

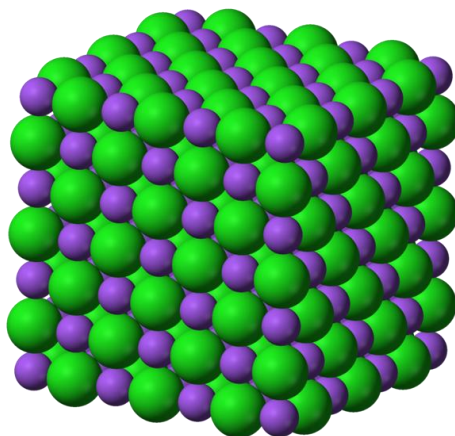


Cathkin High School
Chemistry Department

Senior Phase

NATIONAL 5 CHEMISTRY

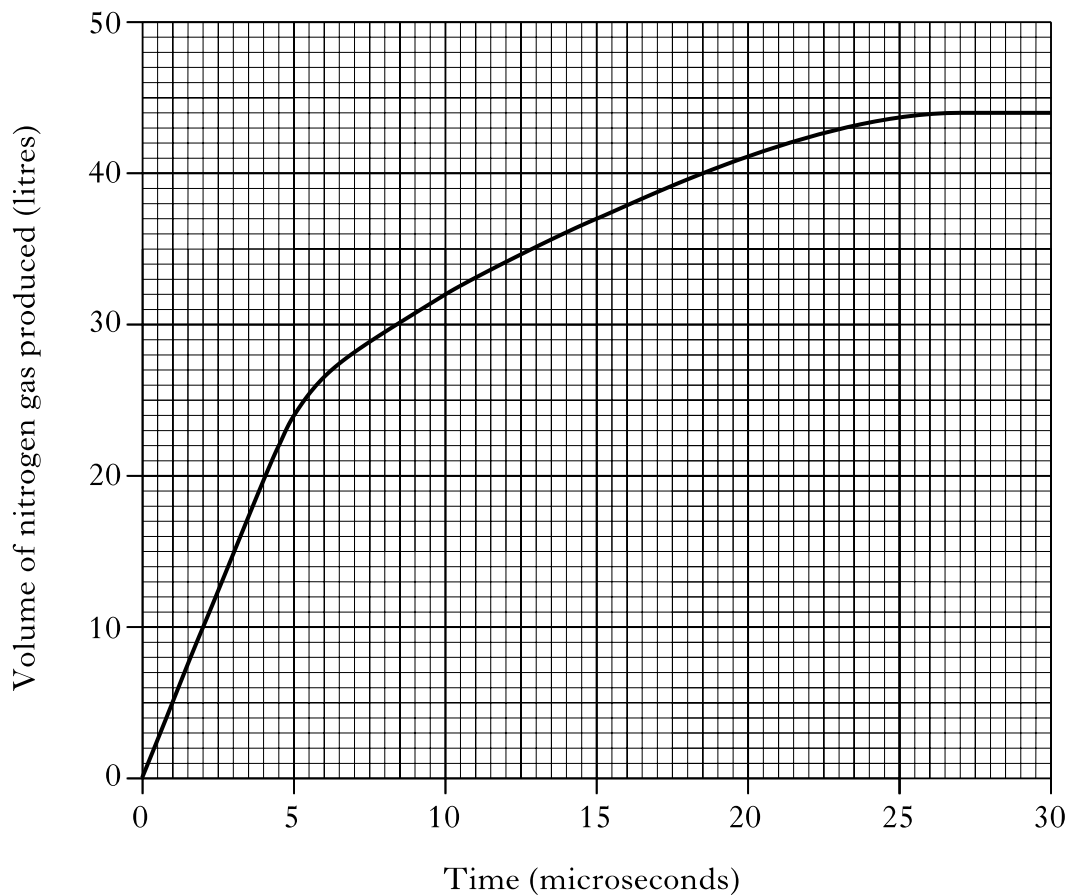
Unit 1:
Chemical Changes and Structure



Past Paper Homework

1. 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.



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

1

2. 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. The volume of gas produced during the reaction was measured.

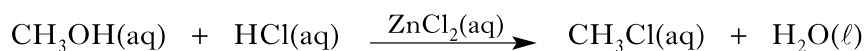
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Time (min)	Volume of gas (cm ³)
0	0
2	47
4	92
6	114
8	118
10	118

Plot these results as a line graph.

