1. (i) $2Mg + O_2 \rightarrow 2MgO$ ✓

ALLOW *multiples. Correct species must be seen*
IGNORE *state symbols*

1

(ii) Fizzes **OR** bubbles **OR** gas produced **OR** effervescing ✓

DO NOT ALLOW *'carbon dioxide gas produced'*
DO NOT ALLOW *'hydrogen produced' without 'gas'*

Mg dissolves **OR** Mg disappears **OR** a solution is formed ✓

ALLOW *'it for Mg'*
IGNORE *Mg reacts*
IGNORE *temperature change*
IGNORE *steam produced*

2

(iii) Quicker **OR** more vigorous **OR** gets hotter

MUST *be a comparison of a reaction observation, not just 'more reactive'*

ALLOW *any comparison of greater rate including more bubbles etc.*
DO NOT ALLOW *more gas produced*

1

[4]

2. (a) BaO ✓
Ba_3N_2 ✓

Treat any shown charges as working and ignore.
Treat B for Ba as a slip

2

(b) (i) $\frac{0.11}{137.3}$ ✓

mark is for the ***working out*** *which* ***MUST*** *lead to the correct answer of* 8×10^{-4} *up to calculator value*

1

(ii) 19.2
OR
calculated answer to **(b)(i)** × 24000 ✓

ALLOW *19 up to calculator value.*

1

(iii) 8.0×10^{-3}
OR
calculated answer to **(b)(i)** × 10 ✓
ALLOW *8.01 × 10^{-3} up to calculator value*

1

(iv) any pH > 7 but <15 ✓
ALLOW *a correct range of pH.*

1

(c) Less barium to react **OR**
some barium has already reacted ✓
ALLOW *less volume because contains some BaO or Ba_3N_2*

1

(d) reactivity increases (down the group) ✓

atomic radii increase **OR**
there are more shells ✓

there is **more** shielding **OR more** screening ✓

the nuclear attraction decreases **OR**
Increased shielding and distance outweigh the
increased nuclear charge ✓

easier to remove (outer) electrons **OR**
ionisation energy decreases ✓
USE annotations with ticks, crosses, ecf, etc for this part.
DO NOT ALLOW *more orbitals* ***OR*** *more sub-shells*
*'**More**' is essential*
ALLOW *'more electron repulsion from inner shells'*
ALLOW *'nuclear pull'*
IGNORE *any reference to 'effective nuclear charge'*
ALLOW *easier to form positive ion*

5

[12]

3. $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
equation ✓
state symbols ✓

*state symbols are **dependent** on correct formulae of $CaCO_3$, CaO and CO_2*
***DO NOT ALLOW** the 'equation mark' if O_2 is seen on both sides (but note that the 'state symbol mark' may still be accessible)*

[2]

4. (i) $Ca(OH)_2$ ✓

***IGNORE** charges, even if wrong*

1

(ii) $Ca(NO_3)_2$ ✓

***IGNORE** charges, even if wrong*

1

[2]

5. (i) because Ca has changed from 0 to +2 **(1)**
and H has changed from +1 to 0 **(1)** 2

(ii) Calcium reacts with water producing
hydrogen/H_2/calcium/hydroxide/$Ca(OH)_2$ **(1)** (i.e. one product)
$Ca(s) + H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$ **(1)** (i.e. full equation)
Equation would subsume both two marks 2

[4]

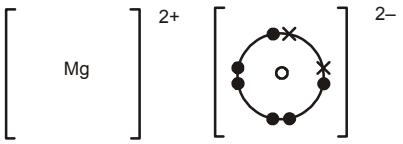
6. (i) loss (of electrons) ✓ 1

(ii) Ba ✓
$0 \rightarrow (+)2$ ✓ (accept 2+) 2

[3]

7. (i) Oxidation state goes from 0 in O_2 ✓
$\rightarrow -2$ in MgO ✓ 2

(ii)



or with Mg full shell.
correct dot and cross✓; correct charges✓ 2

[4]

8. (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]

9. (i) hydrogen / H_2 ✓ 1

(ii) $Sr + 2H_2O \rightarrow Sr(OH)_2 + H_2$ ✓ 1

(iii) different numbers of moles/atoms/ different A_r values✓
so different number of moles of H_2 /more moles of Ca✓
(*i.e. an attempt to quantify difference*) 2

(iv) 8 – 14 ✓ 1

[5]

