Q1 A mixture of the oxides of two elements of the third period is dissolved in water. The solution is approximately neutral.
What could be the constituents of the mixture?
A Al_2O_3 and MgO
B Na_2O and MgO
C Na_2O and P_4O_{10}
D SO_3 and P_4O_{10}

Q2 Aluminium chloride catalyses certain reactions by forming carbocations (carbonium ions) with chloroalkanes as shown.

$$RCl + AlCl_3 \rightarrow R^+ + AlCl_4^-$$

Which property makes this reaction possible?
A $AlCl_3$ is a covalent molecule.
B $AlCl_3$ exists as the dimer Al_2Cl_6 in the vapour.
C The aluminium atom in $AlCl_3$ has an incomplete octet of electrons.
D The chlorine atom in RCl has a vacant p orbital.

Q3 What are the products of the thermal decomposition of magnesium nitrate?
A magnesium nitride and oxygen
B magnesium oxide and nitrogen
C magnesium oxide, nitrogen and oxygen
D magnesium oxide, nitrogen dioxide and oxygen

Q4 Chlorine compounds show oxidation states ranging from –1 to +7.
What are the reagent(s) and conditions necessary for the oxidation of elemental chlorine into a compound containing chlorine in the +5 oxidation state?
A $AgNO_3$(aq) followed by NH_3(aq) at room temperature
B concentrated H_2SO_4 at room temperature
C cold dilute NaOH(aq)
D hot concentrated NaOH(aq)

Q5 Which gaseous hydride most readily decomposes into its elements on contact with a hot glass rod?
A ammonia
B hydrogen chloride
C hydrogen iodide
D steam

Q6 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)

Q7 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** C_8H_{18} **C** CO **D** NO

Q8 Which of these equations represents the reaction of sulphur dioxide with an excess of aqueous sodium hydroxide?
A $SO_2 + NaOH \_ NaHSO_3$
B $SO_2 + 2NaOH \_ Na_2SO_3 + H_2O$
C $SO_2 + 2NaOH \_ Na_2SO_4 + H_2O$

D $SO_2 + 2NaOH$ _ $Na_2SO_4 + H_2$

Q9 Which ion is most polarising?
A Al^{3+}
B Ba^{2+}
C Mg^{2+}
D Na^{+}

Q10 Which element has the same oxidation number in all of its known compounds?
A beryllium
B chlorine
C nitrogen
D sulphur

Q11 Due to their similar ionic radii, the reactions of lithium and magnesium and their corresponding compounds are very similar.
Which statement concerning the reactions of lithium and its compounds is correct?
A Lithium carbonate decomposes on heating at a relatively low temperature, forming lithium oxide and carbon dioxide.
B Lithium nitrate decomposes on heating, forming lithium nitrite and oxygen.
C Lithium only burns slowly in oxygen.
D Lithium reacts violently with cold water, liberating hydrogen.

Q12 Which statement is most likely to be true for astatine, which is below iodine in Group VII of the Periodic Table?
A Astatine and aqueous potassium chloride react to form aqueous potassium astatide and chlorine.
B Potassium astatide and hot dilute sulphuric acid react to form white fumes of only hydrogen astatide.
C Silver astatide reacts with dilute aqueous ammonia in excess to form a solution of a soluble complex.
D Sodium astatide and hot concentrated sulphuric acid react to form astatine.

Q13 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

Q14 The following species contain the same number of electrons.
In which order do their radii increase?

	smallest radius ⟶		largest radius
A	Ar	K^+	Ca^{2+}
B	Ca^{2+}	Ar	K^+
C	Ca^{2+}	K^+	Ar
D	K^+	Ar	Ca^{2+}

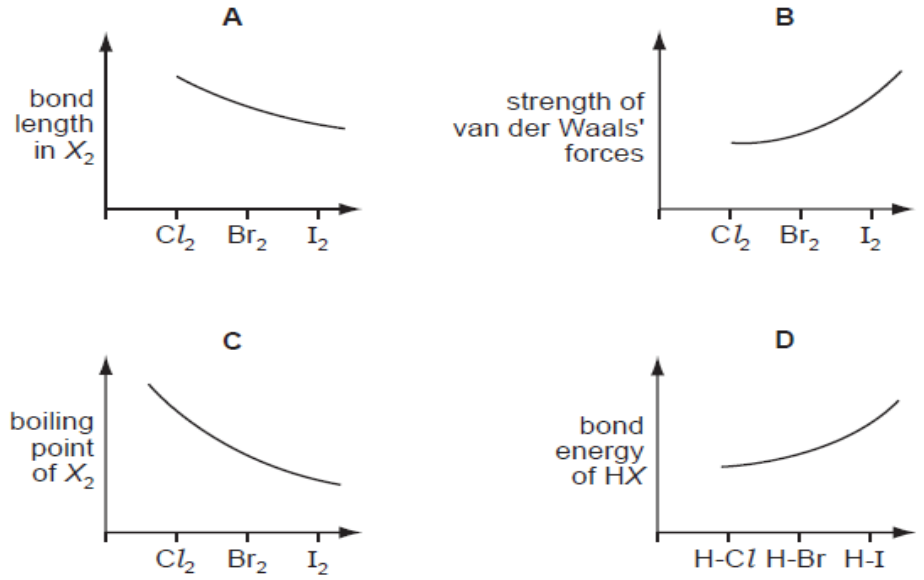
Q15 Use of the Data Booklet is relevant to this question.
Which element is likely to have an electronegativity similar to that of aluminium?

A barium
B beryllium
C magnesium
D strontium

Q16 Use of the Data Booklet is relevant to this question.
Which is true for calcium or its compounds compared with the corresponding statements for magnesium?
A Calcium has a smaller atomic radius.
B Calcium oxide reacts less vigorously with water.
C Calcium reacts more vigorously with water.
D The sum of the first two ionisation energies of calcium is greater.

Q17 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

Q18 Which graph correctly describes a trend found in the halogen group?



Q19 Limestone, $CaCO_3$, has been used as a building material for thousands of years, and was used on the Pyramids in Egypt. In the past hundred years many limestone buildings have begun to suffer damage.
What is the cause of this damage?
A hydrocarbon emissions from motor vehicles
B increased temperature due to global warming
C increased ultraviolet radiation as the ozone layer is destroyed
D sulphur dioxide from fossil fuels forming ‘acid rain’

Q20 In an historically famous experiment Wöhler heated “inorganic” ammonium cyanate in the absence of air. The only product of the reaction was “organic” urea, $CO(NH_2)_2$. No other products were formed in the reaction.

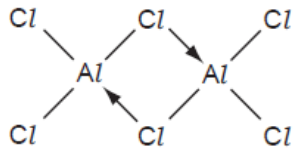
What is the formula of the cyanate ion present in ammonium cyanate?
A CNO^- B CNO_2^- C CO^- D NO^-

Q21 In which pair is the radius of the second atom greater than that of the first atom?
A Na, Mg B Sr, Ca C P, N D Cl, Br

Q22 The oxide and chloride of an element X are separately mixed with water. The two resulting solutions have the same effect on litmus.
What is element X?
A sodium
B magnesium
C aluminium
D phosphorus

Q23 Aluminium chloride sublimes at 178 °C.
Which structure best represents the species in the vapour at this temperature?

A



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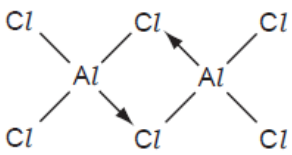

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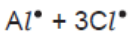
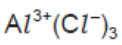


D



Q24 Use of the Data Booklet is relevant to this question.
What mass of solid residue can be obtained from the thermal decomposition of 4.10 g of anhydrous calcium nitrate?
A 0.70 g B 1.00 g C 1.40 g D 2.25 g

Q25 What happens when chlorine is bubbled through aqueous potassium iodide?
A Chlorine is oxidised to chloride ions.
B Hydrochloric acid is formed.
C Iodide ions are oxidised to iodine.
D Potassium iodide is reduced to iodine.

Q26 The emissions from a power station contain about 14 tonnes of SO_2 per hour from the oxidation of FeS_2 contained in the coal.
What is the most practical way of preventing the SO_2 from being released into the atmosphere?
A Cool the gases and the SO_2 will liquefy and can be removed.
B Dissolve the ionic 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 SO_2.

Q27 he gaseous oxides of nitrogen have positive enthalpy changes of formation.
Which factor is likely to make the most significant contribution to these enthalpy changes?
A the high bond energy of the nitrogen molecule, N_2
B the high electron affinity of nitrogen atoms
C the high electron affinity of oxygen atoms
D the similarity of the electronegativities of oxygen and nitrogen

Q28 Which chlorine compound has bonding that can be described as ionic with some covalent character?
A $NaCl$ B $MgCl_2$ C $AlCl_3$ D $SiCl_4$

Q29 $Al\,Cl_3$ reacts with $LiAl\,H_4$ and $(CH_3)_3N$ to give $(CH_3)_3NAl\,H_3$.
Which statement about $(CH_3)_3NAl\,H_3$ is correct?
A It contains hydrogen bonding.
B It is dimeric.
C The Al atom has an incomplete octet of electrons.
D The bonds around the Al atom are tetrahedrally arranged.

Q30 Slaked lime, $Ca(OH)_2$, may be made from limestone, $CaCO_3$.
On heating in a lime kiln at 1000 °C, limestone decomposes as follows.
reaction 1 $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
Water is then reacted with calcium oxide, CaO, as follows.
reaction 2 $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$
What are the enthalpy changes of these reactions?

	reaction 1	reaction 2
A	endothermic	endothermic
B	endothermic	exothermic
C	exothermic	endothermic
D	exothermic	exothermic

Q31 The standard enthalpy changes of formation of HCl and HI are –92 kJ mol^{-1} and +26 kJ mol^{-1} respectively.
Which statement is most important in explaining this difference?
A Chlorine is more electronegative than iodine.
B The activation energy for the H_2 / Cl_2 reaction is much less than that for the H_2 / I_2 reaction.
C The bond energy of HI is smaller than the bond energy of HCl.
D The bond energy of I_2 is smaller than the bond energy of Cl_2.

Q32 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 NO_3 B NHO_3 C NH_2O D $N_2H_4O_3$

Q33 In an experiment, 0.1 g samples of Na_2O, MgO, P_4O_{10} and SO_2 are added to separate 100 cm_3 volumes of water.
For which oxide is the resulting mixture most alkaline?
A Na_2O B MgO C P_4O_{10} D SO_2

Q34 Which element is expected to show the greatest tendency to form some covalent compounds?
A aluminium
B calcium
C magnesium
D sodium

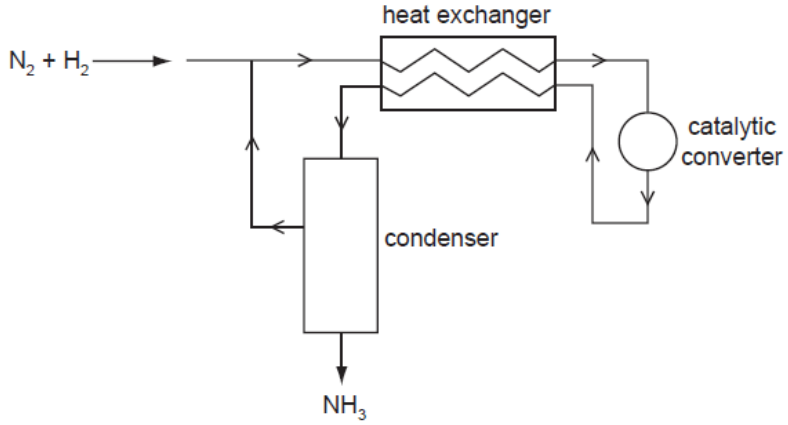
Q35 Use of the Data Booklet is relevant to this question.

The combustion of fossil fuels is a major source of increasing atmospheric carbon dioxide, with a consequential rise in global warming. Another significant contribution to carbon dioxide levels comes from the thermal decomposition of limestone, in the manufacture of cement and of lime for agricultural purposes.
Cement works roast 1000 million tonnes of limestone per year and a further 200 million tonnes is roasted in kilns to make lime.
What is the total annual mass output of carbon dioxide (in million tonnes) from these two processes?
A 440 B 527 C 660 D 880

Q36 Properties of chlorine, iodine and their compounds are compared.
Property Q for chlorine is smaller than for iodine.
What is property Q?
A oxidising ability of the element
B solubility of the silver halide in $NH_3(aq)$
C strength of van der Waals' forces between the molecules of the element
D thermal stability of the hydrogen halide

Q37 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)

Q38 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

Q39 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 $CaSO_4$

Q40 In some fireworks there is a reaction between powdered aluminium and powdered barium nitrate in which heat is evolved and an unreactive gas is produced.
What is the equation for this reaction?

A $2Al + Ba(NO_3)_2 \rightarrow Al_2O_3 + BaO + 2NO$
B $4Al + 4Ba(NO_3)_2 \rightarrow 2Al_2O_3 + 4Ba(NO_2)_2 + O_2$
C $10Al + 3Ba(NO_3)_2 \rightarrow 5Al_2O_3 + 3BaO + 3N_2$
D $10Al + 18Ba(NO_3)_2 \rightarrow 10Al(NO_3)_3 + 18BaO + 3N_2$

Q41 Which group of particles is in order of increasing size?

A	N	O	F
B	N^{3-}	O^{2-}	F^-
C	Na^+	Mg^{2+}	Al^{3+}
D	Na^+	Ne	F^-

Q42

River water in a chalky agricultural area may contain Ca^{2+}, Mg^{2+}, CO_3^{2-}, HCO_3^-, Cl^- and NO_3^- ions. In a waterworks, such water is treated by adding a calculated quantity of calcium hydroxide.

What will be precipitated following the addition of calcium hydroxide?

A $CaCl_2$
B $CaCO_3$
C $Ca(NO_3)_2$
D $Mg(NO_3)_2$

Q43 Over half a million tonnes of bromine are manufactured annually and are mainly used for making other compounds. One important use is for agricultural chemicals.
What is another important use for bromine?
A antiseptic agents
B bleaches for textiles and the paper industry
C flame-retardants and fire extinguishers
D water purification

Q44 In black and white photographic film, light converts silver chloride into metallic silver. After the film has been developed, the unreacted silver chloride is removed by reaction with sodium thiosulfate to produce a 'fixed' negative.
$AgCl + 2Na_2S_2O_3 \rightarrow 4Na^+ + Cl^- + [Ag(S_2O_3)_2]^{3-}$
What is the function of the thiosulfate ion?
A to make the silver ions soluble
B to oxidise the silver ions
C to oxidise the silver metal
D to reduce the silver ions

Q45 Which statement is most likely to be true for astatine, which is below iodine in Group VII of the Periodic Table?
A Astatine and aqueous potassium chloride react to form aqueous potassium astatide and chlorine.
B Potassium astatide and hot dilute sulfuric acid react to form white fumes of only hydrogen astatide.
C Silver astatide reacts with dilute aqueous ammonia in excess to form a solution of a soluble
complex.
D Sodium astatide and hot concentrated sulfuric acid react to form astatine.