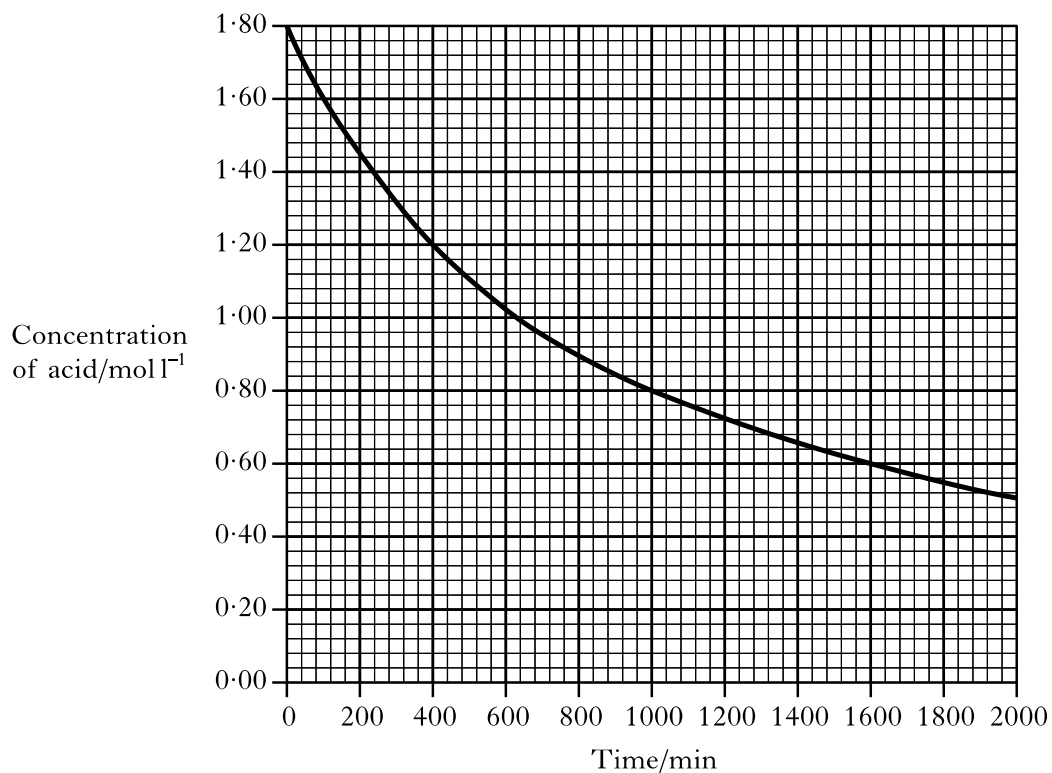
2011 H 1

3. Chloromethane, CH₃Cl, can be produced by reacting methanol solution with dilute hydrochloric acid using a solution of zinc chloride as a catalyst.



The graph shows how the concentration of the hydrochloric acid changed over a period of time when the reaction was carried out at 20 °C.

1

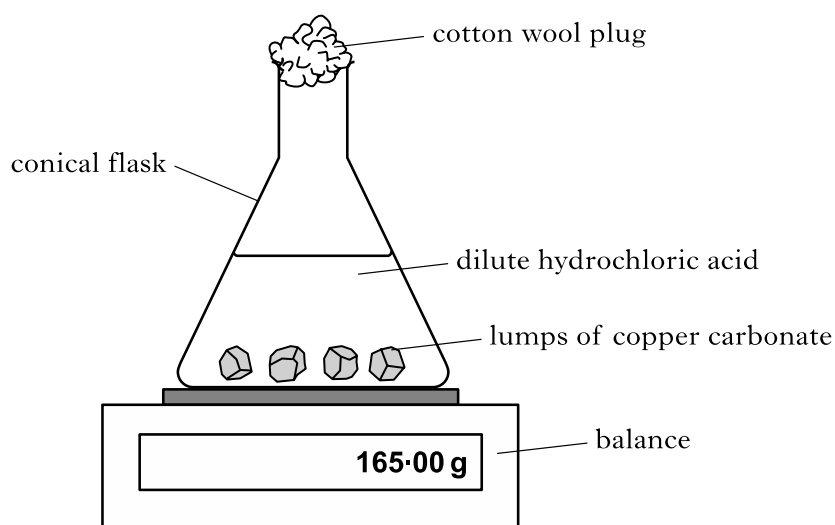


Calculate the average rate, in mol l⁻¹ min⁻¹, in the first 400 minutes.

