

1. (i) The  $H^+$  ion in an (nitric) acid has been replaced by a metal ion  
OR by a  $Ca^{2+}$  ion ✓

**DO NOT ALLOW** it has been produced by the reaction of an acid and a base as this is stated in the question.

**IGNORE** references to replacement by  $NH_4^+$  ions or positive ions.

**ALLOW H OR** Hydrogen for  $H^+$ ;

**DO NOT ALLOW** Hydrogen atoms

**ALLOW Ca OR** Calcium for  $Ca^{2+}$ .

**DO NOT ALLOW** Calcium atoms

**ALLOW** 'metal' for 'metal ion'

1

- (ii)  $2HNO_3(aq) + Ca(OH)_2(aq) \rightarrow Ca(NO_3)_2(aq) + 2H_2O(l)$

Formulae ✓

Balance AND states ✓

**ALLOW** multiples

**ALLOW** (aq) OR (s) for  $Ca(OH)_2$

2

- (iii) Accepts a proton OR accepts  $H^+$  ✓

**ALLOW**  $H^+ + OH^- \rightarrow H_2O$

**ALLOW**  $OH^-$  reacts with  $H^+$  OR  $OH^-$  takes  $H^+$

**ALLOW**  $OH^-$  'attracts'  $H^+$  if 'to form water' is seen

**DO NOT ALLOW**  $OH^-$  neutralises  $H^+$  ('neutralises' is in the question)

1

[4]

2. (a) (i) Calculate correctly  $\frac{0.0880 \times 25.0}{1000} = 2.20 \times 10^{-3}$  mol

OR 0.00220 mol ✓

**ALLOW** 0.0022 OR  $2.2 \times 10^{-3}$  mol

1

- (ii) Calculates correctly  $\frac{0.00220}{2} = 1.10 \times 10^{-3}$  mol

OR 0.00110 mol ✓

**ALLOW** 0.0011 OR  $1.1 \times 10^{-3}$  mol

**ALLOW** ECF for answer (i)/2 as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes

1

(iii)  $\frac{0.00110 \times 1000}{17.60} = 0.0625 \text{ mol dm}^{-3}$

**OR**  $6.25 \times 10^{-2} \text{ mol dm}^{-3}$  ✓

**ALLOW** 0.063 **OR**  $6.3 \times 10^{-2} \text{ mol dm}^{-3}$

**ALLOW** ECF for answer (ii)  $\times 1000/17.60$

**OR**

ECF from (i) for answer (i)/2  $\times 1000/17.60$  as calculator value or correct rounding to 2 significant figures or more but ignore trailing zeroes

1

(b) (i) (The number of) Water(s) of crystallisation ✓

**IGNORE** hydrated **OR** hydrous

1

(ii) 142.1 ✓

**ALLOW** 142

**ALLOW**  $M_r$  expressed as a sum

**ALLOW** ECF from incorrect  $M_r$  and  $x$  is calculated correctly

$$x = \frac{(322.1 - 142.1)}{18.0} = 10 \text{ ✓}$$

**ALLOW** ECF values of  $x$  from nearest whole number to calculator value

**ALLOW** 2 marks if final answer is 10 **without any working**

2

[6]

3. (i)  $2\text{NH}_3 + \text{H}_2\text{SO}_4 \rightarrow (\text{NH}_4)_2\text{SO}_4$  ✓

**ALLOW**  $2\text{NH}_4\text{OH} + \text{H}_2\text{SO}_4 \rightarrow (\text{NH}_4)_2\text{SO}_4 + 2\text{H}_2\text{O}$

**ALLOW**  $\text{NH}_3 + \text{H}^+ \rightarrow \text{NH}_4^+$

**ALLOW** any correct multiple

**IGNORE** state symbols

1

(ii) when the  $\text{H}^+$  in an acid is replaced by a metal ion **OR** an ammonium ion **OR** a + ion ✓

**ALLOW** H for  $\text{H}^+$ ;

**ALLOW** 'metal' for 'metal ion'

**i.e.:** H in an acid can be replaced by a metal

1

- (iii) accepts a proton **OR** accepts  $H^+$  ✓  
*ALLOW* donates a lone pair  
*ALLOW* removes  $H^+$   
*ALLOW* forms  $OH^-$  ions

1

- (iv) 132.1 ✓  
*IGNORE* units  
**NO OTHER ACCEPTABLE ANSWER**

1

[4]

4. (i)  $M(MgSO_4) = 120.4$  OR  $120$  ( $g\ mol^{-1}$ ) ✓

$$\text{mol } MgSO_4 = \frac{1.51}{120.4} = 0.0125\ \text{mol} \quad \checkmark$$