Q46 Deposits of ammonium compounds have been discovered in areas of high atmospheric pollution. They are believed to arise from the following reaction.

$SO_3 + H_2O + 2NH_3 \rightarrow (NH_4)_2SO_4$

What does not occur in this reaction?

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

Q47 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 Fe^{2+}.

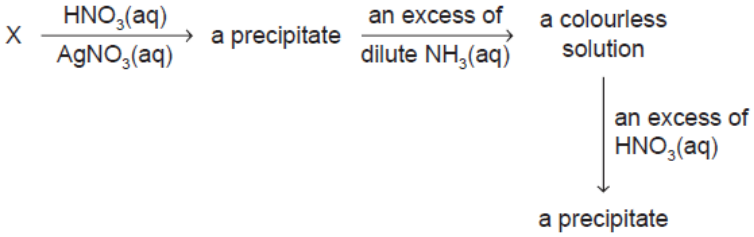
The identity of the second cation was determined by heating solid Mohr's salt with solid sodium hydroxide and a colourless gas was evolved. The gas readily dissolved in water giving an alkaline solution. A grey-green solid residue was also formed which was insoluble in water. What are the identities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

	gas	residue
A	H_2	$FeSO_4$
B	NH_3	Na_2SO_4
C	NH_3	$Fe(OH)_2$
D	SO_2	$Fe(OH)_2$

Q48 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

Q49 X is a salt of one of the halogens chlorine, bromine, iodine, or astatine (proton number 85). The reaction scheme shows a series of reactions using a solution of X as the starting reagent.



What could X be?

A sodium chloride
B sodium bromide
C potassium iodide
D potassium astatide

Q50 Which element of the third period requires the least number of moles of oxygen for the complete combustion of 1 mol of the element?

A aluminium
B magnesium
C phosphorus
D sodium

Q51 Two properties of non-metallic elements and their atoms are as follows.

property 1 has an oxide that can form a strong acid in water

property 2 has no paired 3p electrons
Which properties do phosphorus and sulfur have?

	phosphorus	sulfur
A	1 and 2	1 only
B	1 only	1 and 2
C	1 and 2	1 and 2
D	2 only	1 only

Q52 Consecutive elements X, Y, Z are in the third period of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point.
What could be the identities of X, Y and Z?
A aluminium, silicon, phosphorus
B magnesium, aluminium, silicon
C silicon, phosphorus, sulfur
D sodium, magnesium, aluminium

Q53 Which property of Group II elements (beryllium to barium) decreases with increasing atomic number?
A reactivity with water
B second ionisation energy
C solubility of hydroxides
D stability of the carbonates

Q54 0.02 mol of aluminium is burned in oxygen and the product is reacted with 2.00 mol dm^3 hydrochloric acid.
What minimum volume of acid will be required for complete reaction?
A 15 cm^3 B 20 cm^3 C 30 cm^3 D 60 cm^3

Q55 Steam is passed over heated magnesium to give compound X and hydrogen.
What is not a property of compound X?
A It has an M_r of 40.3.
B It is basic.
C It is a white solid.
D It is very soluble in water.

Q56 X, Y and Z represent different halogens. The table shows the results of nine experiments in which aqueous solutions of X_2, Y_2 and Z_2 were separately added to separate aqueous solutions containing X^-, Y^- and Z^- ions.

	$X^-(aq)$	$Y^-(aq)$	$Z^-(aq)$
$X_2(aq)$	no reaction	no reaction	no reaction
$Y_2(aq)$	X_2 formed	no reaction	Z_2 formed
$Z_2(aq)$	X_2 formed	no reaction	no reaction

Which row in the following table contains the ions X^-, Y^- and Z^- in order of their decreasing strength as reducing agents?

	strongest →		weakest
A	X^-	Y^-	Z^-
B	X^-	Z^-	Y^-
C	Y^-	Z^-	X^-
D	Z^-	X^-	Y^-

Q57 A student observed the reactions when sodium chloride and sodium iodide were each reacted separately with concentrated sulfuric acid and with concentrated phosphoric acid. The observations are recorded in the table.

	sodium chloride	sodium iodide
conc. H_2SO_4	colourless acidic gas formed	purple vapour formed
conc. H_3PO_4	colourless acidic gas formed	colourless acidic gas formed

Which deduction can be made from these observations?
A Concentrated phosphoric acid is a stronger oxidising agent than concentrated sulfuric acid.
B Concentrated phosphoric acid is a stronger oxidising agent than iodine.
C Concentrated sulfuric acid is a stronger oxidising agent than chlorine.
D Concentrated sulfuric acid is a stronger oxidising agent than iodine.

Q58 Ammonium nitrate, NH_4NO_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.

Q59 Nitrogen monoxide, 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 $NO(g) + CO(g) \rightarrow NO_2(g) + C(s)$
B $NO(g) + CO_2(g) \rightarrow NO_2(g) + CO(g)$
C $2NO(g) + 2CO(g) \rightarrow N_2(g) + 2CO_2(g)$
D $2NO(g) + CO_2(g) \rightarrow 2NO_2(g) + C(s)$

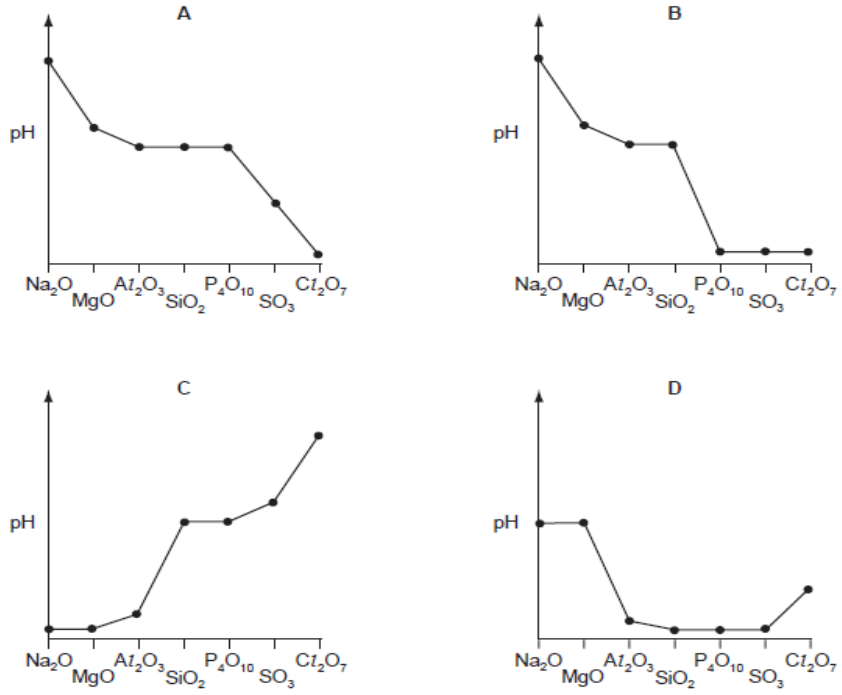
Q60 Use of the Data Booklet is relevant to this question.
Which element is likely to have an electronegativity similar to that of aluminium?
A barium
B beryllium
C magnesium
D strontium

Q61 In 1999, researchers working in the USA believed that they had made a new element and that it had the following electronic configuration.

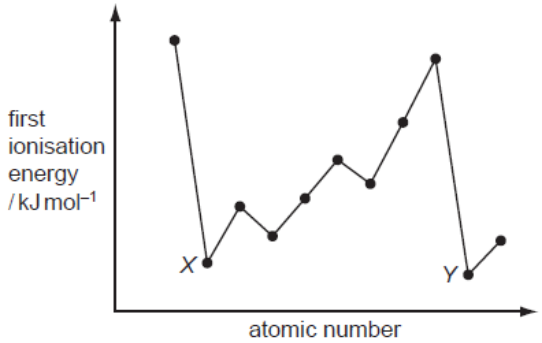
$$[Rn]\ 5f^{14}6d^{10}7s^{2}7p^{6}$$

In which Group of the Periodic Table would you expect to find this element?
A II B IV C VI D 0

Q62 The highest oxides of the elements sodium to chlorine are separately added to water.
Which diagram best represents the pH of the resulting mixtures?



Q63 The diagram shows the first ionisation energies of 11 consecutive elements.



Which type of elements are labelled X and Y ?
A Group I metals
B Group II metals
C halogens
D noble gases

Q64 Why does aluminium oxide dissolve in sodium hydroxide solution?
A Aluminium oxide can behave as a base.
B Aluminium oxide can behave as an acid.
C Aluminium oxide has a giant structure.
D The bonding in aluminium oxide is ionic.

Q65 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

Q66 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	V_2O_5
C	basic	Fe
D	basic	V_2O_5

Q67 Which compound contains two different elements with identical oxidation states?
A HCl O B $Mg(OH)_2$ C Na_2SO_4 D NH_4Cl

Q68 Aluminium chloride catalyses certain reactions by forming carbocations with chloroalkanes as shown.

$$RCl + AlCl_3 \rightarrow R^+ + AlCl_4^-$$

Which property makes this reaction possible?
A $Al Cl_3$ exists as the dimer Al_2Cl_6 in the vapour.
B $Al Cl_3$ is a covalent molecule.
C The aluminium atom in $Al Cl_3$ has an incomplete octet of electrons.
D The chlorine atom in RCl has a vacant p orbital.

Q69 Use of the Data Booklet is relevant to this question.
When a mineral was heated in a Bunsen flame to constant mass, a colourless gas that turned lime water milky was evolved. The remaining solid was cooled and then added to aqueous hydrochloric acid. Vigorous effervescence was seen.
What was the mineral?
A aragonite, $CaCO_3$
B artinite, $MgCO_3.Mg(OH)_2.3H_2O$
C barytocalcite, $BaCO_3.CaCO_3$
D dolomite, $CaCO_3.MgCO_3$

Q70 Use of the Data Booklet is relevant to this question.
The reaction between aluminium powder and anhydrous barium nitrate is used as the propellant in some fireworks. The metal oxides and nitrogen are the only products.
Which volume of nitrogen, measured under room conditions, is produced when 0.783 g of anhydrous barium nitrate reacts with an excess of aluminium?
A 46.8 cm_3 B 72.0 cm_3 C 93.6 cm_3 D 144 cm_3

Q71 The oxides BaO, CaO, MgO and SrO all produce alkaline solutions when added to water. Which oxide produces the saturated solution with the highest pH?
A BaO(aq) B CaO(aq) C MgO(aq) D SrO(aq)

Q72 What trend is observed on descending Group VII?
A The colours of the elements become lighter.
B The elements become more volatile.
C The hydrides of the elements become more thermally stable.
D The reactions of the elements with hydrogen become less vigorous.

Q73 The following two experiments are carried out with anhydrous potassium chloride and observations X and Y are made at the end of each experiment.
Concentrated sulfuric acid is added to the potassium chloride and the fumes produced are bubbled into aqueous potassium iodide solution - observation X.
The potassium chloride is dissolved in aqueous ammonia and this is then added to aqueous silver nitrate - observation Y. What are the observations X and Y?

	X	Y
A	brown solution	colourless solution
B	brown solution	white precipitate
C	colourless solution	colourless solution
D	colourless solution	white precipitate

Q74 Carbon monoxide, CO, nitrogen monoxide, NO, and sulfur dioxide, SO_2, may all be present in the exhaust fumes from a car engine.
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

Q75 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

Q76 The period 4 elements gallium (Ga), germanium (Ge), arsenic (As) and selenium (Se) are the elements below aluminium, silicon, phosphorus and sulfur in the Periodic Table, a portion of which is shown below.

period 3 elements	Al	Si	P	S
period 4 elements	Ga	Ge	As	Se

The properties of each period 4 element resemble those of the period 3 element directly above it.
Which period 4 elements form oxides that dissolve in water to give an acid solution?
A As and Se B Ga and Ge C Ga and Se D Se only

Q77 What can be seen when a piece of magnesium ribbon is placed in cold water?
A A vigorous effervescence occurs.
B Bubbles of gas form slowly on the magnesium.
C The magnesium floats on the surface of the water and reacts quickly.
D The magnesium glows and a white solid is produced.

Q78 Use of the Data Booklet is relevant to this question.
Sodium and sulfur react together to form sodium sulfide, Na_2S.
How do the atomic radius and ionic radius of sodium compare with those of sulfur?

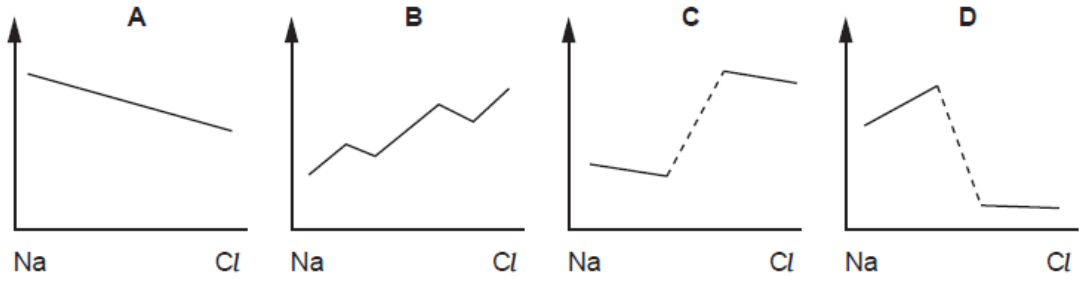
	atomic radius	ionic radius
A	sodium > sulfur	sodium > sulfur
B	sodium > sulfur	sodium < sulfur
C	sodium < sulfur	sodium > sulfur
D	sodium < sulfur	sodium < sulfur

Q79 Which substance does not produce a poisonous gas, when burnt in a limited amount of air?
A hydrogen
B methane

C propene
D sulfur

Q80 The chloride of element **Q** is hydrolysed by water to form an acidic solution and its oxide reacts with acid to form a salt.
What could be the element **Q**?
A magnesium
B aluminium
C silicon
D phosphorus

Q81 Which diagram represents the change in ionic radius of the elements across the third period (Na to Cl)?



Q82 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 NH_4Cl **B** NH_4ClO_3 **C** NH_4ClO_4 **D** N_2H_5Cl

Q83 The standard enthalpy changes of formation of HCl and HI are –92 kJ mol^{-1} and +26 kJ mol^{-1} respectively.
Which statement is **most** important in explaining this difference?
A Chlorine is more electronegative than iodine.
B The activation energy for the H_2/Cl_2 reaction is much less than that for the H_2/I_2 reaction.
C The bond energy of HI is smaller than the bond energy of HCl.
D The bond energy of I_2 is smaller than the bond energy of Cl_2.

