JINJA JOINT EXAMINATIONS BOARD
MOCK EXAMINATIONS 2023

CHEMISTRY P525/1

(MARKING GUIDE)

JIEB DRAFT MARKING GUIDE-2023

1(a) Relative atomic mass – is the mass of an atom of an element measured relative to a $\frac{1}{12}$th mass of an atom of Carbon-12 isotope. ✓ (01)

(b) R.A.M of X $= \frac{(70 \times 20.55) + (72 \times 27.37) + (73 \times 7.67) + (74 \times 36.74) + (75 \times 7.67)}{20.55 + 27.37 + 7.67 + 36.74 + 7.67}$ ✓

$= \frac{1438.5 + 1970.64 + 559.91 + 2718.76 + 575.25}{100} = \frac{7263.06}{100}$ ✓

$= 72.63$ ✓ deny (½ mrk) if (g) unit is indicated (02)

(c) Positive ions of X are produced by ✓
– heating the gaseous atoms ✓
– passing gaseous atoms through an electric spark ✓ (01)
– Collision of gaseous atoms with fast moving electrons.

accept any two methods @ ½ mrk (04)

2(a) blue solution ✓ turns brown ✓, white solid ✓ (03)

$2Cu^{2+}_{(aq)} + 4I^-_{(aq)} \rightarrow Cu_2I_{2(s)} + I_{2(aq)}$ ✓✓

(b) Purple solution ✓ (0½)

$5PbO_{2(s)} + 4H^{+}_{(aq)} + 2Mn^{2+}_{(aq)} \longrightarrow 2MnO^{-}_{4(aq)} + 5Pb^{2+}_{(aq)} + 2H_2O_{(l)}$

(0½)

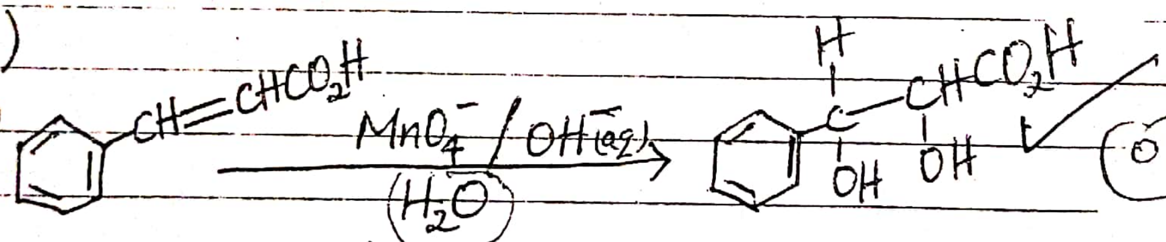
3 (a) Carbon – Carbon double bond ✓ rej double bond, alkene

Carboxyl / Carboxylate group ✓ (01)

rej carboxylic, hydroxyl group, Carbonyl,

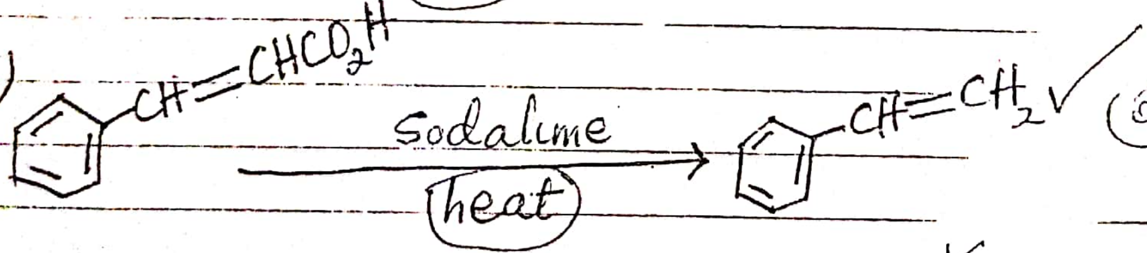
(b)

(i)



(01)

(ii)



(01)

(c) Purple solution turns Colourless ✓ (01)

brown solid ✓

[04]

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4 a) i, Let oxidation state of Al = x

$4x + 3(+4) = 0$ ✓

$x = +3$ ✓ (01)

ii) Let oxidation state of Cr = Y

$2(Y) + 7(-2) = -2$ ✓

$Y = +6$ ✓ (01)

iii) Let oxidation state of I = z

$z + 3(-2) = -1$ ✓

$z = +5$ ✓ (01)

b) i, $Al_4C_{3(s)} + 12H_2O_{(l)} \longrightarrow 4Al(OH)_{3(s)} + 3CH_{4(g)}$ ✓✓

ii) $Cr_2O_7^{2-} + 4H_2O_{2(aq)} + 2H^+_{(aq)} \longrightarrow 2CrO_{5(aq)} + 5H_2O_{(l)}$ ✓✓

iii) $IO_{3(aq)}^- + 5I^-_{(aq)} + 6H^+_{(aq)} \longrightarrow 3I_{2(aq)} + 3H_2O_{(l)}$ ✓✓

