# ST. PATRICK'S SCHOOL
# MASTERY REVIEW 2026
# MARK SCHEME

**LEVEL : SECONDARY 4 EXPRESS**
**SUBJECT : CHEMISTRY**

## SECTION A

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| **B** | **A** | **C** | **B** | **C** | **D** | **A** | **D** | **A** | **C** |

## Section B

| | | | | |
|---|---|---|---|---|
| 1 | a | $FeSO_4$/ $Ag_2CO_3$ | 1 | **5** |
| | b | $Ag_2CO_3$ | 1 | |
| | c | $Al_2O_3$ | 1 | |
| | d | $CaCl_2$ | 1 | |
| | e | $SiO_2$ | 1 | |
| 2 | a | Line through the points is smooth and has the correct profile Ignore 0–5 $cm^3$ section of the graph. (1)<br>Lose this mark if graph is kinked or not a single line. (1)<br>Line ignores the point at 12 $cm^3$ Lose this mark if point clearly not treated as an anomaly. (1) | 3 | **9** |
| | bi | 24.4 $cm^3$ ± 0.2 If no answer in (i) allow answer written on the graph. Allow this answer only. Do not penalise precision. | 1 | |
| | bii | 12.2 $cm^3$ ± 0.1 If no answer in (ii), allow answer written on the graph. Allow answer to (i) divided by 2. Do not penalise precision. | 1 | |
| | biii | 3.9 ± 0.2 If no answer in (iii), allow answer written on the graph or can be detected from the graph). Consequential marking from (ii) Lose this mark if answer not given to 1 dp.( whole no without 1 dp accepted) | 1 | |
| | c | The pH is about 3.8-4.0, which is higher than the pH expected for a strong acid/strong acid has pH 0-2.<br>(Accept has $pK_a$> 0/pH which is of a weak acid)<br>This shows that acid Y only partially ionises in water and is therefore a weak acid. | 1<br><br>1 | |
| | d | pKa = 3.8-4.0 gives methanoic acid.<br>Accept based on their value of pH, the corresponding named acid from $pK_a$<br>No lucky guesses – candidates must apply answer from (c). | 1 | |
| 3 | a | $Cl_2 + 2OH^- \rightarrow ClO^- + Cl^- + H_2O$<br><br>Chlorine oxidation state **decreased from 0 in $Cl_2$ to -1 in $Cl^-$** (1) | 3 | **3** |

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| | | and **increased from 0 in $Cl_2$ to +1 in $ClO^-$**. (1)<br>Both an oxidising and reducing agent.(1)<br><br>Accept : $Cl_2$is an oxidising agent, oxidation states decreases from **decreased from 0 in $Cl_2$ to -1 in $Cl^-$** (1m only)<br>or $Cl_2$is a reducing agent , oxidation sate of chlorine **increased from 0 in $Cl_2$ to +1 in $ClO^-$**. ( 1m only) | | |
| 4 | a | any one from:<br>• carbon monoxide toxic / poisonous as cause starvation of oxygen in body cells/ combined with haemoglobin in red blood cells which carries oxygen.<br>**do not accept carbon monoxide is harmful / dangerous / deadly**<br>• greater public concern / awareness about pollution<br>**do not accept comments about the effects of other pollutants ignore unspecified comments about carbon monoxide pollution**<br>• more cars so otherwise there would be more carbon monoxide entering atmosphere<br>• improved engine technology<br>• catalytic converters have been introduced | 1 | **6** |
| | b | any one from:<br>• (to reduce) health problems allow (to reduce) specified health problems e.g. accept caused breathing difficulties, asthma, lung cancer ( accept lungs or eyes irritation )<br>• (to reduce) smog / (to reduce) the formation of particulates<br>**ignore global warming do not accept to reduce soot** | 1 | |
| | c | **nitrogen** (from atmosphere) reacts with **oxygen** (from atmosphere) at **high temperature** (in engine) and provide **enough energy (1) to break N≡N bond** or to **provide Ea for $N_2$/$O_2$ reaction** (1) | 1<br>1 | |
| | di | $2NO_2(g) \rightarrow N_2(g) + 2O_2(g)$ or $2CO(g) + 2NO(g) \rightarrow 2CO_2(g) + N_2(g)$ | 1 | |
| | d | Catalyst arranged in **honeycombed structures** that **maximise /increase the surface area** for gases to interact with | 1 | |
| 5 | a | $O_2^-$, one oxygen atom **does not have complete/full valence shell/ 7 valence electrons instead of 8** after bonding<br>accept one oxygen atom missing one electron/ one ato has electronic configurtion (2.7) | 1 | **6** |
| | bi | $Na_2O_2$ | 1 | |
| | bii | $Mg(O_2)_2$ | | |

