Chemistry 12 Trial Exam 2
Final- SOLUTIONS

TEE CHEMISTRY

SOLUTIONS

Part 1

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

Part 2

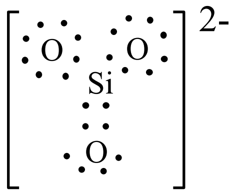
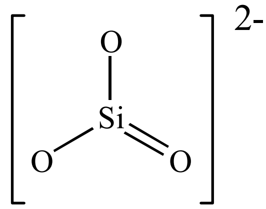
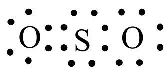
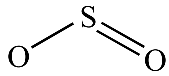
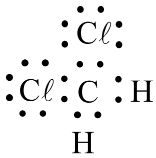
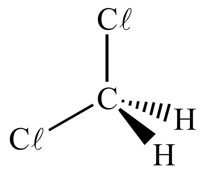
1. (a) Equation: $2Na_{(s)} + 2CH_3OH_{(\ell)} \rightarrow H_{2(g)} + 2CH_3O^-_{(a\ell)} + Na^+_{(a\ell)}$
   Observation: Colourless bubbles produced as the metal dissolved to produce a colourless solution

   (b) Equation: $Co_{(s)} + Cu^{2+}_{(aq)} \rightarrow Co^{2+}_{(aq)} + Cu_{(s)}$
   Observation: The surface of the metal becomes coated with a black substance that may become brown after some time. The blue solution slowly turns pink

   (c) Equation: $2Na_2SO_{3(s)} + 2\,H^+_{(aq)} \rightarrow SO_{2(g)} + H_2O_{(\ell)} + 2Na^+_{(aq)}$
   Observation: An acrid smelling colourless gas is produced. Very small bubbles may be observed. The solid dissolves.

   (d) Equation: $2Fe^{3+}_{(aq)} + 3S^{2-}_{(aq)} \rightarrow Fe_2S_{3(s)}$
   Observation: Black (or brown) precipitate is produced from a yellow or brown and a colourless solution.

2.

Species	Structural formula showing all valence electrons	Draw shape of molecule or ion
silicate ion SiO_3^{2-}		
sulfur dioxide SO_2		
dichloromethane $CH_2C\ell_2$		

3. (a) Cryolite or $Na_3A\ell F_6$
   (b) Oxygen or O2
   (c) Carbon monoxide or CO
   (d) Zinc or Zn or magnesium or Mg
   (e) Chlorine or $C\ell_2$ or ozone or O_3
   (f) Sulfuric acid or H_2SO_4
   (g) Anhydrous sodium carbonate or Na_2CO_3
   or
   Oxalic acid dihydrate or $H_2C_2O_4.2H_2O$

4. To distinguish between silver nitrate and lead nitrate solutions. 4 possible tests are described.

TEST 1: Add NH_3 solution to each solution
OBSERVATION: Silver nitrate produces white precipitate that dissolves as more NH_3 is added to produce a colourless solution.
Lead nitrate white precipitate that does not dissolves as more NH_3 is added.

OR

TEST 2: Add copper metal to each solution
OBSERVATION: Silver nitrate produces black precipitate on the surface of the copper metal.
Lead nitrate produces no precipitate.

OR

TEST 3: Add a solution of $C\ell^-$ to each solution
OBSERVATION: Silver nitrate produces a thick white precipitate that slowly darkens.
Lead nitrate produces a milky white precipitate that dissolves when heated.

OR

TEST 4: Add a solution of SO_4^- to each solution
OBSERVATION: Silver nitrate produces a milky white precipitate that slowly becomes pale yellow.
Lead nitrate produces a thick white precipitate.

To distinguish between silver nitrate and lead nitrate solutions. 4 possible tests are described.

TEST 1: Add a solution of H^+ to each solution
OBSERVATION: Sodium sulfide produces a strongly pungent gas that smells like rotten eggs.
Sodium hydroxide produces no odour but an increase in temperature may be observed.

OR

TEST 2: Add water then add an amphoteric metal, metal oxide or metal hydroxide to each solution
OBSERVATION: Sodium sulfide produces no observable change the solids remain unaffected.
Sodium hydroxide produces colourless bubbles with the metal. The metal oxide and hydroxide will dissolve. The oxide may need heating.

