stated correctly.	Only one idea is stated correctly OR correct diagram is given to show net dipole/partial charges on atoms
CHE1.1.1.4	1.3	1	The intermolecular force is permanent dipole-dipole interactions /attractions /forces.				The correct answer is permanent dipole-dipole interaction /attractions/dipole-dipole forces. NB: No mark for just stating dipole interactions/attractions/forces.
CHE1.2.1.1	1.4a	1	Fusion reaction is a process where two or more smaller atomic nuclei combine to form a larger nucleus.				Fusion reaction is a process where two or more (or multiple) atomic nuclei combine to form larger/ bigger/heavier nucleus

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							OR it is process that releases energy as a result of the union of smaller atomic nuclei to form larger/bigger/heavier nucleus OR fusion reaction is the process of combining of atomic nuclei to form a larger/bigger/heavier nucleus.
CHE1.2.1.2	1.4b	1	Features of fusion reaction are: • High density/energy/temperature environment is required • High amounts of energy is released • Radioactive particles are released • A safer/cleaner form of energy • High production costs				Any one feature is stated correctly.
CHE1.2.2.3	1.4c	2	Properties of $^{4}_{2}He$ or alpha particle: • It is a highly energetic particle **as a result of travelling at a high speed/velocity** • It has a large ionisation power **as a result of positive charge**			Any one property is stated with the contributing reason (**in bold**).	Any one property is stated correctly. • It is a highly energetic particle OR • It has a large ionisation power.
CHE1.2.4.1	1.4d	4	Applications of nuclear chemistry: • Power plants - generation of electricity • Medicine – diagnosis , therapy, sterilisation, insect control, x-rays, radiotherapy, • Agriculture - plant mutation breeding, fertilisers, insect control, consumer products • Food - Food irradiation • Industry – industrial tracers, inspection and instrumentation, carbon dating, desalination, forensics • Transport - Nuclear-powered ships, nuclear reactors for space, hydrogen, electricity and cars • Weapons • Research • Environmental tracers, Water resources Safety concerns of nuclear chemistry: • Storage hazards of nuclear materials for nuclear chemistry applications • Occupational hazards to people working	The student has been able to discuss one application of nuclear chemistry that presents or has presented a safety concern and has /has had negative impact on the environment. A clear linkage of the ideas must be evident, which should have been presented in a flow.	The student has been able to mention two or three ideas correctly and has only provided the link between two of these.	The student has been able to list two or three ideas correctly without linking them.	The student has stated only one idea correctly (application, safety concern or negative impact) out of the three required.

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			with nuclear chemistry applications • Meltdown accidents in which severe overheating of the nuclear reactor results in melting of the reactor's core. • Vulnerability of nuclear plants to attack • Unplanned entry of nuclear materials into the biosphere and food chain (living plants, animals and humans) if breathed or ingested. • Routine emissions of radioactive materials from nuclear chemistry applications in the environment. • Side effects of nuclear chemistry applications due to radiation exposure during diagnosis or treatment • Transport accidents of nuclear waste • Radioactive fallouts from nuclear weapons testing Negative impacts of nuclear chemistry on the environment: • Large quantities of radioactive waste are created from nuclear plants presenting disposal/storage issues in the environment • Mining of radioactive metals have left environment exposed to contamination • Continuing health impacts long after a nuclear disaster				
CHE1.3.2.2	1.5a	2	Transition elements form complex compounds because: • Availability of vacant d orbitals or empty d orbitals to accommodate/ accept electrons coming from the ligands that are attached to them. • Small size/high effective nuclear charge/variable oxidation states of the transition metal ion make the complex compounds more stable.			Two ideas are stated correctly.	Only one idea is stated correctly.
CHE1.3.1.2	1.5b	1	Diamminesilver(I) ion				The only correct answer is diamminesilver(I) ion.
CHE1.3.2.4	1.5c	2	$Zn^{2+}_{(aq)} + 4NH_{3\,(aq)} \rightleftharpoons [Zn(NH_3)_4]^{2+}_{(aq)}$			Balanced equation is given with the correct formula of reactants and product. Source of Zn^{2+} can be any of these: $Zn(OH)_2$, $Zn(SO_4)$, ZnO,	Correct formula of reactants and/or product given but equation is not balanced OR balanced equation is given without