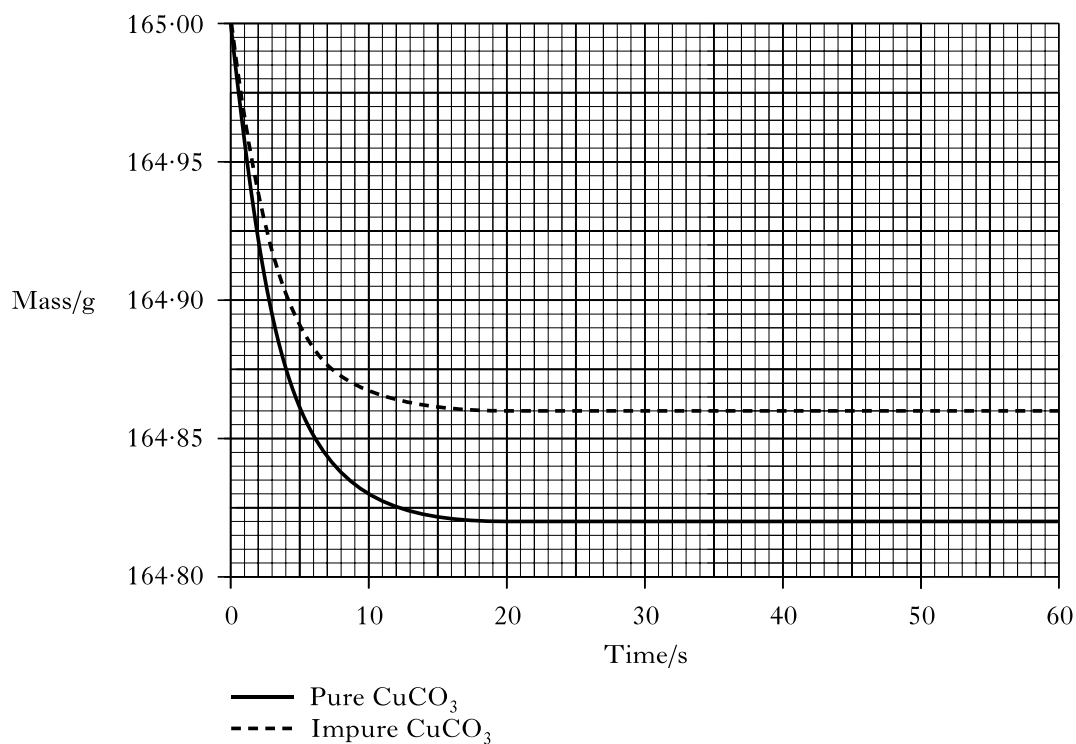
4. Copper(II) carbonate reacts with dilute hydrochloric acid as shown.



A student used the apparatus shown below to follow the progress of the reaction.

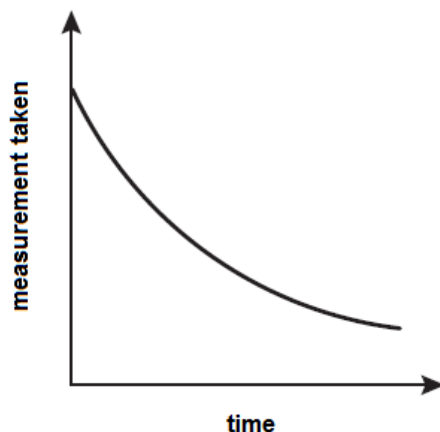


The experiment was carried out using 0.50 g samples of both pure and impure copper(II) carbonate. The graph below shows the results obtained.



For the sample of pure copper(II) carbonate, calculate the average reaction rate, in g s^{-1} , over the first 10 seconds.

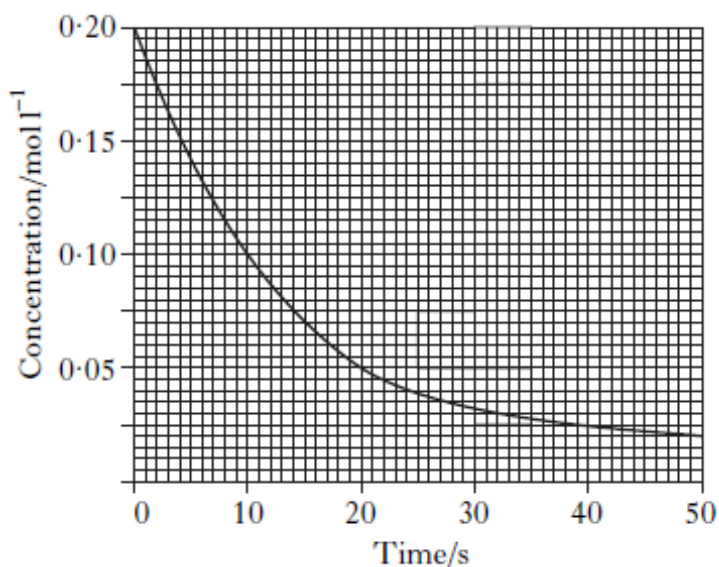
5. Excess marble chips (calcium carbonate) were added to 25 cm³ of hydrochloric acid, concentration 2 mol l⁻¹.



Which of the following measurements, taken at regular intervals and plotted against time, would give the graph shown above? 1

- A Temperature
- B Volume of gas produced
- C pH of solution
- D Mass of the beaker and contents

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



What is the average reaction rate during the first 20 s? 1

- A 0.0025 mol l⁻¹ s⁻¹
- B 0.0050 mol l⁻¹ s⁻¹
- C 0.0075 mol l⁻¹ s⁻¹
- D 0.0150 mol l⁻¹ s⁻¹

7. The following results were obtained in the reaction between marble chips and dilute hydrochloric acid.

Time/minutes	0	2	4	6	8	10
Total volume of carbon dioxide produced/cm³	0	52	68	78	82	84

What is the average rate of production of carbon dioxide, in $\text{cm}^3 \text{min}^{-1}$, between 2 and 8 minutes?

