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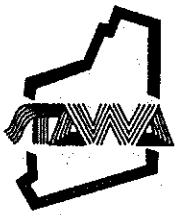

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# *Chemistry*

## 2004 TEE Solutions*

**Production, Distribution and Sales:**
Science Teachers' Association of
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PO Box 1099
Osborne Park 6916

**Question papers and solutions can be obtained from:**
The Curriculum Council
27 Walters Drive
Osborne Park 6017

*These solutions are not a marking key. They are a guide to the possible answers at a depth that might be expected of Year 12 students. It is unlikely that all possible answers to the questions are covered in these solutions.

 acknowledges the support of the Curriculum Council and in particular the TEE Examining Panel members, Mrs Maree Baddock, Dr Stuart Bailey, Dr Steve Errington.

## PART ONE

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

## PART TWO

Question 1:

(a) $Ag^{+}_{(aq)} + OH^{-}_{(aq)} \text{-------} > AgOH_{(s)}$

Two clear colourless solutions are mixed to form a white (brown) precipitate.

(b) $2Na_{(s)} + 2CH_3C(CH_3)_2OH_{(l)} \text{ -----} > 2CH_3C(CH_3)_2ONa_{(l)} + H_{2(g)}$

A silver solid dissolves in a colourless liquid to produce a colourless gas.

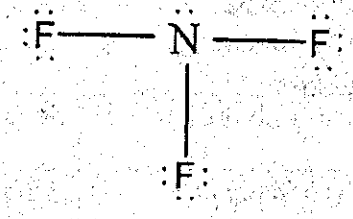
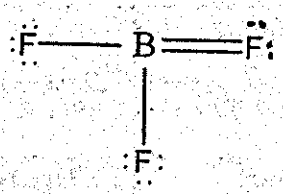
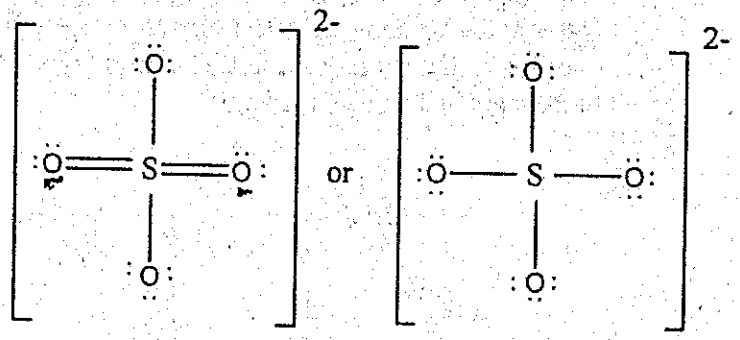
(c) $Cu_{(s)} + 4H^{+}_{(aq)} + 2NO_3^{-}_{(aq)} \text{-----} > Cu^{2+}_{(aq)} + 2NO_{2(g)} + 2H_2O_{(l)}$

Brown solid dissolves, brown pungent gas is produced, and solution turns blue.

(d) $Zn_{(s)} + 2OH^{-}_{(aq)} + 2H_2O_{(l)} \text{ -----} > [Zn(OH)_4]^{2-}_{(aq)} + H_{2(g)}$

Silver solid dissolves in a clear colourless solution producing an odourless colourless gas. Effervescence occurs.

Question 2:

| Species | Structural Formula |
|---|---|
| $NF_3$ |  |
| $BF_3$ |  |
| $SO_4^{2-}$ |  |

Question 3

(a) $O^{2-}$ $1s^2 2s^2 2p^6$

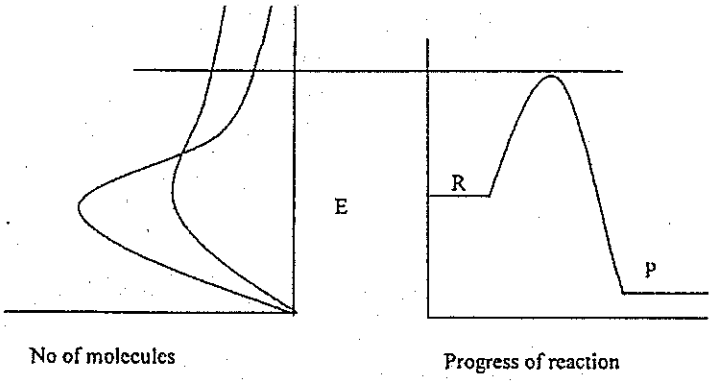
(b) Ca $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

