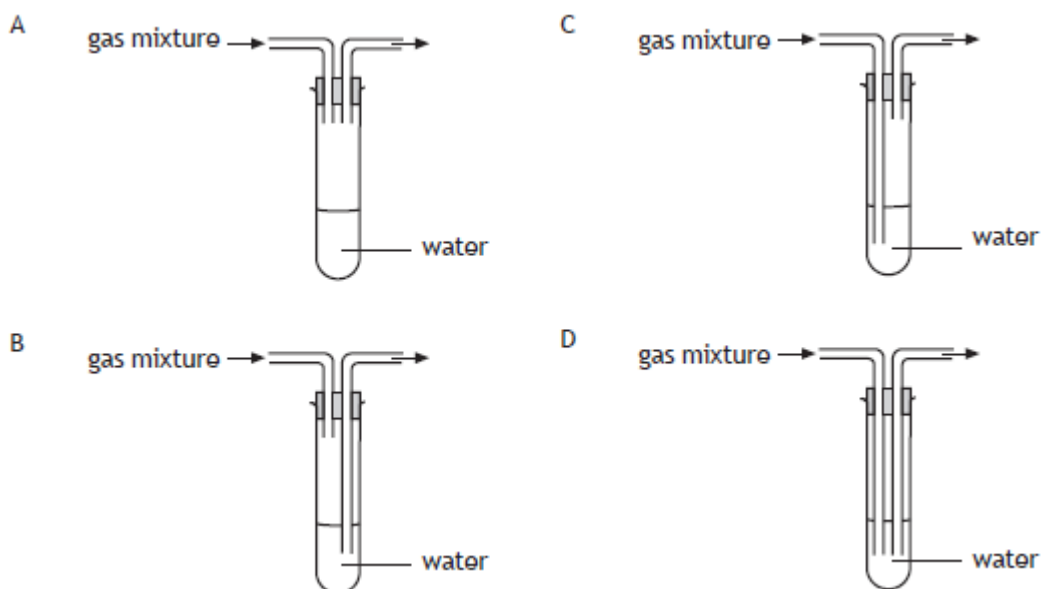


National 5 Unit 1 Chemical Changes and Structure

Past Paper Book by KEY AREA

Rates of Reaction

1. Which of the following diagrams shows the apparatus which would allow a soluble gas to be removed from a mixture of gases?



2. In a reaction, 60 cm^3 of hydrogen gas was collected in 20s.
What is the average rate of reaction, in cm^3s^{-1} , over this time?

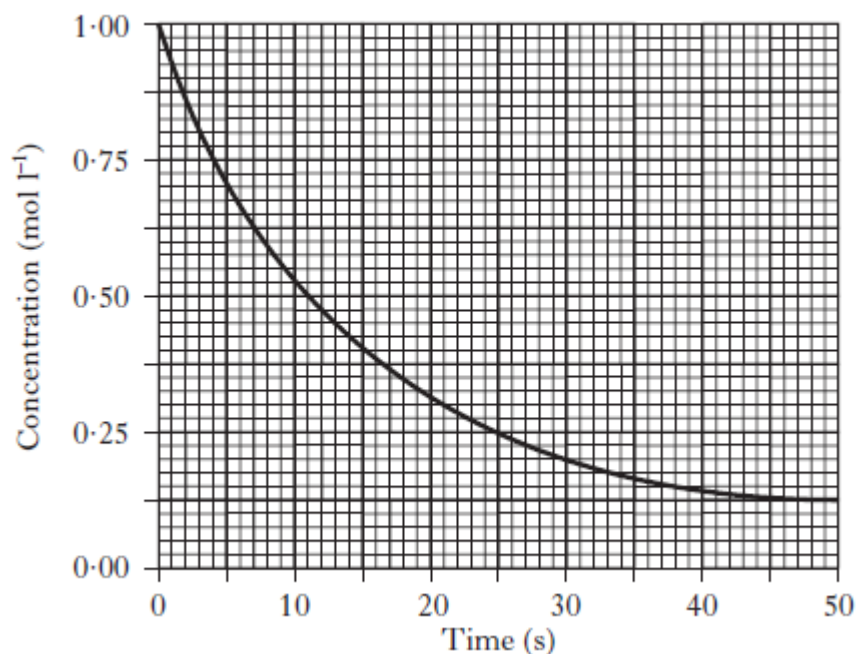
A $\frac{60}{20}$ C $\frac{1}{60}$

B $\frac{20}{60}$ D $\frac{1}{20}$

3. Which of the following pairs of reactants would produce hydrogen most slowly?

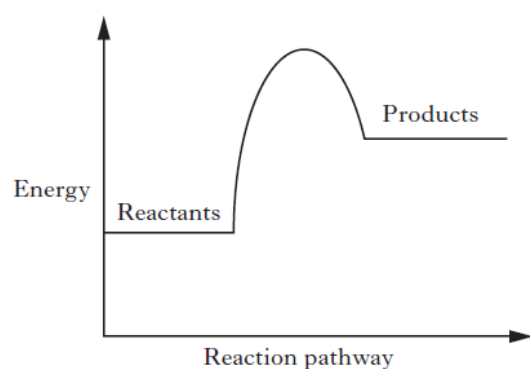
- A Magnesium powder and 4 mol l^{-1} hydrochloric acid
- B Magnesium powder and 2 mol l^{-1} hydrochloric acid
- C Magnesium ribbon and 4 mol l^{-1} hydrochloric acid
- D Magnesium ribbon and 2 mol l^{-1} hydrochloric acid

4. The graph below shows the variation of concentration of a reactant with time as a reaction proceeds.



During the first 25 s, the average reaction rate, in $\text{mol l}^{-1}\text{s}^{-1}$, is

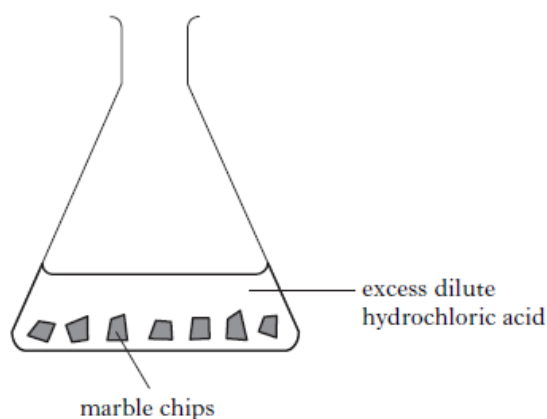
- A 0.01
B 0.02
C 0.03
D 0.04
5. The diagram shows the energy change during a chemical reaction.



Which of the following statements is true?

- A The products have less energy than the reactants
B The temperature of the reaction mixture will fall
C Energy is given out to the surroundings
D The reaction is exothermic

6. In an exothermic reaction
- A there is no energy change
 - B energy is released to the surroundings
 - C energy is absorbed from the surroundings
 - D the energy of the products is greater than the energy of the reactants
7. Which of the following would react fastest with 2 mol l^{-1} hydrochloric acid?
- A Magnesium ribbon
 - B Magnesium powder
 - C Zinc ribbon
 - D Zinc powder
8. A student investigated the reaction between marble chips and excess dilute hydrochloric acid.



- Which of the following would **not** affect the rate of the reaction?
- A Increasing the volume of the acid
 - B Decreasing the size of the marble chips
 - C Decreasing the concentration of the acid
 - D Increasing the temperature of the acid
9. In a reaction, the mass lost in 30 seconds was 2 g.
What is the average rate of reaction, in g s^{-1} , over this time?
- A $\frac{1}{30}$
 - B $\frac{30}{2}$
 - C $\frac{1}{2}$
 - D $\frac{2}{30}$

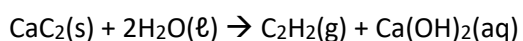
10. A reaction is exothermic if

- A energy is absorbed from the surroundings
- B energy is released to the surroundings
- C energy is required to start the reaction
- D there is no energy change.

11. Ethyne is the first member of the alkyne family.

It can be produced by the reaction of calcium carbide with water.

The equation for this reaction is



- a) The table shows the results obtained in an experiment carried out to measure the volume of ethyne gas produced.

<i>Time (s)</i>	0	30	60	90	120	150	180	210
<i>Volume of ethyne (cm³)</i>	0	60	96	120	140	148	152	152

Calculate the average rate of reaction between 60 and 90 seconds.

Your answer must include the appropriate unit.

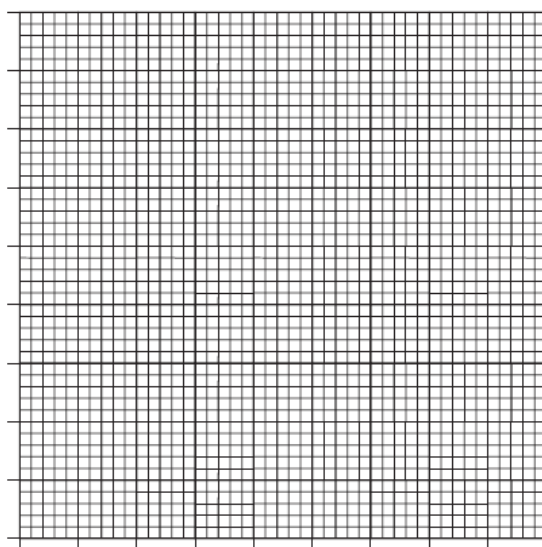
Show your working clearly.

3

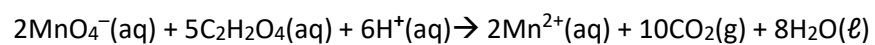
- b) Draw a line graph of the results.

Use appropriate scales to fill most of the graph paper.

3



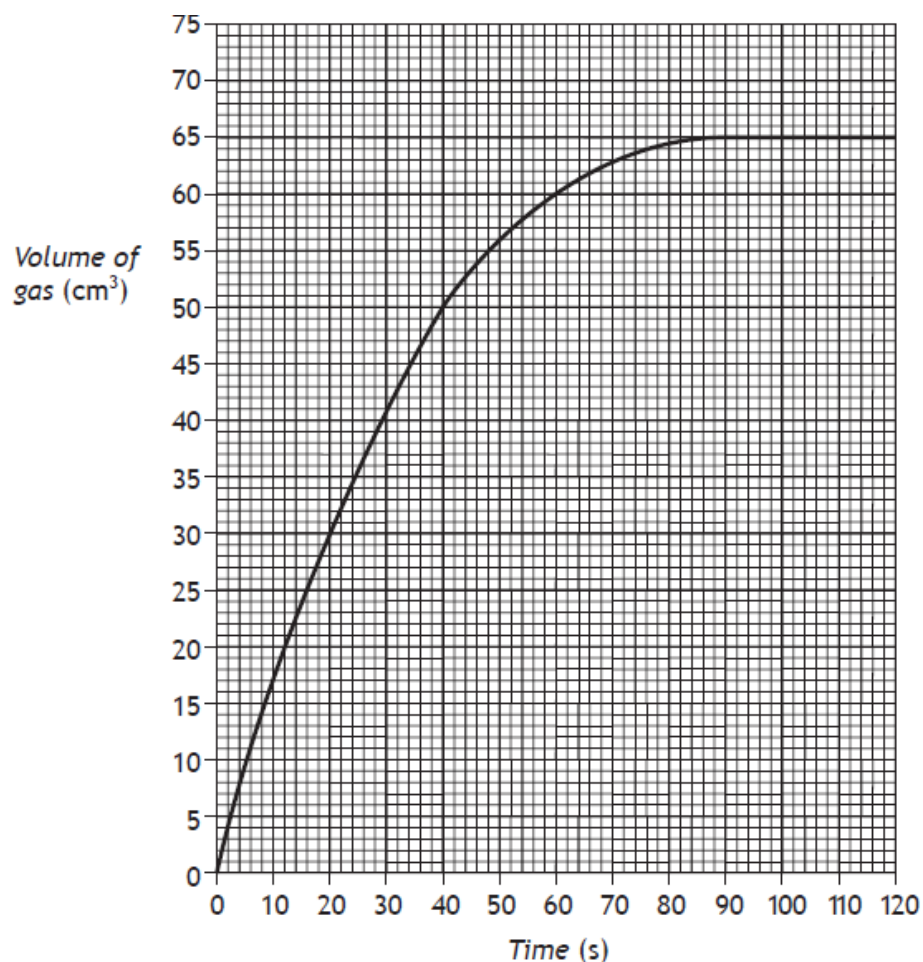
12. A student reacted acidified potassium permanganate solution with oxalic acid, $\text{C}_2\text{H}_2\text{O}_4$.



Using your knowledge of chemistry, comment on how the student could have determined the rate of the reaction.

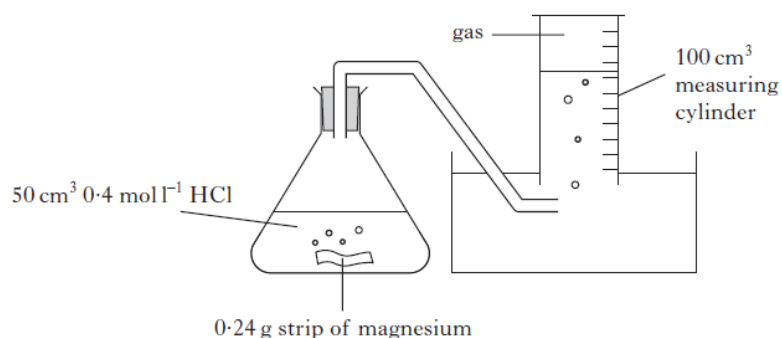
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13. Graphs can be used to show the change in the rate of a reaction as the reaction proceeds.
The graph shows the volume of gas produced in an experiment over a period of time.



- a) State the time, in seconds, at which the reaction stopped. 1
- b) Calculate the average rate of reaction, in cm^3s^{-1} , for the first 20 seconds. 2
Show your working clearly.
- c) The graph shows that the rate of reaction decreases as the reaction proceeds.
Suggest a reason for this. 1

14. A student monitored the rate of reaction between magnesium and dilute hydrochloric acid using a measuring cylinder to collect the gas produced.



