

## ORGANIC CHEMISTRY SPA SKILL A SUMMARY

### (1A) OBSERVATIONS

Reaction Type	Reagent	C=C (ALKENE)	C <sub>6</sub> H <sub>5</sub> -CH / C <sub>6</sub> H <sub>5</sub> - CH <sub>2</sub> X	CH <sub>3</sub> -X (ALK HALIDE)	R-OH (ALCOHOL)	C <sub>6</sub> H <sub>5</sub> -OH (PHENOL)	R-COOH (C ACID)
<i>Electrophilic Substitution / Addition</i>	<b>Br<sub>2</sub> (aq)</b>	Reddish-orange Br <sub>2</sub> (aq) decolourised				Reddish-orange Br <sub>2</sub> (aq) decolourised, white ppt	
<i>Oxidation</i>	<b>KMnO<sub>4</sub>/ H<sup>+</sup>/ Δ</b>	Decolourisation of KMnO <sub>4</sub>	Decolourisation of KMnO <sub>4</sub>		Decolourisation of KMnO <sub>4</sub> (1°/2°)		
	<b>K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>/ H<sup>+</sup>/ Δ</b>				Orange K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> turns green Cr <sup>3+</sup> (1°/2°)		
<i>Hydrolysis</i>	<b>Acid (H<sup>+</sup>)/ Δ</b>						
	<b>Base (OH<sup>-</sup>)/ Δ</b>		White / cream / yellow ppt	(With AgNO <sub>3</sub> ) White / cream / yellow ppt			
<i>Mild Oxidation</i>	<b>AgNO<sub>3</sub>/ NH<sub>3</sub> (excess)/ Δ</b>						
	<b>Fehling's Solution/ Δ</b>						
<i>Acid-Base Reaction</i>	<b>Acid (H<sup>+</sup>)</b>						
	<b>Base (OH<sup>-</sup>)</b>					Dissolves into colourless solution	White crystalline solid on evaporation
<i>Iodoform Test</i>	<b>I<sub>2</sub> (aq)/ NaOH</b>				Yellow ppt of CHI <sub>3</sub>		
	<b>Na (s)</b>				Effervescence of H <sub>2</sub>	Effervescence of H <sub>2</sub>	Effervescence of H <sub>2</sub>
	<b>Na<sub>2</sub>CO<sub>3</sub> (s)</b>						Effervescence of CO <sub>2</sub>
	<b>2,4-dinitrophenylhydrazine (2,4-DNPH)</b>						
	<b>PCl<sub>5</sub> (s)/ room temperature</b>				White fumes of HCl		White fumes of HCl

**(1B) OBSERVATION**

Reaction Type	Reagent	R-COCl (ACID CL)	RCOOR' (ESTER)	R-NH <sub>2</sub> (AMIDE)	R-CONH <sub>2</sub> (AMINE)	R-CHO (ALDEHYDE)	R-CO-R' (KETONE)
<i>Electrophilic Substitution / Addition</i>	Br <sub>2</sub> (aq)			Reddish-orange Br <sub>2</sub> (aq) decolourised, white ppt			
<i>Oxidation</i>	KMnO <sub>4</sub> / H <sup>+</sup> / Δ					Decolourisation of KMnO <sub>4</sub>	
	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> / H <sup>+</sup> / Δ					Orange K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> turns green Cr <sup>3+</sup>	
<i>Hydrolysis</i>	Acid (H <sup>+</sup> )/ Δ	(Add H <sub>2</sub> O) White fumes of HCl			[Test for R-COOH & NH <sub>4</sub> <sup>+</sup> ]		
	Base (OH <sup>-</sup> )/ Δ		[Test for R-OH]		Gas evolved turns red litmus blue		
<i>Mild Oxidation</i>	AgNO <sub>3</sub> / NH <sub>3</sub> (excess)/ Δ					Silver mirror	
	Fehling's Solution/ Δ					Brick-red ppt	
<i>Acid-Base Reaction</i>	Acid (H <sup>+</sup> )			White crystalline solid on evaporation			
	Base (OH <sup>-</sup> )						
<i>Iodoform Test</i>	I <sub>2</sub> (aq)/ NaOH					(Not benzaldehyde) Yellow ppt of CHI <sub>3</sub>	Yellow ppt of CHI <sub>3</sub>
Na (s)							
Na <sub>2</sub> CO <sub>3</sub> (s)							
2,4-dinitrophenylhydrazine (2,4-DNPH)						Orange ppt	Orange ppt
PCl <sub>5</sub> (s)/ room temperature							

