

UNITY SECONDARY SCHOOL  
PRELIMINARY EXAMINATION 2020

CHEMISTRY (ANSWER KEY)

Paper 1

<b>Q1</b>	<b>Q2</b>	<b>Q3</b>	<b>Q4</b>	<b>Q5</b>	<b>Q6</b>	<b>Q7</b>	<b>Q8</b>	<b>Q9</b>	<b>Q10</b>
B	B	A	C	C	C	D	D	D	D
<b>Q11</b>	<b>Q12</b>	<b>Q13</b>	<b>Q14</b>	<b>Q15</b>	<b>Q16</b>	<b>Q17</b>	<b>Q18</b>	<b>Q19</b>	<b>Q20</b>
D	D	C	A	A	A	B	A	A	D
<b>Q21</b>	<b>Q22</b>	<b>Q23</b>	<b>Q24</b>	<b>Q25</b>	<b>Q26</b>	<b>Q27</b>	<b>Q28</b>	<b>Q29</b>	<b>Q30</b>
B	D	D	C	D	B	C	A	B	A
<b>Q31</b>	<b>Q32</b>	<b>Q33</b>	<b>Q34</b>	<b>Q35</b>	<b>Q36</b>	<b>Q37</b>	<b>Q38</b>	<b>Q39</b>	<b>Q40</b>
B	B	D	C	C	A	D	A	D	D

Paper 2

<b>1</b>	<b>(a)</b>	$\text{MgCO}_3 \rightarrow \text{MgO} + \text{CO}_2$	1
	<b>(b)</b>	It is seen that lithium carbonate has the highest temperature needed of 1300 °C for decomposition and silver carbonate required the lowest temperature of 210 °C for decomposition.  So the higher the reactivity of metal, the higher the temperature needed for the decomposition of metal carbonate.	1  1
	<b>(c)</b>	About 300 °C ( range allowed)  Lead is <u>more</u> reactive than silver but less reactive than magnesium. Hence the temperature of decomposing lead(II) carbonate is <u>between</u> those of magnesium carbonate (402 °C) and silver carbonate (210 °C)	1
<b>2</b>	<b>(a)</b>	200 atm, 450 °C, iron as catalyst	1
	<b>(b)</b>	<u>Air, containing oxygen</u> would cause the heated <u>iron to oxidize</u>	1
	<b>(c)</b>	ammonium nitrate	1
		fertiliser	1
	<b>(d)</b>	0	1
		-3	
		+5	
	<b>(ei)</b>	Haber Process: reduction	1
	<b>(eii)</b>	Ostwald Process: oxidation	1

3	(a)	Carbon nanotubes have <u>structure similar to that of graphite</u> , thus they are <u>able to conduct electricity</u> due to <u>presence of free mobile electrons</u> to carry electrical charges.	1
	(b)	Carbon nanotubes have a <u>giant molecular structure</u> .  There are <u>many strong covalent bonds between carbon atoms</u> , thus needing <u>a lot of energy to break these bonds</u> . (Need to quantify, "network of strong covalent bonds accepted").	1 1
	(c)	Metallic bonding is the strong electrostatic forces of attraction between the fixed positive ions and the "sea of mobile electrons".	1
4	(a)	Z, X, Y	1
	(b)	Lead is not found in Period 4, it is found in Period 6.  When oxides of X reacts with dilute hydrochloric acid, lead (II) chloride formed is insoluble and will not dissolve to form a colourless solution.	1 1
5	(a)	ammonia	1
	(b)	8/9/10/11/12	1
	(c)	<u>Aluminium, being more reactive than lead</u> , loses electrons more readily, <u>displaces lead</u> , which is the grey solid, <u>from aqueous lead (II) nitrate</u> .  $3\text{Pb}^{2+}(\text{aq}) + 2\text{Al}(\text{s}) \rightarrow 3\text{Pb}(\text{s}) + 2\text{Al}^{2+}$	1
	(d)	White precipitate; dissolves in excess to give a colourless solution.	1
6	(a)	In 1990, solid fuels like coal was the most common type of fuel used but usage of coal was about halved/ dropped by 35% from 67% in 1990 to 32% in 2002.  In 2002, usage of gaseous fuels increased by 39% from 1% in 1990 to 40% in 2002.  Reasons: (Any one of the following) - Due to better/ more efficient transportation and storage of gaseous fuels - Natural gas burns more cleanly	1 1 1
	(b)	The concentration of CO decreased sharply from air:fuel ratio of 12:1 to 14:1 and decreased gradually after air: fuel ratio of 14:1.  There is a <u>high concentration of CO at the air: fuel ratio of 12:1</u> due to <u>less oxygen</u> present, leading to <u>more incomplete combustion</u> .  As the air: fuel ratio increased to 24:1, <u>more oxygen is available</u> for complete combustion, leading to <u>less incomplete combustion</u> . Hence decreasing the concentration of CO.	1 1 1

