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Cambridge AS & A Level

CHEMISTRY

Paper 1

Topical Past Paper Questions

+ Answer Scheme

2015 - 2021

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Chapter 12

Nitrogen and sulfur

12.1 Nitrogen and sulfur

691. 9701_m21_qp_12 Q: 18

NO, NO_2, CO and unburnt hydrocarbons are present in the exhaust gases of internal combustion engines. When catalytic converters are used to remove these compounds from the exhaust gases, redox reactions occur.

What happens to each compound in the catalytic converter?

	NO	NO_2	CO	unburnt hydrocarbons
A	oxidised	oxidised	reduced	oxidised
B	oxidised	oxidised	oxidised	oxidised
C	reduced	reduced	oxidised	oxidised
D	reduced	reduced	reduced	reduced

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692. 9701_s21_qp_11 Q: 13

The gaseous products of heating a mixture of $Ca(OH)_2$ and NH_4Cl are passed through solid CaO. A single gaseous product, W, is collected.

A sample of W reacts with Cl_2(g) to produce two gases, X and Y.

X is an element. Y is acidic.

Y reacts with W to produce Z.

What are X and Z?

	X	Z
A	N_2	$CaCl_2$
B	N_2	NH_4Cl
C	O_2	$CaCl_2$
D	O_2	NH_4Cl

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693. 9701_s21_qp_11 Q: 18

Acid rain is a dilute solution of sulfuric acid.

Which pollutant also contributes to the formation of acid rain?

A carbon monoxide

B carbon dioxide

C nitrogen dioxide

D hydrocarbons

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694. 9701_s21_qp_12 Q: 18

What is an environmental consequence of the uncontrolled use of nitrate fertilisers?

A acid rain

B low oxygen levels in streams

C ozone depletion

D the greenhouse effect

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695. 9701_s21_qp_13 Q: 14

Which problem can result if too much NH_4NO_3 is applied to crops by farmers?

A Not all the NH_4NO_3 is used by plants and the excess makes the soil alkaline.

B Rain washes some of the NH_4NO_3 into rivers where it forms a precipitate.

C Some of the NH_4NO_3 dissolves in groundwater which may eventually be used for drinking.

D Ammonia is produced; this lowers the pH of the soil.

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696. 9701_w21_qp_11 Q: 19

The table describes two possible environmental consequences of adding too much ammonium nitrate fertiliser to the soil.

Which row is correct?

	increased plant growth in rivers	photochemical smog
A	✗	✗
B	✓	✗
C	✗	✓
D	✓	✓

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697. 9701_w21_qp_12 Q: 11

NO and NO_2 are both present in the lower atmosphere as pollutants.

The reaction sequence shows the production of ozone from oxygen in the lower atmosphere.

This sequence repeats many times.

$$NO_2(g) \rightarrow NO(g) + O(g)$$

$$NO(g) + \tfrac{1}{2}O_2(g) \rightarrow NO_2(g)$$

$$O_2(g) + O(g) \rightarrow O_3(g)$$

Which statement about this reaction sequence is correct?

A NO is acting as a catalyst, but NO_2 is not acting as a catalyst.

B NO_2 is acting as a catalyst, but NO is not acting as a catalyst.

C Neither NO nor NO_2 are acting as catalysts.

D Both NO and NO_2 are acting as catalysts.

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698. 9701_w21_qp_12 Q: 18

Oxides of nitrogen are present in the environment due to natural and man-made sources.

Which row is correct?

	natural source of nitrogen oxides	man-made source of nitrogen oxides
A	electrical discharges in the atmosphere	internal combustion engines
B	electrical discharges in the atmosphere	as a by-product of the Haber process
C	decomposition of dead plants in rivers	internal combustion engines
D	decomposition of dead plants in rivers	as a by-product of the Haber process

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699. 9701_w21_qp_12 Q: 19

Magnesium hydroxide dissolves in aqueous ammonium chloride, but not in aqueous sodium chloride.

Which statement explains this observation?

A The ionic radius of the NH_4^+ ion is similar to that of Mg^{2+} but not that of Na^+.

B NH_4Cl dissociates less fully than $NaCl$.

C The Na^+ and Mg^{2+} ions have the same number of electrons.

D The NH_4^+ ion can donate a proton.

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700. 9701_w21_qp_13 Q: 2

2.0 g of ammonium nitrate, NH_4NO_3, decomposes to give 0.90 g of water and a single gas.

