FACTFILE:
GCE CHEMISTRY

ANSWERS TO A2 1 FACTFILE QUESTIONS

Rewarding Learning

ANSWERS

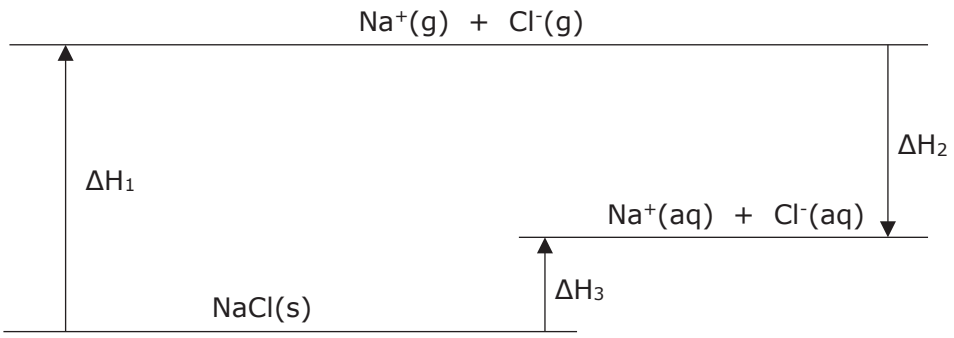
4.1 Lattice enthalpy

1. Answer is B [1]

2.(i) Lattice enthalpy of sodium chloride [1]

(ii) Hydration enthalpy [1]

(iii)



[-1] for each error [3]

(iv) ΔH_3 = +776 -771 = + 5 kJ [1]

3.(a) E [1]
D [1]
B [1]
A [1]

(b) -(-327.6) + 89.5 + 420 + 106.6 + (-295.4) = + 648.3 kJ mol^{-1}
[-1 for each error] [2]

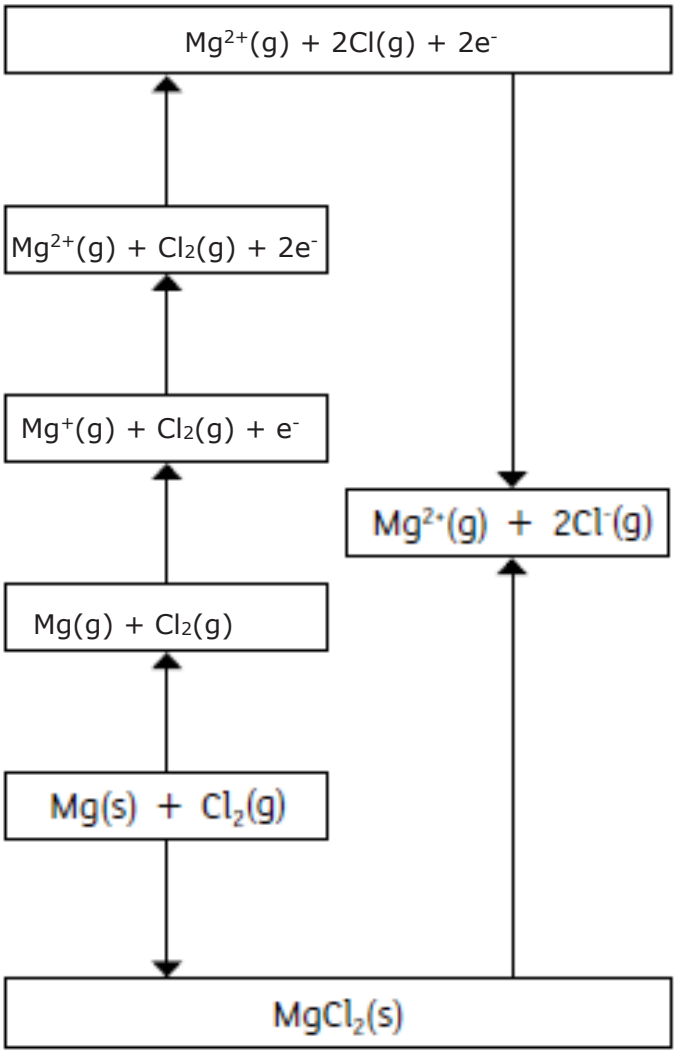
(c) enthalpy of atomisation/bond enthalpy [1]
first electron affinity [1]
enthalpy of formation [1]

