RIVER VALLEY HIGH SCHOOL
YEAR 6 PRELIMINARY EXAMINATION (II)

CANDIDATE NAME: **Suggested Solutions**

CLASS: 6

CENTRE NUMBER: S

INDEX NUMBER:

H2 CHEMISTRY 9647/02

Paper 2 Structured Questions

14 September 2015

2 hours

Candidates answer on the Question Paper.

Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, class, centre number and index number on all the work you hand in.
Write in dark blue or black pen on both sides of paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions in the space provided.
A Data Booklet is provided. Do NOT write anything on it.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use

Paper 2

Question Number	**1**	**2**	**3**	**4**	**5**	**6**			**Total**
Marks	**12**	**14**	**14**	**8**	**9**	**15**			**72**
Paper 1		**40**		**Paper 3**		**80**		**Total**	**192**

This document consists of **20** printed pages.

1 **(a)** **(i)** $Pb^{2+}(aq) + 2Cl^{-}(aq) \rightarrow PbCl_2(s)$ **[1]**

(ii) **Q**: silver(I) ion

Explanation:

Ag^{+} (aq) forms a white, insoluble/sparingly soluble salt, AgC*l*, with Cl^{-}(aq).

$AgCl(s) \rightleftharpoons Ag^{+}(aq) + Cl^{-}(aq)$ ----(1)

$[Ag^{+}]$ decreases as Ag^{+} reacts with NH_3(aq) forming a colourless complex, $[Ag(NH_3)_2]^{+}(aq)$.

Equilibrium position of (1) shifts to the right and thus AgCl dissolves **[2]**

(ii) Chemical Test:

To 1 cm^3 of sample in a test-tube, NaOH(aq), dropwise follow by excess.

Expected observation:

White ppt formed is soluble in excess NaOH(aq) to give a colourless solution.

Reject: Aq NH_3 because it is one of the reagents used in a(i)

[2]

(b)

1. Place the 10 cm^3 of aqueous sample provided in a clean 100 cm^3 beaker.
2. Using a 10 cm^3 measuring cylinder, add 10 cm^3 of 0.10 mol dm^{-3} potassium chloride solution. Stir well to ensure complete precipitation.
3. Using a 10 cm^3 measuring cylinder, add 10 cm^3 (accept 2 cm^3, i.e. 20 times of nCl^{-} used, to 10 cm^3) of 1.0 mol dm^{-3} aqueous ammonia. Stir well to ensure any AgC*l* precipitated will dissolve.
4. Filter the mixture into a clean 100 cm^3 conical flask, and collect the insoluble white precipitate of $PbCl_2$ as residue.
5. To the filtrate in the conical flask, add a dropper full of aqueous potassium chloride to check if there is Pb^{2+} remaining in the solution. If white ppt is formed, repeat steps 2 to 4.
6. With the ppt still on the filtration setup, use deionized water to wash the ppt and discard the washings.
7. Weigh a clean crucible/boiling tube/small beaker. Transfer quantitatively all the ppt into this crucible/boiling tube/small beaker.
8. Dry the ppt by using infrared lamp/oven/press dry with filter paper and leave in a dessicator for some time/ heat the ppt in a **[5]**

boiling tube with known mass for 10 minutes (any one method of drying).

9. Cool and weigh the crucible/boiling tube/small beaker and its content.
10. Repeat step 8 and 9 until the mass of crucible/boiling tube/small beaker and its content is less than 0.01g in different.