1

- A 5
B 26
C 30
D 41

2010 Int2 2MC

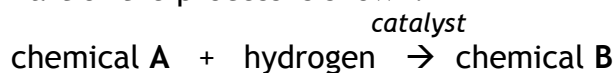
8. During the first 20 seconds of a chemical reaction, 5.0 cm^3 of gas were given off. The average rate of the reaction, in $\text{cm}^3 \text{s}^{-1}$, during the first 20 seconds is

1

- A 20.0
B 5.0
C 4.0
D 0.25.

2011 Int2 4b

9. 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.



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

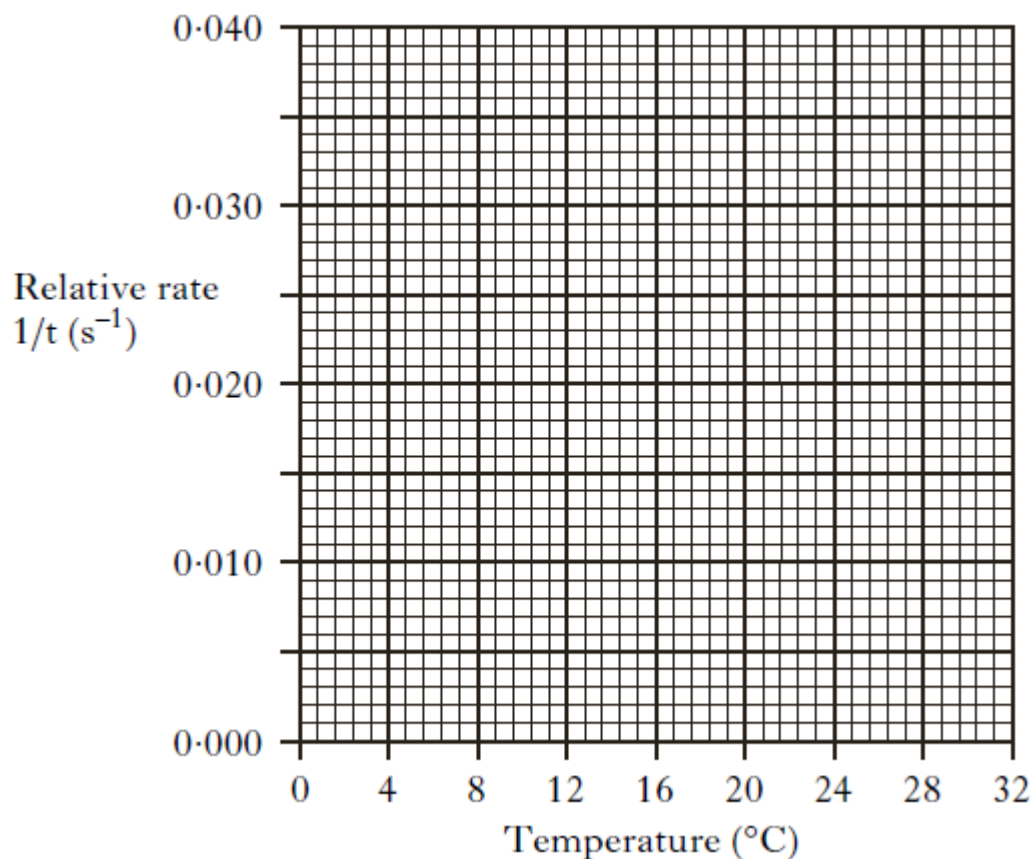
- (a) Draw a line graph showing the decrease in pressure as time proceeds. 2
- (b) Using your graph, at what time did the reaction finish? 1
- (c) Calculate the average rate of the reaction, in bar min^{-1} , between 10 and 20 minutes. 1

10. A student investigated the effect of temperature on the rate of starch formation. The results are shown.

Temperature (°C)	Relative rate $1/t$ (s^{-1})
4	0.003
12	0.010
16	0.016
20	0.022
24	0.033

- (a) Plot these results as a line graph.

1



- (b) At 32 °C the relative rate was $0.0125s^{-1}$.
Use this rate to calculate the reaction time, in seconds, at 32 °C.

1

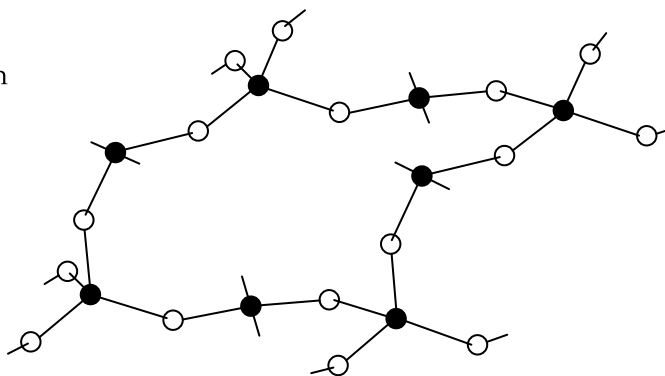
1. (a) Complete the table to match up each type of bonding and structure with its properties.

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.