(d)(i) $KCl(s) + aq \rightarrow K^+(aq) + Cl^-(aq)$ [2]

(ii) $+710 + (-305) + (-384) = +21$ (kJ mol^{-1}) [2]

(iii) Answer is D [1]

4.(a)(i)



[4]

(ii) 2×electron affinity=- 2(+121) – (+1450) – (+736) – (+150) + (-642) + (+2493)
2× electron affinity = -727
electron affinity = -727/2 = -363.5 kJ mol^{-1} [2]

(b) magnesium ions: $1s^2\ 2s^2\ 2p^6$ [1]
chloride ions: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ [1]

(c) The enthalpy change when one mole of a solute dissolves in water [1]

4.2 Enthalpy, entropy and free energy

1. Answer is D [1]

2. Answer is B [1]
a = standard entropy of steam
$138 = 2 \times 27 + 3a - (90 + 3 \times 131)$
$138 = 3a - 429$
$3a = 138 + 429 = 567$
$a = 567/3 = 189$ J K^{-1} mol^{-1}

3. Answer is B [1]
$\Delta G = \Delta H - T\Delta S$
$\Delta G = 178 - 298 \times 0.161$
$\Delta G = 130$ kJ mol^{-1}

4.(a)
(i) $\Delta H = 3 \times -393.5 - 2 \times -824.2 = +467.9$ kJ mol^{-1} [2]

$\Delta S = 4 \times 27.3 + 3 \times 213.6 - (2 \times 87.4 + 3 \times 5.7) = +558.1$ J K^{-1} mol^{-1} [2]

$\Delta G = \Delta H - T\Delta S = 467.9 - 298 \times 0.5581 = +301.6$ kJ mol^{-1} [2]

(ii) ΔG is positive [1]

(b) $T = \frac{\Delta H}{\Delta S} = \frac{467.9}{0.5581} = 838.4$ K [2]

5.(i) $NH_4NO_3 \rightarrow N_2O + 2H_2O$ [1]

(ii) ΔG is negative at all temperatures [1]

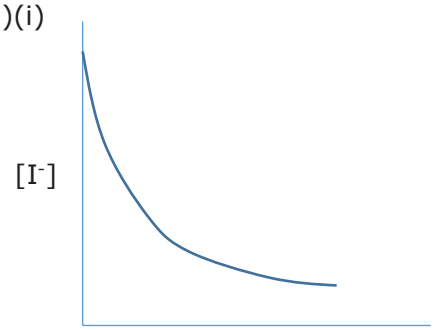
6. Answer is D [1]
$T = \frac{\Delta H}{\Delta S} = \frac{237}{0.190} = 1247.4$ K

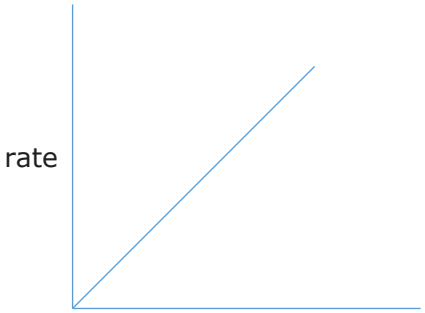
4.3 Rates

1. Answer is A [1]

2.(a) starch [1]
blue-black [1]

(b)(i)





[2]

(ii) order H_2O_2 = 1 [1]
order H^+ = zero [1]

(ii) rate = $k[H_2O_2][I^-]$ or rate = $k[H_2O_2][I^-][H^+]^0$ [1]