- a) The experiment produced more gas than could be measured using the 100 cm³ measuring cylinder. The student changed the experiment to allow the total volume of gas to be measured, using a lower concentration of hydrochloric acid.

- i) Describe another change which would allow the total volume of gas to be measured.

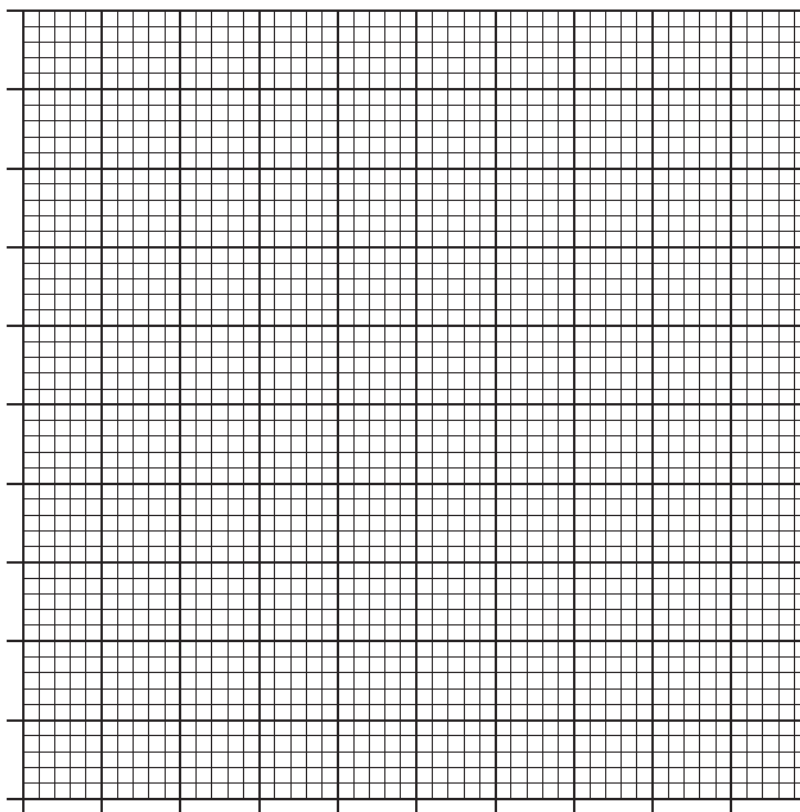
1

- ii) The student obtained the results shown.

Time (min)	0	1	2	4	6	8	10
Volume of gas (cm ³)	0	27	46	71	86	94	94

Draw a line graph of the results.

3



- b) Calculate the average rate of reaction between 2 and 6 minutes.
You must include appropriate units in your answer.

3

- c) At what time did the reaction finish?

1

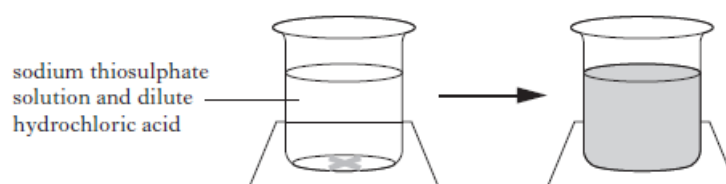
15. Superglue is used widely. Care must be taken when using superglue.



Heat is given out when superglue comes into contact with cotton or wool.
What term is used to describe chemical reactions which give out heat?

1

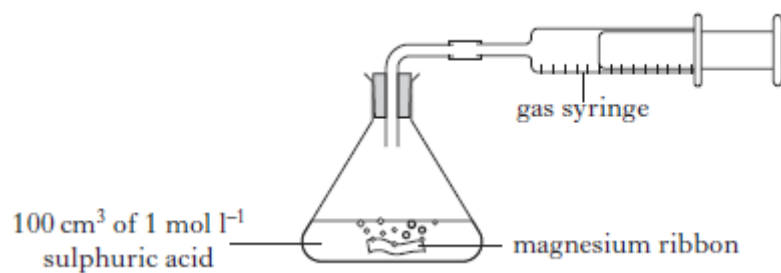
16. In the experiment, "**Effect of temperature on reaction rate**", the reaction between sodium thiosulfate solution and dilute hydrochloric acid is investigated.



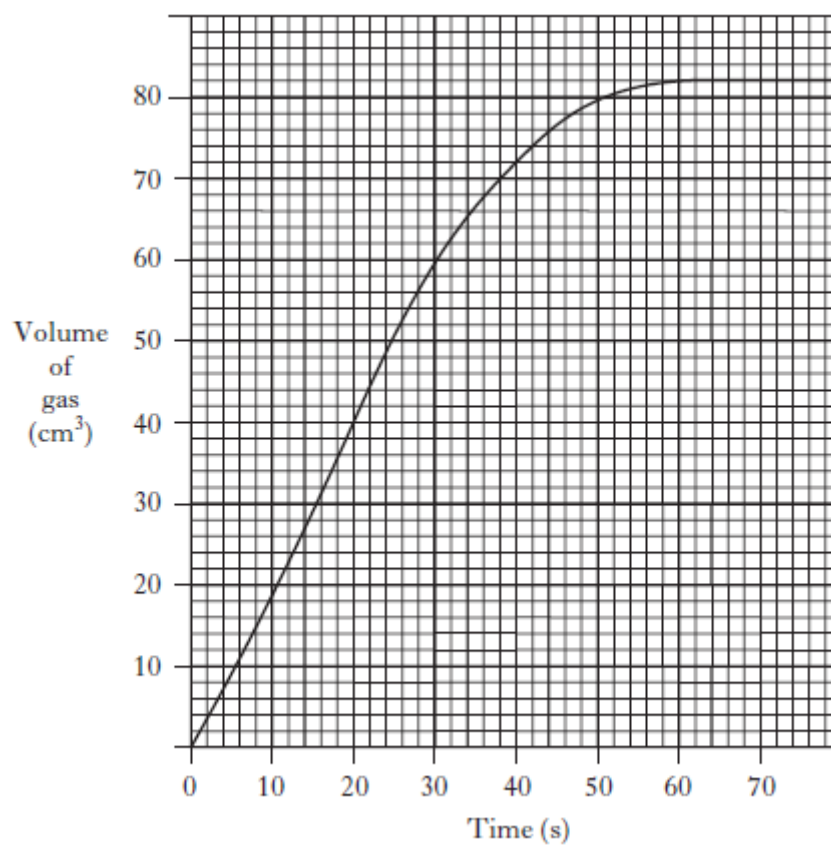
State a factor which should be kept constant.

1

17. Magnesium reacts with dilute sulphuric acid to produce a gas.



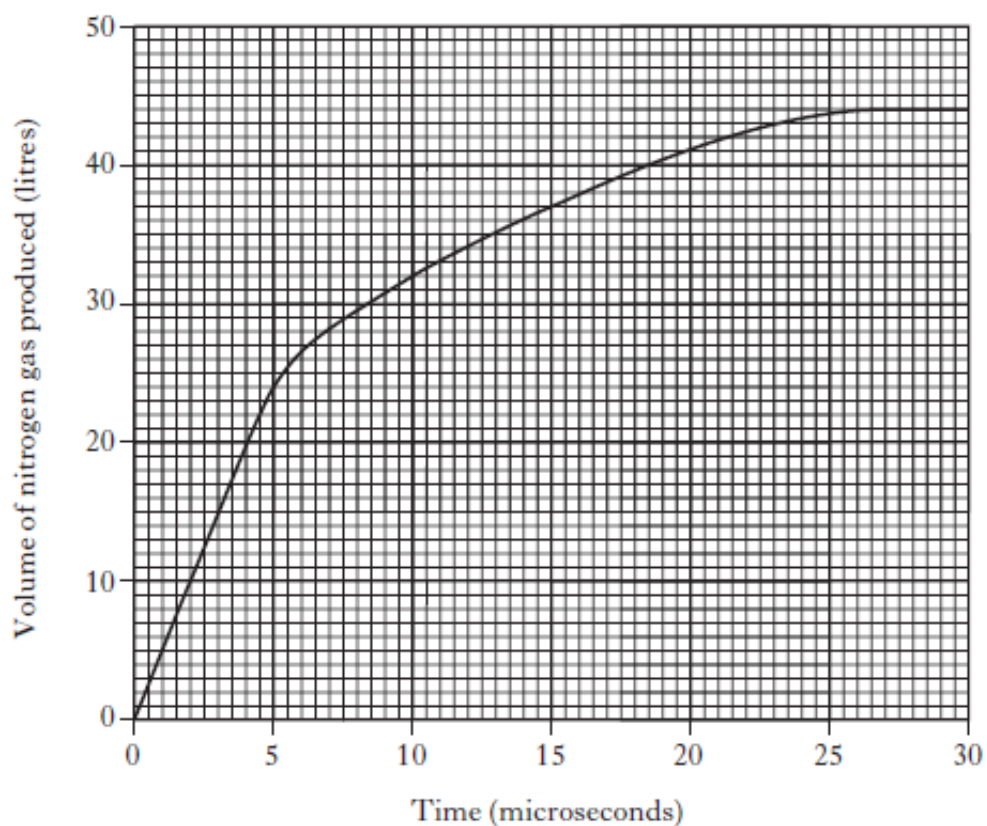
A student carried out the experiment. A graph of the results was plotted.



Calculate the average rate of the reaction, in cm³s⁻¹, for the first 40 seconds.

2

18. Rapid inflation of airbags in cars is caused by the production of nitrogen gas.
The graph gives information on the volume of gas produced over 30 microseconds.



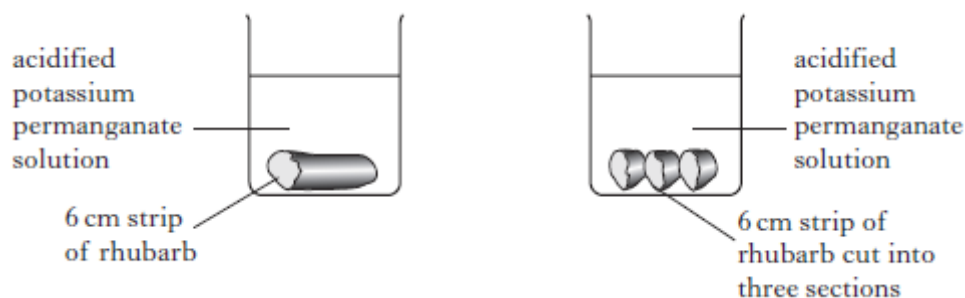
- a) Calculate the average rate of reaction, in litres per microsecond, between 2 and 10 microseconds.

2

- b) At what time has half of the final volume of nitrogen gas been produced?

1

19. A student investigated the effect of surface area on the rate of reaction with acidified potassium permanganate solution.



It was found that when the rhubarb was cut into three sections the reaction was faster.

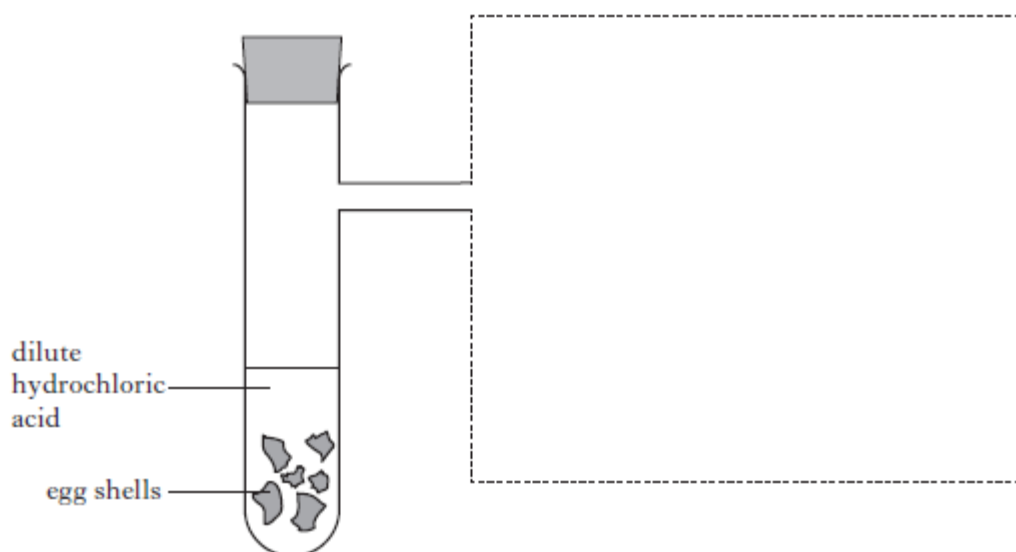
Using collision theory, explain why cutting the rhubarb into three sections increases the rate of reaction.

1

20. Egg shells are made up mainly of calcium carbonate. A pupil carried out an experiment to react egg shells with dilute hydrochloric acid. A gas was produced.

a) Complete the diagram to show the apparatus which could have been used to measure the volume of gas produced.

