Secondary 3 (IP) EOY Answers

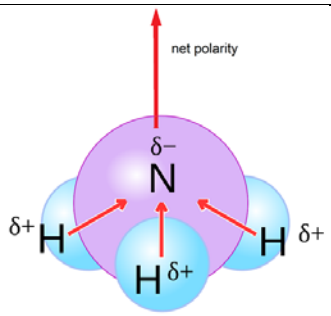
2019 Sec 3 End-of-Year Exam Chemistry Answers

Paper 1

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

<table>
<tr><th>Qn</th><th>Ans</th><th>Explanation</th></tr>
<tr><td>1</td><td>B</td><td>Mixture of solid (ice) and liquid (water) will be at regions with constant temperature. Q-R is at a lower temperature so that would be the solid-liquid mixture.</td></tr>
<tr><td>2</td><td>A</td><td>Neon has the lowest mass (20.2) compared to F_2 (38.0), HCl (36.5) and SO_2 (64.1). Hence, the one with the lowest mass will diffuse out of the balloon the fastest.</td></tr>
<tr><td>3</td><td>B</td><td>The melting point of a pure substance would be lowered when impurities are added. The melting range for BOTH tin and lead (where both are liquids) would thus be from 80 to 220 °C.</td></tr>
<tr><td>4</td><td>A</td><td>The drying agent is a basic oxide that can only dry alkaline or neutral gases. Acidic gases like carbon dioxide and chlorine cannot be dried using calcium oxide. Between ammonia and oxygen, ammonia (NH_3) has a molecular mass of 17 while oxygen (O_2) is 32. Hence, ammonia, being less dense than air, can be collected by upward delivery method.</td></tr>
<tr><td>5</td><td>D</td><td>In a school laboratory (i.e. at room temperature), substances X and Y are both liquids. Since they have different solubilities in water, they are considered immiscible liquids that need to be separated using a separating funnel.</td></tr>
<tr><td>6</td><td>B</td><td>
<table>
<tr><td>amino acid</td><td>R_f value in solvent X</td><td>R_f value in solvent Y</td><td>Identity</td></tr>
<tr><td>I</td><td>5.5/8=0.69</td><td>2/10=0.20</td><td>arginine</td></tr>
<tr><td>II</td><td>3/8=0.38</td><td>3/10=0.30</td><td>glutamic acid</td></tr>
<tr><td>III</td><td>4/8=0.50</td><td>8/10=0.80</td><td>cannot be identified</td></tr>
</table>
</td></tr>
<tr><td>7</td><td>D</td><td>Ozone makes up the ozone layer that cuts down on the harmful UV rays entering the Earth's surface. Hence, it should not increase the chance of skin cancer.</td></tr>
<tr><td>8</td><td>C</td><td>Combustion, flue gas desulfurisation and respiration all release carbon dioxide into the atmosphere.</td></tr>
<tr><td>9</td><td>D</td><td>In acid, bromophenol blue is yellow and congo red is violet.
Initial colours would be yellow and violet, giving D as the only option.</td></tr>
<tr><td>10</td><td>C</td><td>As more copper(II) sulfate appears as crystals, the concentration of the solution decreases because there is less dissolved copper(II) sulfate in solution.</td></tr>
</table>