07½

5 a) Melting points of the oxides increases ✓ from $Na_2O \rightarrow MgO$ and then decreases ✓ from $MgO \rightarrow Cl_2O_7$ (01)

b) Na_2O, MgO adopt a giant ionic structure ✓ but Mg^{2+} has a higher charge than Na^+ as a result, the electrostatic forces of attraction between Mg^{2+} and O^{2-} are stronger ✓ than Na^+ and O^{2-} requiring a greater amount of energy ✓ to break the ionic bond in MgO

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— 6 4p —

Al_2O_3 is an ionic compound with a more covalent character due to the higher charge density of Al^{3+} ions making it lower than that of MgO.

SiO_2 adopts a giant covalent structure composed of Silicon and oxygen atoms held by strong covalent bonds which require a smaller amount of energy to break compared to the bonds in Al_2O_3.

P_4O_{10}, SO_3 and Cl_2O_7 are simple covalent molecules held by weak Vanderwaals forces of attraction which require a smaller amount of energy to break. 04

05

6 i) $CH_3-CH(CH_3)-COOH \xrightarrow{LiAlH_4 \text{ in dry ether}} CH_3-CH(CH_3)-CH_2OH$

$CH_3-CH(CH_3)-CH_2OH \xrightarrow{SOCl_2 \text{ in Pyridine}} CH_3-CH(CH_3)-CH_2Cl$

accept any correct PCl_5 or PCl_3, anhydrous $ZnCl_2$ / conc HCl (02)

ii) $C_6H_5NO_2 \xrightarrow[\text{ii) } NaOH(aq), \text{heat or } Na_2CO_3(aq)]{\text{i) } Sn/\text{conc } HCl} C_6H_5NH_2$

$C_6H_5NH_2 \xrightarrow[0-5^\circ C]{NaNO_2(aq)/\text{conc } HCl} C_6H_5N_2^+Cl^-$

$C_6H_5N_2^+Cl^- \xrightarrow[H^+/H_2O, \text{warm}]{H_2O, 50^\circ C} C_6H_5OH$ (03)

rej $LiAlH_4$ in dry ether for (ii)

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7 (a)(i) 

$_{(aq)} + H_2O_{(l)} \rightleftharpoons$ 

$_{(aq)} + H_3O^+_{(aq)}$ ✓ ✓ (01½)

(ii) $K_a = \dfrac{[\text{C}_6\text{H}_5\text{CH}_2\text{COO}^-][H_3O^+]}{[\text{C}_6\text{H}_5\text{CH}_2\text{CO}_2\text{H}]}$ ✓ (01)

b(i) $pH = -\log[H^+]$ ✓

No of moles of H^+ ions in solution $= \left(\dfrac{0.2 \times 50}{1000}\right)$

$= 0.01$ ✓ (01½)

$pH = -\log(0.01)$

$= 2$ ✓

(ii) $pH = pK_a + \log \dfrac{[\text{salt}]}{[\text{acid}]}$ ✓

Total volume of solution $= 50 + 20 = 70 cm^3$ ✓

No of moles of acid $= \dfrac{0.01 \times 70}{50} = 0.014$

No of moles of salt $= \left(\dfrac{0.2 \times 20}{1000}\right) \times \dfrac{70}{20} = 0.014$

$pH = -\log(5.2 \times 10^{-5}) + \log\left(\dfrac{0.014}{0.014}\right)$

$pH = 4.284$ ✓

change in pH $= 4.284 - 2 = 2.284$ ✓

8 (a) (i) Eutectic mixture; A liquid mixture which on cooling at constant pressure forms a solid with the same composition as the liquid mixture. (OR) A solid mixture which on heating at constant pressure forms a liquid with the same composition as the solid mixture. ✓ (01)

(ii) ✓ The composition of an eutectic mixture changes with a change in pressure. ✓ ✗
✓ Eutectic mixture is heterogenous ✓ ✗ (01)
✓ Eutectic mixture can be separated into pure components by physical or chemical methods

(accept any two correct reasons)

