


Victoria School
2020 Secondary 4 Preliminary Exam Answer Scheme

Paper 1

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

Paper 2 Section A

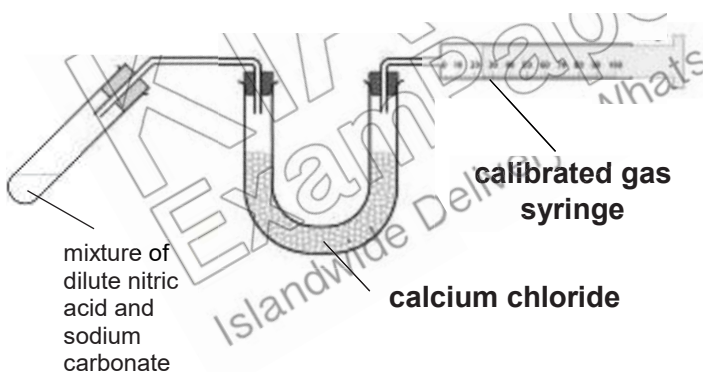
Qn	Suggested answers	Mark				
1a	graphite	1				
1b	lead(II) chloride	1				
1c	calcium chloride, hydrochloric acid	1				
1d	calcium chloride, hydrochloric acid	1				
1e	remains blue / no visible change	1				
1f	<table border="1" style="width: 100%; text-align: center;"> <tr> <td>inert electrodes</td><td>reactive electrodes</td></tr> <tr> <td>graphite/platinum</td><td>lead/copper</td></tr> </table>	inert electrodes	reactive electrodes	graphite/platinum	lead/copper	1
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graphite/platinum	lead/copper					
2a	1. <u>Filter</u> the <u>mixture</u> and obtain the red residue of silver dichromate. 2. Wash with (lots of) distilled water and dry between sheets of filter paper.	1 1				
2bi	+6	1				
2bii	$2\text{Ag}^+(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) \leftrightarrow \text{Ag}_2\text{Cr}_2\text{O}_7(\text{s})$ [1m] – balanced ionic equation [1m] – state symbols	2				
2ci	The dichromate ion (M_r of 216) has a larger relative molecular mass than the silver ion (A_r of 108). Hence silver ion <u>diffuses</u> faster than dichromate ion and the red line is formed <u>nearer</u> to ammonium dichromate.	1 1				
2cii	Shorter [must state but no mark] The ions/particles <u>gain</u> heat energy and <u>kinetic energy</u> and diffuse faster.	1				
3a	calcium	1				
3b	7 ; 4	1				
3c	Similarity: They have the same number of protons which is 114. Difference: ^{289}F has 3 more neutrons than ^{286}F / ^{289}F has 175 neutrons but ^{286}F has 172 neutrons.	1 1				
3di	 <p style="margin-left: 20px;">metal cations</p> <p style="margin-left: 20px;">sea of delocalised electrons</p> <p style="margin-left: 100px;">[1m] – diagram [1m] – labelling</p>	2				

