Higher Chemistry

Past Paper Answers – Book 4

Higher 2018

Specimen Paper 2018

2018

2018 Higher Chemistry Marking Instructions

Multiple choice

① B

Enthalpy change = $H_{products} - H_{reactants}$
$= 50 - 40$
$= +10$ for forward reaction
$\Rightarrow -10$ for reverse

② A

$\text{Rate} = \frac{1}{t} = \frac{1}{100} = 0.010\,s^{-1}$

③ D

Only a catalyst can change E_a
Lowering the temperature results in less successful collisions

④ C

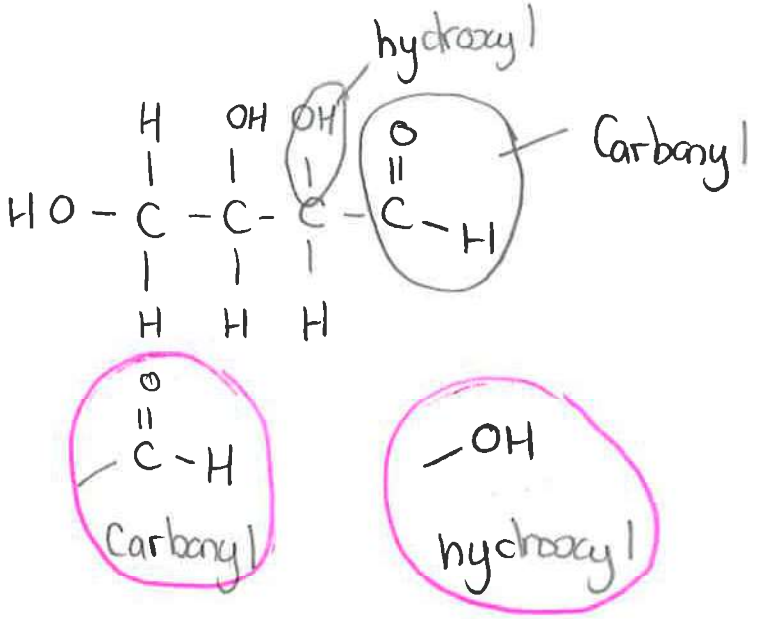
1st Ionisation energy: $Al_{(g)} \rightarrow Al^+_{(g)} + e^-$
2nd " " : $Al^+_{(g)} \rightarrow Al^{2+}_{(g)} + e^-$
3rd " " : $Al^{2+}_{(g)} \rightarrow Al^{3+}_{(g)} + e^-$

Given equation is: $Al^+_{(g)} \rightarrow Al^{3+}_{(g)} + 2e^-$
This combines 2nd + 3rd ionisation energy.
$\Rightarrow 1817 + 2745 = 4562$

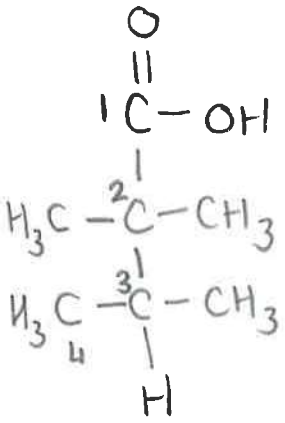
⑤ D

A - covalent network
B - monotamic
C - Metallic
D - covalent molecular

⑥ C



⑦ A



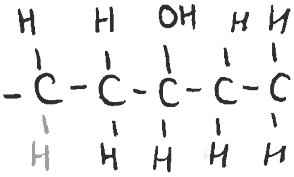
longest carbon chain is 4 carbons => butanoic acid

2 methyl groups on carbon number 2.

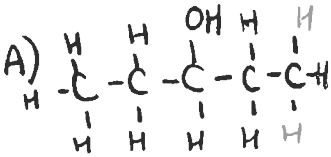
1 methyl group on carbon no. 3.

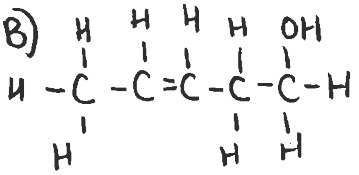
=> 2,2,3-trimethylbutanoic acid.