Q84 The metals of Group II react readily with oxygen to form compounds of general formula MO.
When each of these oxides is added to water, which forms the most alkaline solution?
A MgO **B** CaO **C** SrO **D** BaO

Q85 One mole of each of the following compounds is strongly heated and any gas produced is collected at room temperature and pressure.
From which compound is $24dm^3$ of gas likely to be collected?
[One mole of any gas occupies $24dm^3$ at room temperature and pressure.]
A $MgCl_2$ **B** $MgCO_3$ **C** $Mg(NO_3)_2$ **D** $Mg(OH)_2$.

Q86 In black and white photographic film, light converts silver chloride into metallic silver. After the film has been developed, the unexposed silver chloride is removed by reaction with sodium thiosulphate to produce a 'fixed' negative.

$$AgCl + 2Na_2S_2O_3 \longrightarrow 4Na^+ + Cl^- + [Ag(S_2O_3)_2]^{3-}$$

What is the function of thiosulphate?
A to make the silver ions soluble
B to oxidise the silver ions

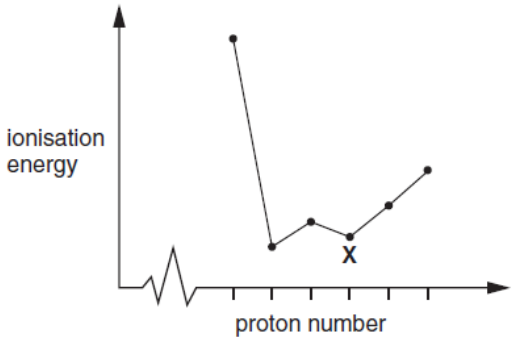
C to oxidise the silver metal
D to reduce silver ions

Q87 In what order does the reducing power of the hydrogen halides increase?
A HC*l*, HBr, HI
B HC*l*, HI, HBr
C HBr, HI, HC*l*
D HI, HBr, HC*l*

Q88 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

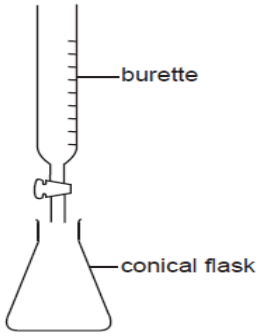
Q89 Nitrogen is frequently used as an inert atmosphere because it is an unreactive gas. Which is the best explanation of this unreactivity?
A Its molecule contains a triple bond.
B The bond energy of the molecule is high (994 kJ mol^{-1}).
C The bond in its molecule is very short (0.110 nm).
D The three p orbitals of nitrogen are half-filled.

Q90 The sketch below shows the variation of first ionisation energy with proton number for six elements of consecutive proton numbers between 1 and 18 (H to Ar).



What is the identity of the element **X**?
A Mg **B** A*l* **C** Si **D** P

Q91

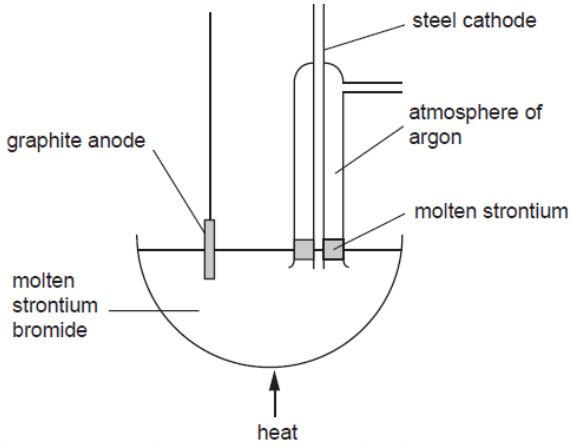


Which of these acid-base (neutralisation) reactions could be titrated using the apparatus shown above to give a sharp end-point?
A sulphuric acid and aluminium oxide
B sulphuric acid and magnesium hydroxide
C sulphuric acid and magnesium oxide
D sulphuric acid and sodium hydroxide

Q92 The species Ar, K^+ and Ca^{2+}
are isoelectronic (have the same number of electrons).
In what order do their radii increase?

	smallest → largest		
A	Ar	Ca^{2+}	K^+
B	Ar	K^+	Ca^{2+}
C	Ca^{2+}	K^+	Ar
D	K^+	Ar	Ca^{2+}

Q93 Strontium metal can be obtained by the electrolysis of molten strontium bromide, $SrBr_2$, using the apparatus shown in the diagram.



Why is an atmosphere of argon used around the cathode?
A The argon keeps the strontium molten.
B The argon stops the molten strontium rising too high in the tube.
C A thin film of a compound of strontium and argon forms on the surface protecting the freshly formed metal.
D Without the argon strontium oxide would form in the air

Q94 A weedkiller can be prepared by heating a bleach solution.

$$\underset{\text{bleach}}{3NaClO} \xrightarrow{\text{heat}} \underset{\text{weedkiller}}{2NaCl + NaClO_3}$$

What are the oxidation states of chlorine in these three compounds?
A –1 –1 +5
B +1 –1 +5
C +1 –1 +7
D +2 +1 +7

Q95 The following report appeared in a newspaper.
Drums of bromine broke open after a vehicle crash on the motorway. Traffic was diverted as purple gaseous bromine drifted over the road (it is denser than air), causing irritation to drivers' eyes. Firemen sprayed water over the scene of the accident, dissolving the bromine and washing it away.
What is wrong with the report?
A Bromine does not dissolve in water.
B Bromine does not vapourise readily.
C Bromine is less dense than air.
D Bromine is not purple.

Q96 Which reaction of ammonia does not involve the non-bonding pair of electrons on the nitrogen atom?

A $NH_3(g) + CH_3I(g) \rightarrow CH_3NH_3^+I^-(s)$

B $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$

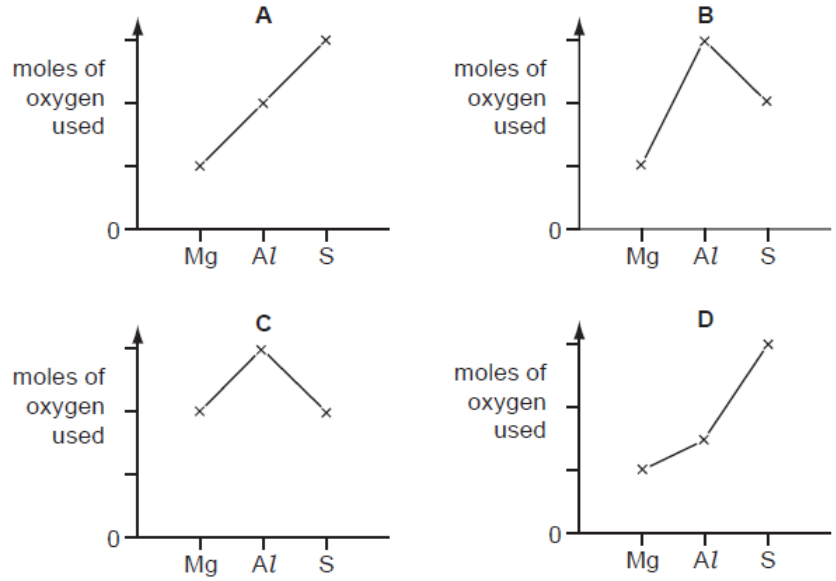
C $2NH_3(l) + 2Na(s) \rightarrow 2NaNH_2(s) + H_2(g)$

D $2NH_3(aq) + Ag^+(aq) \rightarrow [Ag(NH_3)_2]^+(aq)$

Q97 Ammonium sulphate in nitrogenous fertilisers in the soil can be slowly oxidised by air producing sulphuric acid, nitric acid and water.
How many moles of oxygen are needed to oxidise completely one mole of ammonium sulphate?

A 1 B 2 C 3 D 4

Q98 One mole of magnesium, aluminium and sulphur are each completely burned in an excess of oxygen gas.
Which graph shows the moles of oxygen used in each case?



Q99 Consecutive elements X, Y, Z are in Period 3 of the Periodic Table. Element Y has the highest first ionisation energy and the lowest melting point.
What could be the identities of X, Y and Z ?
A sodium, magnesium, aluminium
B magnesium, aluminium, silicon
C aluminium, silicon, phosphorus
D silicon, phosphorus, sulphur

Q100 Use of the Data Booklet is relevant to this question.
What volume of oxygen, measured under room conditions, can be obtained from the thermal decomposition of 8.2 g of calcium nitrate (M_r = 164)?

A 150 cm^3 B 300 cm^3 C 600 cm^3 D 1200 cm^3

Q101 Lime, 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 $CaSO_4$, formed on mixing, causes hard water.
C When dampened, ammonia is given off.

D Sulphuric acid will form.

Q102 Steam is passed over heated magnesium to give compound X and hydrogen.
What is not a property of compound X?
A It has a high melting point.
B It is a basic oxide.
C It is a white solid.
D It is very soluble in water.

Q103 A 5.00 g sample of an anhydrous Group II metal nitrate loses 3.29 g in mass on strong heating. Which metal is present?
A magnesium
B calcium
C strontium
D barium

Q104 Which of the following is not a correct statement about iodine?
A A crystal of iodine contains covalent bonds and van der Waals' forces.
B Iodine vapour is purple.
C The first ionisation energy of iodine is less than that of bromine.
D The hydride of iodine is of greater thermal stability than that of bromine.

Q105 Mixing aqueous silver nitrate and aqueous sodium chloride produces a precipitate. Addition of which reagent to the mixture gives a colourless solution?
A aqueous ammonia
B aqueous potassium iodide
C dilute hydrochloric acid
D dilute nitric acid

Q106 Which is the complete list of all the products from the reaction of concentrated sulphuric acid with potassium bromide?
A potassium hydrogensulphate and hydrogen bromide
B potassium hydrogensulphate, hydrogen bromide and bromine
C potassium hydrogensulphate, hydrogen bromide, bromine and water
D potassium hydrogensulphate, hydrogen bromide, bromine, water and sulphur dioxide

Q107 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.

Q108 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 ^{o}C and a pressure slightly above atmospheric pressure.

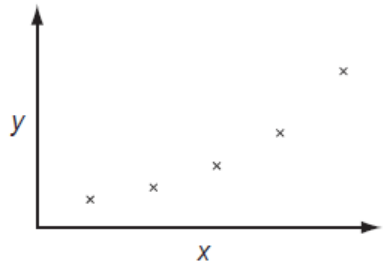
$$2SO_2 + O_2 \rightleftharpoons 2SO_3 \; ; \; \Delta H \text{ negative}$$

What affects the choice of conditions for this reaction?
A A lower temperature would not raise the concentration of SO_3 at equilibrium.
B At a lower temperature of 300^{o}C the V_2O_5 catalyst would not be effective.
C At 450^{o}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 ^{o}C at which temperature the reaction begins to take place.

Q109 When dangerous chemicals are transported by road, vehicles must carry signs that indicate what measures should be taken in the event of a spillage of the chemical carried.
Which material must be used if there were a spillage of metallic sodium?
A ethanol
B jets of water
C sand
D water spray

Q110 Which species has the largest radius?
A P^{3-}
B Cl^-
C Ar
D K^+

Q111 Use of the Data Booklet is relevant to this question.
The sketch graph shows the variation of one physical or chemical property with another for the Group II elements.



What are the correct labels for the axes?

	x-axis	*y*-axis
A	atomic number	mass number
B	atomic number	melting point
C	first ionisation energy	atomic number
D	first ionisation energy	atomic radius

Q112 The chemical properties of an element at the top of a group in the Periodic Table are often different from those of the rest of the elements in the group.
Of the following properties of beryllium and its compounds, which property is typical of the elements below it in Group II?
A Be does not react with hot water.
B $BeCl_2$ is covalent.
C $Be(NO_3)_2$ produces BeO on thermal decomposition.
D BeO dissolves in alkalis.

Q113 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.

Q114 Gaseous nitrogen is less reactive than gaseous fluorine.
What is the reason for this difference in reactivity?
A The boiling point of nitrogen is lower than that of fluorine.
B The relative molecular mass of nitrogen is lower than that of fluorine.
C The atomic radius of nitrogen is greater than that of fluorine.
D The bond strength in the molecule is greater in nitrogen than in fluorine.

Q115 Which oxide, when mixed with water, will produce the most acidic solution?
A CO B CO_2 C SiO_2 D P_2O_5

Q116 Which salt is produced by adding aqueous ammonia to aqueous sulphur dioxide until just alkaline?
A NH_4SO_3 B NH_4SO_4 C $(NH_4)_2SO_3$ D $(NH_4)_2SO_4$

Q117 Aluminium chloride catalyses certain reactions by forming carbocations (carbonium ions) with chloroalkanes as shown.

$$RCl + AlCl_3 \rightarrow R^+ + AlCl_4^-$$

Which property makes this reaction possible?
A $AlCl_3$ exists as the dimer Al_2Cl_6 in the vapour.
B $AlCl_3$ is a covalent molecule.
C The aluminium atom in $AlCl_3$ has an incomplete octet of electrons.
D The chlorine atom in RCl has a vacant p orbital.

Q118 Due to their similar ionic radii, the reactions of lithium and magnesium and their corresponding compounds are very similar.
Which statement concerning the reactions of lithium and its compounds is correct?
A Lithium carbonate decomposes on heating at a relatively low temperature, forming lithium oxide and carbon dioxide.
B Lithium nitrate decomposes on heating, forming lithium nitrite and oxygen.
C Lithium burns only slowly in oxygen.
D Lithium reacts violently with cold water, liberating hydrogen.

Q119 A student observed the reactions when sodium chloride and sodium iodide were each reacted separately with concentrated sulphuric acid and concentrated phosphoric acid. The observations are recorded in the table.

	sodium chloride	sodium iodide
conc. H_2SO_4	colourless acidic gas formed	purple vapour formed
conc. H_3PO_4	colourless acidic gas formed	colourless acidic gas formed

Which deduction can be made from these observations?
A Concentrated phosphoric acid is a stronger oxidising agent than concentrated sulphuric acid.
B Concentrated phosphoric acid is a stronger oxidising agent than iodine.
C Concentrated sulphuric acid is a stronger oxidising agent than chlorine.
D Concentrated sulphuric acid is a stronger oxidising agent than iodine.

Q120 When gaseous chemicals are transported by road or by rail they are classified as follows.
flammable non-flammable poisonous
Which gas is poisonous?
A butane
B carbon dioxide

C hydrogen
D sulphur dioxide

Q121 Which statement explains the observation that magnesium hydroxide dissolves in aqueous ammonium chloride, but not in aqueous sodium chloride?