(iv) $2.1 \times 10^{-6} = k(0.00075)(0.1)$
$k = 0.028$ mol^{-1} dm^3 s^{-1} [1]

(c)(i) slowest step in the reaction [1]

(ii) $IO^- + 2H^+ + I^- \rightarrow H_2O + I_2$ [2]

3.(i) take samples at set time intervals and quench the reaction mixture/add water (to stop the reaction) [1]
Either
Titrate against standard $Na_2S_2O_3$(aq)
or Add $AgNO_3$(aq) and weigh precipitate
or Colorimetry for I_2 [1]

plot graph of [I–]/[I_2] against time [1]
measure gradient to find rate [1]

max [3]

QWC [2]

(ii) order wrt $S_2O_8^{2-}$ = 1
order wrt I^- = 1 [2]

(iii) rate = $k[S_2O_8^{2-}][I^-]$ [2]

(iv) overall order is the sum of the orders = 1 + 1 = 2 [1]

(v) $0.18 = k(0.05)^2$

$k = 0.18/0.05^2 = 72\ mol^{-1}\ dm^3\ s^{-1}$ [2]

4.4 Equilibrium

1.(i) $K_c = \dfrac{[CH_3COOC_5H_{11}][H_2O]}{[CH_3COOH][C_5H_{11}OH]}$ [1]

(ii) converting g to mol

	$C_5H_{11}OH$	+	CH_3COOH	⇌	$CH_3COOC_5H_{11}$	+	H_2O
initial moles	0.0125		0.02		0		0
equilibrium moles	0.0025		0.01		0.01		0.01

$$K_c = \frac{[CH_3COOC_5H_{11}][H_2O]}{[CH_3COOH][C_5H_{11}OH]} = \frac{0.01 \times 0.01}{0.01 \times 0.0025} = 4$$ [4]

2. Answer is B [1]

3. moles of NH_3 which reacts = moles of CH_4 which reacts = 0.1 mol
moles of NH_3 at equilibrium = 0.2 – 0.1 = 0.1 mol
moles of CH_4 at equilibrium = 0.2 – 0.1 = 0.1 mol

$$K_c = \frac{[HCN][H_2]^3}{[NH_3][CH_4]} = \frac{(0.1)(0.3)^3}{(0.1)(0.1)} = 0.27\ mol^2\ dm^{-6}$$ [3]

4. Answer is C [1]

$$K_c = \frac{[CH_3CH_2COOCH_3][H_2O]}{[CH_3CH_2COOH][CH_3OH]} = \frac{(0.5)(2.5)}{(0.5)(0.5)} = 5$$

4.5 Acid-base equilibria

1. Answer is A [1]
$pH = -\log_{10}[H^+] = -\log_{10}(0.1) = 1$

2. Answer is B [1]

3. Answer is C [1]

4.(a) $K_a = 10^{(-2.9)} = 1.259 \times 10^{-3}\ mol\ dm^{-3}$

$[H^+] = \sqrt{K_a \times [acid]} = \sqrt{1.259 \times 10^{-3} \times 0.1} = 0.0112\ mol\ dm^{-3}$

$pH = -\log_{10}[H^+] = -\log_{10}(0.0112) = 1.95$ [3]

(b) phenolphthalein [1]
colour changes in the pH range corresponding to the vertical portion of the titration curve [1]

(c) $C_4H_6O_6 + OH^- \rightarrow C_4H_5O_6^- + H_2O$ [1]
$C_4H_5O_6^- + H^+ \rightarrow C_4H_6O_6$ [1]

5. on addition of acid/H^+ ethanoate ions combine with the H^+ [1]
CH_3COO^- + H^+ → CH_3COOH [1]
on addition of alkali/OH^- ethanoic acid reacts to remove OH^- [1]
CH_3COOH + OH^- → CH_3COO^- + H_2O [1]