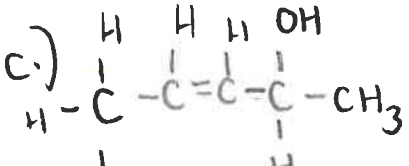
⑧ D

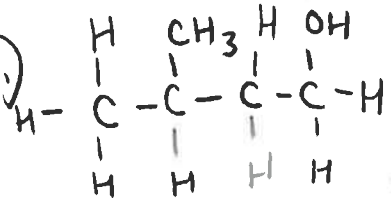
Pentan-3-ol =  $= C_5H_{11}OH$

Isomer = same molecular formula, different structural.

A)  = pentan-3-ol = $C_5H_{11}OH$ => not isomer

B)  $= C_5H_9OH$ => not isomer

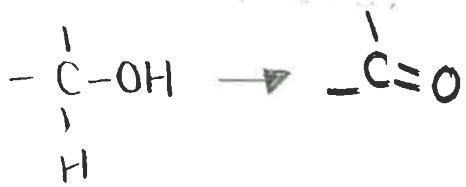
C.)  $= C_5H_9OH$ => not isomer

D.)  = 3-methylbutanol $C_5H_{11}OH$ =>

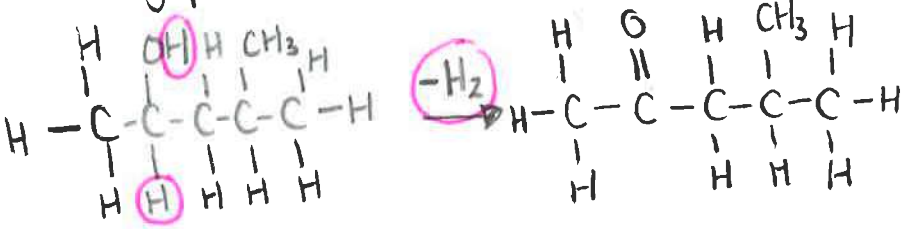
Isomer: same molecular formula, different structural

(9) A

Oxidation is loss of 2 hydrogens



4-methylpentan-2-ol



$H_2 = 2g$

(10) B

[Basic definition]

(11) D

$nCO + (2n+1)H_2 \rightarrow nH_2O$ + hydrcorbons

problem solving: replace n with any number, for example 1.

then,

$CO + 3H_2 \rightarrow H_2O$ + hydrocaban

Count how many of each element you have to work out formula of hydrocarbon

C = 1	C = 0 need 1
O = 1	O = 1
H = 6	H = 2 need 4

⇒ hydrocarbon is CH_4

general formula is C_nH_{2n+2}

(12) D

Sodium chloride: NaCl 1mol Na^+ = 1mol Cl^-

0.6mol Na^+ 0.6mol Cl^-

Sodium sulfate: Na_2SO_4 2mol Na^+ = 1mol SO_4^{2-}

0.4mol Na^+ 0.2mol SO_4^{2-}

x2

Na^+ ions

0.6mol + 0.4mol

= 1.0 moles

(13) A

(A) $n = \frac{m}{gfm} = \frac{0.2}{2} = 0.1mol$

(B) $n = \frac{m}{gfm} = \frac{0.44g}{44} = 0.01mol$

(C) $n = \frac{m}{gfm} = \frac{0.6}{20.2} = 0.03mol$

(D) $n = \frac{m}{gfm} = \frac{0.8}{39.9} = 0.02mol$

(14) A

solid, gas, liquid

$3CuO + \underline{2NH_3} \rightarrow 3Cu + \underline{N_2} + 3H_2O$

2mol — 1mol

100 cm^3 — 50 cm^3

(15) D

(A) Will not effect equilibrium

(B) H^+Cl^- = hydrogen chloride more product => will shift equilibrium to the left

(C) Na^+Cl^- = Sodium chloride = more product => will shift equilibrium to the left

(D) Na^+OH^- = sodium hydroxide = OH^- will react with H^+ => less product => shift equilibrium to the left.

