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8 (a) (changes from) blue (1) to pink (1) [2]

(b) no more (solid) dissolves or no more cobalt(II) carbonate dissolves or no more effervescence or bubbling or fizzing [1]

filter(residue)/centrifuge/decant [1]

evaporate/heat/warm/boil/leave in sun

AND until most of the water has

gone/some water is left/until it is

concentrated/saturation

(point)/crystallisation

point/crystals form on glass rod or

microscope slide/crystals start to form

[1]

Leave/allow to cool/allow to

crystallise/filter (off

crystals)/wash(with distilled

water)/dry crystals with filter paper/dry

crystals in warm place or dry in oven or

dry on windowsill [1]

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6 (a) Rb loses 1 electron/1 electron in outer shell/1 valency or valence electron [1]

Sr loses 2 electrons/2 electrons in outer shell/2 valency or valence electrons [1]

(b) (i) (mix solutions of) rubidium carbonate/Rb₂CO₃ [1]

strontium chloride/SrCl₂ or strontium

nitrate/Sr(NO₃)₂ or strontium

sulfate/SrSO₄ or strontium

hydroxide/Sr(OH)₂ [1]

COND (on two correct reactants) filter or centrifuge or decant (the residue) [1]

wash with water and dry/press between

filter paper/put in (low) oven/put on a

(sunny) windowsill/put in sun/heat [1]

(c) (i) nitric acid or nitric(V) acid or HNO₃ [1]

(ii) 2KNO₃ = 2KNO₂ + O₂ [2]

Species (1)

Balance (1)

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1 (a) Match the following pH values to the solutions given below.

1 3 7 10 13

The solutions all have the same concentration.

solution pH

aqueous ammonia, weak base 10

dilute hydrochloric acid, a strong acid 1

aqueous sodium hydroxide, a strong base

13

aqueous sodium chloride, a salt 7

dilute ethanoic acid, a weak acid 3 [5]

(b) Hydrochloric acid strong acid or

ethanoic acid weak acid [1]

OR: hydrochloric acid completely ionised

or ethanoic acid

partially ionised

hydrochloric acid greater concentration

of/more H⁺ ions (than ethanoic acid) [1]

(c) Rate of reaction with Ca, Mg, Zn, Fe

[1]

Strong (hydrochloric) acid bubbles faster

or more bubbles or dissolves faster [1]

OR: rate of reaction with (metal)

carbonate [1]

strong (hydrochloric) acid faster or more

bubbles or dissolves faster (only if

carbonate insoluble) [1]

OR: electrical conductivity [1]

strong (hydrochloric) acid better

conductor [1]

[Total: 9]

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(b) Ba(C₆H₁₃SO₃)₂ / (C₆H₁₃SO₃)₂Ba [1]

(c) (i) _ magnesium hexanesulfonate + hydrogen [1]

(ii) _ calcium hexanesulfonate + water [1]

(iii) 2C₆H₁₃SO₃H + Na₂CO₃ → 2C₆H₁₃SO₃Na + CO₂ + H₂O

C₆H₁₃SO₃Na = (1) [1]

remaining species correct and equation

balanced = (1) [1]

(d) (i) measure pH / add universal indicator [1]

both acids have a low value / pH 0–2 / same colour / red [1]

or

measure rate with named reactive metal, Mg,

Zn (1)

both fast reactions (1)

or

measure rate using piece of insoluble carbonate, CaCO_3 (1)
both fast reactions (1)
NOTE: must be insoluble for first mark
or

measure electrical conductivity (1)
both good conductors (1)
(ii) to have same concentration of H^+ / one acid is H_2SO_4 , the other is $\text{C}_6\text{H}_{13}\text{SO}_3\text{H}$ / sulfuric acid is dibasic, hexanesulfonic is monobasic [1]
(iii) a strong acid is completely ionised, [1]
a weak acid is partially ionised [1]

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(c)

if the oxide is	predicted result with hydrochloric acid	predicted result with aqueous sodium hydroxide
acidic	NR	R
neutral	NR	NR
basic	R	NR
amphoteric	R	R

(1) per line [4]

5 (a) because they have more than one oxidation state or valency / form ions with different charges [1]
there are two iron oxides (iron(III) oxide and iron(II) oxide) / iron forms Fe^{2+} and Fe^{3+} compounds / iron forms iron(II) and iron(III) compounds [1]
(b) (i) to remove the precipitate / remove the silver(I) chromate(VI) / remove the residue [1]
(ii) to remove soluble impurities / remove named soluble salt e.g. potassium nitrate / remove reactants [1]
(iii) to dry solid / to remove water [1]
(c) (i) need one mole of potassium chromate(VI) for two moles of silver(I) nitrate / correct references to mole ratio [1]

