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# CHEMISTRY MULTIPLE CHOICE QUESTIONS

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L. Nitrogen and Sulphur

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2002 -2014

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1. Sulphur dioxide is an important food preservative.  
What property makes sulphur dioxide useful in this role?

- A It is a gas.
- B It is a reducing agent.
- C It reacts with oxygen to form sulphur trioxide.
- D It reacts with water to form an acidic solution.

[2002 M/J (18)]

2. The propellant used in the solid rocket booster of a space shuttle is a mixture of aluminium and compound X. Compound X contains chlorine in an oxidation state of +7.

Which of the following could be compound X?

- A  $\text{NH}_4\text{Cl}$
- B  $\text{NH}_4\text{ClO}_3$
- C  $\text{NH}_4\text{ClO}_4$
- D  $\text{N}_2\text{H}_5\text{Cl}$

[2002 M/J (15)]

3. When ammonia is converted into nitric acid on a commercial scale, the following reactions can occur.

In which reaction does the greatest change in oxidation number of the nitrogen occur?

reaction	
A	$4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$
B	$3\text{NO}_2 + \text{H}_2\text{O} \rightarrow 2\text{HNO}_3 + \text{NO}$
C	$2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$
D	$4\text{NH}_3 + 6\text{NO} \rightarrow 5\text{N}_2 + 6\text{H}_2\text{O}$

[2003 M/J (8)]

4. Which reagent, when mixed and heated with ammonium sulphate, liberates ammonia?

- A aqueous bromine
- B dilute hydrochloric acid
- C limewater
- D acidified potassium dichromate(VI)

[2003 M/J (18)]

5. Which pollutant is formed in the internal combustion engine and, if not removed by the catalytic converter, may become involved in the formation of acid rain?

- A C
- B  $\text{C}_8\text{H}_{18}$
- C CO
- D NO

[2003 M/J (19)]

6. Which statements are reasons why sulphur dioxide is used as a food preservative?

- 1 It is a reducing agent and therefore an anti-oxidant.
- 2 It prevents alcohols forming sour-tasting acids.
- 3 It does not smell and therefore can be used in more than trace quantities.

[2003 M/J (35)]

7. In a solution of ammonia in water, what combination of ionic and molecular forms of ammonia are present?

- A ions only
- B ions and simple molecules only
- C simple molecules and hydrogen-bonded molecules only
- D simple molecules, hydrogen-bonded molecules and ions

[2003 O/N (18)]

8. Nitrogen is frequently used as an inert atmosphere because it is an unreactive gas.

Which is the best explanation of this unreactivity?

- A Its molecule contains a triple bond.
- B The bond energy of the molecule is high ( $994 \text{ kJ mol}^{-1}$ ).
- C The bond in its molecule is very short (0.110 nm).
- D The three p orbitals of nitrogen are half-filled.

[2003 O/N (19)]

9. Which processes involve the conversion of sulphur dioxide into sulphur trioxide?

- 1 the combustion of sulphur contaminated carbonaceous fuels
- 2 the Contact process for manufacturing sulphuric acid
- 3 the catalytic oxidation of sulphur dioxide by oxides of nitrogen

[2003 O/N (36)]

10. Which of these equations represents the reaction of sulphur dioxide with an excess of aqueous sodium hydroxide?

- A  $\text{SO}_2 + \text{NaOH} \rightarrow \text{NaHSO}_3$
- B  $\text{SO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_3 + \text{H}_2\text{O}$
- C  $\text{SO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$
- D  $\text{SO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2$

[2004 M/J (13)]

11. Nitrogen dioxide and sulphur dioxide have some properties in common.

Which property is shown by **one** of these compounds, but **not** by the other?

- A forms 'acid-rain'
- B is a reducing agent
- C is insoluble in water
- D is used as a food-preservative

[2004 M/J (19)]

12. When coal is burnt, gaseous oxides of carbon and sulphur are formed which pollute the atmosphere. One method of preventing such pollution involves adding calcium carbonate to the burning coal. The temperature of the process causes the decomposition of the calcium carbonate into calcium oxide.

Which reactions will be important in helping to reduce atmospheric pollution?

- 1 Calcium oxide reacts with sulphur dioxide to form calcium sulphite.
- 2 Calcium oxide reacts with sulphur dioxide and more air to form calcium sulphate.
- 3 Calcium oxide reacts with carbon monoxide to form calcium carbonate.

[2004 M/J (35)]

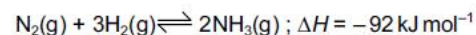
13. Which reaction of ammonia does **not** involve the non-bonding pair of electrons on the nitrogen atom?

- A  $\text{NH}_3(\text{g}) + \text{CH}_3\text{I}(\text{g}) \rightarrow \text{CH}_3\text{NH}_3^+\text{I}^-(\text{s})$
- B  $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \rightarrow \text{NH}_4\text{Cl}(\text{s})$
- C  $2\text{NH}_3(\text{l}) + 2\text{Na}(\text{s}) \rightarrow 2\text{NaNH}_2(\text{s}) + \text{H}_2(\text{g})$
- D  $2\text{NH}_3(\text{aq}) + \text{Ag}^+(\text{aq}) \rightarrow [\text{Ag}(\text{NH}_3)_2]^+(\text{aq})$

[2004 O/N (18)]

14.

Ammonia is produced commercially by the Haber process in which nitrogen and hydrogen react as shown.



Which statements are true of the commercial process?

