Exampro GCSE Chemistry

C3 Chapter 4 Higher

Name:

Class:

Author:

Date:

Time: 98

Marks: 98

Comments:

Q1. 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.

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(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.

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(2)
(Total 6 marks)

Q2. *Drain Buster* is used to clear and degrease drains. Sodium hydroxide is the main chemical substance in *Drain Buster*.

(a) A student planned an experiment to find the concentration of the sodium hydroxide solution in *Drain Buster.*

The teacher had to dilute the *Drain Buster* before the student could use it.

Explain why.

.....

.....

.....

.....

(2)

(b) *In this question you will get marks on using good English, organising information clearly and using specialist terms where appropriate.*

The student wanted to find the volume of hydrochloric acid that reacts with a known volume of diluted *Drain Buster.*

Describe how the student could do this by titration.
In your description you should include:

- the names of pieces of apparatus used
- the names of the substances used
- a risk assessment

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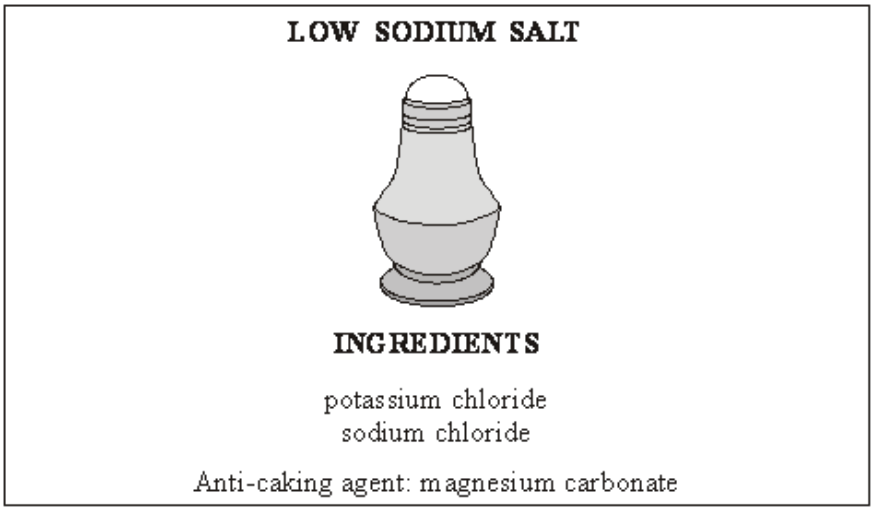
(6)
(Total 8 marks)

Q3. The label is from a packet of Low Sodium Salt.



(a) A student tested some Low Sodium Salt to show that it contains carbonate ions and chloride ions.

(i) Describe and give the result of a test for carbonate ions.

.....

.....

.....

.....

(2)

(ii) A student identified chloride ions using acidified silver nitrate solution.

State what you would **see** when acidified silver nitrate solution is added to a solution of Low Sodium Salt.

.....

(1)

(iii) Flame tests can be used to identify potassium ions and sodium ions.

Suggest why it is difficult to identify **both** of these ions in Low Sodium Salt using a flame test.

.....

.....

(1)

(b) Read the following information and then answer the questions.

Salt – friend or foe?

Sodium chloride (salt) is an essential mineral for our health. It is used to flavour and preserve foods. Too much sodium in our diet may increase the risk of high blood pressure and heart disease. Heart disease is the biggest cause of death in the United Kingdom. Some people claim that excess sodium is a poison that can cause cancer, while others say that more evidence is needed.

Many processed foods contain salt, so it is easy to exceed the recommended daily upper limit of about 5 g of salt per person. A 'healthier' amount should be about 3 g. In the United Kingdom many people consume over 10 g of salt each day.

One way to reduce sodium in our diet is to use Low Sodium Salt. This has two thirds of the sodium chloride replaced by potassium chloride.

A national newspaper asked readers for their views on two options.

Option 1: Ban the use of sodium chloride in foods.

Option 2: Reduce the amount of sodium chloride in all foods to a 'healthier' level.

(i) Suggest why Option **1** was rejected.

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(1)

(ii) Suggest **two** advantages and **one** disadvantage of Option **2**.

