

Edwest Year 12 Chemistry Solutions 2002**Part 1**

1	c	11	d	21	d
2	a	12	b	22	a
3	c	13	c	23	b
4	d	14	b	24	a
5	b	15	c	25	b
6	b	16	c	26	c
7	a	17	d	27	b
8	c	18	a	28	b
9	b	19	c	29	b
10	c	20	c	30	c

[30]

Part 2

- 1 (a) $2\text{Cr}^{3+}_{(aq)} + 3\text{CO}_3^{2-}_{(aq)} \longrightarrow \text{Cr}_2(\text{CO}_3)_3(s)$
green ppt. formed [3]
- (b) $\text{Cr}(\text{OH})_3(s) + \text{OH}^{-}_{(aq)} \longrightarrow \text{Cr}(\text{OH})_4^{-}_{(aq)}$
white solid dissolves [3]
- (c) $\text{Cr}_2\text{O}_7^{2-}_{(aq)} + 2\text{OH}^{-}_{(aq)} \longrightarrow 2\text{CrO}_4^{2-}_{(aq)} + \text{H}_2\text{O}$
solution turns from orange to yellow [3]
- (d) $\text{Cr}_2\text{O}_7^{2-}_{(aq)} + 3\text{C}_2\text{H}_5\text{OH}_{(aq)} + 8\text{H}^{+}_{(aq)} \longrightarrow 3\text{CH}_3\text{CHO}_{(aq)} + 2\text{Cr}^{3+}_{(aq)} + 7\text{H}_2\text{O}$
solution turns from orange to green [3]

2

Description	Names	
Form weakly acidic solutions in water.	ethanoic acid	ammonium nitrate
Show geometric (<i>cis/trans</i>) isomerism.	2-butene	1,2-dichloro-1-pentene
Are coloured.	iron (II) hydroxide	iodine
Are involved in the processing of bauxite.	sodium hydroxide	aluminium hydroxide
Form hydrogen bonds.	ethanoic acid	ammonia
Have a total of 9 atoms in their formula.	ammonium nitrate	1,1,2-trichloropropene

[12]

- 3 (a) $[\text{H}^{+}] = 0.01 \times 2 = 0.02$ $\text{pH} = -\log[\text{H}^{+}]$
 $= -\log 0.02 = \underline{1.7}$ [1]
- (b) $[\text{OH}^{-}] = 2.0$ $[\text{H}^{+}][\text{OH}^{-}] = 10^{-14}$
 $[\text{H}^{+}] = 10^{-14}/2.0 = 5 \times 10^{-15}$
 $\text{pH} = -\log(5 \times 10^{-15}) = \underline{14.3}$ [2]

4

change	position	Explanation
Increased Temperature	To right	Forward reaction endothermic.
Reduce the volume	No change	Equal number of moles of gaseous products and reactants
Remove some of the NO(g)	To right	Conc. of NO reduced so reverse reaction reduced. OWTTE

[6]

- 5 $K = \frac{[\text{CoCl}_4]}{[\text{Co}(\text{H}_2\text{O})_6^{2+}][\text{Cl}^{-}]^4}$ [2]

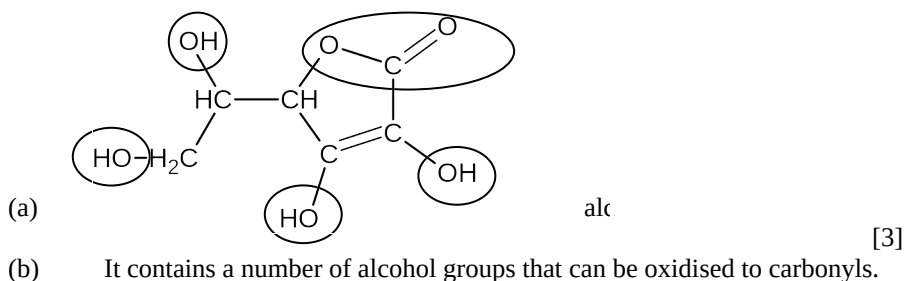
6.