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(b) (i) anhydrous cobalt chloride becomes hydrated [1]
ACCEPT: hydrous
(ii) carbon dioxide is acidic [1]
sodium hydroxide and calcium oxide are bases / alkalis [1]
(iii) Any two of:

water, calcium carbonate and sodium carbonate [2]
ACCEPT: sodium bicarbonate

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(b) (i) heat with carbon or coke or carbon monoxide; [1]
(ii) $\text{ZnO} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2\text{O}$ [2]
[1] for correct reactants [1] for correct products
(iii) zinc (not: ions) more reactive than silver and lead; [1]
zinc displaces both metals / silver and lead produced / ions become atoms / zinc reduces silver ions and lead ions; [1]
(silver and lead) can be removed by filtering / centrifugation / decanting; [1]
an ionic equation; i.e.
 $\text{Zn} + 2\text{Ag}^+ \rightarrow \text{Zn}^{2+} + 2\text{Ag}$ or $\text{Zn} + \text{Pb}^{2+} \rightarrow \text{Zn}^{2+} + \text{Pb}$ [1]
allow: any two correct half equations

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(b) (i) strontium carbonate does not dissolve / no effervescence; [1]
note: not just reaction is complete
(ii) to remove excess / unreacted / undissolved strontium carbonate; [1]
(iii) water of crystallisation needed / $6\text{H}_2\text{O}$ in crystals / would get anhydrous salt / would not get hydrated salt / crystals dehydrate; [1]
not: just to obtain crystals

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(b) (i) strontium carbonate does not dissolve / no effervescence; [1]
note: not just reaction is complete
(ii) to remove excess / unreacted / undissolved strontium carbonate; [1]
(iii) water of crystallisation needed / $6\text{H}_2\text{O}$ in crystals / would get anhydrous salt / would not get hydrated salt / crystals dehydrate; [1]
not: just to obtain crystals

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7 (a) (i) add carbon / animal charcoal [1]
filter [1]
OR

repeat experiment without indicator [1]
using same quantity / volume of acid [1]
(ii) add magnesium metal / carbonate / oxide / hydroxide
to (hot) (hydrochloric) acid [1]
cond: until in excess or no more dissolves or reacts [1]
cond: filter (to remove unreacted solid) [1]

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6 (a) (i) proton or H⁺ acceptor [1]
(ii) (measure) pH or (use) UI indicator [1]
note: can be implied need not be explicit
sodium hydroxide has higher pH / ammonia(aq) has lower pH [1]
(this sentence would score 2 marks)
or
appropriate colours with UI / appropriate numerical values [1]
ammonia is closer to green, blue-green, turquoise or lighter blue
sodium hydroxide is darker blue / purple / violet [1]
or
measure electrical conductivity [1]
can be implied need not be explicit
ammonia (aq) is the poorer conductor/ sodium hydroxide is the better conductor [1]

(e) (i) pH increases [1]
(ii) oxygen needed for rusting / removes oxygen / reacts with oxygen [1]

(b) experiment 1 $\text{Ca}^{2+} + \text{CO}_2 + \text{H}_2\text{O}$

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(e) it would react with/dissolves in a named strong acid [1]
it would react with/dissolves in a named alkali [1]
it shows both basic and acid properties = 1 [1]
it reacts with both acids and bases/alkalis = 1 [1]
[max 2]

2 (a) nitric acid; [1]
sodium hydroxide / carbonate / hydrogen carbonate; [1]
copper(II) oxide / hydroxide / carbonate; [1]
any named soluble chloride; [1]
accept: hydrochloric acid / hydrogen chloride

silver(I) nitrate / ethanoate / sulfate; [1]

must be soluble silver salt not silver oxide / carbonate

zinc(II) sulfate [1]

(b) (i) $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$ [2]

equation correct state symbols missing [1]

(ii) $\text{ZnCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{CO}_2 + \text{H}_2\text{O}$ [2]

correct formula for zinc sulfate = 1
[Total: 10]

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(b) (i) $\text{PCl}_3 + 3\text{H}_2\text{O} \rightarrow 3\text{HCl} + \text{H}_3\text{PO}_3$ [1]

