Name: …… ( ) Class: ……..
Date: …….

Raffles Institution
Year 6 H2 Chemistry 2025

Set A T1W8 – Arenes

☐— Pre-ChemFocus Activity —☐

- Familiarise yourself with the following mechanism: Electrophilic substitution of arenes
- To view infopack at IVY > C2025 – H2 CHEMISTRY > Pages > [ChemFocus] T1W8 Arenes > **FIRST VIDEO ONLY**

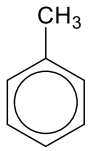
Notes:

Self-Check Questions

Check your answers at IVY > C2025 – H2 CHEMISTRY > Pages > [ChemFocus] T1W8 Arenes > Remaining videos

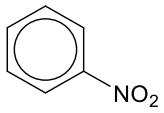
1 Suggest the major organic product(s) formed from the following reactions.
(Refer to the Data Booklet for directing effects)

(a)



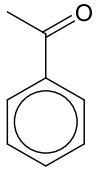
$\xrightarrow{\text{conc } HNO_3, \text{ conc } H_2SO_4, 30^oC}$

(b)



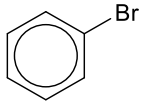
$\xrightarrow{FeBr_3,\ Br_2}$

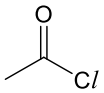
(c)



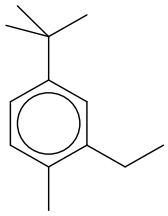
$\xrightarrow{AlCl_3,\ CH_3CH_2Cl}$

(d)



$\xrightarrow{AlCl_3,}$ 

(e)



$\xrightarrow{KMnO_4(aq),\ H_2SO_4(aq),\ \text{heat}}$

2 The nitration of benzene requires concentrated nitric acid and concentrated sulfuric acid, heated to 55 °C. Explain whether the nitration of chlorobenzene requires a temperature greater than, equal to, or less than 55 °C.

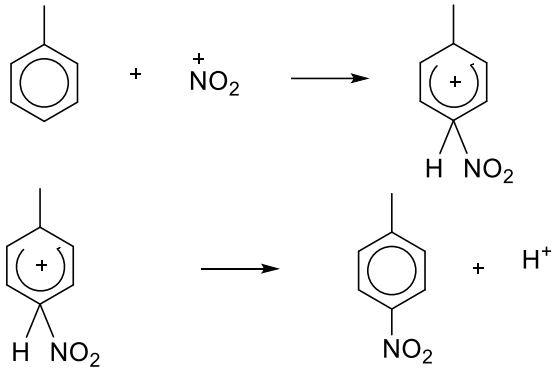
……..……..

……..……..[1]

3 Methylbenzene undergoes nitration to form a mixture of 1-methyl-2-nitrobenzene and 1-methyl-4-nitrobenzene.

(a) A description of the reaction mechanism producing 1-methyl-4-nitrobenzene is illustrated below. Correct the mechanism by annotating on the figure below.

Nitration



(b) Explain why 1-methyl-4-nitrobenzene was produced in greater amount compared to 1-methyl-2-nitrobenzene.

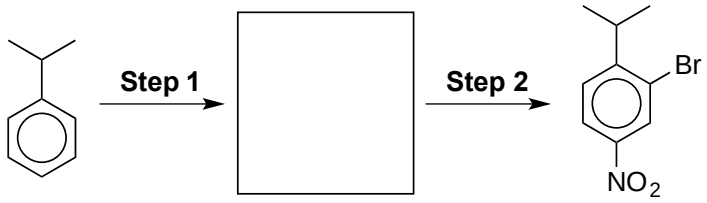
……..

……..……[1]

Tutorial Discussion Questions (to complete before Chemfocus session)

1a State the reagents and conditions needed in each of the following schemes. Draw the structure of the intermediate organic compound in each case.
(Hint: consider the directing effects of the group(s) already bonded to the benzene ring.)

(i)

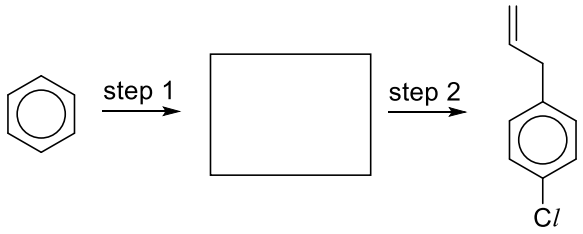


Reagents and conditions

Step 1: ……

Step 2: ……

(ii)