(a)
Oxidation: $2\text{Br}^{-}_{(aq)} \longrightarrow \text{Br}_{2(l)} + 2\text{e}^{-}$
Reduction: $\text{MnO}_4^{-}_{(aq)} + 8\text{H}^{+}_{(aq)} + 5\text{e}^{-} \longrightarrow \text{Mn}^{2+}_{(aq)} + 4\text{H}_2\text{O}_{(l)}$:
Overall: $2\text{MnO}_4^{-}_{(aq)} + 16\text{H}^{+}_{(aq)} + 10\text{Br}^{-}_{(aq)} \longrightarrow 2\text{Mn}^{2+}_{(aq)} + 5\text{Br}_{2(l)} + 8\text{H}_2\text{O}_{(l)}$

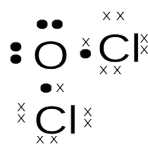
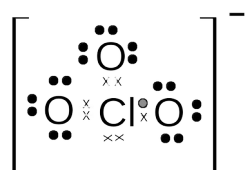
[3]

- (b) required to facilitate the reduction of MnO_4^{-} (as seen in above reaction) [1]
- (c) bromine and carbon tetrachloride are both non-polar compounds
therefore intermolecular bonding relies on dispersion forces
therefore interactions within mixture are similar to those within pure substances [3]

7.



8.

Species	Electron dot diagram	Shape (sketch or name)	Polarity
Cl ₂ O		bent/non-linear	polar
ClO ₃ ⁻		(trigonal) pyramidal	polar

[6]

9.

CH₃CH₂CH₂CHO butanal
 or CH₃CH(CH₃)CHO 2-methylpropanal

CH₃COCH₂CH₃ butanone
 CH₃CH(CH₃)CHO 2-methylpropanal



[6]

10.

- (a) $C + CO_2 \rightarrow 2 CO$ [1]
 (b) calcium oxide (quick lime) and silicon oxide (silica) (names needed) [1]
 (c) chromium (Cr) nickel (Ni) [1]
 (d) reduce reactivity [1]

11.

- (a) $Ni^{2+}_{(aq)} + 2e^- \rightarrow Ni_{(s)}$ $E^\circ = -0.26 V$
 $Zn^{2+}_{(aq)} + 2e^- \rightarrow Zn_{(s)}$ $E^\circ = -0.76 V$
 $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$ $E^\circ = +0.76 V$ $E^\circ(\text{cell}) = -0.26 + 0.76 = \underline{+0.50 V}$ [2]
- (b) electrons move from Zn to Ni [1]
 (c) solid zinc dissolves
 green colour of solution fades
 Zn coated with Ni (2 of these gets full marks) [2]
- (d) Zn is a stronger reducing agent than Ni. (as shown by the redox potentials)
 or E° for the reaction: $Zn_{(s)} + Ni^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Ni_{(s)}$ is positive. [2]

