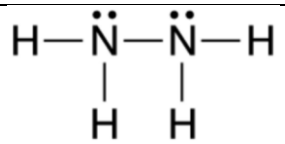
Secondary 3 (IP) EOY Answers

2022 Sec 3 End-of-Year Exam Chemistry Answers

Paper 1

1	**B**	2	**B**	3	**B**	4	**A**	5	**C**
6	**B**	7	**D**	8	**B**	9	**C**	10	**C**
11	**A**	12	**A**	13	**B**	14	**D**	15	**C**
16	**B**	17	**D**	18	**C**	19	**B**	20	**C**
21	**D**	22	**D**	23	**D**	24	**C**	25	**A**
26	**C**	27	**B**	28	**D**	29	**B**	30	**C**

Qn	Ans	Explanation
1	B	A: False, state 1 is changed to state 2 by boiling, not melting. B: True C: False, state 2 is gaseous state, so particles are moving randomly at high speed. D: False, state 3 is solid state.
2	B	M_r of NH_3 (17.0) is lower than that of CO_2 (44.0), so NH_3 will diffuse faster than CO_2 and reach moist blue litmus paper first. NH_3 will have no effect on moist blue litmus paper. When CO_2 reaches the moist blue litmus paper, it will turn moist blue litmus paper red. Overall observation: Moist blue litmus paper turn red.
3	B	Impurities increase boiling point and decrease melting point.
4	A	Carbon dioxide is formed from the reaction between hydrochloric acid and calcium carbonate. Since carbon dioxide is acidic, an acidic or neutral drying agent should be used to dry the gas → from the options only concentrated sulfuric acid is suitable. Since carbon dioxide (M_r of 44.0) is more dense than air (average M_r of approximately 28.8), downward delivery should be used.
5	C	Step 1: Sublimation is done to remove ammonium chloride. Note that sublimation cannot be done after the substance is dissolved in water. Step 2: Water is added to dissolve copper(II) chloride. Silver chloride remains insoluble. Step 3: Filtration is done to remove insoluble silver chloride. Step 4: Hydrated copper(II) chloride is obtained by crystallisation.
6	B	1: False, eg N_2 is a molecule and an element 2. False, eg N_2 is a molecule and an element 3: True, generally metals and non-metals react to form ionic compounds
7	D	Proton number for Y = 79 + 2 = 81 Nucleon number for Y = 197 + 2 + 1 = 200 (add both protons and neutrons) Since 2 protons are added while only 1 electron is added, Y will have a positive charge.

		From the above, answer will be option D.
8	B	**P**: H **Q**: Group 1 element (Li) **R**: Group 16 element (O) **S**: Group 18 element (Ne) A: Form ionic compound, LiH with high melting point B: Form simple covalent compound, H_2O with low melting point C: Form ionic compound, Li_2O with high melting point D: Option can be eliminated since S is a noble gas that is inert and will not form compounds.
9	C	Since total abundance must add up to 100%, $\mathbf{x} + 0.5\mathbf{x} + (\mathbf{x} - 0.2) = 1$ $\mathbf{x} = 0.48$ $20(0.48) + 21(0.24) + 22(0.28) = 20.8$
10	C	 From the structure of N_2H_4, there are 2 valence electrons not involved in covalent bonding for each N atom. There are 2 more inner shell electrons in each N atoms that are not involved in covalent bonding. Therefore there are 8 valence electrons not involved in covalent bonding in the molecule.
11	A	Sulfur dioxide is used as a bleaching agent while sulfuric acid is used for the other stated purposes.
12	A	For the titration of a weak acid with a strong base, the starting pH is around 3-4 and the ending pH is around 13-14. The mid-point of the vertical region of the graph should be higher than 7.
13	B	acidic oxides: CO_2, SO_3 basic oxides: CaO neutral oxides: NO amphoteric oxides: PbO, Al_2O_3
14	D	Options **A** and **B** show reactions between an alkali / base and an ammonium salt while option **C** shows a neutralisation reaction.
15	C	Calcium sulfate is an insoluble salt best prepared by precipitation using two aqueous solutions. A solution of calcium nitrate will be obtained as the filtrate in the first step of option **C**.
16	B	For option **A**, the indicator would be blue both before and after pH 9. For option **C**, the indicator would be yellow at pH 1.