(c) **(i)** amount of lead(II) ions in 10 cm^3 sample

$= $ amount of $PbCl_2$ precipitated

$= $ amount of lead(II) ions in 5 dm^3 wastewater

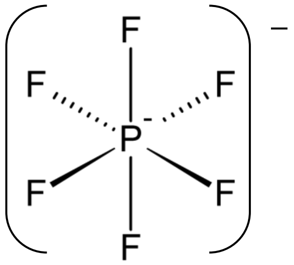
$$n_{\text{lead(II)}} \text{ in } 10\text{ cm}^3 \text{ sample} = \frac{0.102}{207 + 35.5(2)} = 3.67 \times 10^{-4} \text{ mol}$$

concentration of lead(II) ion in wastewater $= 3.67 \times 10^{-4} \div 5$

$= 7.34 \times 10^{-5}$ mol dm^{-3} **[2]**

[Total: 12]

2 **(a)**



90° **[2]**

(b) Both $BMIM^+PF_6^-$ and NaC*l* have giant ionic lattice structure in solid state. Both anion (PF_6^-) and cation size of $BMIM^+PF_6^-$ are significantly larger than that of Na^+ and Cl^-, and they have the same charge. Since charge density of Na^+ and Cl^- is larger, more energy is required to overcome the stronger electrostatic forces of attraction between Na^+ and Cl^- compared to those between $BMIM^+$ and PF_6^-.

[2]

(c) **(i)** In a solution of the weak base at equilibruim:

$$B + H_2O \rightleftharpoons BH^+ + OH^-$$

$$K_b = \frac{[BH^+][OH^-]}{[B]}$$

$$pK_b = -lgK_b$$

[2]

(ii) $n_{base} = \frac{25}{1000} \times 0.1$

$= 0.00250$ mol

$n_{acid} = \frac{20}{1000} \times 0.125$

$= 0.00250$ mol

Hence, an acidic salt solution is formed.

[salt] $= \frac{0.0025}{45} \times 1000$

$= 0.0556$ mol dm^{-3}

K_a of conjugate acid

$= 10^{-(14-6.95)}$

$= 8.91 \times 10^{-8}$

$$8.91 \times 10^{-8} = \sqrt[2]{\frac{[H^+]}{0.0556}}$$

$[H^+] = \sqrt[2]{(8.91 \times 10^{-8})(0.0556)}$

$= 7.06 \times 10^{-5}$ mol dm^{-3}

pH $= -lg(7.06 \times 10^{-5})$

$= 4.15$ **[3]**

(d) Metal 1: A*l*

Metal 2: Zn

Metal 3: Fe **[2]**

(e) **(i)** $[Fe(H_2O)_6]^{2+}$ **[1]**

(ii) $Fe(OH)_2(s)$ **[1]**

(iii) $Fe(OH)_2 + 6CN^- \rightleftharpoons [Fe(CN)_6]^{4-} + 2OH^-$ (or similar reaction) **[1]**

[Total: 14]

3 **(a)** **(i)** $N_2O_4(g) \rightarrow 2NO_2(g)$ **[1]**

(ii) Since $\ln\frac{[N_2O_4]}{[N_2O_4]_0} = -kt$, rate constant, $k = -$ gradient

At 60 s, $\ln\frac{[N_2O_4]}{[N_2O_4]_0} = -1.51$

$k = -\text{gradient} = -\frac{-1.51}{60} = 2.52 \times 10^{-2}\ s^{-1}$

must use given data points from graph* **[1]

(iii) $t_{½} = \frac{\ln 2}{k} = \frac{\ln 2}{2.52 \times 10^{-2}}$

$= 28$ s **[1]**

(iv) **Physical method:**

The rate of decomposition of N_2O_4 can be experimentally determined by measuring the amount of light transmitted through the reaction vessel / absorbed by reaction mixture at regular time intervals, where the colour intensity is proportional to the concentration of NO_2.

The rate of decomposition can be determined by plotting graph of absorbance/turbidity against time and finding the gradient of the tangent of graph.

OR

The rate of decomposition of N_2O_4 can be experimentally determined by measuring the change in total volume of reaction mixture at regular time intervals (of 20s), where the increase in volume is proportional to the volume of N_2O_4 reacted.

