



**Cambridge International Examinations**  
Cambridge International General Certificate of Secondary Education

**CHEMISTRY**

Paper 1 Multiple Choice (Core)

**0620/11**

**October/November 2016**

**45 minutes**

Additional Materials: Multiple Choice Answer Sheet  
Soft clean eraser  
Soft pencil (type B or HB is recommended)



**READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

**DO NOT WRITE IN ANY BARCODES.**

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

**Read the instructions on the Answer Sheet very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 20.

Electronic calculators may be used.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **17** printed pages and **3** blank pages.



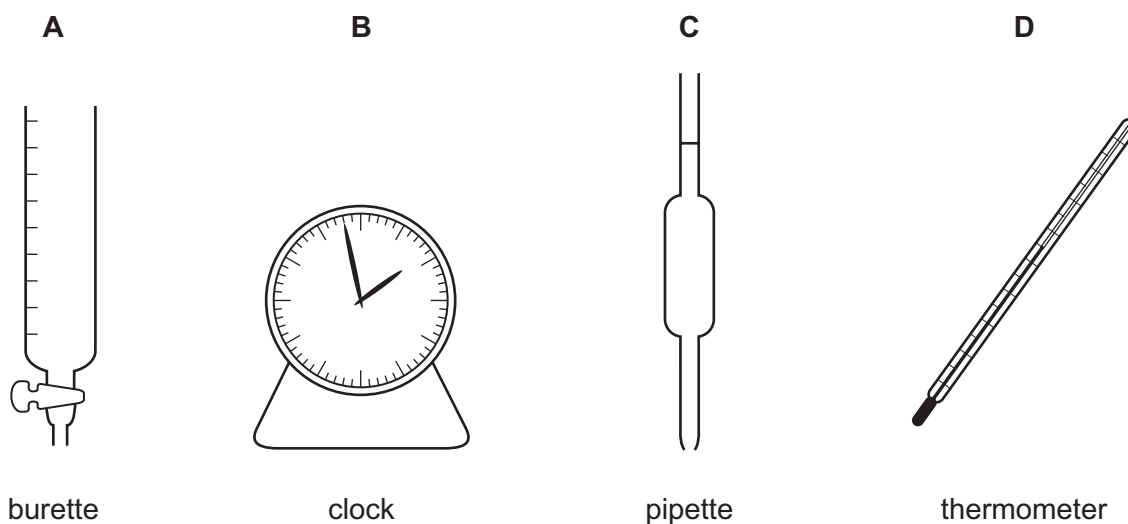
- 1 'Particles moving **very slowly** from an area of higher concentration to an area of lower concentration.'

Which process is being described?

- A a liquid being frozen
  - B a solid melting
  - C a substance diffusing through a liquid
  - D a substance diffusing through the air
- 2 A student mixes  $25\text{cm}^3$  samples of dilute hydrochloric acid with different volumes of aqueous sodium hydroxide.

In each case, the student measures the change in temperature to test if the reaction is exothermic.

Which piece of apparatus is **not** needed?



- 3 Information about the solubility of four solids, P, Q, R and S, is given in the table.

|                     | P         | Q         | R         | S         |
|---------------------|-----------|-----------|-----------|-----------|
| solubility in water | dissolves | insoluble | insoluble | dissolves |

A student attempted to separate mixtures of these solids using the following method.

- 1 Add the mixture to a beaker of water and stir.
- 2 Filter the mixture.
- 3 Crystallise one of the solids from the filtrate.

Which of the following mixtures could **not** be separated by this method?

- A** a mixture of P and R  
**B** a mixture of Q and P  
**C** a mixture of Q and R  
**D** a mixture of R and S

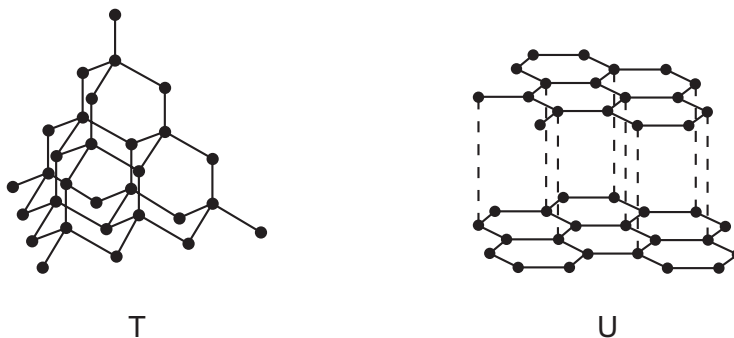
- 4 The table shows information about atoms of three different elements.

| element   | proton number | nucleon number | number of protons | number of neutrons | number of electrons |
|-----------|---------------|----------------|-------------------|--------------------|---------------------|
| chlorine  | 17            | 35             | 17                | W                  | 17                  |
| chlorine  | 17            | X              | 17                | 19                 | 17                  |
| argon     | Y             | 40             | 18                | 22                 | 18                  |
| potassium | 19            | 39             | 19                | 20                 | Z                   |

What are the values of W, X, Y and Z?

|          | W  | X  | Y  | Z  |
|----------|----|----|----|----|
| <b>A</b> | 18 | 35 | 18 | 19 |
| <b>B</b> | 18 | 36 | 18 | 19 |
| <b>C</b> | 19 | 35 | 19 | 18 |
| <b>D</b> | 19 | 36 | 19 | 18 |

- 5 The diagrams show the structures of two forms of the same element.