1

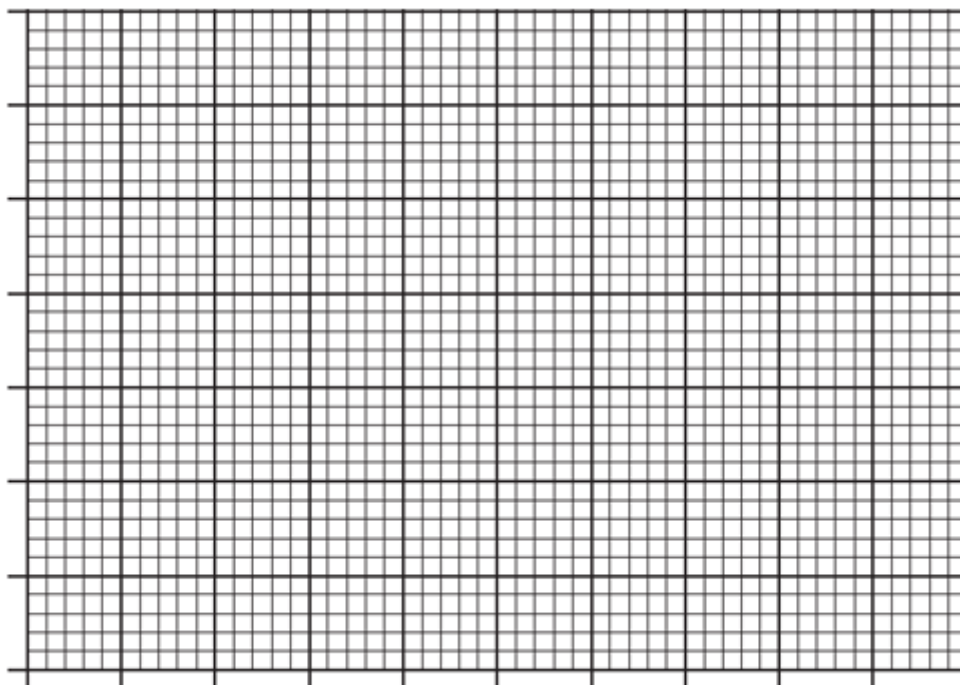


b) The volume of gas produced during the reaction was measured.

Time (min)	Volume of gas (cm ³)
0	0
2	47
4	92
6	114
8	118
10	118

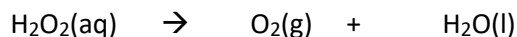
Plot these results as a line graph.

3



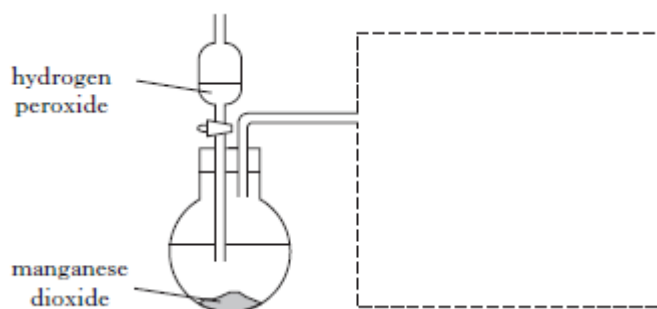
21. Hydrogen peroxide is a useful bleaching agent and is contained in many hair dyes. Over time, the hair dye becomes less effective as the hydrogen peroxide decomposes forming water and oxygen.

The equation for the decomposition of hydrogen peroxide is:



- a) The above reaction is often used to make oxygen in the laboratory. To speed up the reaction, the catalyst manganese dioxide is added. Complete the diagram to show how the oxygen can be collected.

1



- b) State the test for oxygen gas.

1

22. Research is being carried out into making chemicals that can be used to help relieve the side effects of chemotherapy.

Part of the process is shown.



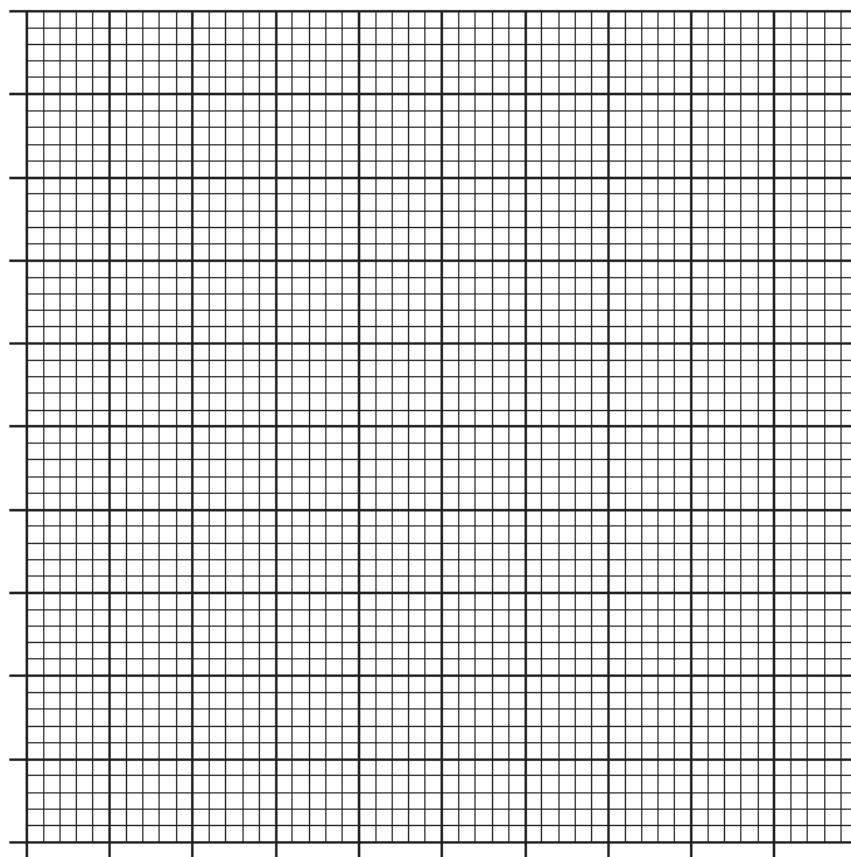
This reaction is catalysed using ruthenium(II) chloride.

- a) As the reaction proceeds the hydrogen is used up and the pressure decreases.

Time (min)	0	5	10	15	20	30	35	45
Decrease in pressure (bar)	0	0.6	1.2	1.7	2.2	2.9	3.1	3.1

Draw a line graph showing the decrease in pressure as time proceeds.

3



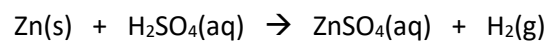
b) Using your graph, at what time did the reaction finish?

1

c) Calculate the average rate of the reaction between 10 and 20 minutes.
You should include appropriate units in your answer.

3

23. A student wanted to investigate whether copper could be used as a catalyst for the reaction between zinc and sulfuric acid.



Using your knowledge of chemistry, suggest how the student could investigate this.

3

Atomic Structure and Bonding

24. An atom has 26 protons, 26 electrons and 30 neutrons.

The atom has

- A atomic number 26, mass number 56
- B atomic number 56, mass number 30
- C atomic number 30, mass number 26
- D atomic number 52, mass number 56

25. The table shows the numbers of protons, electrons and neutrons in four particles, **W**, **X**, **Y** and **Z**.

<i>Particle</i>	<i>Protons</i>	<i>Electrons</i>	<i>Neutrons</i>
W	17	17	18
X	11	11	12
Y	17	17	20
Z	18	18	18

Which pair of particles are isotopes?

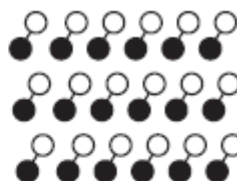
- A **W** and **X**
- B **W** and **Y**
- C **X** and **Y**
- D **Y** and **Z**

26. Which of the following diagrams could be used to represent the structure of a covalent network?

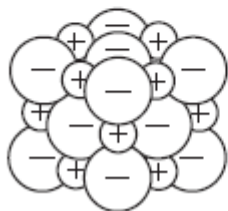
A



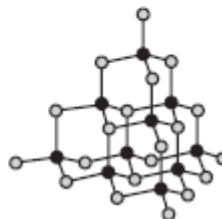
C



B



D



27. Which of the following particles contains a different number of electrons from the others?
You may wish to use the data booklet to help you.

- A Cl^-
- B S^{2-}
- C Ar
- D Na^+

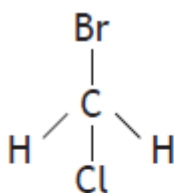
28. The table contains information about calcium and calcium chloride.

	<i>Melting point</i> (°C)	<i>Density</i> (g cm ⁻³)
Calcium	842	1.54
Calcium chloride	772	2.15

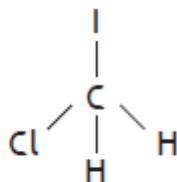
When molten calcium chloride is electrolysed at 800 °C the calcium appears as a

- A solid at the bottom of the molten calcium chloride
 - B liquid at the bottom of the molten calcium chloride
 - C solid on the surface of the molten calcium chloride
 - D liquid on the surface of the molten calcium chloride
29. Molecules in which four different atoms are attached to a carbon atom are said to be chiral.
Which of the following molecules is chiral?

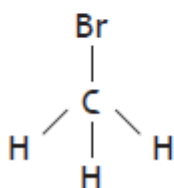
A



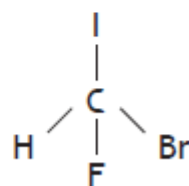
C



B



D



30. Which of the following elements has similar chemical properties to argon?

- A Zinc
- B Potassium
- C Krypton
- D Chlorine

31. An atom is neutral because

- A the number of electrons equals the total number of protons plus neutrons
- B the number of neutrons equals the total number of electrons plus protons
- C the number of protons equals the number of neutrons
- D the number of electrons equals the number of protons

32. 2,8,8 is the electron arrangement for an atom of an element belonging to the

- A halogens
- B noble gases
- C alkali metals
- D transition metals

33. Which of the following is the electron arrangement for a halogen atom?

- A 2, 4
- B 2, 5
- C 2, 6
- D 2, 7

34. Which line in the table shows the properties of a covalent network compound?

	Melting point (°C)	Boiling point (°C)	Conducts electricity	
			Solid	Liquid
A	19	80	no	no
B	655	1425	no	no
C	1450	1740	no	yes
D	1495	2927	yes	yes

35. Which line in the table correctly describes a proton?

	Mass	Charge	Location
A	negligible	0	outside nucleus
B	negligible	-1	outside nucleus
C	1	+1	in nucleus
D	1	0	in nucleus

36. In a hydrogen fluoride molecule, the atoms share electrons in order to achieve the same electron arrangements as atoms in group

- A 0
- B 1
- C 2
- D 7

37. An element, **X**, has the following properties.

- It is a gas.
- It is **not** made up of molecules.
- It does **not** react with other elements.

Element, **X**, is likely to be in group

- A 0
- B 1
- C 2
- D 7

38. Which of the following numbers is the same for lithium and oxygen atoms?

- A Mass number
- B Atomic number
- C Number of outer electrons
- D Number of occupied energy levels

39. Atoms of an element form ions with a single positive charge and an electron arrangement of 2, 8.

The element is

- A fluorine
- B lithium
- C sodium
- D neon





40. Which of the following pairs of elements combine to form an ionic compound?

- A Lead and fluorine
- B Sulfur and oxygen
- C Carbon and nitrogen
- D Phosphorus and chlorine

41. Which of the following compounds exists as diatomic molecules?

- A Carbon monoxide
- B Sulfur dioxide
- C Nitrogen trihydride
- D Carbon tetrachloride

42. The shapes and names of some molecules are shown below.

			
tetrahedral	pyramidal	bent	linear

Phosphine is a compound of phosphorus and hydrogen. The shape of a molecule of phosphine is likely to be

- A tetrahedral
- B pyramidal
- C bent
- D linear

43. Solid ionic compounds do not conduct electricity because

- A the ions are not free to move
- B the electrons are not free to move
- C solid substances never conduct electricity
- D there are no charged particles in ionic compounds

44. Which of the following compounds contains both a transition metal ion and a halide ion?

- A Aluminium bromide
- B Cobalt chloride
- C Iron oxide
- D Sodium fluoride

45. An atom has 26 protons, 26 electrons and 30 neutrons.

The atom has

- A atomic number 26, mass number 56
- B atomic number 56, mass number 30
- C atomic number 30, mass number 26
- D atomic number 52, mass number 56

46. Which of the following compounds contains only two elements?

- A Magnesium hydroxide
- B Magnesium phosphate
- C Magnesium sulfite
- D Magnesium nitride

47. Which line in the table describes a **neutron**?

	Mass	Charge
A	1	-1
B	negligible	0
C	1	+1
D	1	0

48. Which of the following elements exists as a covalent network?

- A Helium
- B Nitrogen
- C Silicon
- D Sulfur

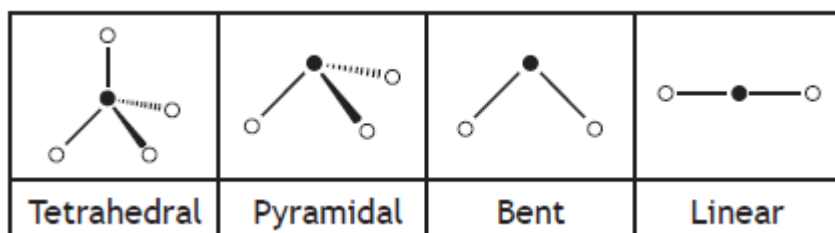
49. Which line in the table correctly describes an electron?

	Mass	Charge
A	negligible	+1
B	negligible	-1
C	1	+1
D	1	0

50. Solid ionic compounds do **not** conduct electricity because

- A the ions are not free to move
- B the electrons are not free to move
- C solid substances never conduct electricity
- D there are no charged particles in ionic compounds

51. The shapes of some molecules are shown below.



Phosphine is a compound of phosphorus and hydrogen. The shape of a molecule of phosphine is likely to be

- A tetrahedral
- B pyramidal
- C bent
- D linear

The next two questions refer to the following table which shows information about different particles.

<i>Particle</i>	<i>Number of</i>		
	<i>protons</i>	<i>neutrons</i>	<i>electrons</i>
A	9	10	10
B	11	12	11
C	15	16	15
D	19	20	18

52. Identify the particle which is a negative ion.

53. Identify the particle which would give a lilac flame colour.
(You may wish to use the data booklet to help you).

54. An atom has 21 protons, 21 electrons and 24 neutrons.
The atom has

- A atomic number 24 and mass number 42
- B atomic number 45 and mass number 21
- C atomic number 21 and mass number 45
- D atomic number 24 and mass number 45.