(ii) acid solutions same concentration [1]
measure pH/pH paper/Universal indicator [1]
hydrochloric acid lower pH [1]

colours of Universal indicator can be given as red<orange<yellow

ignore precise pH values as long as HCl is lower than H_3PO_3

OR Acid solutions same concentration [1]

add magnesium or any named metal above Hydrogen in reactivity series but not above magnesium

calcium carbonate or any insoluble carbonate [1]

hydrochloric acid react faster/shorter time [1]

OR acid solutions same concentration [1]

measure electrical conductivity [1]

hydrochloric acid better conductor/bulb brighter [1]

OR acid solutions same concentration [1]

add sodium thiosulphate [1]

hydrochloric acid forms precipitate faster/less time [1]

(iii) sodium hydroxide/sodium carbonate [1]

titration cond on correct reagent [1]

second mark scores for mention of titration /burette/pipette/indicator.

experimental detail not required

any named soluble calcium salt e.g. calcium chloride/nitrate/hydroxide [1]

precipitation/filter/decant/centrifuge [1]

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5 (a) (i) $2\text{Li} + 2\text{HI} \rightarrow 2\text{LiI} + \text{H}_2$ [1]

(ii) zinc carbonate + hydriodic acid → zinc iodide + carbon dioxide + water [1]

(iii) $\text{MgO} + 2\text{HI} \rightarrow \text{MgI}_2 + \text{H}_2\text{O}$ [1]

(b) reaction 1 is redox / Li/2HI reaction [1]

cond reason either oxidation number/state / electron transfer [1]

(d) (i) the reaction is exothermic / reaction produces heat/energy [1]
all the sodium hydroxide used up/neutralised / reaction has stopped [1]
(ii) adding colder acid / no more heat produced [1]
if not given in (d)(i) any comments such as "reaction has stopped" can gain mark
(iii) 1.33 / 1.3 / 1.3333 (mol/dm³) scores both marks [2]
not 1.34

for a correct method – $M_1 V_1$ / moles of NaOH = 0.02
with an incorrect answer only [1]

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(c) base [1]
not alkali
accepts a proton [2]
accepts hydrogen ion / H⁺ only [1]
proton and H⁺ [2]

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(d) (i) thalium sulfate + ammonia + water [1]
(ii) $2\text{TlOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Tl}_2\text{SO}_4 + 2\text{H}_2\text{O}$ [2]
not balanced = [1]
incorrect formula = [0]
(iii) green precipitate or solid (ignore shades of green but not bluey green etc.) [1]
 $\text{Fe}^{2+} + 2\text{OH}^- \rightarrow \text{Fe}(\text{OH})_2$ accept multiples [1]

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6 (a) (i) Tl_2S [1]
(ii) TlCl_3 [1]
(b) filter / centrifuge / decant
wash the precipitate
dry the solid / heat the solid (in oven) / press between filter paper [3]
all three stated but not in correct order = [2]
two out of three stated in any order = [1]
(c) (i) silver chloride / silver bromide [1]
photography / cameras / films / photo chromic lenses / sunglasses [1]
(ii) increase distance between lamp and paper or put lamp far away /
put a screen or translucent or semi-opaque material between them /
use a less powerful or low voltage or dim lamp /
lower the temperature

any two [2]

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(b) (i) because it accepts a proton [2]
accepts hydrogen ion or H⁺ ONLY [1]
proton and H⁺ [2]
(ii) hydrogen chloride is a strong acid [1]
hydrogen fluoride is a weak acid [1]
weaker or stronger correctly applied for [2]

(iii) hydrogen chloride (aqueous) would have lower pH [1]
OR hydrogen fluoride (aqueous) would have higher pH
If values suggested, not over 7
[Total: 8]

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5 (a) (i) $\text{Ca}^{2+} + 2\text{F}^- \rightarrow \text{CaF}_2$ [2]
Not balanced ONLY [1]
Both species must be correct for first mark.
Second mark is for correct balancing.
(ii) Mole ratio Ca²⁺: F⁻ is 1:2 [1]
Answer must mention moles
accept argument based on charges or number of ions
accept 2 moles of NaF react with 1 mole of CaCl₂
NOT just "2" in equation
If fluorine must specify atoms or ions
(iii) to remove traces of solutions or to remove soluble impurities or to remove a named salt sodium chloride
or sodium fluoride or calcium chloride [1]
To remove impurities is not enough
(iv) to dry (precipitate) or to remove water or to evaporate water [1]
NOT to evaporate some of water NOT to crystallise salt