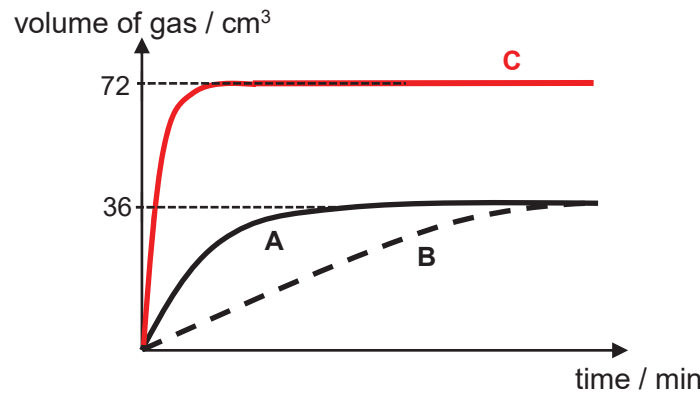
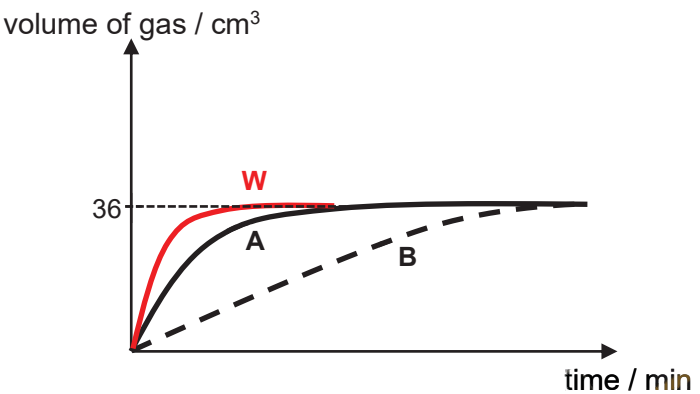
3dii	malleable / ductile / good conductor of electricity / good conductor of heat / lustrous / shiny	1																									
3diii	It reacts with acids to form salt and water / acidic oxides to form salts.	1																									
4ai	Barium carbonate has a lower solubility in water ($9.0 \times 10^{-5} \text{ mol dm}^{-3}$) than calcium carbonate ($1.5 \times 10^{-4} \text{ mol dm}^{-3}$) and hence can protect the monument from rain.	1																									
ii	Reaction slows down corrosion. Barium sulfate has a lower solubility in water ($9.4 \times 10^{-6} \text{ mol dm}^{-3}$) than barium carbonate ($9.0 \times 10^{-5} \text{ mol dm}^{-3}$).	1 1																									
bi	$\text{CO}(\text{NH}_2)_2 + \text{H}_2\text{O} \rightarrow 2\text{NH}_3 + \text{CO}_2$	1																									
ii	Ammonia gas can dissolve in the river, making the water alkaline which is unsuitable for the aquatic life. Carbon dioxide when produced in excess, traps excess heat and causes global warming. Ice caps melt, sea levels rise & flooding of lowlands	1 1 1																									
c	Acid rain	1																									
5a	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>C</th> <th>H</th> <th>N</th> <th>O</th> </tr> </thead> <tbody> <tr> <td>mass in 100 g / g</td> <td>63.6</td> <td>5.9</td> <td>9.3</td> <td>21.2</td> </tr> <tr> <td>A_r</td> <td>12</td> <td>1</td> <td>14</td> <td>16</td> </tr> <tr> <td>no. of moles / mol</td> <td>$63.6/12 = 5.3$</td> <td>$5.9/1 = 5.9$</td> <td>$9.3/14 = 0.664$</td> <td>$21.2/16 = 1.325$</td> </tr> <tr> <td>simplest ratio</td> <td>8</td> <td>9</td> <td>1</td> <td>2</td> </tr> </tbody> </table> <p>Empirical formula is $\text{C}_8\text{H}_9\text{NO}_2$</p>		C	H	N	O	mass in 100 g / g	63.6	5.9	9.3	21.2	A_r	12	1	14	16	no. of moles / mol	$63.6/12 = 5.3$	$5.9/1 = 5.9$	$9.3/14 = 0.664$	$21.2/16 = 1.325$	simplest ratio	8	9	1	2	2
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5bi	Two products (2-nitrophenol and 4-nitrophenol) are produced in step 1.	1																									
5bii	4-nitrophenol ($\text{C}_6\text{H}_5\text{NO}_3$) is <u>reduced as it loses oxygen / gains hydrogen</u> to form 4-aminophenol ($\text{C}_6\text{H}_7\text{NO}$)	1																									
5biii	<p>Mass of paracetamol in 8 tablets = 8×500 = $4000 \text{ mg} = 4 \text{ g}$</p> <p>No. of moles of paracetamol = $4 / [8(12) + 9 + 14 + 2(16)]$ = $4 / 151$ = 0.026490 mol</p> <p>No. of moles of 4-aminophenol = 0.026490 mol</p> <p>Mass of 4-aminophenol = $0.026490 \times [6(12) + 7 + 14 + 16]$ = 0.026490×109 = 2.8874 g = 2.89 g (to 3 s.f.)</p>	1 1 1																									
5biv	Check that melting point is fixed / Check that the paracetamol sample produces only one spot using paper chromatography.	1																									
5bv	Paracetamol has a <u>larger relative molecular mass (M_r)</u> than ethanoic acid so the <u>intermolecular forces of attraction</u> between paracetamol molecules <u>are stronger</u> than that between ethanoic acid molecules.	1																									
	Hence, <u>more energy</u> is required to overcome the intermolecular forces of attraction in paracetamol than ethanoic acid, hence paracetamol has a <u>higher melting point</u> than ethanoic acid.	1																									

c	Maximum dose of Panadol syrup in a day = 600 / 120 x 5 = 25 m/	1
	Maximum dose of Panadol syrup every 6 hours = 25 / (24/6) = 6.25 m/	1
6a	A – iron(II) iodide / FeI ₂ B – iron(II) hydroxide / Fe(OH) ₂ C – lead(II) iodide / PbI ₂	1 1 1
6b	Green precipitate turns reddish-brown.	1
6ci	Green solution <u>turns brown</u> . Since <u>chlorine is more reactive than iodine</u> , chlorine will displace iodine from iron(II) iodide.	1 1
6cii	The oxidation state of chlorine decreases from 0 in Cl ₂ to -1 in Cl ⁻ . This is reduction. The oxidation state of oxygen increases from -1 in H ₂ O ₂ to 0 in O ₂ . This is oxidation. Since reduction and oxidation takes place simultaneously, this is a redox reaction. [must state but no marks]	1 1