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(3)
(Total 8 marks)

Q4. This label has been taken from a packet of *My Baby Food*.

MY BABY FOOD

Infant milk
Pure and natural

Closest to mothers' breast milk
Contains traces of essential minerals

500 g

One of the minerals in *My Baby Food* is calcium carbonate, $CaCO_3$.

(a) Chemical tests are used to identify elements and compounds.

(i) A flame test can be used to identify calcium ions.
What colour do calcium ions give in a flame test?

.....

(1)

(ii) When a flame test was carried out on *My Baby Food*, the presence of calcium ions was **not** seen. A yellow flame was produced.
Name the ion which gives a yellow flame test.

.....

(1)

(iii) Suggest **one** advantage of using an instrumental method to detect the elements present in *My Baby Food*.

.....

.....

(1)

(iv) Name an instrumental method for detecting elements.

.....

(1)

(b) Read the information in the box below and then answer the question.

> Calcium carbonate occurs naturally as marble and limestone. They are important building materials and are often used for gravestones.
>
> Calcium carbonate is also an essential mineral for good health and is present in many baby foods in small amounts.
>
> *My Baby Food* is recommended as being the closest to a mother's own breast milk. It is given free to mothers in the developing world – without it their babies might die of malnutrition.
>
> *Responsible Mothers Are Us (RMAU)* is a United Kingdom pressure group. They want to ban chemicals in baby foods. The group was founded by Mrs I. M. Right who has made a career in 'goodness' and is paid from donations given to *RMAU* by members of the public.
>
> When interviewed, she said: "Calcium carbonate is a chemical and so it is a pollutant. *My Baby Food* must be banned to prevent the mass medication of babies. I don't feed my baby the stuff of gravestones."

Many people do **not** agree with Mrs Right's ideas.

Suggest why.

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(3)

(Total 7 marks)

Q5. Chlorine and bromine are important Group 7 elements.

(a) Explain why chlorine is added to drinking water.

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(1)

(b) Describe what you would **see** when bromine water is added to an unsaturated organic compound.

.....

.....

(1)

(c) Bromine can be extracted from seawater. The dissolved bromide ions are reacted with chlorine. Bromine and chloride ions are formed.

(i) Complete and balance the equation below, which represents the reaction between chlorine and bromide ions.

$Cl_2 + 2Br^- \rightarrow$ ..... + ...

(1)

(ii) Describe what you **see** when chlorine is added to a solution containing bromide ions.

.....

.....

(1)

(d) In terms of electronic structure:

(i) state why bromine and chlorine are both in Group 7

.....

.....

(1)

(ii) explain why bromine is less reactive than chlorine.

.....

.....

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.....

(3)

(e) What is the result of adding acidified silver nitrate solution to a solution containing:

(i) chloride ions

.....

(1)

(ii) bromide ions?

.....

(1)

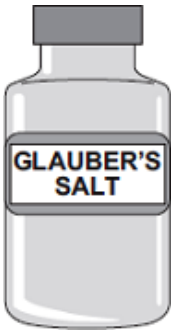
(Total 10 marks)

Q6. Four bottles of chemicals made in the 1880s were found recently in a cupboard during a Health and Safety inspection at Lovell Laboratories.

Sodium carbonate

Sodium chloride

Sodium nitrate



Sodium sulfate

The chemical names are shown below each bottle.

(a) You are provided with the following reagents:

- aluminium powder
- barium chloride solution acidified with dilute hydrochloric acid
- dilute hydrochloric acid
- silver nitrate solution acidified with dilute nitric acid
- sodium hydroxide solution.
- limewater
- red litmus paper

(i) Describe tests that you could use to show that these chemicals are correctly named.

In each case give the reagent(s) you would use **and** state the result.

Test and result for carbonate ions:

.....

.....

.....

Test and result for chloride ions:

.....

.....

.....

Test and result for nitrate ions:

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.....

.....

Test and result for sulfate ions:

.....

.....

.....

(4)

(ii) Suggest why a flame test would **not** distinguish between these four chemicals.

.....

(1)

(b) Instrumental methods of analysis linked to computers can be used to identify chemicals.

Give **two** advantages of using instrumental methods of analysis.

