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Chemistry

*1997 TEE Solutions**

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Curriculum Council
27 Walters Drive
Osborne Park WA 6017

** These solutions are not a marking key. They are a guide to 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.*

 STAWA appreciates the support of the Curriculum Council, which provided the marker's guides used as a basis for these solutions.

TEE Chemistry 1997 Solutions

Part 1

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

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

* We have tried to prepare a set of model answers. As such we have not attempted 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 other answers are correct; thus in Part 2 Q6, there are a number of correct answers.

* Occasionally in these model answers two solutions have been given, as in Part 2 Q2.

* In the calculations, a method of working has been used which emphasises reasoning. The answers given here are modelled on approaches adopted by students where their schools have been conspicuously successful in public examinations.

Part 2

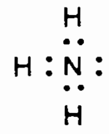
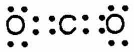
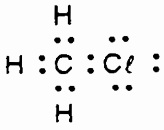
1 (a) $H^+(aq) + CH_3COO^-(aq) \rightarrow CH_3COOH(aq)$
No visible reaction
(b) $CoCO_3(s) + 2H^+(aq) \rightarrow H_2O(l) + CO_2(g) + Co^{2+}(aq)$
Pink solid fizzes
(c) No reaction, so no equation
No visible reaction
(d) $C_6H_{10}(l) + Br_2(aq) \rightarrow C_6H_{10}Br_2(l)$
Orange solution is decolourised (or turns colourless)

2. Note that the question asks for a formula to be written in each case.

C_8H_{18}	H_2SO_4
NaOH or NaCN or HCl or H_2SO_4	CaO
Cu or HCl	NaCN
SO_2	Na_3AlF_6 or NaOH
H_2	HCl

3. (a) $1s^2\ 2s^2\ sp^6\ 3s^2\ 3p^4$
(b) $1s^2\ 2s^2\ sp^6\ 3s^2\ 3p^6$

4.

	pyramidal
	linear
	tetrahedral

5. $CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$

6.

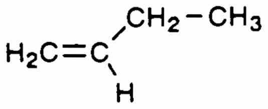
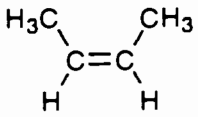
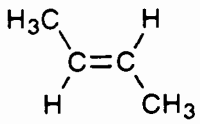
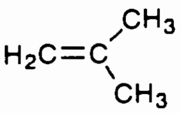
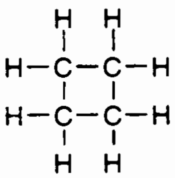
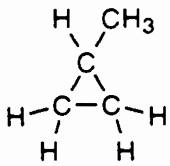
$NaNO_3$ and Na_2SO_4	Dissolve each in water and add $BaCl_2$ solution	with $NaNO_3$ no visible reaction with Na_2SO_4 white precipitate
1 mol L^{-1} HCl and 1 molL^{-1} HNO_3	Add $AgNO_3$ solution to separate samples of each	with HCl white precipitate with HNO_3 no visible reaction

7. $Sm^{3+} + 3OH^- \rightarrow Sm(OH)_3$

8. Oxidation half equation
$2Br^- \rightarrow Br_2 + 2e^-$
Reduction half equation
$2BrO_3^- + 12H^+ + 10e^- \rightarrow Br_2 + 6H_2O$
Redox equation
$5Br^- + BrO_3^- + 6H^+ \rightarrow 3Br_2 + 3H_2O$

9. i) +6 sodium hydroxide solution
ii) +3 a solution containing iron(II) sulfate and sulfuric acid

10.

	1-butene
	cis-2-butene
	trans-2-butene
	2-methylprop-1-ene
	cyclobutane
	methylcyclopropane

11. i) ester group
    ii) aromatic group
    iii) carbonyl group

12

i) rate: the rate is faster at the higher temperature
   yield: the yield is lower, but the high rate more than compensates for the lower yield

ii) rate: the rate would be faster at a higher pressure (increased concentration), but the rate must be high enough at 1 atmosphere
   yield: a low pressure would slightly increase the yield (5:6)

iii) rate: a catalyst increases the rate (lower activation energy)
   yield: no effect

13.

i)	→	see the amount of white solid decrease
ii)	←	see the amount of white solid increase
iii)	no change	no visible reaction
iv)	no change	no visible reaction

14. $H^+ + OH^- \rightarrow H_2O$

$n(H^+) = 1.00 \times 10^{-3}$ mol $n(OH^-) = 1.50 \times 10^{-3}$

excess $OH^- = 5.00 \times 10^{-4}$ mol

$[OH^-] = 5.00 \times 10^{-4} / 0.0250 = 0.0200$ mol L^{-1}

$[H^+] = 1.00 \times 10^{-14} / 0.0200 = 5.00 \times 10^{-14}$

pH = 12.3

PART 3

1.

