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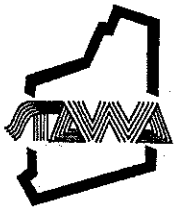

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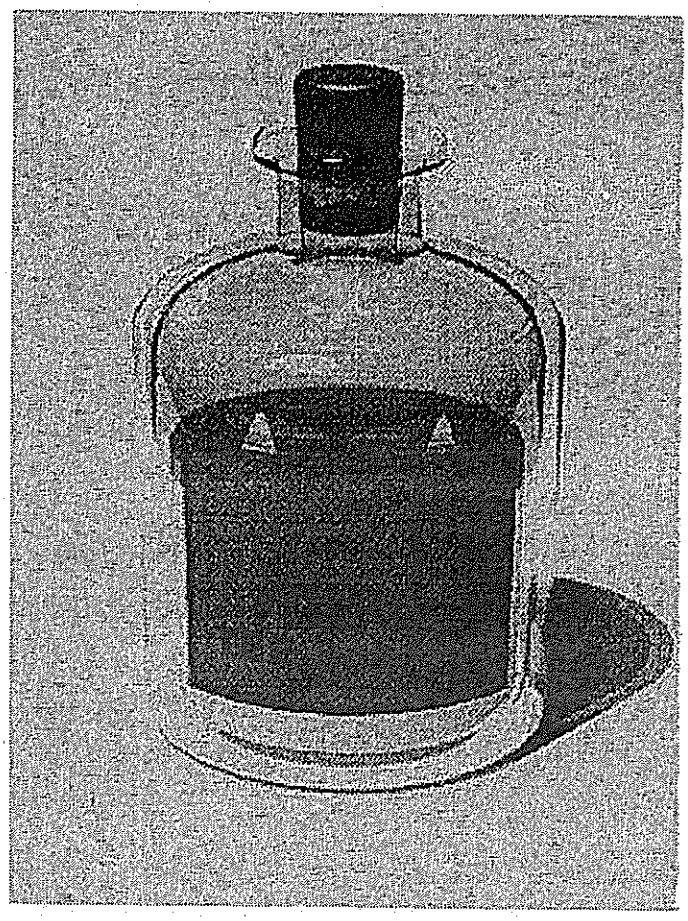
Chemistry

2002 TEE Solutions*



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*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.

2002 CHEMISTRY TEE MARKING GUIDE

PART 1 (60 MARKS)

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

For Parts 2 and 3 the answers have been prepared according to the following guidelines:

- These are a set of model answers. As such, there has been no attempt to cover all possibilities and thus clutter the document with qualifications. The aim has been to produce one set of answers that a good student could aspire to.
- In most cases only one answer has been given even when a number of other answers are correct.
- Occasionally in these model answers multiple solutions have been provided, as in Part 2 Q 3 and Q 4.

PART 2 (70 MARKS)

1. (a) $CH_3\text{-}CH_2\text{-}CH{=}CH_2 + Br_2 \rightarrow CH_3\text{-}CH_2\text{-}CHBr\text{-}CH_2Br$ OR

$C_4H_8 + Br_2 \rightarrow C_4H_8Br_2$

Brown solution fades to colourless. (orange/brown; red/brown etc)

(b) $Pb^{2+}_{(aq)} + 2\,I^-_{(aq)} \rightarrow PbI_2(s)$

Yellow (white) precipitate formed.

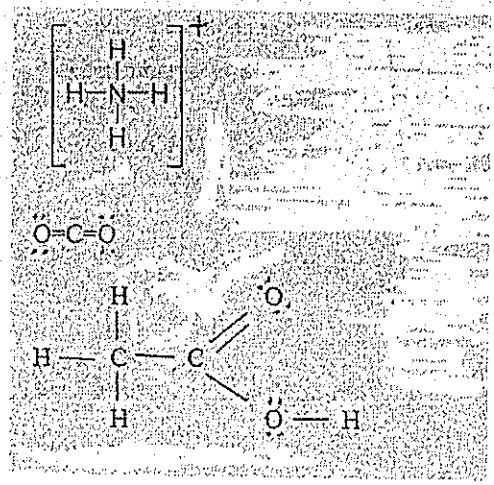
(c) $2\,Au^{3+}_{(aq)} + 3\,Cu_{(s)} \rightarrow 2\,Au_{(s)} + 3\,Cu^{2+}_{(aq)}$

[yellow] solution turns blue. [Brown/salmon pink] solid dissolves, gold[black] precipitate formed.

