M1.(a) 0.943 g water (M1)

If Mr of $NiSO_4$ wrong, can allow M1 and M3 from method 1 i.e. max 2

$NiSO_4$ H_2O

$\frac{1.344}{154.8}$ (M2) $\frac{0.943}{18}$ (M3)

(8.68×10^{-3} 0.052)

1 6 or $x = \underline{6}$ (M4)

Allow Mr = 155

Allow other methods e.g.

M_r ($NiSO_4$) = 58.7 + 32.1 + 64.0 = 154.8

n($NiSO_4$) = $\frac{1.344}{154.8}$ = 0.008682 mol (M1)

M_r ($NiSO_4.xH_2O$) = $\frac{2.287}{0.008682}$ = (263.4) (M2)

so $18x$ = 263.4 − 154.8 = (108.6) (M3)

so x = $\frac{108.6}{18}$ = $\underline{6}$ (M4)

If using alternative method and Mr of $NiSO_4$ wrong, allow ecf to score M2 and M3 only i.e. max 2

4

(b) re-heat

Heat to constant mass = 2 marks

1

check that mass is unchanged

M2 dependent on M1

Allow as alternative:

M1: record an IR spectrum

M2: peak between 3230 and 3550 (cm^{-1})

1

[6]

M2. Mass of crucible and boric acid on the y−axis

Axes must be labelled but do not penalise lack of units (unless incorrect).

1

Suitable scale used

Plotted points must cover at least half the printed grid.(both directions).

1

All points plotted correctly

Allow + / − one small square.

1

Suitable line drawn

Good best−fit line based on their points (+ / − one small square).

Do not award if kinked, doubled or very thick line.

1

[4]

M3.(a) (i) M1 - M_r calcium phosphate = 310(.3)

If M_r wrong, lose M1 and M5.

1

M2 - Moles calcium phosphate = $\frac{7.26}{M1}$ (= 0.0234)

0.0234 moles can score M1 and M2.

If M_r incorrect, can score M2 for $\frac{7.26}{M1}$.

Allow M2 and / or M3 to 2 significant figures here but will lose M5 if answer not 1.23.

1

M3 - Moles phosphoric acid = 2 × 0.0234 = 0.0468

Allow student's M2 × 2. If not multiplied by 2 then lose M3 and M5.

1

M4 - Vol phosphoric acid = 0.038(0) dm^3

If not 0.038(0) dm^3 then lose M4 and M5.

1

Conc phosphoric acid = $\frac{0.0468}{0.038(0)}$

M5 = 1.23 (mol dm^{-3})

This answer only – unless arithmetic or transcription error that has been penalised by 1 mark.

Allow no units but incorrect units loses M5.

1

(ii) $\frac{492.3}{688.3} \times 100$ **OR** $\frac{492}{688} \times 100$

1 mark for both M_r correctly placed.

= 71.5%

2

(b) $3Ca(OH)_2 + 2H_3PO_4 \longrightarrow Ca_3(PO_4)_2 + 6H_2O$

Allow multiples.

1

(c)

Ca	H	P	O
1.67 / 40.1	0.17 / 1	2.59 / 31	5.33 / 16
= 0.042 / 1	0.17 / 4	0.084 / 2	0.333 / 8

If x = 2 with no working, allow M4 only.

Ca = 1.67 g (M1).

1

Mark for dividing by correct A_r in Ca and P (M2).
If M1 incorrect can only score M2.

1

Correct ratio (M3).

1

$CaH_4P_2O_8$ **OR** $Ca(H_2PO_4)_2$ **OR** x = 2

Value of x or correct formula (M4).

1

Alternative

Ca H_2PO_4

Ca = 1.67 g (M1).

$\frac{1.67}{40.1}$ $\frac{8.09}{97.0}$

Mark for dividing by correct A_r / M_r in Ca and H_2PO_4 (M2).
If M1 incorrect can only score M2.

= 0.042 0.083
1 2

Correct ratio (M3).

$CaH_4P_2O_8$ **OR** $Ca(H_2PO_4)_2$ **OR** x = 2

Value of x or correct formula (M4).

[12]

M4.(a) 2,2,4-trimethylpentane

1

(b) 5

1

(c) $C_{20}H_{42} \longrightarrow C_8H_{18} + 2C_3H_6 + 3C_2H_4$

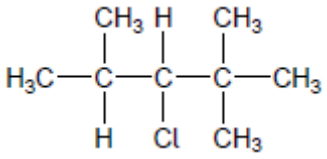
1

(d) Mainly alkenes formed

1

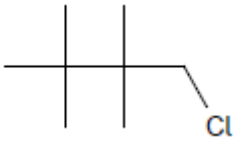
(e) 4 (monochloro isomers)

1



1

(f)



1

(g) $C_8H_{17}{}^{35}Cl = 96.0 + 17.0 + 35.0 = 148.0$
and $C_8H_{17}{}^{37}Cl = 96.0 + 17.0 + 37.0 = 150.0$
Both required

1

M_r of this $C_8H_{17}Cl$ $\frac{(1.5 \times 148.0)}{2.5} + \frac{(1.0 \times 150.0)}{2.5} = 148.8$

1

(h) $\frac{24.6}{12} \quad \frac{2.56}{1} \quad \frac{72.8}{35.5} = 2.05 : 2.56 : 2.05$

Simplest ratio = $\frac{2.05}{2.05} : \frac{2.56}{2.05} : \frac{2.05}{2.05}$

= 1 : 1.25 : 1

1

Whole number ratio (× 4) = 4 : 5 : 4

1

MF = $C_8H_{10}Cl_8$

1

[12]

M5.(a) Percentage of oxygen by mass = 100 – 40.9 – 4.5 = 54.6

1

	C	H	O
%	40.9	4.5	54.6
Divide by A_r	12	1	16
	= 3.41	= 4.5	= 3.41

1

Divide by smallest = $\frac{3.41}{3.41} = 1$ $\frac{4.5}{3.41} = 1.32$ $\frac{3.41}{3.41} = 1$

Nearest whole number ratio = 1 × 3 1.32 × 3 1 × 3

= 3 : 3.96 : 3

Nearest integer ratio = 3 : 4 : 3

1

Empirical formula $C_3H_4O_3$

Empirical formula mass = 88 = molecular formula mass

Therefore, molecular formula is same as the empirical formula - $C_3H_4O_3$

1

(b) $C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$

1

(c) Advantage – ethanol is produced at a faster rate

1

Disadvantage – more energy is used / required in the reaction

1

(d) Air gets in / oxidation occurs

1

(e) Alcohol OH absorption in different place (3230–3550 cm^{-1}) from acid OH absorption (2500–3000 cm^{-1})

1

The C=O in acids has an absorption at 1680–1750 cm^{-1}

1

[10]