- 1 A temperature of 1000 °C is used.
- 2 A pressure of 100 - 200 atm is used.
- 3 The yield of ammonia is less than 20%.

[2004 O/N (32)]

15.

Concentrated sulphuric acid is added to separate solid samples of sodium chloride, sodium bromide or sodium iodide.

With which sample(s) does sulphuric acid act as an oxidising agent?

- A sodium chloride only
- B sodium chloride and sodium bromide
- C sodium bromide and sodium iodide
- D sodium iodide only

[2005 M/J (15)]

16.

In an historically famous experiment Wöhler heated "inorganic" ammonium cyanate in the absence of air. The only product of the reaction was "organic" urea,  $\text{CO}(\text{NH}_2)_2$ . No other products were formed in the reaction.

What is the formula of the cyanate ion present in ammonium cyanate?

- A CNO      B  $\text{CNO}^2$       C CO      D NO

[2005 M/J (18)]

17.

How does ammonia behave when its aqueous solution is used to dissolve silver chloride,  $\text{AgCl}$ ?

- A as a base
- B as a ligand with the  $\text{Ag}^+$  ion
- C as a ligand with the  $\text{Cl}^-$  ion
- D as a reducing agent

[2005 O/N (17)]

18.

Lime,  $\text{CaO}$ , is used to reduce the acidity of soil, and ammonium sulphate is a nitrogenous fertiliser.

Why can they **not** be used in a mixed form?

- A The dry mixture is explosive.
- B  $\text{CaSO}_4$ , formed on mixing, causes hard water.
- C When dampened, ammonia is given off.
- D Sulphuric acid will form.

[2005 O/N (18)]

19.

Which equations represent stages in the Contact process for manufacturing sulphuric acid?

- 1  $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$
- 2  $\text{H}_2\text{O} + \text{SO}_2 \rightarrow \text{H}_2\text{SO}_3$
- 3  $\text{H}_2\text{SO}_3 + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{SO}_4$

[2005 O/N (37)]

20.

The emissions from a power station contain about 14 tonnes of  $\text{SO}_2$  per hour from the oxidation of  $\text{FeS}_2$  contained in the coal.

What is the most practical way of preventing the  $\text{SO}_2$  from being released into the atmosphere?

- A Cool the gases and the  $\text{SO}_2$  will liquefy and can be removed.
- B Dissolve the ionic  $\text{FeS}_2$  in hexane.
- C Pass the emissions through a bed of calcium oxide.
- D Pass the gases through concentrated sulphuric acid to dissolve the  $\text{SO}_2$ .

[2006 M/J (18)]

21. Ammonia and chlorine react in the gas phase.



Which statements are correct?

- 1 Ammonia behaves as a reducing agent.
- 2 Ammonia behaves as a base.
- 3 The oxidation number of the hydrogen changes.

[2006 M/J (36)]

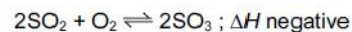
22. Sulphur dioxide is an important food preservative.

Which property makes sulphur dioxide useful in this role?

- A It is a gas.
- B It is a reducing agent.
- C It reacts with oxygen to form sulphur trioxide.
- D It reacts with water to form an acidic solution.

[2006 O/N (18)]

23. In the Contact process for the production of sulphuric acid, sulphur dioxide is mixed with air and passed over a vanadium(V) oxide catalyst at about 450 °C and a pressure slightly above atmospheric pressure.



What affects the choice of conditions for this reaction?

- A A lower temperature would not raise the concentration of  $\text{SO}_3$  at equilibrium.
- B At a lower temperature of 300 °C the  $\text{V}_2\text{O}_5$  catalyst would not be effective.
- C At 450 °C nitrogen and oxygen from the air combine to form nitrogen oxides which are needed as additional catalysts.
- D The heat generated by the reaction raises the temperature of the catalyst bed to 600 °C at which temperature the reaction begins to take place.

[2006 O/N (19)]

24. Which fertilisers, when washed out of soil by rain, cause excessive growth of river plants and algae with the result that fish in the river die?

- 1  $\text{K}_2\text{SO}_4$
- 2  $\text{NH}_4\text{NO}_3$
- 3  $\text{NaNO}_3$

[2006 O/N (36)]

25. A solid nitrate fertiliser reacts with an alkali to produce a gas which turns damp pH paper blue.

What is the empirical formula of this fertiliser?

- A  $\text{NO}_3$       B  $\text{NHO}_3$       C  $\text{NH}_2\text{O}$       D  $\text{N}_2\text{H}_4\text{O}_3$

[2007 M/J (18)]

26. Nitrogen and oxygen react in a hot car engine to form nitrogen monoxide which is a serious pollutant in our cities and in the countryside. However, nitrogen and oxygen do not react at room temperature.

Which statements help to explain why nitrogen and oxygen do not react at room temperature?

- 1 The reaction is endothermic.
- 2 A high activation energy is required.
- 3 Nitrogen has a high bond energy.

[2007 M/J (37)]

27.

There are three stages in the Contact process for the production of sulphuric acid.

- 1  $S + O_2 \rightarrow SO_2$
- 2  $SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$
- 3  $SO_3 + H_2O \rightarrow H_2SO_4$

Which statement about this process is correct?

- A In the first stage a large excess of air under high pressure is used to improve the yield.
- B Two of the three stages are equilibria.
- C All three stages are exothermic.
- D In the final stage  $SO_3$  is absorbed by water droplets.