55. The table contains information about magnesium and magnesium chloride.

	<i>Melting Point</i> (°C)	<i>Density</i> (g cm ⁻³)
Magnesium	650	1.74
Magnesium chloride	714	2.32

When molten magnesium chloride is electrolysed at 730 °C the magnesium appears as a

- A solid on the surface of the molten magnesium chloride
- B solid at the bottom of the molten magnesium chloride
- C liquid at the bottom of the molten magnesium chloride
- D liquid on the surface of the molten magnesium chloride.

56. Draw a diagram, showing all outer electrons, to represent a molecule of hydrogen sulfide, H₂S.

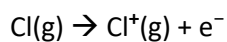
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57. Electrons can be removed from all atoms.

The energy required to do this is called the ionisation energy.

The first ionisation energy for an element is defined as the energy required to remove one mole of electrons from one mole of atoms, in the gaseous state.

The equation for the first ionisation energy of chlorine is



- a) State the electron arrangement for the Cl⁺ ion.

1

You may wish to use the data booklet to help you.

- b) Write the equation for the first ionisation energy of magnesium.

1

c) Information on the first ionisation energy of some elements is given in the table.

<i>Element</i>	<i>First ionisation energy (kJ mol⁻¹)</i>
lithium	526
fluorine	1690
sodium	502
chlorine	1260
potassium	425
bromine	1150

Describe the trend in the first ionisation energy going down a group in the Periodic Table.

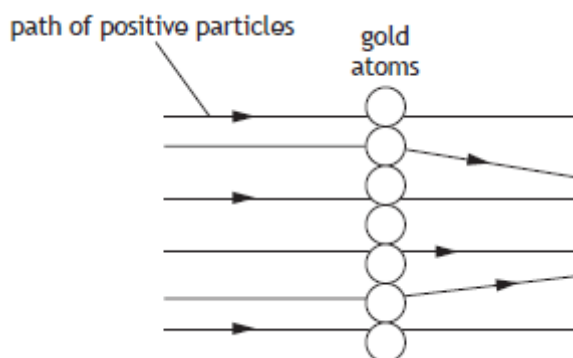
1

58. Titanium(IV) chloride is a liquid at room temperature and does not conduct electricity.

Suggest the type of bonding that is present in titanium (IV) chloride.

1

59. In 1911, Ernest Rutherford carried out an experiment to confirm the structure of the atom. In this experiment, he fired positive particles at a very thin layer of gold foil. Most of the particles passed straight through but a small number of the positively charged particles were deflected.



a) What caused some of the positive particles to be deflected in this experiment?

1

- b) Gold is the heaviest element to have only one naturally occurring isotope.
The isotope has a mass number of 197.

- i) Complete the table to show the number of each type of particle in this gold atom. 1

You may wish to use the data booklet to help you.

<i>Particle</i>	<i>Number</i>
Proton	
Electron	
Neutron	

- ii) Most elements have more than one isotope.
State what is meant by the term isotope. 1

60. The properties of a substance depend on its type of bonding and structure. There are four types of bonding and structure.

Discrete covalent molecular	Covalent network	Ionic lattice	Metallic lattice
-----------------------------	------------------	---------------	------------------

Complete the table to match up each type of bonding and structure with its properties. 2

<i>Type of bonding and structure</i>	<i>Properties</i>
	do not conduct electricity and have high melting points
	have high melting points and conduct electricity when liquid but not when solid
	conduct electricity when solid and have a wide range of melting points
	do not conduct electricity and have low melting points

61. The group 7 element bromine was discovered by Balard in 1826.

Bromine gets its name from the Greek 'bromos' meaning stench.

Bromine consists of a mixture of two isotopes, $^{79}_{35}\text{Br}$ and $^{81}_{35}\text{Br}$.

a) What is meant by the term isotope?

1

b) Complete the table for $^{79}_{35}\text{Br}$.

1

Isotope	Number of protons	Number of neutrons
$^{79}_{35}\text{Br}$		

c) The relative atomic mass of an element can be calculated using the formula:

$$\frac{(\text{mass of isotope A} \times \% \text{ of isotope A}) + (\text{mass of isotope B} \times \% \text{ of isotope B})}{100}$$

A sample of bromine contains 55% of the isotope with mass 79 and 45% of the isotope with mass 81.

Calculate the relative atomic mass of bromine in this sample.

2

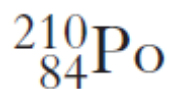
Show your working clearly.

d) In 1825 bromine had been isolated from sea water by Liebig who mistakenly thought it was a compound of iodine and chlorine.

Using your knowledge of chemistry, comment on why Liebig might have made this mistake.

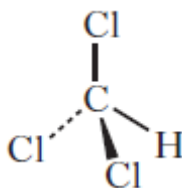
3

62. The element polonium was discovered by the scientist Marie Curie.
An isotope of polonium is shown.



- a) How many neutrons are present in an atom of ${}_{84}^{210}\text{Po}$? 1
- b) State what is meant by the term isotope. 1

63. Chloroform, CHCl_3 , was once widely used as an anaesthetic.
A diagram of a molecule of chloroform is shown.



- a) State the term used to describe the **shape** of this molecule. 1
- b) One use of chloroform today is in the production of chlorodifluoromethane, CHClF_2 , and hydrogen chloride, HCl .

Circle the correct words to complete the sentence.

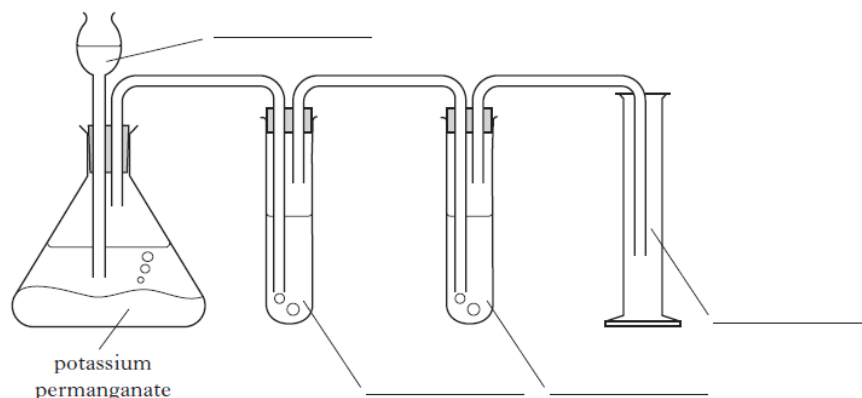
Chlorodifluoromethane exists as molecules. The bonds **between** the molecules are

$\left\{ \begin{array}{l} \text{weak} \\ \text{strong} \end{array} \right\}$ and the bonds **within** the molecules are $\left\{ \begin{array}{l} \text{weak} \\ \text{strong} \end{array} \right\}$. 1

64. Chlorine gas can be formed in the laboratory by adding concentrated hydrochloric acid to potassium permanganate. The gas is bubbled through water, to remove any unreacted hydrochloric acid, and then concentrated sulphuric acid to dry it. The chlorine gas is then collected in a gas jar.

a) Label the diagram for the preparation and collection of chlorine.

1



Draw a diagram to show how the outer electrons are arranged in a molecule of chlorine, Cl_2 .

1

65. Titanium can be used in the manufacture of bike frames. Titanium is extracted from the ore titanium oxide in several stages.

The first stage involves converting titanium oxide to titanium chloride, TiCl_4 .

Titanium chloride is a liquid at room temperature.

Suggest the **type** of bonding present in titanium chloride.

1

66. Ammonia is a compound of nitrogen and hydrogen.

- a) Draw a diagram to show how the outer electrons are arranged in a molecule of ammonia, NH_3 . 1

- b) Ammonia is a gas at room temperature.

What does this indicate about the **bonding** and **structure** of the ammonia molecule? 2

67. Strontium compounds have many uses.

- a) Strontium nitrate is used in warning flares.

What colour of flame will strontium nitrate give? 1

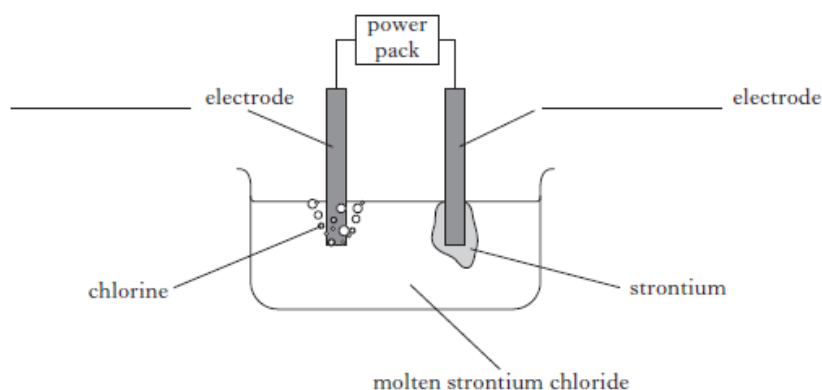
(You may wish to use the data booklet to help you.)

- b) Strontium chloride hexahydrate can be used in toothpaste for sensitive teeth as it plugs the holes in the tooth enamel. This is possible because strontium has similar chemical properties to calcium.

Why does strontium have similar chemical properties to calcium? 1

- c) Strontium can be extracted from the compound strontium chloride using electrolysis.

Label the diagram to show the **charge** on each electrode. 1



68. Tritium is a naturally occurring isotope of hydrogen. It can be represented as



a) Complete the table to show the number of particles in an atom of tritium.

1

Type of particle	Number of particles
proton	
neutron	
electron	

b) Hydrogen has three isotopes.

Isotope of hydrogen	Mass number
protium	1
deuterium	2
tritium	3

The relative atomic mass of hydrogen is 1.

Which isotope of hydrogen is the most abundant?

1

69. Dishwasher tablets contain many different types of chemicals.

Many dishwasher tablets contain sand which can help to remove food deposits. Sand contains the covalent compound silicon dioxide.

What type of **structure** does silicon dioxide have?

1

(You may wish to use the data booklet to help you.)

70. Glass is made from the chemical silica, SiO_2 , which is covalently bonded and has a melting point of 1700°C .

a) What does the melting point of silica suggest about its **structure**? **1**

b) In the manufacture of glass, other chemicals can be added to alter the properties of the glass. The element boron can be added to glass to make oven proof dishes.

i) Information about an atom of boron is given in the table below.

Particle	Number
proton	5
electron	5
neutron	6

Use this information to complete the nuclide notation for this atom of boron. **1**



ii) Atoms of boron exist which have the same number of protons but a different number of neutrons from that shown in the table.

What name can be used to describe the different atoms of boron? **1**

71. Rapid inflation of airbags in cars is caused by the production of nitrogen gas.

Potassium nitrate is also present in the airbag to remove the sodium metal by converting it into sodium oxide.

Why is it necessary to remove the sodium metal? **1**

72. The properties of a substance depend on its type of bonding and structure.
There are four types of bonding and structure.

Discrete covalent molecular	Covalent network	Ionic lattice	Metallic lattice
------------------------------------	-------------------------	----------------------	-------------------------

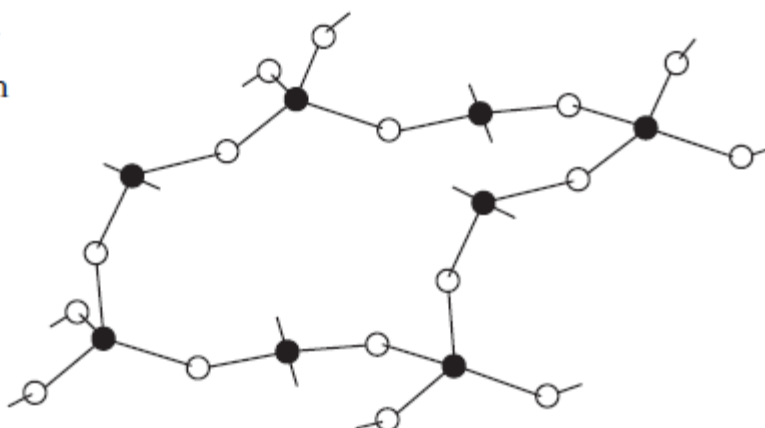
- a) Complete the table to match up each type of bonding and structure with its properties.

2

Bonding and structure type	Properties
	do not conduct electricity and have high melting points
	have high melting points and conduct electricity when liquid but not when solid
	conduct electricity when solid and have a wide range of melting points
	do not conduct electricity and have low melting points

- b) A section of a covalent network compound is shown below.

● = silicon
○ = oxygen



Write the formula for this covalent network compound.

1

73. Information on some two-element molecules is shown in the table.

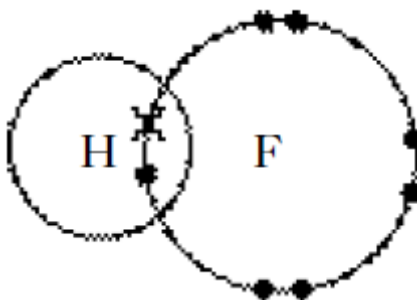
Name	Formula	Shape of molecule
hydrogen fluoride	HF	
water	H ₂ O	
ammonia	NH ₃	

a)

i) Complete the table to show the **shape** of a molecule of ammonia. **1**

ii) Name the shape of this molecule. **1**

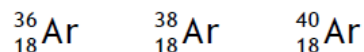
b) The hydrogen fluoride molecule can be represented as:



Showing **all** outer electrons, draw a similar diagram to represent a molecule of water, H₂O.

1

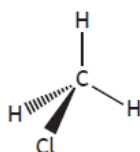
74. A sample of argon contains three types of atom.



- a) State the term used to describe these different types of argon atom. **1**
- b) Explain why the mass number of each type of atom is different. **1**
- c) This sample of argon has an average atomic mass of 36.2.
State the mass number of the most common type of atom in the sample of argon. **1**

75. Chlorine can form covalent and ionic bonds.

- a) Chlorine gas is made up of diatomic molecules.
Draw a diagram, showing all outer electrons, to represent a molecule of chlorine, Cl_2 . **1**
- b) Chloromethane is a covalent gas with a faint sweet odour.
The structure of a chloromethane molecule is shown.