.....

.....

.....

.....

(2)
(Total 7 marks)

Q7. 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)

Q8. The colours of fireworks are produced by chemicals.

(a) Information about four chemicals is given in the table.

Complete the table below.

Chemical	Colour produced in firework
barium chloride	green
..... carbonate	crimson
sodium nitrate	.....
calcium sulfate	red

(2)

(b) Describe a test to show that barium chloride solution contains chloride ions.

Give the result of the test.

.....

.....

.....

.....

(2)

(c) A student did two tests on a solution of compound **X**.

Test 1
Sodium hydroxide solution was added.
A blue precipitate was formed.

Test 2
Dilute hydrochloric acid was added.
Barium chloride solution was then added.
A white precipitate was formed.

The student concluded that compound **X** is iron(II) sulfate.

Is the student's conclusion correct?

Explain your answer.

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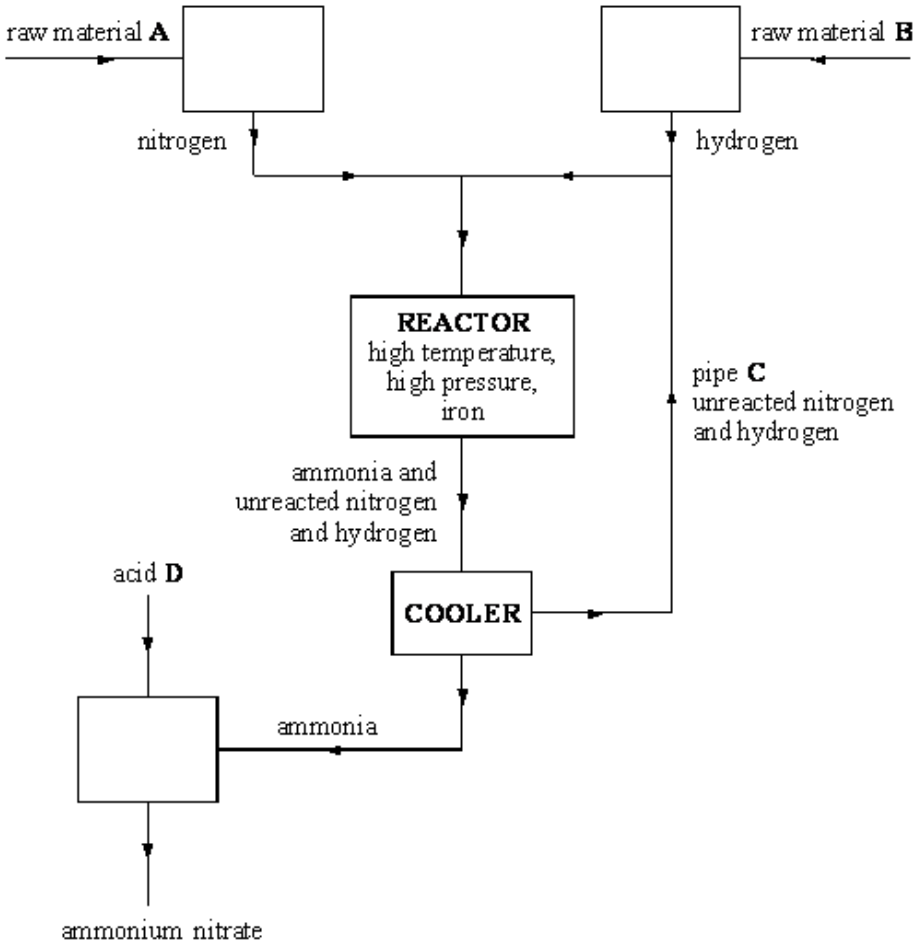
(3)
(Total 7 marks)

Q9. The flow chart below shows the main stages in the production of ammonium nitrate.



(i) Name the **two** raw materials shown in the flow chart as **A** and **B** by choosing words from the list.

air **coke** **limestone** **natural gas**

Raw material **A** .....

Raw material **B** .....

(2)

(ii) Complete the word equation for the reaction which makes ammonia.

..... + ... → ammonia

(1)

(iii) What is the purpose of the iron in the reactor?