(b) (i) P; Liquid ✓ ✗
Q; (Solid Water / ice) and Liquid mixture of H_2O/$NaNO_3$ ✓
R; Solid $NaNO_3$ and Liquid mixture of H_2O/$NaNO_3$ ✓
S; Solid water + Solid $NaNO_3$ ✓ ✗ (02)

(ii) AE; depression / lowering of freezing point of water as more sodium nitrate is added ✓ ✓ (solubility curve of $NaNO_3$ in water) 1
BE; Variation of solubility of $NaNO_3$ with temperature ✓ ✓
BE (solubility curve of $NaNO_3$ in water)

(iii) At E Liquid mixture solidifies forming pure crystals of ice and $NaNO_3$ with same composition as liquid mixture at constant temperature. ✓ ✓ 1

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9 a) Volume of CO_2 produced = $120cm^3$, Volume of O_2 used = $200-20$ ✓
$= 180cm^3$ ✓

$20x = 120$ ✓
$x = 6$ ✓

$20(6 + y/4) = 180$

$120 + 5y = 180$

$y = 12$ ✓ (02)

Molecular formula of P is C_6H_{12} ✓

b) $C_6H_{12} \xrightarrow[\text{heat, } 600°C]{Al_2O_3/Cr_2O_3}$ ✓ ✓ (01)

03

SECTION – B (54 MARKS)

10. a) Titration / titrimetric method ✓
Calorimetry ✓
Conductivity measurements ✓
Measurement of Pressure, colour intensity
Spectrometry
(accept any three correct methods) (01½)

b(i) axes Labelled with Units ✓ each @ ½ (01)
plotting ✓
Shape ✓

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(ii) $T_{1/2} = \frac{191.25 + 202.5}{2} = \frac{393.75}{2}$

Average $(T_{1/2}) = 196.88\ s$ ✓ (1½)

The graph is a curve showing an exponential decrease of $[Br_2]$ with time and $T_{1/2}$ is nearly constant. ✓

(iii) $\lambda = \frac{\ln 2}{T_{1/2}}$ ✓

$\lambda = \frac{0.693}{196.88} = 3.52 \times 10^{-3}\ s^{-1}$ ✓ ✓ ✓ (2½)

[09]

(To be fastened together with other answers to paper)

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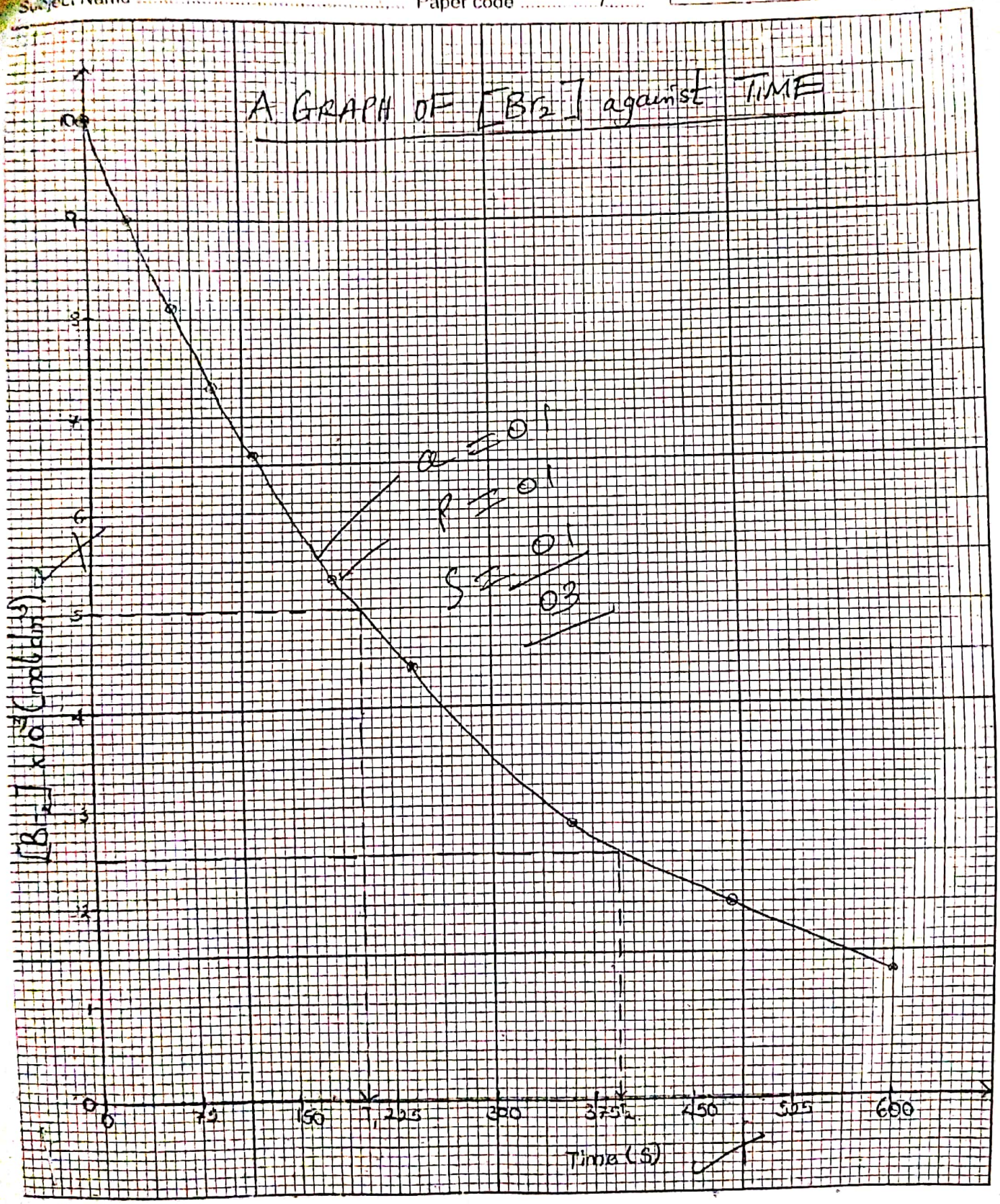