What are the reasons for using T in cutting tools and U as a lubricant?

|          | T                                                                            | U                                                                           |
|----------|------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| <b>A</b> | It is very hard because each atom is held in place by strong covalent bonds. | The layers can slide over each other because the covalent bonds are weak.   |
| <b>B</b> | It is very hard because each atom is held in place by strong covalent bonds. | The layers can slide over each other due to weak forces between the layers. |
| <b>C</b> | It is very hard because there are no electrons able to move.                 | The layers can slide over each other because the covalent bonds are weak.   |
| <b>D</b> | It is very hard because there are no electrons able to move.                 | The layers can slide over each other due to weak forces between the layers. |

- 6 Ions are formed by elements losing or gaining electrons.

Which statement is correct?

- A** Metal atoms gain electrons to form positive ions.  
**B** Non-metal atoms lose electrons to form positive ions.  
**C** The charge on an ion is always either +1 or –1.  
**D** Group I ions have the same electronic structure as noble gases.
- 7 A molecule of X contains two carbon atoms, four hydrogen atoms and two oxygen atoms.

What is the formula of X?

- A**  $\text{CH}_2\text{CO}_2\text{H}$       **B**  $\text{CH}_3\text{COH}$       **C**  $\text{CH}_3\text{COOH}$       **D**  $\text{C}_2\text{H}_3\text{COOH}$

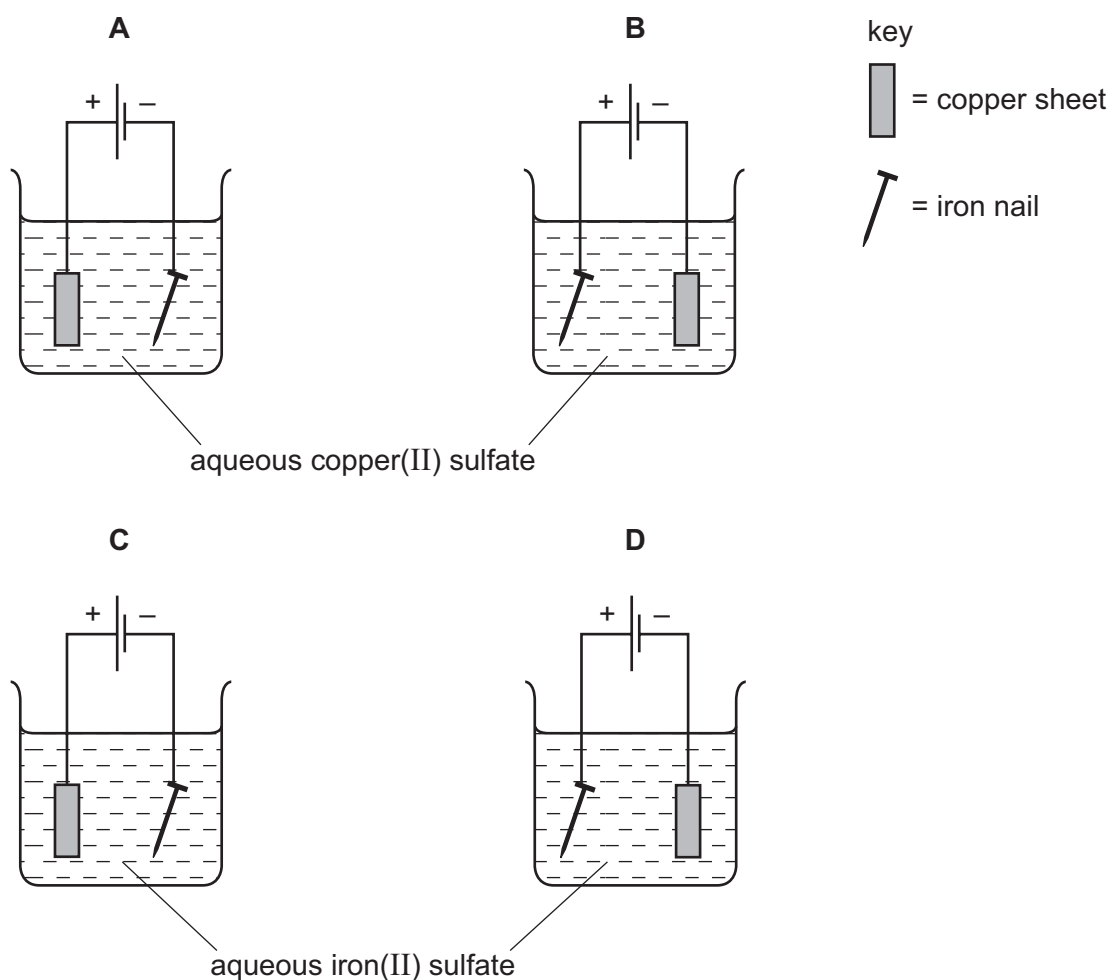
- 8 Concentrated aqueous potassium chloride is electrolysed using platinum electrodes.

The solution contains the ions  $K^+$ ,  $Cl^-$ ,  $H^+$  and  $OH^-$ .