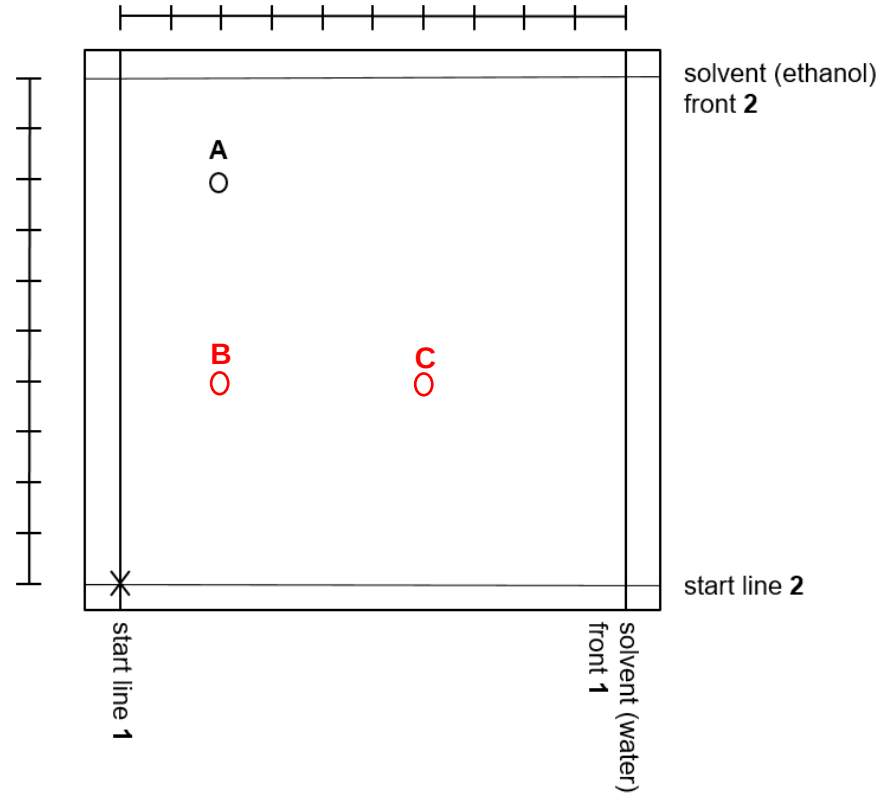
		For option **D**, the indicator would be able to distinguish between the two acids since it has a different colour at pH 1 compared to pH 5.
17	D	theoretical yield of of iron = 5000 ÷ 159.6 × 2 × 55.8 ÷ 1000 = 3.496 kg % yield = 2.83 / 3.496 × 100% = 80.9%
18	C	mass of pure H_2O_2 = 1650/24000 × 2 × 34 = 4.675 g % purity = 4.675 / 9.62 × 100% = 48.6%
19	B	M_r of butane = 3.48 ÷ (1440 / 24000) = 58.0 let molecular formula of butane be $C_{2n}H_{5n}$ **n** = 58.0 ÷ 29.0 = 2 molecular formula = C_4H_{10}
20	C	volume of O_2 needed to react completely with 160 cm^3 of NH_3 = 160 ÷ 4 × 3 = 120 cm^3 < 160 cm^3 NH_3 is the limiting reactant volume of N_2 formed = 160 ÷ 4 × 2 = 80 cm^3 volume of unreacted O_2 = 140 – 120 = 20 cm^3 Total volume of resultant gas mixture = 80 + 20 = 100 cm^3
21	D	no. of moles of SO_2Cl_2 in 25.0 cm^3 solution = 0.350 ÷ 135.1 = 0.0025907 For every 1 mole of SO_2Cl_2 reacted with water, there are 4 moles of H^+ ions produced. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ no. of moles of KOH needed for titration = no. of moles of H^+ ions in 25.0 cm^3 solution = 0.0025907 × 4 = 0.010363 volume of KOH needed for titration = 0.010363 ÷ 0.267 = 0.0388 dm^3 = 38.8 cm^3
22	D	no. of atoms in 50.0 cm^3 of CO_2 = 50.0 ÷ 24000 × 6.02 × 10^{23} × 3 = 3.76 × 10^{21} no. of atoms in 0.00750 moles of NO = 0.00750 × 6.02 × 10^{23} × 2 = 9.03 × 10^{21} no. of atoms in 0.45 g of SCl_2 = 0.45 ÷ 103.1 × 6.02 × 10^{23} × 3 = 7.88 × 10^{21}