6. moles of MgO = $\frac{0.0006}{40}$ = 1.5×10^{-5} mol
moles of OH^- = $1.5 \times 10^{-5} \times 2 = 3 \times 10^{-5}$ mol
$[OH^-] = 3 \times 10^{-5} \times 10 = 3 \times 10^{-4}$ mol dm^{-3}
$K_w = [H^+][OH^-] = 1 \times 10^{-14}$
$[H^+] = \frac{1 \times 10^{-14}}{3 \times 10^{-4}} = 3.33 \times 10^{-11}$ mol dm^{-3}
$pH = -\log_{10}[H^+] = -\log_{10}(3.33 \times 10^{-11}) = 10.48$ [3]

7. Answer is C [1]
moles of HCl = $\frac{500 \times 0.4}{1000}$ = 0.2 mol
moles of NaOH = $\frac{500 \times 0.1}{1000}$ = 0.05 mol
moles of HCl left over = 0.2 – 0.05 = 0.15 mol in 1000 cm^3
[HCl] = 0.15 mol dm^{-3} so $[H^+]$ = 0.15 mol dm^{-3}
$pH = -\log_{10}[H^+] = -\log_{10}(0.15) = 0.82$

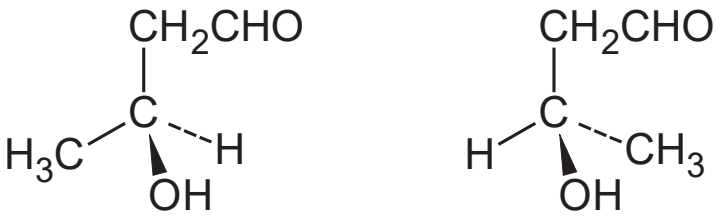
4.6 Isomerism

1. Answer is A [1]

2. Answer is A [1]

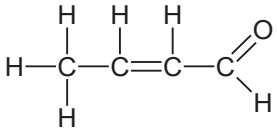
3.(i) rotates the plane [1] of plane polarised light [1]

(ii)



[2]

(iii)

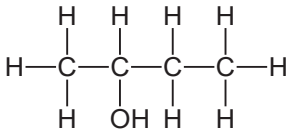


[1]

4.(a) an asymmetric centre is an atom which has four different atoms or groups attached [1]

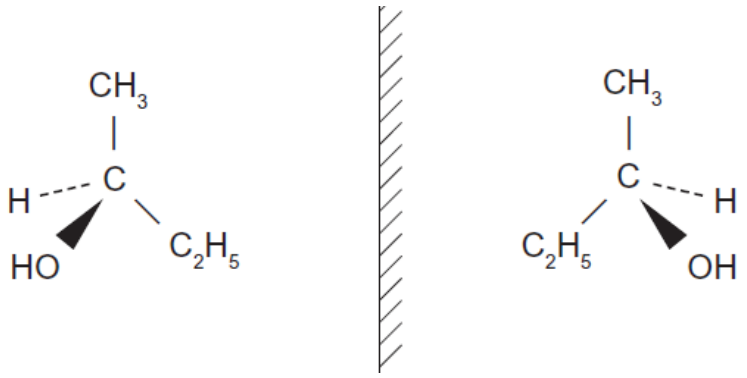
(b) optical isomers are isomers which exist as non-superimposable [1] mirror images [1]

(c)



[1]

(d)



[2]

(e) plane polarised light [1]
rotated in opposite directions [1]