The rate of decomposition can be determined by plotting graph of change in total volume against time and finding the gradient of the tangent of graph.

do not accept* ***measuring* *volume of NO_2 produced or N_2O_4 left*

OR initial rate method:

The rate of decomposition of N_2O_4 can be experimentally determined by measuring the **change** in total pressure/volume at regular time intervals (of 20 s) using varying initial concentrations of N_2O_4.

The rate of decomposition can be determined by comparing changes in initial [N_2O_4] with proportional changes in total pressure/volume.

time for experiment should be short, not beyond 20 s, if mentioned* **[2]

(b) **(i)**

Time / s	[N_2O_4] / mol dm^{-3}
0	1.00
20	**0.60**
40	0.35
60	0.22
80	0.22
100	0.22

[3]

(working not required)

From (a)(ii), $k = 2.52 \times 10^{-2}\ s^{-1}$

Using $\ln\frac{[N_xO_y]}{1.00} = -kt$, *at 20s,* $[N_2O_4] = 0.60\ mol\ dm^{-3}$

OR

At 40s where $[N_2O_4] = 0.35$, $k = 2.62 \times 10^{-2}\ s^{-1}$

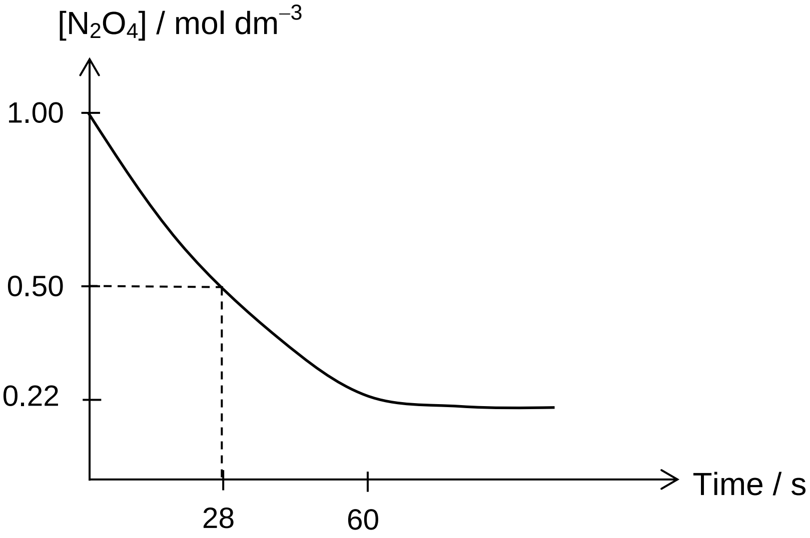
Using $\ln\frac{[N_xO_y]}{1.00} = -kt$, *at 20s,* $[N_2O_4] = 0.59\ mol\ dm^{-3}$

OR

From (a)(iii), $t_{½} = 28$ s

$$[N_2O_4] = 1.00 \times 0.5^{\frac{20}{28}}$$

$$= 0.61\ mol\ dm^{-3}$$



(ii) $[N_2O_4]$ at equilibrium = 0.22 mol dm^{-3}

Degree of dissociation = $\frac{1-0.22}{1} \times 100\%$ = 78.0 % **[1]**

(iii) $[NO_2]$ at equilibrium = (1–0.22) × 2 = 1.56 mol dm^{-3}

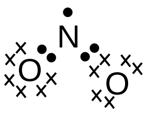
OR

	N_2O_4	$\rightleftharpoons$	$2NO_2$
Initial conc / mol dm^{-3}	1.00		0
Change / mol dm^{-3}	–0.78		+1.56
Eqm conc / mol dm^{-3}	0.22		1.56

$$K_c = \frac{[NO_2]^2}{[N_2O_4]} = \frac{1.56^2}{0.22} = 11.1\ mol\ dm^{-3}$$

[3]

(c) **(i)**



[1]

(ii) Phosphorus is able to expand its octet configuration as it has energetically accessible vacant 3d subshells, whereas nitrogen does not. **[1]**

[Total: 14]

4 **(a)** SiO_2 has a giant covalent structure while SO_3 has a simple covalent structure. More energy is required to overcome the strong covalent bonds between Si and O atoms compared to the weak van der Waals forces between SO_3 molecules. **[2]**

(b) Na_2O reacts vigorously with water to form a strongly alkaline solution (pH = 12).