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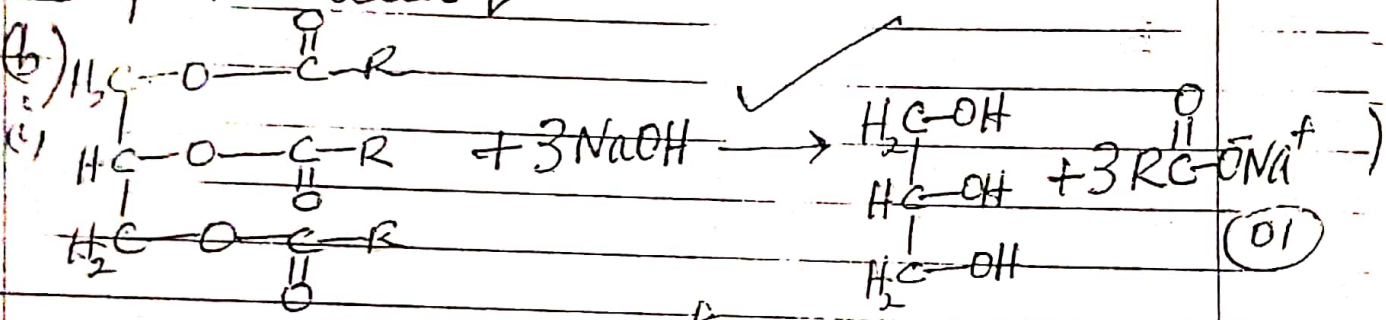
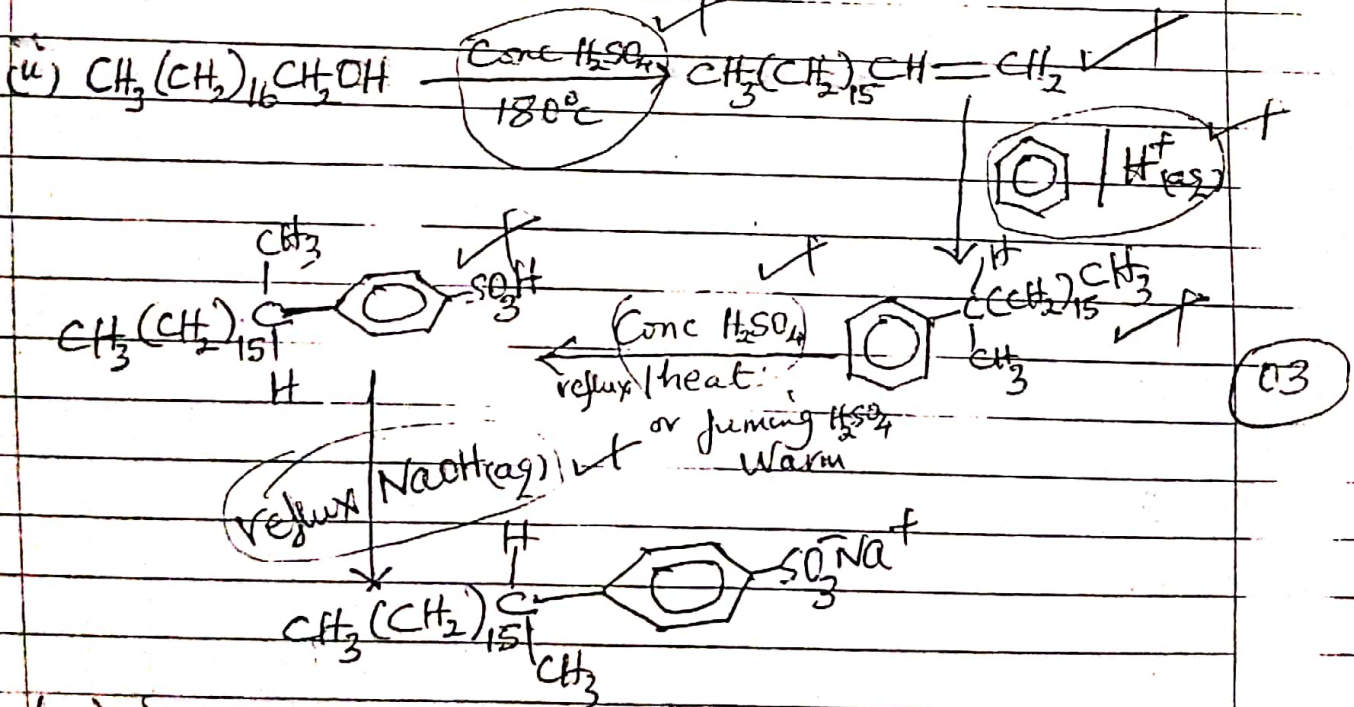
II (a) Soap is a sodium salt of a long chained alkanoic acid ✓ whereas a soapless detergent is a sodium salt of a long chained alkylated aromatic/benzene sulphonic acid ✓ (02)