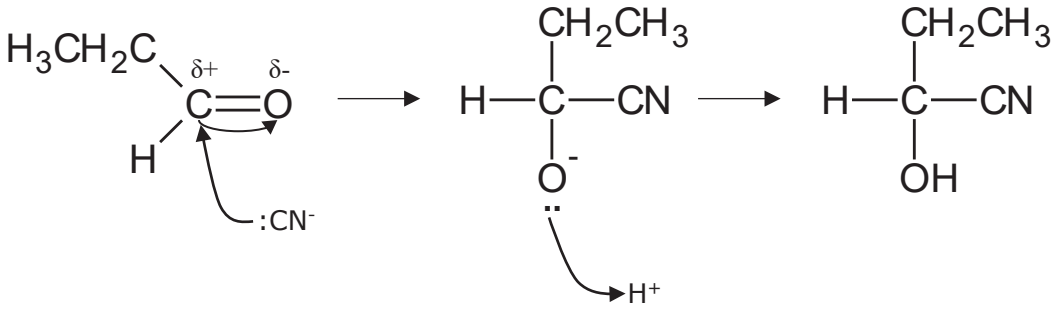
4.7 Aldehydes and Ketones

1. Answer is C [1]

2. Answer is C [1]

3.(a) ethanal [1] carbonyl [1]

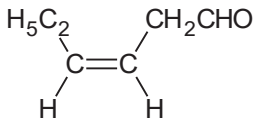
(b) nucleophilic addition [1]



[3]

(c) CN^- attacks at either side of C=O plane [1]
equal mixture of both optical isomers [1]

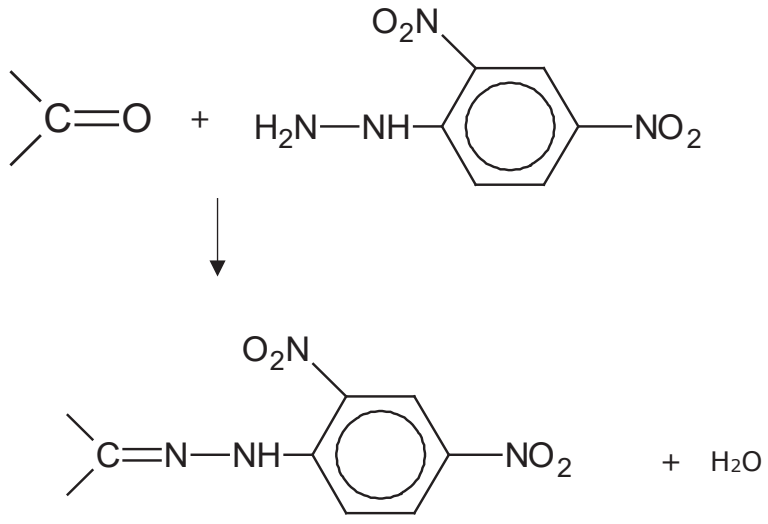
4.(a)



[2]

(b) blue solution [1] changes to give a red precipitate [1]

(c)



[3]

4.8 Carboxylic acids

1. Answer is D [1]

2.(a) $C_6H_{12}O$ [1]

(b) –COOH/ethanoic acid forms H-bonds [1]
formed between H of H_2O (or H of COOH) and O of COOH (or O of H_2O) [1]
lauric acid has hydrophobic/long chain [1]

(c) add carbonate/hydrogencarbonate to liquid lauric acid [1]
fizzing/test for CO_2 [1]

(d) $C_{11}H_{23}COOH + PCl_5 \rightarrow C_{11}H_{23}COCl + POCl_3 + HCl$ [2]

(e)(i) $C_{11}H_{23}COOH + 4[H] \rightarrow C_{11}H_{23}CH_2OH + H_2O$ [2]

(ii) lithium tetrahydridoaluminate(III)/lithal [1]

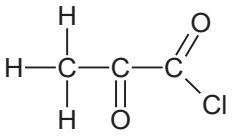
3.(a) $2CH_3CH_2COOH + Mg \rightarrow (CH_3CH_2COO)_2Mg + H_2$ [1]

$2HCOOH + Na_2CO_3 \rightarrow 2HCOONa + H_2O + CO_2$ [1]

$CH_3CH_2CH_2COOH + KOH \rightarrow CH_3CH_2CH_2COOK + H_2O$ [1]