[2007 O/N (17)]

28.

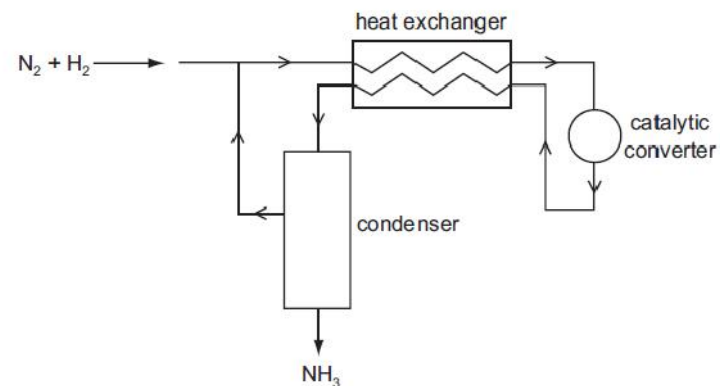
Which reagent, when mixed and heated with ammonium sulphate, liberates ammonia?

- A aqueous bromine
- B dilute hydrochloric acid
- C limewater
- D acidified potassium dichromate(VI)

[2008 M/J (17)]

29.

The diagram represents the Haber process for the manufacture of ammonia from nitrogen and hydrogen.



What is the purpose of the heat exchanger?

- A to cool the incoming gas mixture to avoid overheating the catalyst
- B to cool the reaction products and separate the  $NH_3$  from unused  $N_2$  and  $H_2$
- C to warm the incoming gas mixture and shift the equilibrium to give more  $NH_3$
- D to warm the incoming gas mixture and speed up the reaction

[2008 M/J (18)]

30.

Total elimination of the pollutant sulphur dioxide,  $SO_2$ , is difficult, both for economic and technical reasons. Its emission can be reduced in furnace chimneys using desulphurisation plants, where the gases are scrubbed (washed) with calcium hydroxide to remove the  $SO_2$ .

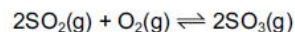
What is the main product formed initially?

- A CaO
- B  $Ca(OH)_2$
- C  $CaSO_3$
- D  $CaSO_4$

[2008 M/J (19)]

31.

Catalysts are used in many reversible reactions in the chemical industry. Vanadium(V) oxide is used in this way in the Contact process for the formation of  $\text{SO}_3$ .



What effect does vanadium(V) oxide have on this equilibrium?

- 1 It speeds up the forward reaction.
- 2 It increases the value of  $K_p$ .
- 3 It increases the value of  $E_a$  for the reverse reaction.

[2008 M/J (32)]

32.

Which salt is produced by adding aqueous ammonia to aqueous sulphur dioxide until just alkaline?

- A**  $\text{NH}_4\text{SO}_3$     **B**  $\text{NH}_4\text{SO}_4$     **C**  $(\text{NH}_4)_2\text{SO}_3$     **D**  $(\text{NH}_4)_2\text{SO}_4$

[2008 O/N (14)]

33.

When gaseous chemicals are transported by road or by rail they are classified as follows.

flamable    non-flamable    poisonous

Which gas is poisonous?

- A** butane
- B** carbon dioxide
- C** hydrogen
- D** sulphur dioxide

[2008 O/N (18)]

34.

Mohr's salt is a pale green crystalline solid which is soluble in water. It is a 'double sulfate' which contains two cations, one of which is  $\text{Fe}^{2+}$ .

The identity of the second cation was determined by heating solid Mohr's salt with solid sodium hydroxide and a colourless gas was evolved. The gas readily dissolved in water giving an alkaline solution. A grey-green solid residue was also formed which was insoluble in water.

What are the identities of the gas and the solid residue?

	gas	residue
<b>A</b>	$\text{H}_2$	$\text{FeSO}_4$
<b>B</b>	$\text{NH}_3$	$\text{Na}_2\text{SO}_4$
<b>C</b>	$\text{NH}_3$	$\text{Fe}(\text{OH})_2$
<b>D</b>	$\text{SO}_2$	$\text{Fe}(\text{OH})_2$

[2009 M/J (18)]

35.

When sulfur trioxide is manufactured from sulfur dioxide and oxygen, using the Contact process, which condition affects the value of the equilibrium constant,  $K_c$ ?

- A** adjusting the temperature
- B** adjusting the pressure
- C** using a catalyst
- D** removing  $\text{SO}_3$  from the equilibrium mixture

[2009 O/N-11 (17)]

36.

Most modern cars are fitted with three-way catalytic converters in the exhaust system.

Which three gases are removed by such a catalytic converter?

- A** carbon monoxide, hydrocarbons, nitrogen oxides
- B** carbon monoxide, carbon dioxide, nitrogen oxides
- C** carbon monoxide, nitrogen oxides, sulfur dioxide
- D** hydrocarbons, nitrogen oxides, sulfur dioxide

[2009 O/N-11 (18)]

37.

A farmer added lime to damp soil, followed by the nitrogenous fertiliser ammonium sulfate. A chemical reaction occurred in the soil.

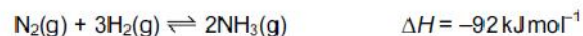
Which substances were formed in this reaction?

- 1 sulfuric acid
- 2 calcium sulfate
- 3 ammonia

[2009 O/N-11 (35)]

38.

The Haber process for the manufacture of ammonia is represented by the following equation.



Which statement is correct about this reaction when the temperature is increased?