$Na_2O(s) + H_2O(l) \rightarrow 2NaOH(aq)$

MgO reacts with water to form $Mg(OH)_2$, which dissolves sparingly in water to give a weakly alkaline solution (pH = 8).

$MgO(s) + H_2O(l) \rightarrow Mg(OH)_2(s)$

$Mg(OH)_2(s) \rightleftharpoons Mg^{2+}(aq) + 2OH^-(aq)$ **[4]**

(c) $Al_2O_3(s) + 6H^+(aq) \rightarrow 2Al^{3+}(aq) + 3H_2O(l)$

$Al_2O_3(s) + 2OH^-(aq) + 3H_2O(l) \rightarrow 2[Al(OH)_4]^-(aq)$ **[2]**

[Total: 8]

5 **(a)** **(i)** The $\mathbf{M}^{2+}(aq)/\mathbf{M}(s)$ half-cell is the anode.

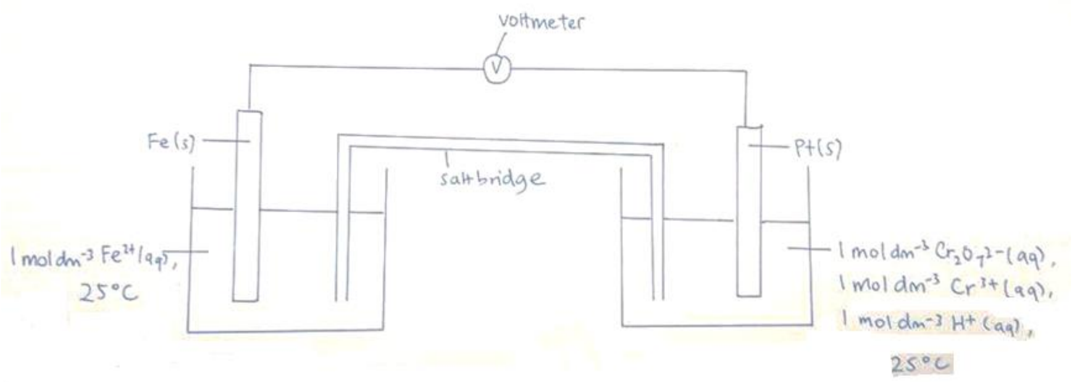
$E^\ominus_{cell} = E^\ominus_{red} - E^\ominus_{ox}$

$+1.77 = +1.33 - E^\ominus_{ox}$

$E^\ominus_{ox} = -0.44$ V

Hence, **M** is Fe. **[2]**

(ii)



[3]

(b) Relative atomic mass of **Y** = 1/3(69) + 2/3(70)

= 69.7

Amount of **Y** deposited = 1.81/69.7

= 0.0260 mol

Q = It

= 2.5 x 50 x 60

= 7500 C

Q = nF

n = Amount of e^-

= 7500/96500

= 0.0777 mol

$\mathbf{Y}^{x+} + xe^- \rightarrow \mathbf{Y}$

Amount of e^- needed to deposit 1 mol of Y = x

= 0.0777/0.0260

= 3 **[4]**

[Total: 9]

6 **(a)** **(i)** PMD can form Van der Waals forces with non-polar cyclohexane molecules. **[1]**