What is the identity of the gas?

A NO **B** NO_2 **C** N_2O **D** N_2

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701. 9701_m20_qp_12 Q: 15

Solid ammonium nitrate is put into a test-tube and solution X is added to it. The resulting mixture is warmed and the gas given off is tested with damp red litmus paper. The litmus paper changes colour from red to blue.

What could be the identity of X and its role in the reaction?

	identity of X	role of X
A	NaOH(aq)	proton donor
B	NaOH(aq)	proton acceptor
C	HCl(aq)	proton donor
D	HCl(aq)	proton acceptor

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702. 9701_m20_qp_12 Q: 19

Which statement about nitrogen or its compounds is correct?

A In the Haber process the temperature is kept high to give a good equilibrium yield of ammonia.

B Nitrogen gas is unreactive because of the strong nitrogen–nitrogen double bond.

C Nitrogen monoxide will react with carbon monoxide under suitable conditions.

D The formula of ammonium sulfate is NH_4SO_4.

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703. 9701_s20_qp_12 Q: 15

Ammonium carbonate is a crystalline solid. On gentle warming a reaction occurs, forming ammonia as one product.

How are the carbonate ions behaving during this reaction?

A Brønsted-Lowry acid

B Brønsted-Lowry base

C oxidising agent

D reducing agent

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704. 9701_s20_qp_13 Q: 5

Nitrogen reacts with oxygen to form nitrogen monoxide, NO, and nitrogen dioxide, NO_2. Nitrogen dioxide reacts with water and with hydroxide ions.

$$N_2(g) + O_2(g) \rightarrow 2NO(g)$$

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

$$2NO_2(g) + H_2O(l) \rightarrow HNO_2(aq) + H^+(aq) + NO_3^-(aq)$$

$$2NO_2(g) + 2OH^-(aq) \rightarrow NO_2^-(aq) + NO_3^-(aq) + H_2O(l)$$

What can be deduced using **only** the information from these equations?

A HNO_2 is a strong acid.

B HNO_3 is a weak acid.

C NO_2 is a neutral gas.

D NO is a reducing agent.

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705. 9701_s20_qp_13 Q: 12

Compound T is a white crystalline solid.

When a sample of compound T is mixed with aqueous sodium hydroxide and heated, a gas is produced which turns damp red litmus paper blue.

Further testing of a solution of compound T with aqueous barium chloride produces a dense white precipitate which does not dissolve when dilute hydrochloric acid is added to the mixture.

What is the identity of compound T?

A ammonium carbonate

B ammonium sulfate

C sodium carbonate

D sodium sulfate

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706. 9701_s20_qp_13 Q: 16

Nitrogen oxides are removed from the exhaust gases of internal combustion engines by the action of a catalyst in a catalytic converter.

Which row is correct?

	change in oxidation number of nitrogen	type of catalyst
A	decrease	heterogeneous
B	decrease	homogeneous
C	increase	heterogeneous
D	increase	homogeneous

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707. 9701_w20_qp_11 Q: 17

Ammonia can undergo an acid–base reaction with hydrogen chloride to form ammonium chloride.

Which statement is correct?

A The ammonium ion is basic.

B The hydrogen atom from HC*l* donates a lone pair of electrons to the nitrogen atom.

C The H–N–H bond angle in ammonia is the same as the H–N–H bond angle in the ammonium ion.

D The H–N–H bond angle in the ammonium ion is the same as the H–C–H bond angle in methane.

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708. 9701_w20_qp_12 Q: 15

Water and ammonia take part in a reaction that produces the ammonium ion.

Which statement about this reaction is correct?

A The ammonia molecule and the ammonium ion do not have dipole moments.

B The bond angle changes from 109.5° in the ammonia molecule to 107° in the ammonium ion.

C The reaction is a redox reaction.

D The water is acting as an acid.

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709. 9701_m19_qp_12 Q: 19

Ammonia, NH_3, and hydrazine, NH_2NH_2, are two compounds of nitrogen, N_2.

Which statement is correct?

A The N–N bond in NH_2NH_2 is polar.

B NH_3 and NH_2NH_2 have lone pairs of electrons but N_2 does not.

C The oxidation number of each nitrogen in NH_2NH_2 is +2.

D The reaction of nitrogen with hydrogen has a high activation energy.

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710. 9701_s19_qp_11 Q: 19

Which statement is correct?

A Ammonia reacts with alkalis to form the ammonium ion.