- A Both forward and backward rates increase.
- B The backward rate only increases.
- C The forward rate only increases.
- D There is no effect on the backward or forward rate.

[2010 M/J-11 (7)]

39.

How does concentrated sulfuric acid behave when it reacts with sodium chloride?

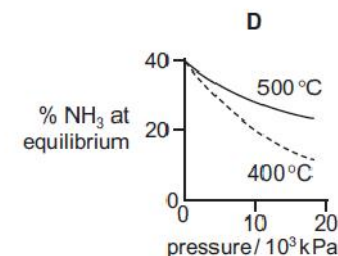
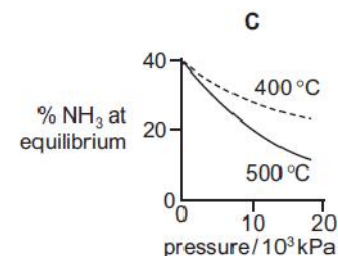
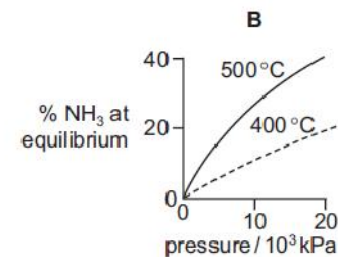
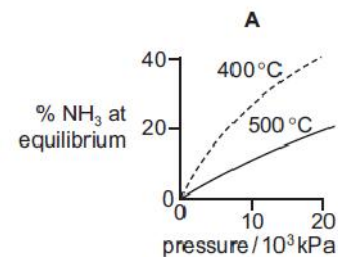
- A as an acid only
- B as an acid and oxidising agent
- C as an oxidising agent only
- D as a reducing agent only

[2010 M/J-11 (13)]

40.

The percentage of ammonia obtainable, if equilibrium were established during the Haber process, is plotted against the operating pressure for two temperatures, 400°C and 500°C.

Which diagram correctly represents the two graphs?



[2010 M/J-11 (15)]

41.

In a car engine, non-metallic element X forms a pollutant oxide Y.

Further oxidation of Y to Z occurs in the atmosphere. In this further oxidation, 1 mol of Y reacts with  $\frac{1}{2}$  mol of gaseous oxygen.

What can X be?

- 1 carbon
- 2 nitrogen
- 3 sulfur

[2010 M/J-11 (35)]



42. Sulfur dioxide and sulfites are used in food preservation.

Why are they used for this purpose?

- 1 They are reducing agents so retard the oxidation of food.
- 2 They inhibit the growth of aerobic bacteria.
- 3 They react with  $\text{NO}_2(\text{g})$  converting it to  $\text{NO}(\text{g})$ .

[2010 M/J-11 (36)]

43. Ammonium sulfate in nitrogenous fertilisers in the soil can be slowly oxidised by air producing sulfuric acid, nitric acid and water.

How many moles of oxygen gas are needed to oxidise completely one mole of ammonium sulfate?

- A 1                      B 2                      C 3                      D 4

[2010 O/N-11 (15)]

44. Sulfur dioxide is used to bleach wood pulp in the production of paper. It is also used as an additive in the production of jam and marmalade, often in the form of sulfite compounds. When it is present in quantities greater than 10 mg / kg it is required to be listed as an ingredient of the jam.

Why is sulfur dioxide added to jam?

- A It is a bleaching agent and removes the undesirable colours from the fruit used in the jam.
- B It is a preservative that destroys unwanted bacteria and enzymes.
- C It is a reducing agent and removes the acids that give the jam a sharp taste.
- D It is an acidic gas and maintains the pH of the jam at a suitable value to give it a sharp taste.

[2010 O/N-11 (18)]

45. When ammonia,  $\text{NH}_3$ , is produced in a school or college laboratory, it is usually dried before being collected.

Which drying agents may be used to dry ammonia?

- 1 calcium oxide,  $\text{CaO}$
- 2 phosphorus(V) oxide,  $\text{P}_4\text{O}_{10}$
- 3 concentrated sulfuric acid,  $\text{H}_2\text{SO}_4$

[2010 O/N-12 (31)]

46. In which ways are the main reactions in the Haber and Contact processes similar?

- 1 A higher yield is favoured by higher pressures.
- 2 The reaction is a redox process.
- 3 The forward reaction is exothermic.

[2010 O/N-12 (35)]

47. A car burning lead-free fuel has a catalytic converter fitted to its exhaust. On analysis its exhaust gases are shown to contain small quantities of nitrogen oxides.

Which modifications would result in lower exhaust concentrations of nitrogen oxides?

- 1 an increase in the surface area of the catalyst in the converter
- 2 an increase in the rate of flow of the exhaust gases through the converter
- 3 a much higher temperature of combustion in the engine

[2010 O/N-12 (36)]

48. Ammonium nitrate,  $\text{NH}_4\text{NO}_3$ , is manufactured in large quantities for use in fertiliser.

Which statement about ammonium nitrate fertiliser is **not** correct?

- A It can cause environmental problems.
- B It consists of 35% nitrogen by mass.
- C It is insoluble in water.
- D Nitric acid is used in its manufacture.

[2011 M/J-11 (17)]

49. Nitrogen monoxide,  $\text{NO}$ , is a primary pollutant produced by petrol engines and is found in their exhaust gases.

Which reaction occurs in a catalytic converter and decreases the emission of nitrogen monoxide?

