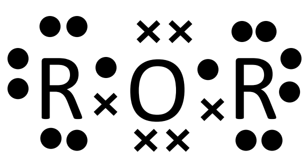
2012 Secondary Three
End-of-Year Paper 1 and 2 (Chemistry)

Paper 1

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

Paper 2
Section A

No	Answers	Marks
A1(a)	Element **V** has a lower melting point. Element **V** has simple molecular structure with weak intermolecular forces of attraction while element **W** is a metallic element with strong metallic bonds. During melting, less energy is required to overcome the weak intermolecular forces of attraction between molecules in **V** than strong metallic bonds in **W**.	[3]
b(i)	It does not conduct electricity in molten state.	[1]
(ii)	 Start with 2 marks, deduct 1 mark for the any of the errors listed (max 2 marks). 1. Wrong chemical symbols. (e.g. Uses C*l* instead of R) 2. Shares wrong number of electrons./ Wrong number of non bonding electrons 3. Non bonding electrons are not paired. 4. Uses symbols other than dot and cross. 5. Brackets Max 1 mark if ionic compound is drawn. [e.c.f. from **bi**]	[2]
c(i)	Gp II	[1]
(ii)	**U** is able to conduct electricity in solid state as it is a metal with 'sea of delocalized electrons'.	[2]
A2(a)	Any excess aqueous nitric acid in the reaction is difficult to separate from the soluble salt product while excess insoluble magnesium hydroxide may be removed easily by filtration.	[2]

No	Answers	Marks
b(i)	3 ions	[1]
(ii)	Covalent and ionic bonds	[1]
A3(a) (i)	$K_2CO_3(aq) + 2HNO_3(aq) \rightarrow 2KNO_3(aq) + H_2O(l) + CO_2(g)$	[2]
(ii)	Amount of K_2CO_3 added = 4.80÷ Molar mass of K_2CO_3 = 4.80÷138 = 0.03478 mol Amount of HNO_3 used = 0.024x 1.67 = 0.04008 mol Mole ratio of K_2CO_3 : HNO_3 is 1:2. Thus, 0.03478 x 2 = 0.06956 mole HNO_3 is required to completely react with 4.80 g of K_2CO_3. HNO_3 is the limiting reagent.	[2]
(iii)	Since HNO_3 is the limiting reagent, and mole ratio of HNO_3: KNO_3 is 1:1, theoretical yield of KNO_3 is 0.04008 mole. Percentage yield = mass of actual yield ÷ mass of theoretical yield x 100 1.70 = mass of actual yield÷(0.04008 x 101) Mass of actual yield = 6.88g (to 3 s.f.)	[1]
(iv)	Excess potassium carbonate added dissolved in the solution and thus could not be removed by filtration.	[1]
b(i)	$OH^-(aq) + H^+(aq) \rightarrow H_2O(l)$	[2]
(ii)	$M_1V_1 \div M_2V_2$ = Mole ratio of KOH is to HNO_3 (0.400 x 0.0300) ÷ (concentration of HNO_3 x 0.0200) = 1 Concentration of HNO_3 = 0.600 mol/dm^3	[2]
(c)	Student **B**'s method is more suitable.	[1]
A4(a)	Dibasic/ 2	[1]
b(i)	Every mole of **HA** will produce 2 mole of ions. Moles of **HA** that dissociated = 2 moles **HA**	[1]
(ii)	Every mole of **H_2B** will produce 3 mole of ions. Moles of **H_2B** that dissociated = 2 moles **H_2B**	[1]
(iii)	**HA** is the stronger acid.	[1]
(c)	1. The solid may be zinc as reaction did not occur due to the absence of water. 2. Not all metals will react with acid. Unreactive metals such as copper and silver will not.	[2]
A5a(i)	**D, C, B, A**	[1]
(ii)	Particles at point **Q** are closely packed while those at point **P** are far apart from each other. Particles at point **P** moves around at a faster speed than those at point **Q**. / Particles at **P** move randomly by bombarding with one another at higher speed and particles at **Q** move by sliding over one another.	[2]
b(i)	$2CH_4(g) + 3O_2(g) \rightarrow 2CO(g) + 4H_2O(g)$	
(ii)	From the equation, gas volume ratio of CH_4 :CO is 1:1. Volume of methane burnt = 30cm^3 Mass of methane = Moles of methane x molar mass of methane = 0.03 ÷ 24 x (12+4) = 0.02 g	[2]
(iii)	Mole ratio = volume ratio Moles of water vapor = $0.05 \times \frac{4}{5} \div 24$ = 0.001667mole No. of water vapor molecules = 0.001667 x 6.02 x10^{23} molecules = 1.00 x 10^{21} molecules (3s.f.)	[2]