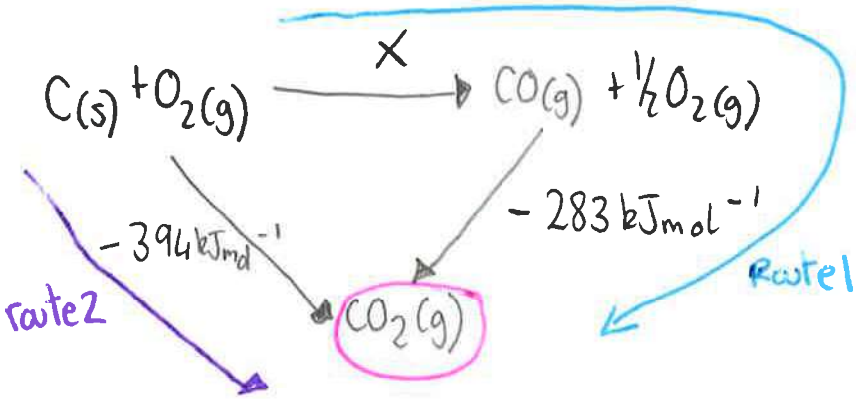
(16) C

Remember enthalpy of combustion is exothermic => always negative.

Mass		Energy
3.6g	→	124kJ
72g	→	x
3.6x	→	124×72
x	→	$\frac{124 \times 72}{3.6} = -2480$

[Remember enthalpy of combustion is the energy released when 1mole of substance burns in oxygen]

(17) B



Rate 1 = Rate 2

$X - 283 = -394$

$X = -394 + 283$

$X = -111\ kJmol^{-1}$

(18) C

Oxidising agents at bottom left of p12 of the data booklet. It must be below the equation:

$SO_3^{2-}(aq) + H_2O(l) \rightarrow SO_4^{2-}(aq) + 2H^+(aq) + 2e^-$

and at the left hand side.

(19) B

$NO_3^- \longrightarrow NO$

Add H_2O to balance oxygen: $NO_3^- \longrightarrow NO + 2H_2O$

Add H^+ to balance hydrogen: $4H^+ + NO_3^- \rightarrow NO + 2H_2O$

Check charge: $4^+ \ 1^-$ $= 3^+$; 0

Balance charge by adding e^-: $4H^+ + NO_3^- + 3e^- \rightarrow NO + 2H_2O$

0 ; 0

(20) B

$ICl(l) + Cl_2(g) \rightleftharpoons ICl_3(s)$ $\Delta H = -106 kJmol^{-1}$

Increase in proportion of solid means shifting equilibrium to the right.

Pressure:

$ICl(l) + Cl_2(g) \rightleftharpoons ICl_3(s)$

1 mol gas $\rightleftharpoons$ 0 mol gas

Increasing pressure shifts equilibrium to the lower no. moles of gas => to the right

Temperature

$ICl(l) + Cl_2(g) \rightleftharpoons ICl_3(s)$ $\Delta H = -106 kJmol^{-1}$

Forward reaction is exothermic, decreasing the temperature moves in the exothermic direction => to the right

2018 written

1 a.) i) The attraction an atom has for a shared pair of electrons

ii). The number of shells increases => shielding increases

b) • Intermolecular forces (LDF) increase going down the group

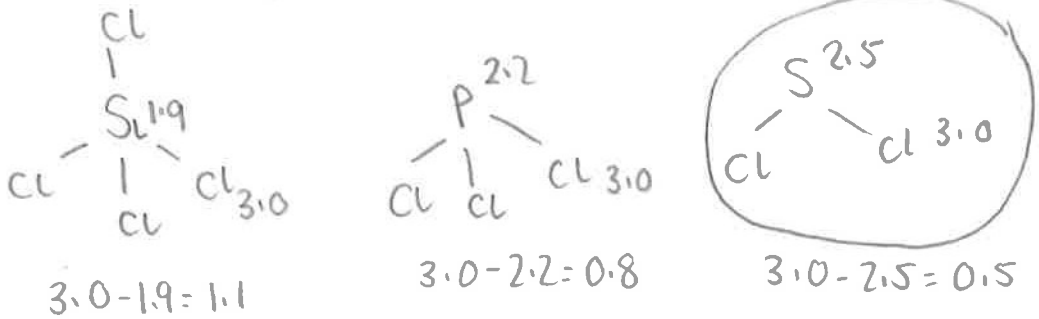
• The intermolecular forces are london dispersion forces

• The more electrons the stronger the LDF.

[Cannot mention any intramolecular forces e.g covalent]

2 a.) Increasing nuclear charge

b.) i)



See p11 of data booklet

ii). • Silicon tetrachloride and hexane are non-polar

• Silicon tetrachloride is non-polar due to its shape / polarities cancelling out.

