2011 A LEVEL PRELIM P1 SOLUTIONS

1	A	11	D	21	B	31	D
2	D	12	A	22	C	32	B
3	B	13	C	23	C	33	B
4	C	14	C	24	C	34	A
5	D	15	C	25	D	35	A
6	B	16	C	26	D	36	B
7	A	17	A	27	A	37	D
8	C	18	C	28	C	38	A
9	A	19	B	29	C	39	B
10	C	20	D	30	B	40	C

2011 Prelims (P2): Suggested Answer

1 (a) No of moles of H_2SO_4 = 10/1000 x 1 = 0.01 mol

No of moles of NaOH = 40/1000 x 1.50 = 0.06 mol (excess)

No of moles of H_2O formed = 0.02 mol

Amount of heat produced = 0.02 x 57 400 = 1148 J

Temperature rise = 1148/(50 x 4.18) = 5.5 ^oC

(b)

Volume of **FA 1** / cm^3	10	20	30	40
Volume of **FA 2** / cm^3	40	30	20	10
Temperature rise, Δ**T** / ^oC	5.5	**11.0**	**8.2 / 8.3**	**4.1 / 4.2**

(c)

1. Measure 10.0 cm^3 of **FA 1** using a 20 cm^3 measuring cylinder.
2. Pour the **FA 1** into a styrofoam cup.
3. Measure the temperature of **FA 1** in the cup using a thermometer.
4. Measure 40.0 cm^3 of **FA 2** using another 50 cm^3 measuring cylinder. Measure the temperature of **FA2**.
5. Take the average of the temperatures of **FA1** and **FA2** as the initial temperature.
6. Pour the **FA 2** into the Styrofoam cup containing **FA 1** and stir using the thermometer.
7. Record the maximum temperature of the mixture.
8. Repeat the experiment using the various volumes of **FA 1** and **FA 2** shown in the table in (**b).**

OR

1. Measure 10.0 cm^3 of **FA 1** using a 20 cm^3 measuring cylinder.
2. Pour the **FA 1** into a styrofoam cup.
3. Measure 40.0 cm^3 of **FA 2** using another 50 cm^3 measuring cylinder.
4. Pour the **FA 2** into the Styrofoam cup containing **FA 1**.
5. Stir the mixture gently and record the initial temperature of the mixture using a

thermometer.

6. Record the maximum temperature of the mixture.
7. Repeat the experiment using the various volumes of **FA 1** and **FA 2** shown in the table in (**b).**

(d) **Source of error and suggestion to minimise error**

Heat absorbed by the calorimeter	Calibration of calorimeter to account for heat absorbed (see calibration of calorimeter)
Heat loss to surrounding	Provide lagging on the body of the calorimeter OR Use a lid to cover the calorimeter OR Consider cooling correction (see next section)
Measuring cylinders not precise in measuring volumes of **FA 1** and **FA 2**.	Use a burette to measure accurately the volumes of **FA 1** and **FA 2**.

(e) From the graph, find the point of **intersection of the two lines** to obtain the vol of **FA 2** with maximum temperature rise.

Assume vol of H_2SO_4 in **FA 1** is V_1 cm^3 at point of intersection

$V_1/1000 \times [H_2SO_4] = (50 - V_1)/1000 \times 1.5/2$

$[H_2SO_4] = \frac{(50 - V_1) \times 1.5}{2\ V_1}$

2 **(a)** **(i)** Powdered iodine has **larger surface area** for effective collision.

Thus the **rate of reaction will increase.**

(ii) The reaction is exothermic and has to be kept in control OR iodine may **oxidise** ethanol.

(iii) To ensure the reaction is complete.

(b) **(i)** $CH_3CH_2OH + CH_3CH_2I \rightarrow CH_3CH_2OCH_2CH_3 + HI$

Iodoethane undergoes nucleophilic substitution with ethanol acting as the nucleophile.

(ii) $I_2 + 2e \rightleftharpoons 2I^-$ $\quad E^\theta = +0.54$

$O_2 + 4H^+ + 4e \rightleftharpoons 2H_2O$ $\quad E^\theta = +1.23$

Overall: $4I^- + O_2 + 4H^+ \rightarrow 2I_2 + 2H_2O$

$E^\theta_{overall} = +1.23 - +0.54 = +0.69$ V

(c) **(i)** To remove / react **H_3PO_3**.

(ii) To remove **water soluble** impurities / ethanol / ether / last traces of sodium carbonate.

(iii) K_2CO_3 / $CuSO_4$ / $CoCl_2$ / $MgSO_4$ / Na_2SO_4 / $CaSO_4$

(iv) The boiling temperature of fixed at 71°C to ensure that the distillate is **pure**.

(d) **(i)** C*l* is more electronegative than I will pull bond pairs of electrons towards itself. Hence, there is lesser repulsion between the bond pairs and the bond angle of PCl_3 is smaller.

(ii) $PI_3 + 3H_2O \rightarrow H_3PO_3 + 3HI$

(iii) **White fumes** were seen for the reaction of PCl_3 and water due to the **formation of HC*l* gas**. The HI formed for the reaction of PI_3 and water undergoes thermal decomposition **to form purple I_2 fumes**.

The **size of I is bigger than C*l***. Thus the atomic overlap between H and I atoms is less effective. The **bond strength of H-I is weaker**, hence it is more easily broken to form I_2.

