2015 Sec 3 End-of-Year Exam Chemistry Answers

Section A

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

Section A

No	Answers	Marks
A1(a)	The brown colour slowly spreads upwards until the mixture is homogeneous./Two jars will be uniformly brown/coloured.	**[1]**
A1(b)	The rate of change increases. OR The change would be faster/Time taken for diffusion to occur will be shorter.	**[1]**
A1(c)	If the bromine sample was impure, it would boil at a temperature higher than 58.8^{o}C. Impure bromine would also boil over a range of temperatures.	**[1]** **[1]**
A2(a)	precipitation	**[1]**
A2(b)	$Ca^{2+}(aq) + CO_3^{2-}(aq) \rightarrow CaCO_3(s)$	**[1]**
A2(c)	filtration	**[1]**
A3(a)	Ionic	**[1]**

No	Answers	Marks
A3(b)	Sodium nitride has a giant lattice/ ionic lattice/ crystal lattice structure. There are strong electrostatic forces of attraction between the sodium and nitride ions./oppositely charged ions.	**[1]** **[1]**
A3(c)	Sodium nitride conducts electricity in the molten or aqueous state. OR Sodium nitride is soluble in water. Sodium nitride is brittle.	**[1]**
A3(d)	monobasic, strong	**[2]**
A3(e)	$Na_3N(s) + 4HCl(aq) \rightarrow 3NaCl(aq) + NH_4Cl(aq)$	**[2]**
A4(a)	methyl orange or any other suitable indicator	**[3]**
A4(b)	A strong acid is one which is completely ionized in water to form H^+ ions.	**[1]**
A4(c)	$MgCO_3(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2O(l) + CO_2(g)$ $2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$	**[1]** **[1]**
A4(d)	Concentration of NaOH = 0.400 ÷ (23+16+1) $= 0.0100\ moldm^{-3}$ No. of moles of NaOH used in titration = 0.0100 × 20.50/1000 $= 2.05 \times 10^{-4}$ Mole ratio of NaOH to H_2SO_4 is 2:1 No. of moles of H_2SO_4 used in titration with NaOH $= 2.05 \times 10^{-4} \div 2$ $= 1.03 \times 10^{-4}$	**[1]** **[1]** **[1]**
A4(e)	No. of moles of $MgCO_3$ used = 0.400 ÷ (24+12+16×3) $= 4.762 \times 10^{-3}$ Mole ratio of $MgCO_3$ to H_2SO_4 is 1:1 No. of moles of H_2SO_4 used = 0.400 ÷ (24+12+16×3) $= 4.76 \times 10^{-3}$	**[1]** **[1]**
A4(f)	Total number of moles of H_2SO_4 $= 2.05 \times 10^{-4} \div 2 \times 100/25.0 + 4.762 \times 10^{-3}$ $= 5.172 \times 10^{-3}$	**[1]** **[1]**

<table>
<tr><th>No</th><th>Answers</th><th>Marks</th></tr>
<tr><td></td><td>Concentration of H_2SO_4 = 5.172 × 10^{-3} ÷ 100/1000
= 0.0517 moldm^{-3}</td><td></td></tr>
<tr><td>A4(g)</td><td>Precipitation.
Any aqueous magnesium salt plus any aqueous carbonate.</td><td>[1]
[1]</td></tr>
<tr><td>A5(a)</td><td>B: $Ca(OH)_2$

C: AgCl

Accept: chemical names</td><td>[1]

[1]</td></tr>
<tr><td>A5(b)</td><td>$NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$</td><td>[1]</td></tr>
<tr><td>A5(c)</td><td>NH_4Cl and $CaCl_2$

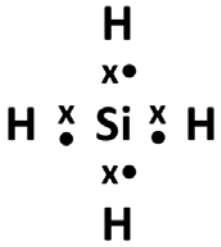
Accept: chemical names</td><td>[2]</td></tr>
<tr><td>A5(d)</td><td>Calcium sulfate is insoluble in water.