B Ammonium chloride contains ionic, covalent and co-ordinate bonds.

C The ammonium ion reacts with acids to produce ammonia.

D The bond angle in the ammonium ion is approximately 107°.

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711. 9701_s19_qp_12 Q: 18

Ammonium sulfate, $(NH_4)_2SO_4$, and ammonium nitrate, NH_4NO_3, are used as fertilisers.

These salts have different percentages by mass of nitrogen. They have the same effect as each other on the pH of wet neutral soil.

Which row is correct?

	higher percentage of nitrogen by mass	effect on pH of soil
A	ammonium nitrate	decrease
B	ammonium nitrate	increase
C	ammonium sulfate	decrease
D	ammonium sulfate	increase

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712. 9701_s19_qp_12 Q: 19

Which reaction gives a product that is an atmospheric pollutant causing acid rain?

A $3Mg(s) + SO_2(g) \rightarrow MgS(s) + 2MgO(s)$

B $(NH_4)_2SO_4(s) + Ca(OH)_2(s) \rightarrow 2NH_3(g) + CaSO_4(s) + 2H_2O(l)$

C $2MnO_4^-(aq) + 5SO_2(g) + 2H_2O(l) \rightarrow 2Mn^{2+}(aq) + 4H^+(aq) + 5SO_4^{2-}(aq)$

D $2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$

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713. 9701_s19_qp_13 Q: 18

Which statement about the ammonium ion is correct?

A It can act as a Brønsted-Lowry base.

B It can react with OH^- to give ammonia.

C It is pyramidal with bond angles of 107°.

D The nitrogen atom is sp^2 hybridised.

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714. 9701_s19_qp_13 Q: 19

In a catalytic converter 5.6 g of carbon monoxide reacts with an excess of nitrogen monoxide.

What is produced in this reaction?

A 2.4 g of C and 6.0 g of NO_2

B 2.4 g of C and 9.2 g of NO_2

C 8.8 g of CO_2 and 1.4 g of N_2

D 8.8 g of CO_2 and 2.8 g of N_2

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715. 9701_w19_qp_11 Q: 18

Which type of reaction occurs when solid ammonium sulfate is heated with an excess of sodium hydroxide solution?

A acid-base

B precipitation

C redox

D thermal decomposition

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716. 9701_w19_qp_11 Q: 19

Catalytic converters are fitted in the exhaust systems of many cars.

Which gas:

- causes acid rain if it is released into the air
- is removed from car exhaust fumes by a catalytic converter?

A carbon dioxide

B carbon monoxide

C hydrocarbon vapour

D nitrogen dioxide

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717. 9701_w19_qp_12 Q: 18

Which emission from an internal combustion engine contributes to the erosion of marble statues?

A carbon monoxide

B nitrogen

C nitrogen dioxide

D unburnt hydrocarbons

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718. 9701_w19_qp_12 Q: 19

Ammonia, carbon dioxide and water react together to form ammonium carbonate.

Which statement about this reaction is correct?

A It is a redox reaction.

B It is an acid-base reaction.

C The H–N–H bond angle decreases as a consequence of this reaction.

D The three substances react in a 1 : 1 : 1 ratio in this reaction.

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719. 9701_s18_qp_11 Q: 17

Oxides of nitrogen are present in the environment due to natural and man-made sources.

Which row is correct?

	natural source of nitrogen oxides	man-made source of nitrogen oxides
A	electrical discharges in the atmosphere	internal combustion engines
B	electrical discharges in the atmosphere	as a by-product of the Haber process
C	decomposition of dead plants in rivers	internal combustion engines
D	decomposition of dead plants in rivers	as a by-product of the Haber process

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720. 9701_s18_qp_12 Q: 19

Sulfur dioxide can be catalytically oxidised by an oxide of nitrogen in the atmosphere.

Which reaction shows the regeneration of the catalyst?

A $N_2 + 2O_2 \rightleftharpoons 2NO_2$

B $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

C $N_2 + O_2 \rightarrow 2NO$

D $NO + \frac{1}{2}O_2 \rightarrow NO_2$

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721. 9701_s18_qp_13 Q: 19

The gaseous products of heating a mixture of $Ca(OH)_2$ and NH_4Cl are passed through solid CaO. This absorbs water vapour and a gas, **W**, is collected.

A sample of **W** is oxidised by $Cl_2(g)$ to produce two gases, **X** and **Y**.

X is an element. **Y** is acidic.

Y reacts with **W** to produce **Z**.