<table>
<tr><th>No</th><th>Answers</th><th>Marks</th></tr>
<tr><td></td><td>Accept answer if student use 6 x 10^{23} as Avogadro’s number.

Alternative answer:

Limiting reagent is oxygen.

Moles of water
= ((20/3) x 4)/ 24000
=0.001111
Moles of water molecules
= 0.001111 x 6.02 x 10^{23}
= 6.69 x 10^{20} (3 s.f.)</td><td></td></tr>
<tr><td>(c)</td><td><table>
<tr><th></th><th>C</th><th>H</th></tr>
<tr><td>Mass ratio</td><td>85.7</td><td>14.3</td></tr>
<tr><td>Mole ratio</td><td>85.7 ÷ 12
= 7.14</td><td>14.3 ÷ 1
= 14.3</td></tr>
<tr><td>Simplest ratio</td><td>1</td><td>2</td></tr>
</table>
Empirical formula is CH_2</td><td>[2]</td></tr>
<tr><td>Section B</td><td></td><td></td></tr>
<tr><td>B6 (a)</td><td>Ammonia</td><td>1</td></tr>
<tr><td>(b)</td><td>Use a piece of moist red litmus paper to test for the gas.
The moist red litmus paper will turn blue.</td><td>2</td></tr>
<tr><td>(c)</td><td>A – Copper (II) oxide
B- copper(II) sulfate
C- copper (II) carbonate
D- Carbon dioxide</td><td>4</td></tr>
<tr><td>(d)</td><td>$CuO(s) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + H_2O(l)$</td><td>1</td></tr>
<tr><td>(e)</td><td>Carbonic acid</td><td>1</td></tr>
<tr><td>(f)</td><td>Her conclusion is incorrect as there is a neutralization reaction taking place between the sodium hydroxide and carbonic acid. OR
Her conclusion is incorrect as sodium carbonate formed is soluble in water and appears as a colourless solution and hence it seems there is no reaction when there is a reaction occurring.</td><td>1</td></tr>
<tr><td>B7 (a)</td><td>$CuO(s) + 2HNO_3\ (aq) \rightarrow Cu(NO_3)_2(aq) + H_2O\ (l)$</td><td>2</td></tr>
<tr><td>(b)</td><td>Number of moles of CuO= 8.00/ (64+16) = 0.100 mol
CuO is the limiting reagent as 0.500 mol of nitric acid is in excess.</td><td>2</td></tr>
<tr><td>(c)</td><td>According to the equation, the number of moles of CuO= the number of moles of $Cu(NO_3)_2$ = 0.100 mol
Theoretical yield of copper(II) nitrate = 0.100 x (64+2x14+16x6) =18.8 g
% yield = 9.45/18.8 x 100% = 50.27% =50.3 % (3 s.f.)</td><td>3</td></tr>
<tr><td>(d)</td><td>As the the impurity of the copper(II) oxide is the only factor affecting the yield, the % purity will be equal to the % yield = 50.3%
OR
Number of mole of copper(II) nitrate =9.45/ (64+16x6+14x2) =9.45 / 188 =0.05027 mol
Number of mole of pure copper(II) oxide = number of mole of copper(II) nitrate = 0.05027 mol
Mass of pure copper(II) oxide = 0.05027 x (64+16) = 4.0216g
% purity = 4.0216/ 8.00 x100 = 50.27 % = 50.3% (3 s.f.)</td><td>1</td></tr>
<tr><td>(e)</td><td>Theoretical mass of copper(II) nitrate = 12.0 / (80/100) = 15.0g
Number of moles of theoretical copper(II) nitrate = 15.0/ (64+2x14+16x6) = 0.07979 mol
According to the equation, the number of moles of CuO= the number of moles of $Cu(NO_3)_2$ = 0.07979 mol
Mass of CuO= 0.07979 x (64+16) =6.38g (3s.f.)</td><td>2</td></tr>
</table>