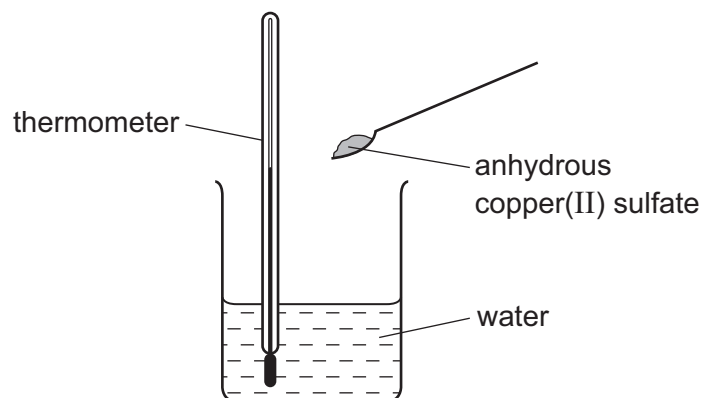
Which electrodes are the ions attracted to during this electrolysis?

|          | anode             | cathode           |
|----------|-------------------|-------------------|
| <b>A</b> | $Cl^-$ and $K^+$  | $H^+$ and $OH^-$  |
| <b>B</b> | $Cl^-$ and $OH^-$ | $H^+$ and $K^+$   |
| <b>C</b> | $H^+$ and $K^+$   | $Cl^-$ and $OH^-$ |
| <b>D</b> | $H^+$ and $OH^-$  | $Cl^-$ and $K^+$  |

- 9 Which apparatus could be used to electroplate an iron nail with copper?



- 10 When anhydrous copper(II) sulfate is added to water a solution is formed and heat is given out.



Which row shows the temperature change and the type of reaction taking place?

|          | temperature change | type of reaction |
|----------|--------------------|------------------|
| <b>A</b> | decrease           | endothermic      |
| <b>B</b> | decrease           | exothermic       |
| <b>C</b> | increase           | endothermic      |
| <b>D</b> | increase           | exothermic       |

- 11 The combustion of element X releases large amounts of energy.

What is X?

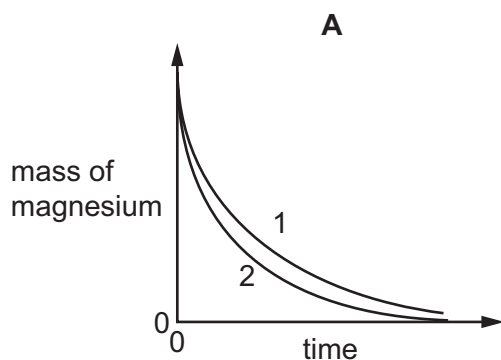
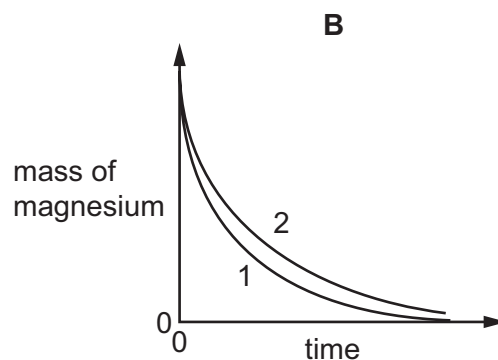
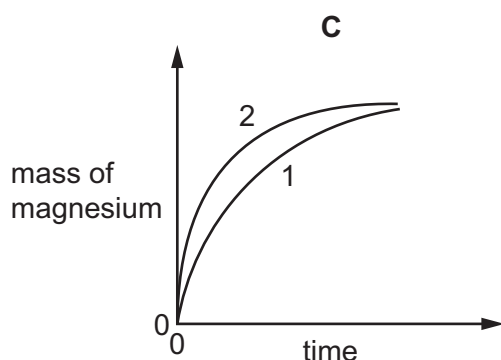
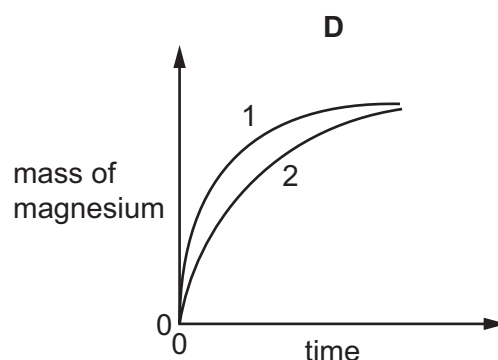
- A** ethanol
- B** hydrogen
- C** methane
- D** uranium

- 12** The rate of reaction between magnesium and excess dilute hydrochloric acid was followed by measuring the mass of magnesium present at regular time intervals.

Two experiments were performed.

Both experiments used 0.1g of magnesium ribbon. The acid in experiment 1 was less concentrated than in experiment 2.

Which graph shows the results of the experiments?



- 13** Which reaction is reversible?

- A**  $\text{CuCO}_3 + 2\text{HCl} \rightarrow \text{CuCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$
- B**  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O} \rightarrow \text{CuSO}_4 + 5\text{H}_2\text{O}$
- C**  $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$
- D**  $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

- 14** Tin is formed when tin(II) oxide is heated with carbon.

What happens to the tin in the tin(II) oxide in this reaction?

- A** It is burnt.
- B** It is electrolysed.
- C** It is oxidised.
- D** It is reduced.

**15** Part of the Periodic Table is shown.

Which element forms an acidic oxide?

A simplified periodic table grid with 10 columns and 4 rows. The grid is divided into four main sections: a 2x2 section on the top left, a 2x2 section on the top right, a 2x10 section in the middle, and a 2x10 section at the bottom. The sections are labeled A, B, C, and D. Section A is the top-left 2x2 section. Section B is the top-right 2x2 section. Section C is the middle 2x10 section. Section D is the bottom 2x10 section. The labels A, B, C, and D are placed in the top-left, top-right, middle-right, and bottom-left cells of their respective sections.

