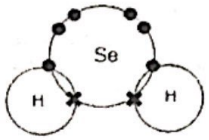
Paper 1 (MCQ) 40 marks

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

Paper 2 Section A (50 marks)

Qn			Answers	Marks
A1	(a)	(i)	No. Water is a solid at -178°C. ACCEPT: Water would have frozen at -178°C	1
		(ii)	A mixture of methane and ethane. They are liquids at -178°C	1 1
	(b)		A mixture of nitrogen, hydrogen and argon	1
A2	(a)		 *[1m – ratio of atoms, 1m – electrons]*	1,1

	(b)		element / Se / O % composition (Or mass in 100g) / 71.2% (71.2g) / 28.8% (28.8g) A_r (Or Molar Mass) / 79 / 16 Number of Moles / 71.2/79 = 0.9013 / 28.8/16 = 1.8 Simplest Mole Ratio / 0.9013/0.9013 = 1 / 1.8/0.9013 ≈ 2 Empirical formula: SeO_2	1 1 1
	(c)	(i)	H_2Se	1
		(ii)	$SeO_2 + 3Mg \rightarrow 2MgO + MgSe$	1
	(d)		Excess magnesium from the reaction with selenium oxide reacts with the hydrochloric acid added to produce hydrogen gas.	1

A3	(a)	(i)	Increase in temperature, decrease in the percentage of ammonia	1
		(ii)	Increase in pressure, increase in the percentage of ammonia	1
		(iii)	Temperature of 100 °C and pressure of 1000 atm Low temperature slows the speed of the reaction To provide high pressure, expensive equipment (pumps and pipes) is needed.	1 1 1
	(b)	(i)	The temperature of the catalyst increases/rises (because the reaction is exothermic/heat is released to the surrounding (catalyst));	1
		(ii)	No. mol of NH_3 = 720/24 = 30.0 mol No. mol of O_2 = 3600/24 = 150 mol Ammonia is limiting reagent. No. of moles of nitric acid produced = 30.0 mol Mass of nitric acid produced = 30 x [1 + 14 + 3(16)] = 1890g (to 3 s.f)	1 1
A4	(a)		element / molecular formula / state at room temperature and pressure / colour F / F_2 / gas / pale yellow Cl / Cl_2 / gas / yellow greenish / greenish yellow Br / Br_2 / liquid / reddish brown I / I_2 / solid / purplish black (REJECT: black) 1m – 2 correct answers	3

	(b)	(i)	Pure hydrogen halides do not have mobile ions to conduct electricity. However, when hydrogen halides are dissolved in water, **hydrogen halides dissociate to form ions**, which can carry charges to conduct electricity.	1 1
		(ii)	Yes Astatine has the **same number of valence electrons** (7) as other elements in the same group.	1

A5	(a)		<table><tr><th>isotope</th><th>nucleon number</th><th>proton</th><th>neutron</th></tr><tr><td>hydrogen</td><td>1</td><td>**1**</td><td>**0**</td></tr><tr><td>deuterium</td><td>2</td><td>**1**</td><td>**1**</td></tr><tr><td>tritium</td><td>3</td><td>**1**</td><td>**2**</td></tr></table> 1m – 2 correct answers	3
	(b)		D_2O and D_2O have **different nucleon numbers**. Hence their physical property (boiling points) are different.	1
	(c)		$2D_2O + Ca \rightarrow Ca(OD)_2 + D_2$	1
A6	(a)		No The elements (tin and lead) are **not chemically combined** in solder.	1 1
	(b)		Solder **can conduct electricity** due to the **delocalized AND mobile/free moving electrons**. Phosphorus **cannot conduct electricity** as it is a non-metal and **does not have free moving/mobile electrons** and ions.	1 1
	(c)		The presence of another metal acts as an impurity and **reduces its melting point**. Hence **lesser heat/energy** is needed to **melt the solder** and join the metals.	1 1