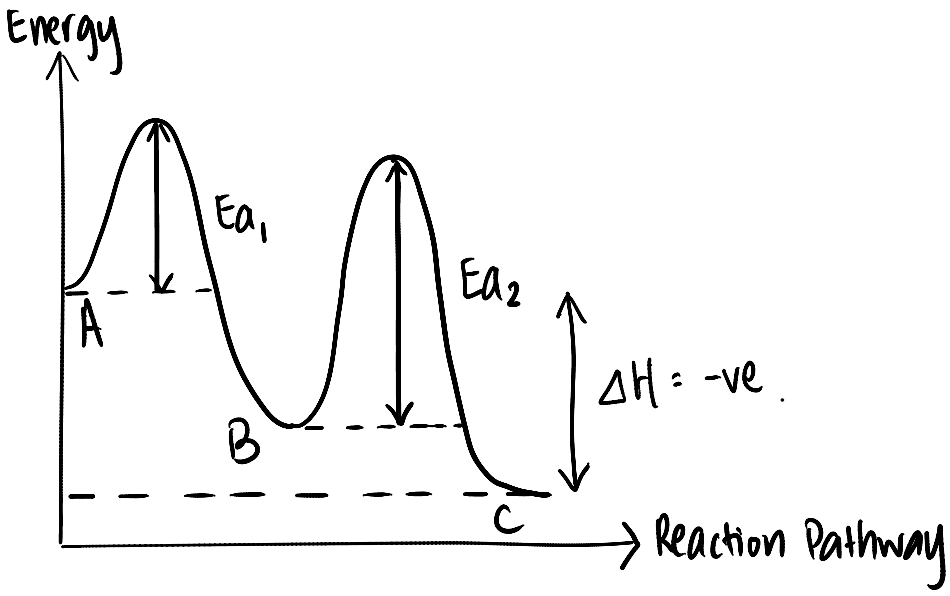
3 **(a)** **(i)** The formation of B is faster than C OR Step 1 is faster than Step 2 as it has a steeper gradient OR the maximum concentration is attained faster in the formation of B than C.

(ii) Step 2

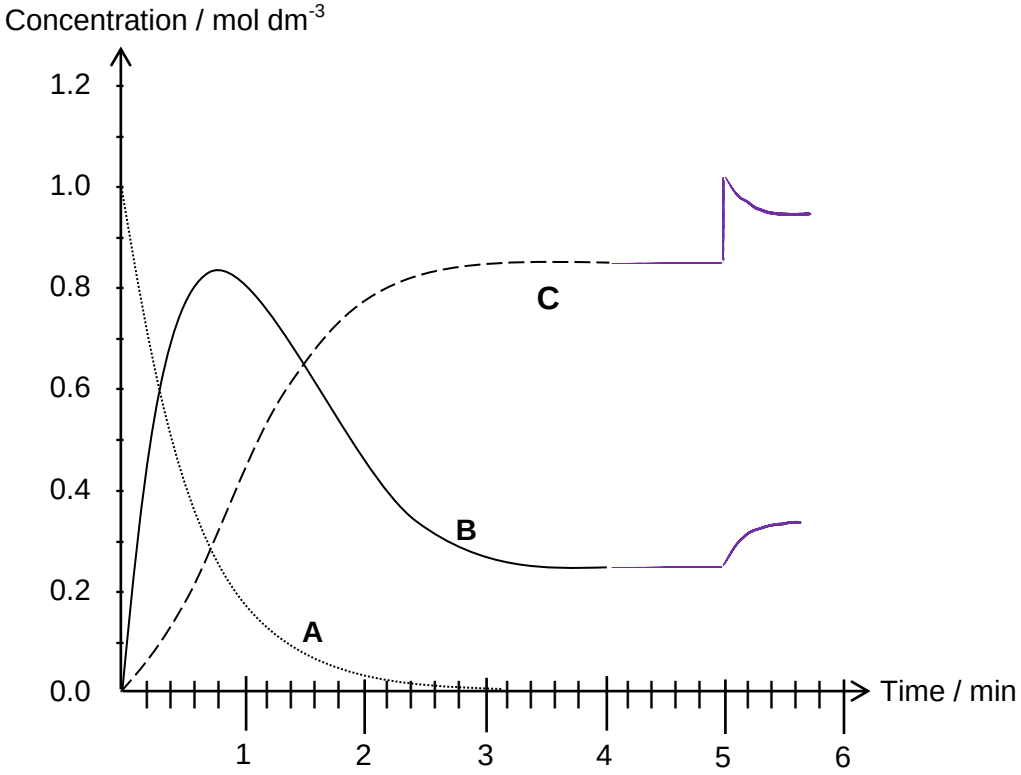
(iii) $t_{1/2}$ = 0.40 min

2 half-lives constant

(iv)



(b)



4 (a) (i) OR **$NiOOH + H_2O + e \rightarrow Ni(OH)_2 + OH^-$**

Iron: **$Fe + 2OH^- \longrightarrow Fe(OH)_2 + 2e$**

(ii) Iron to Nickel oxide-hydroxide

(iii) $1.2 = E°_{cell}$ (NiOOH) – (+0.55)

Thus,

$E°_{cell}$ (NiOOH) = +1.75V

(iv) $NiOOH + H_2O + e \longleftrightarrow Ni(OH)_2 + OH^-$

When the acid is added, it removes the OH- ions and hence reduces its concentration leading to the **equilibrium above to shift to the right** to replenish the OH- ions removed.