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						$Zn(NO_3)_2$, $ZnCl_2$	the correct formula of reactants and/or product
CHE1.3.2.7	1.5d	2	• Small amount of ammonia in copper solution gives a pale blue precipitate • Precipitate dissolves into a deep blue solution upon further/excess addition of ammonia.			Both observations are stated correctly.	Only one observations is stated correctly.
CHE1.3.1.1	1.5e	1	Iron				The only correct answer is iron.
Strand 2: Energy Changes in Chemical and Physical Processes							
CHE2.1.1.3	2.1a	1	Enthalpy of vaporisation				Enthalpy of vaporisation OR enthalpy of evaporation OR heat of vaporisation OR heat of evaporation OR ΔH_{vap}
CHE2.1.2.4	2.1b	2	$H_2O_{(l)} \longrightarrow H_2O_{(g)}$ $\Delta H_{vap} = +2257$ J g^{-1}			The full equation is given correctly.	Only one of the following is given correctly: $H_2O_{(l)} \longrightarrow H_2O_{(g)}$ OR $\Delta H_{vap} = +2257$ J g^{-1}
CHE2.1.3.5	2.1c	3	The enthalpy change is positive/the process absorbs energy from the surrounding/the process is endothermic. Bonds between the molecules of liquid water are broken to transform it to the gas phase. **The process absorb/uses the energy from the surroundings to break strong intermolecular forces/hydrogen bonds between the liquid water molecules.**		The student should have shown a clear relation between energy absorbed from the surroundings for the breaking of the strong intermolecular forces/hydrogen bonds between the water molecules in liquid phase in order to transform it into gas phase (**in bold**).	Two ideas are stated correctly.	Only one idea is stated correctly.
CHE2.1.1.2	2.2	1	Enthalpy of ionisation				Enthalpy of ionisation OR heat of ionisation
CHE2.1.2.1	2.3	2	Exothermic reaction is a reaction that releases energy into the environment in the form of heat.			Exothermic reaction is a reaction that release energy into the surrounding in the form of heat OR a reaction whose enthalpy is less than zero/negative	The description is partially stated.

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						OR a reaction which increases the temperature of the surrounding due to the evolution of heat OR a reaction where the enthalpy of the products is lower than the enthalpy of the reactants of the system.	
CHE2.1.2.5	2.4	2	$q = m \times c \times \Delta T$ $= 200\ g \times 0.129\ J\ g^{-1}\ K^{-1} \times (15-30)$ $= -387\ J$ or $387\ J$ of energy is lost.			• Formula/input of values in formula are correct • The enthalpy change is given as -387 J OR that 387 J of energy is lost is stated.	Formula/Input of values in formula are correct OR answer is left as 387 J only.
Strand 3: Aqueous Equilibrium Systems							
CHE3.1.1.2	3.1a	1	Nitrous acid				The only correct answer is nitrous acid.
CHE3.1.2.4	3.1b	2	• Concentration of each species: $HNO_{2\,(aq)} + H_2O_{(l)} \rightleftharpoons NO_{2\,(aq)}^{-} + H_3O^{+}_{(aq)}$ $0.01\ mol\ L^{-1}$ 0 0 (initial) -x +x +x (change) 0.01 – x x x (Equili.) $[H_3O^+] = x$ $[NO_2^-] = x$ $[HNO_2] = 0.01 - x \approx 0.01$ $[H_2O] \approx 1$ • Determination of $[H_3O^+]$ $K_a = [H_3O^+].[NO_2^-] / [HNO_2]$ $5.6 \times 10^{-4} = (x.x) / (0.01)$ $x^2 = \sqrt{5.6 \times 10^{-6}}$ $x = [H_3O^+]\ 2.3 \times 10^{-3}\ mol\ L^{-1}$ or $0.0023\ mol\ L^{-1}$ (Answer is expressed to 2 significant figures)			• Able to determine the concentration of each species and • Correct linking between K_a of $[HNO_2]$ and $[H_3O^+]$ via an equation to determine $[H_3O^+]$ Not necessary that any or all of the calculation steps are shown prior to the calculation of $[H_3O^+]$.	Only one of the ideas is correctly demonstrated.

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CHE3.2.3.1	3.1c	3	• A strong acid such as HCl is a source of H_3O^+. • The addition of H_3O^+ will shift the equilibrium to the left favouring the backward reaction. • **The system will respond to counter the change introduced, which is by using up the additional H_3O^+ and favour the backward reaction OR addition of the products of a reaction to a system at equilibrium will cause the equilibrium to shift in the direction of the reactants.**		The student should be able to relate the shifting of the equilibrium to the left due to the increase in the concentration of H_3O^+ from the added strong acid/HCl (**in bold**).	Two ideas are correctly demonstrated without being linked.	One idea is correctly demonstrated.
CHE3.1.1.4	3.2	1	The solution can resist pH change upon the addition of an acidic or basic component.				Any one of: The solution can resist pH change upon the addition of an acidic or basic component OR It is an aqueous solution consisting of a mixture of a weak acid and its conjugate base or vice versa. OR It is an alkaline buffer/pH > 7.
CHE3.2.1.1	3.3	1	The analytical composition of a saturated solution, expressed in terms of the proportion of a designated solute in a designated solvent, is the solubility of that solute. (IUPAC definition)				IUPAC definition is given OR Solubility is the amount of a substance/solute that dissolves in a unit volume of a liquid substance/solvent to form a saturated solution under specified conditions of temperature and pressure OR Solubility is the maximum quantity of solute that can dissolve in a certain quantity of solvent or quantity of solution at a specified temperature or pressure.
CHE3.2.2.4	3.4	2	• Comparison of Q to K_{sp} Q (2×10^{-4} mol L^{-1}) > K_{sp} (2.4×10^{-5}) • precipitate will form			• Q is compared to K_{sp} correctly • conclusion is made correctly	One idea is demonstrated correctly.