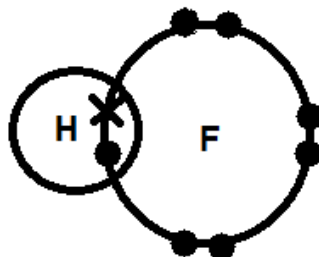
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2. Information on some two-element molecules is shown in the table.

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

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

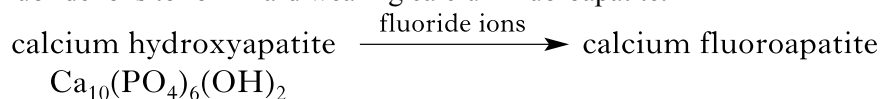
(b) The hydrogen fluoride molecule can be represented as: 1



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

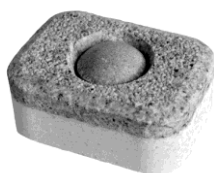
3. Write the formula for ruthenium(II) chloride. 1

4. 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

5. Dishwasher tablets contain many different types of chemicals.



- Phosphate ions, present in some types of dishwasher tablets, react with calcium ions in water forming calcium phosphate. 1

Write the formula for calcium phosphate.

6. The table shows information about some useful compounds.

Compound	Formula
Y	Na_3PO_4
ammonia	NH_3
ammonium nitrate	NH_4NO_3

- Name compound Y. 1

7. 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

8. The nuclide notation for an isotope of hydrogen is ${}^1_1\text{H}$
An isotope of copper has atomic number 29 and mass number 63.
- (a) (i) Write the nuclide notation for this isotope of copper. 1
(ii) How many neutrons are present in this isotope of copper? 1
- (b) A sample of copper was found to contain equal amounts of two isotopes. One has mass number 63 and the other has mass number 65. 1
- What is the relative atomic mass of this sample of copper?

9. Metals can be extracted from their ores by different methods.
Mercury can be extracted from the ore cinnabar, HgS.
Write the formula for the mercury ion in cinnabar. 1

10. Nitrogen trifluoride, NF_3 , is used in the manufacture of plasma screens.
- (a) Draw a diagram showing all outer electrons to represent a molecule of nitrogen trifluoride. 1
- (b) The atoms in nitrogen trifluoride are held together by covalent bonds. 1
- Circle the correct words to complete the sentence.
- A covalent bond forms when two $\left\{ \begin{array}{l} \text{positive} \\ \text{negative} \\ \text{neutral} \end{array} \right\}$ nuclei are held together
by their common attraction for a shared pair of $\left\{ \begin{array}{l} \text{protons} \\ \text{neutrons} \\ \text{electrons} \end{array} \right\}$.

11. Hydrogen gas is made up of diatomic molecules.
Draw a diagram to show how the electrons are arranged in a molecule of hydrogen, H_2 . 1

12. Ammonium phosphate is used as a fertiliser.
Write the ionic formula for ammonium phosphate. 1

13. A student investigated how the concentration of sodium chloride in water affected the freezing point.

(a) What type of bond is broken in sodium chloride when it dissolves in water? 1

(b) The table shows information about the freezing point of different sodium chloride solutions.

Concentration of sodium chloride solution (mol/l)	0	0.09	0.18	0.27	0.37	0.46
Freezing point (°C)	0	-0.2	-0.5	-0.8	-1.1	-1.5

Describe the relationship between the concentration and freezing point. 1

(c) Predict the freezing point, in °C, of a 0.55 mol/l sodium chloride solution. 1

2011 SG 12

14. Ethanol, for alcoholic drinks, can be made from glucose.

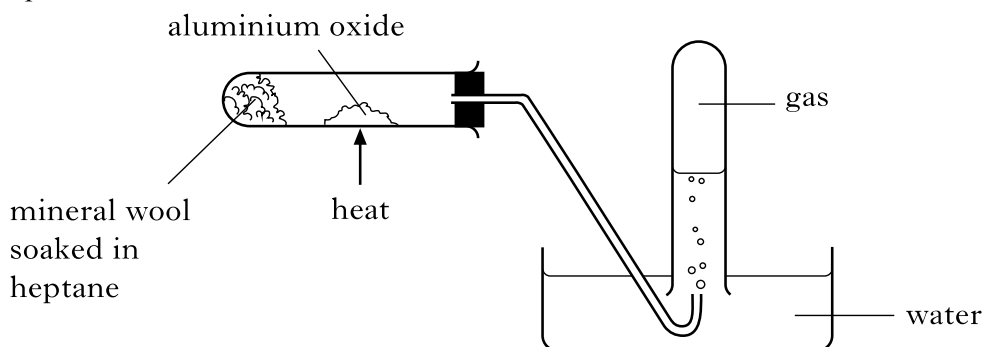
The table below shows the relationship between the percentage of ethanol and the density of alcoholic drinks.