(d) $2Na + 2CH_3COOH \rightarrow 2\,CH_3COONa + H_2$

Solid dissolves, colourless solution formed, colourless, odourless gas produced. Temperature increase/heat generated

2.



3. This question allowed for answers as either formulas or names

Al, Cr, Zn
Mg, Al, Zn
NH_3
H_2S, NH_3, SO_2, HCl
NO_2, Br_2
Hg Br_2 (Ga)
$C_2H_2O_4.2H_2O$; $Fe(NH_4)_2(SO_4)_2$; $Na_2C_2O_4$

4.

H_2O/NO_2^-	$SO_3/C\ell_2/CH_4$	$HF/H_2O/NH_3$	SO_3
CH_2Cl_2	CH_2O	NH_3	$C\ell_2$

5. Initially Cu^{2+} is in excess and a pale blue precipitate of copper(II) hydroxide forms:

$$Cu^{2+} + 2\,NH_3 + 2\,H_2O \rightarrow Cu(OH)_2(s) + 2\,NH_4^+ \quad (1)$$

OR

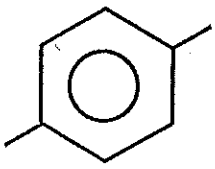
$$NH_3 + H_2O \rightarrow NH_4^+ + OH^- \quad ....(2)$$

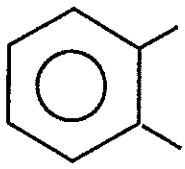
$$Cu^{2+} + 2OH^- \rightarrow Cu(OH)_2 \quad ...(3)$$

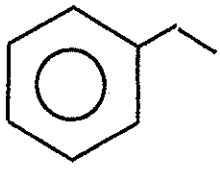
When ammonia is in large excess, the precipitate dissolves giving a deep blue solution of $Cu(NH_3)_4^{2+}$

$$Cu(OH)_2(s) + 4\,NH_3 \rightarrow Cu(NH_3)_4^{2+}(aq) + 2\,OH^-(aq) \quad (4)$$

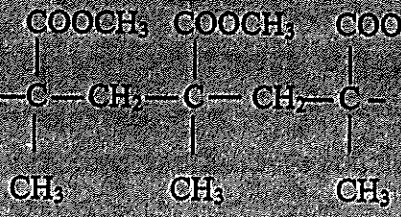
6.







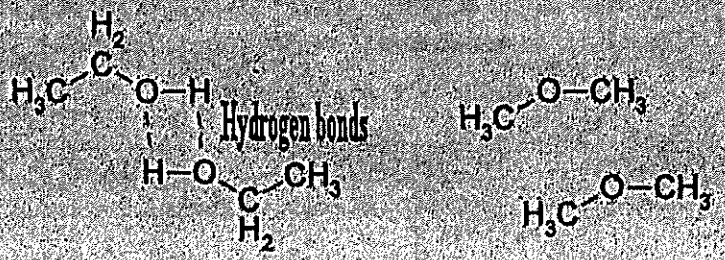
7. (a)



(b) Addition polymer

(c) Unsaturated/double bond

8.



Hydrogen bonding occurs between molecules of ethanol. Dipole-dipole forces occur between molecules of ether (it is not a symmetrical molecule). Hydrogen bonding is a stronger force of attraction than dipole-dipole, therefore more energy will be required to break the bonds between ethanol molecules than ether molecules.

9. $K = [Ca^{2+}][CrO_4^{2-}]$

$$K = \frac{[O_2]^7[NH_3]^4}{[NO_2]^4[H_2O]^6}$$

or

$$K = \frac{p(O_2)^7\, p(NH_3)^4}{p(NO_2)^4\, p(H_2O)^6}$$

10.

increase	right
no change	no change
increase	left

11. Equilibrium conditions that favour high yield are low temperature and high pressure.
Rates conditions that favour high rate are high temperature and high pressure.
For temperature yield and rate are at odds so a compromise temperature is used.
At this temperature the yield and rate are satisfactory.
High pressure, which would favour both high yield and high rate is very expensive and not justified on economic grounds, so atmospheric pressure is used.

12. From the information given in the question, the adhesive must be polar.
Hydrocarbons do not interact strongly enough with the polar adhesive to compete with the strong polar interactions within in.
Acetone and alcohols are polar and form strong enough interaction with the adhesive to separate the molecular strands.