	(c)	Accept answers between 14: to 16:1.	1
7	(a)	Hydrogen burns in air to produce water which is not a pollutant to the environment.	1
		When petrol burns, by-products such as SO <sub>2</sub> and CO gases produced are pollutants to the environment.	1
	(bi)	Energy density of H <sub>2</sub> gas = 287/2 = 143.5 kJ	1
		Energy density of C <sub>8</sub> H <sub>18</sub> gas = 5473/(8X12+18) = 5477/114 = 48 kJ	1
		Thus H <sub>2</sub> has a greater energy density as compared to petrol.	1
	(bii)		2
	(biii)	As petrol is a liquid and hydrogen is a gas at room temperature, thus it is easier to store petrol as a fuel in motor vehicles than hydrogen.	1
	(biv)	Energy released to form 2 mol C=O bonds and 4 mol of O-H bonds is more than energy absorbed to break 4 mol of C-H bonds and 2 mol of O=O bonds.	1
			1
8	(ai)	Number of moles of CaF <sub>2</sub> = 15.6/78 = 0.2 mol	1
		Number of moles of H <sub>2</sub> SO <sub>4</sub> = 12.5/1000 x 20.0 = 0.25 mol	
		From the equation, 1 mol of acid reacts with 1 mol of calcium fluoride. So 0.25 mol acid will react with 0.25 mol of calcium fluoride. Since there is only 0.2 mol of calcium fluoride, calcium fluoride is the limiting reactant.	1
	(aii)	From the equation, 1 mol calcium fluoride will produce 2 mol of hydrogen fluoride. So 0.2 mol of calcium fluoride will produce 0.2 x 2 = 0.4 mol of HF.	1
		Theoretical volume of HF = 0.4 x 24 dm <sup>3</sup> = 9.6 dm <sup>3</sup>	1
	(b)	Number of mol of HF formed = 7.68 dm <sup>3</sup> / 24 dm <sup>3</sup> = 0.32 mol	

		<p>From equation, 2 mol of HF comes from 1 mol of <math>\text{CaF}_2</math> Hence, 0.32 mol of HF will come from <math>0.32/2 = 0.16</math> mol of <math>\text{CaF}_2</math></p> <p>Mass of pure <math>\text{CaF}_2 = 0.16 \times 78 \text{ g}</math> <math>= 12.48 \text{ g}</math></p> <p>% purity of <math>\text{CaF}_2 = 12.48 / 15.6 \times 100 \%</math> <math>= 80 \%</math></p>	1
			1
9	(a)	X: aspirin Y: acetaminophen Z: caffeine	1
	(b)	Based on the $R_f$ values, <u>caffeine</u> has the highest affinity for the silica gel.	1
		Caffeine has the <u>lowest</u> $R_f$ value as compared to aspirin and acetaminophen, this shows that the <u>distance moved</u> by caffeine on the TLC plate is <u>the shortest distance</u> . Hence this shows that caffeine has high affinity for silica gel.	1
	(c)	The <u>experimental melting points</u> for all three compounds are <u>lower</u> than the <u>literature values</u> .	1
		A possible reason is that <u>compounds X, Y and Z</u> are <u>not 100% pure</u>	1
		Or the compounds may contain <u>impurities</u> .	
10	(a)	As the concentration of the reagent increases, the rate of reaction also increases.	1
		Comparing experiment 2, 4 and 5, while keeping the concentration of aqueous chlorine dioxide the same, as the concentration of aqueous sodium hydroxide/hydroxide ion increases, the rate of disappearance of aqueous chlorine dioxide also increases.	1
		Comparing experiment 1, 2 and 6, while keeping the concentration of aqueous sodium hydroxide /hydroxide ion the same, as the concentration of aqueous chlorine dioxide increases, the rate of disappearance of aqueous chlorine dioxide also increases.	1
		Note: 1m for stating the general trend	

