

## 6092 Chemistry Prelim Examination 2020 Marking Scheme

### Multiple-Choice Questions [40 M]

|    |    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|----|
| 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 |
| C  | B  | B  | A  | B  | A  | B  | C  | A  | D  |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| A  | C  | B  | C  | A  | D  | B  | D  | D  | B  |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| D  | B  | C  | B  | D  | A  | D  | D  | C  | B  |
| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| B  | D  | C  | A  | B  | D  | D  | A  | D  | C  |

### Section A: Short-Structured Questions [50 M]

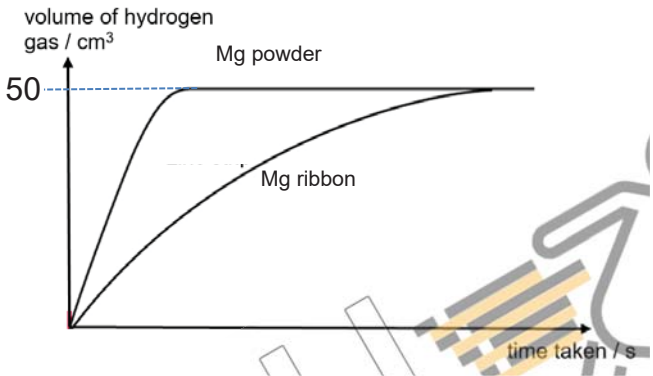
|   |     |  |            |
|---|-----|--|------------|
| 1 | (a) | Zn   | [1]        |
|   | (b) | CaO  | [1]        |
|   | (c) | C  | [1]        |
|   | (d) | Cu   | [1]        |
|   | (e) | N <sub>2</sub>   | [1]        |
| 2 |     | Substance 1: sulfuric acid   | [1]        |
|   |     | Substance 2: sodium hydroxide  | [1]        |
|   |     | Substance 3: barium carbonate  | [1]        |
|   |     | Substance 4: magnesium   | [1]        |
| 3 | (a) | Mn: +2<br>O: -1  | [1]<br>[1] |
|   | (b) | Potassium manganate (VII) causes an increase in the oxidation state of oxygen, -1 in hydrogen peroxide to 0 in oxygen gas, oxidizing hydrogen peroxide.<br>Manganese decreased in oxidation state from +7 in potassium manganate (VII) to +2 in manganese sulfate, reducing itself.<br><br>Must explain with the comparison of o.s. as question says from part (a)<br><br>Allow ECF from incorrect o.s. from (a) | [1]<br>[1] |

|   |  |                          |
|---|--|--------------------------|
| 4 | <p>The dissolving of sodium chloride in water (is an endothermic process) and has an enthalpy change of + 4.3 kJ/mol / absorbs 4.3kJ/mol of energy.</p> <p>Heat is absorbed from the ice cream (surroundings) / ice cream loses heat to the melting ice and salt solution, decreasing the temperature of the ice cream, keeping it intact.</p> <p>The dissolving of lithium chloride in water (is an exothermic process) and has an enthalpy change of -35.0 kJ/mol / gives out 35.0kJ/mol of energy.</p> <p>Heat is given out to the ice cream (surroundings) / ice cream gains heat from the melting ice and salt solution, increasing the temperature of the ice cream, causing it to melt.</p> <p>Therefore, sodium is recommended.</p> <p><i>Reject: surroundings feel hot/get warmer or cold/get cooler.</i></p> <p>All 4 points – 3m<br/>3 points – 2m<br/>2 points – 1m<br/>0/1 point – 0m, No data given: deduct 1 mark</p> | [3]                      |
| 5 | <p>Dissolve excess calcium carbonate / calcium oxide in nitric acid to ensure all acid has reacted. <i>[mention of reactants + dissolving]</i></p> <p>Filter the mixture to obtain calcium nitrate as the filtrate.</p> <p>Heat the filtrate to saturation and allow it cool to form calcium nitrate crystals.</p> <p>Wash crystals with little deionized water to remove water soluble impurities and dry between sheets of filter paper.</p>   | [1]<br>[1]<br>[1]<br>[1] |
| 6 | (a) The larger the current, the larger the increase in mass of the negative electrode.   | [1]                      |
|   | (b) 0.2 g  | [1]                      |
|   | (c) $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$<br>$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$<br>Overall: $\text{Cu}^{2+}(\text{aq}) + 2\text{Ag}^+(\text{aq}) \rightarrow \text{Cu}(\text{s}) + 2\text{Ag}(\text{s})$  | [1]                      |
|   | 2 equations are given or overall equation  | [1]                      |
|   | 2 mol of electrons form 2 mol of Ag but<br>2 mol of electrons only form 1 mol of Cu.   | [1]                      |
|   | As the relative atomic mass of Ag ( $A_r = 108$ ) and Cu ( $A_r = 64$ ) is different, the mass is different, mass of Ag solid = 216g and mass of Cu solid = 64g.   | [1]                      |
| 7 | (a) $2\text{Cu} + \text{O}_2 \rightarrow 2\text{CuO}$  | [1]                      |
|   | (b) mass of copper reacted with air = $5.00 - 3.40 = 1.60\text{ g}$<br>no. of moles of Cu reacted = $1.60 \div 64 = 0.0250\text{ mol}$   | [1]                      |
|   | (c) no. of moles of $\text{O}_2$ reacted = $0.0250 \div 2 = 0.0125\text{ mol}$<br>volume of $\text{O}_2$ reacted = $0.0125 \times 24 = 0.300\text{ dm}^3$  | [1]                      |
|   | Allow for ECF if equation in (a) is incorrect.   | [1]                      |
|   | (d) % of $\text{O}_2$ in the planet's atmosphere = $0.300 \div 1.000 \times 100\% = 30\%$<br>Allow for ECF if answer in (c) is incorrect.  | [1]                      |