State the name used to describe the shape of a molecule of chloromethane. **1**

- c) When chlorine reacts with sodium the ionic compound sodium chloride is formed.
A chloride ion has a stable electron arrangement.
Describe how a chlorine atom achieves this stable electron arrangement. **1**

- d) Covalent and ionic compounds have different physical properties.
Complete the table by circling the words which correctly describe the properties of the two compounds.

2

<i>Compound</i>	<i>Melting point</i>	<i>Conductor of electricity</i>
chloromethane gas	high / low	yes / no
solid sodium chloride	high / low	yes / no

Formulae and Reaction Quantities

76. What is the charge on the chromium ion in CrCl_3 ?

- A 1+
- B 1—
- C 3+
- D 3—

77. $x \text{ Al(s)} + y \text{ Br}_2(\text{l}) \rightarrow z \text{ AlBr}_3(\text{s})$

This equation will be balanced when

A $x = 1$, $y = 2$ and $z = 1$

B $x = 2$, $y = 3$ and $z = 2$

C $x = 3$, $y = 2$ and $z = 3$

D $x = 4$, $y = 3$ and $z = 4$

78. 0.2 mol of a gas has a mass of 12.8g.

Which of the following could be the molecular formula for the gas?

- A SO_2
- B CO
- C CO_2
- D NH_3

79. What is the charge on the zinc ion in the compound zinc phosphate $\text{Zn}_3(\text{PO}_4)_2$?

- A 2+
- B 3+
- C 2—
- D 3—

80. $\text{Fe}_2\text{O}_3 + x \text{ CO} \rightarrow y \text{ Fe} + 3\text{CO}_2$

This equation will be balanced when

- A $x = 1$ and $y = 2$
- B $x = 2$ and $y = 2$
- C $x = 3$ and $y = 2$
- D $x = 2$ and $y = 3$

81. A compound of iron has the formula $\text{Fe}(\text{NO}_3)_3$.

The charge on the iron ion in this compound is

- A 1+
- B 3+
- C 1-
- D 3-

82. 0.2 mol of gas has a mass of 12.8g.

Which of the following could be the molecular formula for the gas?

- A SO_2
- B CO
- C CO_2
- D NH_3

83. What is the charge on the zinc ion in the compound zinc phosphate, $\text{Zn}_3(\text{PO}_4)_2$?

- A 2+
- B 3+
- C 2-
- D 3-

84. $\text{Fe}_2\text{O}_3 + x \text{CO} \rightarrow y \text{Fe} + 3\text{CO}_2$

This equation will be balanced when

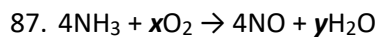
- A $x = 1$ and $y = 2$
- B $x = 2$ and $y = 2$
- C $x = 3$ and $y = 2$
- D $x = 2$ and $y = 3$

85. 0.5 mol of gas **X** has a mass of 23g. Gas **X** could be

- A CH_4
- B CO_2
- C NO_2
- D NH_3

86. What is the name of the compound with the formula VO_2 ?

- A Vanadium (V) oxide
- B Vanadium (IV) oxide
- C Vanadium (III) oxide
- D Vanadium (II) oxide



The equation will be balanced when

- A $x = 5, y = 6$
- B $x = 5, y = 10$
- C $x = 3, y = 6$
- D $x = 3, y = 10$

88. Which of the following substances has the smallest gram formula mass?

- A CO
- B CO_2
- C N_2
- D CH_4

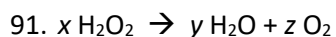
89. What is the charge on the chromium ion in CrCl_3 ?

- A 1+
- B 1–
- C 3+
- D 3–

90. What is the charge on the zinc ion in zinc dichromate, ZnCr_2O_7 ?

You may wish to use the data booklet to help you.

- A 2+
- B 2–
- C 1+
- D 1–



This equation will be balanced when

- A $x = 1, y = 2$ and $z = 2$
- B $x = 1, y = 1$ and $z = 2$
- C $x = 2, y = 2$ and $z = 1$
- D $x = 2, y = 2$ and $z = 2$.

92. 0.25 moles of a gas has a mass of 7 g.

Which of the following could be the molecular formula for the gas?

- A C_2H_6
- B C_2H_4
- C C_3H_8
- D C_3H_6

93. Which of the following solutions contains the least number of moles of solute?

- A 100 cm^3 of 0.4 mol l^{-1} solution
- B 200 cm^3 of 0.3 mol l^{-1} solution
- C 300 cm^3 of 1.0 mol l^{-1} solution
- D 400 cm^3 of 0.5 mol l^{-1} solution

94. Read the passage below and answer the questions that follow.

Clean coal technology comes a step closer

It is claimed a process called Coal-Direct Chemical Looping (CDCL) is able to release energy from coal while capturing 99% of the carbon dioxide emitted. CDCL works by extracting the energy from coal using a reaction other than combustion.

A mixture of powdered coal and beads of iron(III) oxide is heated inside a metal cylinder. Carbon in the coal and oxygen from the beads react to form carbon dioxide which can be captured for recycling or stored.

This reaction gives off heat energy that could be used to heat water in order to drive electricity-producing steam turbines.

Adapted from *Focus: Science and Technology*, April 2013

a) The CDCL process produced 300 tonnes of carbon dioxide.

Calculate the mass, in tonnes, of carbon dioxide released into the atmosphere.

1

b) Write the ionic formula for the iron compound used in CDCL.

1

c) State the term used to describe all chemical reactions that release heat energy.

1

95. A student was asked to carry out an experiment to determine the concentration of a copper (II) sulfate solution.

Part of the work card used is shown.

Determination of the Concentration of Copper(II) Sulfate Solution

1. Weigh an empty crucible
2. Add 100 cm³ copper(II) sulfate solution
3. Evaporate the solution to dryness
4. Weigh the crucible containing dry copper(II) sulfate

The student found that the 100cm³ solution contained 3.19g of copper (II) sulfate, CuSO₄. Calculate the concentration of the solution in mol l⁻¹.

Show your working clearly.

3

96. Read the passage below and answer the questions that follow.

Potassium – The Super Element

Potassium is an essential element for almost all living things. The human body requires a regular intake of potassium because humans have no mechanism for storing it. Foods rich in potassium include raisins and almonds. Raisins contain 0.86 g of potassium in every 100g.

Naturally occurring salts of potassium such as saltpetre (potassium nitrate) and potash (potassium carbonate) have been known for centuries. Potassium salts are used as fertilisers.

Potassium was first isolated by Humphry Davy in 1807. Davy observed that when potassium was added to water it formed globules which skimmed about on the surface, burning with a coloured flame and forming an alkaline solution.

- a) State why the human body requires a regular intake of potassium.

1

- b) Calculate the number of moles of potassium in 100g of raisins.

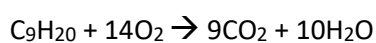
Show your working clearly.

2

- c) State the colour of the flame which would be seen when potassium burns. **1**
You may wish to use the data booklet to help you.

- d) Write the **ionic** formula for saltpetre. **1**

97. Nonane burns to produce carbon dioxide and water.



Calculate the mass, in grams, of carbon dioxide produced when 32g of nonane is burned.

Show your working clearly. **3**

98. A student investigated the reaction of carbonates with dilute hydrochloric acid.

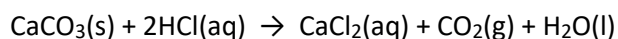
- a) In one reaction lithium carbonate reacted with dilute hydrochloric acid.

The equation for the reaction is:



Balance this equation. **1**

- b) In another reaction 1g of calcium carbonate reacted with excess dilute hydrochloric acid.



Calculate the mass, in grams, of carbon dioxide produced. **3**

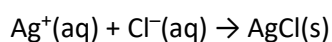
99. Antacid tablets are used to treat indigestion which is caused by excess acid in the stomach. Different brands of tablets contain different active ingredients.

<i>Name of active ingredient</i>	magnesium carbonate	calcium carbonate	magnesium hydroxide	aluminium hydroxide
<i>Reaction with acid</i>	fizzes	fizzes	does not fizz	does not fizz
<i>Cost per gram (pence)</i>	16.0	11.0	7.5	22.0
<i>Mass of solid needed to neutralise 20 cm³ of acid (g)</i>	0.7	1.2	0.6	0.4
<i>Cost of neutralising 20 cm³ of acid (pence)</i>		13.2	4.5	8.8

Write the **ionic** formula for aluminium hydroxide.

1

100. The concentration of chloride ions in water affects the ability of some plants to grow. A student investigated the concentration of chloride ions in the water at various points along the river Tay. The concentration of chloride ions in water can be determined by reacting the chloride ions with silver ions.



A 20cm³ water sample gave a precipitate of silver chloride with a mass of 1.435g.

- a) Calculate the number of moles of silver chloride, AgCl, present in this sample.

Show your working clearly.

2

- b) Using your answer to part (a), calculate the concentration, in mol l⁻¹, of chloride ions in this sample.

Show your working clearly.

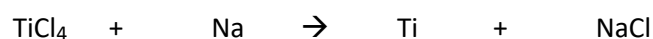
2

101. Write the ionic formula for sodium hydride.

1

102. Titanium can be used in the manufacture of bike frames. Titanium is extracted from the ore titanium oxide in several stages.

The second stage involves reacting the titanium chloride with sodium in an atmosphere of argon gas.



Balance this equation.

1

103. A student was asked to carry out an experiment to determine the concentration of a copper (II) sulfate solution. Part of the work card used is shown.

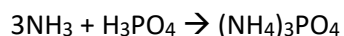
Determination of the Concentration of Copper(II) Sulphate Solution

- 1 Weigh an empty crucible
- 2 Add 100 cm³ copper(II) sulphate solution
- 3 Evaporate the solution to dryness
- 4 Weigh the crucible containing dry copper(II) sulphate

The student found that the 100cm³ solution contained 3.19g of copper (II) sulfate, CuSO₄. Calculate the concentration of the solution in mol l⁻¹.

3

104. Ammonia, a weak base, can be used to make the fertiliser ammonium phosphate.



Calculate the mass of ammonium phosphate that would be produced from 510g of ammonia.

3

105. Vinegar is an aqueous solution of ethanoic acid.

Vinegar contains 6g of ethanoic acid, CH_3COOH , in 100cm^3 of solution.

Calculate the concentration, in mol l^{-1} , of this solution.

3

106. Write the formula for aluminium hydroxide.

1

107. Dishwasher tablets contain many different types of chemicals.

- a) A dishwasher tablet was found to contain 1.57g of the bleaching agent, sodium percarbonate.

Calculate the number of moles in 1.57g of sodium percarbonate.

1

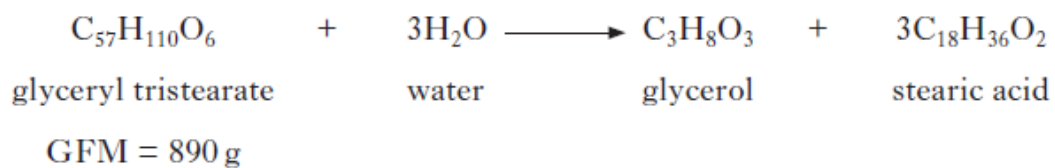
(Formula mass of sodium percarbonate = 157.)

- b) Phosphate ions, present in some types of dishwasher tablets, react with calcium ions in water forming calcium phosphate.

Write the formula for calcium phosphate.

1

108. The equation below shows the breakdown of glyceryl tristearate to form glycerol and stearic acid.



Calculate the mass, in g, of stearic acid produced from 8.9 g of glyceryl tristearate. **3**

109. Glass is made from the chemical silica, SiO_2 , which is covalently bonded and has a melting point of 1700°C .

Antimony(III) oxide is added to reduce any bubbles that may appear during the manufacturing process.

Write the chemical formula for antimony(III) oxide. **1**

110. In some types of airbag, electrical energy causes sodium azide, NaN_3 , to decompose producing sodium metal and nitrogen gas.

Write a formula equation for this reaction. **1**

111. A strip of rhubarb was found to contain 1.8 g of oxalic acid.

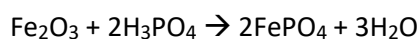
Calculate the number of moles of oxalic acid, $\text{C}_2\text{H}_2\text{O}_4$, contained in 1.8g.

1

(Formula mass of oxalic acid = 90)

112. Rust, iron(III) oxide, that forms on cars can be treated using rust remover which contains phosphoric acid.

When painted on, rust remover changes iron(III) oxide into iron(III) phosphate.



The rust remover contains 250cm^3 of 2 mol l^{-1} phosphoric acid.

a) Calculate the number of moles of phosphoric acid in the rust remover.

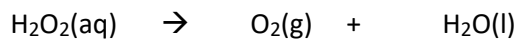
1

b) Using your answer in part (i), calculate the mass of iron(III) oxide that will be removed by 250cm^3 of 2 mol l^{-1} phosphoric acid.

2

113. Hydrogen peroxide is a useful bleaching agent and is contained in many hair dyes. Over time, the hair dye becomes less effective as the hydrogen peroxide decomposes forming water and oxygen.

The equation for the decomposition of hydrogen peroxide is:



- a) Balance this equation. **1**

- b) When 34g of hydrogen peroxide decomposes, 12 litres of oxygen is produced.
Calculate the volume of oxygen produced, in litres, when 1.7g of hydrogen peroxide decomposes. **2**

114. Research is being carried out into making chemicals that can be used to help relieve the side effects of chemotherapy.

Part of the process is shown.



This reaction is catalysed using ruthenium(II) chloride.

Write the formula for ruthenium(II) chloride. **1**

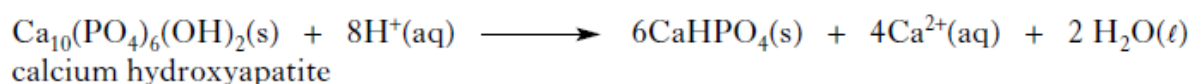
115. Ammonium sulphate is a commonly used fertiliser. It can be produced by the reaction between ammonium carbonate and calcium sulphate.