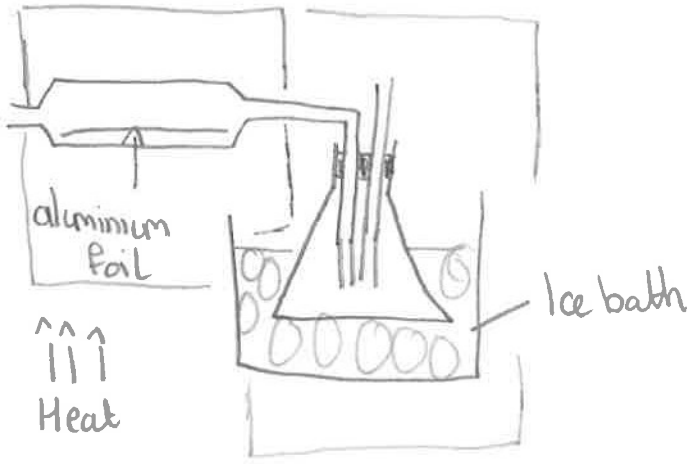
c.) i). Silicon nitride is a covalent network
- (Strong) covalent bonds are being broken

ii) Atom economy = $\frac{\text{Mass desired product}}{\text{mass of reactants}} \times 100$

$= \frac{140.3}{(170.1 \times 3) + (16 \times 17_9)} \times 100$

$= \underline{\underline{17.9\%}}$

d.) i)



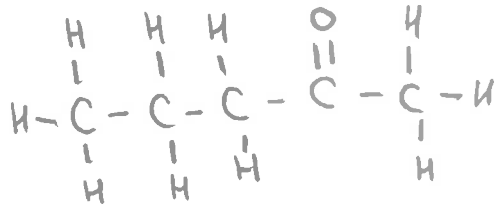
ii) To provide (initial activation energy
or
energy to form activated complex

3 a.) Heating mantle or hot plate or water bath

b) To act as a condenser

c) i) water

[Esterification reaction also produces water]

4a) 

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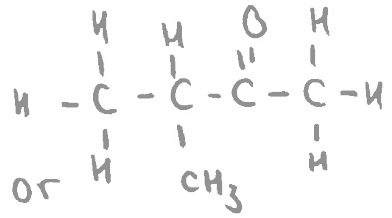

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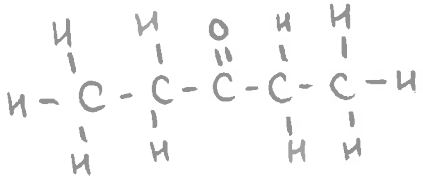
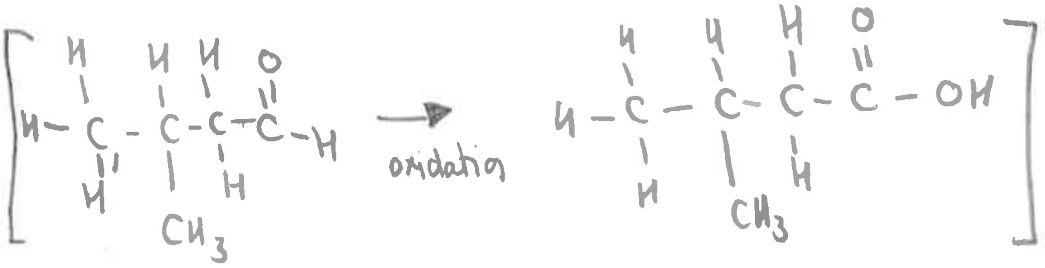


(ketone )

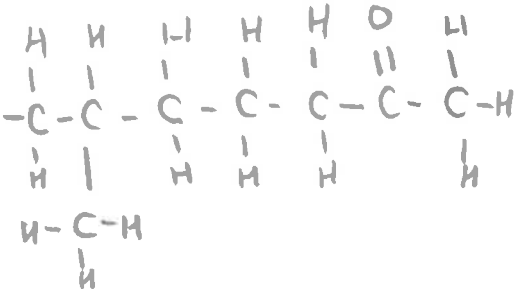
b.) Fehlings solution /
Tollens reagent /
acidified potasium dichromate /
Benidicts solution

c.) Permenant dipole - permenant dipole (PD-PD)

d.) • It will undergo oxidation / react with oxygen
• It will form a carboxylic acid



e.) i) It has <u>two molecules joining together</u> with a <u>loss of water.</u>

ii) 6-methylheptan-2-one 

c)ii) C_6H_5COOH + CH_3OH → $C_6H_5COOCH_3$

C_6H_5COOH: $m = 5.0g$, $gfm = 122g$, $n = \frac{m}{gfm} = \frac{5}{122} = 0.04098$

