Marking Schemes

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Chemistry
Paper 1

SECTION A

Question No.	Key	Question No.	Key
Part I		**Part II**	
1.	A (81%)	25.	C (77%)
2.	C (88%)	26.	B (60%)
3.	D (59%)	27.	D (67%)
4.	C (75%)	28.	C (58%)
5.	B (86%)	29.	C (26%)
6.	B (59%)	30.	D (68%)
7.	A (58%)	31.	A (34%)
8.	A (66%)	32.	B (66%)
9.	C (77%)	33.	D (72%)
10.	B (63%)	34.	B (77%)
11.	A (84%)	35.	A (64%)
12.	B (50%)	36.	A (65%)
13.	C (51%)		
14.	D (75%)		
15.	B (36%)		
16.	A (68%)		
17.	C (73%)		
18.	A (85%)		
19.	C (27%)		
20.	D (38%)		
21.	C (72%)		
22.	D (49%)		
23.	C (77%)		
24.	D (58%)		

Note: Figures in brackets indicate the percentages of candidates choosing the correct answers.

SECTION B

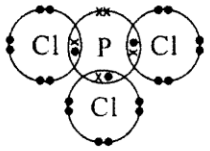
Part I

Marks

1. (a) 2, 8, 5 — 1

(b) Chlorine exists as isotopes. / There are chlorine atoms with same number of protons but different number of neutrons. — 1

(c) (i) Number of moles of P : Number of moles of Cl = 0.226/31.0 : 0.774/35.5 — 2
= 1 : 3
Molecular formula is $(PCl_3)_n$
$(31.0 + 35.5x3)\ n < 250$
$n = 1$
Molecular formula is PCl_3

(ii) 

1

2. (a) To increase the electrical conductivity of the filter paper / To increase the number of mobile ions / To provide mobile ions — 1

(b) pale green — 1

(c) Blue colour appears around the middle of the filter paper. — 1
$Fe^{2+}(aq)$ ions move towards negative pole and $Fe(CN)_6^{3-}(aq)$ ions move towards positive pole forming a blue compound. — 1

(d) The colour around the middle of the filter paper remains unchanged. — 1
$Fe^{2+}(aq)$ ions and $Fe(CN)_6^{3-}(aq)$ ions do not migrate towards each other. / $K^+(aq)$ ions and $SO_4^{2-}(aq)$ ions migrate towards each other but do not form coloured compounds. — 1

3. (a) cracking — 1
To produce alkenes / To produce smaller hydrocarbons from larger hydrocarbons / To convert heavy oil to petrol — 1

(b) The reaction will be faster when using broken unglazed porcelain instead of a large piece of unglazed porcelain due to larger surface area. — 1

(c) (i) $C_8H_{18} \rightarrow C_2H_6 + 2CH_3CH{=}CH_2$ / $C_8H_{18} \rightarrow C_2H_6 + 2C_3H_6$ — 1

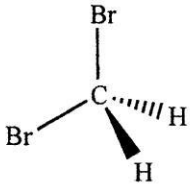
(ii) (1) Orange / brown Br_2 solution turns to colourless. — 1

(2) $CH_3CHBrCH_2Br$ — 1

(d) The delivery tube should be taken out of the water level before removing the heating source, — 1
otherwise sucking back will happen / the boiling tube will be cracked. — 1

Marks

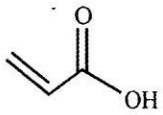
4. (a) (i) $S{=}C{=}S$ 1

(ii) 

1

(b) • C—H and C—Br bonds are polar. 1
• C and H / C and Br have different electronegativities. / 1
C is more electron-withdrawing than H / Br is more electron-withdrawing than C.