		no. of atoms in 2.35×10^{20} molecules of CH_4 $= 2.35 \times 10^{20} \times 5 = 1.18 \times 10^{21}$
23	D	colourless aqueous potassium sulfate is produced for option **D**. Neutralisation reaction does not produce a gas.
24	C	NH_4^+ ions are absent as shown by the first test while NO_3^- ions are present as shown by the second test.
25	A	CO_3^{2-} ions are present as shown by the first test while either Pb^{2+} or Al^{3+} ions are present as shown by the second test. Since HCl is used and a colourless solution was produced, Pb^{2+} ions are eliminated since $PbCl_2$ is insoluble in water.
26	C	**P** must be a base since carbonates and metals would have reacted to produce a gas. **Q** must contain Cu^{2+} ions because of the blue coloration. Cu^{2+} ions produce a blue precipitate which is insoluble in excess aqueous sodium hydroxide.
27	B	A: True, since helium is used in balloons B: False, argon is used in light bulbs, not neon. Neon is used in advertising lights C: True, since noble gases are inert D: True
28	D	A: Can be predicted since whether the oxide is metallic or non-metallic will give information about the basic or acidic nature of the oxide. B: Can be predicted since the number of valence electrons can be found from Group number, which in turn allows charge of ion to be predicted. C: Can be predicted using staircase line in Periodic Table D: Cannot be predicted
29	B	**S** has a lower boiling point than **R** → **S** is higher in Group 17 than **R** **S** is darker in colour than **Q** → **S** is lower in Group 17 than **Q** **R** displaces **P** from its halide solution → **R** is higher in Group 17 than **P** From top to bottom: **Q**, **S**, **R**, **P**
30	C	A: Incorrect since it is a chemical equation, not ionic equation B: Incorrect since it is not balanced C: Correct D: Incorrect since halogens should be diatomic

Paper 2

A1	Answers	Marks
(a)(i)	H_2SO_4, MgO / $Mg(OH)_2$ / $MgCO_3$ / Mg (excess)	[2]
(a)(ii)	Filtration	[1]
(a)(iii)	Crystallisation	[1]
(b)(i)	250	[1]
(b)(ii)	M_r = 24.3 + 32.1 + 16.0 × 4 = 120.4	[1]
(b)(iii)	No. of moles = 2.41 ÷ 120.4 = 0.0200	[1]
(b)(iv)	Mass of water lost = 4.93 − 2.41 = 2.52 g No. of moles of water lost = 2.52 ÷ 18 = 0.140 **n** = 0.140 ÷ 0.0200 = 7 chemical formula of Epsom salt = $MgSO_4.7H_2O$	[1] [1] [1]
	Total	**[10]**

A2	Answers	Marks
(a)	Diffusion Diffusion occurs due to the **random movement of particles** OR Phenomenon occurs because particles tend to diffuse from a **region of higher concentration to a region of lower concentration**	[1] [1]
(bi)	Substances A and B have the **same R_f value of 0.20 in water/same** solubility in water OR Substances B and C have the **same R_f value of 0.40 in water/same** solubility in ethanol. 2D chromatography would be able to separate/identify all 3 substances OR if chromatography is done using only either water or ethanol only 2 spots would be seen/only 2 substances can be identified.	[1] [1]