5. The dark green precipitate is chromium (III) hydroxide, $Cr(OH)_3$, which is insoluble and produced as in the equation

$$Cr^{3+}{}_{(aq)} + OH^-{}_{(aq)} \rightarrow Cr(OH)_{3(s)}$$

Dark green solid

This then reacts with further OH– to produce the chromite ion (chromium hydroxide complex ion) which is soluble and is produced as in the equation.

$$Cr(OH)_{3(s)} + OH^-{}_{(aq)} \rightarrow [Cr(OH)_4]^-{}_{(aq)}$$

Intense deep green solution

Part 3 Calculations

(a) $NH_{3(aq)} + H^+_{(aq)} \rightarrow NH_4^+{}_{(aq)}$

$m(NH_3) = cV = 70.0 \times 0.250 = 17.5 \text{ g}$

$n(NH_3) = \frac{m}{M} = \frac{17.5}{17.034} = 1.027 \text{ mol}$ $[M(NH_3) = 27.0345\text{g mol}^{-1}$

$n(H_2SO_4) = \frac{1}{2} n(H^+) = \frac{1}{2} n(NH_3) = \frac{1}{2}(1.027) = 0.51368 \text{ mol}$

$m(H_2SO_4) = nM = 0.51368 \times 98.06$ $[M(H_2SO_4) = 98.076 \text{ g mol}^{-1}]$
$= 50.3795 \text{ g}$

$M(H_2SO_4)_{solution} = \frac{100}{83} \times 50.3795 = 61.438 \text{ g}$

$V(H_2SO_4)_{solution} = \frac{M}{1.59} = \frac{61.438}{1.59} = \underline{38.6 \text{ mL}}$

(b) $2NH_4^+{}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow (NH_4)_2SO_{4(s)}$

$n((NH_4)_2SO_4) + \frac{1}{2} n(NH_4^+) = \frac{1}{2}NH_3) = \frac{1}{2}(1.027) = 0.51368 \text{ mol}$
$[M(NH_4)_2SO_4) = 132.144 \text{ g mol}^{-1}]$

$m((NH_4)_2SO_4) = nM = 0.51368 \times 132.144 = 67.9 \text{ g}$

(c) Solution would be acidic

$NH_4^+ + H_2O \rightleftarrows H_3O^+ + NH_3$

2.

(a) $m(C) = \frac{12.01}{44.01} \times 3.533 = 0.96412 \text{ g}$ $\%C = \frac{0.96413}{1.573} \times 100 = 61.29\%$

$m(H) = \frac{2.016}{18.016} \times 0.7232 = 0.080926\text{g}$ $\%H = \frac{0.080926}{1.573} \times 100 = 5.1447\%$

$H^+ + NH_3 \rightarrow NH_4^+$

$n(H^+) = n(HC\ell) = cV = 0.4201 \times 0.02367 = 9.94377 \times 10^{-3} \text{ mol}$
$n(N) = n(NH_3) = n(H^+) = 9.94377 \times 10^{-3} \text{ mol}$
$m(N) = nM = 9.94377 \times 10^{-3} \times 14.01 = 0.1393 \text{ g}$

$\%N = \frac{0.1393}{1.363} \times 100 = 10.221\%$
$\%O = 100 - (61.293 + 5.1447 + 10.221) = 23.3413\%$

	C	H	N	O
%	61.293	5.1447	10.221	23.3413
n in 100 g	$\frac{61.293}{12.01} = 5.1035$	$\frac{5.1447}{1.008} = 5.1039$	$\frac{10.221}{14.01} = 0.72955$	$\frac{23.3413}{16.00} = 1.4588$
simplest ratio	$\frac{5.1035}{0.72955} = 6.995$	$\frac{5.1039}{0.72955} = 6.996$	$\frac{0.72955}{0.72955} = 1.00$	$\frac{1.4588}{0.72955} = 1.9906$
	7	7	1	2

Empirical formula is $C_7H_7NO_2$

(b) $n(OH^-) = n(NaOH) = cV = 3.579 \times 10^{-3} \times 0.03533 = 1.26446 \times 10^{-4}$ mol
$n\,(\text{Compound}) = n(OH^-) = 1.26446 \times 10^{-4}$ mol

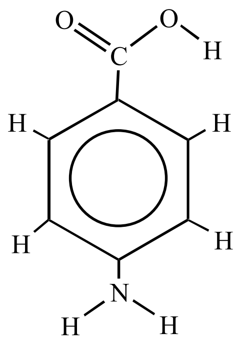
$$n = \frac{m}{M} \text{ therefore } M = \frac{m}{M} = \frac{0.01734}{1.26446 \times 10^{-4}} = 137.13 \text{ g Mol}^{-1}$$

$M(C_7H_7NO_2) = 137.136 \text{ g mol}^{-1}$

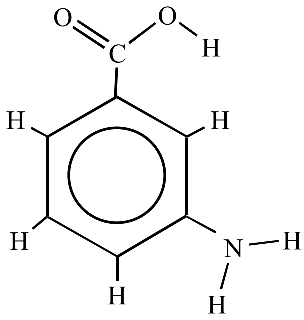
As the molecule mass is equal to the empirical formula mass then the molecular formula is the same as the empirical formula.

