SECTION A – Multiple choice questions (20 marks)

1 **C**	6 **C**	11 **D**	16 **C**
2 **D**	7 **C**	12 **B**	17 **B**
3 **D**	8 **C**	13 **B**	18 **A**
4 **B**	9 **A**	14 **B**	19 **A**
5 **A**	10 **C**	15 **D**	20 **B**

SECTION B – Short answer questions (56 marks)

Question 1 (8 marks) Two marks per equation.

Suggested mark scheme of ½ mark for each correct formula indicated by star; and 1 mark for balanced equation. For ionic equations 1 mark for balanced equation and 1 mark for physical states.

a. $Zn(s) + *H_2SO_4(aq) \rightarrow *ZnSO_4(aq) + H_2(g)$ or $Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$

b. $*Na_2CO_3(s) + 2HCl(aq) \rightarrow *2NaCl(aq) + H_2O(l) + CO_2(g)$

or $Na_2CO_3(s) + 2H^+(aq) \rightarrow 2Na^+(aq) + H_2O(l) + CO_2(g)$

c. $*N_2(g) + *3H_2(g) \rightarrow 2NH_3(g)$

d. $*Ba(OH)_2(aq) + 2HNO_3(aq) \rightarrow *Ba(NO_3)_2(aq) + 2H_2O(l)$ or $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

Question 2 (8 marks) * = 1 mark.

a. **(i)** Ammonia solution is a weak base as only a small proportion of NH_3 molecules ionise.*

The presence of NH_3 molecules acting as a proton (H^+) acceptor allows the solution to act as a base.*

(ii) In the reaction water is acting as an acid*, as it is donating a proton (H^+).*

b. Hydrogen sulfide in solution can donate two protons.

$H_2S(aq) + H_2O(l) \rightarrow HS^-(aq) + H_3O^+(aq)$ *

$HS^-(aq) + H_2O(l) \rightarrow S^{2-}(aq) + H_3O^+(aq)$ *

c. **(i)** H_2CO_3 * **(ii)** CO_3^{2-} *

Question 3 (5 marks)

a. **(i)** $n(Fe_2O_3) = 3.20/159.8$

$= 0.0200$ mol *

(ii) $n(HCl) = 6 \times 0.0200 = 0.120$ mol *

(iii) $V(HCl) = 0.120/2.00$

$= 0.0600$ L (60.0 mL) *

Question 3 (continued)

b. Percentage of oxygen in $K_2Cr_2O_7$ = $\frac{(7X16.0)}{(2X39.1) + (2X52.0) + (7X16.0)}$ = 38.0% *

Percentage of oxygen in $C_6H_{12}O_6$ = $\frac{(6x16.0)}{(6X12.0) + (12X1.0) + (6X16.0)}$ = 53.3% *

Glucose has the higher percentage of oxygen by mass.

Question 4 (7 marks)

a. **(i)** mole ratio C 40.91/12.0 : H 4.54/1.0 : O 54.55/16.0

= 3.41 : 4.54 : 3.41 *

Simplest ratio = 1.00 : 1.33 : 1.00 *

Whole number ratio: = 3 : 4 : 3

Empirical formula $C_3H_4O_3$ *

(ii) Empirical formula mass $C_3H_4O_3$ = $88gmol^{-1}$

Molecular formula mass = $176gmol^{-1}$

Molecular formula is $C_6H_8O_6$ *

b. Abundance of ^{123}Sb isotope = x% Abundance of ^{121}Sb isotope = (100 – x)%

(123x) + 121(100-x) /100 = 218 *

Solving for x: x = 40% *

Abundance of ^{123}Sb isotope = 40% Abundance of ^{121}Sb isotope = 60% *

Question 5 (8 marks)

a. **(i)** Place a glowing splint into the test tube. If it catches alight the gas is oxygen. *

(ii) Bubble the gas through limewater. If the solution goes milky/cloudy the gas is carbon dioxide. *

b. Argon is used as an inert atmosphere e.g. in light globes or in arc welding. * Argon is a noble gas, its stable number of electrons in the outer shell makes it unreactive.*

c. Carbon dioxide does not support combustion* and being denser than air smothers the fire by preventing oxygen from reaching the fuel. *

d. $n(CO_2) = 4.90 \times 10^3/24.5 = 200$ mol *

$Mass(CO_2) = 200 \times 44.0 = 8800g$ (8.80kg) *

Question 6 (9 marks)

a. Charles' Law: The volume of a fixed amount of gas at constant pressure is directly proportional to its absolute temperature. (1 mark for relationship between volume and temperature; 1 mark for constant pressure and amount of gas).

b. $V_1/T_1 = V_2/T_2$

$30.0/295 = 60.0/T_2$ * for temperatures in Kelvin.

$T_2 = 590K$

$= 317^oC$ *

c. When the can is heated, gas particles gain energy and collide with the walls of the container more often, which corresponds to an increase in pressure.* As the volume is fixed, the increased pressure might split the can, causing it to explode. *

d. $P_1V_1/T_1 = P_2V_2/T_2$ * for correct relationship

$(102X340)/293 = (105\ V_2)/313$ * for correct values

$V_2 = 353$ mL *

Question 7 (5 marks)

a. Zinc *, as it reacted with each of the solutions tested.*

b. (Zn) Pb Cu Ag *

c. $2Ag^+(aq) + Zn(s) \rightarrow Zn^{2+}(aq) + 2Ag(s)$ *

d. The rate of the reaction might be too slow to observe.*

Question 8 (5 marks)

a. If the painted surface is damaged, the metal is exposed to air (oxygen) and water, which will cause corrosion. *

b. **(i)** Magnesium or zinc.* The sacrificial electrode is more reactive than iron, and oxidises in preference to it.*

(ii) An opposing current makes the iron a cathode instead of an anode*, preventing the electron flow (or formation of Fe^{2+}) that results from oxidation of the iron.*