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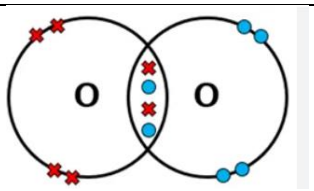
| | c |  <br>1m for shared electrons and 1 m for unshared electrons | 2 | |
| | d | $O_2$ has **double bond** between O atoms while peroxide has a **single bond** between oxygen atoms<br>• the peroxide ion has **gained two electrons**, so fewer electrons need to be shared between the oxygen atoms.<br>OR<br>• Each oxygen already has **more electrons in its outer shell**, so **only one pair of electrons is shared**. | 1<br>1 | |
| 6 | a | The atomic radii increase due to **the increased in the number of electrons** of the halogens down the group.<br>As the number of electrons increases, **more electron shells are required**( to 'house') the electrons, thus creating a bigger atom. | 1<br>1 | **7** |
| | b | Since electronegativity is a measure of the tendency of an atom to attract a bonding pair of electrons, this implies that **the ability of attraction of another electron from other atom decreases on going down the group** as electronegativity decreases on going down the group.<br>Hence, the **decrease in electronegativity(1)** leads to the **decrease of reactivity (1)** down the group.<br>-1 m if failed to note from Graph 2 that electronegativity decreases down the group or vice-versa and explain instead the electrostatic forces of attraction between nucleus and valence electrons decreases | 1<br>2 | |
| | c | Fluorine is **more reactive** than bromine, which is **brown** in colour.<br>The fluorine gas **displaces bromide ions** from potassium bromide, causing it to be oxidised to bromine, resulting in brown colour.<br>$2\ Br^-\ (aq) + F_2\ (g) \rightarrow 2\ F^-\ (aq) + Br_2\ (l)$<br>$F_2$ more reactive + displacement - 1m<br>Bromine liquid is brown - 1m<br>Correct balance equation and sate symbols -1m | 1<br>1<br>1 | |
| **7** | | Mol of acid = 24/1000 x 0.050 = 0.0012 mol<br>Mol of $OH^-$ = 20/1000 x 0.060 =0.0012 mol<br>Mol ratio of acid : Base is 1:1<br>**With Hydrochloric Acid**<br>$M(OH)_2 + 2HCl \rightarrow MCl_2 + 2H_2O$<br>*Ratio is 1 hydroxide : 2 acid.* | 3 | **3** |

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| | | **With Sulfuric Acid**<br>$M(OH)_2 + H_2SO_4 \rightarrow MSO_4 + 2H_2O$<br><br>**M1**<br>**Calculation of Moles**<br>Calculating the number of moles for both the metal hydroxide and the unknown acid<br>**M2 Stoichiometric Ratio**<br>Identifying the reacting mole ratio of acid to base as **1:1** based on the calculated values.<br>**M3 Deduction & Equation**<br>Identifying **sulfuric acid** by explaining that it **is dibasic** and provides the **$2H^+$ ions needed to neutralize the $2OH^-$ ions in 1 mole of $M(OH)_2$**.<br>Accept in embedded chemical equations of metal hydroxide with hydrochloric acid is 1:2 and with sulfuric acid is 1:1 – 1m | | |
| | | | | |
| **8** | a | $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$ | 1 | **6** |
| | b | Catalyst | 1 | |
| | c | $CuSO_4$ reacts with Zn in a **displacement** reaction.<br>**Reduces the amount of Zn** available to react with sulfuric acid | 1<br>1 | |
| | d | No<br>Different metals have $A_r$ => **same mass = different no. of moles of metal** => different no. of moles of $H_2$ = different vol of $H_2$<br>Unreactive metals like silver will not produce any $H_2$ | 1<br>1 | |
| | | | | |
| **9** | ai | Volume increases till 3rd dotted line | 1 | **4** |
| | aii | Steeper graph, same ending point | 1 | |
| | b | Energy profile diagram for ENDOTHERMIC reaction<br>- Shape – reactants < products<br>- Labels – axis, delta H and $E_a$<br>Ecf max 1m if exothermic reaction with correct labels | <br>1<br>1 | |
| | | | | |
| **10** | a | $C_6H_5NH_2$ : 2nd order<br>$Br_2$ : 1st order | 1<br>1 | **10** |
| | b | 0.028 $mol/dm^3s^{-1}$ | 1 | |
| | c | Concentration increase<br>⇨ Particles are closer to one another OR More reacting particles **per unit volume**<br>⇨ **Frequency** of collisions increase<br>⇨ **Rate of reaction** increase | <br>1<br><br>1 | |