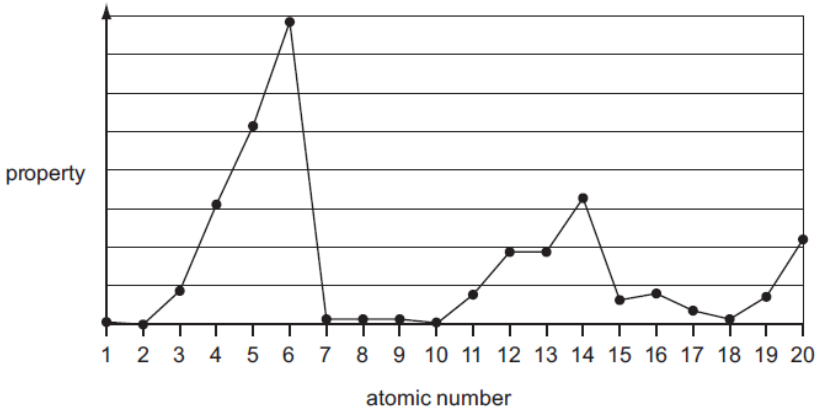
A The ionic radius of the NH_4^+ ion is similar to that of Mg^{2+} but not that of Na^+.

B NH_4Cl dissociates less fully than $NaCl$.

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

D The NH_4^+ ion acts as an acid.

Q122 The following graph shows the variation of a property of the first 20 elements in the Periodic Table with the atomic number of the element.

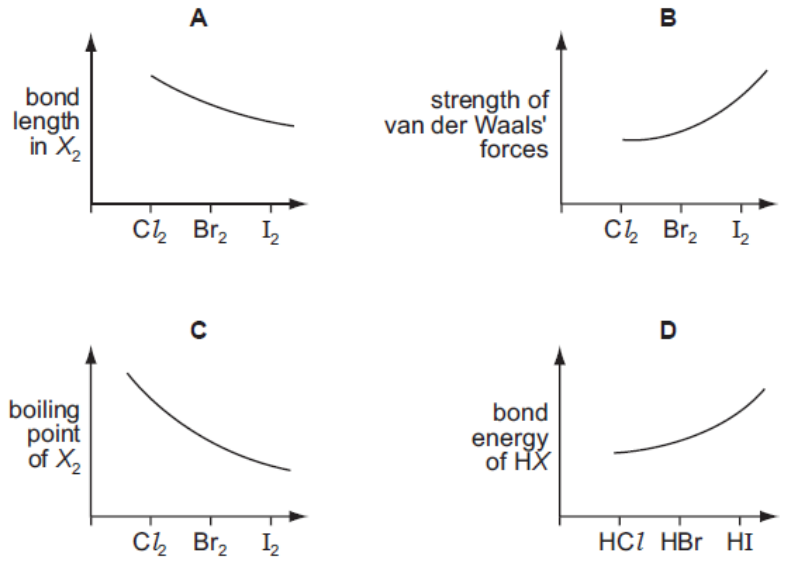


What is the property?
A atomic radius
B first ionisation energy
C ionic radius
D melting point

Q123 Which statement correctly describes what happens when silicon tetrachloride is added to water?
A The $SiCl_4$ dissolves to give a neutral solution only.
B The $SiCl_4$ reacts to give an acidic solution only.
C The $SiCl_4$ reacts to give a precipitate and an acidic solution.
D The $SiCl_4$ reacts to give a precipitate and a neutral solution.

Q124 The oxide and chloride of an element X are separately mixed with water. The two resulting solutions have the same effect on litmus.
What is element X?
A sodium
B magnesium
C aluminium
D phosphorus

Q125 Which graph correctly describes a trend found in the halogen group?
[X represents a halogen atom.]



Q126 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 SO_3 from the equilibrium mixture

Q127 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

Q128 In an historically famous experiment Wöhler heated 'inorganic' ammonium cyanate in the absence of air. The only product of the reaction was 'organic' urea, $CO(NH_2)_2$. No other products were formed in the reaction.
What is the formula of the cyanate ion present in ammonium cyanate?

A CNO^- **B** CNO^{2-} **C** CO^- **D** NO^-

Q129 When magnesium nitrate, $Mg(NO_3)_2.7H_2O$, is heated, which three gases are given off?
A dinitrogen oxide, oxygen, water vapour
B hydrogen, nitrogen, oxygen
C hydrogen, nitrogen dioxide, oxygen
D nitrogen dioxide, oxygen, water vapour

Q130 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

Q131 Chile saltpetre, $NaNO_3$, contains sodium iodide as an impurity.
Aqueous silver nitrate is added to an aqueous solution of Chile saltpetre. Concentrated aqueous ammonia is then added.
Which observations are made?

	with acidified silver nitrate	with concentrated aqueous ammonia
A	no precipitate	no further reaction
B	no precipitate	precipitate forms
C	precipitate forms	precipitate dissolves
D	precipitate forms	precipitate remains

Q132 Which statement describes the halogens chlorine, bromine and iodine?
A Their bond energies decrease with increasing proton number.
B Their first ionisation energies increase with increasing proton number.
C They are all coloured gases at room temperature.
D They are all good reducing agents.

Q133 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.

Q134 Which property of beryllium and its compounds is typical of the elements below it in Group II?
A Be does not react with hot water.
B $BeCl_2$ is covalent.
C $Be(NO_3)_2$ produces BeO on thermal decomposition.
D BeO dissolves in alkalis.

Q135 Equimolar quantities of magnesium carbonate and strontium carbonate are separately heated to bring about complete thermal decomposition. The minimum temperature for this to occur is called T_d.
The cold residues are separately added to equal volumes of water and the change in pH is measured. The change in pH is called ΔpH.
Which metal has the higher value of T_d, and the greater value of ΔpH?

	T_d	ΔpH
A	Mg	Mg
B	Mg	Sr
C	Sr	Mg
D	Sr	Sr

Q136 In aqueous solution, the acid HIO disproportionates according to the following equation where m, n, p and q are simple whole numbers in their lowest ratios.
$mHIO \rightarrow nI_2 + pHIO_3 + qH_2O$
This equation can be balanced using oxidation numbers.
What are the values for n and p?

	n	p
A	1	2
B	2	1
C	4	1
D	4	2

Q137 Use of the Data Booklet is relevant to this question.
Which mass of solid residue can be obtained from the thermal decomposition of 4.10 g of anhydrous calcium nitrate?
A 0.70 g B 1.00 g C 1.40 g D 2.25 g

Q138 Which statement explains the observation that magnesium hydroxide dissolves in aqueous ammonium chloride, but not in aqueous sodium chloride?

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 are isoelectronic (have the same number of electrons).

D The NH_4^+ ion can donate a proton.

Q139 What happens when chlorine is bubbled through aqueous potassium iodide?
A Chlorine is oxidised to chlorate(V) ions.
B Chlorine is oxidised to chloride ions.
C Iodide ions are oxidised to iodine.
D There is no observable reaction.

Q140 Which statement about bromine is correct?
A Bromine is insoluble in non-polar solvents.
B Bromine vapour is more dense than air.
C Bromine will not vapourise significantly under normal conditions.
D Gaseous bromine is purple.

Q141 Concentrated sulfuric acid reacts with both solid sodium chloride at room temperature and with solid sodium iodide at room temperature.
Which row correctly describes how concentrated sulfuric acid behaves in each of these reactions?

	with sodium chloride	with sodium iodide
A	as an oxidising agent only	as an oxidising agent only
B	as a strong acid and as an oxidising agent	as a strong acid only
C	as a strong acid only	as a strong acid and as an oxidising agent
D	as a strong acid only	as a strong acid only

Q142 Which element shows the greatest tendency to form some covalent compounds?
A aluminium
B magnesium
C neon
D potassium

Q143 Use of the Data Booklet is relevant to this question.

A 5.00 g sample of an anhydrous Group II metal nitrate loses 3.29 g in mass when heated strongly.
Which metal is present?
A magnesium
B calcium
C strontium
D barium

Q144 Why do the halogens become less volatile as Group VII is descended?
A The halogen-halogen bond energy decreases.
B The halogen-halogen bond length increases.
C The number of electrons in each molecule increases.
D The van der Waals' forces between molecules become weaker.

Q145 Total removal of the pollutant sulfur dioxide, SO_2, is difficult, both for economic and technicalreasons. The quantities emitted from furnace chimneys can be lowered by using desulfurization plants. The gases are scrubbed (washed) with calcium hydroxide to remove the SO_2. What is the main product formed initially?
A $Ca(HSO_4)_2$ B CaS C $CaSO_3$ D $CaSO_4$

Q146 Methyl mercaptan, CH_3SH, has a foul smell and is often used to impart a smell to natural gas.
What will be formed when CH_3SH is burned in an excess of air?
A CO H_2O SO_2
B CO_2 H_2O H_2S
C CO_2 H_2O SO_2
D CO_2 H_2O SO_3

Q147 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 P → Q → R
B P → R → Q
C Q → P → R
D Q → R → P

Q148 Sodium iodide reacts with concentrated sulfuric acid. The equation which represents one of the reactions that takes place is shown.

$$8NaI + 9H_2SO_4 \rightarrow 8NaHSO_4 + 4I_2 + H_2S + 4H_2O$$

Which species has been oxidised in this reaction?

A H^+ **B** I^- **C** Na^+ **D** SO_4^{2-}

Q149 The standard enthalpy changes of formation of HCl and HI are –92 kJ mol^{-1} and +26 kJ mol^{-1} respectively.
Which statement is most important in explaining this difference?
A Chlorine is more electronegative than iodine.

B The activation energy for the $H_2 + Cl_2$ reaction is much less than that for the $H_2 + I_2$ reaction.
C The bond energy of HI is smaller than the bond energy of HCl.
D The bond energy of I_2 is smaller than the bond energy of Cl_2.

Q150 Lime mortar is made from quicklime, water and sand. Over a period of time, lime mortar changes into a much harder form. Both fresh and old lime mortar react with aqueous hydrochloric acid but only the old lime mortar effervesces during the reaction.
Which equation describes the change from fresh to old lime mortar?
A $CaO + CO_2 \rightarrow CaCO_3$
B $CaO + H_2O \rightarrow Ca(OH)_2$
C $Ca(OH)_2 \rightarrow CaO + H_2O$
D $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

Q151 Why is the ionic radius of a chloride ion larger than the ionic radius of a sodium ion?
A A chloride ion has one more occupied electron shell than a sodium ion.
B Chlorine has a higher proton number than sodium.
C Ionic radius increases regularly across the third period.
D Sodium is a metal, chlorine is a non-metal.

Q152 What are the trends in the stated properties as Group II is descended from magnesium to barium?

	decomposition temperature of the carbonate	first ionisation energy
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

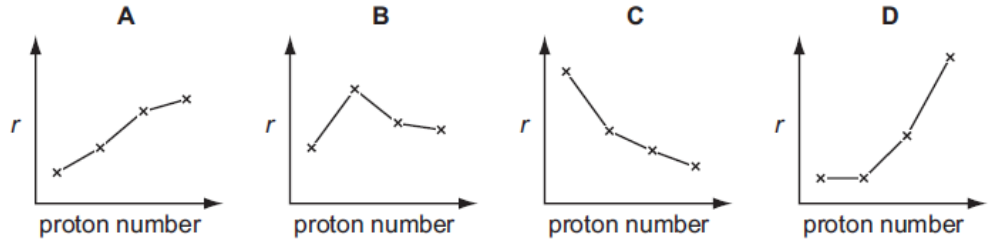
Q153 Use of the Data Booklet is relevant to this question.
The nitrates of beryllium, calcium, magnesium, and strontium all decompose in the same way when heated. When 2.00 g of one of these anhydrous nitrates is decomposed, 1.32 g of gas is produced.
What is the nitrate?
A beryllium nitrate
B calcium nitrate
C magnesium nitrate
D strontium nitrate

Q154 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

Q155 Use of the Data Booklet is relevant to this question.
1.15 g of a metallic element reacts with 300 cm^3 of oxygen at 298 K and 1 atm pressure, to form an oxide which contains O^{2-} ions.
What could be the identity of the metal?
A calcium
B magnesium
C potassium
D sodium

Q156 Elements X and Y are both in period three.
When the chloride of X is added to water, it reacts and a solution of pH 2 is produced.
When the chloride of Y is added to water, it dissolves and a solution of pH 7 is produced.
Which statement explains these observations?
A Both chlorides hydrolyse in water.
B X is phosphorus and Y is aluminium.
C X is silicon and Y is sodium.
D X is sodium and Y is phosphorus.

Q157 Which diagram shows the variation of the metallic radius r of the Group I elements, Li, Na, K and Rb, with increasing proton (atomic) number?



Q158 Use of the Data Booklet is relevant to this question.
Why is the ionic radius of a sulfide ion larger than the ionic radius of a potassium ion?
A Ionic radius always decreases with increasing atomic number.
B Positive ions have smaller radii than negative ions.
C The potassium ion has more protons in its nucleus than the sulfide ion.
D The sulfide ion is doubly charged; the potassium ion is singly charged.

Q159

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

Q160 Use of the Data Booklet is relevant to this question.
When 3.00 g of an anhydrous nitrate of a Group II metal is decomposed, 1.53 g of gas is produced.
What is the nitrate compound?
A beryllium nitrate
B calcium nitrate
C magnesium nitrate
D strontium nitrate

Q161 Rat poison needs to be insoluble in rain water but soluble at the low pH of stomach contents.
What is a suitable barium compound to use for rat poison?
A barium carbonate
B barium chloride
C barium hydroxide
D barium sulfate

Q162 Which oxide, when mixed with water, will produce the solution with the lowest pH?
A CO_2 B Na_2O C P_4O_{10} D SiO_2

Q163 Deposits of ammonium sulfate have been discovered in areas of high atmospheric pollution.
They are believed to arise from the following reaction.
$SO_3 + H_2O + 2NH_3 \rightarrow (NH_4)_2SO_4$
What does not occur in this reaction?
A acid / base neutralisation
B dative bond formation
C ionic bond formation
D oxidation / reduction

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

Q164 Which of the following statements are correct for the sequence of compounds below considered from left to right?
NaF MgO A*l* N SiC
1 The electronegativity difference between the elements in each compound increases.
2 The formula-units of these compounds are isoelectronic (have the same number of electrons).
3 The bonding becomes increasingly covalent.

Q165 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.

Q166 Why is the addition of concentrated sulphuric acid to solid potassium iodide **unsuitable** for the preparation of hydrogen iodide?
1 Hydrogen iodide is not displaced by sulphuric acid.
2 Iodide ions are oxidised to iodine.

3 The product is contaminated by sulphur compounds.

Q167 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.

Q168 When a hot glass rod is placed in a gas jar of hydrogen iodide, there is an immediate reaction as the hydrogen iodide decomposes.
Which statements about this reaction are correct?
1 Hydrogen iodide is purple coloured.
2 The hot rod provides the activation energy.
3 One of the products is a solid.

Q169 Use of the Data Booklet is relevant to this question.
Which properties would be expected from radium, $_{88}Ra$, or its compounds?
1 Radium carbonate decomposes only at a very high temperature.
2 Radium hydroxide is very insoluble.
3 Radium does not react with cold water.

Q170 The number of moles of chlorine that react with 1 mol of X is twice the number of moles of chlorine that react with 1 mol of Y.
Which of these pairs could be X and Y?

