Damai Secondary School
Marking Scheme – 2020 Sec 4E Pure Chemistry Preliminary Exam

Paper 1:

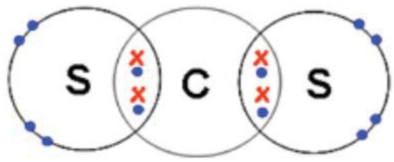
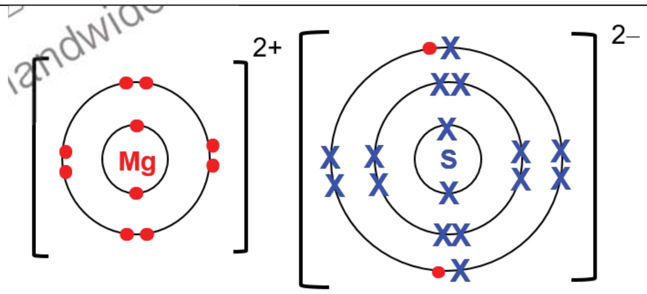
1	D	**11**	B	**21**	C	**31**	D
2	A	**12**	D	**22**	C	**32**	D
3	C	**13**	A	**23**	A	**33**	B
4	D	**14**	D	**24**	D	**34**	D
5	B	**15**	B	**25**	D	**35**	C
6	A	**16**	D	**26**	C	**36**	C
7	A	**17**	C	**27**	B	**37**	A
8	D	**18**	B	**28**	C	**38**	C
9	B	**19**	B	**29**	B	**39**	D
10	B	**20**	A	**30**	A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

Paper 2: Section A

A1	**(a)**	• limestone	[1]
	(b)	• ammonium sulfate <u>*or*</u> barium sulfate	[1]
	(c)	• ammonia	[1]
	(d)	• limestone	[1]
	(e)	• lead(II) nitrate	[1]
	(f)	• hydrogen *or* coke	[1]
			[Total: 6]

A2	**(a)**	• melting point: 40 °C • boiling point: 78 °C	[1] [1]
	(b)	• Heat energy is being <u>absorbed</u> by the particles to <u>break the i forces of attraction between particles</u> during melting and boiling.	[1]
	(c)	• At 60 °C, M is a liquid where its particles are closely packed in a disorderly manner, sliding past one another. • From 78 – 80 °C, M exists as a gas where its particles are far apart and arranged in a disorderly manner. The particles are moving at high speeds in all directions.	[1] [1]
			[Total: 5]

A3	**(a)**	• carbon–12 and carbon–14	[1]
	(b)	• fluorine–19 and iodine–131	[1]
	(c)	• fluorine–19 and neon–20	[1]
	(d)	• strontium–90 and magnesium–24	[1]
	(e)	• fluorine–19	[1]
			[Total: 5]

A4	**(a)**	**(i)**	 1 mark: correct number of shared electrons between C and S 1 mark: correct number of lone pair of electrons on each S	[2]
		(ii)	• Carbon disulfide has a simple molecular structure while silicon disulfide has a giant molecular structure. • Less heat energy is required to overcome the weak intermolecular forces of attraction between CS_2 molecules. • However, a lot of heat energy is required to overcome the strong covalent bonds between Si and C atoms in SiS_2.	[1] [1] [1]
	(b)	**(i)**	• magnesium **2, 8, 2** sulfur **2, 8, 6** Both electronic configurations must be correct to be awarded.	[1]
		(ii)	 1 mark: correct number of electrons transferred from Mg to S and total number of electrons on both ions 1 mark: correct ratio of Mg^{2+} : S^{2-} and charges on both ions	[2]

A4		**(iii)**	<table><tr><td></td><td>true</td><td>false</td></tr><tr><td>Magnesium sulfide is a crystalline solid at room temperature.</td><td>✓</td><td></td></tr><tr><td>Magnesium sulfide has a low melting point.</td><td></td><td>✓</td></tr><tr><td>Magnesium sulfide conducts electricity when molten.</td><td>✓</td><td></td></tr><tr><td>Magnesium sulfide is moderately soluble in water.</td><td>✓</td><td></td></tr></table> 1 mark for 2 correct answers. No ½ mark.	[2]
				[Total: 10]