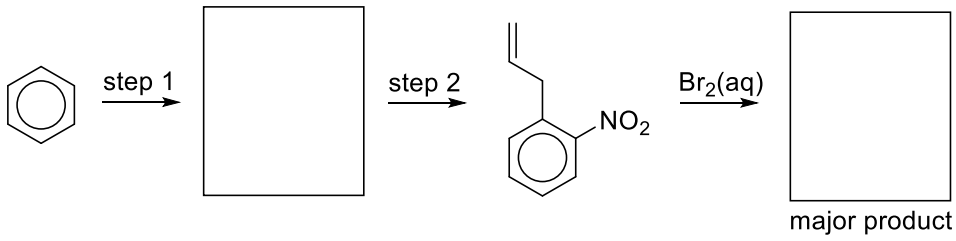


Reagents and conditions

Step 1: ……

Step 2: ……

(iii)

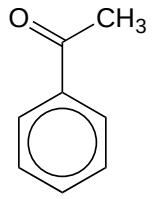


Reagents and conditions

Step 1: ……

Step 2: ……

2a **(i)** Draw the mechanism of the reaction to form compound **A** from benzene, showing any intermediates, and movement of electron pairs by using curly arrows.



A

[2]

(ii) Draw the major product formed when compound **A** reacts with BrC*l* in the presence of a Lewis acid catalyst. Explain your answer

Major product:

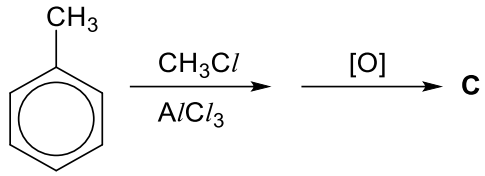
……..

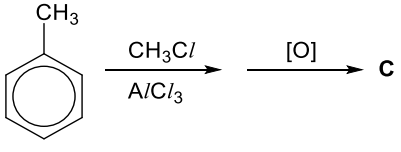
……..[2]

Tutorial Practice Questions (to be attempted **IN CLASS**)

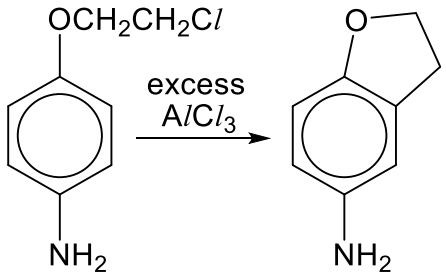
1b [RI 2001 Promos/C3]

Compound **A** has a molecular formula of C_9H_8. When reacted with cold acidified potassium manganate(VII), compound **A** forms **B**, $C_9H_{10}O_2$. However, when the mixture is further heated, compound **C**, $C_8H_6O_4$, is formed. Mononitration of **C** gives a mixture of products. **C** can also be synthesised via the following reaction scheme. [10]



Information	Deductions
Compound **A** has a molecular formula of C_9H_8.	
When reacted with cold acidified potassium manganate(VII), compound **A** forms **B**, $C_9H_{10}O_2$.	**A** has _____ which underwent _____ _____, forming a _____.
However, when the mixture is further heated, compound **C**, $C_8H_6O_4$, is formed.	**A** has ___ _____ _____ which underwent _____ _____ _____, giving 2 _____ groups. **C** could be: [ ] or [ ] or [ ]
Mononitration of **C** gives a mixture of products.	**C** must be [ ] or [ ] as nitration of [ ] will only give 1 nitrated product.
	–CH_3 is a ____-directing group. **C** is: [ ] **A** is: [ ] **B** is: [ ]

2b A*l*C*l*$_3$ acts as a Lewis acid catalyst for electrophilic substitution of the benzene ring.

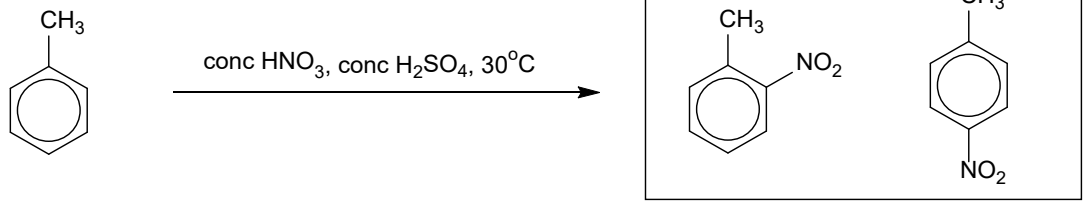


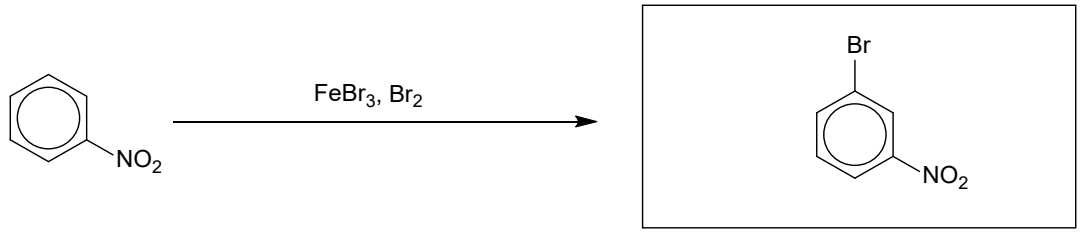
Describe the mechanism of the reaction above.

