M1. (a) (i) Atoms with the same number of protons / proton number **(1)**

NOT same atomic number

with different numbers of neutrons **(1)**

***NOT** different mass number / fewer neutrons*

(ii) Chemical properties depend on the number or amount of (outer) electrons **(1)** OR, isotopes have the same electron configuration / same number of e^-

(iii) $23/6.023 \times 10^{23}$ **(1)**

CE = 0 if inverted or multiplied

tied to M1 $3.8(2) \times 10^{-23}$ [2-5 sig figs] **(1)**

5

(b) $1s^2\ 2s^2\ 2p^6\ 3s^1$ **(1)**

accept subscripted figures

1

(c) Highest energy e^- / outer e^-s / last e^- in (3)d sub-shell **(1)**

OR d sub-shell being filled / is incomplete
OR highest energy sub-shell is (3)d
NOT transition element / e^- configuration ends at 3d
Q of L

1

(d) $^{15}_{7}N$ N correct symbol **(1)**

allow N^{15}_{7}

Mass number = 15 AND atomic number = 7 **(1)**

2

[9]

M2. (a) (i) $75.0 \times 10^{-3} \times 0.500 = 0.0375$ (mol) **(1)**

accept 0.037 or 0.038

(ii) $21.6 \times 10^{-3} \times 0.500 = 0.0108$ (mol) **(1)**

accept 0.011

If both (i) and (ii) answers wrong, allow ONE process mark for both correct processes

(iii) $\underline{0.0375 - 0.0108} = 0.0267$ (mol) **(1)**

Not conseq – must use figures shown

(iv) *Moles of* $MgCO_3 = 0.0267/2 \quad = 0.01335$ (mol) **(1)**

allow 0.0134 - 0.0133

Mass of $MgCO_3 = 0.01335 \times 84.3$ **(1)**

allow 84

mark conseq on moles $MgCO_3$

$= 1.125$g **(1)**

accept 1.13g

mark conseq

Percentage $MgCO_3 = 1.125/1.25 \times 100$ **(1)**

mark conseq (check for inversion)

$= 90\%$ **(1)**

mark conseq

range = 89.5 - 90.5%

If % expression inverted, lose M4 and M5

8

(b) (i) % oxygen = 38.0 **(1)**

Na = 36.5/23 S = 25.5/32(.1) O = 38.0/16 **(1)**

= 1.587 = 0.794 = 2.375

= 2:1:3 **(1)**

If no % of oxygen Max 1 (allow M2 only)

If % for Na and S transposed, or atomic numbers used, M1 only available

(ii) $Na_2SO_3 + 2HCl \rightarrow 2NaCl + H_2O + SO_2$ **(1)**

allow multiples
allow $SO_3^{2-} + 2H^+ \rightarrow H_2O + SO_2$

4

[12]

M3. A

[1]

M4. D

[1]

M5. (a) (i) pV = nRT **(1)**

(ii) Moles ethanol = n = 1.36/46 (=0.0296 mol) **(1)**

$V = nRT/p = \frac{0.0296 \times 8.31 \times 366}{100000}$ **(1)**

if V = p/nRT lose M3 and M4

= 8.996×10^{-4} (m^3) **(1)**
= 899 (900) cm^3 **(1)** *range = 895 – 905*

If <u>final</u> answer = 0.899 award (2 + M1); if = 0.899 dm^3 ***or*** *if = 912 award (3 + M1)*

Note: *If 1.36* ***or*** *46 or 46/1.36 used as number of moles (**n**) then M2 and M4 not available*
Note: *If pressure = 100 then, unless answer = 0.899* ***dm***^{3}*, deduct M3 and mark consequentially*

5

(b) (i) $Mg_3N_2 + \mathbf{6}H_2O \rightarrow \mathbf{3}Mg(OH)_2 + \mathbf{2}NH_3$ **(1)**

(ii) Moles $NH_3 = \frac{0.263}{17}$ (=0.0155 mol) **(1)**

Number of molecules of $NH_3 = 0.0155 \times 6.02 \times 10^{23}$ **(1)**

[mark conseq] = 9.31×10^{21} **(1)**
[range 9.2×10^{21} to 9.4×10^{21}]

*Conseq (**min** 2 sig fig)*

4

(c) Moles NaCl = 800/58.5 (= 13.68) **(1)**

Moles of $NaHCO_3$ = 13.68 **(1)**

Moles of $Na2CO_3$ = 13.68/2 = 6.84 **(1)**

Mass of Na_2CO_3 = 6.84 × 106 = 725 g **(1)** **[**range = 724 – 727]

[1450 g (range 1448 – 1454) is worth 3 marks]

Accept valid calculation method, e.g. reacting masses or calculations via the mass of sodium present. Also, candidates may deduce a direct 2:1 ratio for $NaCl:Na_2CO_3$

4

[13]