(bii)	 **B**: 2 cm from start line 1, 4 cm from start line 2 **C**: 6 cm from start line 1, 4 cm from start line 2 1 mark for each correct spot	[2]
	Total	**[6]**

A3	**Answers**	**Marks**
(a)	Simple covalent/molecular structure No mobile ions or delocalised electrons to conduct electricity	[1] [1]
(b)	Low boiling point **Weak intermolecular forces** between molecules require **little energy** to overcome	 [1] [1]
(c)	Borospherene has **more electrons/larger M_r/larger molecular size** than methane, so it has **stronger intermolecular forces** that require **more energy** to overcome	[1] [1]
(d)	Boron has **only 3 valence electrons** so it is **not expected to form more than 3 bonds/not expected to form 4 or 5 bonds**.	[1]
	Total	**[7]**

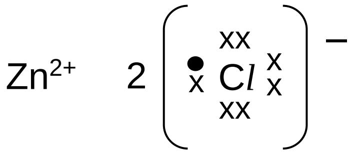
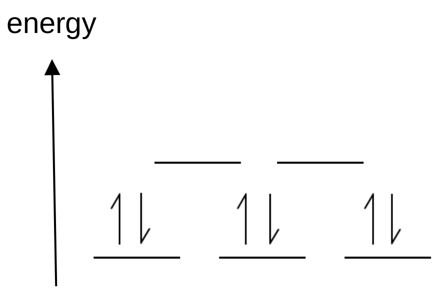
A4	Answers	Marks
(ai)	1	[1]
(aii)	soft/low density/shiny when freshly cut	[1]
(bi)	2**Z**(s) + $2H_2O(l)$ → 2**Z**OH(aq) + H_2(g) 0 if wrong formula -1 if not balanced or wrong state symbols	[2]
(bii)	Down the group, as **number of electron shells increases/atomic size increases** **distance between nucleus and valence electron increases,** **so there is weaker electrostatic forces of attraction between nucleus and valence electrons** making it easier for element **Z** to lose electrons	[1] [1] [1]
(biii)	**Z**, **X**, **Y**	[1]
	Total	**[8]**

A5	Answers	Marks
(a)(i)	no. of moles of Cu reacted = (2.50 – 2.25) ÷ 63.5 = 0.00394 mol	[1]
(a)(ii)	no. of moles of O_2 reacted = 0.0039370 ÷ 2 × 24000 = 47.2 cm^3	[1]
(a)(iii)	% of O_2 in the planet's atmosphere = 47.244 ÷ 80.0 × 100% = 59.1%	[1]
(b)(i)	$CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$	[1]
(b)(ii)	number of moles of HNO_3 reacted = 0.0039370 × 2 = 0.00787 mol	[1]
(b)(iii)	concentration of NaOH in mol dm^{-3} = 3.20 ÷ 40.0 = 0.0800 mol dm^{-3} number of moles of HNO_3 reacted 0.0800 × 19.30/1000 = 0.00154 mol (3sf) OR mass of NaOH = 3.20 x 19.30/1000 = 0.06176 g moles of HNO_3 reacted = 0.06176 ÷ 40.0 = 0.00154 mol	[1] [1] [1] [1]
(b)(iv)	number of moles of nitric acid that did not react with copper(II) oxide = 0.001544 ÷ 25.0 × 150 = 0.009264 number of moles of nitric acid that was added to the mixture = 0.007874 + 0.009264 = 0.0171 mol (3sf)	[1] [1]
	Total	**[9]**