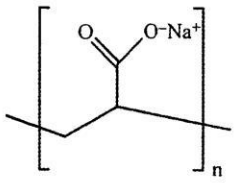
(c) The intermolecular forces between CS_2/ CO_2 molecules are van der Waals' forces. 1
As CS_2 has greater molecular size than CO_2, the van der Waals' forces between CS_2 molecules are stronger than those between CO_2 molecules. 1

5. (a) 

1
propenoic acid 1

(b) addition 1

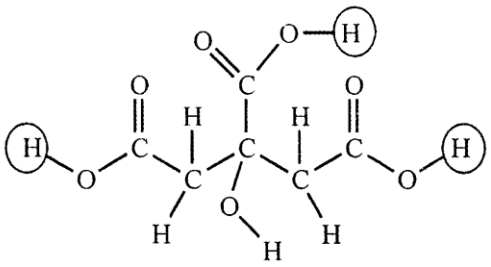
(c) **B** is a mixture of polymer molecules with different lengths. 1

(d) 

1

Marks

6. (a)



1

(b) (i) volumetric flask 1

(ii) Number of moles of NaOH(aq) = 0.123 x 0.01845 3
Number of moles of citric acid reacting with NaOH(aq) = 0.123 x 0.01845 ÷ 3
Number of moles of citric acid in the sample = 0.123 x 0.01845 ÷ 3 x 10
Percentage by mass of citric acid in the solid sample
= (0.123 x 0.01845 ÷ 3 x 10 x 192.0 ÷ 1.65) x 100%
= 88.0 %

(c) (i) Colourless gas bubbles form. / Effervescence occurs. 1

(ii) $H^+ + NaHCO_3 \rightarrow H_2O + CO_2 + Na^+$ 1

7. (a) constant pressure 1

(b) It is very difficult for Mg(s), C(s) and $O_2(g)$ to react directly to form $MgCO_3(s)$. 1

(c) (i) Heat loss to surrounding / PS cup absorbs heat. 1

(ii) No, because insoluble $CaSO_4$ will be formed. 1

(d) 3

	Standard enthalpy change / kJ mol^{-1}
$MgCO_3(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2O(l) + CO_2(g)$	–50
$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$	–467
$C(s) + O_2(g) \rightarrow CO_2(g)$	–394
$H_2(g) + 1/2\ O_2(g) \rightarrow H_2O(l)$	–286
$Mg(s) + C(s) + 3/2\ O_2(g) \rightarrow MgCO_3(s)$	y

$y - 50 = -467 - 394 - 286$
$y = -1097$ kJ mol^{-1}

8. (a) (i) Reddish brown gas is observed. 1

(ii) $Sr^{2+} + 2e^- \rightarrow Sr$ 1

(b) Bromine gas formed is toxic / poisonous. 1

(c) (i) Oxidation number of Mn decreases / changes from +4 to +3. 1
Therefore $MnO_2(s)$ is the oxidising agent. 1

(ii) $2MnO_2(s) + 2NH_4^+(aq) + 2e^- \rightarrow Mn_2O_3(s) + 2NH_3(aq) + H_2O(l)$ 1

Marks

9. • Dissolve the solids separately in water. 1
• Add aqueous ammonia / NaOH(aq) to each of the solutions obtained until excess. 1
• White precipitate formed initially for all of them. But only the precipitate of $ZnSO_4$ dissolves in excess aqueous ammonia / NaOH(aq). 1
• Heat respectively the two remaining solids in a test tube and place a piece of dry $CoCl_2$ paper in the mouth of the tube. 1
• Only $MgSO_4 \cdot 7H_2O$ can turn dry $CoCl_2$ paper from blue to pink. 1
• Communication mark 1

Part II

10. (a) At dynamic equilibrium, the rate of forward reaction is equal to the rate of backward reaction, and not equals zero. / 1
At dynamic equilibrium, reactants are converted to products and products are converted to reactants at equal rate. No net change is observed.

(b) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ 3

	$2SO_2(g)$	$O_2(g)$	$2SO_3(g)$
Initial	2.0 mol	2.0 mol	
At equil.	2.0–2x	2.0–x	2x

where $2x = 1.8$ thus $x = 0.9$

$878 = [1.8/V]^2 / [0.2/V]^2 [1.1/V]$

$V = 11.92\ dm^3$

(c) (i) Decrease. The reaction is exothermic. Increase in temperature will cause the equilibrium position to shift to the left. 1

(ii) No change. A catalyst will increase the rate of forward reaction and that of backward reaction to the same extent. / A catalyst has no effect on the equilibrium position. 1

11. (a) To ensure fair comparisons between the trials. / 1
To ensure the concentration of NaOH(aq) is the only variable. /
The volume of NaOH(aq) used can represent the concentration of NaOH(aq) in the reaction mixtures.