.....

.....

(1)

(iv) What is the purpose of pipe **C**?

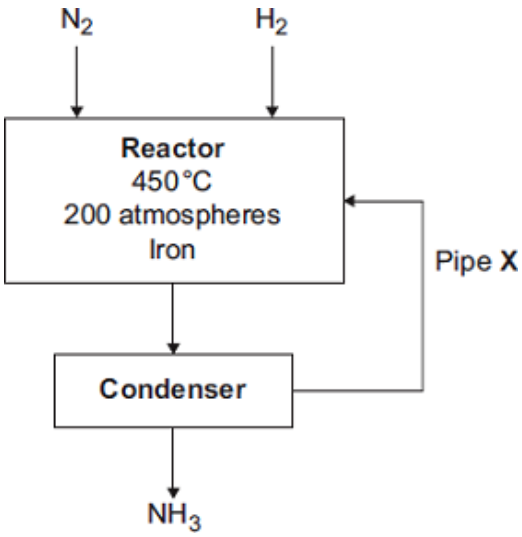
.....

.....

(1)

(Total 5 marks)

Q10. The flow diagram shows the Haber process. In the Haber process, ammonia (NH_3) is produced from nitrogen (N_2) and hydrogen (H_2).



(a) Which raw material is nitrogen obtained from?

.....

(1)

(b) What is the purpose of Pipe **X**?

.....

.....

.....

.....

(2)

(c) Balance the chemical equation below for the production of ammonia.

N_2 + ...H_2 $\rightleftharpoons$ .....NH_3

(1)

(d) A temperature of 450°C is used in the reactor.
The reaction of nitrogen with hydrogen is reversible.
The forward reaction is exothermic.

Explain why a temperature of 450°C is the optimum temperature for the Haber process.

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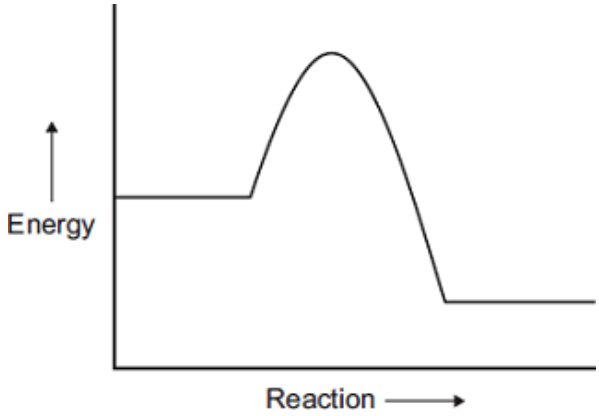
(2)

(e) An energy level diagram for the reaction between nitrogen and hydrogen is shown below.



(i) How does the energy level diagram show this reaction is exothermic?

.....

.....

(1)

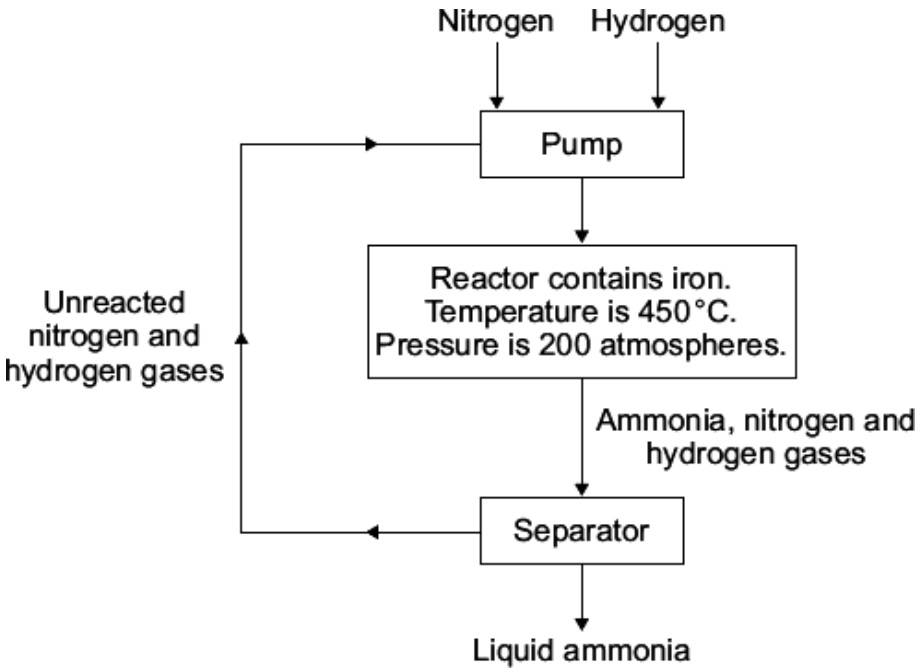
(ii) In the Haber process iron is used as a catalyst.