No	Answers	Marks
B8 Either **(ai)**	No. of moles of sodium hydroxide use = 31.7 / 1000 x 0.1 = 0.00317 mol. The mole ratio of NaOH: acid=1:1 Hence, no. of moles of acid used = 0.00317 mol. Thus the concentration of the acid in mol/dm^3 = 0.00317 x1000/25 = 0.1268 mol/dm^3 **= 0.127 mol/dm^3 (3.s.f)**	3
(aii)	Relative Molecular mass of the acid = 8.00 / 0.1268 = 63.091**= 63.1 (3.s.f)**	2
(aiii)	From part (aii), Mr(HXO_3) = 63.1 Ar(H) + Ar(X) + 3[Ar(O)] = 63.1 Ar(X) = 14.1. From the periodic table, X is nitrogen. Hence the acid is **nitric acid, HNO_3.**	1
(b)	Number of moles of NaOH= 0120 x 0.0208 = 0.002496 Number of moles of acid = 0.002496 / 3 = 0.000832 The concentration of the acid in mol/dm^3 = 0.000832/ 0.025= 0.03328 mol/dm^3. Concentration of the acid in g/dm^3 = conc. in mol/dm^3 x M_r = 0.03328 x 98=3.26144 g/dm^3 Thus, percentage purity = $\frac{3.26144}{5.00}\times 100\%$ **= 65.2%**	4
B8 Or (ai)	No. of moles of $KMnO_4$ that reacted = $\frac{27}{1000}\times 0.02$ **= 5.4 x 10^{-4} or 0.00054 mol**.	1
(aii)	From the equation, 2 moles of $KMnO_4$ reacted with 10 moles of $FeSO_4$. 0.00054 moles of $KMnO_4$ reacted with $\frac{10}{2}\times 0.00054 = 0.0027 moles$ of $FeSO_4$. Thus, in 25.0 cm^3, there are **0.0027 moles** of $FeSO_4$.	1
(aiii)	25.0 cm^3 of solution contains 0.0027 moles of $FeSO_4$. 1000 cm^3 of solution contains **0.108 moles of $FeSO_4$**.	1
(aiv)	$M_r(FeSO_4)$ = 56+32+4x16 = 152 Mass of anhydrous iron(II) sulfate in 1 dm^3 of solution = 0.108 x 152=16.416 g**= 16.4 g**	1
(av)	Mass of water in 30.0 g of hydrated iron(II) sulfate = 30.0 - 16.4 = 13.6 g $\frac{M_r\ of\ ALL\ water\ molecules}{M_r\ of\ FeSO_4} = \frac{13.6}{16.4}$ $\frac{18(X)}{152} = \frac{13.6}{16.4}$ ***X = 7***	2
(bi)	$H_2X + 2NaOH \rightarrow Na_2X + 2H_2O$ 1 mole of the acid reacts with 2 moles of NaOH No. of moles of NaOH = 0.004 moles. No. of moles of H_2X= 0.5 x 0.004= 0.002 moles. Hence concentration of the acid= 0.002 x 1000/20**= 0.0500 mol/dm^3**	3
(bii)	M_r of the acid = $\frac{concentration\ in\ g/dm^3}{concentration\ in\ mol/dm^3}$ = 4.92 / 0.05 **= 98.4**	1