CH_3OH: $m = 2.5g$, $gfm = 32g$, $n = \frac{m}{gfm} = \frac{2.5}{32} = 0.078125$

Mole ratio: C_6H_5COOH : CH_3OH

1 mol : 1 mol

0.04098 needs 0.04098

actual 0.078125

As there is more CH_3OH than needed this is in excess and C_6H_5COOH is limiting.

iii)

Benzoic acid	Cost
500g	£39.80
5g	x

$x = \frac{39.80 \times 5}{500} = £0.398$

Methyl benzoate	Cost
3.1g	0.398
100g	x

$x = \frac{0.398 \times 100}{3.1} = £12.84$

5) Open ended question

6 a.) i) hydrolysis

[Ester broken down is hydrolysis
Retinyl palmitate is an ester]

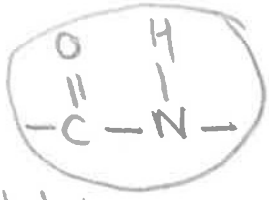
ii) $C_{20}H_{29}OH$ or $C_{20}H_{30}O$

b.) i) Bond breaking by UV light

ii) propagation

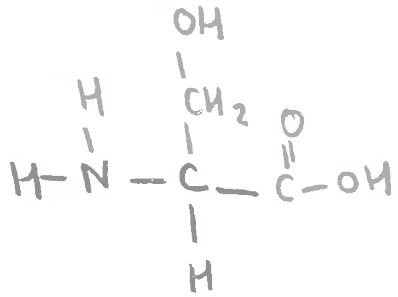
iii) can react with free radicals forming stable molecules / prevent chain reaction

c.) i) circle any



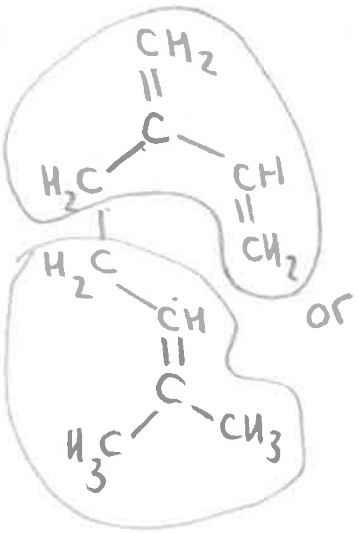
* Full must be circled *

ii)



[Look for the only 1 amino acid in the chain.
There is 2 threonine and 2 lysine]

7 a.) i)



or

Circle either one

ii) Sesquiterpene (3 isoprene units)

[15 carbons ÷ 5 = 3 units]

7 b) i)

Dose	Mass
1 dose →	10.68 mg
500 000 doses →	x

$x = 5345000\ mg$

$= 5345\ g$

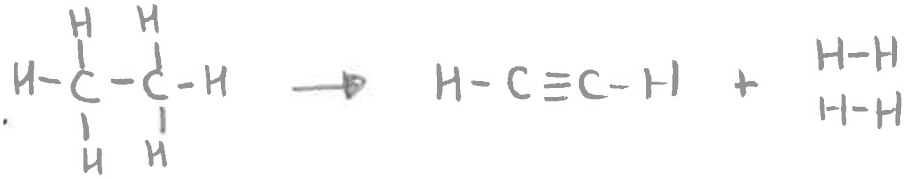
$= 5.345\ kg$

ii) 6 [6 double bonds]

c) i) Addition or hydration

ii) Terpineol is a tertiary alcohol (⇒ cannot be oxidised)

8 a)



p10 of data book

Bond breaking

C-C × 1 = 1 × 348 = 348

C-H × 6 = 6 × 412 = 2472

+ 2820

(endothermic)

Bond Making

C≡C × 1 = 1 × 838 = 838

C-H × 2 = 2 × 412 = 824

H-H × 2 = 2 × 436 = 872

− 2534

(exothermic)