**16** Four substances, P, Q, R and S, are tested as shown.

| test                                                    | substance                                        |                                           |                                                       |             |
|---------------------------------------------------------|--------------------------------------------------|-------------------------------------------|-------------------------------------------------------|-------------|
|                                                         | P                                                | Q                                         | R                                                     | S           |
| dilute hydrochloric acid added                          | gas given off which 'pops' with a lighted splint | gas given off which turns limewater milky | no reaction                                           | no reaction |
| dilute aqueous sodium hydroxide added and warmed gently | no reaction                                      | no reaction                               | gas given off which turns damp, red litmus paper blue | no reaction |

What are P, Q, R and S?

|          | P                               | Q                               | R                               | S                  |
|----------|---------------------------------|---------------------------------|---------------------------------|--------------------|
| <b>A</b> | Mg                              | Na <sub>2</sub> CO <sub>3</sub> | NH <sub>4</sub> Cl              | NaCl               |
| <b>B</b> | Mg                              | NH <sub>4</sub> Cl              | Na <sub>2</sub> CO <sub>3</sub> | NaCl               |
| <b>C</b> | Mg                              | Na <sub>2</sub> CO <sub>3</sub> | NaCl                            | NH <sub>4</sub> Cl |
| <b>D</b> | Na <sub>2</sub> CO <sub>3</sub> | Mg                              | NaCl                            | NH <sub>4</sub> Cl |

**17** Acids can react with metal oxides, carbonates and metals.

Which reactions produce a gas?

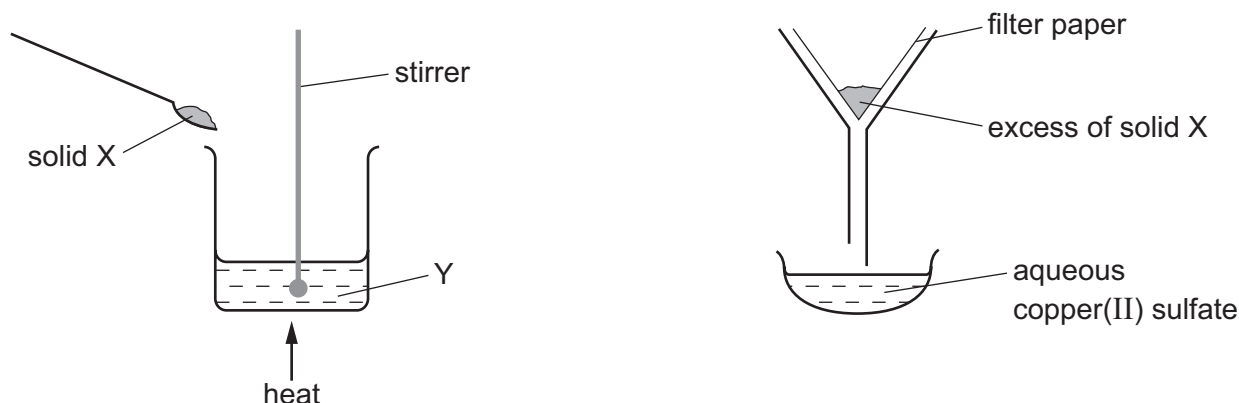
|          | acid with<br>metal oxide | acid with<br>carbonate | acid with<br>metal |
|----------|--------------------------|------------------------|--------------------|
| <b>A</b> | ✓                        | ✓                      | ✓                  |
| <b>B</b> | ✓                        | x                      | x                  |
| <b>C</b> | x                        | ✓                      | ✓                  |
| <b>D</b> | x                        | ✓                      | x                  |

key

✓ = gas is produced

$x$  = no gas is produced

18 The apparatus shown is used to prepare aqueous copper(II) sulfate.



What are X and Y?

|          | X                   | Y                           |
|----------|---------------------|-----------------------------|
| <b>A</b> | copper              | aqueous iron(II) sulfate    |
| <b>B</b> | copper(II) chloride | sulfuric acid               |
| <b>C</b> | copper(II) oxide    | sulfuric acid               |
| <b>D</b> | sulfur              | aqueous copper(II) chloride |

19 Which statement about trends in the Periodic Table is **not** correct?

- A** Elements in the same period have the same number of electron shells.
- B** The elements change from metals to non-metals from left to right.
- C** The number of protons in an atom of an element increases from left to right.
- D** The oxides of the elements change from acidic to basic from left to right.

20 What is **not** a property of Group I metals?

- A** They are soft and can be cut with a knife.
- B** They react when exposed to oxygen in the air.
- C** They produce an acidic solution when they react with water.
- D** They react rapidly with water producing hydrogen gas.

21 Which statement about the element with proton number 54 is correct?

- A** It burns in the air to form an oxide.
- B** It could be used in balloons because it has a very low density.
- C** It is a gas at room temperature.
- D** It is reactive because it has a full outer shell of electrons.

22 Which element is a transition element?

|          | colour of chloride | melting point of element / °C |
|----------|--------------------|-------------------------------|
| <b>A</b> | orange             | 113                           |
| <b>B</b> | orange             | 1535                          |
| <b>C</b> | white              | 113                           |
| <b>D</b> | white              | 1535                          |

23 Which row describes the trends in the properties of the Group VII elements as the group is descended?

|          | colour   | density   | reactivity with halide ions |
|----------|----------|-----------|-----------------------------|
| <b>A</b> | darkens  | decreases | increases                   |
| <b>B</b> | darkens  | increases | decreases                   |
| <b>C</b> | lightens | decreases | increases                   |
| <b>D</b> | lightens | increases | decreases                   |

24 Four metals are listed in decreasing order of reactivity.

magnesium

zinc

iron

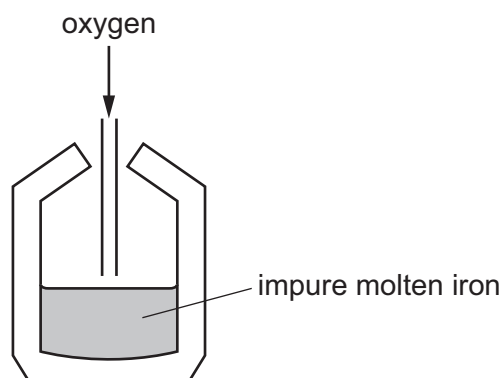
copper

Titanium reacts with acid and cannot be extracted from its ore by heating with carbon.