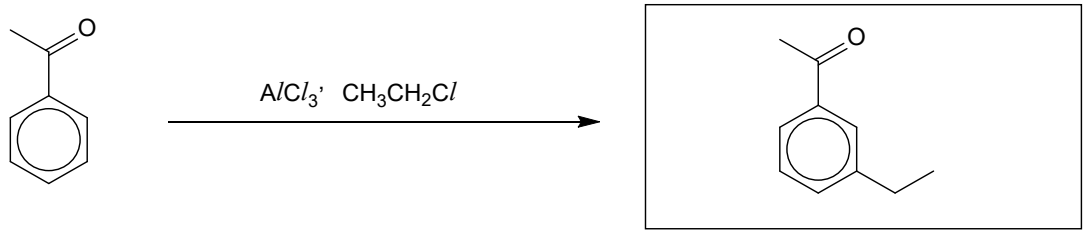
[3]

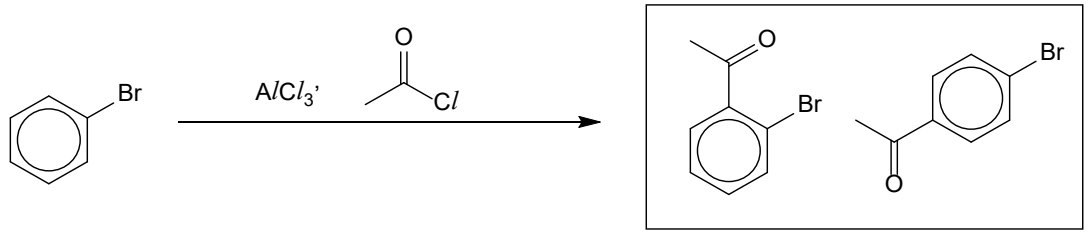
Self-Check Questions

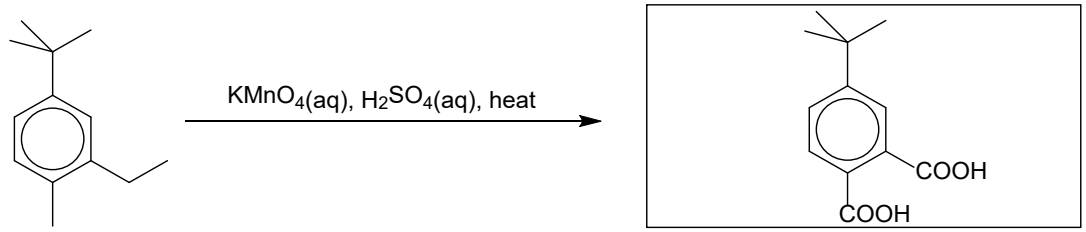
1

(a) 

(b) 

(c) 

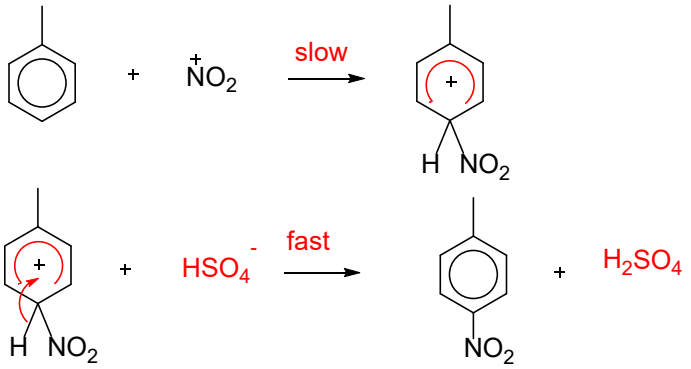
(d) 

(e) 

2 The chloro-substituent is <u>electron withdrawing</u>, causing the benzene ring to be <u>more electron poor / less electron rich</u>. Hence, the benzene ring is <u>less susceptible to electrophilic attack</u>, hence a <u>higher temperature</u> is needed for reaction to occur.