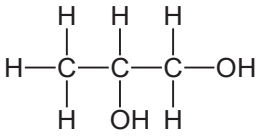
(b)

with PCl_5



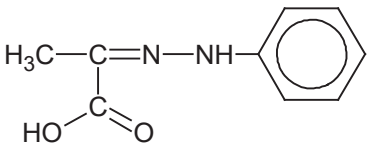
[1]

with excess $LiAlH_4$



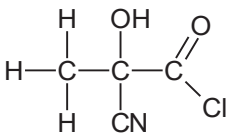
[1]

with $H_2NNHC_6H_4$ (phenylhydrazine)



[1]

with HCN



[1]

4.9 Derivatives of carboxylic acids

1. Answer is B [1]

moles of butan-1-ol = $\frac{6.0}{74}$ = 0.0811 mol

theoretical yield of ester ($CH_3CH_2COOC_4H_9$) = 0.0811 × 130 =10.54 g

percentage yield = $\frac{7.4}{10.54} \times 100$ = 70.2 % = 70%

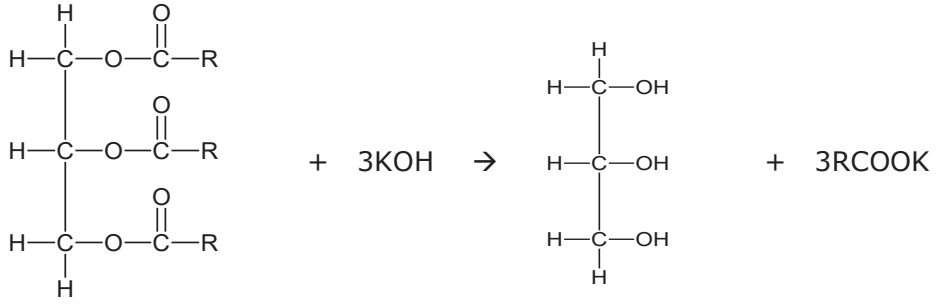
2.(i) $CH_3CH_2COOH + CH_3OH \rightleftharpoons CH_3CH_2COOCH_3 + H_2O$ [1]

(ii) catalyst/increases yield/pushes position of equilibrium to right hand side/absorbs water [1]

(iii) hydrogen bonds between propanoic acid molecules
no hydrogen bonds/only VDW/permanent dipole-dipole attractions between methyl propanoate molecules [1]
comment on relative strength of bonding, e.g. hydrogen bonds stronger than VDW/permanent dipole-dipole attractions [1]

(iv) any **two** from:
higher yield/not reversible [1]
faster [1]
other product gaseous [1]

3.(a)
(i)



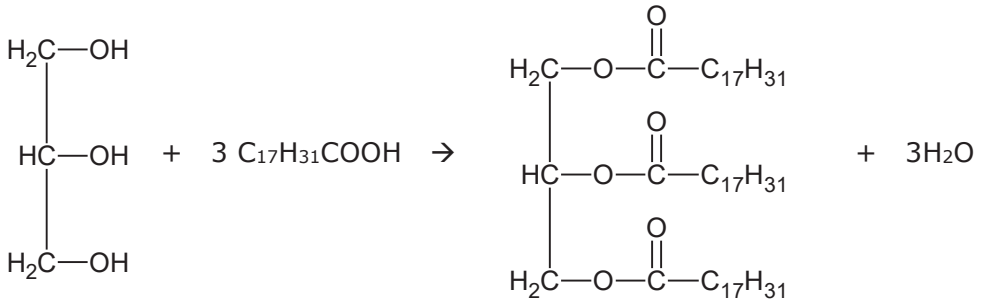
[2]

(ii) propane-1,2,3-triol [1]

(b)(i) $C_{19}H_{38}O_2$ [1]

(ii) $2C_{19}H_{38}O_2 + 55O_2 \rightarrow 38CO_2 + 38H_2O$ [2]