$\Delta H = \Sigma \Delta H_{\text{bonds broken}} + \Sigma \Delta H_{\text{bonds made}}$

$= 2820 + (-2534)$

$= +286\ kJ\,mol^{-1}$

8b.) TE: $3C(s) + 2H_2(g) \rightarrow C_3H_4(g)$

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -394\ kJmol^{-1}$] x3

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ $\Delta H = -286\ kJmol^{-1}$] x2

$C_3H_4(g) + 4O_2(g) \rightarrow 3CO_2(g) + 2H_2O(l)$ $\Delta H = -1939\ kJmol^{-1}$] (-1)

$3C(s) + 3O_2(g) \rightarrow 3CO_2(g)$ $\Delta H = -1182\ kJmol^{-1}$

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ $\Delta H = -572\ kJmol^{-1}$

$3CO_2(g) + 2H_2O(l) \rightarrow C_3H_4(g) + 4O_2(g)$ $\Delta H = +1939\ kJmol^{-1}$

$3C(s) + 2H_2(g) \rightarrow C_3H_4(g)$

$\Delta H = -1182 - 572 + 1939$

$= \underline{+185\ kJmol^{-1}}$

c.) i) $40g \rightarrow -1939\ kJmol^{-1}$

$1000\ g \rightarrow x$

$40x \rightarrow -1939 \times 1000$

$x \rightarrow \frac{-1939 \times 1000}{40}$

$x = \underline{-48475\ kJmol^{-1}}$

[Remember: Enthalpy of combustion is the energy released when 1 mole of substance burns in oxygen

1 mole = gfm]

cii) $C_3H_4(g) + 4O_2(g) \rightarrow 3CO_2(g) + 2H_2O(l)$

$m = 1g$ $\quad m = ?$ $\quad m = n \times gfm$

$gfm = 40g$ $\quad gfm = 32g$ $\quad = 0.1 \times 32$

$n = \frac{1}{40}$ $\quad n = 0.1$ $\quad = \underline{3.2g}$

$= 0.025$

Mole ratio: $C_3H_4 : 4O_2$

$1mol : 4mol$

$0.025 : 0.1$

Mass of air = 4.3 x mass of oxygen

$= 4.3 \times 3.2$

$= \underline{13.76g}$

iii) Methanol and ethanol contain oxygen => (less additional oxygen needed)

9a.i) - recycle waste gases
- use catalyst
- reduce energy
- use low temp
- use inexpensive feedstock
- use by-product

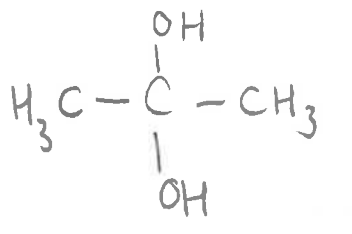
} any from this list

9a)ii) Distillation

b.) • Propan-1-ol has fewer hydroxyl graps than ethane-1,2-diol

• Less hydrogen bonding between propan-1-ol

c.) Any from the following: (diol = 2 OH graps)



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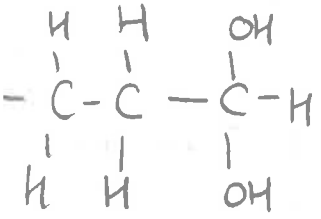

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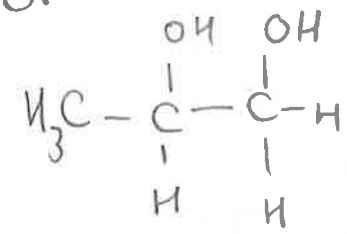

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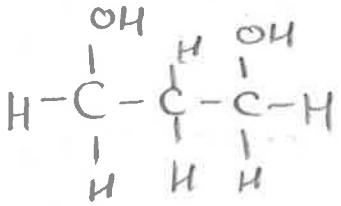


d)i) -Use pipette to measure $20cm^3$ of ethanol

-Use volumetric flask to make up to $100cm^3$

ii)

