Year 11
Chemistry TRIAL EXAM

SOLUTIONS

Part 1:

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

(60)

Part 2:

1(a) $Ba^{2+}(aq) + CO_3^{2-}(aq) \rightarrow BaCO_3(s)$
White precipitate forms. (3)

1(b) $CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$
Solid dissolves; colourless odourless gas given off; solution gets warmer (3)

1(c) $Al(OH)_3(s) + OH^-(aq) \rightarrow [Al(OH)_4]^-(aq)$
Solid dissolves (3)

2(a) (i) $1s^2\ 2s^2\ 2p^3$ (2.5) (1)

(ii) $1s^2\ 2s^2\ 2p^6$ (2,8) (1)

2(b) (i) any two of: P^{3-}, S^{2-}, Cl^-, K^+, Ca^{2+} (2)

(ii) any two of: H^-, Li^+, Be^{2+}, B^{3+} (<u>not</u> H^+) (2)

3(a) In the solid state ions are effectively locked into fixed positions so no conduction can occur. When liquid or aqueous, the ions are free to move and conduct their charge.

3(b) Most elements in nature consist of several isotopes. The atomic weight is actually the weighted averages of the relative atomic masses of the various isotopes that occur naturally - therefore, the averages are not necessarily whole numbers.

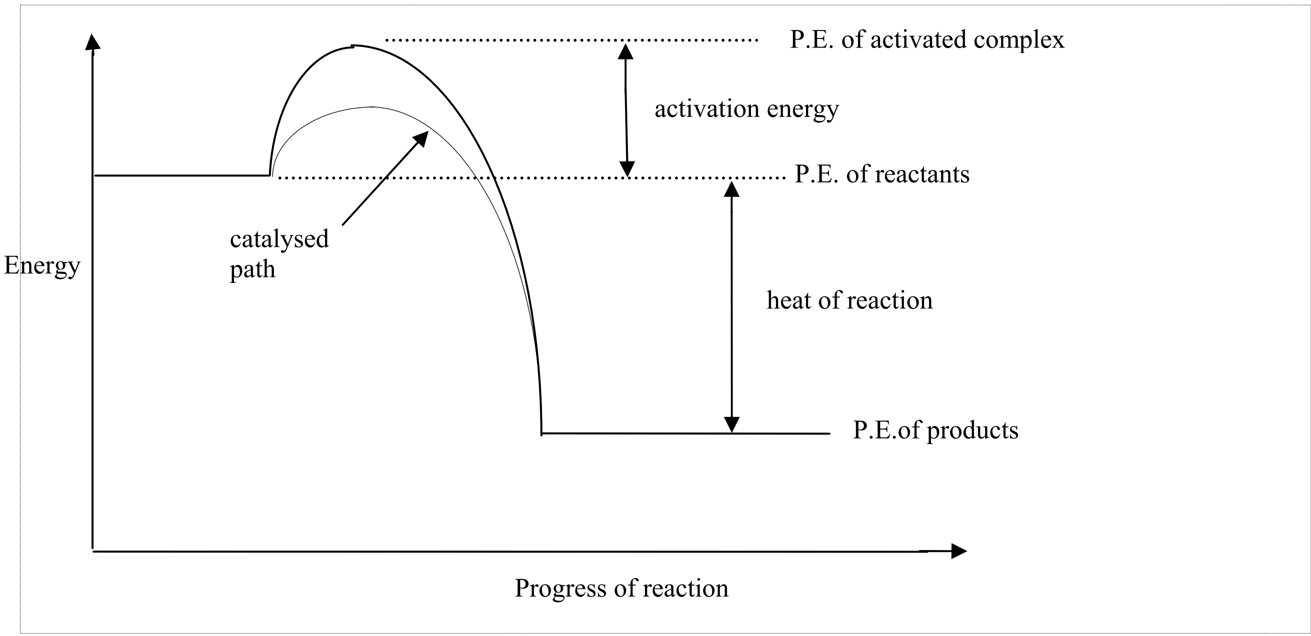
3(c) When the lattice is distorted, no real relative change in the position of the positive ions occurs and the mobile delocalised electrons continue to hold it together.

3(d) The attractive forces between gas particles become significant.

3(e) Neon has a stable electron configuration and therefore does not share electrons and will therefore form
no bonds. Fluorine has seven valence electrons one of which is shared with another fluorine atom so that both have stable electron configurations.