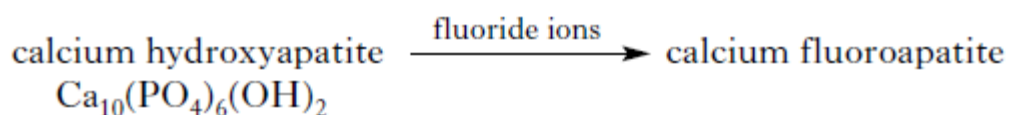
What mass of ammonium carbonate, $(\text{NH}_4)_2\text{CO}_3$, would be needed to make 13.2 kg of ammonium sulphate, $(\text{NH}_4)_2\text{SO}_4$? **3**

116. Fizzy drinks contain acids.

These acids can attack the compound calcium hydroxyapatite which is found in tooth enamel. The equation for the reaction is:



Fluoride prevents tooth decay by replacing the hydroxide ions of calcium hydroxyapatite with fluoride ions to form hard wearing calcium fluoroapatite.



Write the formula for calcium fluoroapatite.

1

117. Read the passage below and attempt the questions that follow.

Hydrogen Storage

The portable storage of hydrogen (H_2) is key to the development of hydrogen fuel cell cars. While many chemists focus their attention on the use of metal alloys and hydrides for storing hydrogen, others have investigated the potential use of carbon nanotubes.

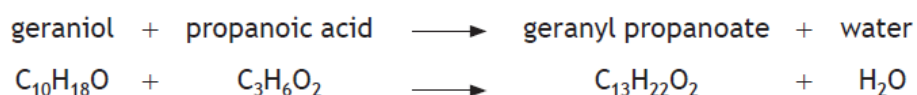
A carbon nanotube is a tiny rolled up sheet of graphite. A research team has designed a pillared structure made up of vertical columns of carbon nanotubes which stabilise parallel graphene sheets. Graphene sheets are layers of carbon which are one atom thick.

Lithium atoms are added to the pillared structure to increase the hydrogen storage capacity. Researchers claim that one litre of the structure can store 41 g of hydrogen gas, which comes close to the US Department of Energy's target of 45 g.

Adapted from *InfoChem Magazine* (RSC), Nov 2008

- a) Name the term used to describe a tiny rolled up sheet of graphite. 1
- b) Name the metal added to the pillared structure to increase the hydrogen storage capacity. 1
- c) Calculate the number of moles of hydrogen that, researchers claim, can be stored by one litre of this structure. 2
- Show your working clearly.**

118. A student prepared a sample of geranyl propanoate from geraniol and propanoic acid.



15.4 g of geraniol was reacted with excess propanoic acid.

Calculate the mass, in grams, of geranyl propanoate which would be produced. 3

Show your working clearly.

Acids and Alkalis

119. Which of the following oxides, when shaken with water, would leave the pH unchanged?
You may wish to use the data booklet to help you.

- A Carbon dioxide
- B Copper oxide
- C Sodium oxide
- D Sulfur dioxide

120. Which compound would **not** neutralise hydrochloric acid?

- A Sodium carbonate
- B Sodium chloride
- C Sodium hydroxide
- D Sodium oxide

121. An acidic solution contains

- A only hydrogen ions
- B only hydroxide ions
- C more hydrogen ions than hydroxide ions
- D more hydroxide ions than hydrogen ions

122. Which of the following oxides, when shaken with water, would give an alkaline solution?

- A Calcium oxide
- B Nickel oxide
- C Nitrogen dioxide
- D Sulfur dioxide

123. Which of the following compounds is **not** a salt?

- A Calcium nitrate
- B Sodium chloride
- C Potassium sulfate
- D Magnesium hydroxide

124. $\text{H}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) + \text{K}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{K}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) + \text{H}_2\text{O}(\ell)$

The spectator ions present in the reaction above are

- A $\text{K}^+(\text{aq})$ and $\text{NO}_3^-(\text{aq})$
- B $\text{K}^+(\text{aq})$ and $\text{H}^+(\text{aq})$
- C $\text{OH}^-(\text{aq})$ and $\text{NO}_3^-(\text{aq})$
- D $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$

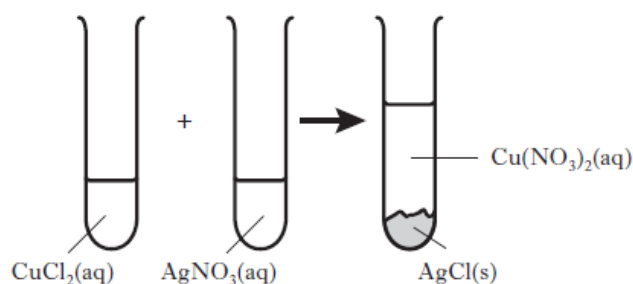
125. Which of the following oxides, when shaken with water, would leave the pH unchanged?
You may wish to use the data booklet to help you.

- A Carbon dioxide
- B Copper oxide
- C Sodium oxide
- D Sulfur dioxide

126. Which compound would **not** neutralise hydrochloric acid?

- A Sodium carbonate
- B Sodium chloride
- C Sodium hydroxide
- D Sodium oxide

127. The diagram below shows what happens when two solutions are mixed.



Which of the following terms describe the reaction that has taken place?

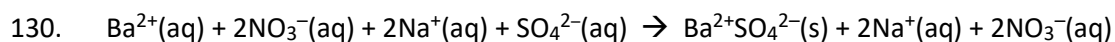
- A Addition
- B Neutralisation
- C Precipitation
- D Redox

128. An acidic solution contains

- A only hydrogen ions
- B only hydroxide ions
- C more hydrogen ions than hydroxide ions
- D more hydroxide ions than hydrogen ions

129. Which of the following oxides, when shaken with water, would give an alkaline solution?

- A Calcium oxide
- B Nickel oxide
- C Nitrogen dioxide
- D Sulphur dioxide



The type of reaction represented by the equation above is

- A addition
- B displacement
- C neutralisation
- D precipitation

131. When hydrogen chloride gas is dissolved in water a solution containing hydrogen ions and chloride ions is formed.

Which equation correctly shows the state symbols for this change?

- A $\text{HCl}(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}^{+}(\text{aq}) + \text{Cl}^{-}(\text{aq})$
- B $\text{HCl}(\text{l}) + \text{H}_2\text{O}(\text{aq}) \rightarrow \text{H}^{+}(\text{l}) + \text{Cl}^{-}(\text{l})$
- C $\text{HCl}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}^{+}(\text{aq}) + \text{Cl}^{-}(\text{aq})$
- D $\text{HCl}(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}^{+}(\text{l}) + \text{Cl}^{-}(\text{l})$

132. An alkaline solution contains

- A hydroxide ions but no hydrogen ions
- B equal numbers of hydrogen and hydroxide ions
- C more hydroxide ions than hydrogen ions
- D more hydrogen ions than hydroxide ions

133. Which of the following compounds is a base?

- A Sodium carbonate
- B Sodium chloride
- C Sodium nitrate
- D Sodium sulphate

134. Which of the following compounds is a salt?

- A Ammonium chloride
- B Calcium oxide
- C Hydrogen chloride
- D Sodium hydroxide

135. A student adds a powder to dilute hydrochloric acid. A gas which burns with a pop is produced.

The powder could be

- A carbon
- B calcium oxide
- C sodium carbonate
- D zinc

136. Which of the following substances is **not** a salt?

- A Copper sulphate
- B Sodium oxide
- C Magnesium chloride
- D Calcium nitrate

137. Which of the following oxides dissolves in water to produce a solution with a pH greater than 7?

- A Na_2O
- B Al_2O_3
- C SO_2
- D Ag

138. Which line in the table describes what happens to a dilute solution of hydrochloric acid when water is added to it?

	pH	$\text{H}^+(\text{aq})$ concentration
A	increases	increases
B	increases	decreases
C	decreases	increases
D	decreases	decreases

139. $\text{H}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) + \text{K}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{K}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) + \text{H}_2\text{O}$

The spectator ions in the reaction are

- A $\text{H}^+(\text{aq})$ and $\text{K}^+(\text{aq})$
- B $\text{NO}_3^-(\text{aq})$ and $\text{OH}^-(\text{aq})$
- C $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$
- D $\text{K}^+(\text{aq})$ and $\text{NO}_3^-(\text{aq})$

140. Which of the following statements correctly describes the concentrations of $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$ ions in pure water?

- A The concentrations of $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$ ions are equal
- B The concentrations of $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$ ions are zero
- C The concentration of $\text{H}^+(\text{aq})$ ions is greater than the concentration of $\text{OH}^-(\text{aq})$ ions
- D The concentration of $\text{H}^+(\text{aq})$ ions is less than the concentration of $\text{OH}^-(\text{aq})$ ions

141. Which of the following compounds is a base?

- A Sodium carbonate
- B Sodium chloride
- C Sodium nitrate
- D Sodium sulfate

142. $\text{AgNO}_3(\text{aq}) + \text{KCl}(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{KNO}_3(\text{aq})$

Which of the following are the spectator ions in this reaction?

- A Ag^+ and Cl^-
- B K^+ and NO_3^-
- C Ag^+ and NO_3^-
- D K^+ and Cl^-

143. Which of the following salts can be prepared by a precipitation reaction?

You may wish to use the data booklet to help you.

- A Barium sulfate
- B Lithium nitrate
- C Calcium chloride
- D Ammonium phosphate

144. A solution of accurately known concentration is more commonly known as a

- A correct solution
- B precise solution
- C standard solution
- D prepared solution.

145. Some sources of methane gas contain hydrogen sulfide, H_2S .
- a) If hydrogen sulfide is not removed before methane gas is burned, sulfur dioxide is formed. When sulfur dioxide dissolves in water in the atmosphere, acid rain is produced. Circle the correct words to complete the sentence. **1**

Acid rain contains more $\left\{ \begin{array}{c} \text{hydrogen} \\ \text{hydroxide} \end{array} \right\}$ ions than $\left\{ \begin{array}{c} \text{hydrogen} \\ \text{hydroxide} \end{array} \right\}$ ions.

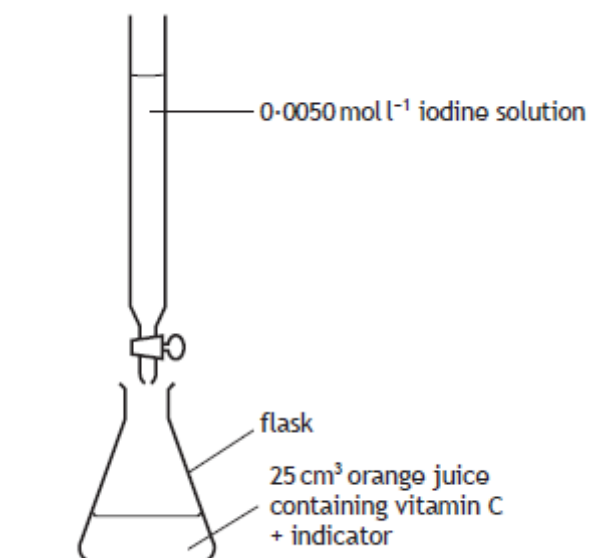
- b) In industry, calcium oxide is reacted with sulfur dioxide to reduce the volume of sulfur dioxide released into the atmosphere. Explain why calcium oxide is able to reduce the volume of sulfur dioxide gas released. **2**

146. A student was asked to carry out an experiment to determine the concentration of a copper(II) sulfate solution. Part of the work card used is shown.

Determination of the Concentration of Copper(II) Sulfate Solution	
1.	Weigh an empty crucible
2.	Add 100 cm^3 copper(II) sulfate solution
3.	Evaporate the solution to dryness
4.	Weigh the crucible containing dry copper(II) sulfate

- Suggest how the student could have evaporated the solution to dryness. **1**

147. Vitamin C is found in fruits and vegetables.
Using iodine solution, a student carried out titrations to determine the concentration of vitamin C in orange juice.

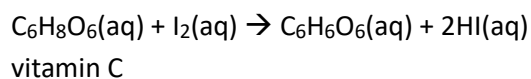


The results of the titration are given in the table.

<i>Titration</i>	<i>Initial burette reading (cm³)</i>	<i>Final burette reading (cm³)</i>	<i>Titre (cm³)</i>
1	1.2	18.0	16.8
2	18.0	33.9	15.9
3	0.5	16.6	16.1

- a) Calculate the average volume, in cm³, that should be used in calculating the concentration of vitamin C. **1**

- b) The equation for the reaction is

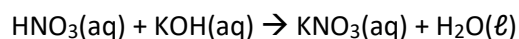


Calculate the concentration, in mol l⁻¹, of vitamin C in the orange juice.

Show your working clearly.

3

148. Nitric acid can be converted to potassium nitrate.
The equation for the reaction taking place is



- a) Name the type of chemical reaction taking place.

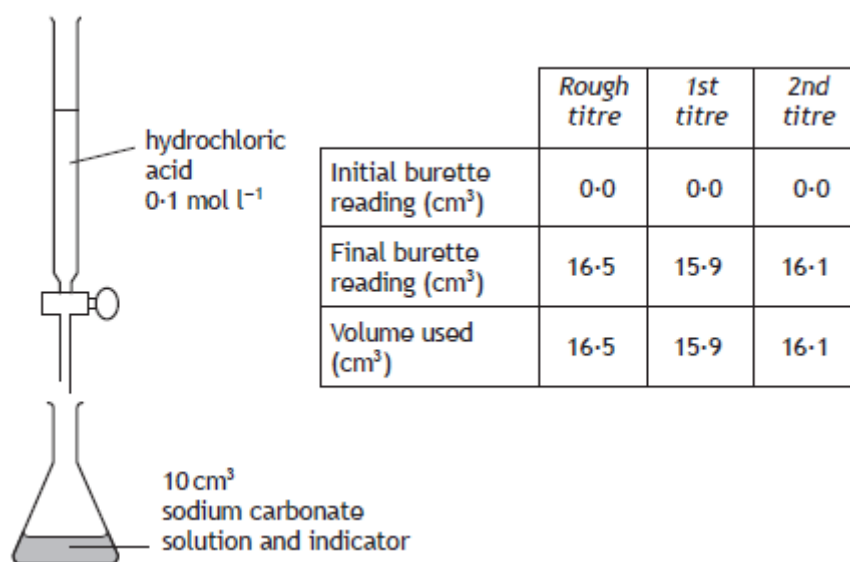
1

- b) State how a sample of **solid** potassium nitrate could be obtained from the potassium nitrate solution.