**(2A) OTHER REAGENTS, CONDITIONS & PRODUCTS**

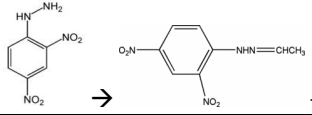
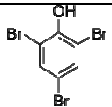
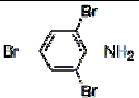
Reaction Type	Reagent	C=C (ALKENE)	C <sub>6</sub> H <sub>5</sub> -CH / C <sub>6</sub> H <sub>5</sub> -CX	CH <sub>3</sub> -X (ALK HALIDE)	R-OH (ALCOHOL)	C <sub>6</sub> H <sub>5</sub> -OH (PHENOL)	R-COOH (C ACID)
<i>Electrophilic Substitution / Addition</i>	Br <sub>2</sub> (aq)	CH(Br)-CH(OH)				2,4,6-tribromophenol	
<i>Oxidation</i>	KMnO <sub>4</sub> / H <sup>+</sup> / Δ	CO <sub>2</sub> / R-COOH / R-CO-R'	C <sub>6</sub> H <sub>5</sub> COOH		R-CHO / R-CO-R'		
	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> / H <sup>+</sup> / Δ				R-CHO / R-CO-R'		
<i>Hydrolysis</i>	Acid (H <sup>+</sup> )/ Δ						
	Base (OH <sup>-</sup> )/ Δ			R-OH, AgX			
<i>Mild Oxidation</i>	AgNO <sub>3</sub> / NH <sub>3</sub> (excess)/ Δ						
	Fehling's Solution/ Δ						
<i>Acid-Base Reaction</i>	Acid (H <sup>+</sup> )						
	Base (OH <sup>-</sup> )					C <sub>6</sub> H <sub>5</sub> O <sup>-</sup>	R-COO <sup>-</sup> , H <sub>2</sub> O
<i>Iodoform Test</i>	I <sub>2</sub> (aq)/ NaOH				R-COO <sup>-</sup> , CHI <sub>3</sub> , I <sup>-</sup> , H <sub>2</sub> O		
Na (s)					R-O <sup>-</sup> Na <sup>+</sup> , H <sub>2</sub>	C <sub>6</sub> H <sub>5</sub> O <sup>-</sup> Na <sup>+</sup> , H <sub>2</sub>	R-O <sup>-</sup> Na <sup>+</sup> , H <sub>2</sub>
Na <sub>2</sub> CO <sub>3</sub> (s)							R-COO <sup>-</sup> Na <sup>+</sup> , CO <sub>2</sub> , H <sub>2</sub> O
2,4-dinitrophenylhydrazine (2,4-DNPH)							
PCl <sub>5</sub> (s)/ room temperature					R-Cl & HCl		R-COCl, HCl