$C_xH_yO_z$	+	O_2	→	CO_2	+	H_2O
0.5991g		?		1.334g		0.233g

a)

mass C = $\frac{1.334 \times 12.01}{44.01}$ = 0.3640g mass H = $\frac{0.233 \times 2.016}{18.016}$ = 0.02607g

	C	H	O
mass	0.3640g	0.02586g	0.5991 - (0.3640+0.02607) = 0.2090
at mass	12.01	1.008	16.00
n mol = m/M	0.03031	0.02586	0.01306
ratio	2.321	1.980	1.00
whole no ratio	6.962	5.941	3.00
rounding	7	6	3

so empirical formula = $C_7H_6O_3$

b) 72 mL of "A" at 373K & 1.00 atm has a mass of 0.3301g

24470 mL "A" at 373K & 1atm has a mass of $\frac{0.3301}{72} \times 22470$ g

22470 mL of "A" at 298K and 1.00 atm has a mass of

$\frac{0.3301 \times 24470 \times 373}{72 \times 298}$ = 140g

OR PV = nRT so $PV = \frac{mRT}{M}$

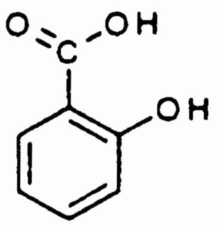
so $M = \frac{mRT}{PV}$

$= \frac{0.3301 \times 0.08206 \times 373}{1.00 \times 0.072}$

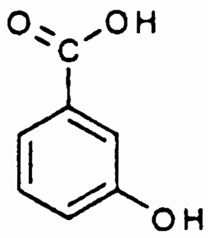
$= 140 \text{ g mol}^{-1}$

c) since EF mass = molecular weight (molar mass)
molecular weight = 140g

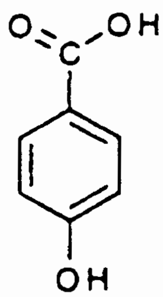
d)



1-hydroxybenzoic acid



2-hydroxybenzoic acid



3-hydroxybenzoic acid

2. a) From the equations:

As	→	Na_3AsO_4	→	AsO_4^{3-}	→	$H_2AsO_4^-$	→	Ag_3AsO_4	→	Ag^+
1 mol	→	1 mol	→	1 mol	→	1 mol	→	1 mol	→	3 mol

Ag^+ reacts with NCS^-
3 mol → 3 mol

b) $n(NCS^-) = \frac{23.38 \times 0.10034}{1000} = 0.002346$ mol

$n(As) = \frac{0.002346}{3} = 0.0007820$ mol

$m(As) = 0.0007820 \times 74.92 = 0.05859$ g

$\% As = \frac{0.05859 \times 100}{0.0603}$
$= 97.2\%$

3. a) $Mg + 2H^+ \rightarrow H_2 + Mg^{2+}$

b) $n(Mg) = \frac{0.1046}{24.31} = 0.004303$ mol

$n(H^+) = \frac{50.00 \times 0.1000}{1000} = 0.005000$ mol

equation ratio $H^+ : Mg = 2/1 = 2.00$
actual ratio $H^+ : Mg = 0.005/0.004303 = 1.162$
therefore H^+ is the limiting reagent

3 c)i) n(Mg reacting) = half the number of moles of H^+

= 0.5 x 0.00500 = 0.002500

m(Mg reacting) = 0.002500 x 24.31 = 0.06078g

m(Mg remaining) = 0.1046 - 0.06078 = 0.04382g

ii) Since H^+ is the limiting reagent, there will be no moles of hydrogen ion remaining

iii) All H^+ is converted into H_2

$n(H_2) = 0.5 \times n(H^+) = 0.002500$

$\text{volume } (H_2) = 0.02500 \times 24.47 = 0.0612 \text{ L}$

iv) n(Mg in soln) = n(Mg reacting) = 0.002500

$$\text{conc}(Mg^{2+}) = \frac{0.002500}{0.050}$$

$= 0.0500 \text{ mol L}^{-1}$

4.a)

