CHEMISTRY

SEMESTER ONE EXAMINATION
ANSWERS

PART 1

1.	(c)	6.	(b)	11.	(c)	16.	(a)
2.	(a)	7.	(d)	12.	(d)	17.	(c)
3.	(a)	8.	(c)	13.	(c)	18.	(b)
4.	(c)	9.	(b)	14.	(a)	19.	(a)
5.	(d)	10.	(c)	15.	(c)	20.	(b)

PART 2

(a) Equation: $Cr_2O_{3(s)} + 6H^+_{(aq)} \rightarrow 2Cr^{3+}_{(aq)} + 3H_2O_{(\ell)}$

Observation: Green solid dissolves to produce a deep green solution.

(b) Equation: $3Ni^{2+}_{(aq)} + 2PO_4^{3-}{}_{(aq)} \rightarrow Ni_3(PO_4)_{2\,(s)}$

Observation: A bright green solution and a colourless solution produces a green precipitate.

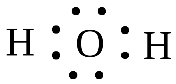
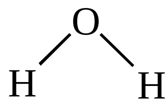
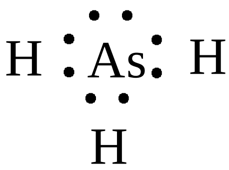
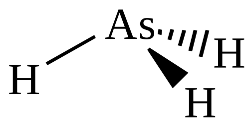
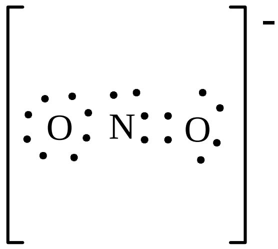
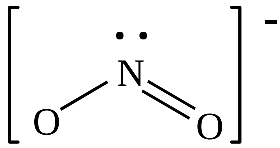
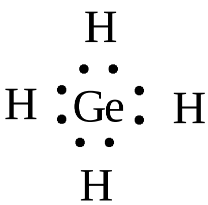
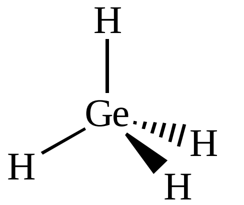
(c) Equation: $Ca(OH)_{2(s)} + 4NH_{3(aq)} \rightarrow [Cu(NH_3)_4]^{2+}_{(aq)} + 2OH^-_{(aq)}$

Observation: Pale blue solid dissolves to produce a deep blue solution.

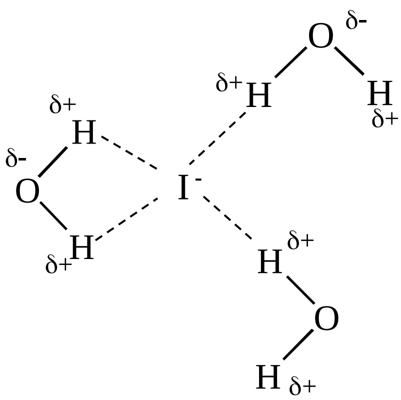
(d) Equation: $2CrO_4^{2-}{}_{(aq)} + 2H^+_{(aq)} \rightleftarrows Cr_2O_7^{2-}{}_{(aq)} + H_2O_{(\ell)}$

Observation: A yellow solution changes to an orange coloured solution

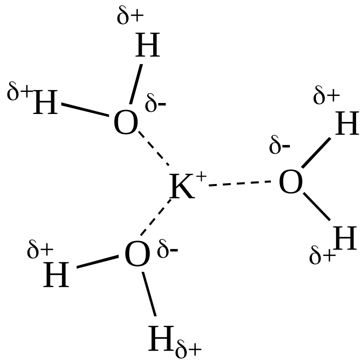
2.

Species	Structural formula (showing all valence electrons)	Sketch and name the shape
EXAMPLE: Water (H_2O)		 Name of shape Bent
Arsine (AsH_3)		 Name of shape Pyramidal
Nitrite ion (NO_2^-)		 Name of shape Bent or V-Shaped
Germane (GeH_4)		 Name of shape Tetrahedral

3.



and



4.

Substances	Chemical Test	Observations
Solid zinc nitrate and Solid magnesium nitrate	1. Add OH^- or NH_3 solution. OR 2. Add water to each then add OH^- or NH_3 solution gradually until in excess	For zinc nitrate 1. Dissolves to form a colourless solution. 2. White precipitate forms which dissolves to form a colourless solution
		For magnesium nitrate 1. Does not dissolve. 2. White precipitate forms which does not dissolve.

5.

