Chemistry 12 Trial Exam 1
Final - SOLUTIONS

TEE CHEMISTRY

Semester 2 Examination 2002
SOLUTIONS

Part 1

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

Part 2

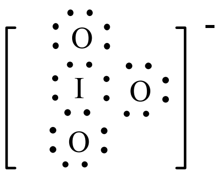
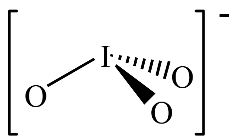
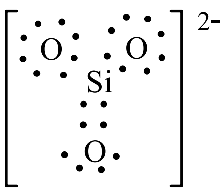
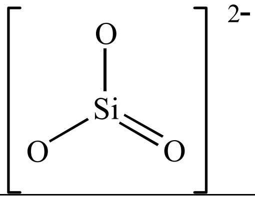
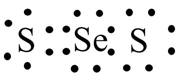
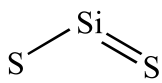
1. (a) Equation $3Fe^{2+}(aq) + 2PO_4^{3-}(aq) \rightarrow Fe_3(PO_4)_2\,(s)$
Observation: Pale green ppt produced

(b) Equation $Ag(s) + NO_3^{-}(aq) + 2H^{+}(aq) \rightarrow Ag^{+}(aq) + NO_2(g) + H_2O(\ell)$
Observation: Bubbles of brown acrid smelling gas produced. Metal dissolves to colourless solution

(c) Equation $Cl_2(g) + 2I^{-}(aq) \rightarrow I_2(aq) + 2C\ell^{-}(aq)$
Observation: Solution changes from colourless to orange/brown/red

(d) Equation $Cr_2O_7^{2-}(aq) + 3HCHO(aq) + 8H^{+}(aq) \rightarrow 2Cr^{3+}(aq) + 3HCOOH(aq) + 4H_2O(\ell)$
Observation: Orange solution turns dark green

2.

Species	Structural formula (showing all valence electrons)	Draw (include all atoms)	Polarity (non Polar or Polar)
Iodate ion IO_3^{-}			Polar
Metasilicate ion SiO_3^{2-}			Non Polar
Selenium disulfide SeS_2			Polar

3.

Name	Formula
Aluminium Chromium Zinc Lead	Al Cr Zn Pb
Ethanoic acid Hydrogen fluoride Hydrogen sulphide etc	CH_3COOH HF H_2S etc
Propene	$CH_3CH = CH_2$
Water Ammonia	H_2O NH_3
Graphite	C
1 – Butene or 2 – Butene	C_4H_8 or $CH_2CHCH_2CH_3$ or $CH_3CHCHCH_3$ etc
Sulphur	S

4. (a) $Mg_{(s)} + F_{2(g)} \rightarrow MgF_{2(s)}$

(b) Fast: Mg is a strong reducing agent so easily loses e^- and
F_2 is a strong oxidising agent so easily gains e^-

5. (a) $H^+ + OH^- \rightleftharpoons H_2O + \text{Heat}$

(b) Equilibrium constant is only constant at a given temperature
that is it varies with temperature

(c) Increase in temperature results in greater concentration of H^+ (and OH^-)

as $pH = -\log [H^+]$
greater $[H^+]$ means smaller pH
so pH is less than 7

6.

Solution	Name or formula of salt	Equation
Produces an acidic solution	$NH_4C\ell$ or $NaHSO_4$ etc	$NH_4^+ + H_2O \leftrightarrows NH_3 + H_3O^+$ or $HSO_4^- \leftrightarrows H^+ + SO_4^{2-}$ etc
Produces a basic solution	CH_3COONa or Na_2CO_3 etc	$CH_3COO^- + H_2O \leftrightarrows CH_3COOH + OH^-$ or $CO_3^{2-} + H_2O \leftrightarrows HCO_3^- + OH^-$ etc

7.

$$K = \frac{[Zn^{2+}][NH_3]^2}{[NH_4^+]^2}$$

$$K = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$$

8.

Substances	**Describe the Test**	**Observation for Magnesium nitrate solution**	**Observation for Zinc nitrate solution**
Magnesium nitrate solution and Zinc nitrate solution	1. Add excess OH^- to each 2. Add excess NH_3 solution to each	white ppt observed that persists even when each solution is added in excess	white ppt which dissolves to form a colourless solution when added in excess
	3. Add clean Mg to solution (also use Mn & Al) NOTE: TEST 3 does not work very well in dilute solution	no change	metal surface becomes dark (black)

Substances	**Describe the Test**	**Observation for methyl-2-propanol**	**Observation for 1-propanol**
methyl-2-propanol and 1-propanol	1. Add acidified $KMnO_4$ solution	solution remains purple	solution turns colourless (or brown ppt)
	2. Add acidified $Cr_2O_7^{2-}$ solution	solution remains orange	solution turns dark green
	3. Add Na metal	very slow colourless bubbles produced	colourless bubbles produced faster

9.

