Harris Academy Greenwich

Science

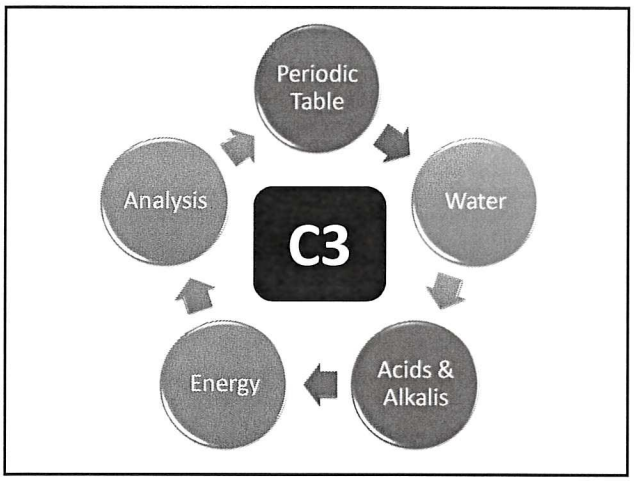
Triple Chemistry (C3)

Revision Pack

Student Name: _____

Teacher Name: _____

C3 Revision Cards



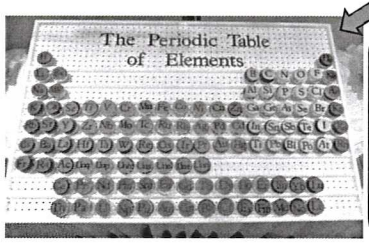
Periodic Table — Early Periodic Table

NEWLANDS:
- Built on Dalton's Law of Octaves (every 8th element had similar properties)
- Arranged by atomic mass
- Two elements in same box

MENDELEEV:
- Arranged by atomic mass
- Similar properties
- Left gaps for elements yet to be discovered

Periodic Table — Modern Periodic Table

YUMMY!!

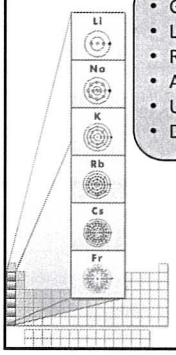


- Metals/Non-metals
- Arranged by proton number
- Groups – number of electrons on outer shell
- Periods – number of shells

Periodic Table — Group 1 – Alkali Metals

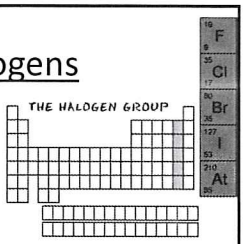
Stored in oil, as reacts with oxygen in air

- Group 1 metals → 1+ ion
- Li, Na, K – less dense than water
- Reaction with water --> make H_2
- Alkali metals….metal hydroxide
- Universal indicator – purple
- Down group – lower mpt/bpt



- Reactivity INCREASES down the group
- Larger atom
- Outer electron further away from +ve nucleus
- EASIER to lose due to SHIELDING effect of other electrons
- Less electrostatic force

Periodic Table — Group 7 – Halogens



- Group 7 non-metals → 1- ion
- Coloured vapours
- Diatomic molecules
- Down the group – higher mpt/bpt
- Forms ionic compounds with Grp1

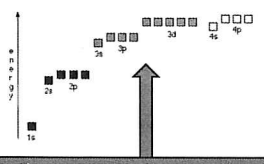
HALOGEN DISPLACEMENT
A more reactive halogen will displace a less reactive one from a compound

- Reactivity DECREASES down the group
- Larger atom
- Outer shell further away from +ve nucleus
- HARDER to gain an electron due to SHIELDING effect of other electrons
- Less electrostatic force to attract electron

Periodic Table — Transition Metals

Compared with Group 1…
- Higher mpt
- Higher density
- Stronger/harder
- Much less reactive

Used for catalysts
Form coloured compounds
Ions with diff charges



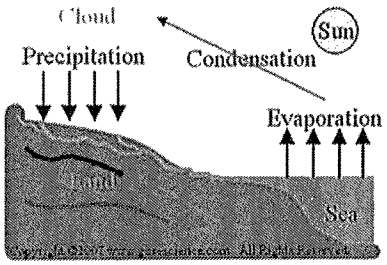
- Similar properties because they fill an inner 3rd shell (3d shell). This can hold 18 electrons, once 2 electrons fill the 4th energy level.
- Usually have same number of electrons on outer shell

Water

Water Cycle

- Water evaporates due to Sun's thermal energy.
- Condenses to form clouds
- Precipitation (rain/snow/sleet) occurs.

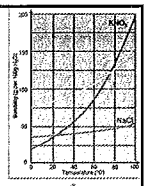
Ionic compounds are **soluble**, but covalent ones are not.



Water

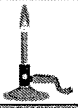
Solubility

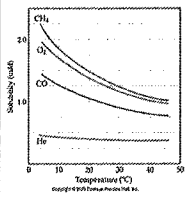
Saturated Solution → maximum amount of solute that can be dissolved in a solvent at a given temperature.



Heat up solvent....more solid solute will be dissolved

Leave to cool...solid solute will crystallise out of solution





GASES:
Increase temperature....solubility DECREASES
Increase pressure...solubility INCREASES

Hot water from cooling towers → THERMAL POLLUTION

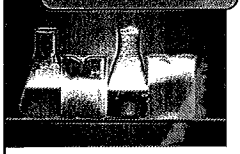
Less O2 for me!

Water

Hard Water

Contains Mg^{2+} and Ca^{2+} ions, dissolved when water passes through rocks

Soft water → easy lather
Hard water → less lather



SCUM
When hard water reacts with soap.