(b) $[OH^-(aq)] = 2.0 \times (4.0/5.0) = 1.6\ mol\ dm^{-3}$ 3

$[H^+(aq)] \times 1.6 = 1.0 \times 10^{-14}$

$[H^+(aq)] = 6.25 \times 10^{-15}\ mol\ dm^{-3}$

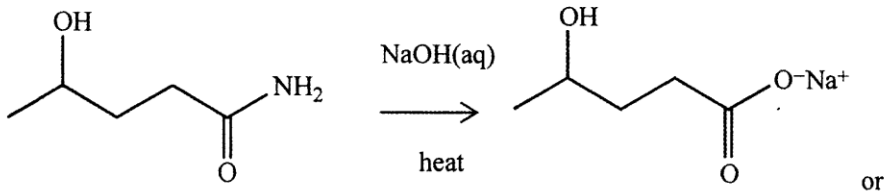
$pH = -\log (6.25 \times 10^{-15}) = 14.2$

(c) The concentration of NaOH(aq) 1
The shorter the time for the pink colour disappeared, the faster the reaction. An increase in concentration of NaOH(aq) will result in an increase in the reaction rate. 1

(d) Using colorimeter / measuring relative transmittance / absorbance of the mixture 1

Marks

12. Step 1: 3



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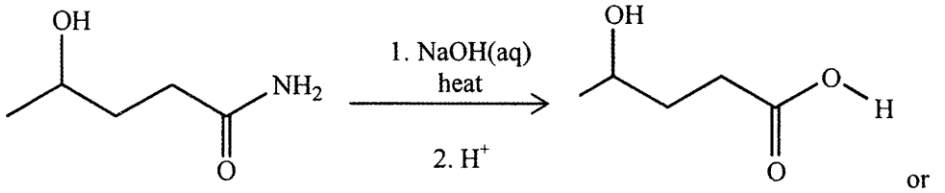

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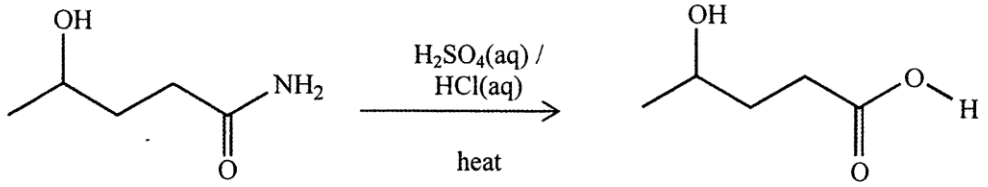
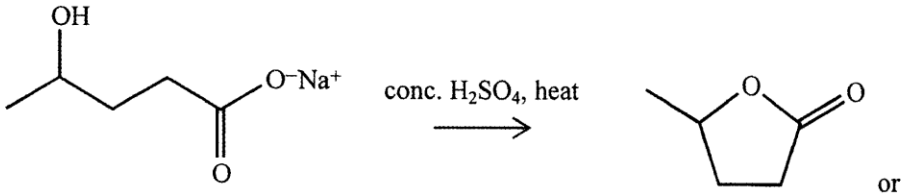


Step 2:



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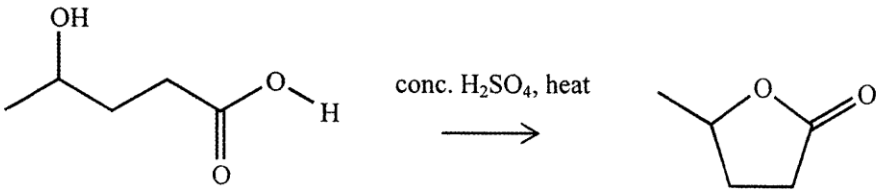
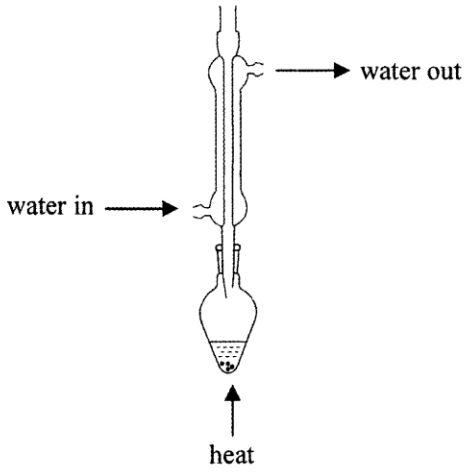


Marks

13. (a) 2



(b) $LiAlH_4$ / H_2 (catalyst - Pt) 1

(c) enantiomers / optical isomers 1

(d) optical activity / 1
P and **Q** rotate plane-polarised light to opposite directions to the same degree / extent.