**(2B) OTHER REAGENTS, CONDITIONS & PRODUCTS**

Reaction Type	Reagent	R-COCl (ACID CL)	RCOOR' (ESTER)	R-NH <sub>2</sub> (AMIDE)	R-CONH <sub>2</sub> (AMINE)	R-CHO (ALDEHYDE)	R-CO-R' (KETONE)
<i>Electrophilic Substitution / Addition</i>	Br <sub>2</sub> (aq)			2,4,6-tribromophenol			
<i>Oxidation</i>	KMnO <sub>4</sub> / H <sup>+</sup> / Δ					R-COOH	
	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> / H <sup>+</sup> / Δ					R-COOH	
<i>Hydrolysis</i>	Acid (H <sup>+</sup> )/ Δ	(Add H <sub>2</sub> O) R-COOH, HCl	R-COOH, R-OH'		R-COOH, NH <sub>4</sub> <sup>+</sup>		
	Base (OH <sup>-</sup> )/ Δ		R-COO <sup>-</sup> , R'-OH		R-COO <sup>-</sup> , NH <sub>3</sub>		
<i>Mild Oxidation</i>	AgNO <sub>3</sub> / NH <sub>3</sub> (excess)/ Δ					R-COO <sup>-</sup> , Ag, NH <sub>3</sub> , H <sub>2</sub> O	
	Fehling's Solution/ Δ					R-COO <sup>-</sup> , Cu <sub>2</sub> O, H <sub>2</sub> O	
<i>Acid-Base Reaction</i>	Acid (H <sup>+</sup> )			R-NH <sub>3</sub> X <sup>-</sup>			
	Base (OH <sup>-</sup> )						
<i>Iodoform Test</i>	I <sub>2</sub> (aq)/ NaOH					R-COO <sup>-</sup> , CHI <sub>3</sub> , I <sup>-</sup> , H <sub>2</sub> O	R-COO <sup>-</sup> , CHI <sub>3</sub> , I <sup>-</sup> , H <sub>2</sub> O
Na (s)							
Na <sub>2</sub> CO <sub>3</sub> (s)							
2,4-dinitrophenylhydrazine (2,4-DNPH)						2,4-DNP Hydrazone	2,4-DNP Hydrazone
PCl <sub>5</sub> (s)/ room temperature							