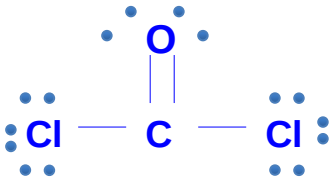
11	C	$H_nX \rightarrow nH^+ + X^{n-}$ Let concentration of acid be 1 mol/dm^3 and volume of acid be 2 dm^3. no. of mol of acid = 2 mol Let concentration of alkali be 2 mol/dm^3 and volume of alkali be 3 dm^3. no. of mol of alkali = 6 mol Hence mole ratio of acid:alkali = 2:6 = 1:3 1 mole of acid requires 3 moles of OH^- for complete neutralisation. Therefore, acid must be a tribasic acid and n=3.
12	A	$C_6H_5NH_2$ forms OH^- when dissolved in water, showing that it is an alkaline. Hence, it should turn litmus paper blue and form a blue ppt with copper(II) sulfate due to the presence of hydroxide ions. It should also react with sulfuric acid to form the salt $(C_6H_5NH_3)_2SO_4$.
13	A	Presence of Al^{3+} ions forms white ppt in NaOH that is soluble in excess NaOH. Hence, a colourless solution would be obtained. Presence of SO_4^{2-} ions forms a white ppt in $BaCl_2$ that does not dissolve in excess.
14	C	The following options show no observable change. Option A: Copper is unreactive in dilute acids. Option B: Magnesium does not react with carbonates. Option D: Both silver chloride and barium nitrate are salts. One is insoluble and the other is soluble in water. They will not react with each other.
15	B	Ammonium chloride produces ammonia gas upon warming with alkalis. Iron(III) chloride gives a red-brown ppt, insoluble in excess in both reagents. Zinc sulfate gives a white ppt that is soluble in excess to give a colourless solution in both reagents. Only copper(II) ions will show a blue ppt, soluble in excess to give a dark blue solution in aqueous ammonia. A blue ppt, insoluble in excess will form in sodium hydroxide.
16	A	Green ppt shows presence of Fe^{2+} ion. Since no aluminium metal was added and ammonia gas is produced, the solution should contain ammonium ions.
17	C	Down a group, atomic radius increases. Across a period from left to right, atomic radius decreases. Atomic radius increases from Cl to Br and I. Hence bond strengths should be highest for H-Cl, followed by HBr and Hi. Atomic radius across a period from N to O to F decreases. Hence, bond strength should increase from H-N to H-O to H-F.

18	A/C	There are 12 bonding electrons present. This is an ion that was formed by a transfer of electrons. All electrons on sulfur are already involved in covalent bonding. Hence, there are no lone pair electrons around sulfur atom. There is only covalent bonding within this ion. Hence **C** is also accepted.
19	B	A triple bond has 1 σ and 2 π bonds.
20	D	 N is more electronegative and will pull electrons towards itself. Hence, electron density is said to have shifted towards N. There is a net dipole moment upwards due to the trigonal pyramidal shape. As N is bonded to H, hydrogen bonding would exist.
21	D	Having a giant covalent structure causes graphene to have a high melting point. As each carbon atom is bonded to 3 other carbon atoms, leaving one electron delocalised and not involved in bonding, the delocalised electron is able to carry charge and conduct electricity.
22	D	Sodium chloride is an ionic compound that does not conduct electricity in solid state but conducts electricity in aqueous or molten state. The sodium chloride crystals dissolve in the water and dissociate to form mobile ions that can act as charge carriers.
23	B	1 mole of NO reacts with oxygen to form 1 mole of NO_2, which in turn reacts with water and oxygen to form 1 mole of HNO_3 due to the mole ratios.
24	C	no. of mol of LiOH = 1.50 x 0.025 = 0.0375 mol no. of mol of **X**Cl_n = 0.250 x 0.050 = 0.0125 mol Since LiOH : **X**Cl_n = n : 1, n = 0.0375/0.0125 = 3
25	B	Na_2CO_3 + 2HCl → 2NaCl + H_2O + CO_2 no. of mol of HCl = 0.100 x 0.020 = 0.002 mol By mole ratio, no. of mol of Na_2CO_3 = 0.001 mol Concentration of Na_2CO_3 solution = 0.001 / 0.025 = 0.04 mol/dm^3 no. of mol in 0.5 dm^3 of solution = 0.04 x 0.5 = 0.02 mol mass of Na_2CO_3 = 0.02mol x [2(23)+12+3(16)] = 2.12g % purity = 2.12/5 x 100% = 42.4%
26	B	no. of mol of sulfuric acid used = 294/98 = 3 mol mass of **3 mol** of $(NH_4)_2SO_4$ = 3 x 132.1 = 396 g mass of **1.5 mol** of $Ca(H_2PO_4)_2$ = 1.5 x 234.1 = 351 g

27	C	70% = 0.325g 100% = 0.325/7 x 10 = 0.464g no. of mol of $C_9H_8O_4$ = 0.464/180 = 0.002579 mol By mole ratio. no. of mol of $C_7H_6O_3$ = 0.002579 mol mass of $C_7H_6O_3$ needed = 0.002579 mol x 138 g/mol = 0.356 g
28	A	no. of mol of O_2 = 58.9 / 24000 = 0.00245 mol no. of mol of $NaBrO_3$ = 0.00245/3 x 2 = 0.00164 mol
29	B	Marble chips are in excess, so increasing the mass will not lead to a bigger decrease in contents. Moreover, the initial mass would be higher than curve 1. An increase in temperature will only lead to an increase in rate but not a further decrease in mass of beaker and contents.
30	C	Only reactions that produce a gas will be suitable for this method of rate determination.