PART 3

1(a) $2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$

b)

$$n(C_8H_{18}) = \frac{74}{114.2}$$
$$= 0.6478 \text{ mol}$$
$$n(O_2) = \frac{80(260)}{8.315(293)}$$
$$= 8.538 \text{ mol}$$

1 mole of C_8H_{18} requires 12.5 moles of O_2
0.6478 moles of C_8H_{18} requires 8.098 moles of O_2
$n(O_2)$ required < $n(O_2)$ present
therefore C_8H_{18} is the limiting reagent

$$n(CO_2) = \frac{16}{2} n(C_8H_{18})$$
$$= \frac{16}{2}(0.6478)$$
$$= 5.182 \text{ mol}$$

$$P(CO_2) = \frac{5.182(8.315)(299)}{260}$$
$$= 49.6 \text{ kPa}$$

c) $n(O_2)$ remaining $= 8.538 - 8.0975$

$= 0.4405$ mol

$m(O_2) = 0.4405 \times 32.0$

$= 14.1$ g

2. $Zn \rightarrow Zn^{2+} + 2e^-$

$n(Zn) = \frac{1}{65.39}$

$= 0.0153$ mol

$n(e^-) = 2 \times 0.0153$

$= 0.0306$ mol

$Q = 0.0306 \times 96\,490$

$= 2.95 \times 10^3$ C

b)

$Pb \rightarrow Pb^{2+} + 2e^-$

$n(Pb) = \frac{1}{207.2}$

$= 0.00483$ mol

$n(e^-) = 2 \times 0.00483$

$= 0.00965$ mol

$Q = 0.00965 \times 96\,490$

$= 9.31 \times 10^2$ C

c) 2.95×10^3 A.s at 0.10 A. Time $= 2.95 \times 10^3 \div 0.10 =$ **2.95×10^4 s = 8.19 h**

d) 9.31×10^2 A.s at 0.10 A. Time $= 9.31 \times 10^2 \div 0.10 =$ **9.31×10^3 s = 2.59 h**

3(a)

$Fe_x(CO)_y.zH_2O \rightarrow Fe_x(CO)_y + zH_2O$

5.319 g 4.029 g

$m(H_2O) = 5.319 - 4.029 = 1.290$ g

$n(H_2O) = \frac{1.290}{18.016} = 0.07160$ mol

$Fe_x(CO)_y + O_2 \rightarrow Fe_2O_3 + CO_2$

4.029 g 1.914 g 4.214 g

$n(Fe_2O_3) = \frac{1.914}{159.7} = 0.01198$ mol

$n(Fe) = 2 \times 0.01198 = 0.02397$ mol

$n(CO_2) = \frac{4.214}{44.01} = 0.09575$ mol $= n(CO)$

	Fe	CO	H_2O
Number of moles	0.02397	0.09575	0.07160
smallest no (0.02397)	1	3.99	2.99
Round	1	4	3

3(b) To make sure all the water has been driven off.

4(a) $Fe + Cu^{2+}(aq) \rightarrow Cu(s) + Fe^{2+}(aq)$

b) $Cr_2O_7^{2-} + 14\,H^+ + 6\,e^- \rightarrow 2\,Cr^{3+} + 7\,H_2O$

$Fe^{2+} \rightarrow Fe^{3+} + e^- \quad (\times 6)$

$Cr_2O_7^{2-} + 6\,Fe^{2+} + 14\,H^+ \rightarrow 2\,Cr^{3+} + 6\,Fe^{3+} + 7\,H_2O$

c)

$n(Cr_2O_7^{2-}$ reacting with 50.0 mL of sample) $= 0.0169 \times 0.0143$
$= 2.42 \times 10^{-4}$ mol

$n(Cr_2O_7^{2-}$ reacting with 250.0 mL of sample) $= 2.42 \times 10^{-4} \left(\frac{250}{50}\right)$
$= 1.21 \times 10^{-3}$ mol

$n(Fe^{2+}) = 6 \times 1.21 \times 10^{-3}$
$= 7.25 \times 10^{-3}$ mol

$m(Fe^{2+}) = 7.25 \times 10^{-3} (55.85)$
$= 0.4049$ g

%Fe: $= \frac{0.4049}{1.068} \times 100$
$= 37.9\ \%$

d) $\frac{55.85}{135.73} \times 100 = 41.1\%$

e) Sources of discrepancy:
Overburden contained in the original sample or
Non-stoichiometric reduction reaction (still some $FeTiO_3$).
Some Fe^{2+} oxidised to Fe^{3+} due to oxygen in water