- A  $\text{NO}(\text{g}) + \text{CO}(\text{g}) \rightarrow \text{NO}_2(\text{g}) + \text{C}(\text{s})$
- B  $\text{NO}(\text{g}) + \text{CO}_2(\text{g}) \rightarrow \text{NO}_2(\text{g}) + \text{CO}(\text{g})$
- C  $2\text{NO}(\text{g}) + 2\text{CO}(\text{g}) \rightarrow \text{N}_2(\text{g}) + 2\text{CO}_2(\text{g})$
- D  $2\text{NO}(\text{g}) + \text{CO}_2(\text{g}) \rightarrow 2\text{NO}_2(\text{g}) + \text{C}(\text{s})$

[2011 M/J-11 (18)]

50. Which descriptions of the ammonium ion are correct?

- 1 It contains ten electrons.
- 2 It has a bond angle of  $109.5^\circ$ .
- 3 It has only three bonding pairs of electrons.

[2011 M/J-11 (37)]

51. Ammonia is manufactured on a large scale by the Haber process.

In a particular plant, conditions of  $400^\circ\text{C}$  and  $250\text{ atm}$  in the presence of an iron catalyst are used.



What could contribute most to increasing the equilibrium yield of ammonia?

- A adding more catalyst
- B increasing the pressure to  $400\text{ atm}$
- C increasing the temperature to  $1000^\circ\text{C}$
- D using air rather than nitrogen

[2011 M/J-12 (5)]

52. Concentrated sulfuric acid can behave **both** as a strong acid **and** as an oxidising agent.

With which compound does concentrated sulfuric acid react in this way?

- A ethanol
- B magnesium carbonate
- C propanenitrile
- D sodium bromide

[2011 M/J-12 (17)]

53. In the Contact process, what is the nature of the gaseous product and what is the identity of the catalyst?

	nature of gaseous product	catalyst
A	acidic	Fe
B	acidic	$\text{V}_2\text{O}_5$
C	basic	Fe
D	basic	$\text{V}_2\text{O}_5$

[2011 M/J-12 (18)]

54.

In a car engine pollutant oxide Y, which contains non-metallic element X, is formed.

Further oxidation of Y to Z occurs in the atmosphere. In this further oxidation, 1 mol of Y reacts with 0.5 mol of gaseous oxygen.

X could be either nitrogen or sulfur.

Which statements about X, Y and Z can be correct?

- 1 The oxidation number of X increases by two from Y to Z.
- 2 Y may have an unpaired electron in its molecule.
- 3 Y is a polar molecule.

[2011 M/J-12 (36)]

55.

In the last century the Haber process was sometimes run at pressures of 1000 atm and higher. Now it is commonly run at pressures below 100 atm.

What is the reason for this change?

- A An iron catalyst is used.
- B Maintaining the higher pressures is more expensive.
- C The equilibrium yield of ammonia is increased at lower pressures.
- D The rate of the reaction is increased at lower pressures.

[2011 M/J-13 (5)]

56.

Total removal of the pollutant sulfur dioxide, SO<sub>2</sub>, is difficult, both for economic and technical reasons. The quantities emitted from furnace chimneys can be lowered by using desulfurisation plants. The gases are scrubbed (washed) with calcium hydroxide to remove the SO<sub>2</sub>.

What is the main product formed initially?

- A Ca(HSO<sub>4</sub>)<sub>2</sub>    B CaS    C CaSO<sub>3</sub>    D CaSO<sub>4</sub>

[2011 O/N-11 (18)]

57.

A farmer spreads lime on land which has already been treated with an ammonium nitrate fertiliser.

Which reactions will occur in the treated soil?

- 1  $\text{Ca(OH)}_2 + 2\text{NH}_4^+(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + 2\text{NH}_3 + 2\text{H}_2\text{O}$
- 2  $\text{Ca(OH)}_2 + 2\text{H}^+(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + 2\text{H}_2\text{O}$
- 3  $\text{Ca(OH)}_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 + \text{H}_2\text{O}$

[2011 O/N-11 (34)]

58.

In a car engine, non-metallic element X forms a pollutant oxide Y.

Further oxidation of Y to Z occurs spontaneously in the atmosphere. In this further oxidation, 1 mol of Y reacts with 0.5 mol of gaseous oxygen.

Which statements about X, Y and Z are correct?

- 1 X forms a basic hydride.
- 2 Y is a diatomic molecule.
- 3 Z is a polar molecule.

[2011 O/N-11 (36)]

59.

In the Haber process for the manufacture of ammonia, why is the heterogeneous catalyst iron in a finely divided state?

- A to increase its surface area
- B to produce the maximum reduction in the activation energy
- C to reduce its loss during the reaction
- D to reduce its surface area

[2011 O/N-12 (1)]

60.

Methyl mercaptan,  $\text{CH}_3\text{SH}$ , has a foul smell and is often used to impart a smell to natural gas.

What will be formed when  $\text{CH}_3\text{SH}$  is burned in an excess of air?

- A  $\text{CO}$   $\text{H}_2\text{O}$   $\text{SO}_2$
- B  $\text{CO}_2$   $\text{H}_2\text{O}$   $\text{H}_2\text{S}$
- C  $\text{CO}_2$   $\text{H}_2\text{O}$   $\text{SO}_2$
- D  $\text{CO}_2$   $\text{H}_2\text{O}$   $\text{SO}_3$

[2011 O/N-12 (13)]

61.

