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 (i) The H^+ ion in an (nitric) acid has been replaced by a metal ion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 $\mathbf{H^+}$ ✓

ALLOW $\boldsymbol{H^+ + OH^- \rightarrow H_2O}$
ALLOW *OH^- reacts with* $\boldsymbol{H^+}$ ***OR*** *OH^- takes* $\boldsymbol{H^+}$
ALLOW *OH^- 'attracts'* $\boldsymbol{H^+}$ *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*** *2.2×10^{-3} mol*

1

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

OR 0.00110 mol ✓

ALLOW *0.0011* ***OR*** *1.1×10^{-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 6.25×10^{-2} mol dm^{-3} ✓

ALLOW *0.063* ***OR*** *6.3×10^{-2} mol dm^{-3}*

ALLOW *ECF for answer* ***(ii)*** *× 1000/17.60*

OR

ECF from ***(i)*** *for answer* ***(i)****/2 × 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***

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

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) $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ ✓

ALLOW *$2NH_4OH + H_2SO_4 \rightarrow (NH_4)_2SO_4 + 2H_2O$*

ALLOW *$NH_3 + H^+ \rightarrow NH_4^+$*

ALLOW *any correct multiple*

IGNORE *state symbols*

1

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

ALLOW *H for 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}) ✓

mol $MgSO_4 = \frac{1.51}{120.4} = 0.0125$ *mol* ✓

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 ÷ M*

2

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

ALLOW *0.09 up to calculator value of 0.08722222*

1

(iii) × = 7 ✓

ALLOW *ecf i.e. answer to (ii) ÷ answer to (i)*

ALLOW *correctly calculated answer from 1 significant figure up to calculator value, ie, × 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) $Ca(NO_3)_2$ ✓

IGNORE *charges, even if wrong*

1

[2]

6. (i) Molar mass of $CaCO_3$ = 100.1 g mol^{-1} **(1)**
2.68/100.1 = 0.0268/0.027 **(1)** 2

(ii) 0.0268 mol × 24,000 = 643 cm^3 **(1)** 1

(iii) moles HNO_3 = 2 × 0.0268
= 0.0536 /0.054 mol **(1)**
(i.e. answer to (i) × 2)

volume of HNO_3 = 0.0536 × 1000/2.50 = 21.4 cm^3 **(1)** 2

[5]

7. (i) MgO has reacted with CO_2✓ 1

(ii) Solid dissolves / disappears✓
Fizzing / bubbles✓ 2
$MgO + 2HCl \rightarrow MgCl_2 + H_2O$✓
$MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$✓
both reactions form magnesium chloride/$MgCl_2$✓ 3

[6]

8. (i) $CaCO_3$ (s) + 2HCl(aq) → $CaCl_2$(aq) + CO_2(g) + H_2O (l)

$CaO(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O$ (l)

each balanced equation 1 mark (2)

all state symbols (1) 3

(ii) $CaCO_3$ fizzes/ gas given off/ gas evolved / carbon dioxide evolved (1) 1

[4]

9. (i) a proton donor ✓ 1

(ii) $MgO + 2HCl \rightarrow MgCl_2 + H_2O$ ✓ 1

[2]

10. $CaCO_3$ reacts with (or neutralises) HC*l* ✓
(or $CaCO_3$ + HC*l* in an equation)

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$ ✓
(correct equation would score both marks)

[2]

11. (i) as a base (1) ……. accepts a proton/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) $2HCl + Mg \rightarrow MgCl_2 + H_2$

[correct formula for $MgCl_2$. Allow equation with HI/MgI_2 instead of HC*l*] ✓

[balancing: e.g. $2HCl + 2Mg \rightarrow 2MgCl + H_2$ will get this mark but not the 1st] ✓ 2

[3]

13. No mark scheme available

14. No mark scheme available