Hence the E°cell at the cathode becomes greater than +1.75V, resulting in the **e.m.f becomes greater than +1.2V**

(v) When the volume of the hydroxide increase, there is **no change in concentration of the OH-** hence no shift in equilibrium

Hence, there is **no change in e.m.f**

(b) (i) $2Ni(OH)_2 + Fe(OH)_2 \longrightarrow 2NiOOH + Fe + 2H_2O$

(ii) Mass of Fe required = 3 x 0.95 = 2.85g

No. of moles of Fe = 2.85/55.8 = 0.05107

No of moles of electrons required = 0.05107 x 2 = 0.1022

Thus,

Total amount of electricity required = 0.1022 x 96500 = 9857.5C

Thus minimum current = 9857.5 / (2 x 60 x 60) = **1.37A**

(iii) Total amount of electricity = 1.37 x (2 x 60 x 60) = 9864 C

Total number of electrons = **total number of nickel oxide-hydroxide**

= 9864 / 96500 = 0.102 **[1]**

Total mass of nickel oxide-hydroxide = 0.102 x (58.7 + 32 +1) = 9.35g

Actual mass of nickel oxide-hydroxide = 9.35/0.95 = **9.85g**

(iv) $O_2 + 2H_2O + 4e \leftrightarrow 4OH^-$ $E°_{red} = +0.40V$

Having a **more negative than +1.75V** ($E°_{red}$ of the reaction at the nickel (III) oxide-hydroxide), the hydroxide ions are also discharged to produce oxygen gas.

5 (a) (i) $Fe(s) + 3/2\ Cl_2(g) \longrightarrow FeCl_3(s)$

(ii) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$

(iii) $Fe(H_2O)_6]^{3+} + H_2O \longrightarrow [Fe(H_2O)_5(OH)]^{2+} + H_3O^+$

$2H^+ + CO_3^{2-} \longrightarrow CO_2 + H_2O$

(iv) **A:** $[Fe(H_2O)_6]^{3+}.3Cl^-$ OR $[Fe(H_2O)_6]Cl_3$ OR $[Fe(H_2O)_6]^{3+}$

B: $Fe(OH)_3$ (s)

C: $Fe(OH)_2$ (s)

D: neutral $FeCl_3$(aq)

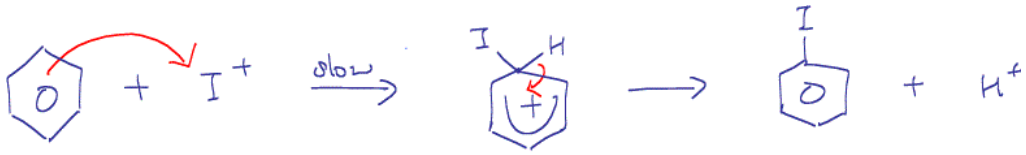
(v) Ligand exchange

$[Fe(EDTA)]^-$

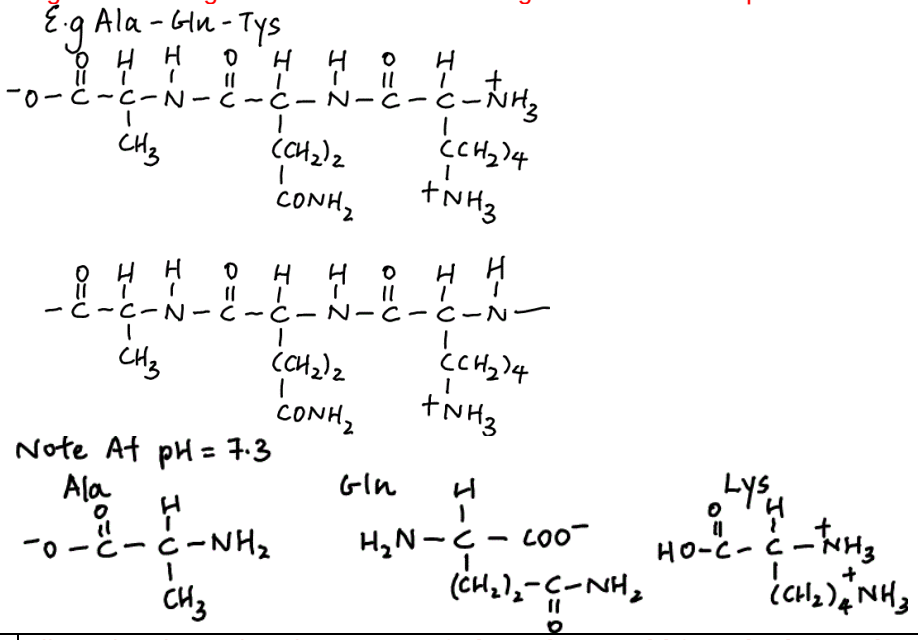
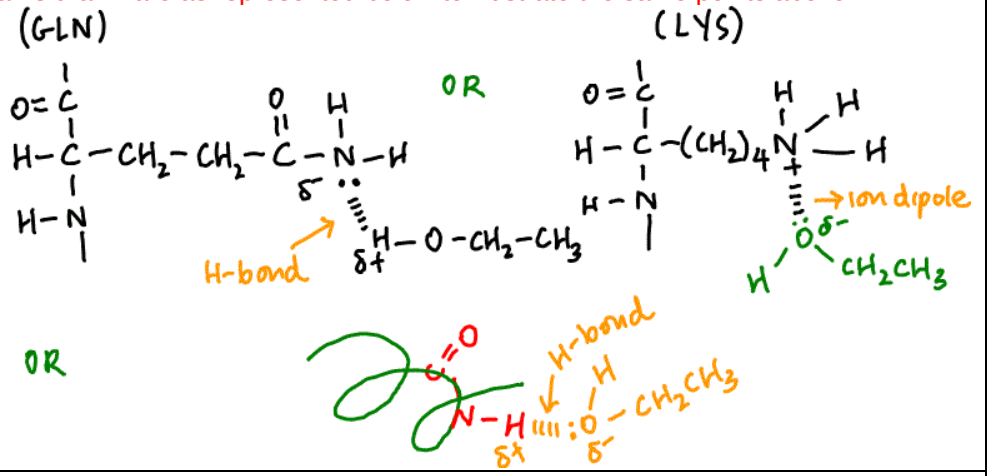
(b) (i) $I_2 + 2Cu^{2+} \longrightarrow 2I^+ + 2Cu^+$