Nitrogenous fertilisers are used extensively in modern farming. If rainwater washes excess fertiliser into a nearby lake, a process called eutrophication may occur.

Three of the stages of eutrophication are described below.

- P Water plants growing on the lake bed die due to lack of sunlight.
- Q An excessive growth of algae occurs.
- R Excessive bacterial activity causes a reduction in oxygen levels.

In which order do these three stages occur?

- A  $\text{P} \rightarrow \text{Q} \rightarrow \text{R}$
- B  $\text{P} \rightarrow \text{R} \rightarrow \text{Q}$
- C  $\text{Q} \rightarrow \text{P} \rightarrow \text{R}$
- D  $\text{Q} \rightarrow \text{R} \rightarrow \text{P}$

[2011 O/N-12 (14)]

62.

In a car engine, non-metallic element **X** forms a pollutant oxide **Y**.

Further oxidation of **Y** to **Z** occurs spontaneously in the atmosphere. In this further oxidation, 1 mol of **Y** reacts with 0.5 mol of gaseous oxygen.

Which statements about **X**, **Y** and **Z** are correct?

- 1 The oxidation number of **X** increases by 2 from **Y** to **Z**.
- 2 The molecule of **Y** has no unpaired electrons.
- 3 The molecule of **Z** contains three oxygen atoms.

[2011 O/N-12 (36)]

63.

Ammonia is manufactured by the Haber Process, in an exothermic reaction.

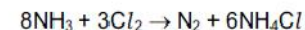
Assuming that the amount of catalyst remains constant, which change will **not** bring about an increase in the rate of the forward reaction?

- A decreasing the size of the catalyst pieces
- B increasing the pressure
- C increasing the temperature
- D removing the ammonia as it is formed

[2012 M/J-11 (12)]

64.

Ammonia and chlorine react in the gas phase.



Which statements are correct?

- 1 Ammonia behaves as a reducing agent.
- 2 Ammonia behaves as a base.
- 3 The oxidation number of the hydrogen changes

[2012 M/J-11 (34)]

65.

In the manufacture of sulfuric acid the reaction  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$  usually takes place at  $400\text{ }^\circ\text{C}$  and 1 atm pressure. In one industrial plant, it is decided to change the pressure to 20 atm.

What will be the consequences of this change?

- 1 increased running costs
- 2 an increased percentage of sulfur trioxide in the equilibrium mixture
- 3 the rate of the backward reaction increases

[2012 M/J-11 (36)]

66.

In which substance does nitrogen exhibit the highest oxidation state?

- A NO            B  $\text{N}_2\text{O}$             C  $\text{N}_2\text{O}_4$             D  $\text{NaNO}_2$

[2012 M/J-12 (11)]

67.

Which gas is present in the exhaust fumes of a car engine in a much greater amount than any other gas?

- A carbon dioxide  
B carbon monoxide  
C nitrogen  
D water vapour

[2012 M/J-12 (13)]

68.

*Use of the Data Booklet is relevant to this question.*

Sodium and sulfur react together to form sodium sulfide,  $\text{Na}_2\text{S}$ .

How do the atomic radius and ionic radius of sodium compare with those of sulfur?

	atomic radius	ionic radius
A	sodium > sulfur	sodium > sulfur
B	sodium > sulfur	sodium < sulfur
C	sodium < sulfur	sodium > sulfur
D	sodium < sulfur	sodium < sulfur

[2012 M/J-12 (18)]

69.

Which substance does **not** produce a poisonous gas, when burnt in a limited amount of air?

- A hydrogen  
B methane  
C propene  
D sulfur

[2012 M/J-12 (19)]

70.

Which statements are true about the Haber process for the manufacture of ammonia?

- 1 At higher temperatures, the yield goes down but the rate of production of ammonia is faster.
- 2 At higher pressures, the yield goes down but the rate of production of ammonia is faster.
- 3 In the presence of a catalyst, the yield goes down but the rate of production of ammonia is faster.

[2012 M/J-12 (36)]

71.

In a car engine, non-metallic element  $X$  forms a pollutant oxide  $Y$ .  $Y$  can be further oxidised to  $Z$ . Two students made the following statements.

- Student P      The molecule of  $Y$  contains lone pairs of electrons.  
Student Q      The oxidation number of  $X$  increases by 1 from  $Y$  to  $Z$ .

$X$  could be carbon or nitrogen or sulfur.

Which student could be correct if  $X$  were any of these elements?

- A P only  
B Q only  
C both P and Q  
D neither P nor Q

[2012 O/N-11 (16)]

72.

How may nitrogen exist in compounds?

- 1 bonded by a triple covalent bond  
2 as part of a cation  
3 having lost 3 electrons to form an anion

[2012 O/N-11 (31)]

73.

Which equations represent stages in the Contact process for manufacturing sulfuric acid?

- 1  $\text{SO}_2 + \frac{1}{2} \text{O}_2 \rightarrow \text{SO}_3$   
2  $\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3$   
3  $\text{H}_2\text{SO}_3 + \frac{1}{2} \text{O}_2 \rightarrow \text{H}_2\text{SO}_4$

[2012 O/N-11 (35)]

74.

Mohr's salt is a pale green crystalline solid which is soluble in water. It contains two cations, one of which is  $\text{Fe}^{2+}$  and one anion which is  $\text{SO}_4^{2-}$ .

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

A grey-green solid residue was also formed which was insoluble in water.