Question 4

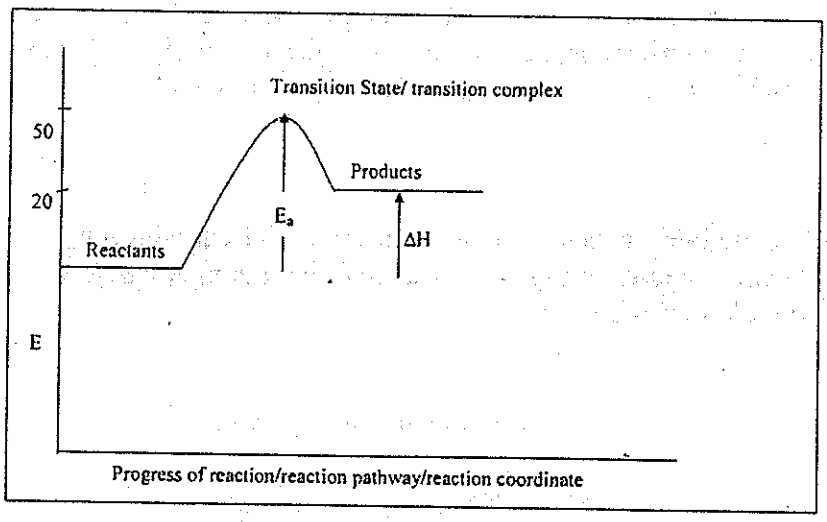
| Description | Name or formula |
|---|---|
| A coloured transition metal | Au, Cu |
| A cleaning agent you would suggest to remove calcium carbonate from bricks | HCl |
| A metallic element with only one d electron | Sc, Y, La, Ac |
| A monomer used to make an addition polymer | Anything containing at least one carbon-carbon double bond. |
| A halogen which is a solid at room temperature | $I_2$, $At_2$ |
| A substance used for bleaching | $Cl_2$, $SO_2$, HOCl, $Ca(OCl)_2$, NaOCl etc |
| A metal that reacts with water to form an alkaline solution | Group I and II metals |
| A primary standard for redox reactions | $Fe(NH_4)_2(SO_4)_2$, $H_2C_2O_4.2H_2O$ etc |

Question 5

(a) More successful collisions occur per unit time because the particles move faster and collide more often, therefore more successful collisions occur over time, and more particles have sufficient energy to react. This factor is more significant (see diagram).



b See diagram



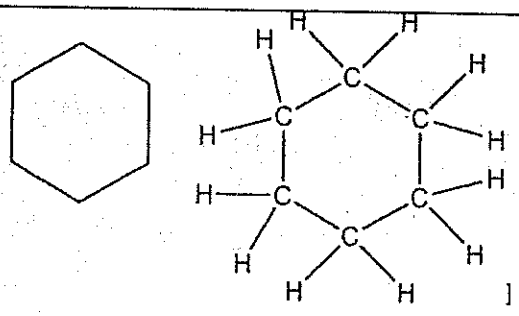
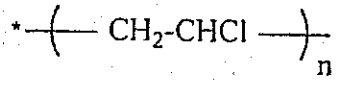

Question 6

The concentrated acid should be added to the water. This reaction is very exothermic so adding a small amount of water to a larger amount of acid results in the water boiling and acid spitting out of the container.

Question 7

| Imposed Change | Effect on rate | Effect on yield. |
|---|---|---|
| Increase the temperature to 45°C | Increase | Decrease |
| Increase the pressure to 200 kPa | No Change | No Change |
| Dissolve NaCl in the solution | Increase | Increase |
| Divide the solution into ten 50 mL portions in ten 100 mL beakers to increase the state of subdivision | No Change | No Change |