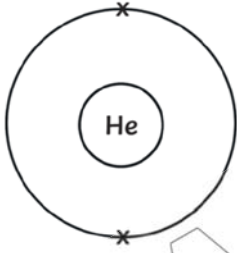
|    |          |   |                         |
|----|----------|---|-------------------------|
| 8  | (a)      | Mercury, nickel , zinc , magnesium  | [1]                     |
|    | (b)(i)   | Solution changes from green to colorless.<br>Grey/Silvery solid is formed.  | [1]<br>[1]              |
|    | (b)(ii)  | $Mg (s) + Ni^{2+} (aq) \rightarrow Mg^{2+} (aq) + Ni (s)$   | [1]                     |
|    | (c)(i)   | The gas produced extinguishes a lighted splint with a 'pop' sound and hence hydrogen gas is produced.   | [1]                     |
|    | (c)(ii)  | Silvery solid is formed.<br>Nickel(II) oxide has been reduced to grey solid nickel by hydrogen.   | [1]<br>[1]              |
| 9  | (a)      | Zinc electrode will decrease in size/mass over time. (or dissolve)<br>Copper electrode will increase in size/mass over time. (or pink solid/Cu metal)   | [1]<br>[1]              |
|    | (b)      | Zinc is more reactive than copper and will lose electrons more readily than copper.<br><br>The electrode from which electrons flow out is the negative electrode, hence it is zinc.   | [1]<br>[1]              |
|    | (c)      | Zinc being more reactive than copper will displace copper(II) ions from copper(II) sulfate solution to form zinc sulfate.<br><br>This will reduce the cell's ability to reach its maximum voltage.  | [1]<br>[1]              |
| 10 | (a)(i)   | $ZnCO_3 (s) \rightarrow ZnO (s) + CO_2 (g)$<br><br>No. of mol. of ZnO = No. of mol. of $ZnCO_3 = 6.2 \text{ g} \div 125 = 0.0496 \text{ mol}$<br>Mass of ZnO = $0.0496 \text{ mol} \times (65+16) = 4.02 \text{ g}$ (to 3 s.f.)   | [1]<br>[1]              |
|    | (a)(ii)  | Sample D, as there is no change in mass between attempts 1 and 2.   | [1]                     |
|    | (a)(iii) | The zinc carbonate has fully decomposed. (The reaction is complete.)  | [1]                     |
|    | (b)(i)   | Ans 1: He should record the time taken for white ppt. to form in limewater.<br>Ans 2: He should record the mass of white ppt. formed in a given time.   | [1]                     |
|    | (b)(ii)  | Ans 1:<br><ul style="list-style-type: none"> <li>The metal carbonate that took the shortest time to produce a white ppt. is copper(II) carbonate</li> <li>while the metal carbonate that took the longest time to produce a white ppt. is zinc carbonate.</li> <li>The metal carbonate that did not produce a white ppt. is sodium carbonate.</li> </ul> <p>Hence sodium carbonate is most thermally stable, followed by zinc carbonate and copper(II) carbonate.</p> <p>Ans 2:<br/> <ul style="list-style-type: none"> <li>The metal carbonate that produces the most white ppt is copper(II) carbonate</li> <li>while the metal carbonate that produces the less white ppt is zinc carbonate.</li> <li>The metal carbonate that did not produce a white ppt. is sodium carbonate.</li> </ul> <p>Hence sodium carbonate is most thermally stable, followed by zinc carbonate and copper(II) carbonate.</p></p> | [1]<br>OR<br>[1]<br>[1] |