## SPA SKILL A ORGANIC REACTIONS SUMMARY

Type of Reaction		Conditions	Functional Groups / Structure	Products	Equations
Oxidation	$\text{Cr}_2\text{O}_7^{2-} / \text{H}^+$	$\text{K}_2\text{Cr}_2\text{O}_7, \text{H}_2\text{SO}_4, \Delta$	$1^\circ \text{R-OH}$	$\text{R-CHO}, \text{Cr}^{3+}$	$\text{R-CH}_2\text{OH} + [\text{O}] \rightarrow \text{R-CHO} + \text{H}_2\text{O}$
			$2^\circ \text{R-OH}$	$\text{R-CO-R}', \text{Cr}^{3+}$	$\text{R-CHOH-R}' + [\text{O}] \rightarrow \text{R-CO-R}' + \text{H}_2\text{O}$
			$\text{R-CHO}$	$\text{R-COOH}, \text{Cr}^{3+}$	$\text{R-CHO} + [\text{O}] \rightarrow \text{R-COOH}$
	$\text{MnO}_4^- / \text{H}^+$	$\text{KMnO}_4, \text{H}_2\text{SO}_4, \Delta$	$1^\circ \text{R-OH}$	$\text{R-COOH} / \text{R-CHO}, \text{Mn}^{2+}$	$\text{R-CH}_2\text{OH} + [\text{O}] \rightarrow \text{R-CHO} + \text{O}_2$
			$2^\circ \text{R-OH}$	$\text{R-CO-R}', \text{Mn}^{2+}$	$\text{R-CHOH-R}' + [\text{O}] \rightarrow \text{R-CO-R}' + \text{H}_2\text{O}$
			$\text{C}_6\text{H}_5\text{-R}$	$\text{C}_6\text{H}_5\text{-COOH}, \text{Mn}^{2+}$	$\text{C}_6\text{H}_5\text{-R} + [\text{O}] \rightarrow \text{C}_6\text{H}_5\text{-COOH} + \text{CO}_2 + \text{H}_2\text{O}$
			$\text{C}=\text{C}$	$\text{R-COOH} / \text{R-CO-R}' / \text{CO}_2 \& \text{H}_2\text{O}, \text{Mn}^{2+}$	$=\text{CH}_2 + [\text{O}] \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ $=\text{CHR} + [\text{O}] \rightarrow \text{R-COOH}$ $=\text{CR}_2 + [\text{O}] \rightarrow \text{R-CO-R}'$
	Tollen's	$\text{AgNO}_3, \text{NH}_3, \Delta$	$\text{R-CHO}$	$\text{Ag}, \text{R-COO}^-\text{Na}^+$	$\text{R-CHO} + 2 [\text{Ag}(\text{NH}_3)_2]^+ \rightarrow \text{R-COO}^- + 2 \text{Ag} + 4 \text{NH}_3 + 2 \text{H}_2\text{O}$
			$\text{C}_6\text{H}_5\text{-CHO}$	$\text{C}_6\text{H}_5\text{-COO}^-\text{Na}^+$	$\text{C}_6\text{H}_5\text{-CHO} + 2 [\text{Ag}(\text{NH}_3)_2]^+ \rightarrow \text{C}_6\text{H}_5\text{-COO}^- + 2 \text{Ag} + 4 \text{NH}_3 + 2 \text{H}_2\text{O}$
	Fehling's	$\text{CuO}, \Delta$	$\text{R-CHO}$	$\text{R-COOH}, \text{Cu}_2\text{O}$	$\text{R-CHO} + 2 \text{CuO} + 5 \text{OH}^- \rightarrow \text{Cu}_2\text{O} + \text{R-COO}^- + 3 \text{H}_2\text{O}$
Hydrolysis	$\text{H}^+$	Dilute $\text{H}_2\text{SO}_4, \Delta$	$\text{R-COO-R}'$	Salt, $\text{H}_2\text{O}$	$\text{R-COO-R}' + \text{H}_2\text{O} \rightarrow \text{R-COOH} + \text{R}'\text{-OH}$
			$\text{R-CONH}_2$	$\text{R-COOH}, \text{NH}_4^+$	$\text{R-CONH}_2 + \text{H}_2\text{O} + \text{H}^+ \rightarrow \text{R-COOH} + \text{NH}_4^+$
			$\text{R-CN}$	$\text{R-COOH}, \text{NH}_4^+$	$\text{R-CN} + \text{H}_2\text{O} + \text{H}^+ \rightarrow \text{R-COOH} + \text{NH}_4^+$
	$\text{OH}^-$	Dilute $\text{NaOH}, \Delta$	$\text{R-COO-R}'$	Salt, $\text{H}_2\text{O}$	$\text{R-COO-R}' + \text{OH}^- \rightarrow \text{R-COO}^- + \text{NH}_3$
			$\text{R-CONH}_2$	$\text{R-COO}^-, \text{NH}_3$	$\text{R-CONH}_2 + \text{OH}^- \rightarrow \text{R-COO}^- + \text{NH}_3$
			$\text{R-CN}$	$\text{R-COO}^-, \text{NH}_3$	$\text{R-CN} + 2 \text{OH}^- \rightarrow \text{R-COO}^- + \text{NH}_3$
			$\text{R-X}$	$\text{R-OH}, \text{X}^-$	$\text{R-X} + \text{OH}^- \rightarrow \text{R-OH} + \text{X}^-$
	$\text{H}_2\text{O}$	$\text{H}_2\text{O} (\text{l})$	$\text{R-COCl}$	$\text{R-COOH}$	$\text{R-COCl} + \text{H}_2\text{O} \rightarrow \text{R-COOH} + \text{HCl}$