Draw a line on the energy level diagram to show the effect of adding a catalyst.

(1)

(Total 8 marks)

Q11. Ammonia is made using the Haber process.



(a) How is ammonia separated from unreacted nitrogen and hydrogen in the separator?

.....

.....

.....

.....

(2)

(b) The equation shows the reaction which takes place in the reactor:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(i) Why does the yield of ammonia at equilibrium increase as the temperature is decreased?

.....

.....

(1)

(ii) A temperature of 450 °C is used in the reactor to make the reaction take place quickly.

Explain, in terms of particles, why increasing the temperature makes a reaction go faster.

.....

.....

.....

.....

(2)

(iii) Why does the yield of ammonia at equilibrium increase as the pressure is increased?

.....

.....

(1)

(iv) The pressure used in the reactor is 200 atmospheres.
Suggest why a much higher pressure is **not** used.

.....

.....

(1)

(c) Use the equation for the reaction in the reactor to help you to answer these questions.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(i) It is important to mix the correct amounts of hydrogen and nitrogen in the reactor.

20 m^3 of nitrogen is reacted with hydrogen.

What volume of hydrogen (measured at the same temperature and pressure as the nitrogen) is needed to have the correct number of molecules to react with the nitrogen?

Volume of hydrogen needed = ... m^3

(1)

(ii) Calculate the maximum mass of ammonia that can be made from 2 g of nitrogen.

Relative atomic masses: H = 1; N = 14.

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.....

Maximum mass of ammonia = ... g

(3)

(d) The expected maximum mass of ammonia produced by the Haber process can be calculated.

(i) In one process, the maximum mass of ammonia should be 80 kg.

The actual mass of ammonia obtained was 12 kg.

Calculate the percentage yield of ammonia in this process.

.....

.....

Percentage yield of ammonia = ... %

(1)

(ii) Give **two** reasons why it does **not** matter that the percentage yield of ammonia is low.
Use the flow diagram at the start of this question to help you.

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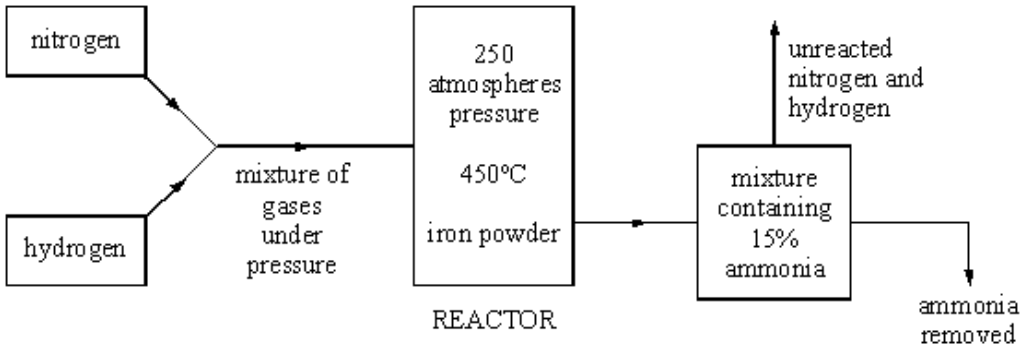
(2)
(Total 14 marks)

Q12. Ammonia is manufactured from nitrogen and hydrogen in the Haber Process. The diagram shows some details of the manufacturing process.



(a) Nitrogen is obtained from the air.
From where is the hydrogen obtained?

.....