10. (i) $Ca^{+}(g) \rightarrow Ca^{2+}(g) + e^{-}$
Equation with correct charges and 1 electron lost ✓
state symbols ✓
'−' not required on 'e' 2

(ii) same number of protons or same nuclear charge attracting
less electrons/
electron removed from an ion/
less electron-electron repulsion (**not** less shielding)/
ion is smaller✓ 1

(iii) atomic radii of Sr > atomic radii of Ca/
Sr has electrons in shell further from nucleus than Ca/
Sr has electrons in a higher energy level/
Sr has more shells ✓
Therefore less attraction ✓
Sr has **more** shielding than Ca ✓
(***'more'*** *is essential*) 3

increased nuclear charge is outweighed / despite increased nuclear charge …..by at least one of the factors above ✓

[6]

11. $CaCO_3 \rightarrow CaO + CO_2$ ✓
state symbols not required

[1]

12. (a) ……Ca(s) + …..2 ✓ HC*l*(aq) …….Ca$C\!l_2$(aq) + .H_2(g). ✓ 2

(g) not required for H_2

(b) In Ca, oxidation state = 0 ✓ and 2
In Ca$C\!l_2$, oxidation state = +2 ✓
Oxidation number increases from Ca to Ca$C\!l_2$

[4]

13. (i) moles HC*l* = 2.0 × 50/1000 = 0.10 ✓ 1

(ii) moles Ca = ½ × moles HC*l* = 0.050 ✓
mass Ca = 40.1 × 0.050 = 2.00 g / 2.005 g ✓ 2
(accept 40 × 0.050 = 2.0 g)
(mass Ca of 4.0 g would score 1 mark as 'ecf' as molar ratio has not been identified)

(iii) Ca has reacted with water ✓
$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ ✓✓
state symbols not required

1st mark for H_2 3
2nd mark is for the rest of the balanced equation

[6]

14. (a) $RaCl_2$ ✓ 1

(b) Reduction is gain of electrons/decrease in oxidation number
✓

Ra^{2+} gains 2 electrons → Ra/
Oxidation state goes from +2 in $RaCl_2$ → 0 in Ra ✓ 2

[3]

15. (i) effervescence/bubbles ✓
Ra disappears/dissolves ✓ 2

(ii) 8-14 ✓ 1

[3]

16. $CaCO_3$ 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]

17. Strontium reacts with oxygen/strontium oxide forms/SrO

forms ✓

$2Sr + O_2 \rightarrow 2SrO$ /

$Sr + ½ O_2 \rightarrow SrO$ ✓

[2]

18. (i) In Sr, oxidation number = 0 ✓
In $Sr(OH)_2$, oxidation number = (+)2 ✓
OR

Oxidation number increases from $Sr \rightarrow Sr(OH)_2$ ✓ by 2 ✓ 2

(ii) $0.438/87.6 = 5.00 \times 10^{-3}$ / 0.00500 mol ✓ 1

(iii) $0.00500 \times 24.0 = 0.120\ dm^3$ ✓ (accept 120 cm^3) 1

(iv) $0.00500 \times 1000/200 = 0.0250\ mol\ dm^{-3}$ ✓ 1

[5]

19. (i) heat ✓ 1

(ii) ...3..SrO(s) + ...2..Al(s) → ...3..Sr(s) + ...Al_2O_3(s) ✓ 1

(iii) Molar mass of $SrCO_3 = 87.6 + 12 + 16x3 = 147.6\ g\ mol^{-1}$ ✓

Mass $SrCO_3$ required = $100 \times 147.6/87.6 = 168$ tonnes ✓

Mass of ore needed = mass $SrCO_3 \times 100/2$
= $168 \times 100/2 = 8400$ tonnes /
8425 tonnes (*from 168.484931507*) ✓
(answer depends on rounding)
5000 tonnes is 50 × 100 tonnes: worth 1 mark 3

(iv) 98% waste produced which must be disposing of /made into something worthwhile/CO_2 being removed by something sensible/
any sensible comment ✓ 1

[6]

20. (i) Answer is inclusive of 9 – 14 inclusive ✓ 1

(ii) Ca(s): $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$ ✓

$Ca(OH)_2$(aq): $1s^2 2s^2 2p^6 3s^2 3p^6$ ✓ 2

[3]

21. barium atoms are larger ✓

barium atoms have more shielding ✓

this outweighs the increase in nuclear charge ✓

barium electrons are lost more easily
/less energy required
/ionisation energy decreases ✓

[4]