(b) $\text{T}_3(\text{PO}_4)_2$ allow correct example [1]
explain why 8 cm³ react fully [1]
comment about mole ratio [1]
[Total: 8]

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7 (a) repeat experiment without indicator or use carbon to remove indicator [1]
(partially) evaporate or boil or heat [1]
allow to cool or crystallise or crystals [1]
dry crystals [1]
MUST be in correct order

NB evaporate to dryness, marks one and two ONLY

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(c) hydrogen chloride or hydrochloric acid [1]
carbon dioxide or carbonic acid or hydrogen carbonate [1]
(d) 8e around both chlorine atoms [1]
4e between carbon and oxygen atoms [1]
8e around carbon atom [1]
8e around oxygen [1]
if a bond contains a line with no electrons, no marks for atoms joined by that line
ignore keying

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4 (a) (i) magnesium + sulphuric acid = magnesium sulphate + hydrogen [1]
ACCEPT hydrogen sulphate
(ii) $\text{Li}_2\text{O} + \text{H}_2\text{SO}_4 \rightarrow \text{Li}_2\text{SO}_4 + \text{H}_2\text{O}$ [2]
formulae correct but not balanced [1]
(iii) $\text{CuO} + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{H}_2\text{O}$ [2]
OR $\text{CuO} + 2\text{HCl} \rightarrow \text{CuCl}_2 + \text{H}_2\text{O}$
OR $\text{CuO} + 2\text{HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + \text{H}_2\text{O}$
formulae correct but not balanced [1]
(iv) sodium carbonate + sulphuric acid → sodium sulphate + carbon dioxide + water [1]
(b) it accepts a proton [2]
it accepts a hydrogen ion [1] ONLY
(c) sulphuric acid is completely ionised [1]
or few molecules and many ions
ethanoic acid is partially ionised [1]
or many molecules and few ions
[Total: 10]

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3 (i) method C [1]
sulphuric acid (allow if given in equation) [1]
zinc oxide + sulphuric acid = zinc sulphate + water [1]
(ii) method A [1]
hydrochloric acid [1]
 $\text{KOH} + \text{HCl} = \text{KCl} + \text{H}_2\text{O}$ [1]
(iii) method B [1]
potassium iodide or any soluble iodide [1]
 $\text{Pb}^{2+} + 2\text{I}^- = \text{PbI}_2$ accept a correct equation even if soluble iodide is wrong [2]
Not balanced - $\text{Pb}^{2+} + \text{I}^- = \text{PbI}_2$ ONLY [1]
[Total: 10]

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3 (a) ammonia 10

hydrochloric acid 1
sodium hydroxide 13
ethanoic acid 4
All correct [2]
Two correct [1]
(b) With strong acid bulb brighter [1]
faster rate of bubbles [1]
OR corresponding comments for weak acid
(c) proton NOT hydrogen ion [1]
 H^+ not conditional on proton [1]
Only way for [2] is proton and H^+
(d) (i) CaO and MgO [1]
(ii) CO_2 and SO_2 [1]
(iii) Al_2O_3 [1]
(iv) CO [1]
[TOTAL = 10]

(c) reaction no reaction [1]
reaction reaction [1]

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4 (a) (i) correct word equation (carbon dioxide and water) [1]
Accept correct symbol equation
(ii) Must have a correct reagent otherwise wc = 0
add (acidified) barium chloride(aq) or nitrate or add barium ions [1]
COND white precipitate [1]
NOT lead(II) compounds
(iii) low pH or universal indicator turns red(aq) [1]
pH 3 or less

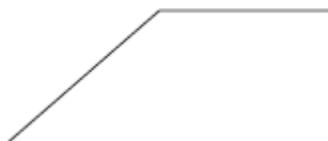
(b) (i) to remove fibres or remove solid NOT precipitate, NOT impurities, NOT to obtain a filtrate [1]
(ii) because silver atoms have lost electrons [1]
OR oxidation number increased
(iii) silver chloride [1]

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2 (a) $\text{Zn} + \text{I}_2 = \text{ZnI}_2 + 2\text{I}^-$ [2]
For having either reactants or products correct ONLY [1]
(b) for zinc and sodium hydroxide white precipitate [1]
dissolves in excess (only if precipitate mentioned) [1]
for zinc and ammonia same results [1]
Mark either first (sodium hydroxide or aqueous ammonia), if completely correct, then an additional [1] can be awarded for stating that the other has the same results.