A5	**(a)**	• During crystallisation, copper(II) sulfate formed contained water of crystallisation which was lost during evaporation to dryness.		[1]
	(b)	**(i)**	• Both calcium sulfate and silver chloride are insoluble salts. • Only a very small amount of the salts dissolve, resulting in a very small amount of them being recovered from the solution. Or • Both calcium sulfate and silver chloride are insoluble salts. • When they are formed, they coat the solid carbonate which prevented further reaction of the carbonates with the acid.	[1] [1] [1] [1]
		(ii)	aqueous silver nitrate <u>and</u> hydrochloric acid or aqueous silver nitrate <u>and</u> sodium chloride (or any other soluble chorides)	[1]
	(c)	**(i)**	$ZnCO_3(s) + 2HNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + CO_2(g) + H_2O(l)$ 1 mark: balanced equation 1 mark: correct state symbols	[2]
		(ii)	Number of moles of nitric acid (limiting reactant) reacted = 0.1×0.5 = 0.05 mol • Number of moles of zinc nitrate formed = $0.05 \div 2$ = 0.025 mol M_r of $Zn(NO_3)_2$ = 189 • Theoretical yield of zinc nitrate = 0.025×189 = 4.725 g • $\therefore$ experimental yield of zinc nitrate = $4.725 \times (92 / 100)$ = 4.35 g	 [1] [1] [1]

<table>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5" align="right">[Total: 9]</td></tr>
<tr><td>A6</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><td></td><td>aqueous zinc nitrate</td><td>aqueous chromium(III) nitrate</td><td>aqueous copper(II) nitrate</td></tr>
<tr><td>zinc</td><td></td><td>green solution turned colourless and grey metal coated with silvery solid</td><td>blue solution turned colourless and grey metal coated with reddish brown solid</td></tr>
<tr><td>chromium</td><td>No visible change / reaction
[1/2 mark]</td><td></td><td>blue solution turned green and silvery metal coated with reddish-brown solid
[1 mark]</td></tr>
<tr><td>copper</td><td>No visible change / reaction
[1/2 mark]</td><td>no visible reaction</td><td></td></tr>
</table>
</td><td>[2]</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>• $3Zn(s) + 2Cr^{3+}(aq) \rightarrow 3Zn^{2+}(aq) + 2Cr(s)$

[1] Balanced equation
[1] Correct state symbols</td><td>[2]</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>• In order of increasing reactivity:
copper, iron, chromium, zinc
• Chromium is more reactive than iron since it corrodes first in stainless steel.
• Since zinc displaces chromium from its solution, chromium is less reactive than zinc. Hence, chromium is between iron and zinc.
[Chromium is more reactive than copper since it displaces copper from its solution.]</td><td>[1]
[1]
[1]</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>• The volumes of CO_2 produced has not reached a constant value yet / volume of CO_2 produced is still increasing.</td><td>[1]</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>• calcium carbonate, $CaCO_3$</td><td>[1]</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>• The more reactive the metal, the slower the rate of the thermal decomposition of its carbonate.</td><td>[1]</td></tr>
<tr><td colspan="5" align="right">[Total: 10]</td></tr>
</table>

A7	**(a)**		• Electrons flow from zinc metal to silver metal.	[1]
	(b)		• Increasing order of reactivity: Cu, Zn, Mg The larger the difference in reactivity between the metal electrodes, the larger the voltage of the cell.	[1]
			• In both cells, **reduction occurs at the copper electrode**. Extent of **oxidation** is higher **at the magnesium electrode** in cell 2 than at the **zinc electrode** in cell 1.	[1]
	(c)		(table below) 1 mark for each correctly predicted voltage.	[2]

metal 1	metal 2	predicted voltage / V
copper	iron	**0.79**
silver	magnesium	**3.18**

1 mark for each correctly predicted voltage.

