

Correction of Tutorial 1 - Grade 13

Section A

1. C 2. D 3. C 4. D 5. B

6. C 7. C 8. A 9. A 10. C

11. D 12. C 13. A 14. A 15. C

Section B

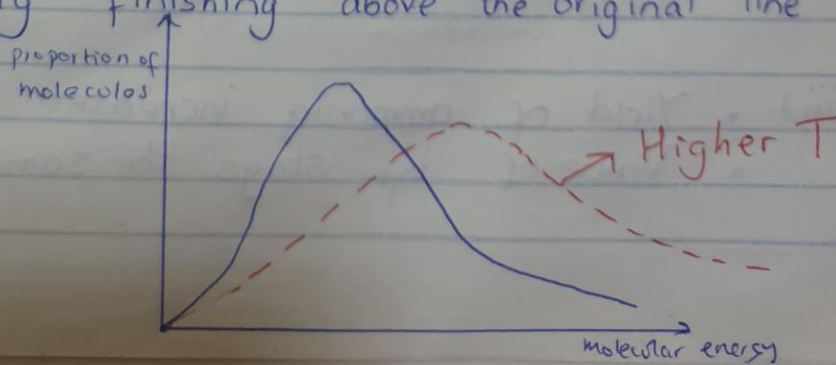
16. B 17. A 18. D 19. B 20. A

Section C

1 (a)(i) The energy needed to break a mole of covalent bond in the gaseous state.

$$(ii) \quad E(N-H) = +390.7 \text{ kJmol}^{-1}$$

- b) (i)
- curve displaced to the right of the original line and starts at origin.
 - the peak is lower and curve crosses once only finishing above the original line



f (b)(ii) Rate increases.

- At higher Temp, more molecules have $E \geq E_a$
- Higher frequency of successful collisions.

(b) (iii) Reduces yield of ammonia

- Increasing temp, shifts equilibrium to the left in endothermic reaction
- to oppose change / absorb the additional heat

(c) (i) $N_2 = 0.850 \text{ mol}$ $H_2 = 2.55 \text{ mol}$

(ii) $n_{\text{Total}} = 3.7 \text{ mol}$

mol fraction of $NH_3 = \frac{0.3}{3.7}$

$p_{NH_3} = 2 \times 10^7 \times \left(\frac{0.3}{3.7} \right) = 1.62 \times 10^6$

(d) (i) $K_p = \frac{p_{NH_3}^2}{p_{N_2} \times p_{H_2}^3}$

(ii) $K_p = 1.00 \times 10^{-16} \text{ Pa}^{-2}$

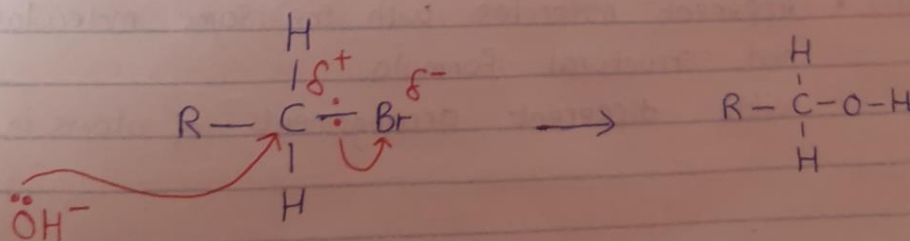
(iii) • Yield of ammonia increases

- Value of K_p stays the same.

2(a)

Reaction #	reagents and conditions	type(s) of reaction
1	aq. dilute NaOH / KOH	substitution (hydrolysis)
2	ethanolic NaOH / KOH	elimination
3	NaCN / KCN in ethanol	substitution
4	aq. dilute H_2SO_4 / H^+	hydrolysis or substitution or addition-elimination
5	acidified $K_2Cr_2O_7$ + distill (NOT reflux)	oxidation or elimination
6	acidified $K_2Cr_2O_7$ Fehling's / Tollen's	oxidation

(b)



(c)(i) different molecules with same molecular formula but different structural formulae / displayed formulae

- chain
- functional group
- positional / regioisomerism

(ii) nucleophilic substitution

- $(\text{CH}_3)_3\text{CBr}$ is a tertiary halogenoalkane which forms a stable carbocation

- in 1-bromobutane (primary halogenoalkane) there is no stable carbocation formed.

- The three alkyl groups in $(\text{CH}_3)_3\text{CBr}$ donate electrons by the positive inductive effect. The effect is lesser in 1-bromobutane.

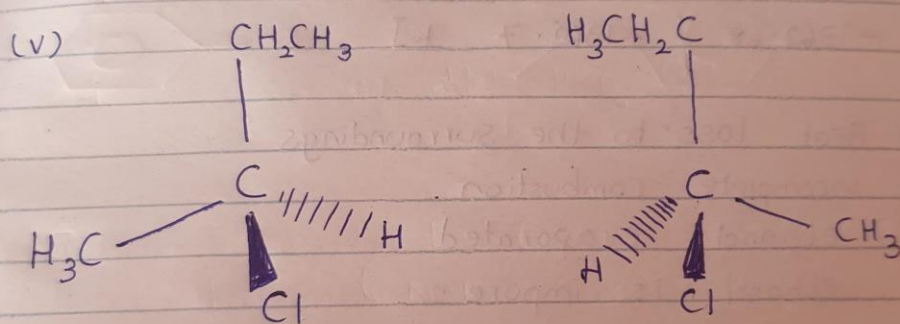
(d)(i) • different molecules with the same molecular and structural formula with different arrangements of atoms in space

2d) (ii) • No chiral carbon atom / achiral
• one carbon of double bond has identical groups.

