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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/Rb<sub>2</sub>CO<sub>3</sub> [1]

strontium chloride/SrCl<sub>2</sub> or strontium

nitrate/Sr(NO<sub>3</sub>)<sub>2</sub> or strontium

sulfate/SrSO<sub>4</sub> or strontium

hydroxide/Sr(OH)<sub>2</sub> [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 HNO<sub>3</sub> [1]

(ii) 2KNO<sub>3</sub> = 2KNO<sub>2</sub> + O<sub>2</sub> [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<sup>+</sup> 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(C<sub>6</sub>H<sub>13</sub>SO<sub>3</sub>)<sub>2</sub> / (C<sub>6</sub>H<sub>13</sub>SO<sub>3</sub>)<sub>2</sub>Ba [1]

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

(ii) \_ calcium hexanesulfonate + water [1]

(iii) 2C<sub>6</sub>H<sub>13</sub>SO<sub>3</sub>H + Na<sub>2</sub>CO<sub>3</sub> \_ 2C<sub>6</sub>H<sub>13</sub>SO<sub>3</sub>Na + CO<sub>2</sub> + H<sub>2</sub>O

C<sub>6</sub>H<sub>13</sub>SO<sub>3</sub>Na = (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,  $\text{CaCO}_3$  (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  $\text{H}^+$  / one acid is  $\text{H}_2\text{SO}_4$ , 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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### PAGE 72

(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  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  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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### PAGE 73

(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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### PAGE 74

(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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### PAGE 75

(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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### PAGE 76

(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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### PAGE 77

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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### **PAGE 78**

6 (a) (i) proton or H<sup>+</sup> 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]

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

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### **PAGE 79**

(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]

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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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### **PAGE 80**

(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  $\text{H}_3\text{PO}_3$   
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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### **PAGE 81**

5 (a) (i)  $2\text{Li} + 2\text{HI} \rightarrow 2\text{LiI} + \text{H}_2$  [1]  
(ii) zinc carbonate + hydriodic acid  $\rightarrow$  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/dm<sup>3</sup>) 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<sup>+</sup> only [1]  
proton and H<sup>+</sup> [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)  $\text{Tl}_2\text{S}$  [1]  
(ii)  $\text{TlCl}_3$  [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<sup>+</sup> ONLY [1]  
proton and H<sup>+</sup> [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]

### PAGE 86

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 Ca<sup>2+</sup>: F<sup>-</sup> 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  
CaCl<sub>2</sub>  
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 cm<sup>3</sup> react fully [1]  
comment about mole ratio [1]  
[Total: 8]

### PAGE 88

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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### **PAGE 89**

(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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### **PAGE 90**

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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### **PAGE 91**

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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### **PAGE 92**

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]  
 $\text{H}^+$  not conditional on proton [1]  
Only way for [2] is proton and  $\text{H}^+$   
(d) (i) CaO and MgO [1]  
(ii)  $\text{CO}_2$  and  $\text{SO}_2$  [1]  
(iii)  $\text{Al}_2\text{O}_3$  [1]  
(iv) CO [1]  
[TOTAL = 10]

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

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### **PAGE 94**

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

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(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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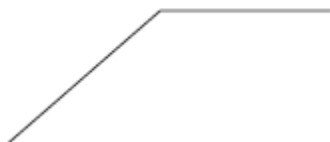
### **PAGE 95**

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 8cm<sup>3</sup>  
[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  $\text{H}^+$   
[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  $\text{H}^+$  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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### PAGE 101

(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]

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2 dilute  
filter  
saturated  
cool  
blue  
sulphate [6]

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### PAGE 102

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

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(c) (i) proton  
hydrogen ion **or**  $\text{H}^+$  **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  $\text{NH}_4\text{OH}$   
(d) measure pH **or** add universal indicator **or** pH meter  
ammonia has lower pH if numerical values given

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

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### PAGE 103

(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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### PAGE 104

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  $\text{CH}_2$   
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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### PAGE 105

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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### PAGE 106

(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 /  $\text{SO}_2$  (formed) (1)  
(form) sulfuric /  $\text{H}_2\text{SO}_4$  / sulfurous acid /  $\text{H}_2\text{SO}_3$  (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 /  $\text{HNO}_3$  / nitrous acid /  $\text{HNO}_2$  (1) [3]

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#### PAGE 107

(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  $\text{CaCO}_3$ , 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)  $\text{CuSO}_4$   
 $\text{H}_2\text{O}$  [2]  
(iii)  $\text{CH}_2(\text{COO})_2\text{Mg}$   
 $\text{H}_2$  [2]  
(iv)  $\text{K}_2\text{SO}_4$   
 $\text{CO}_2$  and  $\text{H}_2\text{O}$  **NOT**  $\text{H}_2\text{CO}_3$  [2]

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#### PAGE 108

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]  
 $\text{Ca}^{2+}$  gives (white) ppt [1]  
**or:**  
flame test [1]  
 $\text{Ca}^{2+}$  brick red / orange / orange-red [1]  
 $\text{NH}_4$   
+ 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 /  $\text{CaCO}_3$  / lime / slaked lime / quicklime / limestone [1]

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#### PAGE 109

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 cm<sup>3</sup>  
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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### **PAGE 110**

(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

---

### **PAGE 111**

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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### **PAGE 112**

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

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(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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### **PAGE 113**

(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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### **PAGE 114**

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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### **PAGE 115**

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