		1m for comparing the correct experiment 1m for mention that keeping concentration of the other reagent the same	
	(b)	When the concentration of aqueous chlorine dioxide or hydroxide ions increases, the number of aqueous chlorine dioxide particles or hydroxide ions per unit volume increases or the number of moles of aqueous chlorine dioxide particles or hydroxide ions per unit volume increases. This causes an increase in the frequency of effective collisions, hence, the rate of reaction also increases.	1 1
	(c)	Comparing experiment 1 and 2, when the concentration of aqueous chlorine dioxide is doubled/twice, rate of disappearance increased by 4 times. Comparing experiment 2 and 4 or (1 and 3), when the concentration of aqueous sodium hydroxide /hydroxide ion is doubled/twice, rate of disappearance increased by 2 times/ is doubled/twice. Hence, I agreed with student 1. OR Comparing experiment 2 and 5, when the concentration of aqueous chlorine dioxide is thrice, rate of disappearance increased by 9 times.  Comparing experiment 2 and 6, when the concentration of aqueous sodium hydroxide /hydroxide ion is thrice, rate of disappearance increased by 3 times. Hence, I agreed with student 1.	1 1
	(d)	Rate of disappearance = using expt 4 (0.040 mol/dm <sup>3</sup> of ClO <sub>2</sub> and 0.060 mol/dm <sup>3</sup> of OH <sup>-</sup> ) multiply by 2 = 0.02208 x 2 =0.04416 mol/ dm <sup>3</sup> s	1
	(e)	The oxidation state of chlorine increased from +4 in ClO <sub>2</sub> to +5 in ClO <sub>3</sub> <sup>-</sup>  The oxidation state of chlorine decreased from +4 in ClO <sub>2</sub> to +3 in ClO <sub>2</sub> <sup>-</sup>	1 1
11	(ai)	Cathode: 2H <sup>+</sup> (aq) + 2e <sup>-</sup> → H <sub>2</sub> (g)  Anode: 2Cl <sup>-</sup> (aq) → Cl <sub>2</sub> (g) + 2e <sup>-</sup>	1 1
	(aii)	<u>Effervescence</u> of a <u>colourless gas</u> produced at <u>cathode</u> . <u>Hydrogen</u> is <u>less reactive</u> than <u>sodium</u> in the reactivity series, therefore, <u>H<sup>±</sup> ions</u> is <u>preferentially discharged</u>	1 1

		<u>Effervescence of a greenish yellow gas produced at anode.</u> <u>Cl<sup>-</sup> ions</u> are preferentially discharged because it is a <u>concentrated</u> solution.	1 1
	<b>(bi)</b>	Number of mol of oxygen = $6/24 \text{ dm}^3 = 0.25 \text{ mol}$  As 4 mol hydroxide ions produce 4 mol of electrons and 1 mol oxygen, With 0.25 mol oxygen produced, there will be only 1 mol of electrons.  2 mol of electrons needed for 1 mol of copper to be formed. So 1 mol of electrons will produce $\frac{1}{2}$ mol of copper. Mass of copper formed = $\frac{1}{2} \times 64 \text{ g} = 32 \text{ g}$	1  1
	<b>(bii)</b>	Solution will turn from <u>blue to colourless.</u>  <u>Copper ions</u> are <u>preferentially discharged</u> from the solution; leaving behind hydrogen and sulfate ions in the solution which forms colourless sulfuric acid.	1  1
either			
<b>12</b>	<b>(ai)</b>	From zinc to copper	1
	<b>(aii)</b>	$2\text{H}^+ (\text{aq}) + 2\text{e} \rightarrow \text{H}_2 (\text{g})$	1
	<b>(aiii)</b>	Nb. Ethanol exists as a simple covalent molecule. It has no free ions or electrons /no mobile charge carriers so cannot conduct electricity.	1 1
	<b>(aiv)</b>	Larger reading. There is a greater difference in reactivity between copper and magnesium than that between zinc and copper.	1 1
	<b>(bi)</b>	Cathode: hydrogen gas (for both correct answer) Anode: water and oxygen gas	1
	<b>(bii)</b>	$4\text{OH}^- (\text{aq}) \rightarrow \text{O}_2 (\text{g}) + 2\text{H}_2\text{O} (\text{l}) + 4\text{e}$	1
	<b>(biii)</b>	When hydrogen ions are discharged at C, there is more hydroxide ions present there so the litmus turns blue	1
	<b>(biv)</b>	The <u>oxygen given off at the electrode forms causes a layer of aluminium oxide to be coated onto the aluminium preventing conduction of electricity.</u>	1
or			
<b>12</b>	<b>(a)</b>	Barium sulfate	1
	<b>(bi)</b>	yellow	1

	<b>(bii)</b>	Red/pink	1
	<b>(ci)</b>	4 cm	1
	<b>(cii)</b>	The height of the precipitate has become constant after reaction tube 4. This shows that <u>reaction is complete/all the hydroxide ions are used up</u> . Hence, the <u>height of the precipitate remains as 4 cm</u> in reaction tube 6.	1
	<b>(d)</b>	The electrical conductivity <u>decreases from reaction tube 1 and reaches a minimum at test tube 4</u> . The electrical conductivity <u>increases from reaction 4 to 6</u> .	1 1
	<b>(ei)</b>	Rinse the residue with distilled water.	1
	<b>(eii)</b>	After filtration, besides aqueous sodium nitrate, the filtrate may contain unreacted aqueous lead (II) nitrate or aqueous sodium sulfate. Hence, the crystal formed may not be pure sodium nitrate.	1
	<b>(eiii)</b>	titration	1