Question 8

| |
|---|
| $CH_3COCH_2CH_3$ |
| $CH_3CHBrCH_2Br$ |
| $CH_3Cl$ |
|  |
|  |

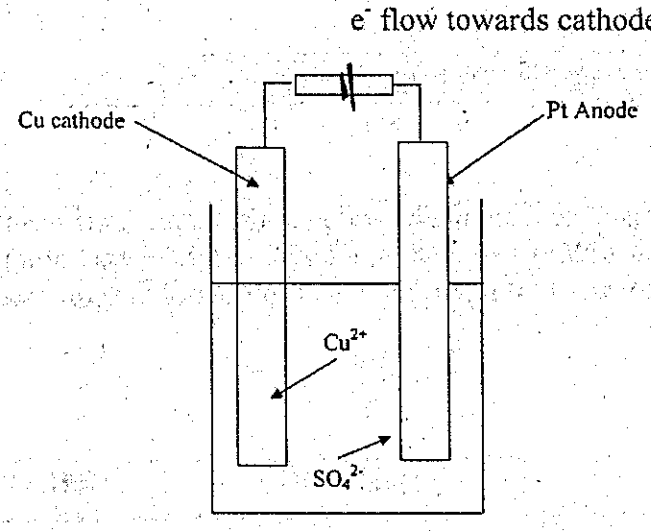
Question 9

Sodium carbonate is available in a pure state and does not absorb water from the atmosphere or readily react with atmospheric $CO_2$, whereas sodium hydroxide absorbs water from the atmosphere and reacts with $CO_2$.

Question 10

C; the intermolecular bond is represented, hydrogen is bound to the electronegative oxygen and this hydrogen is interacting with an oxygen from a neighbouring molecule.

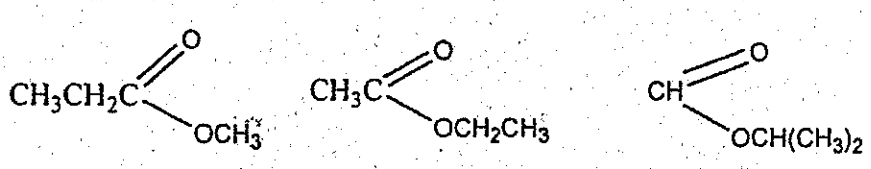
Question 11




| | |
|---|---|
| Anode | $2H_2O$ ----> $O_2 + 4H^+ + 4e^-$ |
| Cathode | $Cu^{2+} + 2e^-$ ----> Cu |

The blue colour would fade from the solution. A black/brown solid forms on the cathode. Bubbles of odourless gas produced on a silver coloured electrode.

Question 12



**PART 3**

Question 1

$Ag^+ + Cl^- \text{----> } AgCl$

$n(AgCl) = {}^{1.02}/_{143.35}$
$= 7.115 \times 10^{-3}$ mol
$n(NaCl) = n(AgCl)$
$m(NaCl) = 7.115 \times 10^{-3} (58.44)$
$= 0.4158$ g
$m(NaHCO_3) = 12.45 - 0.4158$
$= 12.03$ g

% Purity $= (12.03/12.45) \times 100$
$=$ **96.7 %**

Question 2

Average Titration Volume $= (16.60 + 16.72 + 16.63)/3$
$= 16.65$ mL

$n(Na_2B_4O_7.10H_2O) = {}^{2.334}/_{381.4}$
$= 6.120 \times 10^{-3}$ mol in 250 mL
$= ({}^{20}/_{250}) \times 6.120 \times 10^{-3}$ in 20 mL
$= 4.896 \times 10^{-4}$ mol in 20 mL

$n(H^+) = 2n(B_4O_7^{2-})$
$= 2(4.896 \times 10^{-4})$
$= 9.792 \times 10^{-4}$ mol

$c(HCl) = 9.792 \times 10^{-4}/0.01665$
$=$ **$0.0588$ molL$^{-1}$**

Question 3.

(a) $NaHCO_3 + H^+ \text{ --> } Na^+ + H_2O + CO_2$
$3NaHCO_3 + C_6H_8O_7 \text{ ---> } 3Na^+ + C_6H_5O_7^{-3} + 3H_2O + 3CO_2$

$n(NaHCO_3) = 1.998/84.01 = 2.378 \times 10^{-2}$ mol
$n(C_6H_8O_7) = 1.11/192.12 = 5.783 \times 10^{-3}$ mol

The limiting reagent can be determined by any number of methods.
(working out must be shown)
$n(NaHCO_3)$ available > $n(NaHCO_3)$ required
Citric acid is limiting

$n(CO_2) = 3 \times n(C_6H_8O_7) = 1.733 \times 10^{-2}$ mol

$PV = nRT$
$99.2 \times V = 8.315 \times 1.733 \times 10^{-2} (273 + 37)$
**$V = 0.451$ L**

(b) $n(NaHCO_3)_{remaining} = 2.378 \times 10^{-2}$ mol - $1.733 \times 10^{-2}$ mol
$= 6.43 \times 10^{-3}$ mol

$c(NaHCO_3) = 6.43 \times 10^{-3}/0.120$
$= \mathbf{5.36 \times 10^{-2}\ molL^{-1}}$