ie. $C_7H_7\,NO_2$

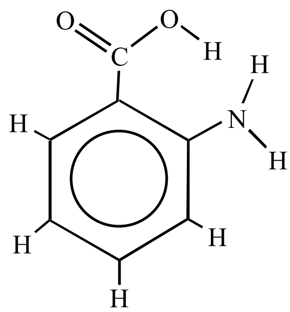
(c) Possible structures



OR



OR



3. (a) (i) Cathode
(ii) Chromium

(b) (ii) Anode: $Cr \rightarrow Cr^{3+} + 3e^-$
Cathode: $C^{3+} + 3e^{--} \rightarrow Cr$

(ii) $q = It = 3.12 \times 20.0 \times 60 \times 60 = 224640$ C

$$n(e^-) = \frac{q}{96490} = \frac{224640}{96490} = 2.3281 \text{ mol}$$

$$n(Cr) = \frac{1}{3} n(e^-) = \frac{1}{3}(2.3281) = 0.77604 \text{ mol}$$

$M(Cr) = nM = 0.77604 \times 52.00 = 40.354 = 40.4$ g

4.

	Rough Trial	Trial 1	Trial 2	Trial 3	Trial 4
Initial reading	1.32	20.16	0.69	19.08	0.02
Final reading	20.16	38.78	19.08	37.86	18.77
Volume used		18.62	18.39	18.78	18.75

(a) $BrO_3^- + 6H^+ \; 6e^- \rightarrow Br^- + 3H_2O$

$(AsO_3^{3-} + H_2O \rightarrow AsO_4^{3-} + 2H^+ + 2e^-) \times 3$

$BrO_3^- + 3AsO_3^{3-} \rightarrow Br^- + 3AsO_4^{3-}$

(b) $V(BO_3^-)_{average} = \dfrac{18.62 + 18.78 + 18.75}{3} = 18.72 \text{ mL}$

$n(BrO_3^-) = n(KBrO_3) = cV = 2.0732 \times 10^{-5} \times 0.01872 = 3.881 \times 10^{-7} \text{ mol}$

$n(AsO_3^{3-})_{\text{ in 20 mL}} = 3n(BrO_3^-) = 3(3.881 \times 10^{-7}) = 1.164 \times 10^{-6} \text{ mol}$

$n(AsO_3^{3-})_{\text{ in 50 mL water}} = n(AsO_3^{3-})_{\text{ in 250 ml Dil water}} = \dfrac{250}{20} \times 1.164 \times 10^{-6} = 1.455 \times 10^{-5} \text{ mol}$

(c) $n(As)_{\text{ in 1L}} = n(AsO_3^{3-})_{\text{ in 1L}} = 2.911 \times 10^{-4} \text{ mol}$

$m(As)_{\text{in 1L}} = nM = 2.911 \times 10^{-4} \times 74.92 = 0.02181 \text{ g}$

$\text{Concentration in ppm} = \dfrac{m(As) \text{ in mg}}{m(\text{solution}) \text{ in kg}}$ $(1.00 \text{ L} = 1.00 \text{ kg})$

$= \dfrac{0.02181 \times 10^3}{1.00} = 21.8 \text{ ppm}$

5. (a) (i) $n(H_2) = \dfrac{PV}{RT} = \dfrac{105 \times 877 \times 10^3}{8.315 \times 301} = 36792.57 \text{ mol}$

$n(Ni) = \frac{1}{3} n(H_2) = \frac{1}{3}(36792.57) = 12264.19 \text{ mol}$

$m(Ni) = nM = 12264.19 \times 58.69 = 719785.3 \text{ g} = 719.7853 \text{ kg}$

$\% \text{ Ni} = \dfrac{719.7956}{1000} \times 100 = 71.978\% = 72.0\%$

(ii) $[M(NH_4)_2SO_4) = 132.144 \text{ g mol}^{-1}]$

$M((NH_4)_2SO_4)_{\text{ total in soln}} = 771 \times \dfrac{100}{85} = 907.059 \text{ kg}$

$n(SO4^{2-}) = n((NH_4)_2SO_4) = \dfrac{m}{M} = \dfrac{907.059 \times 10^3}{132.144} = 6864.171 \text{ mol}$

$n(NiS) = n(SO_4^{2-}) = 6864.171 \text{ mol}$

$m(NiS) = nM = 6864171 \times 90.75$ $[M(NiS) = 90.75 \text{ g Mol}^{-1}]$

$= 622923.5 \text{ g}$

$= 0.6229235 \text{ tonne}$

$\%NiS = \dfrac{0.6229235}{1.00} \times 100 = 62.3\%$

(b) $n(Ni)_{in\ Ni\ matte} = n(Ni)_{total} - n(NiS)_{in\ Ni\ matte} = 12264.19 - 6864.171 = 5400.019$ mol

$n(SO_2) = n(Ni)_{in\ Ni\ matte} = 5400.019$ mol

$m(SO_2) = nM = 5400.019 \times 64.06$ $[M(SO_2) = 64.06 \text{ g mol}^{-1}]$

$= 345.703.8$ g

$= 346$ kg $= 0.346$ tonne

For answers to the Part 4 please see the section containing Extended Answer Questions