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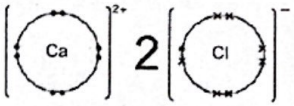
A7	(a)		Nitrogen oxides; When the speed of the car increases, the **engine gets hotter / increase in temperature in car engine** causes **more nitrogen and oxygen in the air react** to form nitrogen oxides.	1 1
	(b)		Emissions of carbon monoxide **decreases during 50 to 80kmh^{-1}** and **increases during 80 to 120kmh^{-1}** Explanation for decrease during 50 to 80kmh^{-1}: As the car moves faster from 50 to 80kmh^{-1}, **more oxygen is taken in** into the car engine leading to **less incomplete combustion of petrol** taking place. This decreases the amount of carbon monoxide; Explanation for increase during 80 to 120kmh^{-1}: At higher speed from 80kmh^{-1} onwards, **rate of combustion of petrol is greater than** the **rate of oxygen gas entering the engine**; ACCEPT: insufficient O_2 required for complete combustion of fuel to take place.	1 1 1
A8	(a)		Co^{2+}, NO_3^-, H^+, OH^-	1
	(b)		$Co^{2+}(aq) + 2e \rightarrow Co(s)$	1
	(c)	(i)	A layer of grey solid is formed	1
		(ii)	Red solution turns pale red/colourless OR Red solution gradually fades	1
	(d)	(i)	$4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e$	1
		(ii)	Carbon dioxide REJECT: it is not oxygen gas	1
		(iii)	Hydroxide ions are preferentially discharged at the anode, hence **oxygen gas produced at the anode**. The graphite anode is hot and it **reacts with the oxygen gas** produced to **form carbon dioxide gas**. ACCEPT: Carbon monoxide (CO_2 formed is reduced by carbon in graphite to form CO)	1 1

Paper 2 Section B (30 marks)

Qn			Answers	Marks
B9	(a)		Metal oxide	1
			fused calcium chloride REJECT: drying agent	1
	(b)	(i)	L, K, J, M	1
		(ii)	M is a very reactive metal, therefore it **reacts with water** (present in silver nitrate solution) to form **hydrogen gas**	1 1
		(iii)	$L(s) + 2Ag^+(aq) \rightarrow L^{2+}(aq) + 2Ag(s)$ *[ACCEPT Cu in place of L]*	1,1
	(c)		Iron will rust very fast/faster/rapidly. Metal L is less reactive than iron, (ACCEPT: iron will corrode/react in place of copper/metal L) Iron loses electrons more readily to form Fe^{2+}.	1 1 1

B10	(a)		Precipitation	1
	(b)	(i)	Mr $CaCO_3$ = 40+12+16x3 = 100 No. of mol $CaCO_3$ = 50x1000x1000/100 = 500000 (50/100 → penalise 1m) **No. mol $CaCl_2$ = 500000** Mr $CaCl_2$ = 40+35.5x2 = 111 Mass $CaCl_2$ = 500x111 = **55500000 g / 55.5 tonnes / 55500 kg**	1 1
		(ii)	Mass of NaCl = 55500/15 x 85 = 314500000 g = **315000 kg (3sf) / 315 tonnes**	1
		(iii)	The mass of the other impurities is negligible.	1
		(iv)	 *[1m – number of electrons transferred; 1m – number of electrons in ions]* *Any mistakes minus 1m*	1,1
	(c)	(i)	Thermal decomposition	1
		(ii)	Slaked lime reacts with ammonium nitrate to form **ammonia gas** that escapes into the air. This **reduces the amount nitrogen content in the fertiliser** that is needed for plant growth.	1 1
B11	(a)	(i)	$(NH_4)_2Cr_2O_7(s) \rightarrow Cr_2O_3(s) + 4H_2O(g) + N_2(g)$	1,1
		(ii)	Chromium has been reduced. The **oxidation state of chromium decreases** from **+6** (in $(NH_4)_2Cr_2O_7$) to **+3** (in Cr_2O_3).	1 1
		(iii)	Reaction is exothermic. It is described that there is **evolution of heat**.	1 1
	(b)	(i)	It is an **amphoteric oxide**.	1
		(ii)	It is hard. This is because it has a **giant lattice/ionic structure** and has very **strong electrostatic forces of attraction between chromium and oxide ions**, which **require a lot of energy to overcome**. ACCEPT: oppositely charged ions	1 1 1

B12	(a)		Temperature can affect the speed of a reaction.	1
	(b)	(i)	<u>Increases the speed of a reaction</u> by providing an <u>alternative pathway</u> with a <u>lower activation energy</u>.	1
		(ii)	<u>Physical appearance of a catalyst may change</u> at the end of the reaction. Catalyst is <u>not used up</u> during reaction. Accept: same amount of catalyst is present at the beginning and at the end of the reaction.	1 1
		(iii)	Group I metal compounds are <u>ineffective</u> as catalysts compared to transition metal compound. <u>Tests A and G</u> use metal compounds as catalysts and the <u>reactions take longer times</u> to complete compared to <u>Tests B and F</u>. ACCEPT: not as effective / does not work as well as transition metal compound *[2nd mark – correctly identify tests A and G, B and F;* *3rd mark – tests A and G take longer]*	1 1 1
	(c)	(i)	Yes. <u>Tests C and E (or Tests A and D)</u> takes the <u>same time</u> to complete the reactions.	1 1
		(ii)	26s	1