Question 4
(a)

| | |
|---|---|
| Anode | $C_{(s)} + 2O^{-2}_{(aq)} \text{---> } CO_{2(g)} + 4e^-$ |
| Cathode | $Al^{+3}_{(aq)} + 3e^- \text{---> } Al_{(s)}$ |

(b) $n(Al) = 1.000 \times 10^6/26.98 = 3.706 \times 10^4$ mol
$n(e\text{-}) = 3 \times n(Al) = 3 \times 3.706 \times 10^4 = 1.112 \times 10^5$ mol
$Q = n(e\text{-}) \times F = 1.112 \times 10^5 \times 9.649 \times 10^4 = 1.073 \times 10^{10}$
$t = Q/I = 1.073 \times 10^{10}/1.000 \times 10^5 = \mathbf{1.073 \times 10^5\ s}$

(c) The electrolysis of sodium would take less time because each mole of sodium only uses 1 mole of electrons.
Compare $Na^{+1} + e^- \text{---> } Na$ to $Al^{+3} + 3\ e^- \text{---> } Al$

Question 5:
(a) $n(C) = n(CO_2) = 1.09/44.01 = 0.02477$ mol
$m(C) = 0.02477 \times 12.01 = 0.2975$ g
$\%(C) = (0.2975/0.6678) \times 100 = 44.55\%$

$n(H) = 2n(H_2O) = 2 \times (0.390/18.016) = 0.04362$ mol
$m(H) = 0.04362 \times 1.008 = 0.04364$g
$\%(H) = (0.04364/0.6678) \times 100 = 6.53\%$

$n(Cl) = n(AgCl) = 0.221/143.34 = 1.542 \times 10^{-3}$ mol
$m(Cl) = 1.542 \times 10^{-3}\ (35.45) = 0.05466$g
$\%(Cl) = (0.05466/0.3320) \times 100 = 16.47\%$

$\%N = 100 - 44.55 - 6.53 - 16.47 = 32.45\%$

| | C | H | Cl | N |
|---|---|---|---|---|
| Mass in 100 g | 44.55 | 6.53 | 16.47 | 32.45 |
| Number of moles(n) | 44.55/12.01 | 6.53/1.008 | 16.47/35.45 | 32.45/14.01 |
| | 3.71 | 6.48 | 0.465 | 2.32 |
| Ratio | 8 | 14 | 1 | 5 |

**Empirical Formula = $C_8H_{14}N_5Cl$**

(b) $PV = nRT$
$125.4 \times 0.956 = (7.20/M) \times 8.315 \times (273.15 + 150)$
$M = 211.2$ g/mol

Empirical Formula Mass = Molecular Mass
Molecular Formula = $C_8H_{14}N_5Cl$

**PART 4**

For the first time in 2004 there was no choice of extended answer question in Part 4.

There is no one correct solution to this extended answer. The following points summarize what the examiners expect in a satisfactory answer.

- 2-3 pages of good chemistry,
- relevant to the topic,
- written in reasonable English (literacy skills are satisfactory),
- an attempt made to link evidence and theory, and
- no errors or only trivial errors.

For full marks you must make reference to the material in the text of the question.
For example you may discuss the physical properties of acetic acid.
"It is miscible with water and with ethanol"
To appropriately address this you would need to discuss the nature of the intermolecular bonding between particles of water, ethanol and acetic acid (all have H-bonding) and how this fact allows the particles to mix with each other.

The examiners required discussion of both the production and the chemistry of acetic acid for full marks.

**Production**

You must write the equations for the reactions described in the question that describe the production of ethanol.

i.e $CO_{(g)} + 2H_{2(g)} \rightarrow CH_3OH_{(g)}$

$CH_3OH_{(g)} + CO_{(g)} \rightarrow CH_3CH_2OH_{(g)}$ $\Delta H = -135.31\ kJmol^{-1}$

Factors that result in a faster reaction rate for such a process, such as high pressure, high temperature, excess reactants and use of a catalyst should be discussed. This should be compared and contrasted with the factors that would result in a high yield such as high pressure and low temperatures.

**Chemistry**

You could discuss the types of reactions that acetic acid undergoes within the context of acid/base theory or organic chemistry. A discussion of weak vs strong acids may be appropriate. The formation of carboxylic acids via oxidation could be included here. Where reactions are described equations must be provided.

You could also discuss the physical properties of acetic acid with reference to inter-molecular forces.