B6	Answers	Marks
(a)(i)	The green precipitate turned **reddish-brown**.	[1]
(a)(ii)	$Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$	[1]
(b)(i)	AgC*l* / silver chloride	[1]
(b)(ii)	Because the anion of **F** cannot be CO_3^{2-} (or OH^-) since $FeCO_3$ (or $Fe(OH)_2$) is insoluble and cannot form **C** which is a solution.	[1] [1]
(c)(i)	CO_3^{2-} / carbonate	[1]
(c)(ii)	PbI_2 / lead(II) iodide OR AgI / silver iodide	[1]
(c)(iii)	KC*l* / K_2SO_4/ Any Group 1 choride or sulfate OR NH_4C*l* / $(NH_4)_2SO_4$ OR HC*l* / H_2SO_4	[1]
(d)	$PbCO_3$ and $FeCl_2$ / lead(II) carbonate and iron(II) chloride OR Ag_2CO_3 and $FeCl_2$ / silver carbonate and iron(II) chloride	[2]
	Total	**[10]**

B7	Answers	Marks
(a)(i)	A strong acid is one that ionises completely in water to form (a high concentration of) H^+ ions.	[1]
(a)(ii)	The acid strength increases down Group 17.	[1]
(a)(iii)	The bond energy of H−**X** decreases down Group 17.	[1]
(a)(iv)	The higher the bond energy H−**X**, the weaker the acid is. A larger H−**X** bond energy of H−**X** means larger amount of energy required to **break** all the **H–X bonds in** one mole of HX **molecules.** Hence acid **dissociates to a smaller extent**.	[1] [1] [1]
(b)	$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$	[1]
(c)(i)	$HF(aq) \rightleftharpoons H^+(aq) + F^-(aq)$	[1]
(c)(ii)	Yes, a **concentrated weak acid** can have the **same concentration of H^+ ions** as a **dilute strong acid**.	[2]
	Total	**[10]**

B8 EITHER	Answers	Marks
(ai)	Basic	[1]
(aii)	White precipitate formed that is insoluble in excess aqueous sodium hydroxide.	[1]
(aiii)	White precipitate formed that is insoluble in excess aqueous ammonia.	[1]
(b)	Lead(II) sulfate is **insoluble** in water So there are **no aqueous / mobile Pb^{2+}** to react with OH^- to form a precipitate	[1] [1]
(ci)	Moles of $Al(OH)_3$ = $\frac{0.1}{78.0}$ = 0.0012821 mol Moles of Al^{3+} = 0.0012821 mol $[Al^{3+}]$ = 0.0012821 ÷ $\frac{2}{1000}$ = 0.641 mol dm^{-3} OR Concentration of Al^{3+} in g dm^{-3} = 0.1 ÷ $\frac{2}{1000}$ = 50.0 g dm^{-3} $[Al^{3+}]$ = $\frac{50}{78.0}$ = 0.641 mol dm^{-3}	[1] [1]
(cii)	Lower than concentration present in 2 cm^3 solution / Amount / Mass of precipitate measured is lower than expected, As some precipitate will remain on the filter paper OR Higher than concentration present in 2 cm^3 solution / Amount / Mass of precipitate measured is higher than expected, As not all of the distilled water might be dried off completely OR Higher than concentration present in 2 cm^3 solution Amount / Mass of precipitate measured is higher than expected, As not all of the impurities might be removed in the washing step	[1] [1] [1] [1] [1] [1]
(ciii)	The experiment will not be feasible, because the **precipitate / zinc hydroxide is soluble** in excess aqueous ammonia.	[1]
	Total	**[10]**

B8 OR	**Answers**	**Marks**
(ai)	Transition metals have a giant metallic structure. The **strong electrostatic forces of attraction** between the metallic **cations** and the **sea of delocalised electrons** require **a lot of energy** to overcome.	[1] [1]
(aii)	Any two of the following: Transition metals form ions with variable oxidation states Transition metals form coloured compounds Transition metals and its compounds are used as catalysts	[2]
(b)	Cr: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$ Ni: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ 4s^2$	[1] [1]
(c)		[1]
(di)	d-orbitals are **expected to have the same energy levels** rather than 2 different energy levels OR d-orbitals have **different energy levels**	[1]
(dii)	<u>expected electronic configuration</u> 	[1]
(diii)	The actual electronic configuration shown **reduces / minimises** inter-**electronic repulsion**	[1]
	Total	**[10]**