1. (a) Butane:
 $m(\text{C}_4\text{H}_{10})$ burned per hour = $500\text{g}/150 = 3.33\text{g}$
 $M(\text{C}_4\text{H}_{10}) = 58.12$
 $n(\text{C}_4\text{H}_{10}) = 3.33/58.12 = 0.05735$
 $n(\text{O}_2) = (13/2) \times n(\text{C}_4\text{H}_{10})$
 $= (13/2) \times 0.05735 = \underline{0.373 \text{ mol}}$ [3]
Methane:
Equation: $\text{CH}_4 + 2\text{O}_2 \longrightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
Using $PV = nRT$
 $n(\text{CH}_4) = PV/RT = 200 \times 2.4/8.315 \times 293 = 0.197 \text{ mol}$
 $n(\text{O}_2) = (2/1) \times 0.197 = \underline{0.394 \text{ mol}}$ Methane requires more oxygen [3]
- (b) $n(\text{C}_4\text{H}_{10}) = 0.05735 \times 10 \text{ hours} = 0.5735 \text{ mol}$
 $n(\text{CO}_2) = (8/2) \times 0.5735 = 2.294 \text{ mol}$
Using $PV = nRT$
 $v(\text{CO}_2) = nRT/P = 2.294 \times 8.315 \times 293/101.3 = \underline{55.2 \text{ L}}$ [2]
- (c) $n(\text{C}_4\text{H}_{10}) = 0.5735 \text{ mol}$
 $n(\text{H}_2\text{O}) = (10/2) \times 0.5735 = 2.867 \text{ mol}$
 $M(\text{H}_2\text{O}) = 18.016$ $m(\text{H}_2\text{O}) = 18.016 \times 2.867 = \underline{51.7 \text{ g}}$ [2]
2. (a) $M(\text{Na}_2\text{S}_2\text{O}_5) = (22.99 \times 2) + (32.06 \times 2) + (16.00 \times 5) = 190.1$
 $m(\text{Na}_2\text{S}_2\text{O}_5) = 8 \times 0.440\text{g} = 3.52\text{g}$
 $n(\text{Na}_2\text{S}_2\text{O}_5) = 3.52/190.1 = \underline{1.85 \times 10^{-2} \text{ mol}}$ [3]
- (b) $n(\text{SO}_2) = (2/1) \times n(\text{Na}_2\text{S}_2\text{O}_5) = 2 \times 1.85 \times 10^{-2} = \underline{3.70 \times 10^{-2} \text{ mol}}$ [1]
- (c) $m(\text{SO}_2)$ added per litre = $20\text{mg} = 0.020\text{g}$
volume = 100 L
total $m(\text{SO}_2) = 0.020\text{g} \times 100 = 2.00\text{g}$
 $M(\text{SO}_2) = 64.06$ $n(\text{SO}_2) = 2.00/64.06 = \underline{3.122 \times 10^{-2} \text{ mol}}$ [2]
Efficiency = (actual moles/predicted moles) $\times 100$
 $= (3.122 \times 10^{-2}/3.70 \times 10^{-2}) \times 100 = \underline{84 \%}$ [2]
- (d) Increasing the pH will remove $\text{H}^+_{(\text{aq})}$ / reduce $\text{H}^+_{(\text{aq})}$ concentration and hence the equilibrium position will shift to the left so efficiency will be reduced. [2]
3. (a) % by mass = $370/(370 + 890) \times 100 = \underline{29.3 \%}$ [1]
- (b) $Q = 4 \text{ hours} \times 10 \text{ amps} \times 60 \text{ minutes} \times 60 \text{ seconds} = 144\,000 \text{ C}$
 $N(e^-) = 144\,000/9.649 \times 10^4 = \underline{1.492 \text{ mol}}$ [2]
- (c) $n(\text{H}_2\text{SO}_4) = 1.492$ $M(\text{H}_2\text{SO}_4) = 98.076$ $m(\text{H}_2\text{SO}_4) = 1.492 \times 98.076 = \underline{146 \text{ g}}$ [2]
 $n(\text{H}_2\text{O}) = 1.492$ $M(\text{H}_2\text{O}) = 18.016$ $m(\text{H}_2\text{O}) = 1.492 \times 18.016 = \underline{26.9 \text{ g}}$ [1]
- (c) new $m(\text{H}_2\text{SO}_4) = 370 - 146 = 224 \text{ g}$
new $m(\text{H}_2\text{O}) = 890 + 26.9 = 916.9 \text{ g}$ % by mass = $224/(224 + 916.9) \times 100 = \underline{19.6\%}$
Therefore car will not start as % by mass $< 22\%$ [2]
- (e) total $n(\text{H}_2\text{SO}_4) = 370/98.076 = 3.77 \text{ mol}$
volume = 1.08 L
 $c(\text{H}_2\text{SO}_4) = 3.77/1.08 = 3.49 \text{ mol L}^{-1}$
in 100mL $n(\text{H}_2\text{SO}_4) = 3.49 \times (100/1000) = 0.349 \text{ mol}$
 $\text{H}_2\text{SO}_4 + 2\text{NaOH} \longrightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$
 $n(\text{NaOH}) = (2/1) \times n(\text{H}_2\text{SO}_4)$
 $= 2 \times 0.349 = 0.6986$ $V(\text{NaOH}) = n/c = 0.6986/2.00 = \underline{0.349 \text{ L or } 349 \text{ mL}}$ [4]
4. SO_4^{2-} : $M(\text{BaSO}_4) = 233.36$ $M(\text{SO}_4) = 96.06$

$n(\text{BaSO}_4) \text{ in } 25.0 \text{ mL} = 3.58/233.36 = 1.534 \times 10^{-2} \text{ mol}$
 $n(\text{SO}_4) \text{ in } 25.0 \text{ mL} = 1.534 \times 10^{-2} \text{ mol}$
 $n(\text{SO}_4) \text{ in } 250 \text{ mL} = 1.534 \times 10^{-2} \times 10 = 0.1534 \text{ mol}$
 $m(\text{SO}_4) \text{ in original (anhydrous) sample} = 0.1534 \times 96.06 = 14.74$
 $\% (\text{SO}_4) \text{ in original (anhydrous) sample} = (14.74/21.2) \times 100 = \underline{69.5 \%}$

Fe $\%(\text{Fe}) \text{ in anhydrous sample} = 100 - 69.5 = \underline{30.5 \%}$