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- 4 (a) (i) Named soluble zinc salt [1]
corresponding sodium salt [1]
If hydroxide or oxide then 0/2
(ii) Correct equation [2]
not balanced [1] only
(iii) Correct equation [2]
(b) (i) $\text{Fe}^{3+} + 3\text{OH}^- = \text{Fe}(\text{OH})_3$ [1]
(ii) Max at 8cm³
[1]
Same shape of graph



Just the above shape, the height of the precipitate and the volume of sodium hydroxide are irrelevant [1]

- (iii) Maximum then height of precipitate decreases [1]
or graph slopes down to x axis or comes to zero
hydroxide dissolves in excess or it is amphoteric [1]

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- (b) (i) potassium [1]
(ii) ammonium sulphate [1]
(iii) $\text{Ca}_3(\text{PO}_4)_2$ [1]
 $\text{Ca}(\text{H}_2\text{PO}_4)_2$ [1]
(iv) only acceptable responses are:
accepts a proton [2]
accepts H^+
[1] only

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(d) Add excess lead oxide to nitric acid
can imply excess
filter NOT if residue is lead nitrate
evaporate or heat solution

- (b) (i) white precipitate
COND upon a precipitate
dissolves in excess or forms solution
[1]
[1]
(ii) blue precipitate
COND upon a precipitate
does not dissolve in excess
[1]

[1]

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- 5 (a) (i) equilibrium to left or many molecules
and few ions or
partially ionised or reverse reaction favoured
[1]
(ii) Water donates proton [1]
methylamine accepts a proton [1]
NOTE If hydrogen ion then ONLY [1] provided
both are correct
(b) less than 12 more than 7 [1]
smaller concentration of hydroxide ions or
partially dissociated or
poor proton acceptor or poor H^+ acceptor [1]
NOT it is a weak base
(c) (i) $\text{CH}_3\text{NH}_2 + \text{HCl} = \text{CH}_3\text{NH}_3\text{Cl}$ [1]
methylammonium chloride [1]
NOTE the equation must be as written, the
equation with sulphuric acid has been
given as guidance.
(ii) brown precipitate [1]
ACCEPT orange or red/brown or brick red or
brown/red
(iii) sodium hydroxide or any named strong
base [1]
[Total: 9]

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- (c) (i) Any reasonable explanation
Plants prefer soil pH about 7
Plants do not grow (well) in acidic soils/plants grow
better
To increase crop yields
Any ONE [1]
Do NOT accept in acidic soils plants die
(ii) With calcium carbonate, pH cannot go above 7
[1]
It is not washed away by the rain/remains longer in
the soil
It is not absorbed by the plant [1]
OR
With calcium oxide, pH can go above 7 [1]
It is washed away by the rain [1]
(iii) Any correct use - making steel/iron, making
cement, making glass, [1]
disposing of acid wastes, removing sulphur dioxide
from flue
gases, (stone in) building, indigestion tablets,
toothpaste, cosmetics etc
-
- (b)(i) sulphuric acid
COND description of titration
repeat without indicator or with carbon
evaporation
any TWO [3]
(ii) suitable reactants calcium chloride and
sodium fluoride [1]
COND upon correct reagents

filter [1]
wash and dry precipitate [1]
OR Accept synthesis
calcium [1]
fluorine [1]
burn or heat [1] [3]

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(b)(i) calcium ethanoate + hydrogen [1]
(ii) zinc oxide or hydroxide [1]
(c) $\text{CH}_3\text{COOH} + \text{NaOH} \rightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O}$
[2]
reactants [1] products [1]

2 dilute
filter
saturated
cool
blue
sulphate [6]

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5 (a) (i) preserve food **or** sterilising
(ii) making paper

(c) (i) proton
hydrogen ion **or** H^+ **ONLY** [1]
(ii) correct equation molecular **or** ionic
 $\text{NH}_3 + \text{HCl} = \text{NH}_4\text{Cl}$
 $\text{NH}_3 + \text{H}^+ = \text{NH}_4^+$ accept NH_4OH
(d) measure pH **or** add universal indicator **or** pH meter
ammonia has lower pH if numerical values given