What are **X** and **Z**?

	X	Z
A	N_2	$CaCl_2$
B	N_2	NH_4Cl
C	O_2	$CaCl_2$
D	O_2	NH_4Cl

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722. 9701_w18_qp_11 Q: 19

Transition elements and their compounds are widely used as catalysts.

What is the identity and what is the oxidation number of the element present in the catalyst used in the Contact process?

	element	oxidation number
A	iron	0
B	iron	+3
C	vanadium	0
D	vanadium	+5

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723. 9701_w18_qp_12 Q: 18

The product of the Contact process is Z.

Which reaction or process leads to the formation of a gas that can neutralise an aqueous solution of Z?

A atmospheric lightning

B combustion of fuel in an internal combustion engine

C the Haber process

D thermal decomposition of Group 2 nitrates

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724. 9701_m17_qp_12 Q: 19

Methylamine, CH_3NH_2, has very similar chemical properties to ammonia, NH_3.

Methylamine reacts with hydrogen chloride to form a white crystalline salt, methylammonium chloride.

$$CH_3NH_2 + HCl \rightarrow CH_3NH_3^+Cl^-$$

A sample of methylammonium chloride is heated with aqueous sodium hydroxide.

What are the products?

A ammonia, sodium chloride and water

B ammonia, sodium hydrogencarbonate and sodium chloride

C methylamine, hydrogen chloride and water

D methylamine, sodium chloride and water

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725. 9701_s17_qp_11 Q: 16

Which statement about nitrogen or its compounds is correct?

A In the Haber process the temperature is kept high to give a good equilibrium yield of ammonia.

B Nitrogen gas is unreactive because of the strong nitrogen-nitrogen double bond.

C Nitrogen monoxide will react with carbon monoxide under suitable conditions.

D The formula of ammonium sulfate is NH_4SO_4.

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726. 9701_s17_qp_12 Q: 18

The ammonium ion is formed by the following reaction.

$$NH_3 + H^+ \rightarrow NH_4^+$$

Which statement about the species involved in this reaction is correct?

A The ammonia molecule contains a dative covalent bond.

B The ammonium ion is a Brønsted-Lowry base as it has accepted a proton.

C The H–N–H bond angle changes from 107° in ammonia to 90° in the ammonium ion.

D The number of electrons surrounding each nitrogen atom does not change.

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727. 9701_s17_qp_13 Q: 18

Ammonia exists as simple covalent molecules, NH_3. Ammonia can react with suitable reagents to form products containing ammonium ions, NH_4^+. Ammonia can also react with suitable reagents to form products containing amide ions, NH_2^-.

Which of these nitrogen-containing species are present in an aqueous solution of ammonia?

A ammonia molecules and amide ions only

B ammonia molecules and ammonium ions only

C ammonia molecules only

D ammonium ions only

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728. 9701_s17_qp_13 Q: 19

What would be produced when 60 g of nitrogen monoxide react with an excess of carbon monoxide in a catalytic converter?

A 12 g of carbon and 92 g of nitrogen dioxide

B 24 g of carbon and 92 g of nitrogen dioxide

C 88 g of carbon dioxide and 28 g of nitrogen

D 88 g of carbon dioxide and 56 g of nitrogen

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729. 9701_w17_qp_11 Q: 16

Which fertiliser contains the greatest percentage of nitrogen by mass?

A ammonium nitrate, NH_4NO_3

B ammonium sulfate, $(NH_4)_2SO_4$

C diammonium hydrogen phosphate, $(NH_4)_2HPO_4$

D urea, $CO(NH_2)_2$

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730. 9701_w17_qp_12 Q: 18

The reaction of nitrogen and oxygen to produce oxides of nitrogen happens at high temperatures in car engines or lightning strikes during thunderstorms.

What is the main reason for these reactions requiring such high temperatures?

A the lack of reactivity of nitrogen, due to the half-filled 2p subshell in the nitrogen atom

B the lack of reactivity of nitrogen, due to the strength of the bond in N_2

C the lack of reactivity of oxygen, due to electron-electron repulsion in one of its 2p orbitals

D the lack of reactivity of oxygen, due to the strength of the bond in O_2

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731. 9701_m16_qp_12 Q: 17

Ammonium sulfate, $(NH_4)_2SO_4$, and ammonium nitrate, NH_4NO_3, are used as fertilisers.

These salts have different percentages by mass of nitrogen. They have the same effect as each other on the pH of neutral soil.