+ve
- Ca for bones/teeth

SCALE
When hard water is heated

-ve
- Kettles furrow up → less efficient

SCALE is basically limescale which is Calcium Carbonate which is a solid ppt and forms on metal appliances reducing efficiency

Water

Removing Hard Water

(Use washing soda

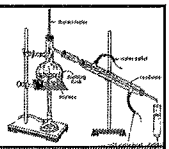
Ion Exchange (Water softener)

Add Sodium Carbonate
Precipitates out the Ca and Mg ions to form insoluble carbonates

Filled with resin. Contain Sodium/Hydrogen ions. As the water is passed through the resin, the Na/H ions are EXCHANGED with the Ca/Mg ions.
Needs to be topped up with Na ions so NaCl is poured in to replenish

Water

Water Treatment



Made safe to drink by removing solids and micro-organisms

Distillation = PURE WATER

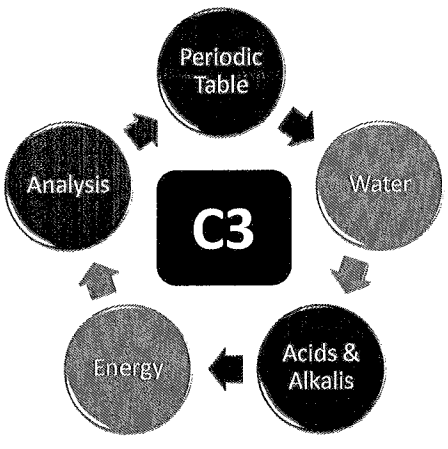
Water source → Filter solids

Sedimentation of small particles using Aluminium sulphate

Carbon → reduces Cl levels
Ion exchange resin
Silver → discourage bacterial growth on filter

Filter of fine sand

Chlorine → used to disinfect



Acids & Alkalis

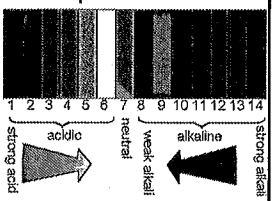
Strong/Weak Acids/Alkalis

TESTING whether strong or weak...use Universal Indicator

STRONG ACIDS fully dissociate into their ions
$HCl \rightarrow H^+ + Cl^-$

WEAK ACIDS partially dissociate into their ions
$CH_3COOH \leftrightarrow H^+ + CH_3COO^-$

pH Scale



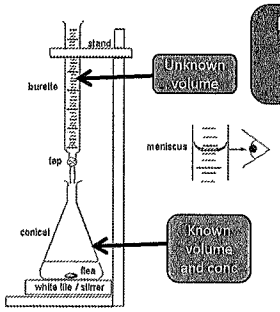
Same for alkalis, just OH- ions

Acids & Alkalis

Titration

NEUTRAL – pH7

Used to determine accurately how much alkali is needed to react completely with a known volume of acid (or vice-versa)



END POINT
Acid-base reaction is complete

Phenolphthalein → STRONG ALKALI and WEAK ACID

Methyl Orange → STRONG ACID and WEAK Alkali

Acids & Alkalis

Titration Calculations

Write what you know from the question.

$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

$V = 30cm^3$ Conc = ? $V = 20cm^3$ Conc = 0.5

1. Convert vol into dm3 by dividing by 1000.
2. Calculate moles of substance of known vol and conc

3. Look at the equation for the ratio. Here, it is 2:1

So we calculate moles of acid here and then multiply this by 2

4. Now rearrange the formula to allow you to work out the unknown

If they want you to work out the g/mol

All you do is multiply the RFM (they give you this!) by the concentration you calculated

MOLES = Vol x Conc

Acids & Alkalis

Theories

Arrhenius

Acid - produces hydrogen ions, H^+ in water solution.
Base - produces hydroxide ions, OH^- in water solution.

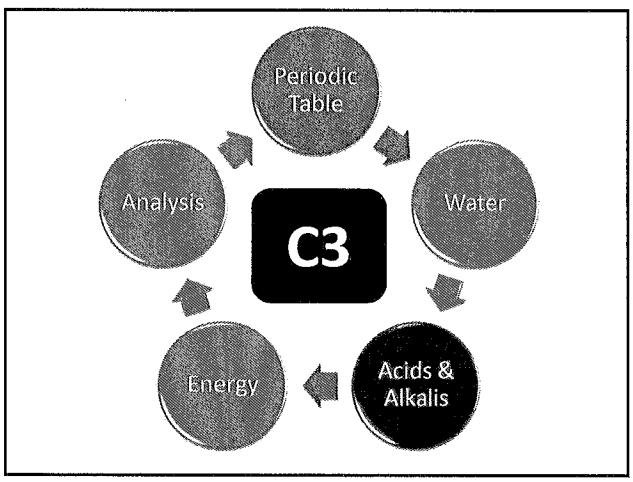
My ideas were rejected as they were new and I was just a student

H^+

Losing it's electron... means it's just a proton

Acid – proton donor
Base – proton acceptor

We are well known and built upon Arrhenius ideas so our ideas were readily accepted



Energy

Energy from fuels

4.2J raises temp of 1g of water by 1 degree

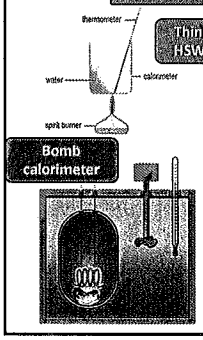
Calorimeter

Think HSW!

A + B → C
If 0.1 mole of reactants, total mass of A and B is 100g.
temp start is 19.6, temp max is 26.1
Work out diff...6.5

Energy change = mass x 4.2 x temp change

(Don't need to learn this, you would get this)
So for 0.1 moles = 2730J
For 1 mole 2730 x 10 27300J (27.3kJ)
...exothermic reaction (as temp rise) = -27.3kJ/mol



Food high in carbs and fats have lots of energy!! → more than body needs → obesity

Energy

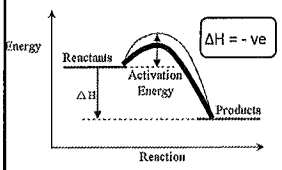
Energy changes

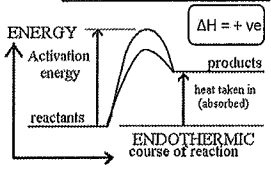
Reaction = bond breaking (endo) and bond making (exo)

EXOTHERMIC
Energy required to break bonds in less than energy released when new bonds are formed

CATALYST
Lowers activation energy

ENDOTHERMIC
Energy required to break bonds in greater than energy released when new bonds are formed

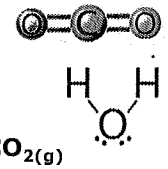




Energy

Bond energies

Identify the bonds... stick diagrams!



$CH_{4(g)} + 2O_{2(g)} \rightarrow 2H_2O_{(l)} + CO_{2(g)}$

Bond	Bond energy kJ/mol
H-H	436
Cl-Cl	242
H-Cl	431
O-H	464
C-C	347
C-O	335
O=O	498

Add up on the bonds in the reactants. This is bond energy needed to break the bonds

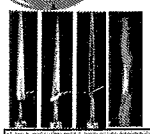
Add up on the bonds in the products. This is bond energy needed to make new bonds.