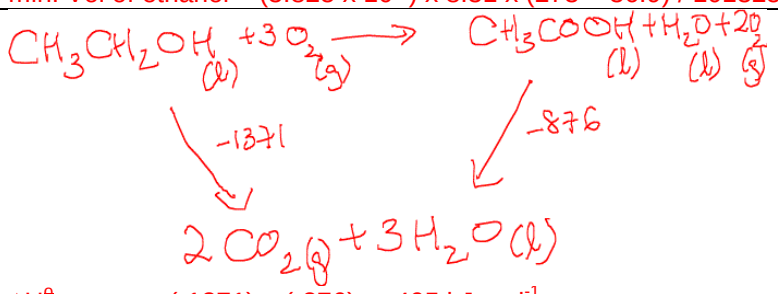
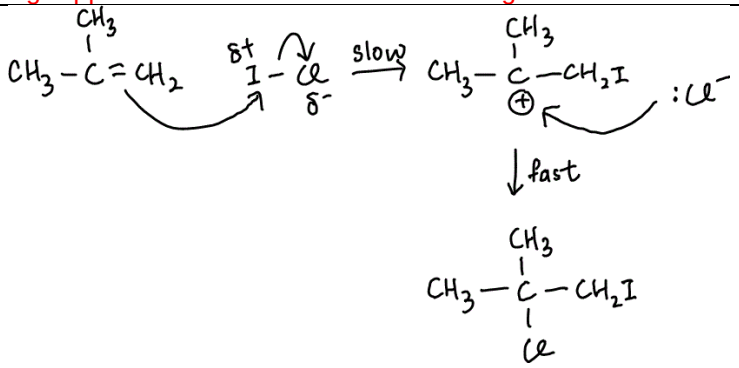
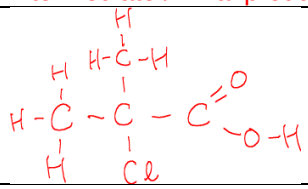
Redox

(ii) Electrophilic substitution



Suggested Solution P3 2011 Prelim H2 Chemistry

1. a) i.			Unique sequence of amino acids held by peptide bonds. Any permutation of Ala, Gln and Lys. To take note of Isoelectric point with respect to pH = 7.3. Diagram involving 3 amino acids. Either diagram below is accepted. 
1.	a)	ii.	disrupting the tertiary (**R-groups of glutamine would form hydrogen bond OR lysine will form ion-dipole interactions with the –OH functional group in ethanol**) disrupting the secondary structure (**peptide linkages would now form hydrogen bonds with ethanol instead of other peptide linkages**) Diagrams drawn are as represented below to illustrate the same points above: 
			causing **the tertiary and secondary structures to unwind and become a random coil thus denaturing / loses the unique 3D conformation of** the protein.
1.	b)	i.	1. acidified potassium dichromate, heat and distill 2. HCN, trace amounts of NaOH (aq), @ 10 – 20 ^{o}C 3. H_2SO_4(aq), heat
		ii.	1. alkaline iodine solution, heat 2. acidify with mineral acid / H^+ (aq)
1.	c)	i.	$CH_3CH_2OH + H_2O \rightarrow CH_3COOH + 4H^+ + 4e^-$ $3CH_3CH_2OH + 2Cr_2O_7^{2-} + 16H^+ \rightarrow 3CH_3COOH + 4Cr^{3+} + 11H_2O$
		ii.	CrO_4^{2-} / chromate (VI) ions / Na_2CrO_4
		iii.	In the isolated gas phase, d orbitals are degenerate. In the presence of ligands, d orbitals split with a **small energy gap** between them. An electron will undergo d-d transition (where **a d electron jumps from a lower energy to the higher energy**) and absorbs from the **visible light** of the electromagnetic spectrum. The colour of the compound seen is the light that is **complementary of the visible light absorbed.**