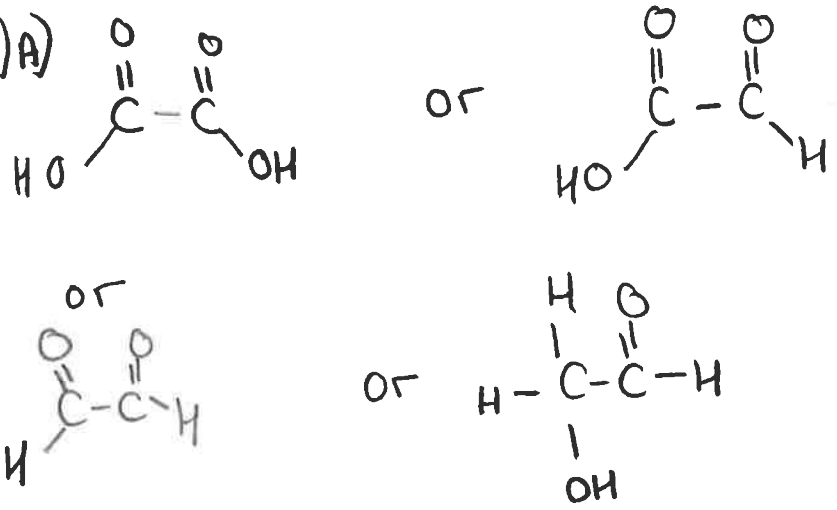
Volume	mass
$5cm^3$	1kg
x	3.5kg

$x = 17.5cm^3$

9 doses $= 9 \times 17.5$

$= 157.5cm^3$

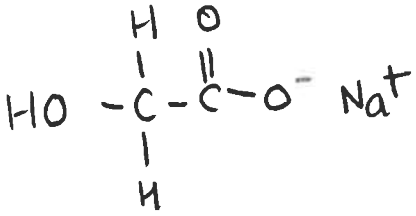
9 d(iii) A)



or

or

B.)



10. Open ended question-

11 a.) • "Tare" balance with container then weigh added sample

or

• Weigh by difference

or

• Weigh container, then weigh container and sample, then subtract the mass of container

b.) $2I_{(aq)} \longrightarrow I_{2(aq)} + 2e^-$

reduction - written as is

$2I_{(aq)} + Br_{2(aq)} \longrightarrow I_{2(aq)} + 2Br^-_{(aq)}$

oxidation (flipped)

Check p12 of the data booklet for this question

Reduction - written as on p12

oxidation - flipped

11c.)i) $\frac{9.4+9.6}{2} = 9.5\,cm^3$ [Do not use first titre as it is a rough titre]

ii) $\underline{I_{2(aq)}} + \underline{2Na_2S_2O_3(aq)} \rightarrow 2NaI_{(aq)} + Na_2S_4O_{6(aq)}$

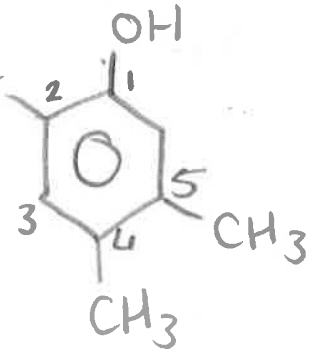
$V = 9.5cm^3$
$\div 1000$
$= 0.0095L$
$C = 0.001 mol L^{-1}$

$n = CV$
$= \underline{9.5 \times 10^{-6}}$

Mole ratio: $I_{2(aq)} : 2Na_2S_2O_3$
$1mol : 2mol$
$x : 9.5 \times 10^{-6}$
$x = 4.75 \times 10^{-6}$ moles

12a.)i) • More chlorines
• More carbons / longer hydrocarbon chain
[problem solving]

ii) 2-chloro-4,5-dimethylphenol



12 b.i) $C_6H_6 + H_2SO_4 + 2NaOH \rightarrow C_6H_5OH + Na_2SO_3 + 2H_2O$

C_6H_6: gfm = 78g, m = 117kg = 117000g

$n = \frac{m}{gfm}$

= 1500moles

C_6H_5OH: gfm = 94g, n = 1500moles

$m = n \times gfm$

= 141000g ← Theoretical

mole ratio: C_6H_6 : C_6H_5OH

1mol : 1mol

1500moles : 1500moles

$$\% \text{ Yield} = \frac{\text{Actual}}{\text{Theoretical}} \times 100$$

$$90 = \frac{x}{141000} \times 100$$

$$\frac{90}{100} = \frac{x}{141000}$$

$$x = \frac{90}{100} \times 141000$$

$$= 126900g$$

ii) Propanone