Compound	Electrical conductivity	Explanation
$HC\ell_{(aq)}$	High	Ionisation of $HC\ell$ to H^+ and $C\ell^-$ is complete $HC\ell_{(aq)}$ □ $H^+_{(aq)} + C\ell^-_{(aq)}$ $[H^+] = [C\ell^-] = [HC\ell] = 0.100\ \text{mol L}^{-1}$ High ion concentration, therefore high conductivity
$NH_{3(aq)}$	Low	Ionisation of NH_3 to NH_4^+ and OH^- is very small $NH_{3(aq)} + H_2O_{(\ell)} \rightleftarrows NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$ $[NH_4^+] = [OH^-] <<< [NH_3] <<< 0.100\ \text{mol L}^{-1}$ Low ion concentration, therefore low conductivity
$NH_4C\ell_{(aq)}$	High	Dissociation of $NH_4C\ell$ to NH_4^+ and $C\ell^-$ is complete $NH_4C\ell_{(s)}$ □ $NH_4^+{}_{(aq)} + C\ell^-{}_{(aq)}$ $[NH_4^+] = [C\ell^-] = [NH_4^+C\ell] = 0.100\ \text{mol L}^{-1}$ High ion concentration, therefore high conductivity

6 (a) To predict changes to the concentration of reactants and products that occur when a change is made to a system in chemical equilibrium.

(b) (i) Increased
(ii) Increased
(iii) unchanged

(c) (i) Decreased
(ii) Increased
(iii) No change

(d) 1. Increase the rate of the forward reaction with no immediate increase in the rate of the reverse reaction.
2. As the concentration of the SO_3 increases the rate of the reverse reaction begins to increase.

3. As the concentration of reactants decreases the rate of the forward reaction decreases.

PART 3

1. (a) $HC\ell(aq) + Ag^+(aq) \rightarrow H^+(aq) + AgC\ell(s)$ [$M(AgC\ell = 143.35\ g\ mol^{-1}$]

$$n(AgC\ell) = \frac{m}{M} = \frac{2.32}{143.35} = 0.01618\ mol$$

$N(HC\ell) = n(AgC\ell) = 0.01618\ mol$

$$V(HC\ell) = \frac{nRT}{P} = \frac{0.01618 \times 8.315 \times 298}{98.0} = 0.4092\ L = 409\ mL$$

(b) $n(Ag^+)_{initial} = n(AgNO_3) = cV = 0.200 \times 0.250 = 0.0500\ mol$

$n(Ag^+)_{ppt} = n(AgC\ell) = 0.01618\ mol$

$n(Ag^+)_{left} = n(Ag^+)_{initial} - n(Ag^+)_{ppt} = 0.0500 - 0.01618 = 0.03382\ mol$

$$[Ag^+] = \frac{n}{V} = \frac{0.03382}{0.250} = 0.135\ mol\ L^{-1}$$

(c) $C_6H_6C\ell_6 + 12O_2 \rightarrow 6CO_2 + 6HC\ell$

$n(C_6H_6C\ell_6) = 1/6n(HC\ell) = 1/6(0.01618) = 2.6967 \times 10^{-3}\ mol$

$[M(C_6H_6C\ell_6) = 290.808\ g\ mol^{-1}]$

$m(C_6H_6C\ell_6) = nM = 2.6967 \times 10^{-3} \times 290.808 = 0.7842\ g$

$$\%Purity = \frac{m(C_6H_6C\ell_6)}{m(Sample)} \times 100 = \frac{0.7842}{1.00} \times 100 = 78.4\%$$

2. $CuCO_3(aq) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + CO_2(s) + H_2O(\ell)$

And $H^+(aq) + OH^-(aq) \rightarrow H_2O(\ell)$

$n(H^+)_{initial} = 2n(H_2SO_4) = 2cV = 2 \times 1.250 \times 0.0250 = 0.0625\ mol$

$n(H^+)_{left} = n(OH^-) = n(NaOH) = cV = 0.250 \times 0.0176 = 4.40 \times 10^{-3}\ mol$

$n(H^+)_{used} = n(H^+)_{initial} - n(H^+)_{left} = 0.0625 - 4.40 \times 10^{-3}\ mol$

$n(Cu) = n(CuCO_3) = ½\ n(H^+)_{used} = ½ \times 0.0581 = 0.02905\ mol$

$n(Cu)_{in\ 5.00\ g} = nM = 0.02905 \times 63.55 = 1.846\ g$

$$m(Cu)_{in\ 1\ tonne} = \frac{1.846 \times 1.00 \times 10^6}{5.00} = 369225.5\ g = 3.69 \times 10^5\ g = 369\ kg \qquad [1\ tonne = 1.00 \times 10^6\ g]$$

3.

$$n(N_2) = \frac{PV}{RT} = \frac{300 \times 101.3 \times 1160}{8.315 \times 773} = 5484.63\ mol$$

$$n(H_2) = \frac{PV}{RT} = \frac{300 \times 101.3 \times 2850}{8.315 \times 773} = 13475.16\ mol$$

$n(H_2)_{\text{required to use all nitrogen}} = 3n(N_2) = 3 \times 5484.63 = 16453.89$ mol

There is only 13475.16 mol of hydrogen so H_2 is the limiting reagent.

From the equations:

$n(HNO_3) = ⅔\, n(H_2) = ⅔\, 13475.16 = 8983.44$ mol

[$M(HNO_3) = 63.018$ g mol^{-1}]

$m(HNO_3) = nM = 8983.44 \times 63.018 = 566118$ g $= 5.66 \times 10^5$ g $= 566$ kg

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