(b) (i)



(01)

(ii)



(03)

(c) (i) Soap reacts calcium or Magnesium ions in hard water to form scum ✓ as result its uneconomical to use soap for cleaning fabric as more soap is used to form foam ✓ (01½)

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c(i) The solubility of soap is reduced in strongly acidic solutions, because the hydrogen ions from the acidic solution react with the alkanoate ion from soap solution to form more soap. This causes soap wastage. (01½) [09]

12(a) i) % by mass of oxygen = 100 − (60.0 + 13.3)
= 26.7

	C	H	O
No of moles	$\frac{60}{12}$	$\frac{13.3}{1}$	$\frac{26.7}{16}$
	5	13.3	1.669
mole ratio	$\frac{5}{1.669}$:	$\frac{13.3}{1.669}$:	$\frac{1.669}{1.669}$ (02)
	3 :	8 :	1

Empirical formula of G is C_3H_8O

(ii) 100g of water dissolved 6.98 g of G
1000g of water dissolves $\left(\frac{6.98}{100} \times 1000\right)$ g of G
= 69.8 g
1.90°C is the freezing point depression caused by 69.8 G

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1.63°C is the freezing point depression caused by $\left(\frac{69.8 \times 1.63}{1.90}\right)$ g of G

$= 59.88 \approx 60$ ✓

$(C_3H_8O)_n = 60$

$(12 \times 3n) + 8n + 16n = 60n = 60$ (02½)

$n = 1$ ✓

∴ Molecular formula of G $\equiv C_3H_8O$ ✓

(b) i) $CH_3-\underset{OH}{CH}-CH_3$ ✓ Propan-2-ol ✓ (01)

ii) $CH_3-\underset{OH}{CH}-CH_3 \xrightarrow[\text{Warm}]{I_2 / NaOH(aq)} CH_3COOH + ICH_3$ ✓ ✓ (01)

(c) $CH_3-\underset{OH}{CH}-CH_3 \longrightarrow CH_3-\underset{OPO_3H_2}{CH}-CH_3 + OPO_3H_2$ ✓

$OH \longrightarrow H-OPO_3H_2$ or H^+ ✓

$-H_2O$ ✓

$CH_3-\underset{+}{CH}-\underset{H}{CH_2}$ ✓ ✓ (2½)

$-H^+$ ✓

$CH_3CH=CH_2 + H_3PO_4$

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Q1B (a) Specific conductivity, is the conductance of an aqueous solution of electrolyte between two parallel electrodes of cross-sectional area $1cm^2$ or $1M^2$ placed 1cm or 1m distance apart. ✓

Equivalent conductivity: is the conductance of an aqueous solution containing one mole of electrolyte between two parallel electrodes of cross-sectional area $1cm^2$ placed 1cm distance apart. ✓ (02)