Test Tube	Experiment	Observation	Explanation
1	A little concentrated sodium cyanide solution is added	solution becomes red	Inc conc of CN^- results in inc rate of forward reaction. This results in formation of more red $[Fe(CN)_6]^{3-}$
2	The solution is warmed	solution becomes red	Increase rate of forward reaction is more than inc rate of reverse reaction. This results in formation of more red $[Fe(CN)_6]^{3-}$
3	A little water is added	solution becomes yellow	Reduced conc means forward reaction is reduced more than reverse reaction (more moles on LHS) more yellow $[Fe(H_2O)_6]^{3+}$ produced

Part 3

1. (a) (i) ANODE: $C.Li \rightarrow C + Li^+ + e^-$

(ii) Cathode $CoO_2 + Li^+ + e^- \rightarrow CoO_2.Li$

(iii) Overall reaction $CoO_2 + C.Li + Li^+ \rightarrow LiCoO_2 + C + Li^+$

OR $CoO_2 + C.Li \rightarrow Li.CoO_2 + C$

(b) $n(e^-) = \dfrac{It}{96490} = \dfrac{133 \times 10^{-3} \times 45 \times 60}{96490}$

$Q = 359.1$ C

$= 3.7216 \times 10^{-3}$ mol

$n(Li) = n(e^-) = 3.7216 \times 10^{-3}$

$m(Li) = nM = 3.7216 \times 10^{-3} \times 6.941 = 0.0258 = 2.58 \times 10^{2}$ g

INCREASE IN MASS

2. $Au_2O_3 + 6HI \rightarrow 2AuI + 2I_2 + 3H_2O$

(a) $n(Au_2O_3) = \frac{m}{M} = \frac{25.7}{442} = 0.05814$ mol $[M(Au_2O) = 442 \text{ g mol}^{-1}]$

$n(HI) = \frac{PV}{RT} = \frac{116 \times 4.92}{8.315 \times 318} = 0.2158$ mol

$n(Au_2O_3)_{\text{required to use all HI}} = \frac{1}{6} n(HI) = \frac{1}{6}(0.2158) = 0.03597$ mol

There is more than this so Au_2O_3 is in excess and HI is LR

Use n(HI) to calculate quantities.

Au_2O_3: $n(Au_2O_3)$ left $= n(Au_2O_3)_{original} - n(Au_2O_3)_{used}$

$= 0.05814 - 0.03597 = 0.022437$ mol

$m(Au_2O_3)$ left $= nM = 0.022437 \times 442 = 9.92$ g

HI: This is all used up as it is the limiting reagent

So amount left = 0.00g

AuI: $n(AuI)$ produced $= \frac{2}{6} n(HI) = \frac{2}{6}(0.2158) = 0.07193$ mol

$m(AuI)$ produced $= nM = 0.07193 \times 323.9 = 23.3$ g

I_2: $n(I_2) = \frac{2}{6} n(HI) = \frac{2}{6}(0.2158) = 0.07193$ mol

$m(I_2) = nM = 0.07193 \times 253.8 = 18.3$ g

H_2O: $n(H_2O) = \frac{3}{6} n(HI) = \frac{3}{6}(0.2158) = 0.1079$ mol

$m(H_2O) = nM = 0.1079 \times 18.016 = 1.94$g

3. (a) $SnO_2 + 4H^+ \rightarrow Sn^{4+} + 2H_2O$

(b) $(Sn^2 \rightarrow Sn^4 + 2e^-)5$

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

$5Sn^{2+} + 2MnO_4^- = 16H^+ \rightarrow 5Sn^{4+} + 2Mn^{2+} + 8H_2O$

$V(MnO_4^-) = \frac{23.45 + 23.52 + 23.56}{3} = 23.51$ mL

$n(MnO_4^-)_{used} = cV = 0.0192 \times 0.02351 = 4.514 \times 10^{-4}$ mol

$n(Sn^{2+})_{\text{in 20 mL}} = \frac{5}{2} n(MnO_4^-) = \frac{5}{2}(4.514 \times 10^{-4}) = 1.1285 \times 10^{-3}$ mol

$n(Sn^{2+})_{\text{in sample}} = n(Sn^{2+})_{\text{in 250mL}} = \frac{250}{20} \times 1.1285 \times 10^{-3} = 0.014106$ mol