		iv.	amount of potassium dichromate = 0.015 x 0.017 = 2.55 x 10^{-4} mol amount of ethanol needed = 2.55 x 10^{-4} x 3/2 = 3.825 x 10^{-4} mol (ecf) min. Vol of ethanol = (3.825 x 10^{-4}) x 8.31 x (273 + 36.9) / 101325 = 9.72 cm^3
1.	d)	i.	 $\Delta H^{\ominus}_{oxidation}$= + (-1371) – (-876) = -495 kJ mol^{-1}
2.	a)	i.	Cl^{4+}: [Ne]$3s^2 3p^1$ S^{4+}: [Ne]$3s^2$ OR The 5th electron is removed from the 3p subshell for chlorine and 3s subshell for sulfur. 3p subshell is further from the nucleus as compared to the 3s subshell and experiences a larger screening effect due to the filled 3s subshell. These factors outweigh the increase in nuclear charge, resulting in a lower effective nuclear charge. Less energy is required to remove the 5th electron from chlorine as compared to sulfur.
		ii.	Hydrogen fluoride and hydrogen chloride are both simple covalent molecules. HCl exhibits induced dipole-induced dipole and permanent dipole-permanent dipole interactions OR VDW. For hydrogen fluoride, it also exhibits hydrogen bonding. Due to the additional hydrogen bonding interaction, hydrogen fluoride molecules **exhibit stronger intermolecular forces of attraction** as compared to hydrogen chloride molecules.
		iii.	Bond strength of C-Cl is stronger as compared to bond strength of C-Br. AgCl ppt is formed at a slower rate than AgBr.
2.	b)		 Arrows / polarity on ICl : Intermediate / Final product:
2.	c)	i.	
		ii.	Concentration of HA after dissociation = 10^{-3} - 14.1 / 100 * 1 x 10^{-3} = 8.59 x 10^{-4} Concentration of $[H^+]$ = 14.1 / 1000 x 10^{-3} = 1.41 x 10^{-4} K_a = $([H^+])^2$ / $[HA]_{after\ dissociation}$ = (1.41 x 10^{-4})^2 / 8.59 x 10^{-4} = 2.31 x 10^{-5} mol dm^{-3}
		iii.	Amount of NaOH added : 0.01 x 5 x 10^{-4} = 5 x 10^{-6} mol Amount of A^- = 5 x 10^{-6} mol Amount of HA initially : 0.01 x 1 x 10^{-3} = 1 x 10^{-5} mol Amount of HA finally : 1 x 10^{-5} - 5 x 10^{-6} = 5 x 10^{-6} mol pH = pK_a + lg($[A^-]$ / [HA]) $[A^-]$ = [HA] OR maximum buffer capacity. = -lg (2.31 x 10^{-5}) + lg((5 x 10^{-6} / 0.02) / (5 x 10^{-6} / 0.02)) = 4.64 (ecf based on the Ka calculated in (ii))

iv. (1) Calculation of concentration of the salt formed.

Amount of $Ca(OH)_2$ added : $0.01 \times 2.5 \times 10^{-4} = 2.5 \times 10^{-6}$ mol

Amount of OH^- added : 5.0×10^{-6} mol

(mol)	OH^-	HA	H_2O	A^-
Initial	5.0×10^{-6}	5.0×10^{-6} (iii)	0	5.0×10^{-6} (iii) ecf
Change	-5.0×10^{-6}	-5.0×10^{-6}	$+5.0 \times 10^{-6}$	$+5.0 \times 10^{-6}$
Final	0	0	5.0×10^{-6}	**1×10^{-5}**

$[A^-] = 1 \times 10^{-5} / 0.03 =$ **3.33×10^{-4}** mol dm^{-3}

(2) Balanced equation.

$$A^- + H_2O \rightleftharpoons HA + OH^-$$

(3) pH of salt formed.

$K_b = K_w / K_a = 1.264 \times 10^{-9}$ mol dm^{-3}

$[OH^-]_{\text{contribution by hydrolysis}} = (K_b \times [\mathbf{A}^-])^{½} = (1.264 \times 10^{-9} \times (1 \times 10^{-5} / 0.03))^{½}$

$= \mathbf{6.49 \times 10^{-7}}$ **mol dm^{-3}**

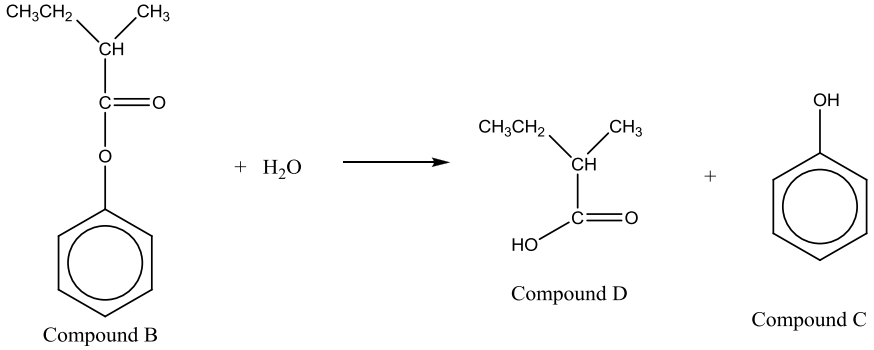
$[OH^-] = 6.49 \times 10^{-7} + (2.92 \times 10^{-14})^{½} = 8.20 \times 10^{-7}$ mol dm^{-3}

$pOH = -\lg(8.20 \times 10^{-7}) = 6.09$

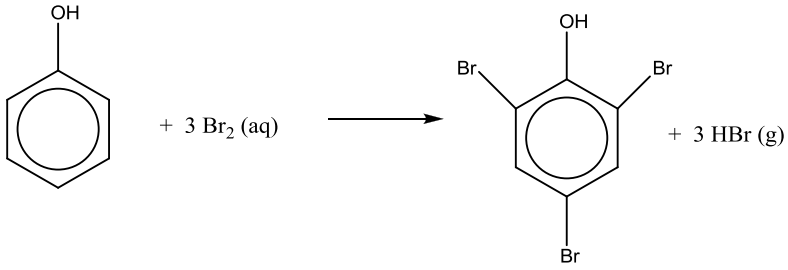
$pH = pK_w - pOH = -\lg(2.92 \times 10^{-14}) - 6.09 =$ **7.44** (3 s.f.)