3 **(a)** Electrophilic substitution

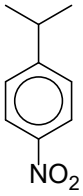
$2H_2SO_4 + HNO_3 \rightleftharpoons NO_2^+ + 2HSO_4^- + H_2O$



(b) The $-CH_3$ group poses <u>steric hindrance to the approach of the electrophile at the 2-position</u> during the reaction. Hence, substitution by $-NO_2$ at the 2-position with respect to $-CH_3$ occurs less than the 4-position.

Set A Tutorial Discussion Questions (to complete before Chemfocus session)

1a (i)



Intermediate:

Step 1: concentrated HNO_3, concentrated H_2SO_4, 30 °C

Step 2: Br_2, $AlBr_3$

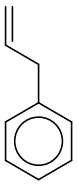
(ii)

Intermediate:

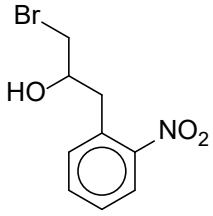
Step 1: Cl_2, $AlCl_3$

Step 2: CH_2CHCH_2Cl, $AlCl_3$

(iii)



Intermediate:

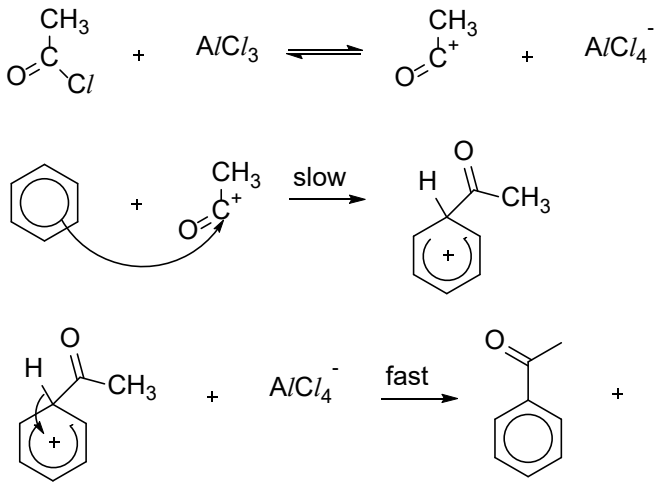


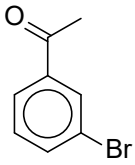
Final product:

Step 1: CH_2CHCH_2Cl, $AlCl_3$

Step 2: concentrated HNO_3, concentrated H_2SO_4, 30 °C

2a (i) Electrophilic substitution

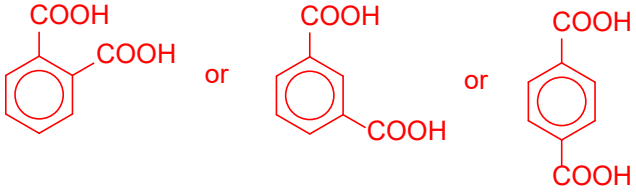
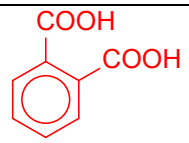
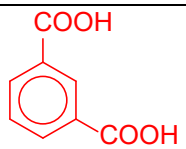
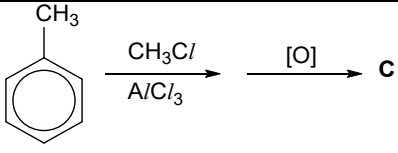
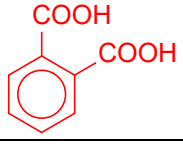
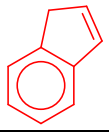
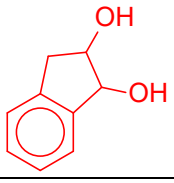


(ii) 

Br is less electronegative than C*l* hence Br adopts a δ^+, and BrC*l* reacts with the Lewis acid catalyst to form Br^+.

Set A Tutorial Practice Questions (to be attempted **IN CLASS**)

1b

Information	Deductions
Compound **A** has a molecular formula of C_9H_8.	C:H ≈ 1:1, presence of benzene ring.
When reacted with cold acidified potassium manganate(VII), compound **A** forms **B**, $C_9H_{10}O_2$.	**A** has an alkene which undergone mild oxidation, forming a diol.
However, when the mixture is further heated, compound **C**, $C_8H_6O_4$, is formed.	**A** has two side chains which underwent side chain oxidation, giving 2 –COOH groups. **C** could be: 
Mononitration of **C** gives a mixture of products.	**C** must be  or  as  nitration of will only give 1 nitrated product.
	–CH_3 is a 2,4-directing group. **C** is:  **A** is:  **B** is: 

2b Electrophilic substitution