REMEMBER... making new bonds is an exothermic reaction...so it is always a –ve number

ΔH = bond breaking + (- bond making)

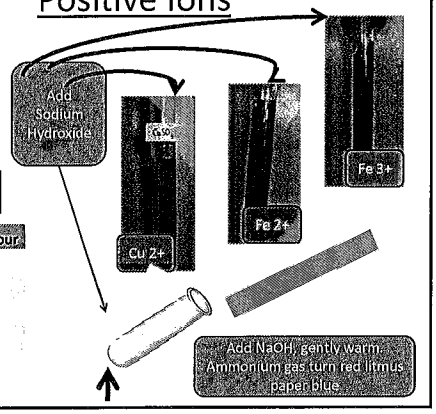
Analysis

Positive Ions



FLAME TESTS

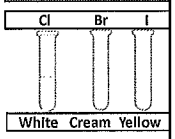
metal	flame test colour
barium	apple green
calcium	brick red
potassium	lilac
lithium	bright red
sodium	orange



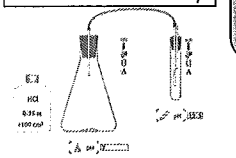
Analysis

Negative Ions

Halides → Add nitric acid and silver nitrate



Carbonates → add acid → bubbles → if they turn limewater cloudy



Copper Carbonate → Copper Oxide

Zinc Carbonate → Copper Oxide

SULPHATES
(add HCl to removes any carbonate ions)
Add Barium Chloride → white ppt

NITRATES
Test for ammonia first → negative result
Add ALUMINIUM (this reduces the nitrate ion to Ammonium ions)
Test again for ammonia gas → positive result

Analysis

Organic Compounds

BURN or CHAR when heated

Unsaturated compounds , have a double/triple bond.
Test using bromine water...goes from orange to colourless

COMBUSTION ANALYSIS (empirical formula)

Complete Combustion → products are always water (H_2O) and Carbon Dioxide (CO_2)

Moles = Mass / Mr
(They will give you the mass and Mr in the question)

	CO_2	H_2O
Moles	44g /44	18g / 18
	1 mole	1 mole (x 2)
Ratio	1	2

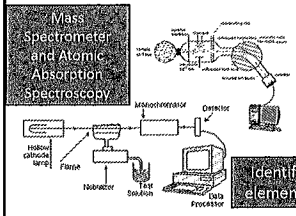
= CH_2

Analysis

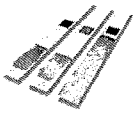
Instrumental Analysis

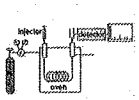
All due to advancements of computers

Mass Spectrometer and Atomic Absorption Spectroscopy



Identify elements





Chromatography can separate compounds in mixtures

\+ Highly accurate, quick and enables small quantities to be tested

\- Expensive, specialist training needed, only interpreted by comparison of known specimans

C3 REVISION – CHAPTER 1 – THE PERIODIC TABLE

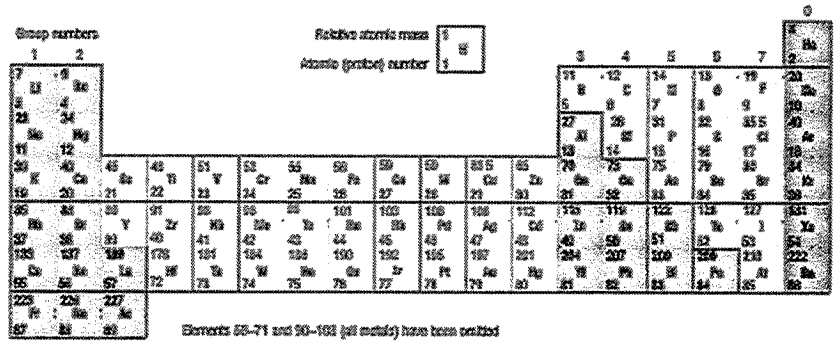
State how each of these scientists aided in the development of the modern periodic table:

Dalton:

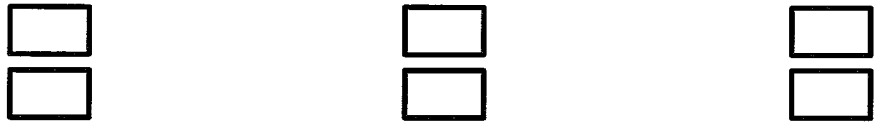
Newland:

Mendeleev:

Describe how the modern periodic table is arranged:



Create a key for the colours displayed on the periodic table above:



Group 1 – the alkali metals:

Describe the properties:

Describe the reactions:

Transition metals:

Describe the physical properties:

Describe the chemical properties:

Describe the types of compounds formed:

The halogens:

Describe the properties:	Describe the reactions:	Describe the displacement reactions:

KEY WORDS:

Dalton	Non-metals	Chemical properties
Newland	Nobel gases	Compound
Mendeleev	Melting point	Halogens
Reactivity	Boiling point	Displacement
Reactive metals	Alkali metals	
Transition metals	Physical properties	

ASSESSMENT:

C3 REVISION – CHAPTER 2 – WATER

Explain what hard water is and how it is formed:

State the equation that shows why hard water wastes soap:

Describe how limescale is formed:

Explain the how the effects of the following on hard water:
Washing soda:

Ion-exchange column:

Heating:

Explain how water is treated to make it safe to drink: You can use a diagram

Explain the issues surrounding the treatment of water with ions such as chlorine and fluoride:

KEY WORDS:

Hard water	Ion-exchange column
Soapless detergents	Water treatment
Scale	Pure water
Temporary hard water	Softener
Permanent hard water	Chlorine
	Fluoride

ASSESSMENT:

C3 REVISION – CHAPTER 3 – ENERGY CALCULATIONS

We calculated the energy used when burning fuels using the following calculation:

Energy released = mass of water heated X specific heat capacity of water X rise in temperature

This is sometimes written as:

$$Q = mc\Delta T$$

We also need to know the amount of energy released per gram or per mole to compare the efficiency of the fuels:

Energy released per gram (kJ/g) = energy released X $\frac{1g}{change\ in\ mass\ of\ fuel}$

Energy released per mole (kJ/mol) = energy released X $\frac{RAM\ of\ fuel}{change\ in\ mass\ of\ fuel}$

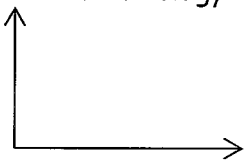
Use these equations to show which fuel is more efficient:
0.2 grams of fuel A heats 50g of water from 16°C to 41°C
0.46 grams of fuel B heats 50 g of water from 21°C to 57°C

Sketch an energy change graph for each of the following and explain the energy changes taking place:

Endothermic

Exothermic:

Activation energy:



Catalysts:

Explain how to calculate bond energy for a reaction:

KEY WORDS:

Energy release	Activation energy
Energy transfer	Catalyst
Solutions	Bond breaking
Exothermic	Bond making
Endothermic	Bond energy

ASSESSMENT:

C3 REVISION – CHAPTER 4 – ANALYSIS AND SYNTHESIS

Fill in the flow chart to show your understanding of positive ion tests:

Metal ion	Colour of precipitate	Further tests required
Copper Cu^{2+}		
	Reddish-brown	
Iron Fe^{2+}		
Magnesium Mg^{2+}		
		Insoluble in excess NaOH, red flame test
Aluminium Al^{3+}	White	

Fill in the table to show your understanding of flame tests:

Metal ion	Flame colour
Lithium (Li^{+})	
Sodium (Na^{+})	
	Lilac
	Red
Barium (Ba^{2+})	

Describe how to carryout a titration:

State the different types of chemical analysis that can be carried out:

Describe the Haber process:

Describe the effects of temperature on this process:

Describe the effects of pressure on this process:

Fill in the table to show your understanding of negative ion tests:

Anion	Test	Observation
		CO_2 gas produced
Halide		Colour precipitate: Chloride → Bromide → Iodide →
Sulphate		White precipitate

KEY WORDS:

Flame test
Sodium hydroxide
Carbonates
Halides
Sulphates
Titration
End point
Concentration
Chemical analysis
Equilibrium
Pressure
Energy
Haber process

ASSESSMENT:

C3 REVISION – CHAPTER 5 – ORGANIC CHEMISTRY

Alcohols:
Draw the structure of the first 3 members:

Methanol Ethanol Propanol

State the some of the uses of alcohol:

Describe the combustion of alcohol:

Describe the reaction of alcohol with sodium:

Describe the oxidation of alcohol:

Carboxylic acids:
Draw the structure of the first 3 members:

Methanoic acid Ethanoic acid Propanoic acid

Describe the reaction of carboxylic acid with carbonates:

Explain why carboxylic acids are called weak acids:

Esters:
Draw the structure of the first of ethyl ethanoate:

Explain how esters are made:

Explain the issues of ethanol in drinks:

Explain the issues of ethanol and esters as biofuels:

KEY WORDS:

Alcohol
Functional group
Homologous series
Carboxylic acid
Esters
Combustion
Oxidation
Ethanol

ASSESSMENT:

① The Periodic Table

Q1. Use the periodic table on the Data Sheet to help you to answer these questions.

(a) The following is a list of symbols of some elements.

Sb	**Se**	**Si**	**Sn**	**Sr**

Choose your answers **only** from the symbols shown in the box above.

Which symbol represents

(i) a Group 5 element ☐

(1)

(ii) the element in the same group as oxygen (O) ☐

(1)

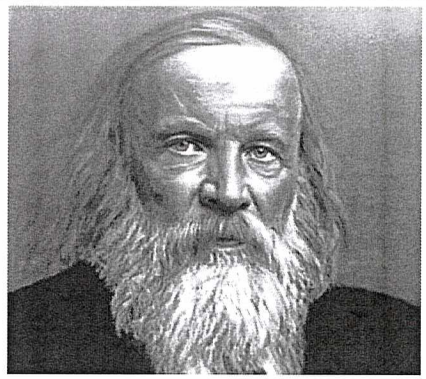
(iii) the element with atomic (proton) number of 50 ☐

(1)

(iv) silicon? ☐

(1)

(b)



Mendeleev suggested his version of the periodic table in 1869.

Part of Mendeleev's table is shown below.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
H						
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K Cu	Ca Zn	# #	Ti #	V As	Cr Se	Mn Br

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There are differences between Mendeleev's table and the periodic table on the Data Sheet.

Draw a ring around the correct answer to complete the sentences.

(i) Mendeleev left gaps (shown by #) in his table.

Mendeleev left gaps for [compounds / elements / mixtures] that had not been discovered.

(1)

(ii) Mendeleev put copper (Cu) in the same box as

- bromine (Br).
- chromium (Cr).
- potassium (K).

(1)

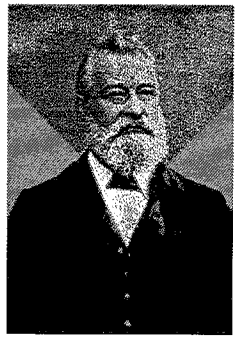
(iii) Mendeleev did **not** have a Group

- 0.
- 3.
- 5.

(1)
(Total 7 marks)

Q2. The periodic table on the Data Sheet may help you answer these questions.

(a) Many chemists have contributed to the development of the periodic table.



John Newlands was one of the first chemists who attempted to classify elements in a systematic way based on atomic weight. In 1866 he suggested that there was a repeating pattern of elements with similar properties every eighth element.
Part of Newlands' periodic table is shown below.

H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co, Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce, La	Zr	Di, Mo	Ro, Ru

Many chemists in 1866 did not accept Newland&#x2019s; periodic table.

By Conget at nl.wikipedia [Public domain], from Wikimedia Commons

(i) Give **one** piece of evidence which supports Newlands' ideas.

.....

.....

(1)

(ii) Suggest **two** reasons why many chemists in 1866 did not accept Newlands' ideas.

1 .....

.....

.....

2 .....

.....

.....

(2)

(b) Chlorine, bromine and iodine are Group 7 elements.

A student investigated the reactivity of these elements.
The student added:

- aqueous chlorine to potassium bromide and potassium iodide solutions
- aqueous bromine to potassium chloride and potassium iodide solutions
- aqueous iodine to potassium chloride and potassium bromide solutions.

The student's results are shown below.

Solution	Potassium chloride	Potassium bromide	Potassium iodide
Chlorine		Solution turned orange-brown	Solution turned brown
Bromine	No reaction		Solution turned brown
Iodine	No reaction	No reaction	

(i) Use these results to state **and** explain the trend in reactivity of these Group 7 elements.

.....

.....

.....

.....

(2)

(ii) Complete the equation below, which represents the reaction between chlorine and potassium bromide.

Cl_2 + 2KBr ⟶ ..... + 2KCl

(1)

(iii) In terms of electronic structure, state why chlorine, bromine and iodine are in Group 7.

.....

.....

(1)

(c) Lithium, sodium and potassium are Group 1 elements.

Group 1 elements become **more** reactive down the group.

Explain why in terms of electronic structure.