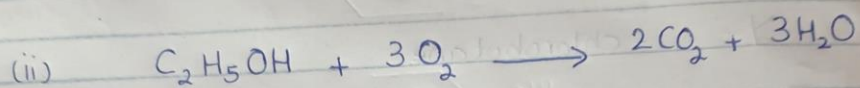
(iii) X = 2-chlorobutane

Y = 1-chlorobutane

(iv) Optical isomerism



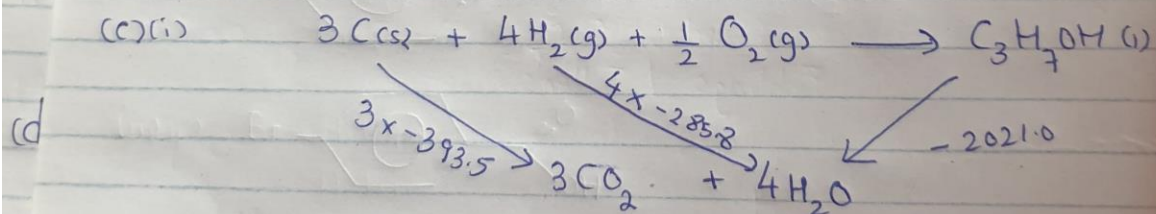
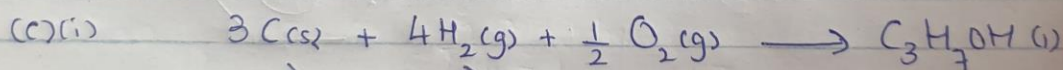
3 (a) Heat change when one mole of a substance burns in excess oxygen under standard conditions



$$(b) (i) \quad 6813.4 \text{ J}$$

$$(ii) \quad -1362.68 \text{ / } -1362.7 \text{ kJ}$$

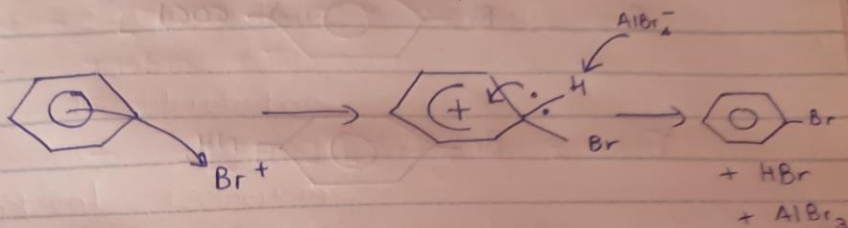
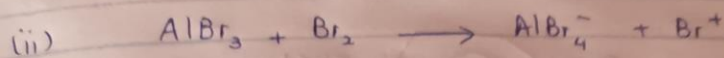
- (iii)
- Heat loss to the surroundings
 - incomplete combustion
 - ethanol evaporated
 - ethanol is impure



$$(ii) \quad \Delta H_f + (-2021.0) = 3(-393.5) + 4(-285.8)$$

$$\Delta H_f = -302.7 \text{ kJ/mol}$$

4 (a)(i) Electrophilic substitution



(b) V: Amide

W: Amide

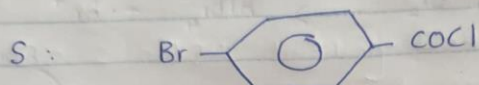
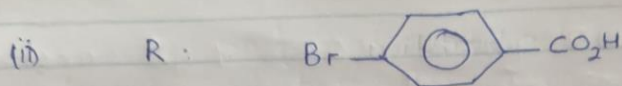
(c) (i) Step 1: $CH_3Cl + AlCl_3$

Step 2: Acidified $KMnO_4$, ~~reptox~~

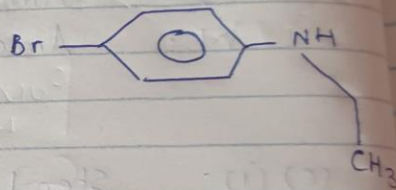
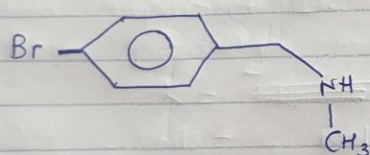
Step 3: conc. $HNO_3 +$ conc. H_2SO_4

Step 4: Tin + conc. HCl

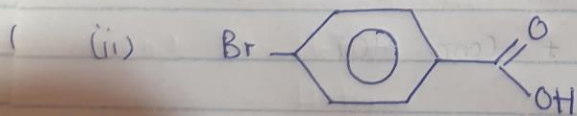
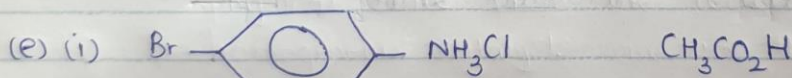
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(d) (i)



(ii) Reduction



(iii) The compound is less polar resulting in less hydrogen bonding to water.

