M1. (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 + **6**H_2O → **3**$Mg(OH)_2$ + **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]

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M2.C

[1]

M3.A

[1]

M4.A

[1]

M5.C

[1]

M6.B

[1]

M7.D

[1]

M8. (a) $L = \frac{1.0078}{1.6734 \times 10^{-24}}$ **(1)** or $\frac{\text{mass of 1 mol}}{\text{mass of 1 atom}}$

must show working

$= 6.0225 \times 10^{23}$ **(1)**

Ignore wrong units

NB answer only scores 1

2

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(b) equal **(1)**

Or same or 1:1

1

(c) PV = nRT (or n = $\frac{PV}{RT}$) **(1)**

= $\frac{98000 \times 0.0352}{8.31 \times 298}$ **(1)**

= 1.39 **(1)**

Allow 1.390 to 1.395

ignore units even if incorrect

answer = 1.4 loses last mark

3

(d) 0.732 × $\frac{1000}{250}$ = 2.93 **(1)** mol.dm^{-3} **(1)**

OR M, mol/dm^3, mol.l^{-1}

allow 2.928 to 2.93

Note unit mark tied to current answer but allow unit mark if answer = 2.9 or 3

2

(e) (i) moles H_2SO_4 = $\frac{25}{1000}$ × 1.24 = 0.0310 **(1)**

If use $m_1v_1 = m_2v_2$ scores 3 if answer is correct otherwise zero

moles NH_3 in 30.8 cm^3 = 0.0310 × 2 = 0.0620 **(1)**

Mark is for ×2

CE if × 2 not used

moles of NH_3 in 1 dm^3 = 0.620 × $\frac{1000}{30.8}$ = 2.01 **(1)** (mol dm^{-3})

Allow 2.010 to 2.015

No units OK, wrong units lose last mark

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(ii) moles $(NH_4)_2SO_4$ = moles H_2SO_4 = 0.310 **(1)**

Allow consequential wrong moles in part (i) if clear H_2SO_4=$(NH_4)SO_4$

Wrong formula for $(NH_4)_2SO_4$ CE=0

M_r $(NH_4)_2SO_4$ = 132.1 **(1)**

Allow (132)

mass = moles × M_r = 0.0310 × 132.1 = 4.10 **(1)**

if moles of $(NH_4)_2SO_4$ not clear CE

(g) wrong unit loses mark

Allow 4.09 – 4.1 – 4.11

6

(f) $Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$

Formulae (1)

Balanced equation (1)

2

[16]

M9. (a) <u>Ideal</u> gas equation law **(1)**

1

(b) *Moles of **X***: $n = \frac{PV}{RT}$ **(1) =** $\frac{110000 \times 2.34 \times 10^{-4}}{8.31 \times 473}$

= 6.55×10^{-3} **(1)**

6.5 to 6.6 × 10^{-3}, min 2 sig figs

If write n = $\frac{RT}{PV}$ zero here, but can score M_r

*Relative molecular mass of **X***: $M_r = \frac{m}{n}$ **(1)**

= 62 **(1)**

61.5 to 62.5

4

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(c) % oxygen = 51.6 **(2)**

C =38.7 / 12 H = 9.68 / 1 O = 57.6**(2)** / 16 **(1)**

= 3.23 = 9.68 = 3.23

1 : 3: 1 ∴ CH_3O **(1)**

If no % O or if wrong A_r used then max 1
Correct empirical formula earns all three marks

3

(d) ($\frac{62}{31}$ × CH_3O) = $C_2H_6O_2$ **(1)**

1

[9]

M10. D

[1]

M11. (a) (i) *Number of moles of O_2 at equilibrium:* $\frac{7.04}{32}$ = 0.22 **(1)**

Number of moles of NO at equilibrium: 0.44 **(1)**

OR 2 × mol of oxygen

3

(ii) *Original number of moles of NO_2:* $\frac{21.3}{46}$ = 0.46(3) **(1)**

Number of moles of NO_2 at equilibrium:
0.46(3) – 0.44 = 0.02(3) **(1)**

OR conseq on mol NO above

1

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(b) *Expression for K_c*: $K_c = \frac{[NO]^2[O_2]}{[NO_2]}$ **(1)**

Calculation: $K_c = \frac{\left(\frac{0.44}{11.5}\right)^2 \times \left(\frac{0.22}{11.5}\right)}{\left(\frac{0.023}{11.5}\right)^2}$ = 7.0(0) mol dm^{-3}

(1) (1) (1)

If mol NO_2 = 0.02; K_c = 9.26 (9.3)
or conseq on values from (a)
If vol missed, score only K_c and units
If K_c wrong: max 2 for correct use of vol and conseq units
If K_c wrong and no vol: max 1 for conseq units

3

(c) pV = nRT **(1)**

$T = \frac{pV}{nR} = \frac{(3.30\times10^5)\times(11.5\times10^{-3})}{0.683\times8.31} =$ **(1)**

(1) for using 11.5 × 10^{-3} as V

T = 669 K **(1)**

4

(d) *Yield of oxygen:* increased **(1)**
Value of K_c: no effect **(1)**

2

[13]

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