.....

.....

.....

.....

.....

.....

(3)
(Total 10 marks)

Q3. By 1869, about 60 elements had been discovered.
Mendeleev arranged these elements in a table, in order of their atomic weight.
He also put elements with similar chemical properties in the same columns.

Mendeleev and part of his table are shown below.

	Group							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Period 1	H							
Period 2	Li	Be	B	C	N	O	F	
Period 3	Na	Mg	Al	Si	P	S	Cl	
Period 4	K Cu	Ca Zn	– –	Ti –	V As	Cr Se	Mn Br	Fe Co Ni

(a) (i) Name **one** element in Group 1 of Mendeleev's table that is not in Group 1 of the periodic table on the Data Sheet.
Give a reason why this element should not be in Group 1.

Name of element .....

Reason .....

.....

(2)

(ii) Which group of the periodic table on the Data Sheet is missing from Mendeleev's table?

.....

(1)

(b) The gaps (–) in Mendeleev's table were for elements that had not been discovered.

(i) Compare Mendeleev's table with the periodic table on the Data Sheet.

Name **one** of the elements in Period 4 that had not been discovered by 1869.

.....

(1)

(ii) Mendeleev was able to make predictions about the undiscovered elements.
This eventually led most scientists to accept his table.

Suggest what predictions Mendeleev was able to make about these undiscovered elements.

.....

.....

.....

.....

.....

(2)

(c) In terms of their electronic structure:

(i) state why lithium and sodium are both in Group 1

.....

.....

.....

(1)

(ii) explain why sodium is more reactive than lithium.

.....

.....

.....

.....

.....

.....

.....

.....

(3)
(Total 10 marks)

M1. (a) (i) Sb

1

(ii) Se

1

(iii) Sn

1

(iv) Si

1

(b) (i) elements

1

(ii) potassium (K)

1

(iii) 0

1

[7]

M2. (a) (i) a correct link between any two named elements eg same group / column same properties / number of outer electrons

allow some link between any two elements in the same group (in both Newlands and or the modern periodic table)

1

(ii) any **two** from:

ignore statements about lack of evidence / proof

- elements still being discovered

  or
  no gaps for undiscovered elements
- some boxes have 2 elements in them
- metals and non-metals in same column / mixed up

  accept some elements in same column have different properties.
  allow any sensible suggestion about misplaced elements eg copper in group 1 elements
- pattern for first 16 or so elements only

  allow did not work for all elements

2

(b) (i) Cl > Br > I

accept reactivity / it decreases down the group

or

I < Br < Cl

1

Cl has 2 reactions, Br has 1 reaction, I doesn't react

owtte

allow Cl has most / more reactions and I has least / less reactions (must be clear about where Br fits in)

1

(ii) Br_2

allow multiples / fractions if correctly completed and balanced

1

(iii) (they) have 7 outer electrons

allow (they) have 7 electrons in highest occupied (energy) level / shells / rings

1

(c) *outer / last / final must be mentioned once in correct context, otherwise max **2** marks comparative required on all three points*
accept converse ie less reactive up group

down group (atom / elements) bigger

or

outer electrons (level / shell /ring) further from nucleus / centre

ignore more electrons

or

more shells / level / rings

*do **not** accept more outer shells for this mark*

1

force(s) / attraction(s) are weaker

allow electron(s) attracted less easily
allow electron(s) less under influence (of nucleus)

or

more shielding

or

1

attracts less

*do **not** accept magnetic / gravitational / intermolecular forces*

electron(s) lost more easily

allow electron(s) more likely to be lost

allow easier to give away

1

[10]

M3. (a) (i) *incorrect or no element = **0** marks*

hydrogen

allow H / H_2

1

all the other elements are metals

allow hydrogen is a not an (alkali / group 1) metal

ignore hydrogen is a gas

OR

copper (1)

allow Cu

(copper) is not an alkali metal (1)

allow Cu is a transition element / metal

allow any valid specific chemical property eg Cu does not react with water

ignore references to electronic structure

ignore physical properties

1

(ii) Group 0 / noble gases

ignore Group 8

1

(b) (i) scandium / gallium / germanium

accept Sc / Ga / Ge

allow Krypton / Kr

1

(ii) predicted they were metals

allow atomic mass / weight

ignore atomic structure

1

predicted their (chemical/physical) properties / reactivity

accept any chemical / physical property

allow similar properties if mentioned in context of a group

1

(c) (i) (both) have one / an electron in the outer energy level / shell

ignore form single plus ions

1

(ii) *accept shell for energy level*

accept converse explanation for lithium

if 'outer' not mentioned, max 2 marks

ignore sodium reacts more easily

sodium loses one outer electron more easily (than lithium)

1

because outer electrons/energy level further from the nucleus in sodium **or** because sodium has more shells (than lithium)

*do **not** accept 'more outer shells'*

allow sodium (atom) is larger

1

because forces/attraction to hold outer electron are weaker in sodium (than lithium)

accept more shielding in sodium (than lithium)

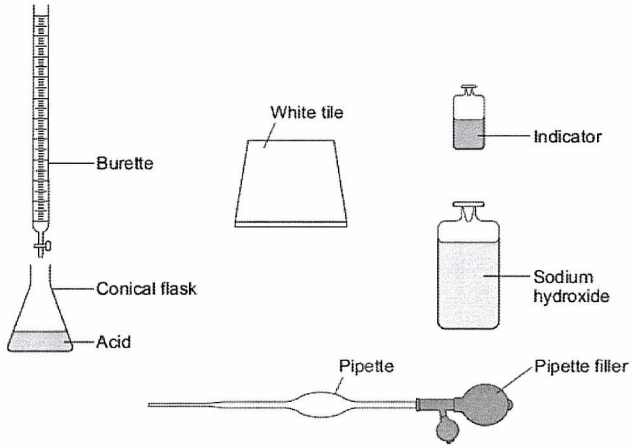
1

[10]

(2) Acids and bases

Q1. *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

A student used the equipment shown to do a titration.



Describe how the student should use this equipment to find the volume of sodium hydroxide solution that reacts with a known volume of acid.
Include any measurements the student should make.

Do **not** describe how to do any calculations.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total 6 marks)

Q2. In 1884 Arrhenius put forward ideas to explain acid-base behaviour. It was many years before his ideas were accepted.

Use the ideas of Arrhenius to answer parts (a) and (b).

(a) Hydrochloric acid is made by dissolving hydrogen chloride gas in water.

