M1.B

[1]

M2.D

[1]

M3.C

[1]

M4. (a) (i) Avogadro's number/constant of molecules/particles/species / 6×10^{23}

[Not 'atoms']

1

Or same number of particles as (there are atoms)

[Not molecules]

in 12.(00)g of ^{12}C

1

(ii) *Moles* $O_2 = \frac{0.350}{32}$ *(= 1.09 × 10⁻² mol)*

1

= 29 (× 1.09 × 10^{-2})

[Accept answers via 4 separate mole calculations]

1

= 0.316 – 0.317 mol [answer to 3 + sf]

[Mark conseq on errors in M1/M2] (1)

1

(iii) Moles of nitroglycerine = 4 × 1.09 × 10^{-2} (= 0.0438 mol)

[Mark conseq on their moles of O_2]

1

M_r of nitroglycerine = 227 or number string

1

Moles of nitroglycerine = 227 × 0.0438 = 9.90 – 9.93(g)

[answer to 3+ sf]

[If string OK but final answer wrong then allow M6 but AE for M7]

[Mark conseq on error in M_r] *[Penalise wrong units]*

[Penalise sig. fig. errors once only in whole question]

(b) $pV = nRT$ **or** $pV = \frac{mRT}{V}$ **or** $p = \frac{mRT}{V}$

1

$p = \frac{mRT}{V} = \frac{0.873 \times 8.31 \times 1100}{1.00 \times 10^{-3}}$

1

= 7980093 **or** 7980 **or** 7.98

[ignore s.f.]

1

units = Pa **or** kPa **or** MPa (as appropriate)

[If error in conversion from Pa, treat as a contradiction of the units mark]

[If transfer error, mark conseq but penalise M2]

[If data from outside of above used, penalise M2 and M3]

[If pV expression incorrectly rearranged, penalise M2 and M3]

[if T = 1373 K used, penalise M2]

1

[11]

M5.(a) UV light

1

$CCl_4 \longrightarrow CCl_3\bullet + \bullet Cl$

1

(b) $Cl\bullet + O_3 \longrightarrow ClO\bullet + O_2$

1

$ClO\bullet + O_3 \longrightarrow Cl\bullet + 2O_2$

1

(c) M_r of CF_3Cl = 104.5

Moles freon = $1.78 \times 10^{-4} \times 10^3 / 104.5 = 1.70 \times 10^{-3}$

1

Number of molecules = $1.70 \times 10^{-3} \times 6.02 \times 10^{23} = 1.02 \times 10^{21}$

1

Molecules in 500 cm^3 = $(1.02 \times 10^{21} \times 500 \times 10^{-6}) / 100 = 5.10 \times 10^{15}$

Allow answer in the range $5.10–5.13 \times 10^{15}$

Answer must be given to this precision

1

[7]

M6. (a) (i) 0.0212

Need 3 sig figs

Allow correct answer to 3 sig figs eg 2.12×10^{-2}

1

(ii) 0.0106

Mark is for (a)(i) divided by 2 leading to correct answer 2 sig figs

1

(iii) M_r = 100.1

1.06 g

Allow 100.1 as 'string'

Need 3 sig figs or more

Consequential on (a)(ii) x 100(.1)

2

(iv) Neutralisation or acid / base reaction

Allow acid / alkali reaction

Apply list principle

1

(b) (i) T = 304(K) and P = 100 000 (Pa)

Only T and P correctly converted

1

$\frac{100\,000 \times 3.50 \times 10^{-3}}{8.31 \times 304}$ OR $n = \frac{PV}{RT}$

1

0.139 (mol)

Allow <u>0.138 – 0.139</u>

1

(ii) 0.0276 – 0.0278(mol)

Allow answer to (b)(i) divided by 5 leading to a correct answer

Allow 0.028

1

(c) 4.20 g $Ca(NO_3)_2$

1

$Ca(NO_3)_2$ H_2O

$\frac{4.20}{164(.1)}$ $\frac{1.84}{18}$

Mark is for dividing by the correct Mr values

M2 and M3 dependent on correct M1

0.0256 0.102

M2 can be awarded here instead

1 : 3.98

$x = 4$

If $Ca(NO_3)_2.4H_2O$ seen with working then award 3 marks

Credit alternative method which gives $x = 4$

1

[12]

M7.B

[1]

M8.(a)

Method 1	Method 2
Mass of H_2O = 4.38−2.46	Percentage of H_2O = 44%
(= 1.92 g)	

If there is an AE in M1 then can score M2 and M3
If M_r incorrect can only score M1

1

$ZnSO_4$	H_2O	ZnSO4	H2O
2.46	1.92	56	44
161.5	18	161.5	18

1

(0.0152	0.107)	(0.347	2.444)
(1	: 7)	(1	: 7)
x = 7		x = 7	

If x = 7 with working then award 3 marks.
Allow alternative methods.
If M1 incorrect due to AE, M3 must be an integer.

1

(b) Moles HCl = 0.12(0)

1

mol $ZnCl_2$ = 0.06(0) ***OR*** 0.12 / 2

1

If M2 incorrect then CE and cannot score M2, M3 and M4.

mass $ZnCl_2$ = 0.06 × 136.4

Allow 65.4 + (2 × 35.5) for 136.4

1

= 8.18(4) (g) ***OR*** 8.2 (g)

Must be to 2 significant figures or more.
Ignore units.

1

(c) Moles $ZnCl_2$ = $\frac{10.7}{136.4}$ (= 0.0784)

1

OR moles Zn = 0.0784

Mass Zn reacting = 0.0784 × 65.4 = (5.13 g)

M2 is for their M1 × 65.4

1

$$\%\,\text{purity of Zn} = \frac{5.13}{5.68} \times 100$$

M3 is M2 × 100 / 5.68 provided M2 is < 5.68

1

= 90.2% ***OR*** 90.3%

Allow alternative methods.

M1 = Moles $ZnCl_2$ = 10.7 (= 0.0784)
136.4

M2 = Theoretical moles Zn = 5.68 (= 0.0869)
65.4

M3 = M1 × 100 / M2 = (0.0784 × 100 / 0.0869)

*M4 = 90.2% **OR** 90.3%*

1

(d) Ionic

If not ionic CE = 0/3

1

Strong (electrostatic) attraction (between ions)

1

between oppositely charged ions / + and − ions / F^- and Zn^{2+} ions

If IMF, molecules, metallic bonding implied CE = 0/3

1

[14]