Where should titanium be placed in the list?

- A** below copper
- B** between iron and copper
- C** between magnesium and zinc
- D** between zinc and iron

25 Impure iron from the blast furnace is converted to steel as shown.



Which statement about the process is correct?

- A Acidic oxides are added to remove alkaline impurities.
- B Coke is added as a reducing agent.
- C Oxygen is blown in to oxidise the impure iron.
- D The steel produced contains less carbon than the impure iron.

26 A student added dilute hydrochloric acid to four metals and recorded the results.

Some of the results are **not** correct.

|   | results   |               |
|---|-----------|---------------|
|   | metal     | gas given off |
| 1 | copper    | yes           |
| 2 | iron      | yes           |
| 3 | magnesium | no            |
| 4 | zinc      | yes           |

Which **two** results are correct?

- A 1 and 3
- B 1 and 4
- C 2 and 3
- D 2 and 4

27 Some properties of three metals, P, Q and R, are shown.

| metal | density | resistance to corrosion | electrical conductivity |
|-------|---------|-------------------------|-------------------------|
| P     | low     | high                    | very good               |
| Q     | high    | high                    | very good               |
| R     | low     | low                     | good                    |

Which metals would be suitable for use in electrical wiring and aircraft manufacture?

|          | electrical wiring | aircraft manufacture |
|----------|-------------------|----------------------|
| <b>A</b> | P                 | Q                    |
| <b>B</b> | Q                 | P                    |
| <b>C</b> | Q                 | R                    |
| <b>D</b> | R                 | P                    |

28 One sample of sea-water is distilled while another sample of sea-water is filtered.

Which statement about the samples is correct?

- A** The distilled sample boils at exactly 100 °C and contains dissolved salts.
- B** The distilled sample boils at 103 °C and does **not** contain dissolved salts.
- C** The filtered sample boils at 103 °C and contains dissolved salts.
- D** The filtered sample boils at exactly 100 °C and does **not** contain dissolved salts.

29 Air is a mixture of gases.

Which gas is present in the largest amount?

- A** argon
- B** carbon dioxide
- C** nitrogen
- D** oxygen

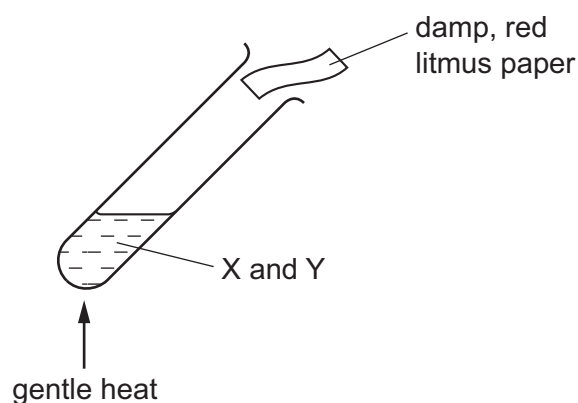
30 Which information about carbon dioxide and methane is correct?

|          |                                   | carbon dioxide | methane |
|----------|-----------------------------------|----------------|---------|
| <b>A</b> | formed when vegetation decomposes | ✓              | ✗       |
| <b>B</b> | greenhouse gas                    | ✓              | ✓       |
| <b>C</b> | present in unpolluted air         | ✗              | ✗       |
| <b>D</b> | produced during respiration       | ✗              | ✓       |

key  
 ✓ = true  
 ✗ = false

31 A mixture of two substances, X and Y, is heated.

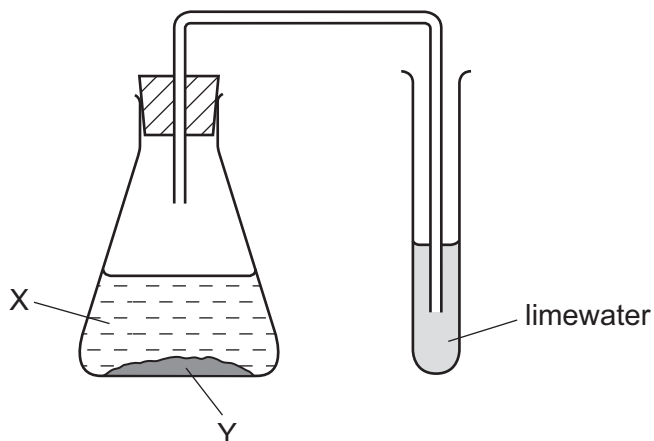
The damp, red litmus paper turns blue.