(b) (i) manganese chloride
water
(ii) manganese(III) and (IV) oxides

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(b) sodium hydroxide **or** carbonate **or** hydrogencarbonate

zinc oxide **or** hydroxide **or** carbonate
NOT zinc

barium nitrate **or** chloride **or** hydroxide **or** barium ions

neutralisation **NOT** acid/base
(c) (i) copper sulphate **or** anhydrous copper sulphate
accept "unhydrated"
NOT formula
(ii) goes blue **or** becomes hot **or** steam
(iii) copper oxide

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8 (a) same general formula
same chemical properties
same functional group
physical properties vary in predictable way
common methods of preparation
consecutive members differ by CH_2
any two [2]
mark first two
ignore others unless it contradicts a point
which has been awarded a mark
(b) (i) $2\text{HCOOH} + \text{CaCO}_3 \rightarrow \text{Ca}(\text{HCOO})_2 + \text{CO}_2 + \text{H}_2\text{O}$ [2]
not balanced = [1]
(ii) zinc + methanoic acid _ zinc methanoate +
hydrogen [2]
[1] for each product
(iii) protected by oxide layer [1]
(c) butanoic acid [1]
 $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-COOH}$ / $\text{C}_4\text{H}_8\text{O}_2$ / $\text{C}_3\text{H}_7\text{COOH}$ /
 $\text{C}_4\text{H}_7\text{OOH}$ [1]
 $\text{C}_2\text{H}_4\text{O}$ [1]
mark ecf to molecular formula

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7 (a) repeat without indicator / repeat
using same volumes of acid and alkali **or**
use
carbon / charcoal to remove indicator (1)
evaporate / heat / warm / boil / leave in
sun (1)
until most of the water has gone / some
water is left / saturation (point) /
crystallisation point (1)
leave / allow to cool / allow to
crystallise (1)
filter (off crystals) / wash (with
distilled water) / dry crystals with
filter paper / dry
crystals in warm place / oven /
windowsill (1) [5]

(c) name or formula of strong acid and
alkali (1)
reacts with or neutralises both acid and
base or alkali (then amphoteric) (1)
it dissolves / soluble in both (acid and
alkali) or form solutions in both (1) [3]

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(c) (i) zinc + propanoic acid \rightarrow zinc
propanoate (+ hydrogen) (1) [1]

(ii) calcium oxide + propanoic acid → calcium propanoate + water (1) [1]
(iii) $\text{LiOH} + \text{CH}_3\text{CH}_2\text{COOH} \rightarrow \text{CH}_3\text{CH}_2\text{COOLi} + \text{H}_2\text{O}$
(1) [1]

(ii) potassium / K (1)
phosphorus / P (1) [2]
(b) (i) burn fossil fuels / burn fuels containing sulfur / burn compounds containing sulfur / burn ores containing sulfur / roast metal sulfides / burn metal sulfides
(1)
sulfur dioxide / SO_2 (formed) (1)
(form) sulfuric / H_2SO_4 / sulfurous acid / H_2SO_3 (1)
OR
nitrogen and oxygen (in air) react at high temperatures / in jet engines / car engines / lightning. (1)
(form) oxides of nitrogen (1)
(form) nitric acid / HNO_3 / nitrous acid / HNO_2 (1) [3]

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(b) (i) malonic is a weaker acid/less dissociated
OR sulfuric acid is a stronger acid/more dissociated [1]
NOT sulfuric acid is a strong acid
(ii) add piece of suitable metal, e.g. Mg
ALLOW Al, Ca NOT K, Na, Cu [1]
sulfuric acid reacts faster **OR** malonic reacts slower [1]
OR
as above add a piece of CaCO_3 , if soluble carbonate then [1] only
OR measure electrical conductivity [1]
sulfuric acid is the better conductor
OR malonic acid poorer conductor [1]
NOT sulfuric acid is a good conductor

(c) (i) sodium malonate and water [1]
(ii) CuSO_4
 H_2O [2]
(iii) $\text{CH}_2(\text{COO})_2\text{Mg}$
 H_2 [2]
(iv) K_2SO_4
 CO_2 and H_2O NOT H_2CO_3 [2]