(5 x 2 = 10)

4(a)



4(a) axes (1)
activation energy (1)
heat of reaction (1)
potential energies (1)

4(b) (i) lower curved line (1)

(ii) provides alternative reaction pathway with a lower activation energy (2)

4(c) increase temperature
increase pressure / reduce volume / add reactants / increase concentration of reactants (2)

5(a) (i) +4 (1)

(ii) +7 (1)

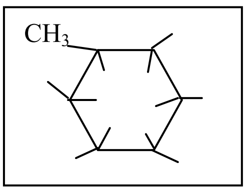
(iii) -1 (1)

5(b) (i) H^+ (1)

(ii) Cu^+ or Cu_2O (1)

(iii) Cl_2 (1)

6(a)



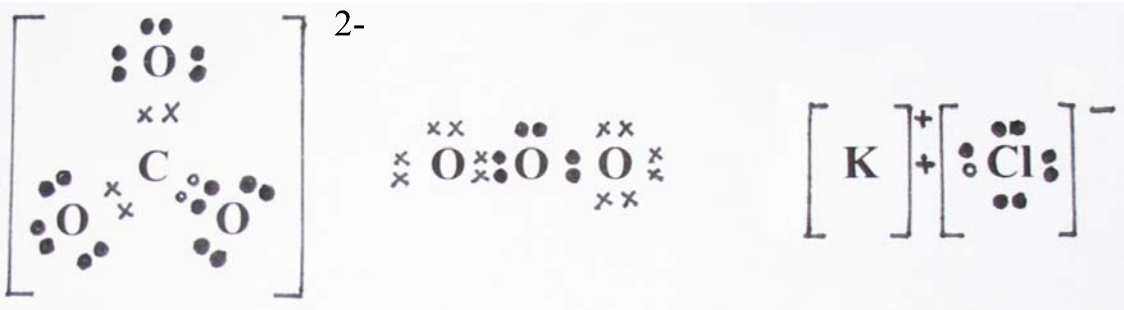
(1)

6(b) 2-methyl-1-pentene (1)

6(c) $CH_3-C\equiv C-CH_3$ (1)

6(d) trans-1,2 -dibromopropene (1)

7.



covalent covalent ionic (3 x 2 = 6)

8(a). Glowing splint test: with O_2(g), the splint stays alight; with CO_2(g), the splint goes out.

OR Bubble through limewater: with O_2(g), no reaction; with CO_2(g), white ppt forms.

OR Dissolve in water and test for pH (meter/litmus): with O_2(g), remains neutral: with CO_2(g), acidic soln. produced. (2)

8(b) Dissolve in water, then add $AgNO_3$(aq): with NaCl, white ppt forms; with $NaNO_3$, no visible reaction. (2)

9(a) Temporary hardness can be removed by boiling. Permanent hardness requires other treatment. (1)

9(b) It forms soluble complex ions with Ca^{2+}(aq) or Mg^{2+}(aq) rather than a precipitate. (1)

9(c) Water in which all cations and anions present have been replaced with H^+ and OH^- respectively. (1)

9(d) $Ca(HCO_3)_2(aq) \rightarrow CaCO_3(s) + CO_2(g) + H_2O(l)$ (1)

10(a) (i) $NaCl(s) + H_2SO_4(l) \rightarrow HCl(g) + Na^+(aq) + HSO_4^-(aq)$ (2)

(ii) $MnO_2(s) + 4H^+(aq) + 2Cl^-(aq) \rightarrow Mn^{2+}(aq) + Cl_2(g) + 2H_2O(l)$

OR $2MnO_4^-(aq) + 16H^+(aq) + 10Cl^-(aq) \rightarrow 2Mn^{2+}(aq) + 8H_2O(l) + 5Cl_2(g)$ (2)

10(b) (i) Colour or solubility in water (1)

(ii) HCl(g) is colourless; Cl_2(g) is pale greenish yellow

HCl(g) is very soluble in water; Cl_2(g) is only moderately soluble (1)

10(c) Upward displacement of air. The gases are denser than air and soluble in water. (2)

11(a) O.N. of Cd changes from 0 → +2. (1)

11(b) $Cd(s) + 2OH^-(aq) \rightarrow Cd(OH)_2(s) + 2e^-$ (2)

11(c) O.N. of Ni changes from +3 → +2. (1)

Part 3:

1(a) $Mn^{2+}(aq) + 2OH^-(aq) \rightarrow Mn(OH)_2(s)$ (2)

If $MnCl_2(aq) + 2KOH(aq) \rightarrow Mn(OH)_2(s) + 2KCl(aq)$ (only 1)

1(b) $n(MnCl_2) = m/M = 6.3/125.84 = 0.0501$ mol $MnCl_2$ (2)

$n(KOH) = c \times V = 0.32 \times 0.125 = 0.04$ mol KOH (1)

SR: $n(MnCl_2) / n(KOH) = ½ = 0.5$

AMR: $n(MnCl_2) / n(KOH) = 0.05001 / 0.04 = 1.25$ (working out 1)

Clearly, AMR > SR Hence, KOH is the limiting reagent (1)

1(c) From the equation, $n(Mn(OH)_2) = ½\ n(KOH) = ½ \times 0.04 = 0.02$ mol $Mn(OH)_2$