(ii) Filtration OR Centrifuge and decant **[1]**

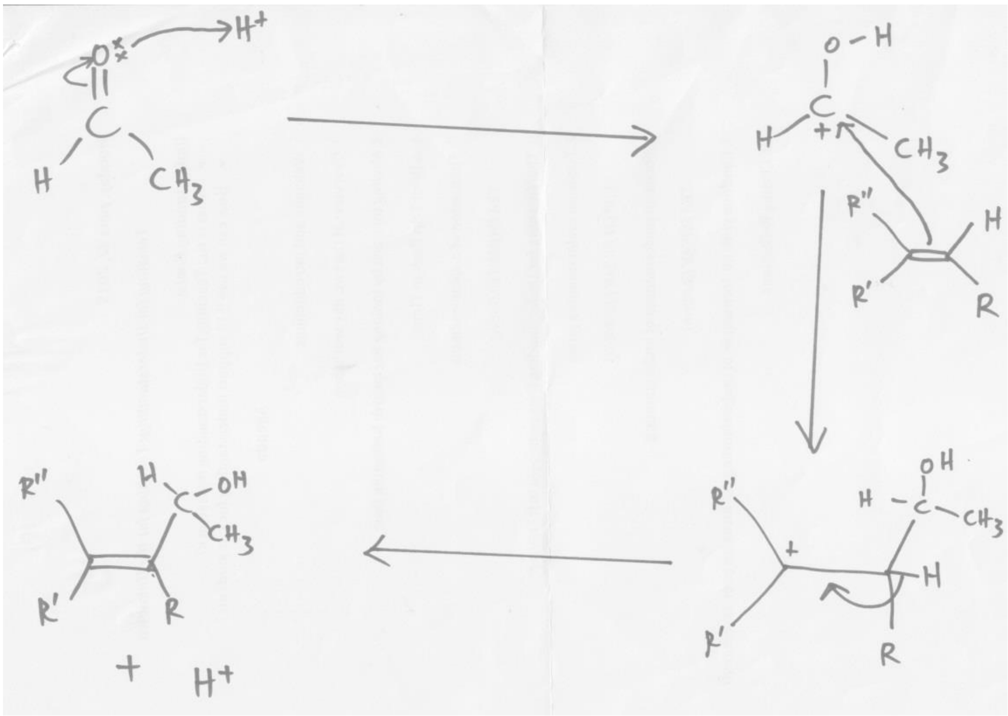
(iii) Drying agent/ absorb moisture/ remove water. **[1]**

(iv) The above setup involves heating under reflux.

Any gas that is boiled off from the flask will condense back into the flask.

Change the setup to simple/ fractional distillation. **[3]**

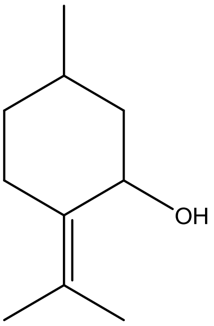
(b)



[3]

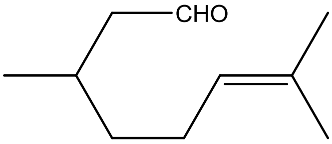
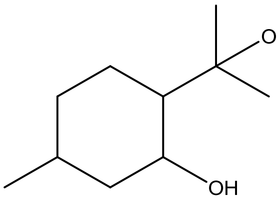
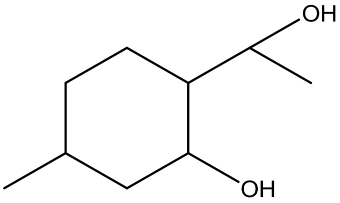
(c)

Y:



Step 2: H_3PO_4, 300 ^{0}C, 65 atm, steam **[2]**

(d)

Compound	Test 1	Test 2
	To 1 cm depth of each cpd, add 2,4-DNPH	To 1 cm depth of each cpd, add I_2/ OH^- (aq) and heat
 citronella	Orange ppt	No pale yellow ppt
 PMD	No orange ppt	No pale yellow ppt
 2-(1-hydroxyethyl)-5-methylcyclohexanol	No orange ppt	Pale yellow ppt

[4]

[Total: 15]