$m(Sn) = nM = 0.014106 \times 118.7 = 1.6744$ g

$\% Sn = \frac{1.6744}{2.562} \times 100 = 65.4\%$

4. (a) $m(H_2O) = 12.56 - 11.518 = 1.042$ g

$$m(H) = \frac{2.016}{18.016} \times 1.042 = 0.1166 \text{ g}$$

$m(NO_2) = 11.518 - 10.454 = 1.064$g

$$m(N) = \frac{14.01}{46.01} \times 1.064 = 0.3240\text{g}$$

$$m(S) = \frac{32.06}{233.36} \times 5.398 = 0.7416\text{g}$$

$m(C) = 3.127 - (0.1166 + 0.3240 + 0.7416) = 1.945$ g

	C	H	N	S
Mass (g)	1.945	0.1166	0.3240	0.7416
n	$\frac{1.945}{12.01} = 0.1619$	$\frac{0.1166}{1.008} = 0.1157$	$\frac{0.3240}{14.01} = 0.02313$	$\frac{0.7416}{32.06} = 0.02313$
Simplest Ratio	$\frac{0.1619}{0.02313} = 6.999$	$\frac{0.1157}{0.02313} = 5.002$	$\frac{0.02313}{0.02313} = 1.00$	$\frac{0.02313}{0.02313} = 1.00$
	7	5	1	1

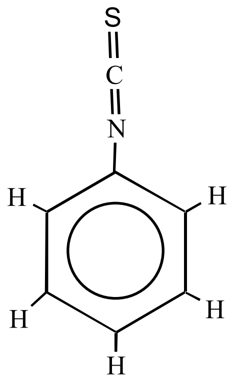
Empirical formula is $\underline{C_7H_5NS}$

(b) $$n(\text{compound}) = \frac{PV}{RT} = \frac{103.5 \times 0.4155}{8.315 \times 295} = 0.01755 \text{ mol}$$

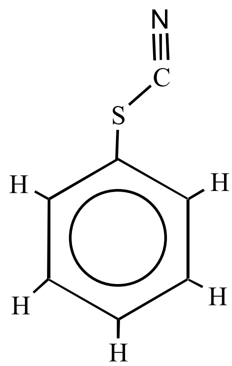
$$n = \frac{m}{M} \quad \therefore \quad M = \frac{m}{n} = \frac{2.372}{0.01755} = 135.2$$

$M(C_7H_5NS) = 135.18$

$\therefore$ Molecular formula = Empirical formula



OR



5. (a) m(FeO) in 1 tonne $= 0.05 \times 10^6 = 50{,}000$ g

$$n(FeO) = \frac{m}{M} = \frac{50{,}000}{71.85} = 695.89 \text{ mol} \qquad [M(FeO) = 71.85 \text{ g mol}^{-1}]$$

$n(C\ell_2)_{\text{reacted with FeO}} = n(FeO) = 695.89$ mol

$m(C\ell_2)_{\text{reacted with FeO}} = nM = 695.89 \times 35.45 \times 2 = 49338.9$ g

$$n(C_6H_5CH_3) = \frac{m}{M} = \frac{35.0\times10^3}{92.134} = 379.88 \text{ mol} \qquad [M(C_6H_5CH_3) = 92.134 \text{ g mol}^{-1}]$$

$n(C\ell) = n(HC\ell) = 8 \times n(C_6H_5CH_3) = 8(379.88) = 3039.05$ mol

$m(C\ell) = nM = 3039.05 \times 35.45 = 107734.39$ g

$m(C\ell)_{\text{total lost}} = 49338.9 + 107734.39 = 157073.3$ g $=$ <u>157 kg</u>

(b) $m(TiO_2) = 0.95 \times 10^6 = 950{,}000$ g

$$n(TiO_2) = \frac{m}{M} = \frac{950{,}000}{79.88} = 11892.8 \text{ mol} \qquad [M(TiO_2) = 79.88 \text{g mol}^{-1}]$$

$n(C\ell_2)_{\text{reacted with TiO2}} = 2n(TiO_2) = 2(11892.8) = 23785.7$ mol

$m(C\ell_2)$ reacted with $TiO_2 = nM = 23785.7 \times 35.45 \times 2 = 1686404.6$g

$m(C\ell)_{\text{total used}} = m(C\ell_2)_{\text{reacted with FeO}} + m(C\ell_2)$ reacted with TiO_2

$= 49338.9 + 1686404.6$

$= 1{,}735{,}743.5$ g $= 1735.7$ kg

$$\% \, C\ell \text{ lost} = \frac{m\,(C\ell)_{\text{lost}}}{m\,(C\ell)_{\text{used}}} \times 100 = \frac{157}{1735.7} \times 100 = 9.05\%$$

For answers to Part 4 please see the Extended Answer Question Answers