(1)

(b) What happens to the unreacted nitrogen and hydrogen?

.....

.....

(1)

(c) Ammonium nitrate is made from ammonia.

Farmers spread nitrates on to soil to make crops grow better.

The nitrates may get into people's bodies even if they do not eat the crops.

Explain how this can happen.

.....

.....

.....

(2)

(d) The equation for the Haber Process is this:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \quad \text{(exothermic)}$$

At equilibrium, nitrogen, hydrogen and ammonia are present in the reactor.

(i) What is meant by 'equilibrium'?

.....

.....

.....

(1)

(ii) Explain, as fully as you can, why:

- the yield of ammonia decreases with increase in temperature,
- despite this fact, a comparatively high temperature of 4500C is used for the industrial process,
- iron powder is added to the reactor.

.....

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.....

(4)
(Total 9 marks)

M1. (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]

M2. (a) Drain Buster is a concentrated sodium hydroxide solution that would damage the skin

1

therefore it is diluted so that it is safe to use for the experiment

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.

No relevant content.

0 marks

There is a brief description of the titration that may include a risk assessment.

Level 1 (1–2 marks)

There is some description of the titration that may include a risk assessment.

Level 2 (3–4 marks)

There is a clear, balanced and detailed description of the titration and an appropriate risk assessment.

Level 3 (5–6 marks)

examples of the chemistry points made in the response

- burette / acid / HCl used correctly
- pipette used for Drain Buster solution / alkali / NaOH correctly
- read meniscus at eye level
- acid / HCl added dropwise
- indicator used
- white background/tile
- end-point of titration recorded
- swirling/mixing
- repeat

example of risk assessment points made in the response eg

- Wear safety goggles – to protect eyes because hydrochloric acid is corrosive / irritant and / or sodium hydroxide is caustic

[8]

M3. (a) (i) hydrochloric acid / HCl

accept any (named) acid

1

carbon dioxide / CO_2

*accept bubbles / fizz / gas **or** limewater gets milky*

ignore 'add limewater'

*do **not** accept other named gases*

2nd mark dependant on first mark

*accept for this answer only heat gives CO_2 / limewater milky = **1** mark*

1

(ii) (white) precipitate / solid

ignore names of substances even if incorrect

accept white deposit / substance

*do **not** accept any coloured precipitate*

1

(iii) eg flame colour of (Na) and flame colour of (K)
interfere / mask / mix with each other

*accept 'can't see the colours' **or** 'difficult to determine the colour' **or** 'both produce different colours' **or** a correct statement of colours **or** hard to distinguish*

1

(b) (i) eg essential (mineral) **or** everyone needs it / some (salt) **or** problems with health if have no salt

accept preservative / flavouring / taste

it = salt

(all) foods contain / use it / sodium chloride / salt

1

(ii)

mark positively ie no list principle

advantages

any **two** from:

*ignore economic arguments throughout **or** people eat less salt*

- more people will be healthier
- (should have) less heart disease
- (should have) less cancer
- (more people with) lower blood pressure

2

disadvantages

any **one** from:

ignore references to too much / too little (salt)

- not everyone affected
- not enough evidence
- does not provide choice
- undemocratic
- less taste / flavour
  ignore no flavour / taste
- shorter shelf life / not preserved (as long)
  ignore references to sell by dates
- too much potassium chloride might be bad

1

[8]

M4. (a) (i) red / brick-red / orange-red / red-orange

allow red-brown or brown-red

*do **not** accept orange alone eg 'red or orange' = 0*

1

(ii) sodium

allow sodium compounds

ignore incorrect symbol

or Na / Na^+

*if symbol alone given do **not** accept Na^{2+} **or** Na^-*

1

(iii) any **one** from

- accurate / sensitive
- use small amounts
- fast / quick / rapid
- ease of automation
- reliable / efficient
- operatives do not need chemical skills
  *ignore cost / safety / human error **or** ease of use **or** shows all the elements*

1

(iv) (atomic absorption) spectroscopy **or** (mass) spectrometry

*accept AAS / aas **or** mass spec*
accept atomic absorption
ignore ms / MS
*do **not** allow UV / IR / NMR / chromatography / GLC*