Type of Reaction		Conditions	Functional Groups / Structure	Products	Equations
Acid / Base	Dilute H <sup>+</sup>	Dilute H <sub>2</sub> SO	R-NH <sub>2</sub>	Salt, H <sub>2</sub> O	RNH <sub>2</sub> + H <sub>2</sub> SO <sub>4</sub> → Salt + H <sub>2</sub> O
	Dilute OH <sup>-</sup>	Dilute NaOH	R-COOH	R-COO <sup>-</sup> Na <sup>+</sup>	R-COOH + NaOH → R-COO <sup>-</sup> Na <sup>+</sup> + H <sub>2</sub> O
			C <sub>6</sub> H <sub>5</sub> -OH	C <sub>6</sub> H <sub>5</sub> -COO <sup>-</sup> Na <sup>+</sup>	C <sub>6</sub> H <sub>5</sub> OH + NaOH → C <sub>6</sub> H <sub>5</sub> COO <sup>-</sup> Na <sup>+</sup> + H <sub>2</sub> O
	Na <sub>2</sub> CO <sub>3</sub>	Na <sub>2</sub> CO <sub>3</sub> (s)	R-COOH	R-COO <sup>-</sup> Na <sup>+</sup> , CO <sub>2</sub> , H <sub>2</sub> O	R-COOH + Na <sub>2</sub> CO <sub>3</sub> → R-COO <sup>-</sup> Na <sup>+</sup> + CO <sub>2</sub> + H <sub>2</sub> O
	Na	Na (s)	R-OH	R-O <sup>-</sup> Na <sup>+</sup> , H <sub>2</sub>	R-OH + Na → R-O <sup>-</sup> Na + H <sub>2</sub>
			R-COOH	R-COO <sup>-</sup> Na <sup>+</sup> , H <sub>2</sub>	R-COOH + Na → R-COO <sup>-</sup> Na <sup>+</sup> + H <sub>2</sub>
C <sub>6</sub> H <sub>5</sub> -OH			C <sub>6</sub> H <sub>5</sub> -O <sup>-</sup> Na <sup>+</sup> , H <sub>2</sub>	C <sub>6</sub> H <sub>5</sub> OH + Na → C <sub>6</sub> H <sub>5</sub> O <sup>-</sup> Na <sup>+</sup> + H <sub>2</sub>	
Iodoform	I <sub>2</sub> / OH <sup>-</sup>	I <sub>2</sub> (aq), NaOH, Δ	R-CHOH(CH <sub>3</sub> ), R-CHO(CH <sub>3</sub> )	CHI <sub>3</sub> , R-COO <sup>-</sup> , I <sup>-</sup> , H <sub>2</sub> O	R-CHO(CH <sub>3</sub> ) + I <sub>2</sub> + NaOH → CHI <sub>3</sub> + R-COO <sup>-</sup> + I <sup>-</sup> + H <sub>2</sub> O
Substitution	PCl <sub>5</sub>	PCl <sub>5</sub> (s)	R-COOH	R-COCl, HCl	R-COOH + PCl <sub>5</sub> → R-COCl + HCl + POCl <sub>3</sub>
			R-OH	R-Cl, HCl	R-OH + PCl <sub>5</sub> → R-Cl + HCl + POCl <sub>3</sub>
Condensation	2,4-DNPH	2,4-DNPH (aq)	R-CHO, R-CO-R'	2,4-DNPHHydrazone	 $R-CO-R' + \text{2,4-DNPH} \rightarrow \text{2,4-DNPHHydrazone} + H_2O$
Addition	Br <sub>2</sub>	Br <sub>2</sub> (aq)	C=C	CH(Br)-CH(OH)	C=C + Br <sub>2</sub> → R-CH(Br)-CH(OH)-R'
			C <sub>6</sub> H <sub>5</sub> -OH	2,4,6-tribromophenol	 $C_6H_5OH + Br_2 \rightarrow \text{2,4,6-tribromophenol}$
			C <sub>6</sub> H <sub>5</sub> -NH <sub>2</sub>	2,4,6-tribromophenylamine	 $C_6H_5NH_2 + Br_2 \rightarrow \text{2,4,6-tribromophenylamine}$