An equation which represents this reaction is:

$$\underset{\text{hydrogen chloride}}{H{-}Cl(g)} \xrightarrow{\text{water}} \underset{\text{hydrochloric acid}}{H^+(aq) + Cl^-(aq)}$$

Explain why

- a solution of hydrogen chloride in water is acidic
- dry hydrogen chloride gas is **not** acidic.

.....

.....

.....

.....

.....

(2)

(b) The equation below represents the reaction between potassium hydroxide solution and dilute hydrochloric acid.

$$KOH(aq) + HCl(aq) \longrightarrow KCl(aq) + H_2O(l)$$

(i) Explain why potassium hydroxide solution, KOH(aq), is a strong alkali.

.....

.....

.....

.....

(2)

(ii) Why is potassium chloride solution, KCl(aq), neutral?

.....

.....

(1)

(c) In 1923, Brønsted and Lowry extended Arrhenius' ideas on acids and bases. Their ideas were quickly accepted.

(i) What is Brønsted and Lowry's definition of a base?

.....

.....

(1)

(ii) Suggest why the ideas of Brønsted and Lowry were accepted more quickly than those of Arrhenius.

.....

.....

.....

(1)

(Total 7 marks)

M1. Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a simple description of using some of the equipment.

Level 2 (3-4 marks)
There is a description of an experimental method involving a measurement, **or** including addition of alkali to acid (or vice versa).

Level 3 (5-6 marks)
There is a description of a titration that would allow a successful result to be obtained.

Examples of chemistry points made in the response could include:

- acid in (conical) flask
- volume of acid measured using pipette
- indicator in (conical) flask
- sodium hydroxide in burette
- white tile under flask
- slow addition
- swirling
- colour change
- volume of sodium hydroxide added

Extra information

- allow acid in the burette to be added to sodium hydroxide in the (conical) flask
- allow any specified indicator

colour change need not be specified

[6]

M2. (a) in water: hydrogen ions / H^+ present

1

when dry: HCl gas is covalent / molecular
accept hydrogen still bonded to chloride / chlorine
or *HCl is not ionic*

1

(b) (i) (KOH) has hydroxide ions / OH^-
ignore K^+

1

fully ionised / dissociated
allow ions fully dissociate
do ***not*** *accept highly ionising*
ignore reference to concentration / pH

1

(ii) equal concentrations / numbers / amounts of H^+ and OH^- ions
accept the acid / base has been neutralised
or *the reaction is a neutralization*
allow *KCl: doesn't have any excess* H^+ *or* OH^- *ions*
accept H^+ *react with / cancel out* OH^- *(to form water)*

1

(c) (i) (base) is a proton acceptor
do ***not*** *accept 'accepts hydrogen ions /* H^+'
ignore reference to OH^- *ions*

1

(ii) B&L: building on established ideas **or** were reputable/known scientists
Arrhenius was 'the first' / a student
allow B&L had more evidence
ignore references to technology / equipment

1

[7]

(3) Water

Q1. Some people use water filters because they are concerned about the quality of drinking water.

(a) Draw a ring around the correct answer to complete each sentence.

(i) One of the active chemicals in many water filters is

carbon.
magnesium.
sulfur.

(1)

(ii) In many areas of the United Kingdom the water is hard.

The hardness in water is caused by

bromide
calcium
hydrogen

ions.

(1)

(b) Describe and give the result of a test to show that some drinking water is hard.

Test .....

.....

Result of test .....

.....

(2)

(c) State and explain **one** benefit of drinking hard water.

.....

.....

.....

.....

(2)
(Total 6 marks)

Q2. The table gives some information about the composition of three samples of water from wells in the Canary Islands, Crete and Cyprus.

	Mineral content of water in mg per litre		
Ions	**Canary Islands**	**Crete**	**Cyprus**
Calcium, Ca^{2+}	28	82	18
Magnesium, Mg^{2+}	14	41	13
Sodium, Na^{+}	53	7	22
Chloride, Cl^{-}	7	143	39
Hydrogencarbonate, HCO_3^{-}	281	5	93
Sulfate, SO_4^{2-}	2	14	16

(a) Describe and explain how ions get into these samples of water.

.....

.....

.....

.....

(2)

(b) The sample of water from Crete is harder than the other two.

Use the information in the table to explain why.

.....

.....

(1)

(c) People who use hard water can expect higher costs than people who use soft water.

Explain why.

.....

.....

.....

.....

(2)

(d) Hard water can be made soft by removing the ions that cause hardness.

State **one** way these ions can be removed.

.....

.....

(1)
(Total 6 marks)

Q3. In the United Kingdom, water companies supply drinking water to our homes. However, some people are concerned about the taste and quality of the water that is supplied.

Describe one method that people can use at home to improve the taste and quality of the tap water supplied. Explain how this method works.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4)
(Total 4 marks)

M1. (a) (i) carbon

1

(ii) calcium

1

(b) (shake with) soap (solution)

ignore detergent

1

scum

accept less lather with hard water
allow solid / precipitate
ignore bubbles
*incorrect test = **0** marks for question*
*correct results with no test score **1***

1

(c) any **two** from:

- good for health / healthier
  ignore vitamins
- stronger bones / teeth
- less heart disease

2

[6]

M2. (a) contact with <u>rocks</u>

1

(ions) dissolve / soluble / react

allow water is a solvent
ignore 'picks up' / 'gets into' / absorbed

1

(b) <u>more</u> calcium / Ca^{2+} and / or magnesium / Mg^{2+} (ions in Crete water)

accept 'a lot' of calcium / magnesium
allow incorrectly charged Ca and Mg ions
accept correct <u>comparison</u> using numbers from the table
*do **not** accept mention of other ions*

1

(c) *if an effect and clarification are given, the clarification must be correct to gain both marks*

two from:

- scum / calcium stearate / magnesium stearate
  accept does not lather (easily)
- (scum) more soap used
  ignore costs more unqualified
- scale / limescale / calcium carbonate / magnesium carbonate
  ignore fur
- (scale) less efficient heating systems / kettles / appliances
  ignore costs more unqualified
  ignore blocks pipes unqualified
- use of a water softener eg sodium carbonate / ion-exchange
  accept salt in dishwashers

2

(d) any **one** from:
ignore filter / filtration

- sodium carbonate / washing soda
  allow soap
- ion-exchange
  accept de-ionised
- distillation
  ignore boiling / heating / evaporation

1

[6]

M3. use of (water) filters / ion exchange

1

containing carbon / charcoal / silver / resins
ignore other substances

1

any **two** from:

- carbon / charcoal removes chlorine
- carbon / charcoal removes soluble / dissolved substances
- silver kills / prevents growth of microorganisms
- ion exchange removes calcium ions / magnesium ions / metal ions
- ion exchange replaces (metal ions) with H^+ / Na^+
  allow exchange for replace
- ion exchange removes hardness

2

[4]

④ Energy calculations

Q1. (a) (i) Which acid should the student add to sodium hydroxide solution to make sodium sulphate?