	X	*Y*
1	Mg(s)	Na(s)
2	H_2	KBr(aq)
3	cold NaOH(aq)	hot NaOH(aq)

Q171 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.

Q172 Hydroxyapatite, a basic calcium phosphate, $Ca(OH)_2.3Ca_3(PO_4)_2$, is the mineral found in bone.
In older people, calcium ions can be lost from the hydroxyapatite, weakening the bone structure.
In such cases, strontium salts are administered to strengthen the bone. The strontium ions replace the lost calcium ions in the hydroxyapatite.
Which statements are correct?
1 Strontium ions are nearly the same size as calcium ions and so may easily replace them in the hydroxyapatite.
2 Strontium hydroxide is less soluble than calcium hydroxide and so will precipitate better in the bone structure.
3 There is ionic, covalent and metallic bonding in hydroxyapatite which gives it strength.

Q173 Ammonia and chlorine react in the gas phase.
$8NH_3 + 3Cl_2 \rightarrow N_2 + 6NH_4Cl$
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.

Q174 Which statements concerning the third period elements (sodium to argon) and their compounds are correct?
1 The elements become more electronegative from sodium to chlorine.
2 Aluminium oxide is the only oxide which is insoluble in water.
3 The maximum oxidation state is shown by silicon.

Q175 Use of the Data Booklet is relevant to this question.
The element astatine lies below iodine in Group VII of the Periodic Table.
What will be the properties of astatine?
1 It forms diatomic molecules which dissociate more readily than chlorine molecules.
2 It reacts explosively with hydrogen.
3 It is a good reducing agent.

Q176 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.

Q177

Water is added to anhydrous aluminium chloride to make a 0.1 mol dm^{-3} solution.

Which observations are correct?

1 The reaction is endothermic.

2 The solution is acidic.

3 The solution contains the ion $[Al(H_2O)_6]^{3+}$.

Q178 The electronic structure of the outer shell of the element radium is $7s^2$.
Which statements will be correct for radium within its group?
1 The element will decompose water, liberating hydrogen.
2 The element will show an oxidation number of +2 in all its compounds.
3 Radium has the highest first ionisation energy.

Q179 When the yellow liquid NCl_3 is stirred into aqueous sodium hydroxide, the reaction that occurs can be represented by the following equation.
$2NCl_3(l) + 6NaOH(aq) \rightarrow N_2(g) + 3NaCl\ (aq) + 3NaOCl\ (aq) + 3H_2O(l)$
What will be the result of this reaction?
1 The nitrogen is oxidised.
2 A bleaching solution remains after the reaction.
3 The final solution gives a precipitate with acidified silver nitrate.

Q180 The following reaction takes place using liquid ammonia as a solvent.

$$Na^+NH_2^- + NH_4^+Cl^- \rightarrow Na^+Cl^- + 2NH_3$$

Which statements best explain why this reaction should be classified as a Brønsted-Lowry acidbase
reaction?
1 The ammonium ion acts as a proton donor.
2 Na^+ Cl^- is a salt.
3 Ammonia is always basic.

Q181 The rock dolomite is a double carbonate of magnesium and calcium, $CaCO_3.MgCO_3$. When heated strongly, a product called calcined dolomite is formed which is used to line some furnaces for the production of metals.
Why is calcined dolomite used for this purpose?
1 It is a refractory material.
2 It will absorb acidic impurities in metallurgical processes.
3 It will reduce metallic oxides to metals.

Q182 Which properties in the sequence hydrogen chloride, hydrogen bromide and hydrogen iodide steadily increase?
1 thermal stability
2 bond length
3 ease of oxidation

Q183 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 ½ mol of gaseous oxygen.
What can X be?
1 carbon
2 nitrogen
3 sulfur

Q184 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 $NO_2(g)$ converting it to NO(g).

Q185 Use of the Data Booklet is relevant to this question.
Zinc reacts with hydrochloric acid according to the following equation.
$Zn + 2HCl \rightarrow ZnCl_2 + H_2$
Which statements are correct?
[All volumes are measured at room conditions.]
1 A 3.27 g sample of zinc reacts with an excess of hydrochloric acid to give 0.050 mol of zinc chloride.
2 A 6.54 g sample of zinc reacts completely with exactly 100 cm^3 of 1.00 mol dm^{-3} hydrochloric acid.
3 A 13.08 g sample of zinc reacts with an excess of hydrochloric acid to give 9.60 dm^3 of hydrogen.

Q186 Which statements are correct?
1 Aluminium chloride dissolves in water to give an acidic solution.
2 Magnesium chloride dissolves in water to give a slightly acidic solution.
3 Sodium chloride dissolves in water to give an alkaline solution.

Q187 Which oxides react with water to give a solution of pH 10 or higher?
1 CaO
2 Na_2O
3 SrO

Q188 Use of the Data Booklet is relevant to this question.
The element astatine lies below iodine in Group VII of the Periodic Table.
What will be the properties of astatine?
1 It forms diatomic molecules which dissociate more readily than chlorine molecules.
2 It reacts explosively with hydrogen.
3 It can oxidise iodide to iodine.

Q189 Which descriptions of the ammonium ion are correct?
1 It contains ten electrons.
2 It has a bond angle of 109.5° .
3 It has only three bonding pairs of electrons.

Q190 When the yellow liquid NCl_3 is stirred into aqueous sodium hydroxide, the reaction that occurs can be represented by the following equation.
$2NCl_3(l) + 6NaOH(aq) \rightarrow N_2(g) + 3NaCl\ (aq) + 3NaOCl\ (aq) + 3H_2O(l)$
What will be the result of this reaction?
1 The nitrogen undergoes a redox reaction.
2 A bleaching solution remains after the reaction.
3 The final solution gives a precipitate with acidified silver nitrate.

Q191 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.

Q192 Nitrogen and phosphorus are both in Group V of the Periodic Table. Phosphorus forms a chloride with the formula PCl_5.
Why is it not possible for nitrogen to form NCl_5?
1 Nitrogen's outer shell can only contain eight electrons.
2 Nitrogen cannot have oxidation state +5.
3 Nitrogen is almost inert.

Q193 Ammonia and chlorine react in the gas phase.
$8NH_3 + 3Cl_2 \rightarrow N_2 + 6NH_4Cl$
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

Q194 Which statements are correct for all three halogens, chlorine, bromine and iodine?
1 They all form hydrides that are strong acids in aqueous solution.
2 They all react with aqueous sodium hydroxide to form oxo-anions.
3 They all require one more electron to fill the p orbitals of their outer shells

Q195

In the manufacture of sulfuric acid the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ usually takes place at 400 °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

Q196

Concentrated sulfuric acid behaves as a strong acid when it reacts with water.

$$H_2SO_4(l) + aq \rightarrow H^+(aq) + HSO_4^-(aq)$$

The HSO_4^- ion formed behaves as a weak acid.

$$HSO_4^-(aq) \rightleftharpoons H^+(aq) + SO_4^{2-}(aq)$$

Which statements are true for 1.0 mol dm^{-3} sulfuric acid?

1 $[H^+(aq)]$ is high

2 $[SO_4^{2-}(aq)]$ is high

3 $[HSO_4^-(aq)] = [SO_4^{2-}(aq)]$

Q197 Silver chloride dissolves in aqueous ammonia.
What happens in this process?
1 A co-ordinate bond is formed.
2 The oxidation number of nitrogen is unchanged.
3 Ammonia acts as a Brønsted-Lowry base.

Q198 Compared with the HCl molecule, the bond ……X…… of the HBr molecule is ……Y…… Which pairs of words correctly complete the above sentence?

	X	Y
1	energy	less
2	polarity	less
3	length	greater

Q199 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.

Q200 Which of the following magnesium compounds lose mass when heated by a bunsen flame?
1 magnesium carbonate
2 magnesium nitrate
3 magnesium oxide

Q201 he element astatine lies below iodine in Group VII of the Periodic Table.
What will be the properties of astatine?
1 It forms diatomic molecules which dissociate more readily than chlorine molecules.
2 It reacts explosively with hydrogen.
3 It is a good reducing agent.

Q202 Ammonia and chlorine react in the gas phase.
$8NH_3 + 3Cl_2 \rightarrow N_2 + 6NH_4Cl$
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.

Q203 Which statements concerning the third period elements (sodium to argon) and their compounds are correct?
1 The elements become more electronegative from sodium to chlorine.
2 Aluminium oxide is the only oxide which is insoluble in water.
3 The maximum oxidation state is shown by silicon.

Q204 A farmer spreads lime on land which has already been treated with a nitrogenous fertiliser. Which reactions will occur over a period of time?

1 $Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$

2 $Ca(OH)_2 + 2H^+(aq) \longrightarrow Ca^{2+}(aq) + 2H_2O$

3 $Ca(OH)_2 + 2NH_4^+(aq) \longrightarrow Ca^{2+}(aq) + 2NH_3 + 2H_2O$

Q205 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

Q206 Which reactions involving calcium and its compounds would produce two gaseous products?
1 heating solid anhydrous calcium nitrate
2 heating solid anhydrous calcium carbonate
3 adding calcium metal to water

Q207 Which properties in the sequence hydrogen chloride, hydrogen bromide and hydrogen iodide steadily increase?
1 thermal stability
2 bond length
3 ease of oxidation

Q208 What properties enable magnesium oxide to be used as a refractory lining in a furnace?
1 It has a high melting point.
2 It has a low thermal conductivity.
3 It does not react with basic slags.

Q209 Chlorine reacts with hot concentrated aqueous sodium hydroxide according to the equation below.
$3Cl_2(g) + 6NaOH(aq) \rightarrow NaCl\ O_3(aq) + 5NaCl\ (aq) + 3H_2O(l)$
Which conclusions can be drawn from this information?
1 The oxidation state of the chlorine in one of the products is +5.

2 The chlorine undergoes disproportionation.
3 The sodium hydroxide acts as a reducing agent.

Q210 Which equations represent stages in the Contact process for manufacturing sulphuric acid?

1 $S + O_2 \rightarrow SO_2$

2 $H_2O + SO_2 \rightarrow H_2SO_3$

3 $H_2SO_3 + \frac{1}{2}O_2 \rightarrow H_2SO_4$

Q211 What happens when chlorine is bubbled through aqueous sodium hydroxide solution?
1 In cold solution, ClO^-(aq) ions are formed.
2 In hot solution, ClO_3^-(aq) ions are formed.
3 Disproportionation of chlorine occurs in both cold and hot aqueous solutions.

Q212 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 K_2SO_4
2 NH_4NO_3
3 $NaNO_3$

Q213 When a firework is lit a fuel and an oxidising agent react.
In such a firework, magnesium is the fuel and barium nitrate is the oxidising agent.
Which solid products are produced when the firework is lit?
1 BaO
2 MgO
3 $Mg(NO_3)_2$

Q214 Why is the addition of concentrated sulphuric acid to solid potassium iodide unsuitable for the preparation of hydrogen iodide?
1 Hydrogen iodide is not displaced by sulphuric acid.
2 Iodide ions are oxidised to iodine.
3 The product is contaminated by sulphur compounds.

Q215 Which mixtures, on heating, produce the gas ND_3?

[D = ^2_1H, an isotope of hydrogen]

1 CaO(s) and ND_4Cl(s)
2 CH_3CN and NaOD in D_2O
3 NDH_3Cl and NaOD in D_2O

Q216 Which statements concerning the Group II elements magnesium, calcium and barium are correct?
1 Their reactivity increases with increasing relative atomic mass.
2 The oxidation number exhibited in their stable compounds is +2.
3 On strong heating, their nitrates give off oxygen only.

Q217 Chlorine is a greenish-yellow gas, bromine is a dark red liquid and iodine is a dark grey solid.
What causes these differences in volatility?
1 the halogen-halogen bond energy
2 the magnitude of the van der Waals' forces between the molecules
3 the number of electrons in the halogen molecule

Q218 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

Q219 Which statements about the reaction of solid sodium bromide with concentrated sulfuric acid are correct?
1 Hydrogen bromide is a product of the reaction.
2 Sulfuric acid is oxidised to sulfur dioxide.
3 Bromide ions are reduced to bromine.

Q220 Which statements are true for an S_N2 reaction?
1 One bond is broken as another bond is formed.
2 The formation of a transition state involves the collision of two molecules or ions.
3 A carbon atom in the transition state is bonded, either fully or partially, to five other atoms.

Q221 Samples of calcium and barium are separately added to beakers of cold water containing a few drops of litmus solution.
Which observations will be made with only the calcium and not with the barium?
1 A white suspension appears in the water.
2 The solution turns blue.
3 A gas is evolved.

Q222A 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

Q223 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 $Ca(OH)_2 + 2NH_4^+(aq) \rightarrow Ca^{2+}(aq) + 2NH_3 + 2H_2O$

2 $Ca(OH)_2 + 2H^+(aq) \rightarrow Ca^{2+}(aq) + 2H_2O$

3 $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

Q224 Which of the halide ions, chloride, bromide or iodide, acts as a reducing agent when its sodium salt reacts with concentrated sulfuric acid?

1 at least one of Cl^-, Br^- and I^-

2 at least two of Cl^-, Br^- and I^-

3 all three of Cl^-, Br^- and I^-

Q225 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.

Q226 Use of the Data Booklet is relevant to this question.
Which properties would be expected for radium, $_{88}Ra$, or its compounds?
1 Radium carbonate would not decompose at the temperature of a Bunsen flame.
2 Radium hydroxide is very insoluble.
3 Radium does not react with cold water.

Q227 When a firework is lit, a fuel and an oxidising agent react together.
In one such firework, magnesium is the fuel and barium nitrate is the oxidising agent.
Which solids are produced when the firework is lit?
1 BaO
2 MgO
3 $Mg(NO_3)_2$

Q228 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.

Q229 The element astatine, At, is below iodine in Group VII of the Periodic Table.
Which statements concerning At will be correct?
1 It is a dark-coloured solid at room temperature.
2 It is a more powerful oxidising agent than iodine.
3 Its hydride is thermally stable.

Q230 When added to water, which oxides will not cause a change in pH?
1 Al_2O_3
2 SiO_2
3 P_4O_{10}

Q231 In the gas phase, aluminium chloride exists as the dimer, Al_2Cl_6.
By using this information, which of the following are structural features of the Al_2Cl_6 molecule?
1 Each aluminium atom is surrounded by four chlorine atoms.
2 There are twelve non-bonded electron pairs in the molecule.
3 Each aluminium atom contributes electrons to four covalent bonds

Q232 An element X and compound YZ react separately with acid as shown.

$$X(s) + 2H^+(aq) \rightarrow X^{2+}(aq) + H_2(g)$$

$$YZ(s) + 2H^+(aq) \rightarrow Y^{2+}(aq) + H_2Z(g)$$

When 1.0 g of either X or YZ is reacted with an excess of acid, the total volume of gas formed is the same.
Which statements are correct?
1 $A_r(X) = M_r(YZ)$
2 X and Y are metals.
3 X and Y must both be in the same Group of the Periodic Table.