M	(55.85)	(96.06)	
	<u>Fe</u>	<u>SO₄</u>	
%	30.5 %	69.5%	
n	30.5/55.85	69.5/96.06	
	= 0.546	= 0.723	
ratio	0.546/0.546	0.723/0.546	
	1	1.33	
	3	4	
	<u>x = 3</u>	<u>y = 4</u>	so anhydrous salt = $\text{Fe}_3(\text{SO}_4)_4$

[4]

$M(\text{Fe}_3(\text{SO}_4)_4) = 551.8$ $M(\text{H}_2\text{O}) = 18.016$
 $m(\text{Fe}_3(\text{SO}_4)_4) = 21.2 \text{ g}$ $m(\text{H}_2\text{O}) = 24.0 - 21.2 = 2.8 \text{ g}$

	<u>(Fe₃(SO₄)₄)</u>	<u>H₂O</u>	
mass	21.2g	2.8 g	
n	21.2/551.8	2.8/18.016	
	= 0.0385	= 0.1554	
ratio	0.0385/0.0385	0.1554/0.0385	
	1	4	
		<u>z = 4</u>	so hydrated salt = $\text{Fe}_3(\text{SO}_4)_4 \cdot 4\text{H}_2\text{O}$

[3]

(b) $M(\text{Fe}_3(\text{SO}_4)_4 \cdot 4\text{H}_2\text{O}) = 623.85$ $m(\text{Fe}_3(\text{SO}_4)_4 \cdot 4\text{H}_2\text{O}) = 5.00 \text{ g}$
 $M(\text{Fe}) = 55.85$ efficiency = 75/100
 $m(\text{Fe}) = (55.85 \times 3) / 623.85 \times 5.00 \text{ g} \times (75/100) = \underline{1.01 \text{ g}}$

[3]

5. (a) $n(\text{S}_2\text{O}_3^{2-}) = 0.100 \times 0.0155 = \underline{1.55 \times 10^{-3} \text{ mol}}$ [2]

(b) $n(\text{I}_2) = (1/2) \times n(\text{S}_2\text{O}_3^{2-})$
 $= (1/2) \times 1.55 \times 10^{-3} = 7.75 \times 10^{-4}$ $n(\text{ClO}^-) = \underline{7.75 \times 10^{-4} \text{ mol}}$

[2]

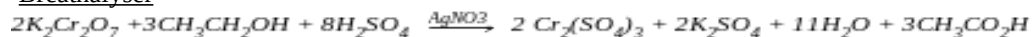
(c) $n(\text{ClO}^-) \text{ in } 250 \text{ mL} = 7.75 \times 10^{-4} \times (250/25) = \underline{7.75 \times 10^{-3} \text{ mol}}$ [1]

(d) $V(\text{bleach}) = 5.00 \text{ mL} = 5.00 \times 10^{-3} \text{ L}$

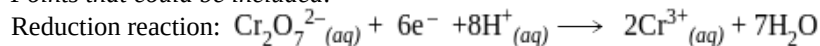
(i) $c = n/V = 7.75 \times 10^{-3} / 5.00 \times 10^{-3} = \underline{1.55 \text{ mol L}^{-1}}$ [1]

(ii) $M(\text{NaClO}) = 74.44$
 $m(\text{NaClO}) = 74.44 \times 7.75 \times 10^{-3} = 0. \text{ g}$
 $\text{concentration} = 0.5769 / 5.00 \times 10^{-3} = \underline{115.4 \text{ g L}^{-1}}$

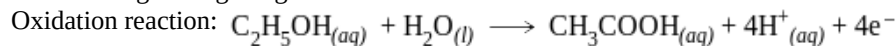
[2]

Part 4 Guidelines for marking.1. Breathalyser

Points that could be included:



colour change orange to green



Sulphuric acid used as a source of hydrogen ions

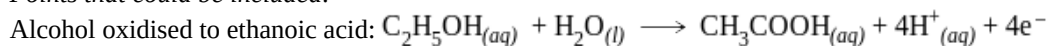
Silver nitrate to catalyse the reaction

Photo cell produces a current based on colour comparison

[max 7]