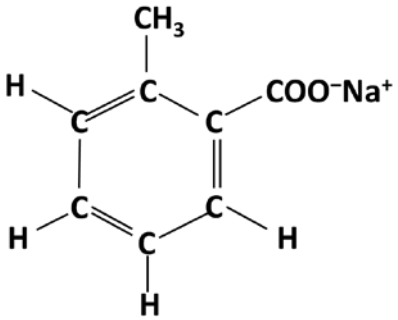
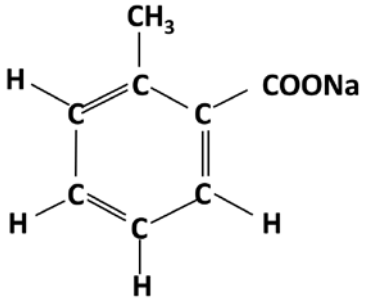
OR

If the sulfate ion was present, A should be a white suspension / white solid in a colourless solution instead of just a colourless solution.</td><td>[1]</td></tr>
<tr><td>A6(a)</td><td>concentration of H^+ ions, surface area of zinc / particle size of zinc</td><td>[2]</td></tr>
<tr><td>A6(b)</td><td><table><tr><td>experiment</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>curve</td><td>II</td><td>I</td><td>IV</td><td>V</td><td>III</td></tr></table>
Number of marks awarded = number of correct answers capped at 4</td><td>[4]</td></tr>
</table>

Section B

<table>
<tr><td colspan="2">B7</td><td></td><td></td></tr>
<tr><td></td><td>(a)</td><td>$2Mg + Si \rightarrow Mg_2Si$</td><td>[1]</td></tr>
</table>

	(b)(i)	Covalent bonds are found between atoms of silicon and hydrogen while van der Waals' forces are found between molecules of silane. [1] Van der Waals' forces between the silane molecules are weak which require less energy to overcome them. [1]	[2]
	(b)(ii)		[1]
	(b)(iii)	Silane is soluble in organic solvents but insoluble in water. Silane does not conduct electricity in any state.	[2]
	(c)	Number of neutrons = 24 – 12 = 12 [1] Electronic configuration = 2, 8 [1]	[2]
	(d)	Number of protons = 48 Number of neutrons = 112 – 48 = 64 Number of electrons = 48 – 2 = 46 [1] [1M] for both numbers of protons and neutrons	[2]
B8			
	(a)(i)	Relative atomic mass of lead sample **A** $= 204 \times \frac{2.7}{100} + 206 \times \frac{48.0}{100} + 207 \times \frac{41.5}{100} + 208 \times \frac{7.8}{100}$ $= 207$	[1]
	(a)(ii)	$Pb + CI_2 \rightarrow PbCI_2$ Let the relative atomic mass of lead sample **B** be *x*. From the equation, no. of moles of Pb = no. of moles of $PbCI_2$	[2]

		$\frac{1.000}{x} = \frac{1.341}{x + 35.5 \times 2}$ [1] $1.341x = x + 71$ $0.341x = 71$ $x = 208$ The relative atomic mass of lead sample **B** is 208. [1] **Alternative answer:** Mass of C*l* atoms reacted = 0.341 g $\text{No. of moles of Cl atoms} = \frac{0.341}{35.5} = 9.606 \times 10^{-3}$ mol [1] $\text{No. of moles of Pb atoms} = \frac{9.606 \times 10^{-3}}{2} = 4.803 \times 10^{-3}$ mol $A_r \text{ of Pb} = \frac{1.000}{4.803 \times 10^{-3}} = 208$ [1]	
	(a)(iii)	Since the relative atomic masses of the two lead samples are different, they have different isotopic compositions.	[1]
	(b)(i)	Add solution of the compound to any carbonates/ moderately reactive metals [1] On reaction with carbonates, carbon dioxide is evolved which forms a white precipitate in limewater/ hydrogen is evolved which extinguishes a lighted splint with a 'pop' sound. [1]	[2]
	(b)(ii)	 or  	[1]
	(c)(i)	Barium carbonate **reacts with the hydrochloric acid in the stomach** to form soluble barium chloride which is toxic to the	[1]