(b) i, • Temperature of solution of electrolyte ✓
• nature of electrolyte ✓
• Concentration/ dilution of electrolyte
• degree of ionisation of weak electrolyte
• ionic (mobility / interference / distance), (01)

accept any two correct factor @ ½

(ii) Temperature, increase in temperature increases Specific conductivity due increased ionic mobility ✓

dilution, Specific conductivity increases with increase in dilution until it becomes nearly constant. ✓ (03)
due to increased interionic distance/reduced ionic interference hence increased ionic mobility (for strong electrolytes) / due to increased degree of ionisation for weak electrolytes

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(c) (i) $\Lambda_{o\,AgCl} = (\Lambda_{o\,AgNO_3} + \Lambda_{o\,KCl}) - \Lambda_{o\,KNO_3}$ ✓

$= (133.4 + 149.9) - 145$ ✓ (C1½)

$= 138.3$ ✓

(ii) $K_{solution\ of\ AgCl} = (3.41 \times 10^{-6}) - (1.60 \times 10^{-6}) = 1.81 \times 10^{-6}$ ✓

$\Lambda_{AgCl} = \frac{1000K}{S}$

$S = \left(\frac{1000 \times 1.81 \times 10^{-6}}{138.3}\right)$ ✓ (1½)

$= 1.31 \times 10^{-5}$ ✓ $mol\,dm^{-3}$

$K_{sp\ of\ AgCl} = (1.31 \times 10^{-5})^2$

$= 1.72 \times 10^{-10}$ ✓ $mol^2 dm^{-6}$

09

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14 a) i) Electronic configuration of chromium;
$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$ ✓ (01)
rej [Ar] $4s^1 3d^5$; $4s^2 3d^4$

ii) +3 ✓, +6 ✓ (01)

iii) CrO_3 ✓, Cr_2O_3 ✓, CrO ✓ (01½)

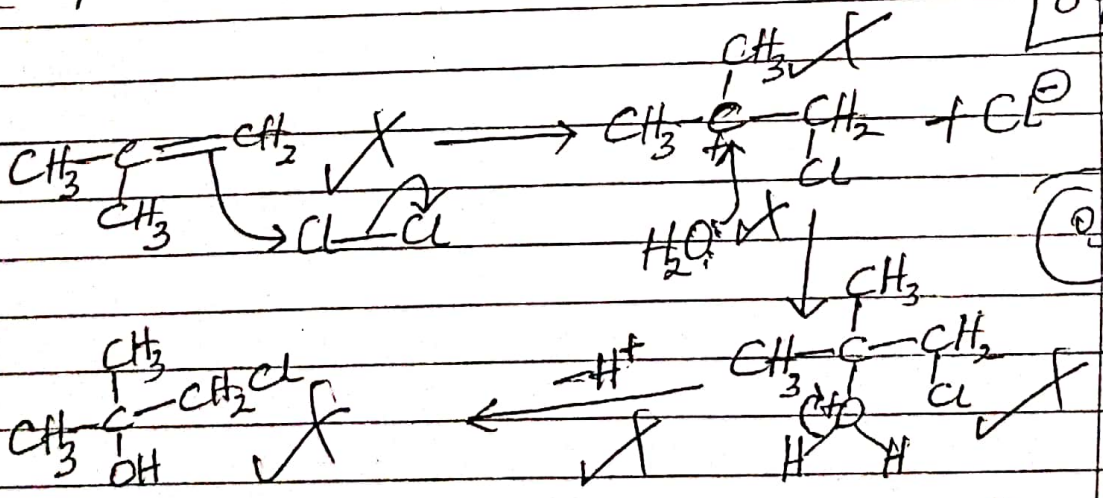
b) i) Orange solid ✓ turns green ✓, Colourless vapour ✓ (03)

ii) $(NH_4)_2Cr_2O_{7(s)} \longrightarrow Cr_2O_{3(s)} + N_{2(g)} + 4H_2O_{(g)}$ ✓✓
Green solid dissolves ✓ forming a green solution ✓ (01)

c) $Cr_2O_{3(s)} + 6OH^-_{(aq)} + 3H_2O_{2(l)} \longrightarrow 2Cr(OH)_6^{3-}{}_{(aq)}$ ✓✓ (01½)
(accept any other correct alternative eqn.)