Q3 (a)	Information	Deduction
B	the molecular formula $C_{11}H_{14}O_2$	C:H ratio close to 1:1 • possesses a benzene function group
	sparingly soluble in water	• large molecule possesses functional groups (-OH, -COO-) which can form hydrogen bonding with water.
	does not decolourise aqueous bromine	• absence of alkene and phenol functional group
	Upon heating with acidified potassium manganate(VII) solution, it does not decolourise the purple solution, but forms 2 organic products, compounds **C** and **D**.	• does not undergo oxidation • acidic hydrolysis occurred
C	forms a violet colouration when neutral iron(III) chloride solution is added.	• presence of phenol functional group
	Upon reaction with aqueous bromine (in a stoichiometric ratio of 1:3), it forms a white precipitate and copious white fumes which turns blue litmus paper red.	• electrophilic substitution occurred • positions 2, 4 and 6 wrt phenol are hydrogen • white precipitate is 2,4,6-tribromophenol
D	able to rotate plane-polarised light	• possesses a chiral carbon
	Upon combustion with excess oxygen, 0.1 mol of compound **D** produces 34.7 dm^3 of gas under 150 ^oC and 101325 Pa. The volume is halved when the gaseous products was passed through anhydrous calcium chloride.	• 34.7 dm^3 of gas = 1 mol of gas (inclusive of water vapour) • 0.1 mol of **D** undergoes complete combustion to form 0.5 mol of CO_2 and 0.5 mol of H_2O • **D** has 5 carbon atoms and 10 hydrogen atoms [Note: anhydrous calcium chloride is a drying agent which removes water vapour]
	reacts with sodium carbonate powder, in a ratio of 2:1, to give effervescence	• possesses 1 carboxylic acid functional group
	reacted with lithium aluminium hydride in dry ether to form compound **E**.	• undergoes reduction
E	Compound **E** is then reacted with excess concentrated sulfuric acid.	• undergoes elimination of water to form an alkene

	Product of elimination is oxidised by $KMnO_4$ (aq)	• Terminal C=C
F	Compound F reacts with 2,4 DNPH	• Ketone



Compound B Compound D Compound C



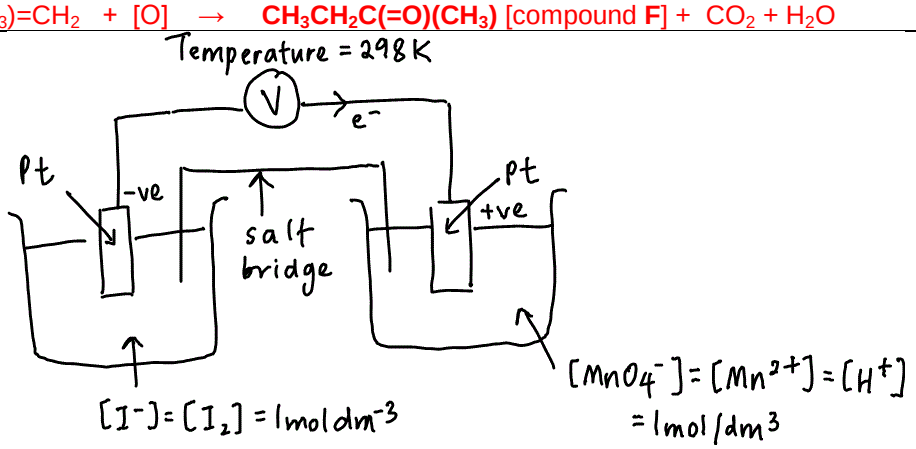
$CH_3CH_2CH(CH_3)COOH + 6½O_2 \rightarrow 5\ CO_2 + 5\ H_2O$

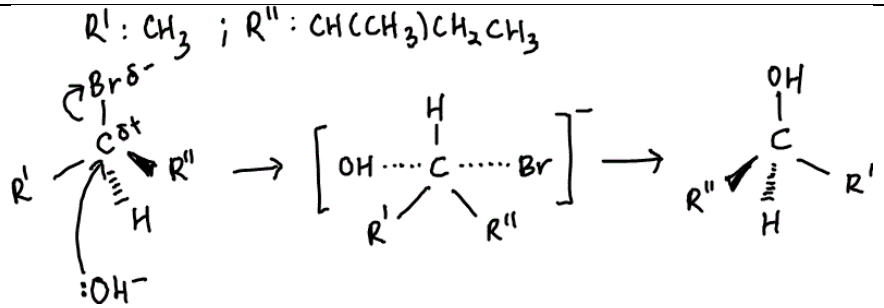
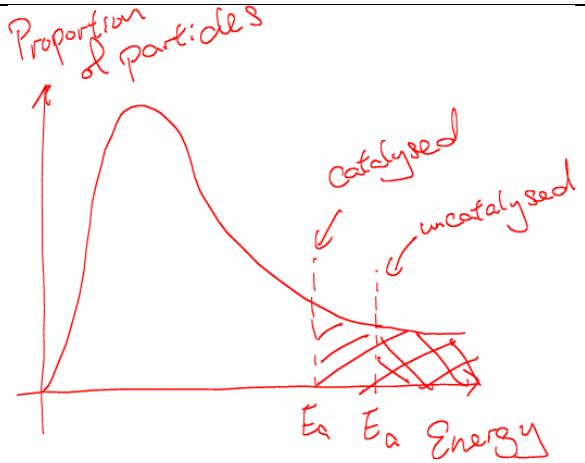
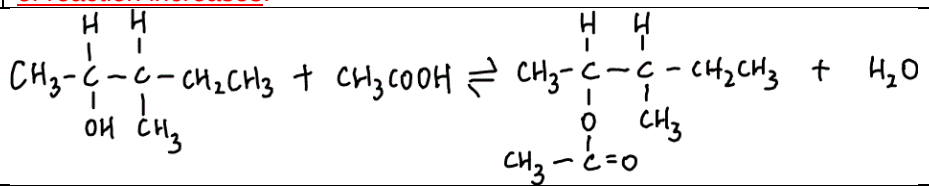
$2CH_3CH_2CH(CH_3)COOH + Na_2CO_3 \rightarrow CO_2 + H_2O + 2CH_3CH_2CH(CH_3)COO^-Na^+$