$$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^- \quad \times 5$$

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O \quad \times 2$$

$$C_2O_4^{2-} + 2MnO_4^- + 16H^+ \rightarrow 10\ CO_2 + 2Mn^{2+} + 8H_2O$$

b) $n(MnO_4^-) = 9.88 \times 10^{-3} \times 0.0005200$

$= 5.138 \times 10^{-6}$

$$n(C_2O_4^{2-}) = \frac{5 \times 5.138 \times 10^{-6}}{2}$$

$= 1.284 \times 10^{-5}$ mol

c) $n(Ca^{2+})$ in 10.00 mL diluted soln $= 1.284 \times 10^{-5}$

$n(Ca^{2+})$ in 100 mL diluted soln $= 1.284 \times 10^{-4}$

$m(Ca^{2+})$ in 100 mL diluted soln $= 1.284 \times 10^{-4} \times 40.08$

$= 5.15 \times 10^{-3}$g

5.a) $n(e^-) = It/9.649 \times 104$

$$= \frac{0.105 \times 30 \times 60}{9.649 \times 104} = 1.95875 \times 10^{-3} \text{ mol}$$

$$Ag^+ + e^- \rightarrow Ag$$

$n(Ag) = n(e^-)$

$m(Ag) = 1.95875 \times 10^{-3} \times 107.9 = 0.211$g

b) $M^{3+} + 3e^- \rightarrow M$

$n(M) = 1/3\ n(e^-) = 6.5292 \times 10^{-4}$ mol

$M = m/n = 0.1291/6.5292 \times 10^{-4}$

$= 198$ g

c) Gold

PART 4

This section is designed to give you the opportunity to demonstrate what you know rather than what you do not 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.

In general, then, for full marks you need to write 2 pages of
* good chemistry
* on the topic given
* written in reasonable English, and
* with reasoning (for example, an inter-relating of evidence and theory)
* with a beginning, middle, and an end

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

Q1

In this essay
* a row of the Periodic Table must be nominated (eg 3rd row)
* specific elements in the chosen row need to referred to
* properties must be explained, with the trends
* all four of the trends cited in the question must be dealt with
* the question says "describe and explain", so descriptions must be explained.
* reasoning must be shown (a 2 page statement of factual examples with no reasoning is worth a maximum of 10/20)

The following points probably need to be made:
* the elements on the left form metallic bonds, and this tendency decreases across the Table
* compounds of the elements on the left do not form covalent bonds in compounds, and there is an increasing tendency to form covalent bonds as one goes to the right.
  [Elements on the right in some instances form both ionic and covalent bonds, for example O in OH^- or S in SH^-]
* the elements on the left tend to lose electrons and thus are oxidised - hence they act as reducing agents; the elements on the right tend to gain electrons and are thus reduced - hence they act as oxidising agents.
* changes in ionisation energy
* changes in electronegativity

Other points which might be mentioned include
. some metals in the middle of the Periodic Table form complex ions; in these they are both forming a positive ion and being covalent
. in the statement above, compounds of the elements on the left contain the element as a positive ion and there is a trend towards the right, where compounds of the element contain the element as a negative ion
. there are elements in the middle of each row where their atoms form neither simple positive nor simple negative ions, and no element forms both a stable monatomic cation and a stable monatomic anion

Q2

In this essay, forces between atoms in all four substances listed must be dealt with.

The essay could be constructed around:
* a discussion of the strengths of dispersion forces, hydrogen-bonding, ionic bonding, and covalent bonding, illustrated by reference to the four substances in the list

OR
* a discussion of the comparative melting and boiling points of the four substances in the list, with explanations in terms of the forces holding the atoms together

The following points probably need to be made:
* the bonding in O2 is discrete covalent, hence the attractive forces between the molecules are dispersion forces
* the bonding in H_2O is highly polar covalent, hence the attractive forces between molecules are those of hydrogen bonding
* the bonding in KCl is ionic, hence the attractive forces between the species are the attractions of a complete +ve charge and a complete -ve charge
* the bonding in SiO_2 is covalent network, hence the attractive forces which must be overcome in order to melt and boil SiO_2 are very strong covalent bonds

Q3

This is the open-ended essay of this exam, and there are a wide variety of approaches that could be used.

Possible discussion points include:
* factors governing solubility
  - forces between solute species
  - forces between solvent species
  - forces between solute and solvent species
  - hopefully a bit more than "like dissolves like"
* solid in liquid, liquid in liquid
* solid in solid - alloys eg steel, brass
* gas in liquid - eg O_2 and CO_2 in sea water
* minerals
* the use of solutions to dissolve other substances eg NaOH with bauxite
* solubility rules for ionic solids in water
* solubility in organic solvents
* unsaturated, saturated and supersaturated solutions preparation of these
* dissolution through complex formation eg $Cu(NH_3)_4^{2+}$, extraction of gold
* calgon and EDTA
* hard water reducing soap solubility
* temperature and solubility
* temperature and rate of dissolution; activation energy
* preparation of standard solutions
* primary and secondary standards
* titrations

The essay needs to be well balanced. There must be an account of solubility and information on the preparation of solutions. Also the essay must contain chemistry.