Paper 2

Question	Answers	Marks
A1		
(a)	Barium sulfate is insoluble in water (and will not be absorbed by the patient.) Accept: "sparingly soluble" Reject: "solid", "precipitate", "toxic", any other similar descriptions	**[1]**
(b)(i)	$8cm^3$	**[1]**
(b)(ii)	Conc. of barium hydroxide = 0.35 x 8 / 20 = 0.140 $moldm^{-3}$ [1] Conc in g/dm^3 = 0.140 x 171.3 = 23.982 [1] Percentage purity = 23.982 / 25 = 95.9% [1] Reject: using impure quantity to get no of moles or concentration	**[3]**
(b)(iii)	Yes (volume used is greater). The concentration of sulfuric acid is less/lower (due to dilution by water spilled) [1]	**[1]**
(b)(iv)	Barium hydroxide contains mobile (Ba^{2+}(aq) and OH^-(aq)) ions/charged particles.[1]	**[1]**
(b)(v)	Barium hydroxide reacted with sulfuric acid added to form barium sulfate which is insoluble and does not dissociate to give ions [1] Reject: "**solid** barium sulfate" Hence, electrical conductivity decreases as no./concentration of	**[3]**

	(mobile) ions decreased. [1] No./concentration of ions increased after $8cm^3$ because excess sulfuric acid is added and sulfuric acid dissociates to give (H^+ and SO_4^{2-})ions. [1]	
	Total	**[10]**
A2		
(a)	$2\ CHCl_3 + O_2 \rightarrow 2COCl_2 + 2HCl$	**[1]**
(b)	No. of mol of chloroform = 10 / 119.5 = 0.083682 mol [1] 0.083682 x 24 = $2.01dm^3$ (3sf) [1]	**[2]**
(c)(i)	 [1] for wholly correct diagram Note: all electron symbols should be "dots" – no crosses (unlike dot-and-cross diagram)	**[1]**
(c)(ii)	Number of sigma-bonds = 3 Number of pi-bonds = 1 [1] for both correct answers. No half-marks.	**[1]**
(c)(iii)	Trigonal planar. [1] The central atom has 0 lone pairs and 3 bonding pairs/ 3 electron groups. [1]	**[2]**
(c)(iv)	(Phosgene contains three polar bonds that are not symmetrically arranged around the central C atom hence) there is a net dipole moment. [1] Note: Explanation for net dipole moment, if given, has to be correct Reject: - movement instead of moment - comparison of electronegativity between O & Cl - "O is the most electronegative atom in the molecule" - any mention of specific polar bonds without looking at overall molecule	**[1]**
	Total	**[8]**
A3		
(a)	As the concentration of reactants decreases, the initial rate of reaction decreases too. OR As concentration of reactants increases, initial rate of reaction increases too. OR Concentration is directly proportional to the initial rate of reaction.	**[1]**
(b)	Increased concentration increases the **number of particles**	**[2]**

	per unit volume [1]. **Increase in frequency of effective collisions** hence increases the speed of reaction [1].	
(c)	With reference to experiment 3 and 5, when concentration of $C_6H_5NH_2$ doubles from 0.001 mol dm^{-3} to 0.002 mol dm^{-3}, rate of reaction increase by **4 times** from **0.021 mol dm^{-3} min^{-1}** to **0.084 mol dm^{-3} min^{-1}.** [2] (1 mark for quoting data and 1 mark for stating the effect of increase conc.) With reference to experiment 1 and 2, when concentration of Br_2 doubles from 0.001 mol dm^{-3} to 0.002 mol dm^{-3}, rate of reaction **doubles** from **0.007 mol dm^{-3} min^{-1}** to **0.014 mol dm^{-3} min^{-1}**. [2] (1 mark for quoting data and 1 mark for stating the effect of increase conc.) OR With reference to experiment 1 and 3, when concentration of Br_2 triples from 0.001 mol dm^{-3} to 0.003 mol dm^{-3}, rate of reaction **triples** from **0.007 mol dm^{-3} min^{-1} to 0.021 mol dm^{-3} min^{-1}**. [2] (1 mark for quoting data and 1 mark for stating the effect of increase conc.) Hence, the concentration of $C_6H_5NH_2$ Br_2 does not have an equal effect on the rate of reaction. Reject: No mark given for data if effect of concentration on initial rate is wrong.	**[4]**
(d)	0.028 mol dm^{-3} [1] Doubling concentration of $C_6H_5NH_2$ causes initial rate of reaction to multiply by 4, hence value is obtained by **multiplying initial rate of expt 1 by 4**. [1] Or Tripling concentration of Br_2 causes initial rate of reaction to multiply by 3, hence value is obtained by **divding initial rate of expt 5 by 3**. Working accepted as explanation.	**[2]**
	Total	**[9]**