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Strand 4: Oxidation–Reduction Reactions							
CHE4.1.1.1	4.1	1	An anion is a monoatomic or polyatomic species having one or more elementary charges of the electron (IUPAC definition).				IUPAC definition given OR ion that is negatively charged OR ion that flows towards the anode OR an atom that has more electrons than protons.
CHE4.1.1.2	4.2	1	Voltaic cell is an electrochemical cell: • that contains a spontaneous reaction • which always has a positive voltage • where electrical energy is released during the reaction/provides a source of energy. • which converts chemical energy into electrical energy • that consists of two compartments called half-cells. • where oxidation occurs at the anode. • where reduction occurs at the cathode. • where electrons flow from the negative electrode/anode to the positive electrode/ cathode • where the current flows from the positive electrode/cathode to the negative electrode/ anode • uses a salt bridge to conduct electricity/balance electrical charge				Any one feature is stated correctly.
CHE4.1.3.4	4.3	3	Cl_2 has a more positive/ higher reduction potential than Zn^{2+}. Cl_2 will undergo reduction readily. **The ability of Cl_2 to gain electrons more readily than Zn^{2+} makes it a stronger oxidant/oxidizing agent than Zn^{2+} OR the ability of Zn^{2+} to lose/give up electrons more readily than Cl_2 makes it a stronger reductant /reducing agent than Cl_2.**		The student has clearly linked the two ideas by relating to the ability of Cl_2 to gain/lose electrons as compared to Zn^{2+} OR the ability of Zn^{2+} to gain/lose electrons as compared to Cl_2 **(in bold)**.	The student has stated the positive / high electrode potential for Cl_2 and the ability of Cl_2 to undergo reduction readily OR the negative/low electrode potential for Zn^{2+} and the ability of Zn^{2+} to undergo reduction readily	The student has only stated either the positive / high electrode potential for Cl_2 OR the ability of Cl_2 to undergo reduction readily OR negative / low electrode potential for Zn^{2+} OR the ability of Zn^{2+} to undergo oxidation readily.
CHE4.1.4.1	4.4	4	• **Composition of wet cell batteries:** These are examples of voltaic or galvanic cells. One battery can consist of a number	The student has discussed all three ideas correctly with clear linking and flow.	The student has at least demonstrated two ideas correctly and	The student has mentioned two or three ideas correctly without linking them.	The student has only mentioned one idea correctly (composition, characteristic or an application of a

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			of voltaic cells. A wet cell battery generates power from a pair of electrodes and a liquid electrolyte solution. The liquid electrolyte can be corrosive liquids. For example, a lead acid battery is a secondary wet cell battery that contains lead, lead oxide, plates and an electrolyte solution that contains a mixture of water and acid. A sheet of insulation separates the anode (negative electrode) from the cathode (positive electrode). The plates in this type of wet cell battery can be anodes that are attached to a negative battery terminal or cathodes attached to a positive battery terminal. For example the car battery is comprised of lead plates in a solution of sulfuric acid. • **Characteristics of wet cell batteries:** There are two types of wet cell batteries: primary and secondary. a) Primary (non-rechargeable): The electricity producing chemical reaction cannot be reversed, so once exhausted it can never be charged again. A primary wet cell battery can only be used until its chemicals no longer react with each other. b) Secondary (rechargeable): The chemical reaction can be reversed and thus battery can be charged “n” number of times. If properly maintained, wet cell batteries also have a high number of charge-discharge cycles. They are also less likely than other batteries to suffer damage from overcharging. Heat, vibration and overcharging will also deplete the battery's power. The batteries must be kept them upright to prevent leakage. Most wet-cell batteries available today are sealed so users are not exposed to the lead and sulfuric acid. To operate the wet cell battery a load is attached to the terminals and a chemical reaction between the electrolyte solution, lead, and lead oxide occurs. The chemical reaction causes electricity to flow through		has linked them together.		wet cell battery).