(e) Correct chemical reagent 1
Correct observations with comparison between the tests on acetophenone and **P** 1
Possible tests and the corresponding observations:

$Cr_2O_7^{2-}$ / H^+	acetophenone – no change; **P** – from orange to green
MnO_4^- / H^+	acetophenone – no change; **P** – from purple to colourless
MnO_4^-	acetophenone – no change; **P** – formation of brown ppt.
MnO_4^- / OH^-	acetophenone – no change; **P** – formation of brown ppt.
2,4-DNP	acetophenone – formation of orange ppt.; **P** – no change
CH_3COOH / H^+ / heat	acetophenone – no change; **P** – pleasant odur substance formed

2,4-DNP = 2,4-dinitrophenylhydrazine

14. Electrical conductivity: aluminium > sodium > silicon = sulphur (or: silicon > sulphur) 1
Any 3 of the following items, each 1 mark 3

- Both aluminium and sodium have giant metallic structures with delocalised electrons so that electrical conductivity of them is high.
- The number of delocalised electrons of aluminium is more than that of sodium so that electrical conductivity of aluminium is higher than that of sodium.
- Silicon has giant covalent structure and its electrons are not mobile and cannot conduct electricity. OR
  Silicon has giant covalent structure and its electrons are not mobile. But silicon is a semi-metal and can conduct electricity in some conditions.
- Suphur has simple molecular structure and its electrons are not mobile and cannot conduct electricity.
- Communication mark 1

Paper 2

Marks

1. (a) (i)
- Higher temperature will have a higher rate of reaction. 1
- But the forward reaction is exothermic, increasing the temperature will shift the equilibrium position to the left. 1

Therefore, the operating temperature is set at 300°C.

(ii) total number of particles / total number of molecules 1

(iii) (1) carbon monoxide / CO and hydrogen / H_2 1

(2) methanol / CH_3OH 1

(b) (i) fractional distillation of liquefied air 1

(ii)
- The hot gas from reaction chamber can help heat up the hydrogen and nitrogen. 1
- It is to save energy. 1

(iii) Number of moles of $N_2(g)$ = 420000/28; Number of moles of H_2 = 96000/2 3
Mole ratio of $N_2(g)$ to $H_2(g)$ = 420000/28 : 96000/2 = 1: 3.2,
$N_2(g)$ is the limiting reagent.
Mass of $NH_3(g)$ produced = 420000/28 x 2 x 17 x 15%
= 76.5 kg

(iv) (1) $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ 1

(2) $4NO_2 + O_2 + 2H_2O \rightarrow 4HNO_3$ 1

(c) (i) (1)
- Compare experiments 1 & 3, [sucrose] remains the same but [HCl] is three times, rate is also three times. Therefore reaction order with respect to HCl is one. 1
- Compare experiments 1 & 2, [sucrose] and [HCl] is doubled, the rate is quadrupled. Therefore reaction order with respect to sucrose is also one. 1

(2) rate = k $[C_{12}H_{22}O_{11}(aq)]$ [HCl(aq)] 1

(3) With data from Trial 1,
$6.0 \times 10^{-7} = k\ (0.010)\ (0.10)$
$k = 6.0 \times 10^{-4}\ dm^3\ mol^{-1}\ s^{-1}$ 1

(ii) Acts as a catalyst. 1

(iii)
- Need not to separate fructose from the mixture after enzymatic hydrolysis of starch but the hydrolysis of sucrose needs to do so. 1
- Higher atom economy as glucose is the only product from the enzymatic hydrolysis of starch. 1

Marks

2. (a) (i) Cellulose is biodegradable. 1

(ii) Molecules in liquid crystals
- are usually long and rigid rod-like / long and disk-like. 1
- contains C=C / N=N double bonds. 1