What are X and Y?

|          | X                 | Y                         |
|----------|-------------------|---------------------------|
| <b>A</b> | aluminium nitrate | hydrochloric acid         |
| <b>B</b> | aluminium nitrate | sodium hydroxide solution |
| <b>C</b> | ammonium chloride | hydrochloric acid         |
| <b>D</b> | ammonium chloride | sodium hydroxide solution |

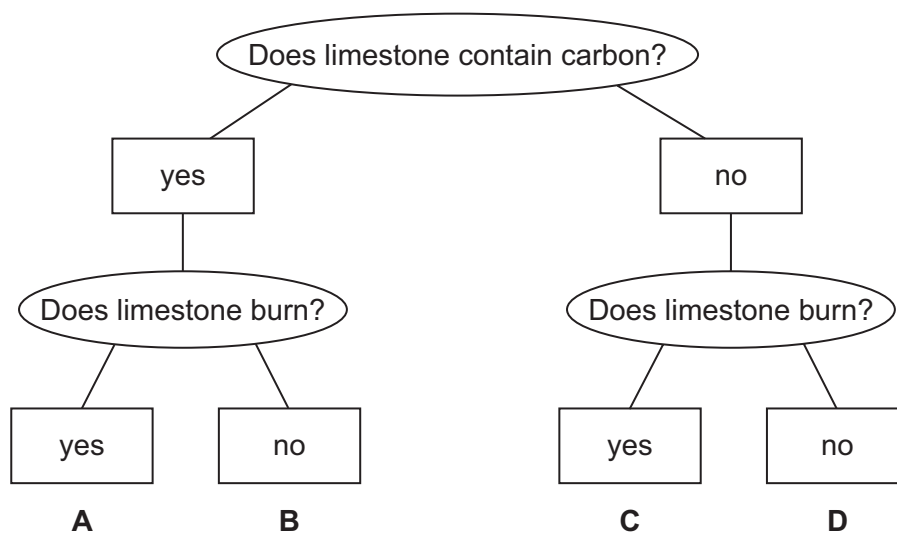
32 In the experiment shown, a white precipitate forms in the limewater.



What are X and Y?

|          | X                        | Y              |
|----------|--------------------------|----------------|
| <b>A</b> | aqueous sodium hydroxide | zinc           |
| <b>B</b> | aqueous sodium hydroxide | zinc carbonate |
| <b>C</b> | dilute sulfuric acid     | zinc           |
| <b>D</b> | dilute sulfuric acid     | zinc carbonate |

33 Which box corresponds to limestone?

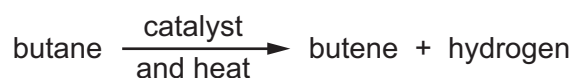


34 Petroleum is an important fossil fuel.

Which row correctly describes petroleum?

|          | type of substance | composition              |
|----------|-------------------|--------------------------|
| <b>A</b> | compound          | mainly hydrocarbons      |
| <b>B</b> | compound          | only hydrogen and carbon |
| <b>C</b> | mixture           | mainly hydrocarbons      |
| <b>D</b> | mixture           | only hydrogen and carbon |

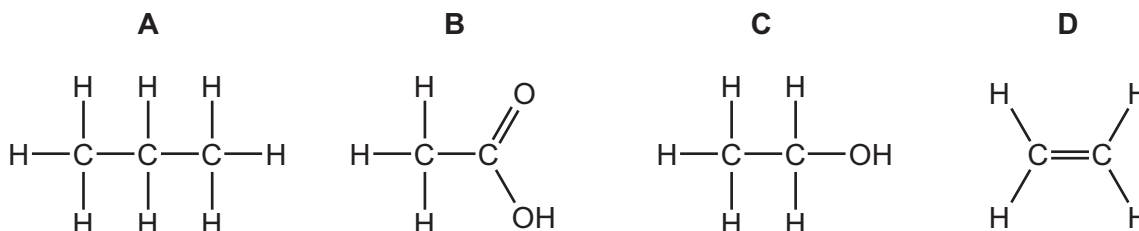
35 Butane reacts as shown.



What is this type of reaction?

- A** combustion
- B** cracking
- C** polymerisation
- D** reduction

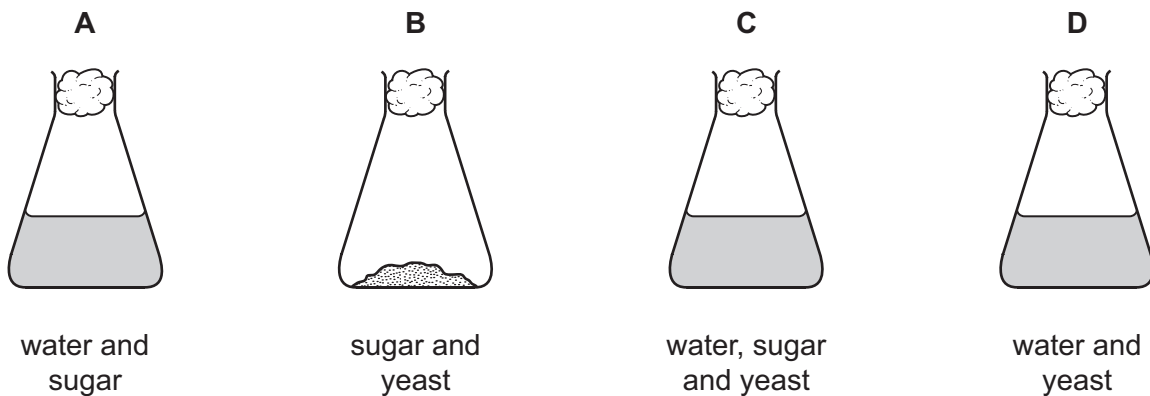
36 Which substance is in the same homologous series as methanol?