A4		
(a)	In CNT, **each carbon atom is bonded to three other covalent atoms**, **one valence electron is delocalized** and hence conduct electricity. [1] Reject: CNT contain 1 delocalised electron; CNT has unpaired electron without decription of electron being delocalised; lone pair electrons conduct electricity CNT consists of a giant molecular/ macromolecular/ giant covalent structure [1] Therefore, greater force / greater amount of energy is needed	**[3]**

	to break these (strong) covalent bonds. [1] Reject: Strong covalent bonds are hard to break; Strong electrostatic forces of attraction between atoms instead of covalent bonds	
(b)	$1s^2 2s^2 2p^2$	**[1]**
	Total	**[4]**

A5		
(a)	NO or nitrogen monoxide gas irritates the eyes. OR Nitrogen monoxide gas irritates lungs and causes breathing difficulties. OR High levels of oxides of nitrogen can lead to inflammation of the lungs / bronchitis. Reject: generic explanations eg. bad for health / harmful / toxic / can cause death	**[1]**
(b)	Add sodium hydroxide in excess to the filtrate.[1] Copper salts will produce a blue precipitate. [1] OR Add aqueous ammonia in excess to the filtrate. [1] Copper salts will produce a blue precipitate / solution [1] Accept: Flame test on filtrate sample. Bluish-green flame observed. Reject: add excess sodium hydroxide / aqueous ammonia to (solid) alloy, add excess sodium hydroxide / aqueous ammonia, Accept: add excess sodium hydroxide / aqueous ammonia to dissolved alloy	**[2]**
(c)	% of gold = (8.77 / 15)*100 = 58.5% →14 carat No marks if there is no working.	**[1]**
	Total	**[4]**

A6		
(a)	If the solution is silver nitrate, there will be no precipitate formed / no visible observation/visible changes / observable changes / only a colourless solution / mixture formed; If the solution is barium chloride, there will be a white precipitate formed. Reject: No reaction / No observation / mixture remains clear when silver nitrate solution is used.	**[1]** **[1]**
(b)	**R**: potassium chloride / KC*l* **S**: lead(II) nitrate / $Pb(NO_3)_2$ No marks if roman numerals not written for chemical name of **S**.	**[2]**
(c)	lead(II) carbonate / $PbCO_3$ No marks if roman numerals not written for chemical name.	**[1]**
	Total	**[5]**

B7		
(a)(i)	The greater the number of bonds between two atoms, the larger the bond energy.	**[1]**
(a)(ii)	Any set containing 2 or more bonds e.g. C-C, C=C and C≡C; N-N and N=N; etc (Atoms involved must be same across all bonds, i.e. cannot compare H-H and H-C)	**[1]**
(b)(i)	The bond length decreases with an increased number of bonds between the same types of atoms.	**[1]**
(b)(ii)	The greater the number of shared electrons (or bonds) [1], the stronger the (electrostatic forces of) attraction OR stronger covalent bonds (between the nucleus of each atom and the shared electrons) [1] (Must show correct cause and effect - cause: number of bonds increase; effect: bond length decreases)	**[2]**
(c)	Across a period, effective nuclear charge increases OR force of attraction between electrons and nucleus increases [1], shielding remains constant [1] and bond length decreases. [1]	**[3]**
	Total	**[8]**
B8		
(a)(i)	No of moles of magnesium = no of moles of hydrogen: 58/24000 = 0.0024167 mol (5 s.f.) [1] Mass of magnesium: 0.0024167 x 24.3 = 0.0587 g (3 s.f.) [1]	**[2]**
(a)(ii)	So that the starting volume of gas can be used to determine/calculate the change in volume at different periods of time (or other words to that effect) OR To ensure that any gas collected in the syringe was from the reaction.	**[1]**
(a)(iii)	1. 18/10 = 1.8 cm^3 s^{-1} [1] 2. (30-18)/10 = 1.2 cm^3 s^{-1} [1] 3. 58/70 = 0.8 cm^3 s^{-1} [1] No working (still award marks) (All should be in 1 d.p. as stated by the question but if students put to 3 sf, still award marks)	**[3]**
(a)(iv)	The rate is changing throughout the reaction (or other words to that effect) Accept: rate is non-linear; rate decreases / slows down over time; rate is not constant.	**[1]**
(a)(v)	Electronic/weighing balances can measure up to 1 or 2 decimal places.	**[1]**
(b)(i)	$Zn^{2+}(aq) + 2OH^-(aq) \rightarrow Zn(OH)_2(s)$	**[1]**
(b)(ii)	Having identified the cation meant that the solution could not have contained the carbonate or hydroxide anion. OR Carbonate and hydroxide ions, if found in original solution, would have formed an insoluble precipitate with zinc ions.	**[1]**
(b)(iii)	Barium carbonate / $BaCO_3$; barium sulfate / $BaSO_4$ [1 each]	**[2]**
	Total	**[12]**