$m(Mn(OH)_2) = n \times M = 0.02 \times 88.956 = 1.779$

Hence, the mass of the precipitate of $Mn(OH)_2$ is 1.78 g (3)

1(d) Initially, $n(MnCl_2) = 0.0501$ Hence, $n(Mn^{2+}) = 0.0501$ mol Mn^{2+}

$n(Cl^-) = 2 \times 0.0501 = 0.1001$ mol Cl^-

$n(KOH) = 0.04$ Hence, $n(K^+) = 0.04$ mol K^+ Hence, $n(OH^-) = 0.04$ mol OH^-

At the end, V(solution) = 100 mL + 125 mL = 225 mL = 0.225 L (1)

$c(K^+) = n(K^+) / V = 0.04 / 0.225 = 0.178$ mol L^{-1} K^+ (1)

$c(Cl^-) = n(Cl^-) / V = 0.1001 / 0.225 = 0.445$ mol L^{-1} Cl^- (1)

$c(OH^-) = 0$ mol L^{-1} OH^-

$n(Mn^{2+})_{end} = n(Mn^{2+})_{initial} - n(Mn^{2+})_{reacted} = 0.05006 - 0.02 = 0.0301$ mol L^{-1} Mn^{2+} (1)

$c(Mn^{2+}) = n(Mn^{2+}) / V = 0.03006 / 0.225 = 0.134$ mol L^{-1} Mn^{2+} (1)

2(a) $n(H^+) = c \times V = 1 \times 10^{-2} \times 10 = 0.1$ mol H^+ (1)

$n(OH^-) = n(KOH) = m / M = 5 / 56.108 = 0.08911$ mol OH^- (1)

$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ (1)

from the equation, $n(H^+)$ reacting $= n(OH^-) = 0.0891$ mol OH^- (1)

$n(H^+)$ left $= n(H^+)$ initial $- n(H^+)$ reacting $= 0.1 - 0.0891 = 0.0109$ mol H^+ (1)

$c(H^+) = n / V = 0.01089 / (10 + 1) = 9.896$ mol L^{-1} H^+ (1)

$c(HCl) = c(H^+) = 9.90 \times 10^{-4}$ mol L^{-1} (1)

2(b) $n(Na_2CO_3) = m / M = 1.6 / 105.99 = 0.015096$ mol Na_2CO_3 (1)

$c(Na_2CO_3) = n / V = 0.015096 / 0.5 = 0.03019$ mol L^{-1} (1)

$2H^+(aq) + CO_3^{2-}(aq) \rightarrow H_2O(l) + CO_2(g)$ (1)

From the equation, $n(CO_3^{2-}) = ½\ n(H^+) = ½\ (0.010886) = 0.00544$ mol CO_3^{2-} (1)

$c(Na_2CO_3) = n / V$ Hence, $V = n / c = 0.005443 / 0.03019) = 0.1803$ L

Hence, the volume of $Na_2CO_3(aq)$ is 0.180 L (1)

2(c) $m(Na_2CO_3.xH_2O) = 4.30$ g and $m(Na_2CO_3) = 1.6$ g

Hence, $m(H_2O) = 4.3 - 1.6 = 2.7$ g (1)

Hence, $n(Na_2CO_3) = m / M = 1.6 / 105.99 = 0.0151$ mol $\equiv 1$

and $n(H_2O) = m / M = 2.7 / 18.016 = 0.1499$ mol $\equiv 10$ (1)

Hence, the true formula of $Na_2CO_3.xH_2O$ is $Na_2CO_3.10H_2O$ ie x = 10. (1)

3(a) m(sample) = 0.5 g ; m(C) = 0.3 g ; m(O) = 0.1776 g.

m(H) = 0.5 - (0.3 + 0.1776) = 0.0224 g. (1)

Hence, $n(C) = m / M = 0.3 / 12.01 = 0.02497 \equiv 2.25 \equiv 9$

$n(H) = m / M = 0.0224 / 1.008 = 0.02 \equiv 2.0 \equiv 8$

$n(O) = m / M = 0.1776 / 16.00 = 0.111 \equiv 1.0 \equiv 4$ (3)

Hence, the Empirical Formula is $C_9H_8O_4$ (1)

3(b) REFM = (9 x 12.01) + (8 x 1.008) + (4 x 16.00) = 180.154 (1)

Molecular formula = (RMM / REFM) x Empirical formula

= (180.154 / 180.154) x $C_9H_8O_4$ = <u>$C_9H_8O_4$</u> (1)

3(c) Concentration (ppm) = m(pure in mg) / m(impure in kg)

= m(aspirin in mg) / m(tablet in kg) = 500 / 0.00102 = <u>4.90×10^5 ppm</u> (2)