What are the identities of the gas and the solid residue?

	gas	residue
A	$\text{NH}_3$	$\text{Fe}(\text{OH})_2$
B	$\text{NH}_3$	$\text{Na}_2\text{SO}_4$
C	$\text{SO}_2$	$\text{Fe}(\text{OH})_2$
D	$\text{SO}_2$	$\text{Na}_2\text{SO}_4$

[2012 O/N-13 (13)]

75.

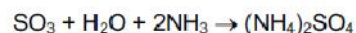
In the Haber process, the reaction between the two gaseous reactants requires the use of a catalyst that contains a transition element.

What is the metal and in what mole ratio do the gases react?

	metal	mole ratio
A	Fe	1:2
B	Fe	1:3
C	V	1:2
D	V	1:3

[2012 O/N-13 (17)]

76. Deposits of ammonium sulfate have been discovered in areas of high atmospheric pollution. They are believed to arise from the following reaction.



What does **not** occur in this reaction?

- A acid/base neutralisation
- B dative bond formation
- C ionic bond formation
- D oxidation/reduction

[2012 O/N-13 (19)]

77. How may nitrogen exist in compounds?

- 1 bonded by a triple covalent bond
- 2 as part of a cation
- 3 in an oxidation state of +5

[2012 O/N-13 (31)]

78. Sulfur trioxide is manufactured from sulfur dioxide and oxygen, using the Contact process.

Which condition affects the value of the equilibrium constant,  $K_c$ ?

- A adjusting the temperature
- B increasing the pressure
- C removing  $\text{SO}_3$  from the equilibrium mixture
- D using a catalyst

[2013 M/J-11 (18)]

79. Which reagent, when mixed and heated with ammonium sulfate, liberates ammonia?

- A aqueous bromine
- B dilute hydrochloric acid
- C limewater
- D potassium dichromate(VI) in acidic solution

[2013 M/J-11 (19)]

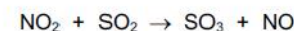
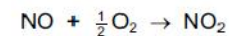
80. Which statement about ammonia is completely correct?

- A Ammonia acts as a nucleophile by accepting a pair of electrons when it reacts with bromoethane.
- B Ammonia can form a co-ordinate bond with a hydrogen ion to form an ammonium ion.
- C Ammonia is a base and accepts hydroxide ions.
- D The shape of the ammonia molecule is pyramidal with bond angles of  $109.5^\circ$ .

[2013 M/J-12 (17)]

81. Sulfur dioxide is an atmospheric pollutant that causes acid rain. One of the reactions in this process is the oxidation of sulfur dioxide to sulfur trioxide.

This oxidation takes place by a two stage reaction involving oxygen and nitrogen monoxide, NO.



Which statements are correct?

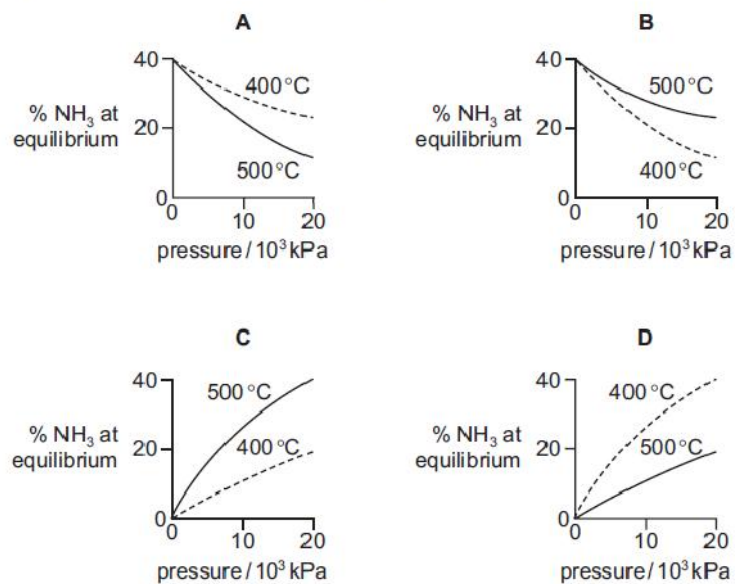
- 1 Nitrogen monoxide is acting as a catalyst for the oxidation.
- 2 Nitrogen atoms are oxidised in the second stage.
- 3 Oxygen atoms are first reduced and are then oxidised.

[2013 M/J-12 (36)]

82.

Graphs can be drawn to show the percentage of ammonia at equilibrium when nitrogen and hydrogen are mixed at different temperatures and pressures.

Which diagram correctly represents these two graphs?



[2013 M/J-13 (17)]

83.

In a famous experiment, Wöhler heated 'inorganic' ammonium cyanate in the absence of air. The only product of the reaction was 'organic' urea,  $\text{CO}(\text{NH}_2)_2$ . No other products were formed in the reaction.

What is the formula of the cyanate ion present in ammonium cyanate?

- A  $\text{CNO}^-$       B  $\text{CNO}^{2-}$       C  $\text{CO}^-$       D  $\text{NO}^-$

[2013 M/J-13 (18)]

84.

Transition elements and their compounds are important as catalysts.

In which process is a transition element compound used, rather than the element itself?

- A catalytic converters  
 B Contact process  
 C Haber process  
 D hydrogenation of oils

[2013 M/J-13 (19)]

85.

Element J is a solid. It occurs as a contaminant of fossil fuels.

Its oxide K is formed in car engines.

In the atmosphere, K can be further oxidised to L.

Which statements about J, K and L are correct?

