**M1.**B

**[1]**

**M2.**(a) M1 550 × $\frac{100}{95}$ = 579 g would be 100% mass

*Allow alternative methods.*

*There are 4 process marks:*

**1**

M2 So $\frac{579}{65}$ = 8.91 moles $NaN_3$

**or**

M1 $\frac{550}{65}$ = 8.46 moles $NaN_3$ (this is 95%)

M2 So 100% would be 8.46 × $\frac{100}{95}$ = 8.91 moles $NaN_3$

*1: mass ÷ 65*

*2: mass or moles × 100 / 95 or × 1.05*

*3: moles $NaN_3$ × 2*

*4: moles $NaNH_2$ × 39*

**1**

Then M3 Moles $NaNH_2$ = 8.91 × 2 = ( 17.8(2) moles)

**1**

M4 mass $NaNH_2$ = 17.8(2) × 39

**1**

M5 693 or 694 or 695 (g)

*If 693, 694 or 695 seen to 3 sig figs award 5 marks*

**1**

(b) M1 308 K and 150 000 Pa

**1**

M2 $n = \frac{PV}{RT}$ or $\frac{150\ 000 \times 7.5 \times 10^{-2}}{8.31 \times 308}$

1

M3 = 4.4(0) or 4.395 moles $N_2$

*Allow only this answer but allow to more than 3 sig figs*

1

M4 Moles $NaN_3$ = 4.395 × $\frac{2}{3}$ (= 2.93)

*M4 is for M3* × $\frac{2}{3}$

1

M5 Mass $NaN_3$ = (2.93) × 65

*M5 is for moles M4 × 65*

1

M6 = 191 g

*Allow 190 to 191 g allow answers to 2 sig figs or more*

1

(c) (i) 150 / 65 = 2.31 moles $NaN_3$ or 2.31 moles nitrous acid

1

Conc = 2.31 × $\frac{1000}{500}$

*M2 is for M1 × 1000 / 500*

1

4.6(1) or 4.6(2) (mol $dm^{-3}$)

*Only this answer*

1

(ii) $3HNO_2 \longrightarrow HNO_3 + 2NO + H_2O$

*Can allow multiples*

1

(d) Ionic

*If not ionic then CE = 0 / 3*

1

Oppositely charged ions / $Na^+$ and $N_3^-$ ions

*Penalise incorrect ions here but can allow M3*

1

Strong attraction between (oppositely charged) ions / lots of energy needed to

overcome (strong) <u>attractions</u> (between ions)

*M3 dependent on M2*

**1**

(e) (i) $N \equiv N \longrightarrow N^-$

*Only*

**1**

(ii) $CO_2$ / $N_2O$ / $BeF_2$ / $HN_3$

*Allow other correct molecules*

**1**

(iii) $MgN_6$

*Only*

**1**

**[21]**

**M3.**(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 |
|---|---|---|---|
| <u>2.46</u> | <u>1.92</u> | <u>56</u> | <u>44</u> |
| 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 = <u>5.68</u> (= 0.0869)*
*65.4*

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

*M4 = <u>90.2%</u> **OR** <u>90.3%</u>*

**1**

(d) Ionic

*If not ionic CE = 0/3*

**1**

<u>Strong</u> (electrostatic) <u>attraction</u> (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]**

**M4.** (a) Hydrogen/H bonds

*Not just hydrogen*

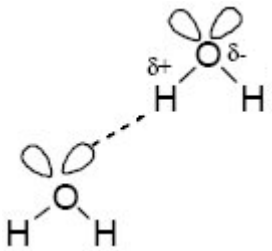
**1**

van der Waals/vdw/dipole-dipole/London/temporarily induced dipole/dispersion forces

*Not just dipole*

**1**

(b)




*M1 for partial charges as indicated in diagram (correct minimum)*
*M2 for all four lone pairs*
*M3 for H bond from the lp to the H (δ+) on the other molecule*

*Lone pair on hydrogen CE = 0*
*OHO CE = 0*
*If only one molecule of water shown*
*CE = 0*

**3**

(c) Hydrogen bonds/IMF (in water) stronger

***OR***

IMF/VDW/dipole-dipole forces (in $H_2S$) are weaker

***OR***

H bonding is the strongest IMF

*Ignore energy references*
*Comparison must be stated or implied*

**1**

(d) Atoms/molecules get larger/more shells/more electrons/more surface area

*Not heavier/greater Mr*

**1**

therefore increased Van der Waals/IMF forces

*Ignore references to dipole-dipole forces*

**1**

(e) Dative (covalent)/coordinate

*If not dative/coordinate CE = 0/2*
*If covalent or blank read on*

**1**

(Lone) pair/both electrons/two electrons on O($H_2$) donated (to $H^+$)
OR pair/both electrons come from O($H_2$)

*Explanation of a coordinate bond specific to oxygen or water required*
*Not just H+ attracted to lone pair since that is nearer to a H bond*

**1**

(f) ionic

**1**

*if not ionic CE = 0*

oppositely charged ions/+ and – ions or particles

*atoms or molecules loses M2 and M3*

**1**

ions attract <u>strongly</u> OR strong/many (ionic) bonds must be broken

*$S^-$ loses M2*

*Reference to IMF loses M2 and M3*

**1**

**[13]**