Concentration (%) = [m(aspirin in g) / m(tablet in g)] x 100

= [0.5 / 1.02] x 100 = <u>49.0%</u> (2)

4(a) p(NH_3): $P_1V_1 = P_2V_2$ Hence, $P_2 = (P_1V_1) / (V_2)$ = (150 x 50) / 60 = 125 kPa (1)

p(O_2): $P_1V_1 = P_2V_2$ Hence, $P_2 = (P_1V_1) / (V_2)$ = (100 x 10) / 60 = 16.7 kPa (1)

P_T = p(NH_3) + p(O_2) = 125 + 16.7 = <u>142 kPa</u> (1)

4(b) $4NH_3(g) + 7O_2(g) \rightarrow 4NO_2(g) + 6H_2O(g)$ + heat (1)

4(c) SR: V(NH_3) / V(O_2) = 4 / 7 = 0.57

AMR p(NH_3) / p(O_2) = 125 / 16.7 = 7.5

AMR > SR Hence, O_2(g) is the limiting reagent (2)

4(d) PV = nRT Hence, n(NH_3) = PV / RT = (125 x 60) / (8.315 x 303.1) = 2.976

PV = nRT Hence, n(O_2) = PV / RT = (16.7 x 60) / (8.315 x 303.1) = 0.3968 (1)

From the equation, n(NO_2) = 4 / 7 n(O_2) = 0.2267 (1)

p(NO_2) = nRT / V = (0.2267 x 8.315 x 573.1) / 60 = 18.01 = <u>18.0 kPa</u>. (1)

[Note: Using $P_1V_1 / T_1 = P_2V_2 / T_2$, p($NO_2$) = 18.3 kPa]

OR

[p(NO_2) = 4 / 7 p(O_2) = 4 / 7 x 16.7

at 300°C: $P_2 = P_1T_2 / T_1$ = 4 / 7 x 16.7 x 573 / 303 = 18.01 = 18.0 kPa]

<u>Part 4:</u> Note: The following marking scheme is a suggestion only - you do not need to have every point to get full marks. Some of the points listed are not in the syllabus, they do not have to be included to get marks but they could be used as possible answers by students.

1 Chemical properties (maximum of 9)

Combustion: combine with oxygen to produce water, carbon dioxide and a large amount of heat (2)

Alkanes are fairly unreactive. Alkanes undergo substitution reactions

C-H bond broken and H atom replaced with an atom of another element (2)

alkenes are very reactive

alkenes and alkynes undergo addition reactions - addition of two new atoms across the double or triple bond (2)

eg hydrogenation, halogenation, hydrohalogenation, hydration (2) alicyclics same types of reactions as aliphatic counterparts (1)

aromatics undergo substitution reactions (esp. halogenation, nitration and alkylation) (1)

Isomerism (maximum of 11)

isomers are different compounds which have the same molecular formula (2)

chain structural isomerism: isomers have different numbers of carbon atoms in their longest carbon chain (2)

positional structural isomerism: functional or substituent groups are located on different carbon atoms in the chain (2)

geometric isomerism: relates to the relative positions of groups attached to carbon atoms joined by a double bond (2)

examples given if appropriate (3)

2. Classifying hydrocarbons (maximum of 8)

hydrocarbons contain only H and C atoms (1)

3 major groups- aliphatics - straight or branched chains (1)

alicyclics - carbon atoms in a closed ring (1)

aromatics - based on parent compound benzene (1)

the aliphatics and alicyclics are further subdivided into:

saturated - contain only single C-C bonds (1)

unsaturated - contain at least one double or triple carbon-carbon bond (1)

the unsaturated can be further subdivided into those that contain either double (C=C) or triple (C≡C) carbon-carbon bonds (2)

eg pentane - a saturated aliphatic hydrocarbon

eg 1-pentene - an unsaturated aliphatic hydrocarbon with a double bond

eg 1-pentyne - an unsaturated aliphatic hydrocarbon with a triple bond

Naming hydrocarbons (maximum of 7)

2 important characteristics:

number of C atoms in hydrocarbon chain (1)

presence of any special or functional groups attached (1)

the number of carbon atoms in the main chain determines the stem name (1)

the special/functional groups determine the suffix:

eg. C-C : -ane; C=C : -ene; C≡C : -yne. (1)

rules: identify the longest carbon chain with the special feature or the functional group (gives stem and suffix) (1)

identify substituent groups branching off the longest chain (gives prefixes) (1)

number the longest chain so that the functional group (or if none, then the substituent group) has the lowest possible number. (1)

Physical properties (maximum of 5)

low melting and boiling points

low density

insoluble in water

dissolve in non-polar solvents

properties related to the nature of the weak intermolecular forces if you increase molecular mass, you increase mp, bp and density.

END OF SOLUTIONS