- Atoms of J have paired p electrons.
- The atmospheric oxidation of K to L is a catalysed reaction.
- With water, L forms a strong acid.

[2013 M/J-13 (36)]

86.

Transition metals and their compounds are used as catalysts.

Which row is correct?

	transition metal present in the catalyst used in the Contact process	transition metal present in the catalyst used in the Haber process
A	iron	iron
B	iron	vanadium
C	vanadium	iron
D	vanadium	vanadium

[2013 O/N-11 (18)]



87.

Sulfur dioxide and sulfites are used in food preservation.

Why are they used for this purpose?

- 1 They are reducing agents which slow down the oxidation of food.
- 2 They inhibit the growth of aerobic bacteria.
- 3 They react with  $\text{NO}_2(\text{g})$  converting it to  $\text{NO}(\text{g})$ .

[2013 O/N-11 (36)]

88.

Ammonia exists as simple covalent molecules,  $\text{NH}_3$ . Ammonia can react with suitable reagents to form products containing ammonium ions,  $\text{NH}_4^+$ . Ammonia can also react with suitable reagents to form products containing amide ions,  $\text{NH}_2^-$ .

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

- A ammonia molecules, ammonium ions and amide ions
- B ammonia molecules and ammonium ions only
- C ammonia molecules only
- D ammonium ions only

[2013 O/N-13 (15)]

89.

Carbon, nitrogen and sulfur are non-metals.

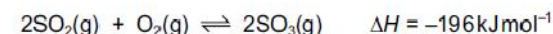
Which statement about their oxides,  $\text{XO}_2$ , is correct? (Where X represents carbon, nitrogen or sulfur.)

- A All of the  $\text{XO}_2$  molecules are linear.
- B In  $\text{XO}_2$ , each element has its highest oxidation number.
- C All  $\text{XO}_2$  molecules dissolve in water to form dibasic acids.
- D All  $\text{XO}_2$  molecules are formed as a result of burning petrol in a car engine.

[2013 O/N-13 (16)]

90.

The Contact process is used in the manufacture of sulfuric acid. The equation for the main reaction is shown below.



Which statement about this reaction is **incorrect**?

- A Increased pressure gives a higher yield of  $\text{SO}_3$ .
- B Increased temperature gives a higher yield of  $\text{SO}_3$ .
- C In the forward reaction the oxidation state of sulfur changes from +4 to +6.
- D Vanadium(V) oxide is used as a catalyst.

[2014 M/J-11 (7)]

91.

Use of the Data Booklet is relevant to this question.

A chemist took  $2.00\text{ dm}^3$  of nitrogen gas, measured under room conditions, and reacted it with a large volume of hydrogen gas, in order to produce ammonia. Only 15.0% of the nitrogen gas reacted to produce ammonia.

What mass of ammonia was formed?

- A 0.213g      B 0.425g      C 1.42g      D 2.83g

[2014 M/J-11 (18)]

92.

Pollutant oxide **Y**, which contains non-metallic element **X**, is formed in a car engine.

Further oxidation of **Y** to **Z** occurs in the atmosphere. In this further oxidation, 1 mol of **Y** reacts with 0.5 mol of gaseous oxygen molecules.

**X** could be either nitrogen or sulfur.

Which statements about **X**, **Y** and **Z** can be correct?

- 1 The oxidation number of **X** increases by two from **Y** to **Z**.
- 2 **Y** has an unpaired electron in its molecule.
- 3 **Y** is a polar molecule.

[2014 M/J-11 (35)]

93. Ammonium sulfate in the soil is slowly oxidised by air, producing sulfuric acid, nitric acid and water as the only products.

How many moles of oxygen gas are needed for the complete oxidation of one mole of ammonium sulfate?

- A 1                      B 2                      C 3                      D 4

[2014 M/J-12 (14)]

94.

A car has a catalytic converter fitted to its exhaust. On analysis its exhaust gases are shown to contain small quantities of nitrogen oxides.

Which modifications would result in lower exhaust concentrations of nitrogen oxides?

- 1 an increase in the surface area of the catalyst in the converter
- 2 an increase in the rate of flow of the exhaust gases through the converter
- 3 a much higher temperature of combustion in the engine

[2014 M/J-12 (36)]

95.

Which statements explain why sulfur dioxide is used as a food preservative?

- 1 It is a reducing agent and therefore an anti-oxidant.
- 2 It prevents alcohols in foods forming sour-tasting acids.
- 3 It does not smell and therefore can be used in large quantities.

[2014 M/J-13 (35)]

96.

Total removal of the pollutant sulfur dioxide,  $\text{SO}_2$ , is difficult. The quantities emitted from furnace chimneys can be lowered by using desulfurisation plants. The gases are reacted with calcium hydroxide to remove the  $\text{SO}_2$ .

What is the main product formed initially?

- A  $\text{Ca}(\text{HSO}_4)_2$     B  $\text{CaS}$                       C  $\text{CaSO}_3$                       D  $\text{CaSO}_4$

[2014 O/N-11 (18)]

97.

Element X is a solid. It is found in some fuels.

Its oxide Y is formed in car engines. Y is acidic.

Further oxidation of Y to Z can occur in the atmosphere.

Which statements about Y and Z are correct?

- 1 Molecule Y has lone pairs of electrons.
- 2 The atmospheric oxidation of Y to Z is a catalysed reaction.
- 3 Y is a colourless gas.

[2014 O/N-13 (36)]