- 5 (a) (i)
- A - H_2 , 1 atm
 - B - platinum
 - C - 1 mol dm⁻³ H^+
 - D - salt-bridge
 - E - platinum
 - F - 1 mol dm⁻³ Fe^{2+} and 1 mol dm⁻³ Fe^{3+}

(ii) positive electrode is platinum
electrons flow clockwise

(b) Cell potential is $0.77 - 0.34$
 $= + 0.43 \text{ V}$

(c) (i) electrode potential would become more negative
as equilibrium shifts to the left.

(ii)
$$E = -0.41 + \left(\frac{0.059}{1}\right) \log \frac{[Cr^{3+}]}{[Cr^{2+}]}$$

$$= -0.41 + 0.059 \log 4.0$$

$$= -0.37 \text{ V}$$

6 (a)(i) Exp 1 and 2: doubling $[\text{ClO}_2]$ quadruples the rate, so second order

Exp 2 and 3: doubling $[\text{OH}^-]$ doubles the rate, so first order

$$\text{rate} = k [\text{ClO}_2]^2 [\text{OH}^-]$$

(ii) From experiment 2: $9.34 \times 10^{-4} = k (2.50 \times 10^{-2})^2 (1.30 \times 10^{-3})$

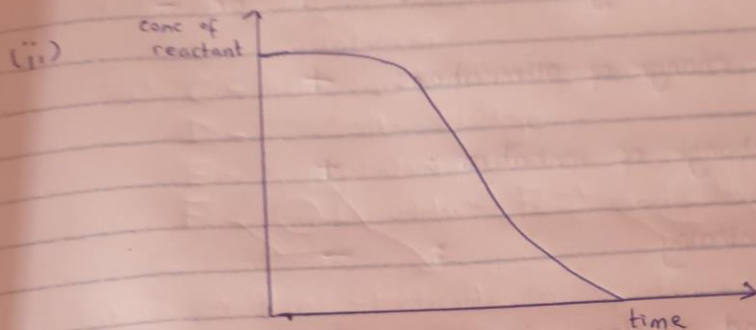
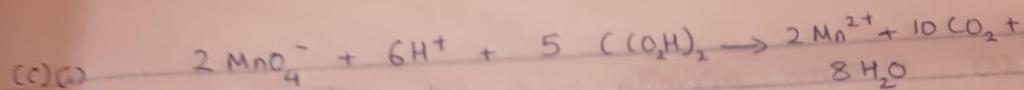
$$k = \frac{9.34 \times 10^{-4}}{1.15 \times 10^{-3}} = 1.15 \times 10^3$$

$$\text{Units} = \text{mol}^{-2} \text{dm}^6 \text{s}^{-1}$$

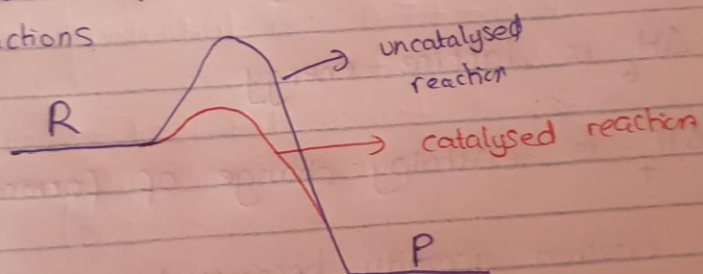
(b) (i) Heterogeneous catalysts are in the different physical state from the reactants and homogeneous catalysts are in the same physical state as the reactants

(ii) Hetero
Hetero
Homo

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(d)(i) • lowers E_a for both the forward and reverse reactions



(ii)

$$K_p = \frac{(p \text{NH}_3)^2}{(p \text{N}_2) \times (p \text{H}_2)^3}$$
$$1.45 \times 10^{-5} = \frac{(p \text{NH}_3)^2}{20 \times 60 \times 60 \times 60}$$

$$p \text{NH}_3 = 7.91$$

7 (a) electron affinity : + or -

enthalpy change of atomisation: +

enthalpy change of ionisation: +

lattice enthalpy : -

(b)(i) the second electron is removed from a more positively charged ion

(ii) ΔH_6 is lattice energy

ΔH_7 is enthalpy change of formation

(c) • the electron affinity becomes less exothermic
• electron affinity depends mainly on the electron-nucleus distance which increases down Group 17

(d) $\Delta G = \Delta H - T\Delta S$

$$\Delta S = 26.9 - (32.7 + 102.5)$$

$$= -108.3 \text{ JK}^{-1}\text{mol}^{-1}$$

$$\left(-10 - 0.1083 \text{ kJ mol}^{-1} \right)$$

$$\Delta G = -602 - (298 \times (-0.1083))$$

$$= -570$$

$$\text{units} = \text{kJ mol}^{-1}$$