..... acid

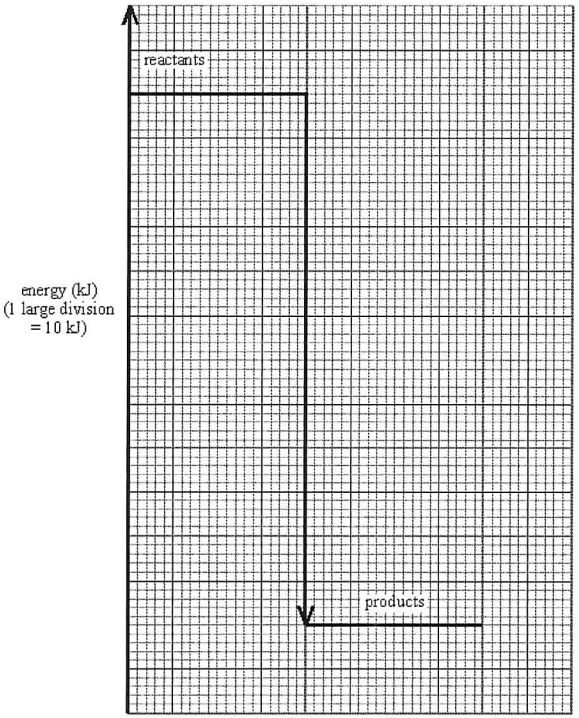
(1)

(ii) Use the table on the Data Sheet to help you to write the formula of sodium sulphate.

Formula: .....

(1)

(b) The student noticed that the solution in the beaker got warm when the acid reacted with the alkali.
The energy diagram below represents this reaction.



(i) In terms of **energy**, what type of reaction is this?

.....

(1)

(ii) Use the energy diagram to calculate a value for the amount of energy released during this reaction.

.....

Energy released ..... kJ

(1)

(iii) Explain, in terms of bond breaking and bond forming, why energy is released during this reaction.

.....

.....

.....

.....

(3)

(iv) The reaction takes place very quickly, without the help of a catalyst. What does this suggest about the activation energy for this reaction?

.....

.....

(1)
(Total 8 marks)

Q2. The following passage was taken from a chemistry textbook.

Germanium is a white, shiny, brittle element. It is used in the electronics industry because it is able to conduct a small amount of electricity.

It is made from germanium oxide obtained from flue dusts of zinc and lead smelters.
The impure germanium oxide from the flue dusts is changed into germanium by the process outlined below.

STEP 1 The germanium oxide is reacted with hydrochloric acid to make germanium tetrachloride. This is a volatile liquid in which the germanium and chlorine atoms are joined by covalent bonds.

STEP 2 The germanium tetrachloride is distilled off from the mixture.

STEP 3 The germanium tetrachloride is added to an excess of water to produce germanium oxide and hydrochloric acid.

STEPS 1 to 3 are repeated several times.

STEP 4 The pure germanium oxide is reduced by hydrogen to form germanium.

(a) Balance the equation below which represents the reaction in step 1.

GeO_2 + ... HCl → $GeCl_4$ + ... H_2O

(1)

(b) Write a word equation for the reaction in step 3.

.....

(1)

(c) Suggest why steps 1 to 3 are repeated several times.

.....

.....

(1)

(d) The equation which represents the reaction in step 4 is shown below.

$$GeO_2 + 2H_2 \rightarrow Ge + 2H_2O$$

(i) Explain what is meant by the term 'reduced'.

.....

.....

(1)

(ii) Calculate the mass of germanium which could be made from 525 g of germanium oxide. (Relative atomic masses: Ge = 73; O = 16).

.....

.....

.....

.....

Mass ..... g

(3)

(e) Germanium is difficult to classify as either a metal or a non-metal.

(i) Give as much evidence as you can from the information in this question to support the view that germanium is a metal. Explain your answer as fully as you can.

.....

.....

.....

.....

.....

(3)

(ii) Give as much evidence as you can from the information in this question to support the view that germanium is a non-metal. Explain your answer as fully as you can.

.....

.....

.....

.....

(3)

(Total 13 marks)

M1. (a) (i) sulphuric acid / H_2SO_4 (accept sulfuric)

for one mark

1

(ii) Na_2SO_4 / $(Na)_2SO_4$ / $Na_2(SO_4)$ / $(Na_+)_2SO_4^{2-}$

for one mark

lower case O (Na_2So_4) not accepted/tops of subscripted numbers should be in line with or lower than lower case letters of symbols / upper case 'a' not accepted

1

(b) (i) exothermic

for one mark

1

(ii) 60 KJ

for one mark

1

(iii) energy given out when bonds form
energy taken in when bonds break
energy given out is greater then energy taken in (owtte)

for 1 mark each

3

(iv) activation energy is low / many molecules have enough energy to react for one mark

1

[8]

M2. (a) 4 HCl / $2H_2O$, allow multiples **or** fractions if whole equation balances

for 1 mark

1

(b) germanium tetrachloride + water = germanium oxide + hydrochloric acid
If symbol equation given it must be correctly balanced
Allow germanium

for 1 mark

1

(c) to purify the germanium oxide/remove impurities/give in pure product/to make pure germanium

for 1 mark

1

ensure complete reaction/reaction does not give a good yield

not to increase efficiency/to purify germanium

for 1 mark

1

(d) (i) remove oxygen/addition of hydrogen/gain up electrons allow remove oxygen molecules

(ii) GeO_2 = 73 + (2 × 16) = 105
mass of germanium = 525 × (73/105)
= 365 g
(or alternative methods)
apply consequential marking

for 1 mark each

3

(e) (i) germanium is shiny/lustrous
conducts a small amount of electricity *
germanium oxide reacts with hydrochloric acid
(and) metal oxides react with acid
metal oxides are basic
metal oxides are reduced by hydrogen
Information must be taken from the passage.
Apply the list principle if more than three answers are given.
Assume the word 'it' refers to the metal.