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			the terminals to the load attached. Some of the acid in the battery remains on the plates as it flows through. When the battery is recharged the acid is returned to the liquid solution to provide more power later. • **Application of wet cell batteries:** These are commonly found in aviation, electric utilities, energy storage and cellphone towers. They are used in industry for standby power for switchgear, telecommunication or large uninterruptible power supplies. The rechargeable ability of these batteries makes them ideal for use in motor vehicles, where the car's alternator recharges the battery after starting. These batteries are used to start most cars.				
Strand 5: Organic Chemistry							
CHE5.1.1.2	5.1a	1	An addition polymer is a polymer that forms by simple linking of monomers without the co-generation of other products.				Addition polymer is a polymer formed by the simple linking of monomers without the co-generation of other products OR a polymer formed by the direct reaction of two or more monomers, and with no resulting water or other by-product.
CHE5.1.1.3	5.1b	1	PVC (unplasticised/rigid): • low-cost/lightweight/ flexible/ very dense/ white/ very brittle/ very hard/very strong/highly stiff/highly durable solid • has good chemical resistance • has poor heat resistance • has good dimensional stability at room temperature • has good electrical insulation • is a good vapour barrier PVC (plasticised/flexible): • low cost/flexible/ high impact strength • good resistance to UV/ acids/alkalis/oils/corrosive inorganic chemicals				Any one feature is correctly stated.

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			• good electrical insulation property • non-flammable property • easier to process than rigid PVC				
CHE5.1.3.14	5.1c	3	Structure and bonding • Polyvinyl chloride (PVC) is a linear polymer. • It consists of polar molecules attracted by dipole-dipole interactions between chlorine and hydrogen atoms. • The regular arrangement of the chlorine atoms in this structure allows the polymer chains to pack together closely and maximises the intermolecular forces between the chains. Property • The maximised intermolecular forces between polymer chains makes it strong. • Close packing reduces the flexibility of polyvinyl chloride and makes it quite rigid. • The application of heat and pressure will cause PVC to soften and take on new shapes since the weak intermolecular forces between the chains are easily broken.		The student is able correctly to relate any one property to the structure and bonding in PVC.	A property and structure/ bonding are mentioned correctly without linking them.	A property or structure/bonding is mentioned correctly.
CHE5.1.1.1	5.2a	1	Constitutional isomers are compounds that have the same molecular formula but different connectivity.				Constitutional isomers are compounds that have the same molecular formula but different connectivity/bonding arrangement of atoms OR compounds that have the same molecular formula but different chemical structures/ structural formulas.
CHE5.2.1.2	5.2b	1	Substitution or chlorination reaction				Substitution or chlorination reaction
CHE5.2.2.10	5.2c	2	• Reaction **Z** conditions are water or acid or base with heat/reflux • Compound **B** is ethanol			Both ideas are correctly demonstrated.	One idea is correctly demonstrated.

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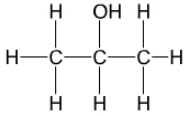
CHE5.2.2.7	5.3	2	• Reaction condition is $LiAlH_4$ or $NaBH_4$ • Structure of alcohol: 			Both ideas are correctly demonstrated.	One idea is correctly demonstrated.
CHE5.2.4.3	5.4	4	•Amines have a lone electron pair on their nitrogen atoms and can accept a proton from water to form substituted ammonium (NH_4^+) ions and hydroxide (OH^-) ions. An example of such a reaction is as follows: $NH_{3\,(aq)} + H_2O_{\,(l)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$ Dilute solutions of ammonia are used as household cleaners for the is effective for removing grease, fats and oils. It reacts with these to form soap, which the water in the ammonia solution dissolves and removes easily. Ammonia is used as commercial fertiliser and is applied directly to soil. Ammonia will rapidly react with soil water to form ammonium (NH_4^+), which is retained on the soil cation exchange sites. Ammonia is sometimes dissolved in water to produce the liquid nitrogen fertiliser. • Nearly all amines, including those that are not very soluble in water, will react with strong acids to form salts soluble in water. An example of such a reaction is as follows: $NH_{3\,(aq)} + HCl_{\,(aq)} \rightarrow NH_4Cl_{\,(aq)}$ These compounds are ionic (salts) and the properties of the compounds (solubility, for example) are those characteristic of salts. Many drugs that are amines are converted to	The student has discussed all three ideas (reaction, application and equation) and has linked them logically and correctly.	The student has demonstrated any two ideas correctly and has linked them together.	The student has mentioned two or three correct ideas without linking them.	The student has mentioned only one correct idea.

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			hydrochloride salts to increase their solubility in aqueous solution. Tetramethyl ammonium iodide is used for disinfecting drinking water. One of the most straightforward methods of preparing a simple salt containing the tetramethylammonium ion is by the reaction between trimethylamine and a methyl halide. • Amines are used for polyamide manufacture e.g. Nylon 6,6 formed from hexanediamine and adipic acid • Amino acids are building blocks for polypeptides (proteins)				