Which row is correct?

	higher percentage of nitrogen by mass	effect on pH of soil
A	ammonium nitrate	decrease
B	ammonium nitrate	increase
C	ammonium sulfate	decrease
D	ammonium sulfate	increase

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732. 9701_s16_qp_11 Q: 18

Which statement about the ammonia molecule and/or the ammonium ion is correct?

A Ammonia molecules are basic because they can donate H^+ ions.

B Ammonium ions are basic because they can accept H^+ ions.

C If ammonium ions are heated with NaOH(aq), ammonia molecules are formed.

D The bond angle in NH_4^+ is 2.5° less than the bond angle in NH_3.

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733. 9701_s16_qp_11 Q: 19

Which reaction **does not** contribute to the problem of acid rain?

A the combustion of fossil fuels

B the oxidation of sulfur dioxide to sulfur trioxide catalysed by nitrogen dioxide

C the reaction between nitrogen monoxide and carbon monoxide in a catalytic converter

D the reaction of sulfur trioxide with water

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734. 9701_s16_qp_12 Q: 15

Ammonia gas, NH_3, and hydrogen sulfide gas, H_2S, react together to form the salt ammonium sulfide, $(NH_4)_2S$. Ammonium sulfide dissolves in water to produce an orange alkaline solution.

$$(NH_4)_2S(aq) \rightleftharpoons NH_3(aq) + NH_4SH(aq)$$

The addition of NaOH(aq) to this solution produces a gas, **X**.
The addition of HCl(aq) to a separate portion of this solution produces a gas, **Y**.

What are the identities of **X** and **Y**?

	X	Y
A	H_2S	H_2S
B	H_2S	NH_3
C	NH_3	H_2S
D	NH_3	NH_3

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735. 9701_s16_qp_13 Q: 19

Which statement does **not** describe an effect of acid rain on the environment?

A Acid rain causes erosion of stone buildings.

B Acid rain causes ozone depletion.

C Acid rain increases the corrosion of some metals.

D Acid rain increases the leaching away of essential nutrients and minerals from soils.

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736. 9701_w16_qp_11 Q: 17

Compound **T** is a white crystalline solid.

When a sample of **T** was mixed with aqueous sodium hydroxide and heated, a pungent smelling gas was produced which turned damp red litmus paper blue. This same gas produced dense white smoke with hydrogen chloride gas.

Further testing of a solution of **T** with barium chloride solution produced a dense white precipitate which did not dissolve when dilute hydrochloric acid was added to the mixture.

What is the identity of compound **T**?

A ammonium carbonate

B ammonium sulfate

C sodium carbonate

D sodium sulfate

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737. 9701_w16_qp_12 Q: 19

Water and ammonia take part in a reaction that produces the ammonium ion.

Which statement about this reaction is correct?

A Neither the ammonia molecule nor the ammonium ion has a dipole moment.

B The bond angle changes from 109.5° in the ammonia molecule to 107° in the ammonium ion.

C The reaction is a redox reaction.

D The water is acting as an acid.

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738. 9701_s15_qp_11 Q: 18

Mohr's salt is a pale green crystalline solid which is soluble in water. It contains two cations, one of which is Fe^{2+}, and one anion which is SO_4^{2-}.

The identity of the second cation was determined by heating Mohr's salt with aqueous sodium hydroxide. A colourless gas was evolved which readily dissolved in water giving an alkaline solution.

A green precipitate was also formed.

What are the identities of the gas and the precipitate?

	gas	precipitate
A	NH_3	$Fe(OH)_2$
B	NH_3	Na_2SO_4
C	SO_2	$Fe(OH)_2$
D	SO_2	Na_2SO_4

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739. 9701_s15_qp_12 Q: 17

Which statement about the ammonium ion, NH_4^+, is correct?

A All bond angles are 107°.

B Ammonium ions are formed when ammonia behaves as an acid.

C Ammonium ions are unreactive when heated with NaOH(aq).

D The bonds are all the same length.

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740. 9701_s15_qp_12 Q: 18

Carbon monoxide, CO, nitrogen dioxide, NO_2, and sulfur dioxide, SO_2, are all atmospheric pollutants.

Which reaction concerning these compounds occurs in the atmosphere?

A CO is spontaneously oxidised to CO_2

B NO_2 is reduced to NO by CO

C NO_2 is reduced to NO by SO_2

D SO_2 is oxidised to SO_3 by CO_2

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