B9 Either		
(a)(i)	No of moles of NaOH: 0.02 x 0.10 = 0.00200 mol [1] No of moles of H_2SO_4: 0.030 x 0.20 = 0.00600 mol [1] As 0.00200 mol NaOH requires 0.00200 x ½ = 0.00100 mol of H_2SO_4, H_2SO_4 is in excess [1 mark for explanation + conclusion; if either is wrong, no marks; no marks if only limiting reagent identified but not excess reactant] Concentration of H_2SO_4 in final solution: (0.00600 – 0.00100)/(0.020+0.030) = 0.100 mol dm^{-3} [1]	**[4]**
(a)(ii)	0.7 ECF for pH corresponding to double concentration of wrong answer for **(a)(i)**	**[1]**
(b)	Burette: Student might have washed it with (distilled) water / the indigestion tablet solution just before titration [1] Conical flask: Student might have rinsed it with the indigestion tablet solution just before titration [1] Reject: Student did not wash burette with acid (error not described) Student did not wash conical flask with water (error not described) (Because the acid was added from the burette, it is more likely that the previous titration mixture contains excess acid than excess sodium bicarbonate.) Any answer about rinsing pipette (No matter what you rinsed the pipette with, it will result in the correct titration reading or lower titration reading) Any answer that is not about rinsing with the wrong chemical is not accepted because of the significant deviation in titration value.	**[2]**
(c)(i)	Any soluble salt of Zn^{2+}; any soluble compound of CrO_4^{2-} [1 each] Accept both chromate and chromate(VI) for chemical name	**[2]**
(c)(ii)	(ionic) Precipitation	**[1]**
	Total	**[10]**

B9 Or		
(a)(i)	No of moles of H_2SO_4: 10.0/250 x 1/1 x 0.0200 = 0.000800 mol [1] No of moles of HCl: 10.0/250 x 2/1 x 0.0200 = 0.00160 mol [1]	**[2]**
(a)(ii)	No of moles of NaOH to neutralise H_2SO_4: 2/1 x 0.000800 = 0.00160 mol [1] No of moles of NaOH to neutralise HCl: 1/1 x 0.00160 mol = 0.00160 mol [1] Volume of NaOH: (0.00160+0.00160) / 0.100 = 0.0320 dm^3 [1]	**[3]**
(b)	If **X** were dibasic, **volume** of **X** at endpoint will be half the volume of KOH used [1] The number of moles of potassium hydroxide needed to neutralise hydrogen ions is twice that the number of moles of acid **X** [1] No marks if student used the term "amount" instead of "volume" Reject: volume of **X** at endpoint smaller than volume of KOH used Accept: Titration graph would have **two equivalence points / regions of drastic pH change**. The dibasic acid reacts with KOH to form an acidic salt which reacts with KOH to form a neutral salt / neutralization occurs in two stages for a dibasic acid. Reject: Using universal indicator to detect the two end points. [Universal indicator will show a spectrum of colour changes from start to end. It would not change colour at just the endpoint.] Indicator changes colour twice during titration [A single indicator cannot change colour twice at different end points. It is more practical to plot a titration graph using a pH meter or data logger for polyprotic (e.g. dibasic / tribasic) acids.]	**[2]**
(c)(i)	sodium carbonate/sodium hydroxide; hydroiodic acid [1 each] OR Na_2CO_3 / NaOH; HI Reject: hydroiodide acid / hydrogen iodide Accept: aqueous hydrogen iodide	**[2]**
(c)(ii)	Titration	**[1]**
	Total	**[10]**