Percentage of ethanol (%)	40	50	60	70	80
Density of alcoholic drink (g/cm³)	0.928	0.907	0.886	0.865	0.844

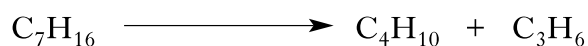
(a) Write a general statement describing how the percentage of ethanol affects the density of the alcoholic drink. 1

(b) The density of a particular brand of alcoholic drink is 0.970 g cm⁻³. Predict the percentage of ethanol in this alcoholic drink. 1

15. Heptane can be cracked as shown.



One of the reactions which takes place is:

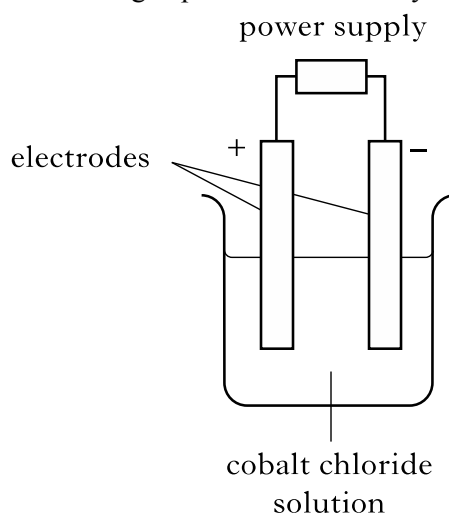


Aluminium oxide is used as a catalyst to speed up the reaction.

Write the formula for aluminium oxide. _____

1

16. A student set up the following experiment to electrolyse cobalt chloride solution.



The formula for cobalt chloride is CoCl_2 .

What is the charge on the cobalt ion in CoCl_2 ?

1

Formulae and reaction quantities

2012 Int2 2

1. Rapid inflation of airbags in cars is caused by the production of nitrogen gas. In some types of airbag, electrical energy causes sodium azide, NaN_3 , to decompose producing sodium metal and nitrogen gas.

1

Write a formula equation for this reaction.

2012 Int2 15

2. 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.

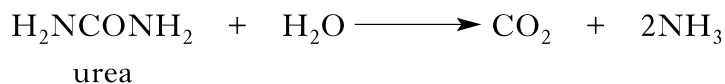


The rust remover contains 250 cm^3 of 2 mol l^{-1} phosphoric acid.

- (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, in grams, that will be removed by 250 cm^3 of 2 mol l^{-1} phosphoric acid. 2

2011 SG 17

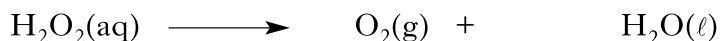
3. Urea reacts with water, breaking down to form carbon dioxide and ammonia.



Calculate the mass of ammonia produced, in grams, when 90 g of urea breaks down. 2

4. 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:

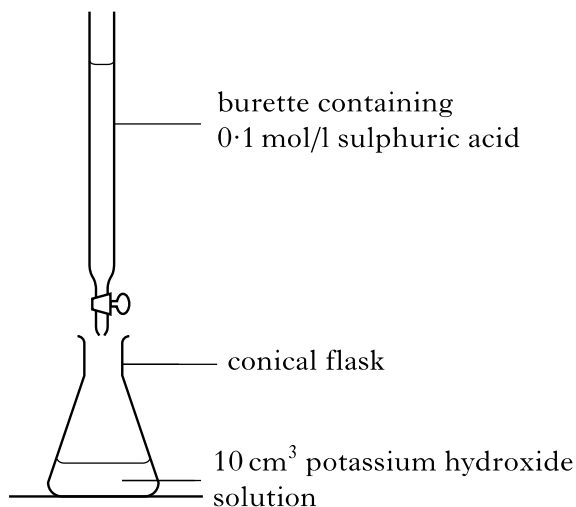


- (a) Balance this equation. 1
- (b) When 34g of hydrogen peroxide decomposes, 12 litres of oxygen is produced. Calculate the volume of oxygen, in litres, produced when 1.7g of hydrogen peroxide decomposes. 1

5. Metal salts can be produced by different methods.
Lead(II) iodide can be produced by reacting lead(II) nitrate solution with sodium iodide solution.
The equation for this reaction is:



- (a) Balance the above equation. 1
- (b) Potassium sulphate can be produced by titrating potassium hydroxide solution with dilute sulphuric acid.



The average volume of sulphuric acid used in the titration is 20 cm³.
Calculate the number of moles of sulphuric acid used. 1

6. Potassium hydroxide reacts with sulphuric acid to form potassium sulphate, which can be used as a fertiliser.
- $$\text{KOH}(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \longrightarrow \text{K}_2\text{SO}_4(\text{aq}) + \text{H}_2\text{O}(\ell)$$
- Balance the above equation. 1

7. A solution of 0.1 mol l⁻¹ hydrochloric acid has a pH of 1.

Calculate the number of moles of hydrochloric acid in 50cm³ of 0.1 mol l⁻¹ hydrochloric acid solution.

1

2012 SG 21

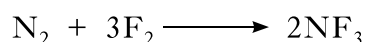
8. Aluminium is extracted from the ore bauxite.
The composition of a 250 g magnet is shown.