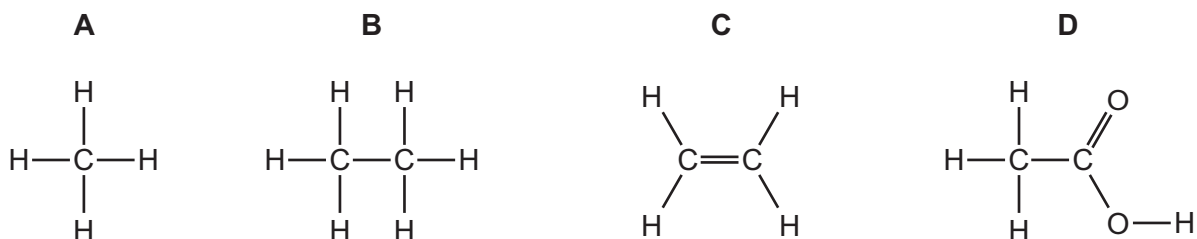
37 Which statement could **not** be correct for an alkane?

- A** It burns readily in a plentiful supply of air to form only carbon dioxide and water.
- B** It decolourises aqueous bromine.
- C** It has a boiling point of  $-42^{\circ}\text{C}$ .
- D** The carbon and hydrogen atoms in the molecule are joined by sharing pairs of electrons.

38 In which conical flask will ethanol be produced?



39 Which molecule can be polymerised?



40 Which row describes what happens when ethanol burns in air?

|          | a white powder is left | heat energy is given out | carbon dioxide is formed | water is formed |
|----------|------------------------|--------------------------|--------------------------|-----------------|
| <b>A</b> | ✓                      | x                        | ✓                        | ✓               |
| <b>B</b> | x                      | ✓                        | ✓                        | ✓               |
| <b>C</b> | x                      | ✓                        | ✓                        | x               |
| <b>D</b> | x                      | ✓                        | x                        | ✓               |

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## The Periodic Table of Elements

| Group                    |                             |                                                                              |                           |                             |                         |                              |                         |                            |                           |                            |                            |                           |                            |                             |                        |                          |                          |                          |                        |                           |                             |                           |                            |                           |                           |                            |                             |                          |                             |                           |                              |                             |                              |                            |                              |                           |                            |                           |                        |                             |                              |                          |                          |                            |                           |                      |                            |                             |                            |                            |                           |                            |                             |                         |                            |                             |                         |                            |                           |                           |                        |                           |                         |                     |                                 |                           |                              |                           |                           |                              |                                |                               |                               |                            |                             |                             |                               |                              |                             |
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| I                        | II                          | Key                                                                          |                           |                             |                         |                              |                         |                            |                           |                            |                            | III                       | IV                         | V                           | VI                     | VII                      | VIII                     |                          |                        |                           |                             |                           |                            |                           |                           |                            |                             |                          |                             |                           |                              |                             |                              |                            |                              |                           |                            |                           |                        |                             |                              |                          |                          |                            |                           |                      |                            |                             |                            |                            |                           |                            |                             |                         |                            |                             |                         |                            |                           |                           |                        |                           |                         |                     |                                 |                           |                              |                           |                           |                              |                                |                               |                               |                            |                             |                             |                               |                              |                             |
|                          |                             | <div>1<br/>H<br/>hydrogen<br/>1</div>                                        |                           |                             |                         |                              |                         |                            |                           |                            |                            |                           |                            |                             |                        |                          |                          |                          |                        |                           |                             |                           |                            |                           |                           |                            |                             |                          |                             |                           |                              |                             |                              |                            |                              |                           |                            |                           |                        |                             |                              |                          |                          |                            |                           |                      |                            |                             |                            |                            |                           |                            |                             |                         |                            |                             |                         |                            |                           |                           |                        |                           |                         |                     |                                 |                           |                              |                           |                           |                              |                                |                               |                               |                            |                             |                             |                               |                              |                             |
|                          |                             | <div>atomic number<br/>atomic symbol<br/>name<br/>relative atomic mass</div> |                           |                             |                         |                              |                         |                            |                           |                            |                            |                           |                            |                             |                        |                          |                          |                          |                        |                           |                             |                           |                            |                           |                           |                            |                             |                          |                             |                           |                              |                             |                              |                            |                              |                           |                            |                           |                        |                             |                              |                          |                          |                            |                           |                      |                            |                             |                            |                            |                           |                            |                             |                         |                            |                             |                         |                            |                           |                           |                        |                           |                         |                     |                                 |                           |                              |                           |                           |                              |                                |                               |                               |                            |                             |                             |                               |                              |                             |
| 3<br>Li<br>lithium<br>7  | 4<br>Be<br>beryllium<br>9   |                                                                              |                           |                             |                         |                              |                         |                            |                           |                            |                            |                           |                            |                             |                        |                          |                          |                          |                        |                           |                             |                           |                            |                           |                           |                            |                             |                          |                             |                           |                              |                             |                              |                            |                              |                           |                            |                           |                        |                             |                              |                          |                          |                            |                           |                      |                            |                             |                            |                            |                           |                            |                             |                         |                            |                             |                         |                            |                           |                           |                        |                           |                         |                     |                                 |                           |                              |                           |                           |                              |                                |                               |                               |                            |                             |                             |                               |                              |                             |
| 11<br>Na<br>sodium<br>23 | 12<br>Mg<br>magnesium<br>24 | 13<br>Al<br>aluminium<br>27                                                  | 14<br>Si<br>silicon<br>28 | 15<br>P<br>phosphorus<br>31 | 16<br>S<br>sulfur<br>32 | 17<br>Cl<br>chlorine<br>35.5 | 18<br>Ar<br>argon<br>40 | 19<br>K<br>potassium<br>39 | 20<br>Ca<br>calcium<br>40 | 21<br>Sc<br>scandium<br>45 | 22<br>Ti<br>titanium<br>48 | 23<br>V<br>vanadium<br>51 | 24<br>Cr<br>chromium<br>52 | 25<br>Mn<br>manganese<br>55 | 26<br>Fe<br>iron<br>56 | 27<br>Co<br>cobalt<br>59 | 28<br>Ni<br>nickel<br>59 | 29<br>Cu<br>copper<br>64 | 30<br>Zn<br>zinc<br>65 | 31<br>Ga<br>gallium<br>70 | 32<br>Ge<br>germanium<br>73 | 33<br>As<br>arsenic<br>75 | 34<br>Se<br>selenium<br>79 | 35<br>Br<br>bromine<br>80 | 36<br>Kr<br>krypton<br>84 | 37<br>Rb<br>rubidium<br>85 | 38<br>Sr<br>strontium<br>88 | 39<br>Y<br>yttrium<br>89 | 40<br>Zr<br>zirconium<br>91 | 41<br>Nb<br>niobium<br>93 | 42<br>Mo<br>molybdenum<br>96 | 43<br>Tc<br>technetium<br>— | 44<br>Ru<br>ruthenium<br>101 | 45<br>Rh<br>rhodium<br>103 | 46<br>Pd<br>palladium<br>106 | 47<br>Ag<br>silver<br>108 | 48<br>Cd<br>cadmium<br>112 | 49<br>In<br>indium<br>115 | 50<br>Sn<br>tin<br>119 | 51<br>Sb<br>antimony<br>122 | 52<br>Te<br>tellurium<br>128 | 53<br>I<br>iodine<br>127 | 54<br>Xe<br>xenon<br>131 | 55<br>Cs<br>caesium<br>133 | 56<br>Ba<br>barium<br>137 | 57–71<br>lanthanoids | 72<br>Hf<br>hafnium<br>178 | 73<br>Ta<br>tantalum<br>181 | 74<br>W<br>tungsten<br>184 | 75<br>Re<br>rhenium<br>186 | 76<br>Os<br>osmium<br>190 | 77<br>Ir<br>iridium<br>192 | 78<br>Pt<br>platinum<br>195 | 79<br>Au<br>gold<br>197 | 80<br>Hg<br>mercury<br>201 | 81<br>Tl<br>thallium<br>204 | 82<br>Pb<br>lead<br>207 | 83<br>Bi<br>bismuth<br>209 | 84<br>Po<br>polonium<br>— | 85<br>At<br>astatine<br>— | 86<br>Rn<br>radon<br>— | 87<br>Fr<br>francium<br>— | 88<br>Ra<br>radium<br>— | 89–103<br>actinoids | 104<br>Rf<br>rutherfordium<br>— | 105<br>Db<br>dubnium<br>— | 106<br>Sg<br>seaborgium<br>— | 107<br>Bh<br>bohrium<br>— | 108<br>Hs<br>hassium<br>— | 109<br>Mt<br>meitnerium<br>— | 110<br>Ds<br>darmstadtium<br>— | 111<br>Rg<br>roentgenium<br>— | 112<br>Cn<br>copernicium<br>— | 113<br>Nh<br>nihonium<br>— | 114<br>Fl<br>flerovium<br>— | 115<br>Mc<br>moscovium<br>— | 116<br>Lv<br>livermorium<br>— | 117<br>Ts<br>tennessine<br>— | 118<br>Og<br>oganesson<br>— |