Fuel Cell

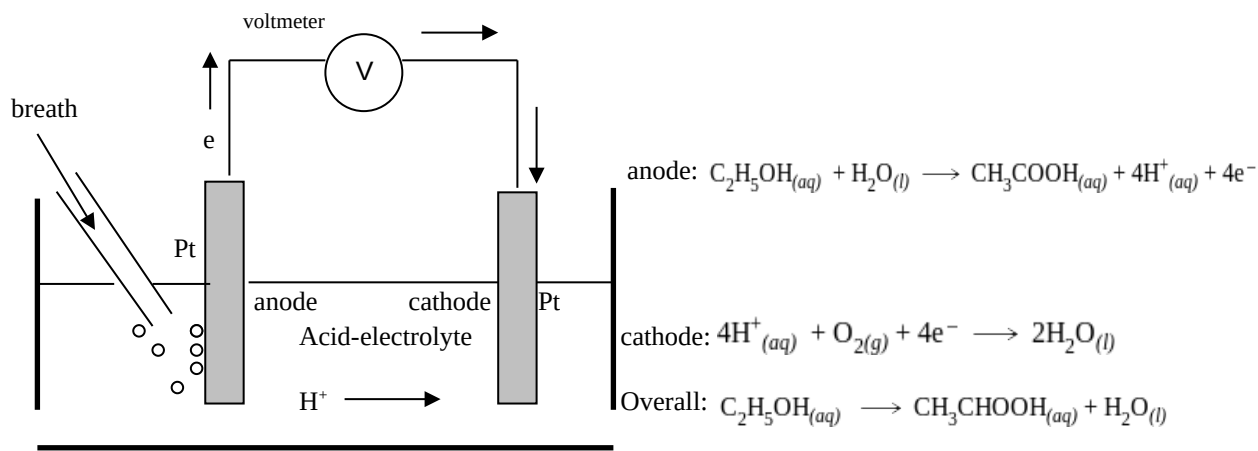
Points that could be included:



Platinum acts as the oxidising agent by absorbing the electrons into the circuit.

This is therefore the anode in the cell (oxidation occurring)

Possible diagram:



The amount of current depends on the rate of the redox reactions occurring.

[max 7]

Differences:

Could mention:

	<u>Breathalyser</u>	<u>Fuel Cell</u>
Current	from photo cell	direct from redox cell
Colour	change	no change
Oxidising agent	dichromate	oxygen

Similarities:

Could mention:

Use of catalyst (silver nitrate and platinum)

Ethanol oxidised to ethanoic acid (same 'anode reaction')

Reading from electric current dependent on this reaction.

[max 8]

3. Table A

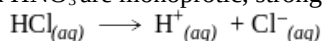
The pH depends on the concentration of hydrogen ions in solution

Higher the $[H^+_{(aq)}]$, the lower the pH

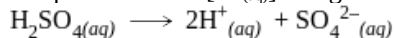
This depends on the concentration of the acid and the strength of the acid (degree of dissociation)

These all have the same concentration

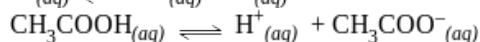
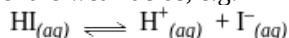
HCl and HNO_3 are monoprotic, strong acids (total dissociation), so have the same pH:



H_2SO_4 is a diprotic acid so $[H^+_{(aq)}]$ is higher and pH is reduced:



remainder are weak acids, e.g:



Could compare strength of HI compared to HCl and explain in terms of bond polarity.

Could rank them in strength $CHOOH > CH_3COOH > HI$

Suggest reasons why $CHOOH$ dissociates more readily than CH_3COOH

[max 10]

Table B

Points to mention:

 $HCl + NaOH$ ($pH = 7.0$)

Salt produced is NaCl

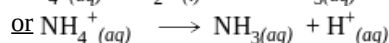
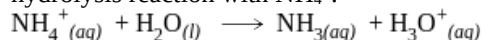
No hydrolysis reactions with Na^+ or Cl^-

So H^+ and OH^- are equal

 $HCl + NH_4OH$ ($pH = 4.0$)

Salt produced is NH_4Cl

hydrolysis reaction with NH_4^+ :

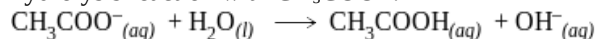


So H^+ is in excess so $pH < 7$

 $CH_3COOH + NaOH$ ($pH = 9.0$)

Salt produced is $Na CH_3COO$

hydrolysis reaction with CH_3COO^- :



So OH^- is in excess so $pH > 7$

 $20\text{mL of } HCl + 19\text{ mL } NaOH$ ($pH = 2.6$)

Salt produced is NaCl

But only 19 of the 20mL of acid is neutralised

So H^+ is in excess

pH still low as pH scale is logarithmic

[max10]