Paper 2 Section B

Qn	Suggested answers	Mark
7a	Weak acid <u>dissolves and dissociates partially</u> in water to give a <u>low concentration of hydrogen ions</u> . [For info: The numerator [H ⁺] ² is less than the denominator [HX], so K _a is less than 1.]	1
7bi	$K_a = \frac{[H^+]^2}{[HX]}$ $6.8 \times 10^{-4} = \frac{[H^+]^2}{0.100}$ $[H^+] = \sqrt{0.100(6.8 \times 10^{-4})}$ $= 8.2462 \times 10^{-3}$ $= 8.25 \times 10^{-3} \text{ mol dm}^{-3} \text{ (to 3 s.f.)}$	1
7bii	pH = -log ₁₀ (8.2452 x 10 ⁻³) = 2.08 (to 3 s.f.)	1
7ci	As K _a increases, pK _a decreases.	1
7cii	-7.0 [Accept any value between -6.1 and -9.5]	1
7di	Down Group VII, the strength of the hydrohalic acids increases.	1
7dii	Down Group VII, <u>bond energy of HX decreases</u> , so H-X is more easily broken. Hence it is <u>easier for the hydrohalic acids, HX, to dissociate into H⁺ and X⁻ ions</u> , so the strength of the acids increases. [3 points – 2 m, 2 points – 1m, 0-1 point – 0m]	2
7ei	Neutralisation reaction is <u>exothermic</u> and releases heat, hence <u>temperature increases</u> when the volume of acid added to the alkali increases. 18.0 cm ³ is the volume of acid required to <u>completely neutralise</u> the alkali. After 18.0 cm ³ , <u>temperature decreases</u> as <u>heat is lost to the surroundings</u> .	1 1 1
7eii	Both HCl and HI are <u>monobasic acids</u> so the <u>same amount of heat energy is released</u> from the bond forming between H ⁺ and OH ⁻ ions.	1
8a	sulfuric acid	1
8bi	4OH ⁻ → 2H ₂ O + O ₂ + 4e ⁻	1
8bii	dilute sulfuric acid	1

8biii	Reduction of zinc oxide with carbon / carbon monoxide	1
8ci	Zinc to graphite	1
8cii	The paste contains <u>mobile ions</u> which can act as charge carrier, unlike in solid state where there are no mobile ions.	1
8ciii	Ammonia is a soluble gas and dissolves in the water produced.	1
8civ	$2\text{NH}_4^+(\text{aq}) + 2\text{MnO}_2(\text{s}) + \text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Mn}_2\text{O}_3(\text{s}) + 2\text{NH}_3(\text{g}) + \text{H}_2\text{O}(\text{l})$	1
Either 9a	As the reactivity of the metals increases, the E° value becomes increasingly negative.	1
9b	Test tube A : No visible reaction. Test tube B : Pink solution turns colourless and a grey solid is formed. $\text{Zn} + \text{Co}^{2+} \rightarrow \text{Zn}^{2+} + \text{Co}$ / $\text{Zn} + \text{CO}(\text{NO}_3)_2 \rightarrow \text{Co} + \text{Zn}(\text{NO}_3)_2$	1 1 1
9c	Barium carbonate will decompose at a <u>higher temperature</u> than cobalt(II) carbonate. Since barium is <u>more reactive</u> than cobalt, barium carbonate is <u>more thermally stable</u> than cobalt(II) carbonate. [3 points – 2 m, 2 points – 1m, 0-1 point – 0m]	2
9d	Metal X : accept any E° value between 0.00 V and +0.34 V Metal Y : accept any E° value between -2.38 V and -0.76 V	1 1
9e	$\left[\text{Zn} \right]^{2+} \quad 2 \left[\text{H} \right]^{-}$ [1m – anion, 1m – coefficient]	2
OR 9a	There is powdered sodium carbonate which did not dissolve/react.	1
9bi	 [1m] – calcium chloride [1m] – calibrated gas syringe	2
9bii	Bubble the gas into <u>limewater</u> / <u>aqueous calcium hydroxide</u> . <u>White precipitate</u> will be formed.	1
9ci	The <u>limiting reactant</u> is the <u>acid</u> . Both acids <u>have the same number of moles of hydrogen ions</u> / are monobasic and <u>have the same concentration of hydrogen ions</u> so the volume of gas produced is the same in both test tubes A and B .	1 1
9cii	Ethanoic acid is a <u>weak acid</u> but nitric acid is a strong acid. Hence, ethanoic acid will dissolve and <u>dissociate partially</u> to produce <u>a low concentration of hydrogen ions</u> / <u>lower number of hydrogen ions per unit volume</u> . This results in less collisions hence <u>lower frequency of effective collisions</u> between the <u>reacting particles</u> (sodium carbonate particles and hydrogen ions) so <u>slower rate of reaction</u> , so for graph B has a gentler gradient.	1 1

9d	<p>volume of gas / cm³</p>  <p>72</p> <p>36</p> <p>A</p> <p>B</p> <p>C</p> <p>time / min</p>	1
9e	<p>volume of gas / cm³</p>  <p>36</p> <p>A</p> <p>B</p> <p>W</p> <p>time / min</p>	1