lanthanoids

|                                     |                                   |                                        |                                     |                                    |                                    |                                    |                                      |                                   |                                      |                                     |                                  |                                      |                                     |                                     |
|-------------------------------------|-----------------------------------|----------------------------------------|-------------------------------------|------------------------------------|------------------------------------|------------------------------------|--------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|----------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|
| 57<br><b>La</b><br>lanthanum<br>139 | 58<br><b>Ce</b><br>cerium<br>140  | 59<br><b>Pr</b><br>praseodymium<br>141 | 60<br><b>Nd</b><br>neodymium<br>144 | 61<br><b>Pm</b><br>promethium<br>— | 62<br><b>Sm</b><br>samarium<br>150 | 63<br><b>Eu</b><br>europium<br>152 | 64<br><b>Gd</b><br>gadolinium<br>157 | 65<br><b>Tb</b><br>terbium<br>159 | 66<br><b>Dy</b><br>dysprosium<br>163 | 67<br><b>Ho</b><br>holmium<br>165   | 68<br><b>Er</b><br>erbium<br>167 | 69<br><b>Tm</b><br>thulium<br>169    | 70<br><b>Yb</b><br>ytterbium<br>173 | 71<br><b>Lu</b><br>lutetium<br>175  |
| 89<br><b>Ac</b><br>actinium<br>—    | 90<br><b>Th</b><br>thorium<br>232 | 91<br><b>Pa</b><br>protactinium<br>231 | 92<br><b>U</b><br>uranium<br>238    | 93<br><b>Np</b><br>neptunium<br>—  | 94<br><b>Pu</b><br>plutonium<br>—  | 95<br><b>Am</b><br>americium<br>—  | 96<br><b>Cm</b><br>curium<br>—       | 97<br><b>Bk</b><br>berkelium<br>— | 98<br><b>Cf</b><br>californium<br>—  | 99<br><b>Es</b><br>einsteinium<br>— | 100<br><b>Fm</b><br>fermium<br>— | 101<br><b>Md</b><br>mendelevium<br>— | 102<br><b>No</b><br>nobelium<br>—   | 103<br><b>Lr</b><br>lawrencium<br>— |

actinoids

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.)