1

(b) any **three** from:

- (safe because) similar to mothers. milk

  allow calcium carbonate is in breast milk
  allow some mothers unable to breast feed
  ignore 'recommended' alone

- babies (in developing world) would die

  accept causes malnutrition

- if banned there would be a cost involved

  allow it is free

- it is not a pollutant / harmful / dangerous

  accept not all chemicals are pollutants / harmful / dangerous

- not mass medication

- not just used for gravestones

  allow it has many uses
  *ignore only small amounts of it **or** it occurs naturally*

- (calcium carbonate) is needed for bones / teeth / health

  allow 'essential mineral'

- Mrs Right has a personal interest **or** not impartial **or** distorts information / bias **or** she is paid by a charity

  accept 'it is (only) her opinion'

3

[7]

M5. (a) kills bacteria / sterilises (water)

allow kills microorganisms / microbes / germs
*allow 'makes (water) safe (to drink)' **or** disinfectant*
*ignore cleans water **or** removes impurities / bacteria*

1

(b) goes colourless / decolourised (from red / red-brown / brown / yellow / orange)

allow colour disappears
*ignore 'goes clear' **or** discoloured*
*do **not** accept incorrect initial colour*
*do **not** accept precipitate*

1

(c) (i) Br_2 **and** $2Cl^-$

allow multiples / fractions if whole equation balanced

1

(ii) changes to red / red-brown / brown / yellow / orange

*do **not** accept effervescence / fizzing / precipitate / gas given off*
ignore vapour / temperature changes / ignore initial colour

1

(d) (i) 7 outer electrons **or**

same number of outer electrons

allow last / final shell for outer
allow energy level / orbit / ring for shell
allow 'need to gain 1 e^- to have a full outer shell'
ignore 'similar number of outer electrons'

1

(ii) bromine / it (atom) is bigger **or**

must be a comparison

outer electrons (level / shell) further from nucleus **or** more shells

*do **not** accept more outer shells*
ignore more electrons

forces / attractions are weaker **or** more shielding **or** attracts less

*do **not** accept magnetic / gravitational / intermolecular forces*
allow 'electron(s) attracted less easily'

electron(s) gained less easily

*"outer / last / final" must be mentioned once, otherwise max **2** marks.*
accept converse for chlorine throughout where clearly stated

3

(e) (i) white precipitate **or** white solid

ignore names of chemicals

1

(ii) cream precipitate **or** cream solid

allow pale yellow / off-white precipitate / solid
ignore names of chemicals

1

[10]

M6. (a) (i) Na_2CO_3: HCl → gas / effervescence / bubbles (1)

CO_2 / carbon dioxide / turns lime water milky (1)

1

NaCl: $AgNO_3$ → white ppt (1)

silver chloride (1)

1

$NaNO_3$: Al + NaOH → pungent / sharp smell / choking gas (1)

NH_3 / ammonia / turns (red) litmus blue(1)

1

Na_2SO_4: $BaCl_2$ → white ppt (1)

barium sulfate (1)

1

*each correct test and one result = **1** mark*

***one** other result for any test = **1** mark this mark can only be awarded <u>once</u>*

(ii) all would give a yellow / yellow-orange (flame) / same coloured (flame) / same results

allow <u>orange</u> (flame) 1

or

they all contain sodium

1

(b) any **two** from:

ignore cost/errors

- fast / quick or comment about speed

  allow precise

- small amounts/sensitive

  allow can be left to run/continuous analysis

- accurate

- ease of automation

  accept operators do not need chemical skills

- sample not used up

- reliable / efficient

2

[7]

M7. (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]

M8. (a) lithium

allow Li^+ / Li

1

yellow

allow orange

1

(b) silver nitrate (solution)

*incorrect test = **0** marks*
ignore (nitric) acid
*do **not** allow other named acids*

1

white precipitate

1

(c) blue precipitate (with sodium hydroxide) indicates copper ions

allow Cu^{2+}

1

and white precipitate (with barium chloride) indicates sulfate ions

allow SO_4^{2-}

*accept compound X is copper sulfate / $CuSO_4$ for **1** mark*

1

but iron(II) ions produce a green precipitate (with sodium hydroxide)

