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 (i) The H^+ ion in an (nitric) acid has been replaced by a metal ion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 $\dfrac{0.0880 \times 25.0}{1000} = 2.20 \times 10^{-3}\,mol$

OR 0.00220 mol ✓

> *ALLOW 0.0022 **OR** 2.2×10^{-3} mol*

1

(ii) Calculates correctly $\dfrac{0.00220}{2} = 1.10 \times 10^{-3}$ 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) $\dfrac{0.00110 \times 1000}{17.60} = 0.0625 \text{ mol dm}^{-3}$

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***

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

> ***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$_4$OH + H$_2$SO$_4$ → (NH$_4$)$_2$SO$_4$ + 2H$_2$O*
> ***ALLOW** NH$_3$ + H$^+$ → 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 $MgSO_4$ = $\dfrac{1.51}{120.4}$ = 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) $\dfrac{1.57}{18.0}$ = 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 $\times 24{,}000 = 643$ cm^3 **(1)**   1

     (iii)   moles $HNO_3 = 2 \times 0.0268$

           $= 0.0536 /0.054$ mol **(1)**

           (i.e. answer to (i) × 2)

           volume of $HNO_3 = 0.0536 \times 1000/2.50 = 21.4$ 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) $\rightarrow CaCl_2$(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. CaCO₃ reacts with (or neutralises) HC*l* ✓
(or CaCO₃ + 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 MgC*l*₂. Allow equation with HI/MgI₂ instead of HC*l*] ✓

[balancing: e.g. 2HC*l* + 2Mg → 2MgC*l* + H₂ will get this mark but
not the 1ˢᵗ] ✓ 2

[3]

13. No mark scheme available

14. No mark scheme available