any 3 for 1 mark each

3

(ii) germanium is brittle
germanium tetrachloride is a (volatile) liquid
made of molecules
germanium tetrachloride has covalent bonding or when two non-metals react they have covalent bonding
$GaC1_4$/the salt of germanium undergiven hydrolysis/reacts with water
germanium is not a good conductor of electricity*
* conductivity mark can only be given once

any 3 for 1 mark each

3

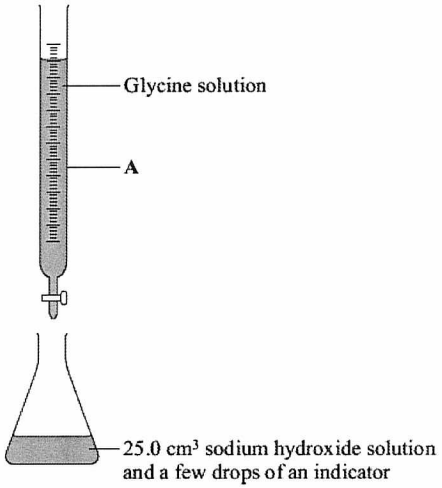
[13]

⑤ Analysis

Q1. Glycine is an amino acid. It is found in fish, meat, beans and dairy produce.

A student carried out a titration to find the amount of glycine solution that reacts with 25.0 cm^3 of sodium hydroxide solution.

The diagram shows the apparatus that the student used.



(a) Which **one** of the following words is the correct name for apparatus **A**?

Draw a ring around your answer.

burette **cylinder** **pipette**

(1)

(b) How would the student know when enough glycine solution had been added to react with all of the sodium hydroxide solution?

.....

.....

(1)

(c) The student's results are given in the table.

Titration	Volume of glycine solution added in cm^3
1	18.5
2	18.3
3	18.4

(i) What is the range?

.....

(1)

(ii) Calculate the mean.

.....

(1)

(iii) Suggest why the student repeated the titration.

.....

.....

(1)

(Total 5 marks)

Q2. Alums are salts. They have been used since ancient times in dyeing and medicine and still have many uses today.

Three alums are shown in the table:

Name	Ions present
Ammonium alum	NH_4^+ Al^{3+} SO_4^{2-}
Potassium alum	K^+ Al^{3+} SO_4^{2-}
Sodium alum	Na^+ Al^{3+} SO_4^{2-}

(a) These alums contain sulfate ions (SO_4^{2-}).

Describe and give the result of a chemical test to show this.

Test .....

.....

Result .....

.....

(2)

(b) These alums contain aluminium ions (Al^{3+}).

Describe how sodium hydroxide solution can be used to show this.

.....

.....

.....

.....

.....

(2)

(c) Aluminium ions do not give a colour in flame tests. However, flame tests can be used to distinguish between these three alums.

Explain how these three alums could be identified from the results of flame tests.

.....

.....

.....

.....

.....

(2)
(Total 6 marks)

Q3. A student investigated an egg shell.

Trish Steel [CC-BY-SA-2.0], via Wikimedia Commons

(a) The student did some tests on the egg shell.

The student's results are shown in the table below.

	Test	Observation
1	Dilute hydrochloric acid was added to the egg shell.	A gas was produced. The egg shell dissolved, forming a colourless solution.
2	A flame test was done on the colourless solution from test **1**.	The flame turned red.
3	Sodium hydroxide solution was added to the colourless solution from test **1**.	A white precipitate formed that did not dissolve in excess sodium hydroxide solution.
4	Silver nitrate solution was added to the colourless solution from test **1**.	A white precipitate formed.

(i) The student concluded that the egg shell contains carbonate ions.

Describe how the student could identify the gas produced in test **1**.

.....

.....

.....

.....

(2)

(ii) The student concluded that the egg shell contains aluminium ions.

Is the student's conclusion correct? Use the student's results to justify your answer.

.....

.....

.....

.....

(2)

(iii) The student concluded that the egg shell contains chloride ions.

Is the student's conclusion correct? Use the student's results to justify your answer.

.....

.....

.....

.....

(2)

(b) Some scientists wanted to investigate the amount of lead found in egg shells.
They used a modern instrumental method which was *more sensitive* than older methods.

(i) Name **one** modern instrumental method used to identify elements.

.....

.....

(1)

(ii) What is the meaning of *more sensitive*?

.....

.....

(1)
(Total 8 marks)

M1. (a) burette

1

(b) indicator changed colour
allow any indication of colour change

1

(c) (i) 0.2 **or** 18.3 to 18.5

1

(ii) 18.4

1

(iii) improve reliability
allow improve accuracy
allow to calculate a mean / average
or *get rid of anomalous result*
ignore fair test / correct results / random results

1

[5]

M2. (a) (acidified) barium chloride / nitrate
*incorrect reagent **or** no reagent = **0** marks*
*do **not** accept acidified with sulfuric acid (still allow result mark if correct)*
*allow solution of barium ions / salt **not** barium solution*
*do **not** accept barium hydroxide*

1

(white) precipitate / solid
*do **not** accept incorrect colour for precipitate*
allow barium sulfate (formed)
ignore 'it goes white / cloudy'

1

(b) (white) precipitate / solid
allow aluminium hydroxide (formed)
*do **not** allow incorrect colour for precipitate*

1

(precipitate) dissolves (in excess)
allow sodium aluminate (formed)
allow goes clear / colourless
if incorrect colour precipitate then allow dissolves (in excess)

1

(c) any **two** from:
apply list principle

- yellow = sodium (alum)
  *allow orange **or** yellow orange*
- lilac = potassium (alum)
  allow purple
- colourless = ammonium (alum)
  *if no colours given, allow 'different coloured flames' for **1** mark*

2

[6]

M3. (a) (i) (bubble gas produced through) limewater
incorrect tests = zero

1

(limewater) goes cloudy / milky

1

(ii) *ignore yes or no*

red flame indicates that calcium / lithium ions present
allow aluminium has no flame colour

or

Ca/Mg also produce a (white) precipitate with NaOH

1

the (white) precipitate formed in test 3 **or** by adding sodium hydroxide solution would dissolve (in excess) if aluminium ions were present

1

(iii) *ignore yes or no*

because a white precipitate is formed in test 4 **or** by adding silver nitrate

1

but chloride ions are in hydrochloric acid

1

(b) (i) mass spectrometry
allow MS

or

atomic absorption spectroscopy
allow AAS
spectrometry / spectroscopy alone is insufficient

1

(ii) can detect a small(er) amount of the substance
allow can detect small(er) changes
allow small(er) sample sizes
ignore references to precision / accuracy

1

[8]