[09]

15 a)



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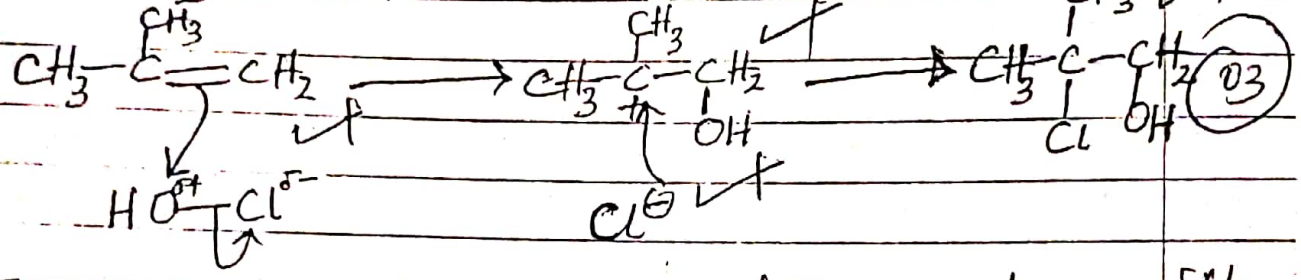
OR. $HO + Cl_2 \rightleftharpoons HOCl + HCl$ ✓



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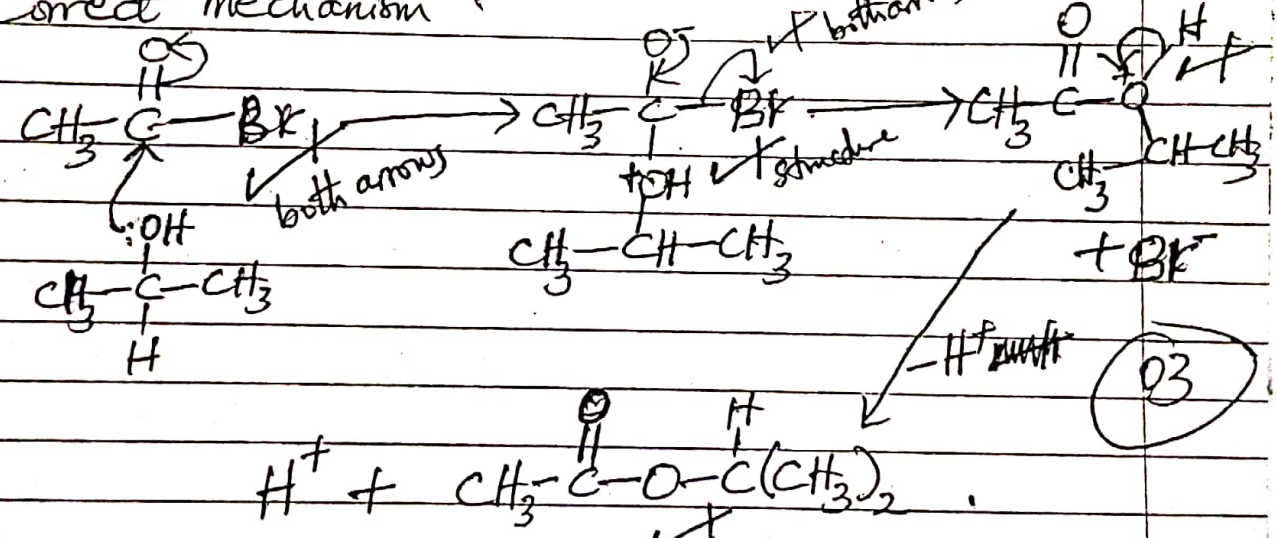
[note there two different products] accept any with corect mechanism.

(b)



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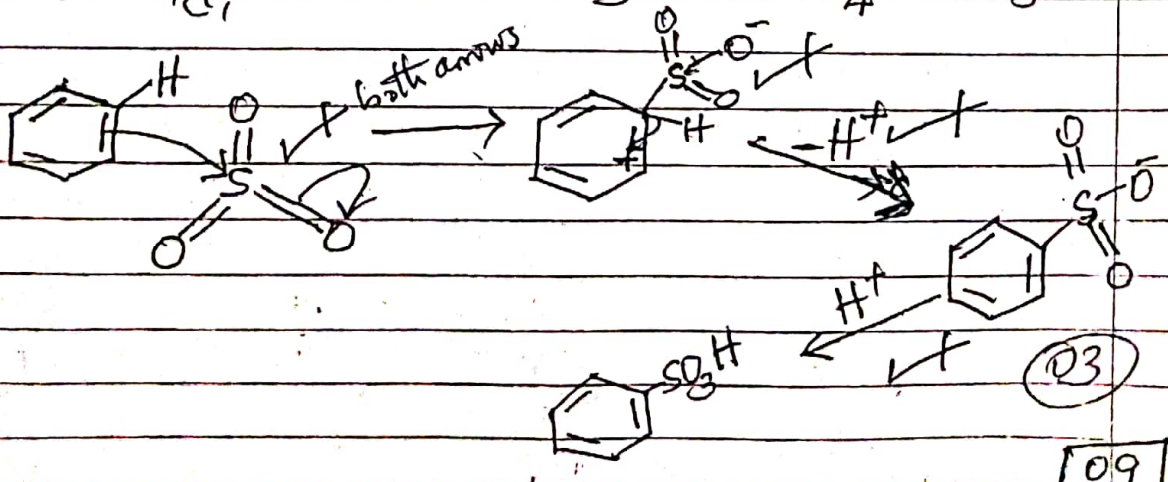
(c) $2H_2SO_{4(l)} \rightleftharpoons SO_3 + HSO_4^- + H_3O^+$ ✓