1. C
2. C
3. D
4. D
5. C
6. C
7. D
8. B
9. A
10. A
11. A
12. D
13. D
14. C
15. B
16. C
17. C
18. B
19. D
20. A
21. D
22. D
23. A
24. C
25. C
26. C
27. A
28. B
29. D
30. B
31. C
32. D
33. A
34. A
35. B
36. C
37. C
38. D
39. C
40. C
41. D
42. B
43. C
44. A
45. D

46. D
47. C
48. A
49. A
50. D
51. A
52. C
53. B
54. C
55. D
56. B
57. D
58. C
59. C
60. B
61. D
62. B
63. A
64. B
65. D
66. B
67. A
68. C
69. C
70. B
71. A
72. D
73. C
74. C
75. C
76. A
77. B
78. B
79. A
80. B
81. C
82. C
83. C
84. D
85. B
86. A
87. A
88. D
89. B
90. B

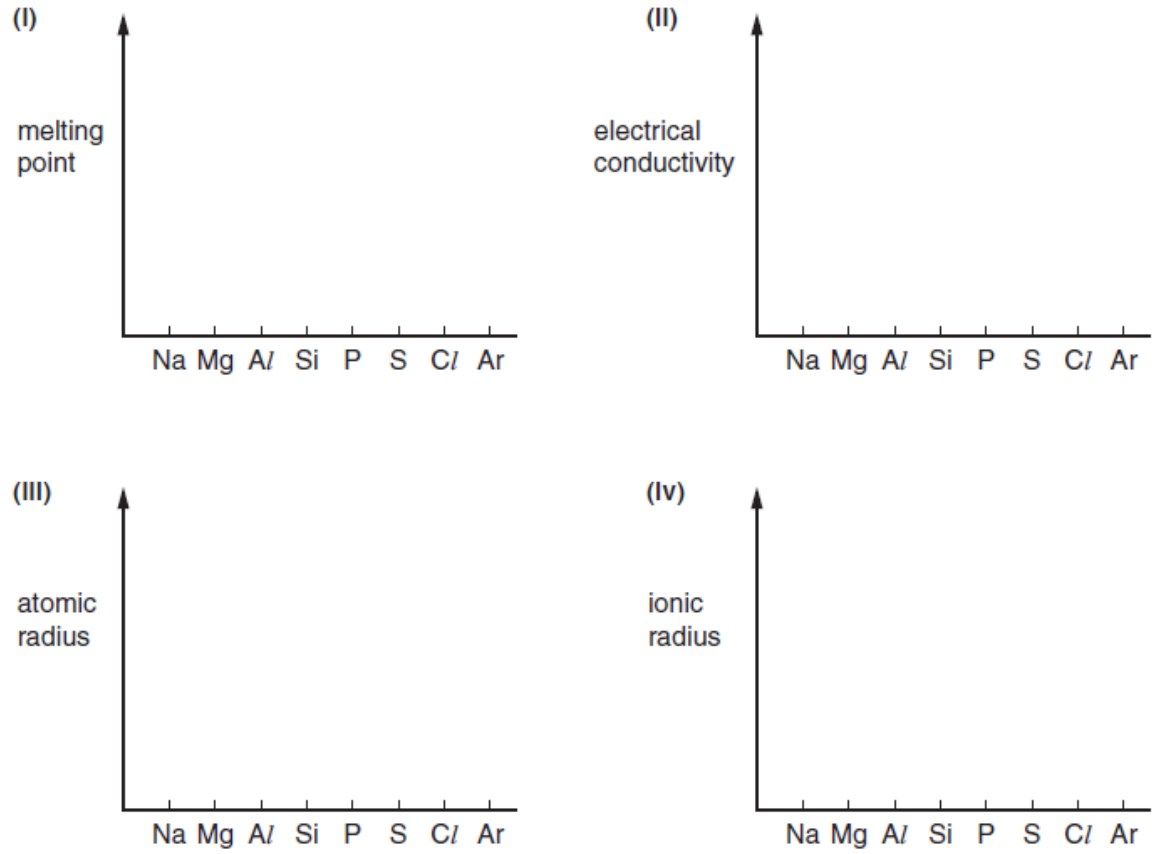
91. D
92. C
93. D
94. B
95. D
96. C
97. D
98. D
99. D
100. C
101. C
102. D
103. B
104. D
105. A
106. D
107. B
108. B
109. C
110. A
111. A
112. C
113. C
114. D
115. D
116. C
117. C
118. A
119. D
120. D
121. D
122. D
123. C
124. D
125. B
126. A
127. A
128. A
129. D
130. D
131. D
132. A
133. B
134. C
135. D

136. B
137. C
138. D
139. C
140. B
141. C
142. A
143. B
144. C
145. C
146. C
147. C
148. B
149. C
150. D
151. A
152. C
153. B
154. A
155. D
156. C
157. A
158. C
159. A
160. D
161. A
162. C
163. D
164. C
165. B
166. C
167. B
168. C
169. D
170. B
171. D
172. D
173. B
174. D
175. D
176. A
177. C
178. B
179. C
180. B

181. C
182. B
183. C
184. B
185. D
186. B
187. A
188. D
189. B
190. A
191. A
192. D
193. B
194. A
195. A
196. D
197. B
198. A
199. D
200. B
201. D
202. B
203. D
204. A
205. C
206. D
207. C
208. A
209. B
210. D
211. A
212. C
213. B
214. C
215. B
216. B
217. C
218. D
219. C
220. A
221. D
222. D
223. A
224. B
225. A

226. D
227. B
228. D
229. D
230. B
231. D
232. B

Q1 (a) The use of the *Data Booklet* is relevant to this question. Complete these sketches for elements of the third period (sodium to argon) to show how each property changes along the period. (J 2003)



(b) (i) In the boxes below, write the formulae of **one** of the oxides of each of these five elements.

sodium	magnesium	aluminium	phosphorus	sulphur

(ii) Write an equation for sodium oxide reacting with water.

……

(iii) Write an equation for your chosen oxide of sulphur reacting with an alkali.

.....[3]

Q2 Compounds of phosphorus have many uses in everyday life, e.g. fertilisers, matches and in water softeners. (J 2004)

(a) State the full electronic configuration of phosphorus.

.....[1]

(b) Phosphoric acid, H_3PO_4, is used in the manufacture of phosphate fertilisers.
Deduce the oxidation number of phosphorus in H_3PO_4.

.....[1]

(c) The salt sodium phosphate, Na_3PO_4, is a water-softening agent.

(i) Write the equation for the complete neutralisation of phosphoric acid with aqueous sodium hydroxide.

……

(d) Phosphorus sulphide, P_4S_3, is used in small amounts in the tip of a match. On striking a match, this compound burns.
(i) Construct an equation for this reaction.

……

(ii) Both oxides formed in **(i)** dissolve in water to give acidic solutions. Construct an equation for the reaction of each oxide with water.

.....

.....[4]

Q3 Ammonia, NH_3, is a colourless, pungent-smelling gas which has been known to man from the beginning of recorded time. It is given off from urine such as that on a wet nappy from a baby. (J 2004)
The nitrogen-containing substance in urine is urea, $CO(NH_2)_2$, and this decomposes by hydrolysis into ammonia and another colourless gas.
(a) Construct an equation for the hydrolysis of aqueous urea.

……[2]

(b) 1.20dm^3 of ammonia gas were dissolved in water to form 200 cm^3 of aqueous alkali at room temperature and pressure.
(i) Use the *Data Booklet* to calculate how many moles of $NH_3(g)$ were dissolved.

(ii) Write the equation for the neutralisation of aqueous ammonia by dilute sulphuric acid.

……

(iii) Calculate the volume of 0.50 $moldm^{-3}$ sulphuric acid that is required to neutralise the 200 cm^3 of aqueous ammonia.

Q4 Sulphur and its compounds are found in volcanoes, in organic matter and in minerals. Sulphuric acid, an important industrial chemical, is manufactured from sulphur by the Contact process. There are three consecutive reactions in the Contact process which are essential. (J 2005)

(a) Write a balanced equation (using $\rightleftharpoons$ where appropriate) for **each** of these reactions **in the correct sequence**.

1……. .....

2 .....

3 ..... [4]

(b) What catalyst is used?

……..... [1]

Hydrogen sulphide, H_2S, is a foul-smelling compound found in the gases from volcanoes. Hydrogen sulphide is covalent, melting at –85 °C and boiling at –60 °C.

(c) (i) Draw a 'dot-and-cross' diagram to show the structure of the H_2S molecule.

Hydrogen sulphide burns with a blue flame in an excess of oxygen to form sulphur dioxide and water.

(d) (i) Write a balanced equation for the complete combustion of H_2S.

……

(ii) What is the change in the oxidation number of sulphur in this reaction?

from ..... to .....

(iii) What volume of oxygen, measured at room temperature and pressure, is required for the complete combustion of 8.65 g of H_2S? Give your answer to two decimal places.

Hydrogen sulphide is a weak diprotic (dibasic) acid. Its solution in water contains HS^- and a few S^{2-} ions.

(e) (i) What is meant by the term *weak acid*?

……

.....

(ii) Write an equation, with state symbols, for the **first** ionisation of H_2S when it dissolves in water.

..... [3]

Q5 Magnesium is the eighth most common element in the Earth's crust.
The metal is widely used in alloys which are light and strong.
Some reactions of magnesium and its compounds are shown in the reaction scheme below. (J 2005)

(a) Identify, by name or formula, compounds **A** to **F**.

A .....

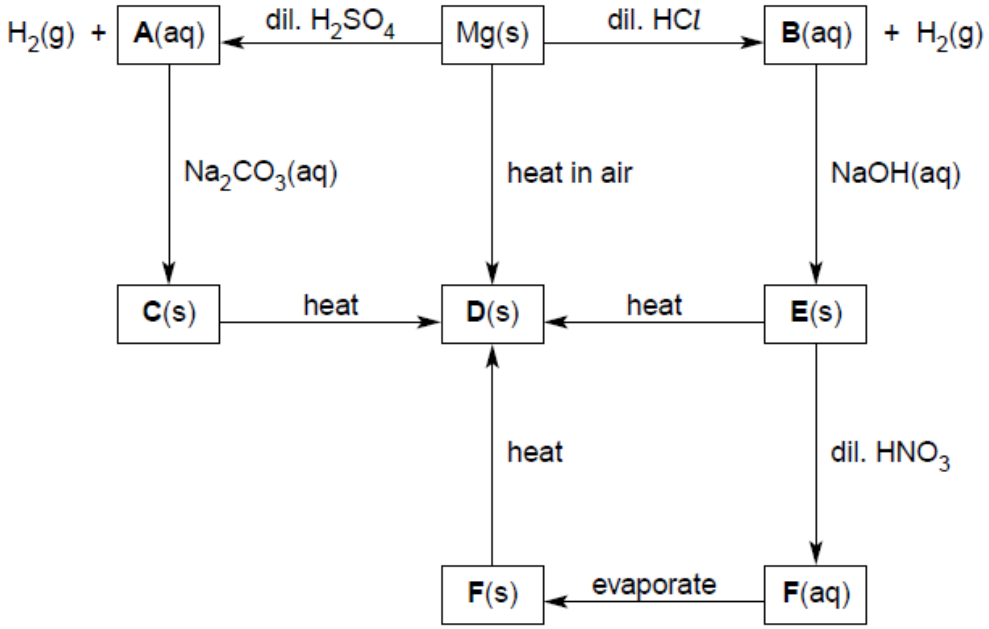
B .....

C .....

D .....

E .....

F .....



(b) (i) Construct balanced equations for the following reactions.
magnesium to compound **A**

……
compound **C** to compound **D**

.....
compound **F** to compound **D**

.....
(ii) Suggest a balanced equation for the effect of heat on compound **E**.

..... [4]

Q6 This question is about the elements of Group VII, the halogens.
(a) Complete the following table. (J 2006)

halogen	colour	physical state at room temperature
chlorine		
bromine		
iodine		

(b) Concentrated sulphuric acid is added to separate solid samples of magnesium chloride, magnesium bromide, and magnesium iodide.
(i) Describe, in **each** case, **one** observation you would be able to make.

$MgCl_2$ .....

.....

$MgBr_2$ .....

.....

MgI_2 .....

.....

(ii) Give an equation for the reaction of concentrated sulphuric acid with magnesium chloride.

.....

(c) When dilute nitric acid and aqueous silver nitrate are added to a solution of a magnesium halide, MgX_2, a pale cream precipitate is formed.
This precipitate is soluble in concentrated aqueous ammonia but not soluble in dilute aqueous ammonia.
(i) What is the identity of the precipitate?

……

(ii) Give an equation, with state symbols, for the reaction of the precipitate with concentrated aqueous ammonia.

.....

(d) A hot glass rod is plunged into separate gas jars, one containing hydrogen chloride and one containing hydrogen iodide.
(i) For **each** gas, state what you would observe, if anything, and write an equation for any reaction that takes place.

HCl .....

.....

HI .....

.....

(ii) Explain your answer to **(i)** in terms of enthalpy changes.

.....

.....

.....

(iii) What is the role of the hot glass rod in any reaction that occurs?

.....

.....

Q7 Mohr's salt is a pale green crystalline solid which is soluble in water. Mohr's salt is a 'double salt' which contains (J 2006)

two cations, one of which is Fe^{2+},

one anion which is SO_4^{2-},

and water of crystallisation.

(a) The identity of the second cation was determined by the following test.
Solid Mohr's salt was heated with solid sodium hydroxide and a colourless gas was evolved. The gas readily dissolved in water giving an alkaline solution.
(i) What is the gas?

……

(ii) What is the formula of the second cation identified by this test?

.....

(iii) In this test, a grey/green solid residue was also formed.
Suggest a name **or** formula for this solid.

.....

(b) The identity of the anion present in Mohr's salt was confirmed by adding dilute hydrochloric acid followed by aqueous barium chloride to an aqueous solution of Mohr's salt. A white precipitate was formed.
Suggest the identity of the white precipitate.

…….....[1]

(c) When a double salt such as Mohr's salt is made, the two individual salts are mixed together in a 1:1 molar ratio, dissolved in water and the solution crystallised.
(i) Give the formula of **each** of the two salts that would be mixed to make the double salt, Mohr's salt.

salt 1 .....

salt 2 .....

(ii) Calculate the relative formula mass of **each** of the salts present in Mohr's salt.
salt 1
relative formula mass of salt 1 .....
salt 2
relative formula mass of salt 2 .....

(iii) The crystals of the double salt contain water of crystallisation.
The relative formula mass of Mohr's salt is 392. Use your answers to **(ii)** to calculate the number of moles of water of crystallisation present in one mole of Mohr's salt.

Q8 his question is about the elements in Group II of the Periodic Table, magnesium to barium. (j 2007)

(a) Complete the table below to show the electronic configuration of calcium atoms and of strontium ions, Sr^{2+}.