1

[7]

M9. (i) A = air
B = natural gas

for 1 mark each

2

(ii) nitrogen

both for 1 mark

1

(iii) catalyst / speed up reaction

for 1 mark

1

(iv) recycle unreacted gases / save money

for 1 mark

1

[5]

M10. (a) air

1

(b) recycle

allow re-use

1

(unreacted) nitrogen and hydrogen

allow N_2 and H_2

1

(c) $N_2 + \mathbf{3}H_2 \rightarrow \mathbf{2}NH_3$

allow correct multiples

1

(d) *allow converse arguments*
ignore references to compromise

because a higher temperature would reduce (equilibrium) yield

allow higher temperature favours backward reaction

1

because a lower temperature would reduce rate

1

(e) (i) (energy of) reactants greater than (energy of) products

allow converse

allow (overall) energy decreases

allow energy required to break bonds is less than the energy released making bonds

1

(ii) line starting and finishing at same levels but with lower peak

1

[8]

M11. (a) mixture is cooled / cooling

1

so ammonia / it condenses

or

so ammonia <u>turns into</u> a liquid (but nitrogen and hydrogen remain as gases)

1

(b) (i) exothermic reaction

accept reverse reaction is endothermic

or

equilibrium / reaction moves in the direction which raises the temperature

ignore answers based on rate or collisions

1

(ii) they / particles / molecules move faster **or** have more (kinetic) energy

allow atoms instead of particles

ignore particles move more / vibrate

*do **not** accept electrons (max1)*

1

any **one** from:

- particles / molecules collide more often / more frequently / more likely to collide

  ignore collide faster

  ignore more collisions

- more of the collisions are successful **or** particles collide with more energy / harder **or** more of the particles have the activation energy

  accept more successful collisions

1

(iii) more molecules / particles / moles / volumes on LHS (of equation than RHS)

accept 4 molecules / particles / moles / volumes on LHS and 2 molecules / particles / moles / volumes on RHS

or

greater volume on LHS (than RHS)

or

equilibrium / reaction moves in the direction which reduces the pressure / volume

accept converse

1

(iv) cost

or

difficulty in containing such a high pressure

allow risk of explosion

ignore dangerous

1

(c) (i) 60

1

(ii) 2.4(2857….)

*correct answer gains **3** marks with or without working*

accept any answer that rounds to 2.4

ignore units

*if answer is incorrect look for evidence of correct working to a maximum of **2** marks.*

moles of N_2 = 2/28 &#x003D (0.0714)

moles of ammonia = 2 × 0.0714 = (0.1428)

mass of ammonia = 0.1428 × 17 = (2.4276)

or

28 → 34

1g →34/28

2g →2.4… ….

3

(d) (i) 15

1

(ii) unreacted gases are recycled

allow unreacted gases are reused

1

rate (of production) is fast

accept production is continuous

ignore compromise between rate and yield

1

[14]

M12. (a) from natural gas [*allow from water/ steam / brine / river / lake / sea*]

for 1 mark

1

(b) *idea that* they are recycled / re-used

for 1 mark

1

(c) *ideas that*

- nitrates may get into ground water / rivers
- so contaminate / get into our drinking water
- eating animals which have eaten crop/ or eating contaminated fish

[do not allow 'eutrophication']

any two for 1 mark each

2

(d) (i) *idea that*

when rate of forward = rate of reverse reaction

[<u>not</u> just 'reversible' or 'can be reversed']

[allow ammonia is breaking up into nitrogen and hydrogen as fast as nitrogen and hydrogen are forming ammonia

<u>or</u> amounts of products and reactants stay constant*]*

for 1 mark

1

(ii) *ideas that*

- at higher temperatures, equilibrium moves to **the** left **or** reverse / endothermic
- reaction / favoured **or** makes products → reactants
- but at lower temperatures the (rate of) reaction is (very) slow
- so a higher temperature is used for economic reasons/so ammonia is produced at higher rate
- iron powder is a catalyst / speeds up the reaction
  [not increases the yield]
- low yield not wasteful if reactants re-cycled

[credit iron powder has a greater surface area]

each for 1 mark

4

[9]