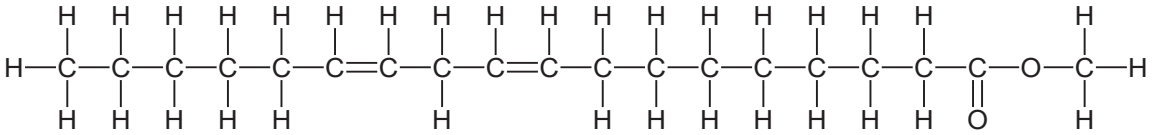
4.(a)



[2]

(b) fatty acids contain C=C [1]

(c)



[2]

4.10 Aromatic chemistry

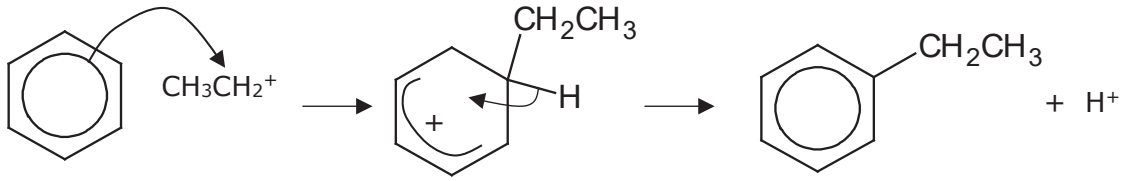
1. Answer is C [1]

2.(a) aluminium chloride [1]

(b) $CH_3CH_2Cl + AlCl_3 \rightarrow AlCl_4^- + CH_3CH_2^+$ [2]

(c) $C_6H_6 + CH_3CH_2Cl + C_6H_5CH_2CH_3 + HCl$ [1]
ethylbenzene [1]

(d)

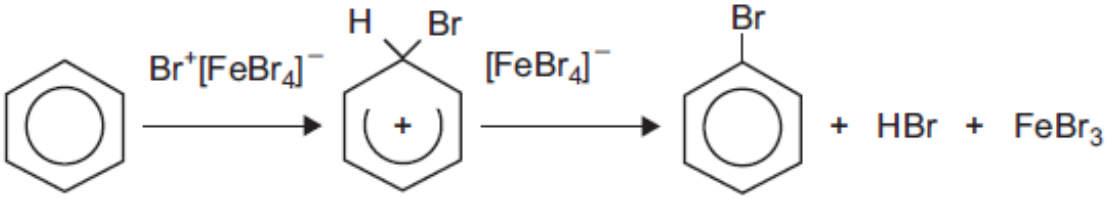


[3]

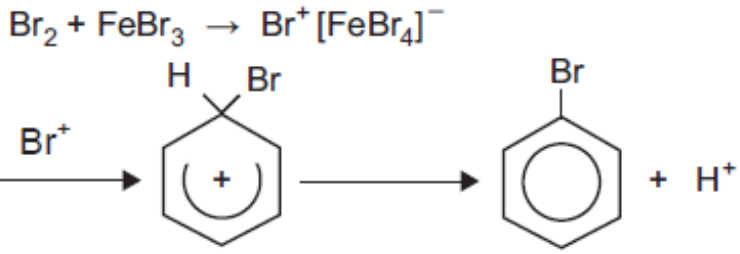
3.(a)
(i) electrophilic addition [1]

(ii) iron or iron(III) bromide [1]

(iii)



or

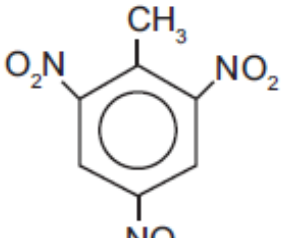


([-1] for each mistake) [3]

(iv) electrophilic substitution [1]

(iv) electrophilic substitution [1]

(b)(i)



(ii) concentrated nitric acid and concentrated sulfuric acid [1]
$HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + 2HSO_4^- + H_3O^+$ [1]

4. Answer is B [1]