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16 (a) (i) $Al_2O_3 \cdot 2H_2O$ ✓, Bauxite ✓ or Aluminium (III) oxide dihydrate ✓ (01)

reject $Al_2O_3 \cdot nH_2O$, name without (correct formula)

(ii) Iron (III) oxide ✓, Titanium (IV) oxide ✓ and Silicon (IV) oxide / Silicon dioxide ✓ (01½)

(b) Bauxite is roated to drive off water, then the ore is reacted with concentrated sodium hydroxide solution to dissolve Aluminium oxide and Silicon (IV) oxide. Iron (III) oxide and other materials remain insoluble.

$$Al_2O_{3(aq)} + 2OH^-_{(aq)} + 3H_2O_{(l)} \longrightarrow 2Al(OH)^-_{4(aq)}$$

$$SiO_{2(s)} + 2OH^-_{(aq)} \longrightarrow SiO^{2-}_{3(aq)} + H_2O_{(l)}$$

The mixture is the filtered and then seeded by adding freshly prepared aluminium hydroxide or passing Carbon dioxide gas to precipitate Aluminium (III) oxide.

$$2Al(OH)^-_{4(aq)} + CO_{2(g)} \longrightarrow 2Al(OH)_{3(s)} + CO^{2-}_{3(aq)} + H_2O_{(l)}$$

Aluminium (III) oxide is heated to obtain pure Al_2O_3.

$$2Al(OH)_{3(s)} \longrightarrow Al_2O_{3(s)} + 3H_2O_{(l)}$$

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observation:

(c) White solid/ppt ✓ and bubbles ✓ of colourless effervescence gas. (01)

Eqn: $2Al(H_2O)_{6(aq)}^{3+} + 3CO_{3(aq)}^{2-} \rightarrow 3CO_{2(g)} + 2Al(OH)_{3(s)} + 9H_2O_{(l)}$ ✓ ✓ (01½)

09

(17) a) SEP – is the potential difference between an element and its solution containing one mole per dm^3 of its ions measured at 1atm pressure and 25°C temperature. (01)

(b)

$M_{(s)} \xrightarrow{E^{\ominus}(V)} M^{n+}_{(aq)} + ne^-$

$M_{(s)} \xrightarrow{\text{atomisation/sublimation energy}} M_{(g)} \xrightarrow{\text{Ionisation energy}} M^{n+}_{(g)} + ne^-$

$M^{n+}_{(g)} \xrightarrow{\text{Hydration energy}} M^{n+}_{(aq)}$ (01½)

(States should be included to score for the energy change)

(c)

(i) $Pt_{(s)} / H_2S_{(g)} / S_{(s)} / H^+_{(aq)} // Cr_2O_7^{2-}{}_{(aq)}, H^+_{(aq)}, Cr^{3+}_{(aq)}, H_2O_{(l)} / Pt_{(s)}$ (01)

accept without H_2O

(ii) $Cr_2O_7^{2-}{}_{(aq)} + 3H_2S_{(g)} + 8H^+_{(aq)} \rightarrow 3S_{(s)} + 2Cr^{3+}_{(aq)} + 7H_2O_{(l)}$ (01½)

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(d) $\Delta G = -nFE^{\ominus}$ ✓

$E^{\ominus}$ of cell $= +1.36 - 0.14$

$= +1.22$ V ✓

$\Delta G = -[6 \times 96500 \times 1.22]$ ✓

$= -706,380$ (Jmol^{-1}) ✓ (03)

deny if wrong unit is indicated or no unit

(e) The cell reaction is feasible ✓ because Gibb's free energy is negative / emf of cell reaction is positive. ✓ (01)

END