Metal	aluminium	nickel	cobalt	copper	titanium	iron
% by mass	10	25	20	4	1	40

- (a) Calculate the mass, in grams, of aluminium in the magnet.
Show your working clearly. 1
- (b) Using your answer to (c)(i), calculate the number of moles of aluminium in the magnet.
Show your working clearly. 1

2013 SG 17

9. Nitrogen trifluoride, NF₃, is used in the manufacture of plasma screens.
The equation for the formation of nitrogen trifluoride, NF₃, is:



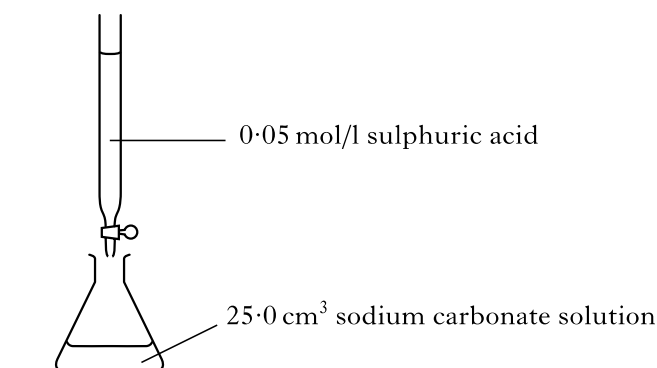
Calculate the mass, in grams, of nitrogen trifluoride produced from 7 g of nitrogen. 2

Show your working clearly.

2013 SG 18

10. A student investigated the reaction between dilute sulphuric acid and sodium carbonate.

A student carried out an experiment to determine the concentration of sodium carbonate solution by titration with sulphuric acid.



The results showed that 20cm³ of sulphuric acid was required to neutralise the sodium carbonate solution.

Calculate the number of moles of sulphuric acid in this volume.

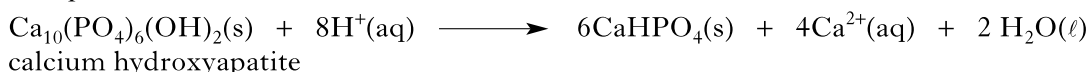
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Acids and Bases

2011 Int2 15

1. Fizzy drinks contain acids.

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

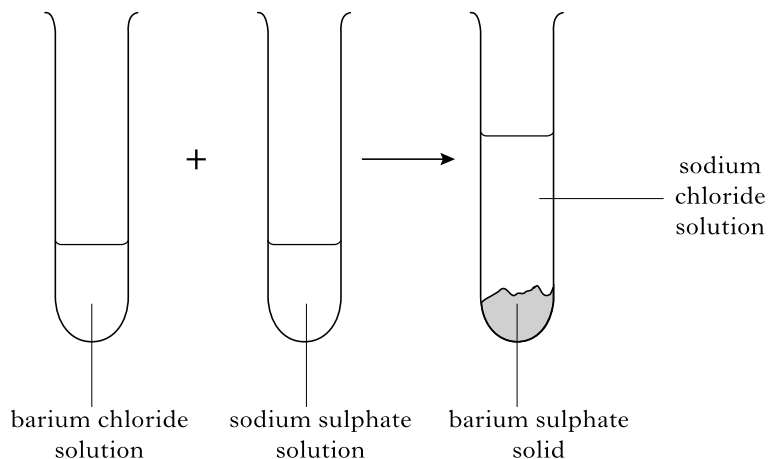


What will happen to the pH as the tooth enamel is attacked by the acids?

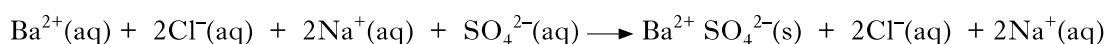
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2012 Int2 13

2. A student carried out the following experiment.



The equation for the reaction is



(a) Rewrite the equation showing only the ions which react.

1

(b) What term is used to describe the ions which do not react?

1

2011 SG 14

3. When sulphur dioxide dissolves in water in the atmosphere “acid rain” is produced.

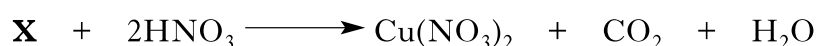
Circle the correct phrase to complete the sentence.

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. 1

2011 SG 20

4. Metal salts can be produced by different methods.

The salt copper(II) nitrate can be produced as shown.

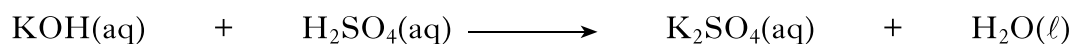


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Name substance X.