	1s	2s	2p	3s	3p	3d	4s	4p	4d
Ca	2	2	6						
Sr^{2+}	2	2	6						

(b) Explain the following observations.
(i) The atomic radii of Group II elements increase down the Group.

……

.....
(ii) The strontium ion is smaller than the strontium atom.

.....

.....
(iii) The first ionisation energies of the elements of Group II decrease with increasing proton number.

.....

.....

.....

……
(c) Samples of magnesium and calcium are placed separately in cold water and left for some time. In **each case**, describe what you would see and write a balanced equation for each reaction.
(i) magnesium
observation ……

.....

equation .....
(ii) calcium
observation ……

.....

equation .....
(d) Strontium nitrate, $Sr(NO_3)_2$ undergoes thermal decomposition.
(i) State one observation you would make during this reaction.

.....

.....
(ii) Write a balanced equation for this reaction.

.....

Q9 When hydrocarbons such as petrol or paraffin wax are burned in an excess of air in a laboratory, carbon dioxide and water are the only products. (J 2008)

When petrol is burned in a car engine, nitrogen monoxide, NO, is also formed.
(a) Explain how NO is formed in an internal combustion engine but not formed when a small sample of petrol is burnt in an evaporating basin.

……

.....

..... [2]
The engines of modern motor cars have exhaust systems which are fitted with catalytic converters in order to reduce atmospheric pollution from substances such as NO.
(b) (i) State **three more** pollutants, other than CO_2 and H_2O, that are present in the exhaust gases of a car engine.

..... and ..... and .....
(ii) What is the active material present in the catalytic converter?

……
(iii) Write **one** balanced equation to show how NO is removed from the exhaust gases of a car engine by a catalytic converter.

.....

Q10 Copper and titanium are each used with aluminium to make alloys which are light, strong and resistant to corrosion. (J 2009 P21)
Aluminium, A*l*, is in the third period of the Periodic Table; copper and titanium are both transition elements.
(a) (i) Outline how, starting from aluminium powder, this reaction could be carried out in a school or college laboratory to give a small sample of aluminium chloride. A diagram is not necessary.

.....

.....

.....
(ii) Describe what you would see during this reaction.

.....

.....
Copper forms two chlorides, Cu*Cl* and $CuCl_2$.
(b) When copper is reacted directly with chlorine, only $CuCl_2$ is formed.
Suggest an explanation for this observation.

.....

..... [1]

Q11 Separate samples of magnesium chloride and magnesium oxide are shaken with water. In **each** case, describe what you would see when this is done, and state the approximate pH of the water after the solid has been shaken with it. (J 2009 P21)
(i) magnesium chloride

observation .....

approximate pH of the water ……
(ii) magnesium oxide

observation .....

approximate pH of the water ……
Magnesium nitride reacts with water to give ammonia and magnesium hydroxide.
(i) Construct an equation for the reaction of magnesium nitride with water.

……

Q12 Separate small samples of phosphorus(V) chloride and phosphorus(V) oxide are shaken with water. In **each** case, describe what you would see when this is done, and state the approximate pH of the water after the solid has been shaken with it. (J 2009 P22)
(i) phosphorus(V) chloride

observation .....

approximate pH of the water .....
(ii) phosphorus(V) oxide

observation .....

approximate pH of the water .....
When phosphorus is heated with an excess of sulfur in an inert atmosphere, a pale yellow solid, with formula P_4S_{10} is formed.
P_4S_{10} reacts with water to give phosphoric acid, H_3PO_4, and hydrogen sulfide, H_2S.
(i) Complete the equation for the reaction of P_4S_{10} with water.
$P_4S_{10} + 16H_2O \rightarrow$

Q13 This question refers to the elements shown in the portion of the Periodic Table given below. (J 2010 P21)

							H										He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

(a) From this table, identify in **each** case **one** element that has the property described. Give the **symbol** of the element in each case.
(i) The element that has a molecule which contains exactly eight atoms.

.....
(ii) The element that forms the largest cation.

.....
(iii) An element that floats on water and reacts with it.

.....
(iv) An element that reacts with water to give a solution that can behave as an oxidising agent.

.....
(v) An element whose nitrate gives a brown gas on thermal decomposition.

.....

(b) (i) Give the formula of the oxide of the most electronegative element.

.....

(ii) Several of these elements form more than one acidic oxide.
Give the formulae of **two** such oxides formed by the **same** element.

..... and .....

The formulae and melting points of the fluorides of the elements in Period 3, Na to Cl, are given in the table.

formula of fluoride	NaF	MgF_2	AlF_3	SiF_4	PF_5	SF_6	ClF_5
m.p./K	1268	990	1017	183	189	223	170

(c) (i) Suggest the formulae of **two** fluorides that could possibly be ionic.

…….....

(ii) What is the shape of the SF_6 molecule?

.....

(iii) In the sequence of fluorides above, the oxidation number of the elements increases from NaF to SF_6 and then falls at ClF_5.
Attempts to make ClF_7 have failed but IF_7 has been prepared.
Suggest an explanation for the existence of IF_7 and for the non-existence of ClF_7.

.....

.....

.....

Q14 Separate samples of Na_2O and SO_2 were added to water. (J 2010 P22)
(i) For **each** oxide, write a balanced equation for its reaction with water and suggest a numerical value for the pH of the resulting solution.
Na_2O

equation .....

pH .....
SO_2

equation .....

pH .....
(ii) Construct a balanced equation for the reaction that occurs when a solution of Na_2O in water reacts with a solution of SO_2 in water.

…….....

Q15 When heated in chlorine, all of the alkali metals react to form the corresponding chloride. Describe what you see when sodium is heated in chlorine and write a balanced equation for the reaction. (J 2010 P23)
description

.....

.....

.....
equation

.....

Q16 This question refers to the elements shown in the section of the Periodic Table below.

							H										He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

(a) From this list of elements, identify in **each** case **one** element that has the property described. Give the symbol of the element. (J 2010 P23)
(i) an element that sinks in cold water and reacts readily with it

.....
(ii) an element that forms an oxide that is a reducing agent

.....
(iii) the element that has the largest first ionisation energy

.....
(iv) the metal in Period 3 (Na to Ar) that has the smallest cation

.....
(v) the element which has a giant molecular structure **and** forms an oxide which also has a giant molecular structure

.....
(vi) the element in Period 3 (Na to Ar) with the greatest electrical conductivity

.....
(b) From the section of the Periodic Table above, identify **two** elements whose hydrides form hydrogen bonds between their molecules.

..... and .....
(c) Use the elements in Period 3 (Na to Ar) in the section of the Periodic Table opposite to identify the oxide(s) referred to below.
In **each** case, give the formula of the oxide(s).
(i) an oxide which has no reaction with water

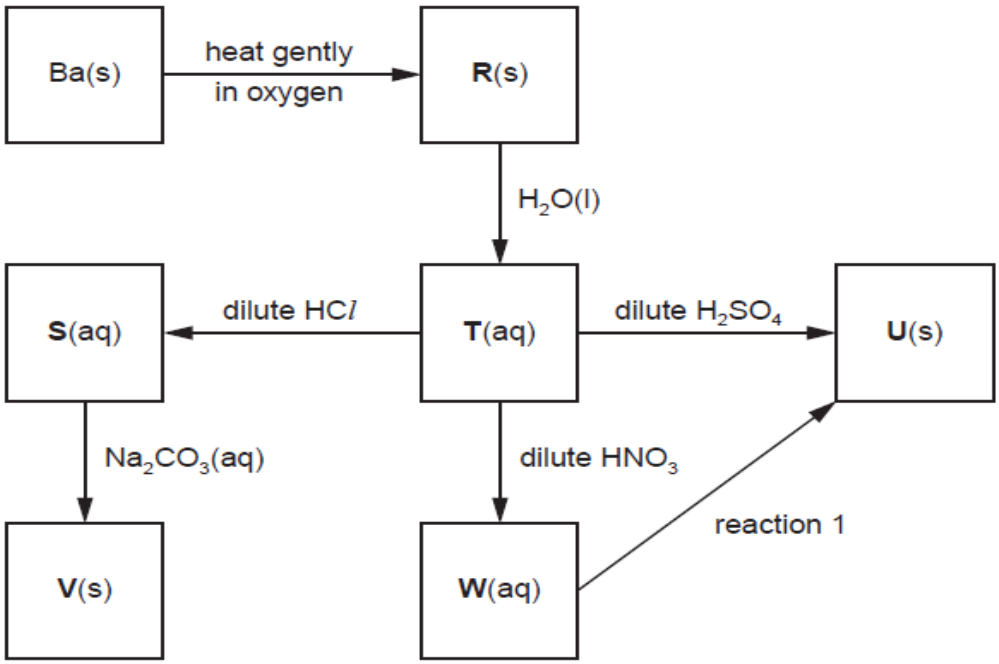
.....
(ii) two acidic oxides formed by the same element

..... and .....
(iii) an oxide which dissolves readily in water to give a strongly alkaline solution

.....
(iv) an oxide which is amphoteric

.....

Q17 Barium, proton number 56, is a Group II element which occurs in nature as the carbonate or sulfate. (J 2011 P22)
The element was first isolated by Sir Humphry Davy in 1808.
Some reactions of barium and its compounds are shown in the reaction scheme below.



(a) State the formula of **each** of the barium compounds **R** to **W**.

R ..... **S** .....

T..... **U** .....

V ..... **W** .....

(b) (i) Write balanced equations for the following reactions.
compound **T** to compound **W**

……
the roasting of **V** in air

.....

(ii) Suggest a gaseous reagent for the conversion of **T** into **V** and write a balanced equation for the reaction.

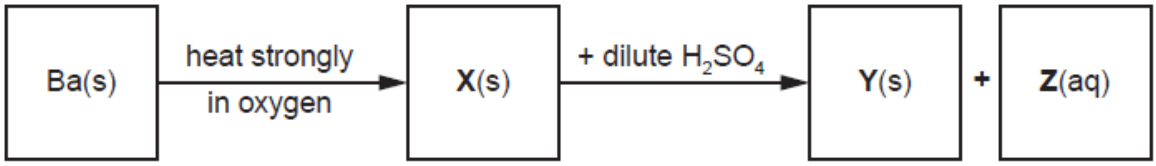
reagent .....

equation .....

(c) Suggest the formula of an aqueous reagent, other than an acid, for reaction 1.

…… [1]

When barium is heated strongly in oxygen, an oxide **X** is formed.
The oxide **X** contains 18.9% of oxygen by mass.
The oxide **X** reacts with dilute sulfuric acid in a 1:1 ratio.
Two products, one insoluble and one soluble, are formed.

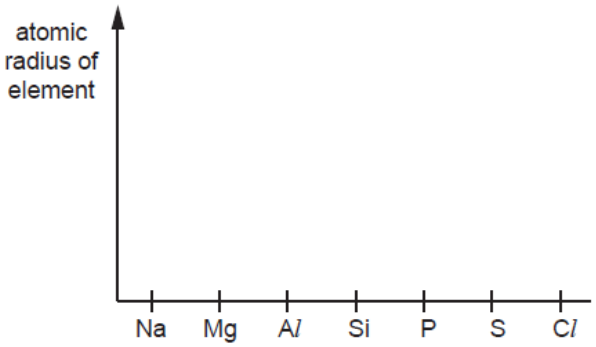


(d) (i) Calculate the empirical formula of **X**.
(ii) Suggest the identity of the solid **Y**.

.....
(iii) Use your answers to **(i)** and **(ii)** to construct an equation for the reaction of **X** with H_2SO_4.

…….. [4]

Q18 Elements in the same period of the Periodic Table show trends in physical and chemical properties. The grids on this page and on the opposite page refer to the elements of the third period, Na to C*l*. (J 2011 P23)
On **each** of these grids, draw a clear sketch to show the variation of the stated property.
Below **each** grid, briefly explain the variation you have described in your sketch.
For each explanation you should refer to the important factors that cause the differences in the property you are describing.

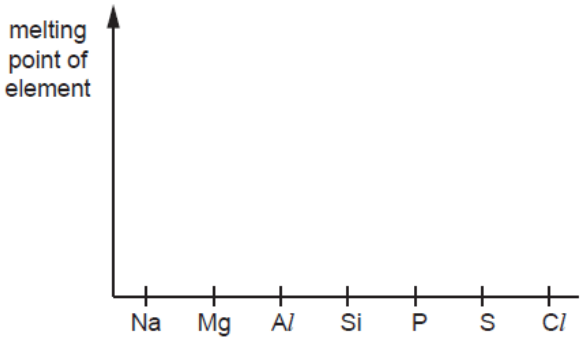


explanation …….....

.....

…….....

.....

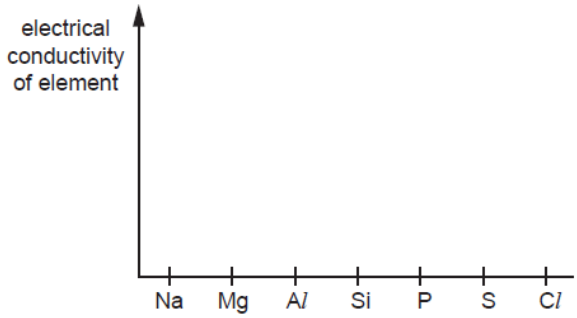


explanation …….....

.....

……

……



explanation ……

……

……

……

The melting points of some of the oxides of the elements sodium to sulfur are given in the table below.

compound	Na_2O	MgO	Al_2O_3	SiO_2	P_4O_6	SO_2
mp/K	1193	3173	2313	1883	297	198

(i) What type of bond is broken when **each** of the following compounds is melted?

Na2O .....

SiO2 .....

P4O6 .....

(ii) Identify **one** of these six oxides that has no reaction at all with water.

.....

Q19 Oxides are compounds which usually contain oxygen combined with one other element. Oxides are classifi ed as follows. (June 2012 P21)

Acidic alkaline amphoteric basic

(a) Using these terms only, complete the table to describe the oxides of the elements of the third period of the Periodic Table sodium to sulfur.

Na_2O	MgO	Al_2O_3	SiO_2	P_4O_{10}	SO_2	Cl_2O_7
						acidic

(b) Give the names of **two** elements from sodium to chlorine which form more than one oxide.

..... and ..... [1]

(c) Sodium reacts with water.

(i) Describe, as fully as you can, what you would see when a piece of sodium is reacted with water.

……

.....

.....

(ii) Write an equation for the reaction of sodium with water.

.....

(d) Sulfur dioxide is present in small, but signifi cant, amounts in the Earth's atmosphere.
(i) State **one** way by which sulfur dioxide enters the atmosphere.

.....

(ii) Give the formula of another sulfur compound which is formed in the atmosphere from sulfur dioxide.

.....

(iii) What are the environmental consequences of the compound you have identified in **(ii)**?

.....

(e) Sulfur dioxide is used as a food preservative.
What property of sulfur dioxide enables it to act in this way?

.....