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| | d | No<br>Step 1 is not redox – no change in oxidation state, o.n. of S remains at +6<br>Step 2 is redox:<br>- O.N. of S decrease from +6 in sulfuric acid to +4 in sulfur dioxide => S is reduced = sulfuric acid = O.A.<br>Need to state either oxidation number of either S or Br | 1<br><br><br>1 | |
| | e | Production of sulfur dioxide – reacts with oxygen and water in the air to produce sulfuric acid.<br>$2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4$<br>Environmental problem:<br>- Acidify waterbodies – kills marine life<br>- Acidify soil – kills crops and plants<br>- Corrode buildings and structures of limestone and metal<br>R: $HSO_4^- + H^+ \rightarrow H_2SO_4$ | 1<br><br>1<br><br>1 | |

**Section C**

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| 11 | a | Cathode: $O_2 + 4H^+ + 4e \rightarrow 2H_2O$<br>Anode: $C_2H_4O_2 + 2H_2O \rightarrow 2CO_2 + 8H^+ + 8e$ | 1<br>1 | **10** |
| | b | Allowing only **$H^+$ ions** to pass through from the anode to the **cathode** | 1 | |
| | c | Fuel produces as much $CO_2$ as the $CO_2$ captured during the production – no nett $CO_2$ is added to the environment through combustion | 1 | |
| | d | Accept any reasonable answer:<br>- MFC can act as biological filter and produce electrical energy at the same time, but HFC only produces electrical energy<br>- MFC uses waste as fuel, but HFC requires purified hydrogen gas<br>This is a comparison-type question | 2 | |
| | e | Temperature increases<br>⇨ More particles that have energy > Ea OR particles have higher KE<br>⇨ Frequency of effective collisions increase<br>⇨ Rate of reaction increases<br>Beyond 60°C, enzymes stop working / denatured hence reaction stops | 1<br><br>1<br><br>1 | |
| | f | Brush has **larger surface area** than a plate => increase **rate of reaction** | 1 | |

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| 12 | a | Higher concentration of glucose<br>⇨ More $H_2O_2$ produced<br>⇨ More e- produced<br>⇨ More current measured<br>R: rate of reaction (wrong concept) | <br>1<br><br>1 | **10** |
| | b | Lower than actual<br>Low $[O_2]$<br>⇨ Limiting reactant, reaction is not complete<br>⇨ Less $H_2O_2$ produced<br>⇨ **Less e-** produced | 1<br><br>1 | |
| | c | +3<br>+2<br>AWW: 3+ , 2+ | 1<br>1 | |
| | d | Cathode: $[Fe(CN)_6]^{3-} + e \rightarrow [Fe(CN)_6]^{4-}$<br>Anode: $C_6H_{12}O_6 + H_2O \rightarrow C_6H_{12}O_7 + 2H^+ + 2e$ | 1<br>1 | |
| | e | Higher than actual<br>Vitamin C oxidises to **produce electrons** which is added to the circuit<br>Meter is measuring the amt of electrons produced | 1<br>1 | |