5. 30.00 mL ~0.5 M NaOH
Acid in sample17.62 mL 0.548 M HCℓ
27.65 mL 0.548 M HCℓ
30.00 mL ~0.5 M NaOH

n(HCl) in 27.65 mL = 0.02765 x 0.548 mol
= 0.0152 mol
= n(NaOH) in 30.00 mL

n(HCl) in 17.62 mL = 0.01762 x 0.548 mol
= 0.00966 mol

n(NaOH reacted with aspirin) = 0.0152 — 0.00966
= 0.005496 mol

Ans°: 5.50×10^{-3} moles

b) n(acetylsalicylic acid) = $\frac{1}{2}$ x 0.005496
= 0.002748 mol in 0.619 g
m(acetylsalicylic acid) = 0.00278 x 180.16
= 0.495 g

c) Number of tablets in 0.619 g = $20 \times \frac{0.619}{7.576}$ g
= 1.63 tablets

d) M(acetylsalicylic acid in 1 tablet) = $\frac{0.4951}{1.634}$
= 0.303 g per tablet

e) 0.303 g per tablet is 101% of stated mass, which conforms to the British Pharmacopoeia standard.

PART 4

This section is designed to give you the opportunity to demonstrate what you know and how you apply that knowledge, rather than what you don t know. Hence, there is no one model answer. Several students could write quite different essays and yet all could score full marks.

Clear setting out and logical order are important, as is clear and concise English expression. Ideally you should include a brief introduction and conclusion. It is imperative that if addition information is given that you are required to refer to, this must be done and in more detail than one or two sentences.

In general, then, for full marks we are looking for two pages of

* good chemistry,
* on the topic given,
* written in reasonable English (without too much concern on our part for spelling),
* with some reasoning shown (for example, an inter-relating of evidence and theory),
* with a beginning, a middle, and an end, and

Include diagrams, graphs, equations, drawings, schematic outlines and so on, if this is an appropriate method for getting your message across.

ESSAY 1

This essay requires students to relate their understandings of the extraction methods for aluminium, iron and gold to the extraction methods described.
While a number of different approaches can be used by students, the following may provide a guide.

The following points could have been made. The processes could have been considered either individually or as groups. It would be more efficient to group similar processes together.

- Sodium, magnesium and aluminium can be considered together.
- The process of electrolysis can be described (a labelled diagram could have been used.)
- A comparison with the electrolytic process for obtaining aluminium should be made.
- The extraction of aluminium in the example provided is not used due to the cost of producing the sodium.
- There is no need for students to describe the Bayer process.
- The positions of these metals on the standard reduction potential table should be referred to with reference to the electrolysis of water.
- It should be noted that salts are relatively cheap reagents but electricity is expensive.
- Silicon could be considered with the above group or just with aluminium, for example.
- Reference to where the half-equation would fit into the table of standard reduction potentials should be made.
- Lead, copper and mercury should be considered together and compared to the extraction of iron. Again their positions on the standard reduction potential table should be discussed.
- It should be noted that oxygen and carbon are cheap reactants.
- The reactions could be discussed in terms of displacement reactions.
- Silver should be compared to the gold process.

- The energy requirements of these processes are much lower than for the other metals described.
- Environmental as well as economic considerations could be mentioned.

ESSAY 2

This essay requires students to relate their understanding of intermolecular interactions to the physical properties of a selection of alcohols, and to discuss chemical reactions that these alcohols undergo.

- The two main intermolecular forces involved in the change of physical properties should be identified as hydrogen bonding and dispersion forces.
- These forces could be briefly described.
- It should be noted that dispersion forces are present in all of the substances.
- Diagrams could be used.
- Effect of chain length should be discussed
- Effect of branching should be discussed
- Both boiling point and solubility must be addressed.
- For reactions students should include reference to
- Combustion reactions
- Redox reactions
- Reactions with carboxylic acids.
- Reaction with sodium
- Relationship between reaction rate and class of alcohol should be included.
- Equations using the examples provided must be included
- The structural differences between primary, secondary and tertiary alcohols could be mentioned.

This essay must address both part a and b of the question, although it is possible to spend more time on one part without penalty.