Q20 The elements of the third period of the Periodic Table, sodium to sulfur, all form chlorides by direct combination. (J 2012 P22)
(a) (i) Sulfur forms a number of chlorides which are liquid at room temperature.
Which other element of the third period forms a chloride which is liquid at room temperature?

.....

(ii) Name **one** element of the third period which burns in chlorine with a coloured fl ame.

.....

(iii) Aluminium chloride may be produced by passing a stream of chlorine over heated aluminium powder in a long hard-glass tube.
State **two** observations you could make during this reaction.

..... and .....

(iv) Write a balanced equation, with state symbols, for this reaction of aluminium with chlorine.

.....

(v) No chloride of argon has ever been produced.
Suggest a reason for this.

.....

.....

(b) When chlorides of the elements of the third period are added to water, some simply dissolve while others can be seen to react with the water.
(i) Complete the table below, stating how the chlorides of Na, A*l*, and Si behave when mixed with water. In the fi rst column use only the terms 'dissolve' or 'react'.

element	Does the chloride dissolve or react?	approximate pH of the resulting solution
Na		
Al		
Si		

(ii) What *type of reaction* takes place between a chloride and water?

.....

Q21 Although the actual size of an atom cannot be measured exactly, it is possible to measure the distance between the nuclei of two atoms. For example, the 'covalent radius' of the Cl atom is assumed to be half of the distance between the nuclei in a Cl_2 molecule. Similarly,the 'metallic radius' is half of the distance between two metal atoms in the crystal lattice of a metal. These two types of radius are generally known as 'atomic radii'.
The table below contains the resulting atomic radii for the elements of period three of the Periodic Table, Na to Cl. (J 2012 P23)

element	Na	Mg	Al	Si	P	S	Cl
atomic radius / nm	0.186	0.160	0.143	0.117	0.110	0.104	0.099

(a) (i) Explain qualitatively this variation in atomic radius.

.....

.....

.....

.....

.....

(ii) Suggest why it is not possible to use the same type of measurement for argon, Ar.

.....

.....

(b) (i) Use the *Data Booklet* to complete the following table of radii of the cations and anions formed by some of the period three elements.

radius of cation / nm			radius of anion / nm		
Na^+	Mg^{2+}	Al^{3+}	P^{3-}	S^{2-}	Cl^-

(ii) Explain the differences in size between the cations and the corresponding atoms.

.....

…….....

.....

(iii) Explain the differences in size between the anions and the corresponding atoms.

.....

.....

.....

(c) Each of the elements Na to C*l* forms at least one oxide. Na_2O is an ionic oxide, SO_2 is a covalent oxide. Both oxides react with water.
(i) Write an equation for the reaction of **each** of these oxides with water.

Na_2O .....

SO_2 .....
(ii) What is the pH of the resulting solution in **each** case?

Na_2O ..... SO_2 .....
(iii) Write an equation for the reaction that occurs between the products of your reactions in **(i)**.

.....

Q22 The oxides of the third period include the following: (N 2002)
Na_2O; MgO; Al_2O_3; SO_2; SO_3.
(a) From the list above, identify one oxide (in each case) which fits the description given.
(i) An oxide that reacts with water forming a strongly alkaline solution.

.....
(ii) An oxide that is insoluble in water.

.....
(iii) An oxide that reacts vigorously with water forming a strongly acidic solution.

.....
(iv) An oxide that has a simple molecular structure.

.....
(v) An oxide that acts as a food preservative.

.....
(c) Write equations for the reaction of
(i) aluminium oxide and dilute hydrochloric acid,

.....
(ii) sulphur dioxide and aqueous sodium hydroxide.

.....

Q23 Nitrogen, which makes up about 80% of the Earth's atmosphere, is very unreactive.
(a) (i) Explain the lack of reactivity of nitrogen. (N 2005)

.....

.....

.....
(ii) Nitrogen does, however, undergo some reactions. Write an equation for **one** reaction of nitrogen, stating the conditions under which it occurs.

equation .....

conditions .....

.....

.....

(iii) Suggest why nitrogen does react in the example you have chosen.

……

.....

Ammonium nitrate, NH_4NO_3, is a commercially important compound of nitrogen.

(b) (i) State **one** large-scale use of ammonium nitrate.

……

(ii) What are the environmental consequences of the uncontrolled use of ammonium nitrate?

.....

.....

.....

.....

When solid ammonium nitrate is heated with solid sodium hydroxide in a test-tube, three products are formed. A colourless alkaline gas, **Y**, is given off, and a colourless liquid can be seen on the cooler parts of the test-tube. A white solid remains in the tube.

(c) (i) Identify gas **Y**.

……

(ii) Write an equation, with state symbols, for the reaction of ammonium nitrate with sodium hydroxide.

.....

(d) In order to produce gas **Y** in a pure state in the laboratory, it must be passed through a drying agent. Why is concentrated sulphuric acid not suitable for drying gas **Y**?

……

.....

Q24 This question refers to the elements shown in the Periodic Table below. (N 2006)

							H										He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

(a) From the elements shown, identify in **each** case **one** element that has the property described. Give the name or formula of the element.

(i) An element that has a molecule which contains only one atom.

.....

(ii) An element that has a molecule which contains only four atoms.

.....
(iii) The element that has the largest atomic radius.

.....
(iv) The element that is a liquid at room temperature and pressure.

.....
(v) The element in Period 3 (Na to Ar) that has the highest melting point.

.....
(vi) The element in Period 3 (Na to Ar) that forms the largest anion.

.....
(b) Use the elements shown opposite to answer the following questions.
(i) Give the formulae of **two** acidic oxides formed by the same element.

..... and .....
(ii) Give the name or formula of an oxide that is amphoteric.

.....
(iii) Identify an element whose oxide dissolves readily in water to give a strongly alkaline solution.

.....
(iv) Identify an element in Period 3 (Na to Ar) whose chloride dissolves in water to give a neutral solution.

.....
(v) Identify an element that reacts with water to give a solution that can behave as an oxidising agent.

.....

Q25 This question concerns the chlorides of the elements sodium to phosphorus of the third period of the Periodic Table. The melting points of these chlorides are given below.(N 2007)

compound	sodium chloride	magnesium chloride	aluminium chloride	silicon tetrachloride	phosphorus(V) chloride
melting point/K	1081	987	451*	203	435

*sublimes at 451 K
(a) Give the equation, with state symbols, for the reaction of phosphorus with chlorine to form phosphorus(V) chloride, PCl_5.

…….....[2]
(b) Write an equation for the reaction of silicon tetrachloride with water.

.....[1]
(c) What is the pH of the solution formed when **each** of the following compounds is dissolved in water?

NaCl ..... PCl_5 .....

Q26 The elements phosphorus, sulphur, and chlorine are regarded as having simple molecular structures. (N 2007)
(a) What are the molecular formulae of **each** of these three elements?

phosphorus .....

sulphur .....

chlorine .....
(b) (i) Place the three elements in order of their melting points **with the highest first**.

highest ..... lowest
(ii) Suggest an explanation for the order you have given in **(i)**.

.....

.....

.....

Q27 Chlorine is very reactive and will form compounds by direct combination with many elements. (n 2008)
Describe what you would see when chlorine is passed over separate heated samples of sodium and phosphorus. In **each** case write an equation for the reaction.

sodium .....

.....

.....

phosphorus .....

.....

.....
Magnesium chloride, $MgCl_2$, and silicon tetrachloride, $SiCl_4$, each dissolve in or react with water.
Suggest the approximate pH of the solution formed in **each** case.

$MgCl_2$ …… $SiCl_4$ ……
Explain, with the aid of an equation, the difference between the two values.

…….....

.....

.....

.....

Q28 Radium was discovered in the ore pitchblende by Marie and Pierre Curie in 1898, and the metal was first isolated by them in 1910.(N 2009 P21)
The metal was obtained by first reacting the radium present in the pitchblende to form insoluble radium sulfate which was converted into aqueous radium bromide. This solution

was then electrolysed using a mercury cathode and a carbon anode.
(a) Radium has chemical reactions that are typical of Group II metals and forms ionic compounds.
(i) What is the characteristic feature of the electronic configurations of all Group II metals?

……
(ii) Radium sulfate is extremely insoluble. From your knowledge of the simple salts of Group II metals, suggest another very insoluble radium salt.

.....
(b) During their electrolysis of aqueous radium bromide, the Curies obtained radium at the cathode and bromine at the anode.
Write half-equations for the two electrode reactions that take place during this electrolysis.

anode ……

cathode .....
(c) (i) Describe what you would see when magnesium reacts with

cold water, ...

.....

steam. .....

.....
(ii) Write an equation for the reaction with steam.

……
(d) Radium reacts vigorously when added to water.
(i) Write an equation, with state symbols, for this reaction.

……
(ii) State **two** observations that could be made during this reaction.

……

.....
(iii) Suggest the approximate pH of the resulting solution.

……
(iv) Will the reaction be more or less vigorous than the reaction of barium with water? Explain your answer.

……

.....

Q29 At room temperature, the chlorides of sodium, magnesium and aluminium are all solids which dissolve in water. (N 2009 P22)
The hydrides of sodium, magnesium and aluminium are also solids which react with water with the rapid evolution of the **same** colourless gas **G** in each case.
(a) (i) What is the pH of the solutions formed when separate samples of sodium chloride,

magnesium chloride, and aluminium chloride are dissolved in water?

chloride	sodium	magnesium	aluminium
pH			

(ii) Suggest an equation for the reaction between sodium hydride and water.

……
(iii) Suggest a value for the pH of the solution formed in **(ii)**.

.....
At room temperature, the chlorides of silicon, phosphorus and sulfur are all low melting point solids or low boiling point liquids that can be seen to react with water.
(d) (i) Suggest what type of bonding is present in sulfur dichloride, SCl_2.

.....
(ii) Write a balanced equation for the reaction between the chloride of silicon, $SiCl_4$, and water.

……

Q30 **(a)** The uncontrolled use of nitrogenous fertilisers can cause environmental damage to lakes and streams. This is known as 'eutrophication'. (N 2010 P22)
What are the processes that occur when excessive amounts of nitrogenous fertilisers get into lakes and streams?

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.....

.....
In many countries, new cars have to comply with regulations which are intended to reduce the pollutants coming from their internal combustion engines.
Two pollutants that may be formed in an internal combustion engine are carbon monoxide, CO, and nitrogen monoxide, NO.
(b) (i) Outline how **each** of these pollutants may be formed in an internal combustion engine.

CO .....

.....

NO .....

.....
(ii) State the main hazard associated with **each** of these pollutants.

CO .....

NO .....
Pollutants such as CO and NO are removed from the exhaust gases of internal combustion engines by catalytic converters which are placed in the exhaust system of a car.
(c) (i) What metal is most commonly used as the catalyst in a catalytic converter?

.....

(ii) Construct **one** balanced equation for the reaction in which **both** CO **and** NO are removed from the exhaust gases by a catalytic converter.

……

Q31 Sulfur and its compounds are found in volcanoes, in organic matter and in minerals. Sulfuric acid, an important industrial chemical, is manufactured from sulfur by the Contact process. The Contact process may be considered to be a three-stage process in which sulfur is converted into sulfuric acid. Each stage consists of a single chemical reaction.
(N 2010 P23)

(a) Write a balanced equation for **each** of these reactions **in the correct sequence**. Where appropriate, use $\rightleftharpoons$ to indicate that the reaction is an equilibrium.

first reaction .....

second reaction .....

third reaction .....

(b) Give **three** different operating conditions that are used in the **second** stage.

condition 1 .....

condition 2 .....

condition 3 .....

(c) State **one** large scale use of sulfuric acid.

.....

(**d)** Most of the sulfur that is used in the Contact process is recovered from sulfur compounds present in crude oil and natural gas by using the Claus process.

(i) In this process, about one third of the hydrogen sulfide, H_2S, present in the oil or gas, is converted into sulfur dioxide, SO_2.

Balance the equation for this reaction.

$$.....H_2S + ...O_2 \rightarrow .....SO_2 + ...H_2O$$

The sulfur present in crude oil is removed in order to prevent the formation of sulfur dioxide when fuels such as petrol (gasoline) or diesel fuel are burned in internal combustion engines.

Other substances that may be present in the exhaust gases of motor vehicles include CO, CO_2, NO/NO_2, and unburnt hydrocarbons.

The emission of sulfur dioxide can produce ‘acid rain’.

(e) (i) Outline, with the aid of equations, how acid rain is formed from the exhaust gases of motor vehicles.

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.....

.....

.....

(ii) State **one** environmental effect of acid rain.

……

(f) Sulfur dioxide is used to preserve dried fruits and vegetables.
What chemical property of SO_2 enables it to be used as a food preservative?

……

Q32 The oxides of the elements of the third Period behave differently with NaOH(aq) and HCl (aq). In some cases, no reaction occurs. Complete the table below by writing a balanced equation for any reaction that occurs, with heating if necessary. If you think no reaction takes place write 'no reaction'. You do not need to include state symbols in your answers. (N 2011 P23)

.....MgO(s) + ... NaOH (aq) →
.....MgO(s) + ... HCl (aq) →
.....Al_2O_3(s) + ... NaOH (aq) + ...H_2O (l) →
.....Al_2O_3(s) + ... HCl (aq) →
.....SO_2(g) + ... NaOH (aq) →
.....SO_2(g) + ... HCl (aq) →

Q33 Each of the Group VII elements chlorine, bromine and iodine forms a hydride.(N 2012 P22)
(i) Outline how the relative thermal stabilities of these hydrides change from HCl to HI.

……

.....
(ii) Explain the variation you have outlined in **(i)**.

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.....

.....

Q34 Concentrated sulfuric acid may be used in a school or college laboratory to produce hydrogen chloride by reaction with solid chlorides such as sodium chloride. (N 2012 P23)
(a) (i) What will be seen when concentrated sulfuric acid is carefully added to solid sodium chloride?

……
(ii) Write a balanced equation for this reaction.

……
(iii) Solutions of both H_2SO_4 and HCl are strong acids.
What is meant by the term *strong acid* ?

……

.....
(b) If the same reaction is carried out with solid sodium iodide and concentrated sulfuric acid, hydrogen iodide is **not** produced.
(i) State **one** observation you would make when carrying out this reaction with solid

sodium iodide.

……

(ii) Explain why hydrogen iodide is **not** a product of this reaction.

……

……

(c) Aqueous silver nitrate and aqueous ammonia are used to test for the presence of halide ions.

(i) Aqueous silver nitrate is slowly added to aqueous sodium chloride and the resulting mixture is then shaken with an excess of aqueous ammonia.

Describe what you would observe at **each** stage of this process.

……

……

……

……

(ii) Write balanced equations, with state symbols, for **all** reactions that occur in this process.

(iii) The same process of adding aqueous silver nitrate followed by an excess of aqueous ammonia is repeated using aqueous sodium iodide instead of aqueous sodium chloride.

State **two** differences that would be observed with aqueous sodium iodide.

……

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