		body. Accept: Barium carbonate reacts with dilute hydrochloric acid in the stomach to produce gas which causes discomfort.	
	(c)(ii)	Ionic equation 1: Reaction of barium hydroxide with dilute nitric acid/ hydrochloric acid $Ba(OH)_2(s) + 2H^+(aq) \rightarrow Ba^{2+}(aq) + 2H_2O(l)$ [1] Ionic equation 2: Reaction of aqueous barium nitrate/ barium chloride with dilute sulfuric acid $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ [1]	[2]
B9 Either			
	(a)(i)	<table><tr><td></td><td>C</td><td>H</td><td>O</td></tr><tr><td>Mass (%)</td><td>40.9</td><td>4.6</td><td>54.5</td></tr><tr><td>A_r</td><td>12</td><td>1</td><td>16</td></tr><tr><td>No. of moles</td><td>$\frac{40.9}{12} = 3.408$</td><td>$\frac{4.6}{1} = 4.600$</td><td>$\frac{54.5}{16} = 3.406$</td></tr><tr><td>Ratio</td><td>$\frac{3.408}{3.406} = 1.001$ (4 s.f.)</td><td>$\frac{4.600}{3.406} = 1.351$ (4 s.f.)</td><td>$\frac{3.406}{3.406} = 1.000$ (4 s.f.)</td></tr><tr><td>Simplest ratio</td><td>3</td><td>4</td><td>3</td></tr></table> Empirical formula = $C_3H_4O_3$ [1]	[2]
	(a)(ii)	$H_2\mathbf{A}(aq) + Na_2CO_3(aq) \rightarrow Na_2\mathbf{A}(aq) + CO_2(g) + H_2O(l)$ $\text{Number of moles of ascorbic acid} = 1.00 \times \frac{22.7}{1000}$ $= 0.02270\text{ mol}$ $\text{Relative molecular mass of ascorbic acid} = \frac{4.00}{0.02270}$ $= 176$ [1] $(\text{nearest whole no.})$	[3]

		Let the molecular formula of ascorbic acid be $(C_3H_4O_3)_x$. $(12\times 3+1\times 4+16\times 3)x=176$ [1] $88x=176$ $x=2$ Molecular formula of ascorbic acid = $C_6H_8O_6$ [1]	
	(b)(i)	Number of moles of aqueous sodium hydroxide used $=0.00500\times\frac{11.30}{1000}=0.0000565$ mol	[1]
	(b)(ii)	1 mol of ascorbic acid reacts with 2 mol of sodium hydroxide Number of moles of ascorbic acid used $=\frac{0.0000565}{2}$ $=0.00002825$ mol [1] Concentration of ascorbic acid in mol/dm^3 $=\frac{0.00002825}{25.0/1000}$ $=0.00113$ mol dm^{-3} $(3$ s.f$)$ [1]	[2]
	(b)(iii)	No. of moles of ascorbic acid in the bottle $=0.00113\times\frac{750}{1000}$ $=0.0008475$ mol [1] Mass of moles of ascorbic acid in the bottle $=0.0008475\times 176$ $=0.149$ g$(3$ s.f.$)$ [1]	[2]
B9 Or			
	(a)	**X**CO_3 + $2HNO_3$ → **X**$(NO_3)_2$ + CO_2 + H_2O	[1]

	(b)	Concentration of nitric acid in mol/dm^3 $= \frac{32.0}{63} = 0.5079$ mol dm^{-3} $(4$ s.f.$)$ [1] Number of moles of nitric acid added $= 0.5079 \times \frac{100}{1000}$ $= 0.0508$ mol (3 s.f.) [1]	[2]
	(c)(i)	$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$ Number of moles of aqueous sodium hydroxide used $= 0.100 \times \frac{26.80}{1000}$ [1] $= 0.00268$ mol 1 mol of nitric acid reacts with 1 mol of aqueous sodium hydroxide Number of moles of nitric acid reacted with NaOH $= 0.00268$ mol [1]	[2]
	(c)(ii)	Number of moles of nitric acid that remained $= 0.00268 \times \frac{250}{25.0}$ [1] $= 0.0268$ mol [1]	[2]
	(d)	Number of moles of nitric acid reacted with the carbonate $= 0.05079 - 0.0268$ $= 0.0240$ mol $(3$ s.f.$)$	[1]
	(e)	2 mol of nitric acid reacts with 1 mol of **X**CO_3 Number of moles of $XCO_3 = \frac{0.02399}{2}$ $= 0.0120$ mol $(3$ s.f.$)$ [1] Relative molecular mass of $XCO_3 = \frac{1.30}{0.0120}$ $= 108$ (nearest whole no.) [1]	[2]