**Section B: Long-Structured Questions [30M]**

|    |     |  |            |
|----|-----|--|------------|
| 11 | (a) | This results in the precipitation of metal carbonate when hydroxide ions in the electrolyte react with the acidic carbon dioxide.<br>This results in less mobile ions to be available to conduct electricity.  | [1]<br>[1] |
|    | (b) | Cathode: $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$<br>Anode: $H_2(g) + 2OH^-(aq) \rightarrow 2H_2O(l) + 2e^-$   | [1]<br>[1] |
|    | (c) | Lower working temperature of zinc-air fuel cell requires lower cost to use as less energy is needed. OR<br>Zinc-air fuel cell is more efficient as the energy density is higher. OR<br>The zinc-air fuel cell is cheaper to manufacture.                                   | [1]        |
|    | (d) | No, I don't agree. Energy is needed to maintain the temperature of the cells.<br>This energy is obtained from the burning of fuels at the power station which produces waste gases that can pollute the environment.   | [1]<br>[1] |
|    | (e) | $2Zn + O_2 \rightarrow 2ZnO$   | [1]        |
|    | (f) | Mass of 1 mole of Zn = 65 g = 0.065 kg<br>Energy density per mole of fuel = $1370 \times 0.065 = 89.1 \text{ Wh/mol}$<br><br>OR<br><br>Number of moles of Zn = $1000 / 65 = 15.385 \text{ mol}$<br>Energy density per mole of fuel = $1370 / 15.385 = 89.0 \text{ Wh/mol}$ | [1]<br>[1] |

|    |     |  |            |
|----|-----|--|------------|
| 12 | (a) | In Experiment I, sulfuric acid, a dibasic acid ionizes completely to form 2 moles of hydrogen ions.  | [1]        |
|    |     | In Experiment II, hydrochloric acid, a monobasic ionizes completely to form 1 mole of hydrogen ions.   | [1]        |
|    |     | As the number of hydrogen ions per unit volume is twice in Experiment I than that of Experiment II, there is a higher frequency of effective collision in Experiment I. Hence a faster reaction.   | [1]        |
|    | (b) | Copper(II) sulfate acts as a catalyst.<br>It reduces the time taken to collect 50 cm <sup>3</sup> of hydrogen gas. Experiment I takes 28s while experiment III takes only 17s. [must give data]  | [1]<br>[1] |
|    | (c) |  <p>1m – labelled axes with units<br/>1m – correct shape of graph for both magnesium ribbon and powder<br/>1m – both graphs produce same volume of hydrogen gas (must show 50cm<sup>3</sup>)</p> | [3]        |
|    | (d) | The volume of hydrogen gas produced will be the same regardless of volume of potassium sulfate added.  | [1]        |
|    |     | Magnesium, being less reactive than potassium is unable to displace potassium from potassium sulfate. Hence, mass of magnesium reacting with sulfuric acid remains the same.   | [1]        |

|            |                 |  |                   |
|------------|-----------------|--|-------------------|
| <b>13E</b> | <b>(a)(i)</b>   | Any value between 10 to 12   | [1]               |
|            | <b>(a)(ii)</b>  | The colour changes from green to purple/violet as ammonia is a weak alkali and dissociates partially to form hydroxide ions.<br><br>start, end colour must be given to get first mark  | [1]<br>[1]        |
|            | <b>(a)(iii)</b> | The ammonia molecules evaporate from the surface of the solution after gaining enough energy from the surroundings.<br><br>The ammonia molecules diffuse from a region of higher concentration, front of class to a region of lower concentration, back of class.<br><br>The ammonia molecules are in constant, random motion hence the students at back of class can smell the ammonia. | [1]<br>[1]<br>[1] |
|            | <b>(b)(i)</b>   | 4 NO, 6 H <sub>2</sub> O   | [1]               |
|            | <b>(b)(ii)</b>  | The energy released by formation of products is greater than that of energy absorbed by breaking bonds between reactants.  | [1]               |
|            | <b>(b)(iii)</b> | NO is oxidized as it gains oxygen to form NO <sub>2</sub> .<br>Need to give name of reactant; NO.  | [1]               |
|            | <b>(c)</b>      | Irritates eyes/nose/skin/mouth/airway/lungs<br>Cannot accept any reason associated to environment  | [1]               |

|          |          |  |     |
|----------|----------|--|-----|
| 13<br>OR | (a)      | The atomic radii increase due to the <u>increased in the number of electrons</u> of the halogens down the group.   | [1] |
|          |          | As the number of electrons increases, <u>more electron shells are required</u> to 'house' the electrons, thus creating a bigger atom.  | [1] |
|          | (b)      | Since electronegativity is a measure of the tendency of an atom to attract a bonding pair of electrons, this implies that <u>the ability of attraction of another electron from other atom decreases on going down the group</u> as electronegativity decreases on going down the group. | [1] |
|          |          | Hence, the decrease in electronegativity leads to the <u>decrease of reactivity</u> down the group.  | [1] |
|          | (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.  | [1] |
|          |          | $2 \text{ Br}^{-}(\text{aq}) + \text{F}_2(\text{g}) \rightarrow 2 \text{ F}^{-}(\text{aq}) + \text{Br}_2(\text{l})$  | [1] |
|          | (d)(i)   |    | [1] |
|          | (d)(ii)  | Helium has a complete valence shell hence it does not need to share or transfer electrons to form compounds.   | [1] |
|          | (d)(iii) | Helium is a limited/finite gas.  | [1] |