[Total: 5]

B8	**(a)**	**(i)**	• Carbon dioxide is a greenhouse gas which **traps heat / absorbs infrared radiation** and hence can lead to an **increase in Earth's average temperature / warming of Earth**.	[1]
		(ii)	• Trees and plants **absorb** carbon dioxide during **photosynthesis** to convert it into glucose and oxygen.	[1]
		(iii)	• Distance travelled in a year = 365×60 = 21 900 km	[1]
			• Mass of CO_2 generated in a year = $(252 / 1000) \times 21\,900$ = 5519 kg (nearest kg)	[1]
	(b)	**(i)**	• Projected amount of CO_2 generated by households $= \frac{7.6}{100} \times 77.2$ = 5.87 million tonnes	[1]
		(ii)	• $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$	[1]
	(c)	**(i)**	• $2H_2 + O_2 \rightarrow 2H_2O$	[1]
		(ii)	(table below)	[2]

fuel	H_2	C_8H_{18}
M_r	2	114
energy per 1 g of fuel	$256 \div 2$ = 128 kJ [1 mark]	$5480 \div 114$ = 48.1 kJ [1 mark]

		(iii)	• Unlike octane which forms carbon dioxide on complete combustion, hydrogen only produces water which does not pollute the environment. • Hydrogen is a more efficient fuel than octane as it produces (2.7 times) more energy per gram.	[1] [1]
		(iv)	• Hydrogen is obtained from electrolysis which is an expensive process.	[1]
				[Total: 12]

B9	**(a)**	**(i)**	Electrolysis of water or Cracking of large hydrocarbons	[1]
		(ii)	Fractional distillation	[1]
	(b)	Enthalpy change, $\Delta H = -1852 + 1368$ $= -484$ kJ 1 mark for working 1 mark for correct answer with unit		[2]
	(c)	**(i)**	• $\Delta H_1 > 0$ as heat energy is **absorbed to break the bonds** in hydrogen and oxygen molecules. • $\Delta H_2 < 0$ as heat energy is **released when bonds are formed** between H and O atoms to form water molecules.	[1] [1]
		(ii)	$\Delta H_1 = 2 \times BE(H–H) + 496 = 1368$ $\therefore$ BE(H–H) = 436 kJ / mol 1 mark for working 1 mark for correct answer with unit	[1] [1]
				[Total: 8]

Either

B10	**(a)**		• Sulfur dioxide dissolves in rain water to form acid rain which can corrode buildings made of limestone or metals / decreases pH of body bodies and hence harms aquatic life.	[1]
	(b)		• The oxidation state of S increases from +4 in SO_2 to +6 in SO_3 and is oxidised. • The oxidation state of O decreases from 0 in O_2 to –2 in SO_3 and is reduced.	[1] [1]
	(c)	**(i)**	• When the pressure is increased, there are more reactant particles per unit volume / the reactant particles are closer together. • Hence, the frequency of collisions increases which in turn increases the frequency of effective collisions. This increases the speed of reaction.	[1] [1]
		(ii)	• It is very costly as extremely strong pipes and containment vessels need to be built to withstand the high pressure. Or • It is very costly to produce and maintain high pressures which <u>increases the cost of the production plant</u>.	[1]
B10	**(d)**		• A catalyst provides an alternative pathway with a lower activation energy for the reaction to occur. • As more reactant particles have energy that is equal or greater to the lowered activation energy, they will collide more frequently. This increases the frequency of effective collisions and hence the rate of reaction.	[1] [1]
	(e)	**(i)**	• The yield of sulfur trioxide decreases with increasing temperature.	[1]
		(ii)	• 93%	[1]
				[Total: 10]

Or

B10	**(a)**	positive electrode $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$ negative electrode $Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$			[1] [1]
	(b)	positive electrode Effervescence of a colourless gas is observed. negative electrode The electrode increases in size as zinc is deposited on it.			[1] [1]
	(c)	**(i)**	positive electrode $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ negative electrode $Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$		[1] [1]
		(ii)	The concentration of zinc sulfate remains constant since the same amount of Zn^{2+} formed at the positive electrode is reduced / used at the negative electrode.		[1]
		(iii)	Percentage purity $= \frac{4.5}{4.8} \times 100$ $= 93.75\ \%$ (or 93.8%)		[1]
		(iii)	• The solid formed is copper. • As copper is less reactive than zinc, it will not be oxidised and hence dislodges from the electrode.		[1] [1]
					[Total: 10]

A1	**(a)**	•	[1]
	(b)	•	[1]
	(c)	•	[1]
	(d)	•	[1]
	(e)	•	[1]
			[Total:]

A4	**(a)**	**(i)**		[2]
		(ii)	•	[2]
		(iii)	•	[1] [1] [1]
	(b)	**(i)**	•	[1]
		(ii)	•	[1]
		(iii)	•	[1]
				[Total:]