1

149. Sodium carbonate solution can be added to the water in swimming pools to neutralise the acidic effects of chlorine.

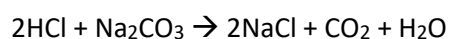
A student carried out a titration experiment to determine the concentration of a sodium carbonate solution.



- a) Using the results in the table, calculate the average volume, in cm³, of hydrochloric acid required to neutralise the sodium carbonate solution.

1

b) The equation for the reaction is



Using your answer from part (a) calculate the concentration, in mol l^{-1} , of the sodium carbonate solution.

Show your working clearly.

3

150. Sulfur dioxide gas is produced when fossil fuels containing sulfur are burned. When sulfur dioxide dissolves in water in the atmosphere "acid rain" is produced.

a) Circle the correct phrase to complete the sentence.

1

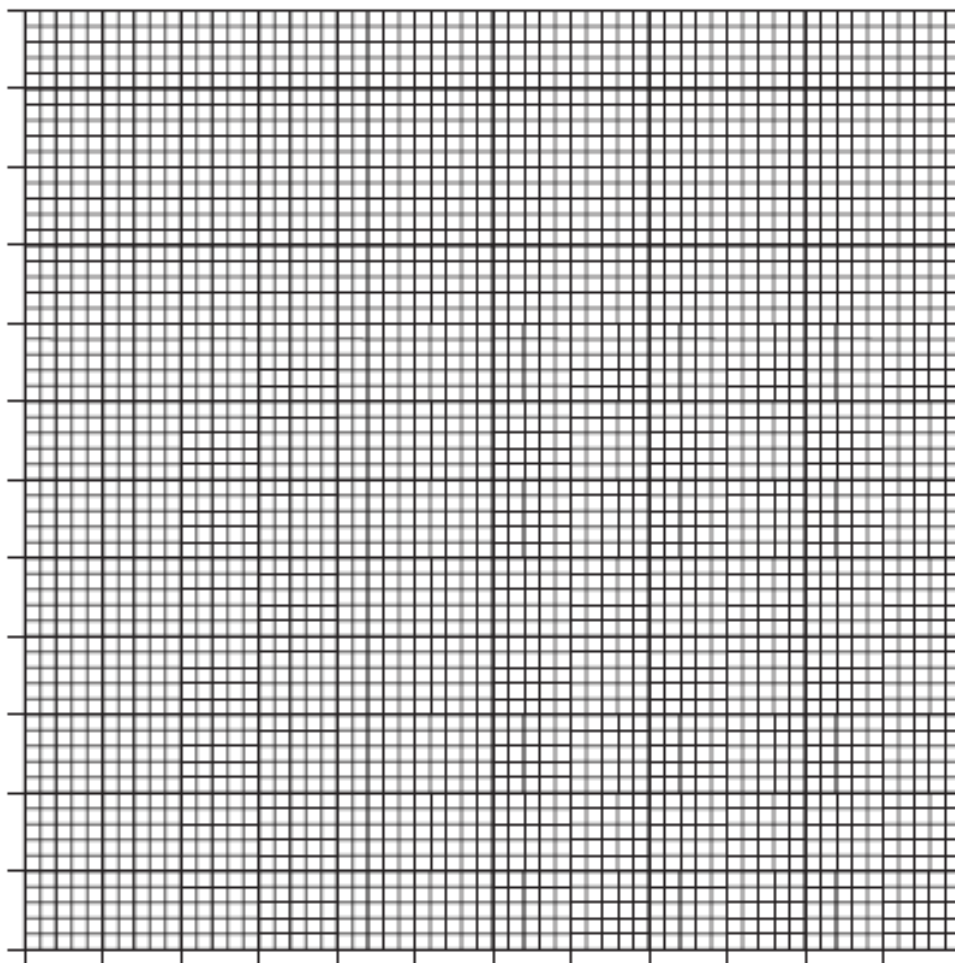
Compared with pure water, acid rain contains $\left\{ \begin{array}{l} \text{a higher} \\ \text{a lower} \\ \text{the same} \end{array} \right\}$ concentration of hydrogen ions.

- b) The table shows information about the solubility of sulfur dioxide.

<i>Temperature (°C)</i>	0	20	30	40	50	60
<i>Solubility (g/100cm³)</i>	22.0	10.0	6.0	3.0	2.0	1.5

- i) Draw a line graph of solubility against temperature.
Use appropriate scales to fill most of the graph paper.

3



- ii) Using your graph, estimate the solubility of sulfur dioxide, in g/100 cm³, at 10 °C.

1

151. A student investigated the reaction of carbonates with dilute hydrochloric acid.

a) In one reaction lithium carbonate reacted with dilute hydrochloric acid.

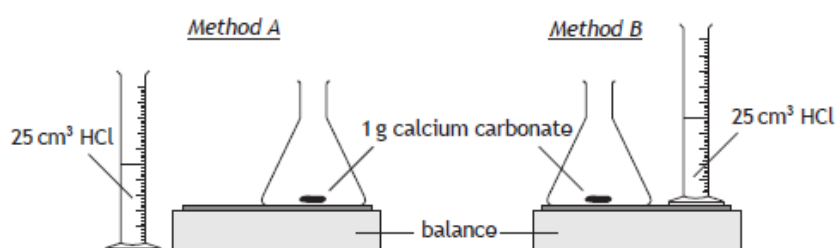
The equation for the reaction is:



Identify the salt produced in this reaction.

1

b) The student considered two methods to confirm the mass of carbon dioxide gas produced in this reaction.



Method A	Method B
1. Add the acid from the measuring cylinder to the calcium carbonate in the flask.	1. Weigh the flask with the calcium carbonate and the acid in the measuring cylinder together.
2. Weigh the flask and contents.	2. Add the acid from the measuring cylinder to the calcium carbonate in the flask and replace the empty measuring cylinder on the balance.
3. Leave until no more bubbles are produced.	3. Leave until no more bubbles are produced.
4. Reweigh the flask and contents.	4. Reweigh the flask, contents and the empty measuring cylinder together.

Explain which method would give a more reliable estimate of the mass of carbon dioxide produced during the reaction.

2

152. Antacid tablets are used to treat indigestion which is caused by excess acid in the stomach. Different brands of tablets contain different active ingredients.

<i>Name of active ingredient</i>	magnesium carbonate	calcium carbonate	magnesium hydroxide	aluminium hydroxide
<i>Reaction with acid</i>	fizzes	fizzes	does not fizz	does not fizz
<i>Cost per gram (pence)</i>	16.0	11.0	7.5	22.0
<i>Mass of solid needed to neutralise 20 cm³ of acid (g)</i>	0.7	1.2	0.6	0.4
<i>Cost of neutralising 20 cm³ of acid (pence)</i>		13.2	4.5	8.8

- a) Complete the table to show the cost of using magnesium carbonate to neutralise 20cm³ of acid. 1
- b) Which **one** of the four active ingredients would **you** use to neutralise excess stomach acid? Explain your choice. 1

153. Read the passage below and answer the questions that follow.

Potassium Permanganate (KMnO₄)—The Purple Solution

Potassium permanganate's strong oxidising properties make it an effective disinfectant. Complaints such as athlete's foot and some fungal infections are treated by bathing the affected area in KMnO₄ solution.

In warm climates vegetables are washed in KMnO₄ to kill bacteria such as *E. coli* and *S. aureus*. Chemists use KMnO₄ in the manufacture of saccharin, ascorbic acid (vitamin C) and benzoic acid.

Baeyer's reagent is an alkaline solution of KMnO₄ and is used to detect unsaturated organic compounds. The reaction of KMnO₄ with alkenes is also used to extend the shelf life of fruit. Ripening fruit releases ethene gas which causes other fruit to ripen. Shipping containers are fitted with gas scrubbers that use alumina or zeolite impregnated with KMnO₄ to stop the fruit ripening too quickly.



The scrubbers indicate when they need to be replaced because the purple colour changes to brown as the KMnO₄ is used up.

The passage on potassium permanganate was taken from an article by Simon Cotton on "Soundbite molecules" in "Education in Chemistry" November 2009.

- a) Suggest a pH for Baeyer's reagent. 1
- b) Name the gas removed by the scrubbers. 1

154. A student was asked to carry out an experiment to determine the concentration of a copper (II) sulfate solution. Part of the work card used is shown.

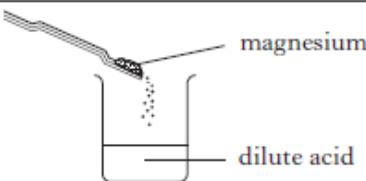
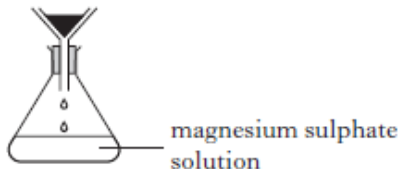
Determination of the Concentration of Copper(II) Sulphate Solution

- 1 Weigh an empty crucible
- 2 Add 100 cm³ copper(II) sulphate solution
- 3 Evaporate the solution to dryness
- 4 Weigh the crucible containing dry copper(II) sulphate

Suggest how the student could have evaporated the solution to dryness.

1

155. A student carried out an experiment to prepare the salt, magnesium sulfate. Part of the student's assessment sheet is shown.

Intermediate 2	Unit 3	
Chemistry	Preparation of a Salt	PPA1
Assessment Sheet		
Aim To prepare a pure sample of magnesium sulphate.		
Procedure		
Step 1 reaction	 <div style="display: flex; justify-content: center; gap: 50px;"> <div style="text-align: left;">magnesium</div> <div style="text-align: left;">dilute acid</div> </div>	
Step 2 filtration	 <div style="display: flex; justify-content: center; gap: 50px;"> <div></div> <div style="text-align: left;">magnesium sulphate solution</div> </div>	

- a) Name the acid used to make this salt. **1**
- b) How would the student know when to stop adding magnesium in Step 1? **1**
- c) Why was the reaction mixture filtered in Step 2? **1**
- d) The pH of a salt depends on whether the acid and base used to make it are weak or strong.

Base	Acid	Salt	pH
sodium hydroxide	hydrochloric acid	sodium chloride	7
sodium hydroxide	ethanoic acid	sodium ethanoate	12
ammonia	hydrochloric acid	ammonium chloride	3
sodium hydroxide	citric acid	sodium citrate	12

From this information, what type of acid is citric acid?

1

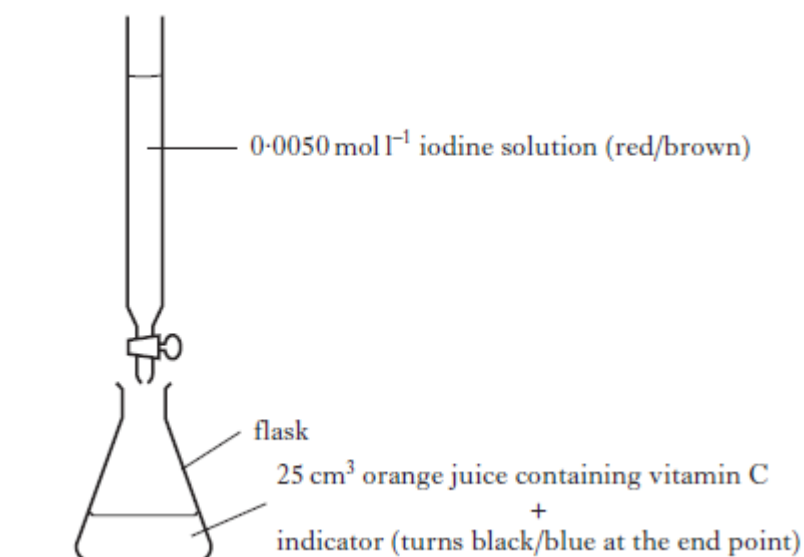
156. Vitamin C is found in fruits and vegetables.

a) Vitamin C is an acid and has a pH value of less than 7.

What is meant by an acid?

1

b) Using iodine solution, a student carried out titrations to determine the concentration of vitamin C in orange juice.



The results of the titration are given in the table.

Titration	Initial burette reading (cm ³)	Final burette reading (cm ³)	Titre (cm ³)
1	1.2	18.0	16.8
2	18.0	33.9	15.9
3	0.5	16.6	16.1

i) What average volume, in cm³, should be used in calculating the concentration of vitamin C?

1

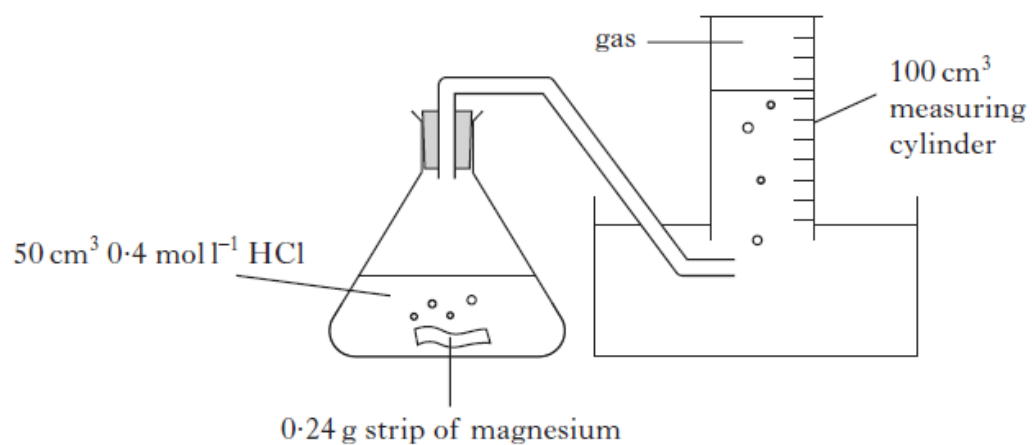
ii) The equation for the reaction between vitamin C and iodine solution is shown.