*ALLOW* 0.013 up to calculator value of 0.012541528 correctly rounded (from  $M = 120.4\ g\ mol^{-1}$ )

*ALLOW* 0.013 up to calculator value of 0.012583333 correctly rounded (from  $M = 120\ g\ mol^{-1}$ )

*ALLOW* ecf from incorrect  $M$  i.e.  $1.51 \div M$

2

- (ii)  $\frac{1.57}{18.0} = 0.0872(2)$  (mol) ✓

*ALLOW* 0.09 up to calculator value of 0.08722222

1

- (iii)  $\times = 7$  ✓

*ALLOW* ecf i.e. answer to (ii)  $\div$  answer to (i)

*ALLOW* correctly calculated answer from 1 significant figure up to calculator value, i.e.  $\times$  does not have to be a whole number. Likely response = 6.95 ✓

1

[4]

5. (i)  $Ca(OH)_2$  ✓  
*IGNORE* charges, even if wrong

1

- (ii)  $\text{Ca}(\text{NO}_3)_2$  ✓  
*IGNORE charges, even if wrong* 1 [2]
6. (i) Molar mass of  $\text{CaCO}_3 = 100.1 \text{ g mol}^{-1}$  (1)  
 $2.68/100.1 = 0.0268/0.027$  (1) 2
- (ii)  $0.0268 \text{ mol} \times 24,000 = 643 \text{ cm}^3$  (1) 1
- (iii) moles  $\text{HNO}_3 = 2 \times 0.0268$   
 $= 0.0536 / 0.054 \text{ mol}$  (1)  
*(i.e. answer to (i)  $\times 2$ )*  
 volume of  $\text{HNO}_3 = 0.0536 \times 1000/2.50 = 21.4 \text{ cm}^3$  (1) 2 [5]
7. (i) MgO has reacted with  $\text{CO}_2$  ✓ 1
- (ii) Solid dissolves / disappears ✓  
 Fizzing / bubbles ✓ 2  
 $\text{MgO} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2\text{O}$  ✓  
 $\text{MgCO}_3 + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$  ✓  
 both reactions form magnesium chloride/ $\text{MgCl}_2$  ✓ 3 [6]
8. (i)  $\text{CaCO}_3 (\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O} (\text{l})$   
 $\text{CaO}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O} (\text{l})$   
 each balanced equation 1 mark (2)  
 all state symbols (1) 3
- (ii)  $\text{CaCO}_3$  fizzes/ gas given off/ gas evolved / carbon dioxide evolved (1) 1 [4]
9. (i) a proton donor ✓ 1
- (ii)  $\text{MgO} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2\text{O}$  ✓ 1 [2]

10.  $\text{CaCO}_3$  reacts with (or neutralises)  $\text{HCl}$  ✓  
(or  $\text{CaCO}_3 + \text{HCl}$  in an equation)  
 $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$  ✓  
(correct equation would score both marks) [2]
11. (i) as a base (1) ..... accepts a proton/ $\text{H}^+$ / **neutralises** an acid/  
reacts with acid to form salt/ has a **lone** pair of electrons (1) 2  
(ii) fertiliser (1) 1  
(iii) manufacture of explosives/ dyes/ nitric acid/ fibres/ ammonium  
nitrate/ urea/ refrigeration/ cleaning agents/ fertiliser  
(if not allowed in (ii) (1) 1 [4]
12. (i) fizzing/gas/hydrogen evolved *or* Mg dissolves/disappears ✓ 1  
[an incorrect observation negates this mark]  
(ii)  $2\text{HCl} + \text{Mg} \rightarrow \text{MgCl}_2 + \text{H}_2$   
[correct formula for  $\text{MgCl}_2$ . Allow equation with  $\text{HI}/\text{MgI}_2$  instead of  $\text{HCl}$ ] ✓  
[balancing: e.g.  $2\text{HCl} + 2\text{Mg} \rightarrow 2\text{MgCl} + \text{H}_2$  will get this mark but  
not the 1<sup>st</sup>] ✓ 2 [3]
13. Proton donor 1 [1]
14. (i)  $2\text{HCl} (\text{aq}) + \text{Na}_2\text{CO}_3 (\text{aq}) \rightarrow 2\text{NaCl} (\text{aq}) + \text{CO}_2 (\text{g}) + \text{H}_2\text{O} (\text{l})$  1  
(ii) Brisk effervescence is observed, indicating the presence of carbon  
dioxide gas. 1 [2]