2012 SG 15

5. Potassium hydroxide reacts with sulphuric acid to form potassium sulphate, which can be used as a fertiliser.

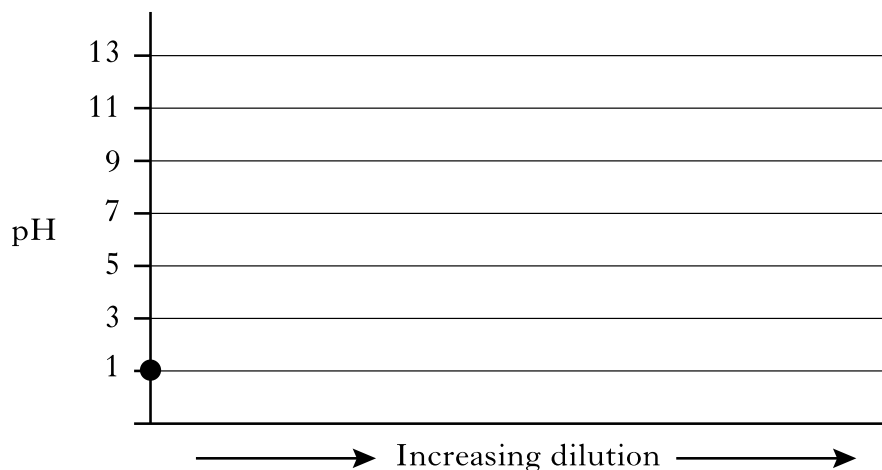


Name the type of chemical reaction taking place.

1

6. A solution of 0.1 mol l^{-1} hydrochloric acid has a pH of 1.

- (a) What colour would universal indicator turn when added to a solution of hydrochloric acid? 1
- (b) Starting at pH 1, draw a line to show how the pH of this acid changes when diluted with water. 1



7. Which of the following increases when hydrochloric acid is diluted with water? 1
- 2007 Int2 19MC*
- A Rate of reaction with magnesium
 B Concentration of H^+ ions
 C Electrical conductivity
 D pH

8. Which of the following statements describes the concentrations of $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$ ions in pure water? 1
- 2007 Int2 20MC*
- 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 $\text{OH}^-(\text{aq})$ ions is greater than the concentration of $\text{H}^+(\text{aq})$ ions.

9. When hydrochloric acid with a pH of 3 is diluted with water to give a solution with a pH of 6, the concentration of
- A $\text{H}^+(\text{aq})$ ions decreases
 - B $\text{OH}^-(\text{aq})$ ions decreases
 - C $\text{H}^+(\text{aq})$ ions and the concentration of $\text{OH}^-(\text{aq})$ ions become equal
 - D $\text{H}^+(\text{aq})$ ions and the concentration of $\text{OH}^-(\text{aq})$ ions remains unchanged

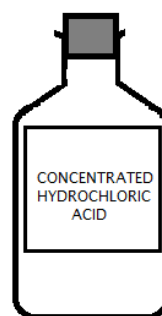
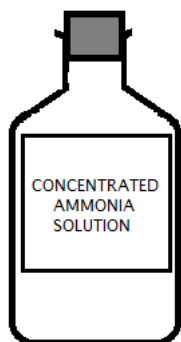
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10. Which of the following sodium compounds is a base?
- A sodium carbonate
 - B sodium chloride
 - C sodium nitrate
 - D sodium sulphate

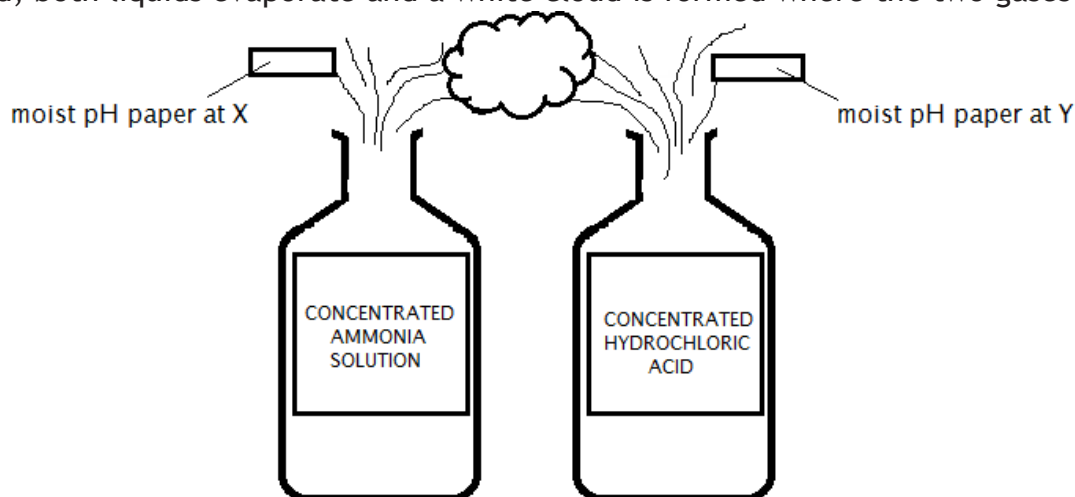
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11. Ammonia gas $\text{NH}_3(\text{g})$, can be dissolved in water to form concentrated ammonia solution.

Hydrogen chloride gas $\text{HCl}(\text{g})$, can be dissolved in water to form concentrated hydrochloric acid.



If both bottles are placed next to each other in a fume cupboard and the stoppers removed, both liquids evaporate and a white cloud is formed where the two gases meet.



- (a) State the colour of the pH paper at (i) X and (ii) Y. 1
- (b) The white cloud appears because the gases react to form a salt. Name the salt. 1