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3 (a) sodium hydroxide solution [1]

warm [1]
(only) ammonium phosphate gives off ammonia / gas (which will turn red litmus paper blue) [1]
or:
sodium hydroxide solution [1]
dissolve fertiliser in water [1]
 Ca^{2+} gives (white) ppt [1]
or:
flame test [1]
 Ca^{2+} brick red / orange / orange-red [1]
 NH_4
+ no colour [1]
(b) iron catalyst [1]
pressure 150–300 atmospheres [1]
temperature 370–470 °C [1]
 $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ [1]
note: units required for temperature and pressure
(c) potassium / K [1]
(d) (i) needs to be soluble / in solution (to be absorbed by plants) [1]
(ii) base [1]
proton acceptor [1]
(e) plant growth depends on soil acidity or pH / plants have optimum pH (for growth) [1]
add $\text{Ca}(\text{OH})_2$ / CaO / CaCO_3 / lime / slaked lime / quicklime / limestone [1]

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6 (a) (i) to neutralise all the acid / so all acid reacts [1]
not: reaction goes to completion
(ii) remove excess carbonate / removes unreacted carbonate [1]
not: remove solid
(iii) need water of crystallisation / hydrated crystals / to get crystals [1]
(iv) filter / decant / wash crystals [1]
dry with filter paper or tissues etc. [1]
accept: in warm oven / warm place / in sun
not: just heat
(b) (i) potassium carbonate is soluble / both salts soluble [1]
(ii) use potassium carbonate solution [1]
accept: implication of solution – in pipette / burette / 25 cm³
titrate / titration term required [1]
use an indicator accept: any named acid/base indicator [1]

repeat without indicator / use carbon to remove indicator [1]

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(b) test it with both hydrochloric acid and sodium hydroxide(aq) [1]
accept: any named strong acid and any strong alkali
if only acid and alkali given then max = 3
basic oxide reacts with acid [1]
acidic oxide reacts with alkali/base [1]
amphoteric reacts with both [1]
accept: for react – form salt and water

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1 (a) (i) lithium oxide / strontium oxide [1]
(ii) sulfur dioxide / nitrogen dioxide [1]
(iii) aluminium oxide [1]
(iv) carbon monoxide [1]
accept: correct formulae
(b) sulfur dioxide [1]
burn (fossil) fuel containing sulfur / volcanoes [1]
nitrogen dioxide [1]
reaction of nitrogen and oxygen [1]
high temperatures / in car engine [1]
not: exhaust

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8 (a) filter / centrifuge / decant [1]
(partially) evaporate / heat / boil [1]
allow to crystallise / cool / let crystals form [1]
dry crystals / dry between filter paper / leave in a warm place to dry [1]
“dry” on its own must be a verb
evaporate to dryness only marks 1 and 2
note if discuss residue only mark 1

(b) (i) zinc / aluminium / lead / tin / chromium [1]
(ii) white precipitate [1]
precipitate dissolves / colourless solution forms / forms a clear solution / soluble in excess [1]

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(c) (i) proton donor [1]
(ii) measure pH / use pH paper [1]
sulfuric acid has the lower pH [1]
accept colours / appropriate numerical values
OR

measure electrical conductivity [1]
sulfuric acid is the better conductor [1]
OR
add magnesium / named fairly reactive metal [1]
ethanedioic acid gives the slower reaction [1]
NOTE result must refer to rate not amount
OR
add a carbonate [1]
ethanedioic acid gives the slower reaction [1]
NOTE result must refer to rate not amount

(ii) add sodium hydroxide(aq) / alkali [1]
carbon dioxide dissolves, leaving methane [1]

(c) (i) V_2O_3 [1]
 VO_2 [1]
(ii) add sodium hydroxide(aq) or other named alkali [1]
not ammonia
cond vanadium(IV) oxide dissolves / reacts [1]
filter (to remove vanadium(III) oxide) [1]

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2 (a) $pH < 7$ [1]
example [1]
 $pH > 7$ [1]
example [1]
NOT amphoteric oxides Be, Al, Zn, Pb, Sn etc
 $pH = 7$ [1]
example H_2O , CO, NO [1]
the two marks are not linked, mark each independently
NOT amphoteric oxides Be, Al, Zn, Pb, Sn etc.
(b) (i) shows both basic and acidic properties [1]
(ii) a named strong acid [1]
a named alkali [1]

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4 (a) (i) C_6H_5COOH or $C_6H_5CO_2H$ [1]
NOT $C_7H_6O_2$ / C_6H_6COO
(ii) sodium hydroxide + benzoic acid = sodium benzoate + water [1]

correct spelling needed NOT benzenoate
ACCEPT correct symbol equation
(iii) sodium carbonate or oxide or
hydrogencarbonate
any TWO [2]
NOT Na