$CH_3CH_2CH(CH_3)COOH + 4[H] \rightarrow CH_3CH_2CH(CH_3)CH_2OH + H_2O$

$CH_3CH_2CH(CH_3)CH_2OH$ [compound **E**] $\rightarrow CH_3CH_2C(CH_3)=CH_2 + H_2O$

$CH_3CH_2C(CH_3)=CH_2 + [O] \rightarrow$ **$CH_3CH_2C(=O)(CH_3)$** [compound **F**] $+ CO_2 + H_2O$

3	(b)	(i)	 **Half cell at anode, Half cell at cathode including concentration and temperature, salt bridge, voltmeter.** E_{cell} = 1.52 – 0.54 = + 0.98 V	
3.	b)	ii.	$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$ +1.52V $Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$ +0.77V $I_2 + 2e^- \rightleftharpoons 2I^-$ +0.54V $5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow 5Fe^{3+} + Mn^{2+} + 4H_2O$ $E^\ominus_{cell}$ = +0.75V $2Fe^{3+} + 2I^- \rightarrow I_2 + 2Fe^{2+}$ $E^\ominus_{cell}$ = +0.23V **MnO_4^- and I^- repel one another** hence rate of reaction is very slow. OR Fe^{2+} acts as a catalyst that will **increase the rate of reaction due to attraction between oppositely charged ions**.	
4.	a)	i.	Using experiments 1 and 2, as the overall volume is the same, concentration is directly proportional to the volume used, [**FA3**] is constant, [**FA4**] increases by 1.2069 times, rate increases by 1.2069 time.	

			Since the increase is between [**FA4**] and rate are approximately the same, the order of reaction with respect to [**FA4**] is 1. Using experiments 1 and 3, [**FA3**] increases by 7.5 times, [**FA4**] decreases by 11.6 times, rate decreases by 1.55 (original rate x 7.5 / 11.6) times. Hence the order of reaction with respect to [**FA3**] is 1.	
4	a	ii.	r = k[2-bromo-3-methylpentane][sodium hydroxide] ecf on (i)	
		iii.	 • reflection of reactant and product i.e. inversion • Arrows / lone pair / polarity.	
		iv.	Using data from experiment 1, ecf based on rate equation in (ii). $8.17 \times 10^{-7} = k(0.001 \times 0.01 / 0.05)(0.029 \times 0.01 / 0.05)$ k = 0.704 Units: $mol^{-1}\ dm^3\ s^{-1}$	
		v.	 Catalyst would lower the activation energy with alternative pathway needed for the reaction to take place, resulting in an increase in the proportion of molecules with energy greater than or equal to the activation energy (OR with legend in the diagram) This results in an increase in frequency of effective collisions and hence the rate of reaction increases.	
4.	b.	i.		
4	b	ii.	amount of KOH used = $0.0248 \times 0.08 = 1.984 \times 10^{-3}$ mol amount of ethanoic acid in 10 cm^3 of ether = 1.984×10^{-3} mol amount of ethanoic acid in 100 cm^3 of ether = 1.984×10^{-2} mol	

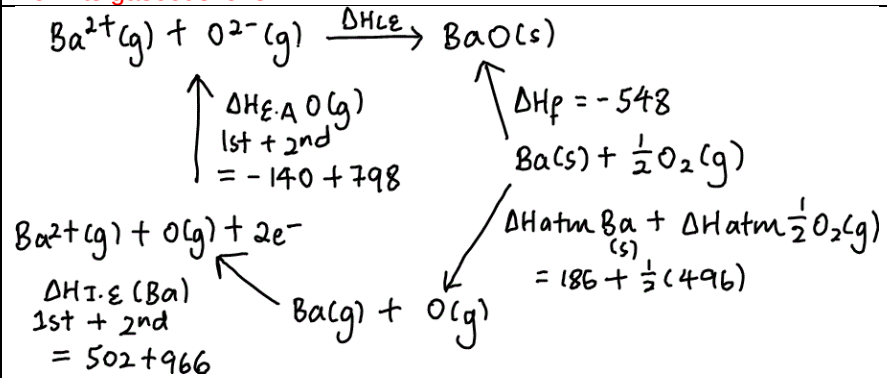
	Compound **G**	Ethanoic acid	Ester	Water
Initial / mol dm^{-3}	0.400	0.200	-	-
Change / mol dm^{-3}	-0.0016	-0.0016	+0.0016	+0.0016
Equilibrium / mol dm^{-3}	0.3984	0.1984	0.0016	0.0016