(iii)
- Many benzene rings in the structure can make it rigid. 1
- There are many strong intermolecular hydrogen bonds between the polymer molecules. 1

(b) (i) face-centred cubic / cubic close-packed 1

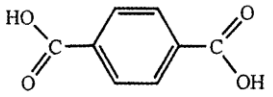
(ii) $(1 \div 4) \times 12 + 1$ 1
$= 4$ 1

(iii) 12 1

(iv)
- 18-carat gold is an alloy which is harder than pure gold. 1
- Different kinds of metal atoms in alloy have different size making the atom layers difficult to slide over one another. 1

(v) stained glass 1

(c) (i) (1) $HOCH_2CH_2CH_2CH_2OH$ 1



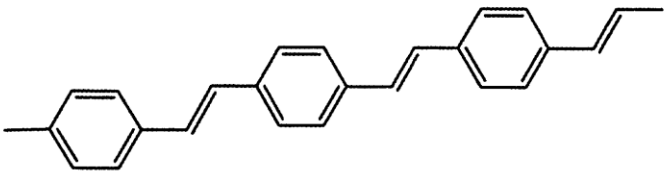
1

(2) Condensation polymerisation 1

(3) Extrusion moulding / injection moulding 1

(ii)
- resistant to chemicals 1
- resistant to tear and wear 1

(iii) (1) 1



(2) Optically inactive because there is no chiral centres. 1

Marks

3. (a) (i) Sodium hydroxide solid is deliquescent. / 1
Sodium hydroxide solid would absorb carbon dioxide gas from air.

(ii) • Add a few drops of HCl(aq). 1
• Pale yellowish-green gas evolved which turns moist blue litmus paper red and then bleaches it. 1

(iii) • Similarity: Both show an absorption peak at 3230–3670 cm^{-1} (O–H groups). 1
• Difference: Only chitin shows an absorption peak at 1680-1800 cm^{-1} (C=O groups). 1

(b) (i) (1) $Cr_2O_7^{2-}(aq) + 6Fe^{2+}(aq) + 14H^+(aq) \rightarrow 2Cr^{3+}(aq) + 6Fe^{3+}(aq) + 7H_2O(l)$ 1

(2) Number of moles of $Fe^{2+} = 0.0642 \times 26.88 \times 10^{-3}$ 2
$= 0.0017257$ mol
$[Cr_2O_7^{2-}(aq)] \times 25.00 \times 10^{-3} \times 6 = 0.0017257$
$[Cr_2O_7^{2-}(aq)] = 0.0115$ mol dm^{-3}

(ii) (1) Blue filter allows blue light to pass through and the orange $Na_2Cr_2O_7(aq)$ solution absorbs blue light to a large extent. 1

(2) The absorbance is directly proportional to the concentration of $Cr_2O_7^{2-}(aq)$. 1

(3) Absorbance = 0.26, $[Cr_2O_7^{2-}(aq)]$ found from the graph = 7.0×10^{-4} mol dm^{-3} 2
$[Cr_2O_7^{2-}(aq)]$ in sample **B** = $7.0 \times 10^{-4} \times (100) = 0.07$ mol dm^{-3}

(iii) Colorimetry is more appropriate.
The very low colour intensity of the solution can still be determined by colorimetry. 1

(c) (i) The mass spectra of **X** and **Y** are recorded respectively.
• In the mass spectrum of **X**, a significant peak at m/z = 43 appears for CH_3CO^+ ions which does not appear in the mass spectrum of **Y**. 1
• In the mass spectrum of **Y**, a significant peak at m/z = 119 appears for $C_6H_5CH_2CO^+$ ions which does not appear in the mass spectrum of **X**. 1

(ii) (1) • $Na_2CO_3(aq)$ is added to the solution of **X** and **Y** in dichloromethane. 1
• The mixture is shaken in a separating funnel. 1
The mixture in the separating funnel is allowed to settle, and the aqueous layer is then separated from the organic layer.
• Dilute $H_2SO_4(aq)$ is added to the aqueous layer until no more precipitate is formed. 1
• Solid **Y** can be obtained by filtration. 1

(2) Measure the melting point of the solid obtained.
If the melting point of the solid is 77°C, it may be pure compound **Y**. 1