Calculate the concentration, in mol l⁻¹, of vitamin C in the orange juice.

3

157. A student monitored the rate of reaction between magnesium and dilute hydrochloric acid using a measuring cylinder to collect the gas produced.



Name the gas produced in this experiment.

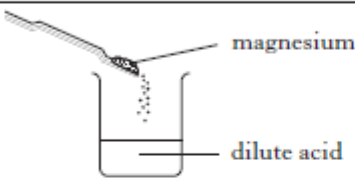
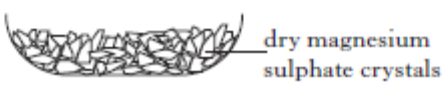
1

158. A student carried out a PPA to prepare the salt, magnesium sulphate.

a) Name the acid used to make this salt.

1

b) Part of the student's PPA assessment sheet is shown.

Intermediate 2 Chemistry	Preparation of a Salt	Unit 3 PPA1
Assessment Sheet		
Aim To prepare magnesium sulphate crystals by reacting excess magnesium with dilute acid.		
Procedure		
<div><div>Step 1 reaction</div><div></div></div>		
<div>Step 2</div> <div>_____</div>		
<div>Step 3</div> <div>_____</div>		
<div>Step 4</div> <div></div>		

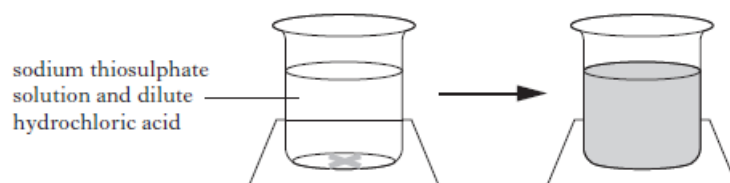
Name steps 2 and 3 in the preparation of magnesium sulphate.

2

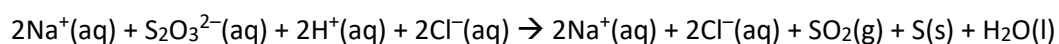
Step 2 _____

Step 3 _____

159. In the experiment, “**Effect of temperature on reaction rate**”, the reaction between sodium thiosulfate solution and dilute hydrochloric acid is investigated.



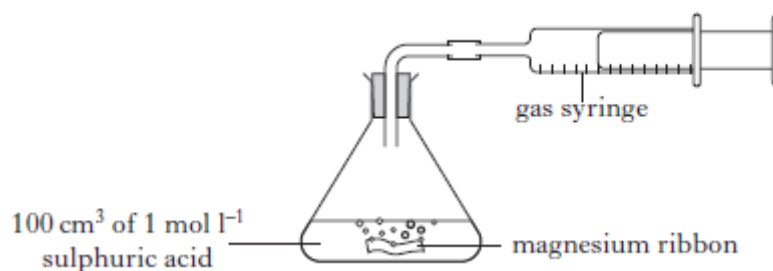
The equation for the reaction taking place is



Rewrite the equation omitting the spectator ions.

1


160. Magnesium reacts with dilute sulphuric acid to produce a gas.



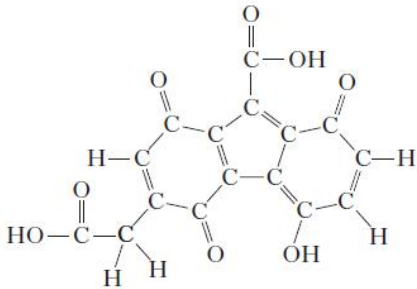
Name the gas produced in this reaction.

1

161.



When a hippopotamus is seen out of water it looks as though it is bleeding. This is due to a red coloured secretion which protects the hippopotamus against sunburn caused by UVB radiation. Scientists have found that one of the active ingredients in this natural sunscreen is a chemical called hipposudoric acid.



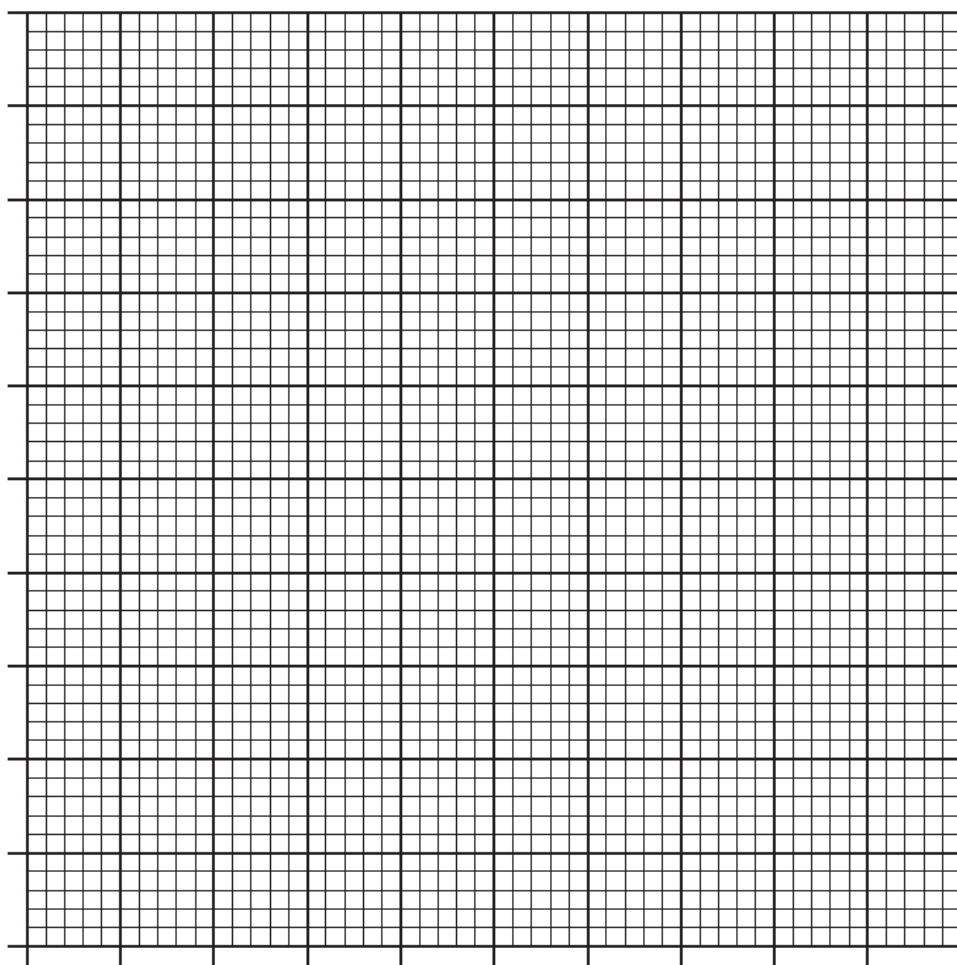
hipposudoric acid

- a) Suggest a pH value for hipposudoric acid. 1
- b) Bottles of sun cream display a sun protection factor which gives an indication of how well the sun cream protects against UVB radiation.
The table gives information about sun protection factors.

Sun protection factor	0	2	4	8	15	30	50
UVB radiation screened (%)	0	50	70	88	94	97	98

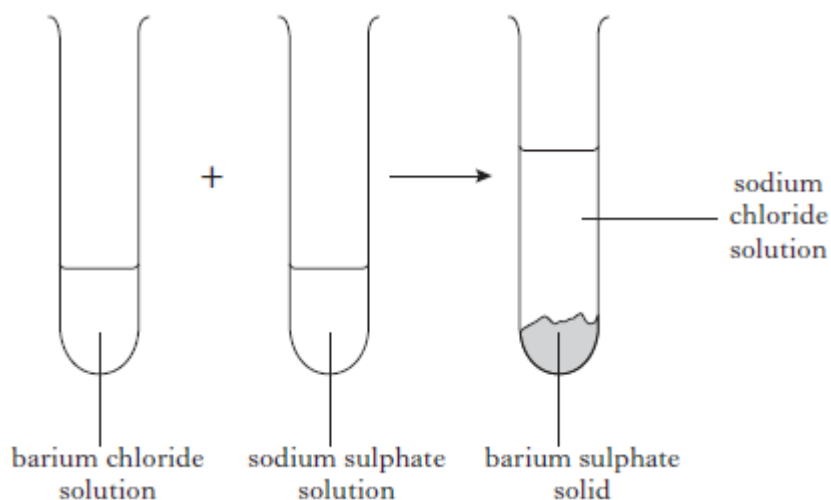
Draw a line graph to show the percentage of UVB radiation screened by different sun protection factors.

3



162. Egg shells are made up mainly of calcium carbonate. A pupil carried out an experiment to react egg shells with dilute hydrochloric acid.
Name the salt produced in this reaction.

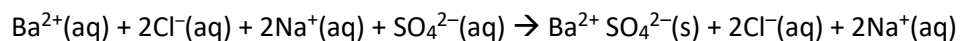
163. A student carried out the following experiment.



- a) During the reaction a solid was formed.
Name the type of chemical reaction taking place.

1

- b) The equation for the reaction is



- i) Rewrite the equation showing only the ions which react.

1

- ii) What term is used to describe the ions which do not react?

1

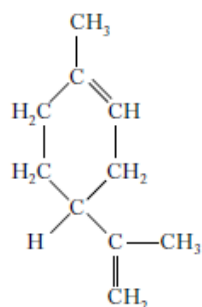
164. Ammonium sulphate is a commonly used fertiliser. It can be produced by the reaction between ammonium carbonate and calcium sulphate.



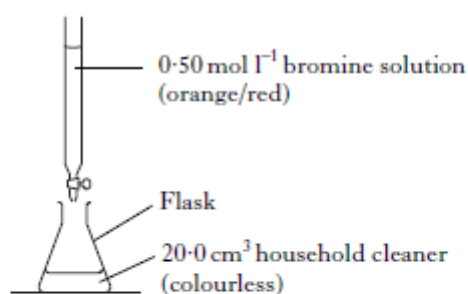
Name this type of chemical reaction.

1

165. Some household cleaners contain the chemical limonene which gives them a lemon smell. The structure of limonene is shown below.



- a) Using bromine solution, a student carried out titrations to determine the concentration of limonene in a household cleaner.



Titration	Initial burette reading (cm ³)	Final burette reading (cm ³)	Titre (cm ³)
1	0.5	17.1	16.6
2	0.2	16.3	16.1
3	0.1	16.0	15.9

- i) What colour change would be seen in the flask that indicates the end point of the titrations? 1
- ii) Calculate the average volume, in cm³, that should be used in calculating the concentration of limonene. 1
- iii) The equation for the reaction between limonene and bromine solution is shown.



Calculate the concentration, in mol l⁻¹, of limonene in the household cleaner. 3

166. Some indicators can have different colours when in solutions of different pH values.
The tables give information about two indicators, bromothymol blue and methyl orange.

Bromothymol blue	
Colour	pH
yellow	below 6.0
blue	above 7.6

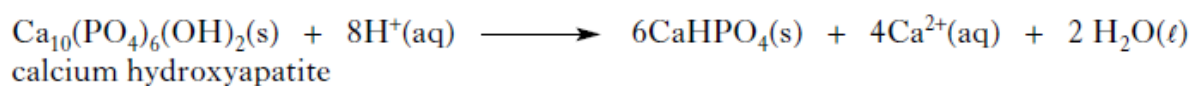
Methyl orange	
Colour	pH
red	below 3.1
yellow	above 4.4

The pH of three solutions was investigated using both indicators.
The results are shown below.

Substance	Colour with bromothymol blue	Colour with methyl orange
A	yellow	red
B	yellow	yellow
C	blue	yellow

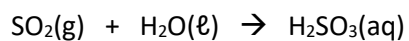
- a) State which solution is alkaline. 1
- b) Suggest a pH value for solution B. 1

167. Fizzy drinks contain acids.
These acids can attack the compound calcium hydroxyapatite which is found in tooth enamel.
The equation for the reaction is:



State what will happen to the pH as the tooth enamel is attacked by the acids. 1

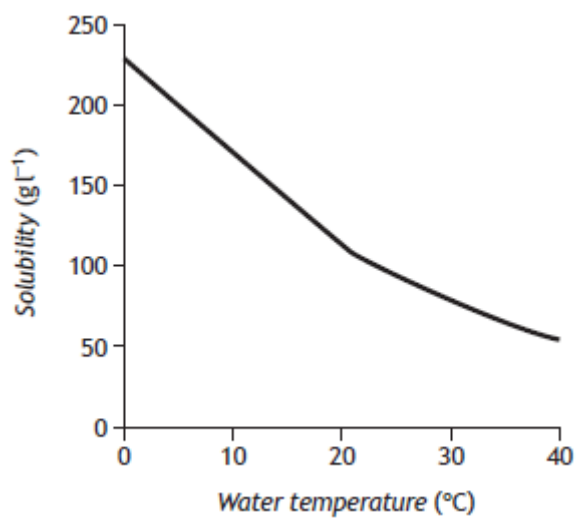
168. Sulfur dioxide is an important industrial chemical.
Sulfur dioxide dissolves in water to produce sulfurous acid.



- a) Explain the change in the pH of the solution as sulfur dioxide dissolves.

2

- b) The graph shows the solubility of sulfur dioxide at different temperatures.



Describe the general trend in solubility as the temperature of the water increases.

1

169. A student was given two solutions of sodium carbonate, one solution with a concentration of 0.1 mol l^{-1} and the other with a concentration of 0.2 mol l^{-1} .

Using your knowledge of chemistry, suggest how the student could distinguish between the solutions.

3