$K_c = 3.24 \times 10^{-5}$

		iii.	The esterification process is endothermic. With increase in temperature, the equilibrium **favours reactions which absorb heat (favouring endothermic process)**. Hence the **equilibrium would shift towards the right (favouring the formation of the ester)** so as to remove the excess heat applied to the system.
4.	c)	i.	**Method 1:** Reagents : 1. NaOH(aq) and heat 2. alkaline iodine solution and heat OR NaOH (aq), I_2 (aq), heat. Observations: 2-bromo-3-methylpentane will form yellow CHI_3 precipitate and 3-bromo-2-methylpentane will not form yellow CHI_3 precipitate **Method 2:** Reagents : 1. Hot ethanolic NaOH 2. hot acidified $KMnO_4$ Observations: 2-bromo-3-methylpentane will decolourise purple $KMnO_4$ and form effervescence of CO_2, which will form white precipitate with calcium hydroxide. 3-bromo-2-methylpentane will decolourise and not form effervescence
		ii.	acidified potassium manganate(VII) and heat (N-ethyl)methanamide will decolourise purple $KMnO_4$ and form effervescence of CO_2, which will form white precipitate with calcium hydroxide (N-methyl)ethanamide will decolourise purple $KMnO_4$ but not form effervescence
5.	a)		As the Group II metal ion increases in size, the charge density and hence, the polarising power of the ions decreases down the group. Thus, Mg^{2+} being the smallest cation, has the greatest charge density Mg^{2+} has the best ability to polarise/distort the large electron cloud of the carbonate ion compared to other ions of lower charge density. Ease of decomposition of group II carbonates decreases down the group. $XCO_3 \rightarrow XO + CO_2$ (where X = Group II metal)
5.	b)	i.	$K_{sp} = [Ba^{2+}][CO_3^{2-}]$
		ii.	Let the solubility of $Ba(OH)_2$ be x mol dm^{-3} $K_{sp} = [Ba^{2+}][OH^-]^2$ $2.55 \times 10^{-4} = (x)(2x)^2$ $x = 0.039948$ $[OH^-] = 2 \times 0.039948$ mol dm^{-3} pH = 14 – pOH = 12.9

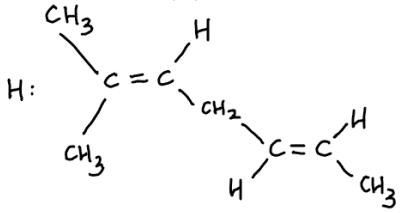
iii.		Ba^{2+}	SO_4^{2-}
	Initial / mol dm^{-3}	0.0005	0.0005
	Change / mol dm^{-3}	- x	- x
	Equilibrium / mol dm^{-3}	0.0005 - x	0.0005 – x

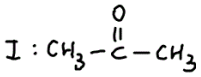
$K_{sp} = [Ba^{2+}][SO_4^{2-}]$
$1.08 \times 10^{-10} = (0.0005 - x)^2$
$x = 4.8961 \times 10^{-4}$ mol dm^{-3}
mass of $BaSO_4$ formed = $0.2 \times 4.8961 \times 10^{-4} \times (137 + 32.1 + 16 \times 4)$
= 0.0228 g (3 s.f.)

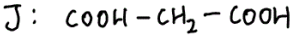
5.	c)	i.	Lattice energy is the energy released when 1 mol of ionic compound is formed from its gaseous ions.
		ii.	 L.E. = -(-140+798) – (+502 + 966) – (+182 + 0.5 x 496) + (-548) = -3104 kJ mol^{-1}

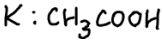
Compound	Information	Deduction
H	decolourises bromine solution in the dark.	• undergoes electrophilic addition reaction • presence of alkene
	reacts with hot acidified potassium manganate(VII) solution, it forms compounds **I**, **J** and **K**.	• undergoes oxidation reaction • presence of 2 C=C
I	forms an orange precipitate with 2,4-dinitrophenylhydrazine	• undergoes condensation reaction • presence carbonyl functional group
	After reacting with alkaline iodine solution and acidifying the resulting mixture, it forms a yellow precipitate and compound **K**.	• yellow precipitate is CHI_3 • presence of $-COCH_3$ group
J	0.104 g of compound **J**, a dicarboxylic acid, neutralises 25.0 cm^3 of **FA5**.	• amount of $Ba(OH)_2$ used = 9.99×10^{-4} mol • M_r of J = 104.1
K	Compound **K** can be formed by boiling ethanitrile with sulfuric acid.	• undergoes acidic hydrolysis

Structure of H, I, J and K:

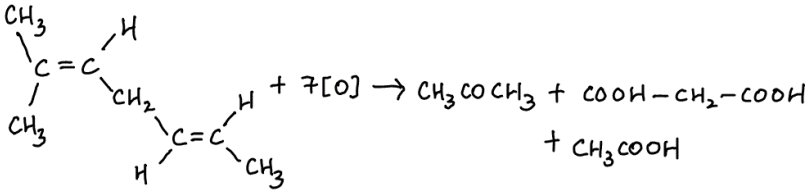


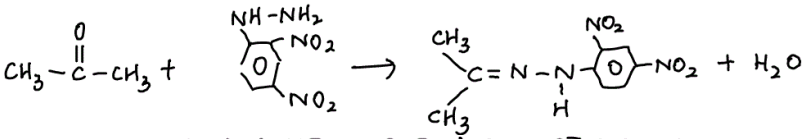






Equations:





$CH_3COCH_3 + 3I_2 + 4OH^- \longrightarrow CHI_3 + CH_3COO^- + 3H_2O$

$CH_3COO^- + H^+ \rightarrow CH_3COOH$

$CH_2(COOH)_2 + Ba(OH)_2 \rightarrow Ba^{2+}[CH_2(COO^-)_2] + 2\ H_2O$

$CH_3CN + 2H_2O + H^+ \rightarrow CH_3COOH + NH_4^+$

-END-