



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

**CHEMISTRY**

**0620/12**

Paper 1 Multiple Choice

**May/June 2014**

**45 Minutes**

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

\* 3 5 4 2 4 4 5 6 4 2 6 \*

**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.**

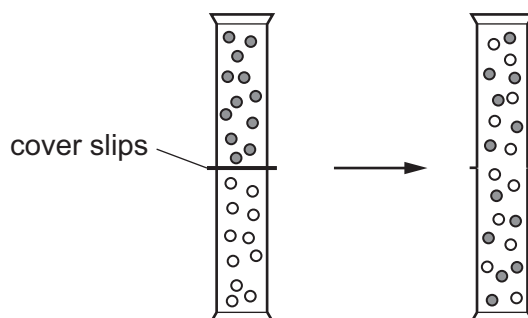
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.  
Any rough working should be done in this booklet.  
A copy of the Periodic Table is printed on page 16.  
Electronic calculators may be used.

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 **16** printed pages.

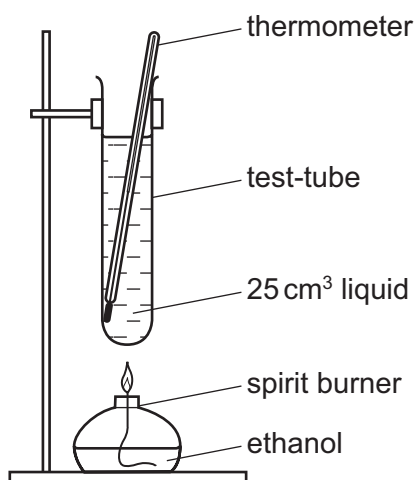
- 1 Two gas jars each contain a different gas. The gas jars are connected and the cover slips are removed.

The diagram shows what happens to the particles of the gases.



Which process has occurred?

- A chemical reaction
  - B condensation
  - C diffusion
  - D evaporation
- 2 A liquid is heated until it boils.



Which result shows that the liquid in the test-tube is pure water?

- A Condensation forms at the top of the test-tube.
- B Steam is produced.
- C The thermometer reads 100 °C.
- D There is nothing left behind in the test-tube.

3 Which two methods can be used to separate a salt from its solution in water?

- 1 crystallisation
- 2 decanting
- 3 distillation
- 4 filtration

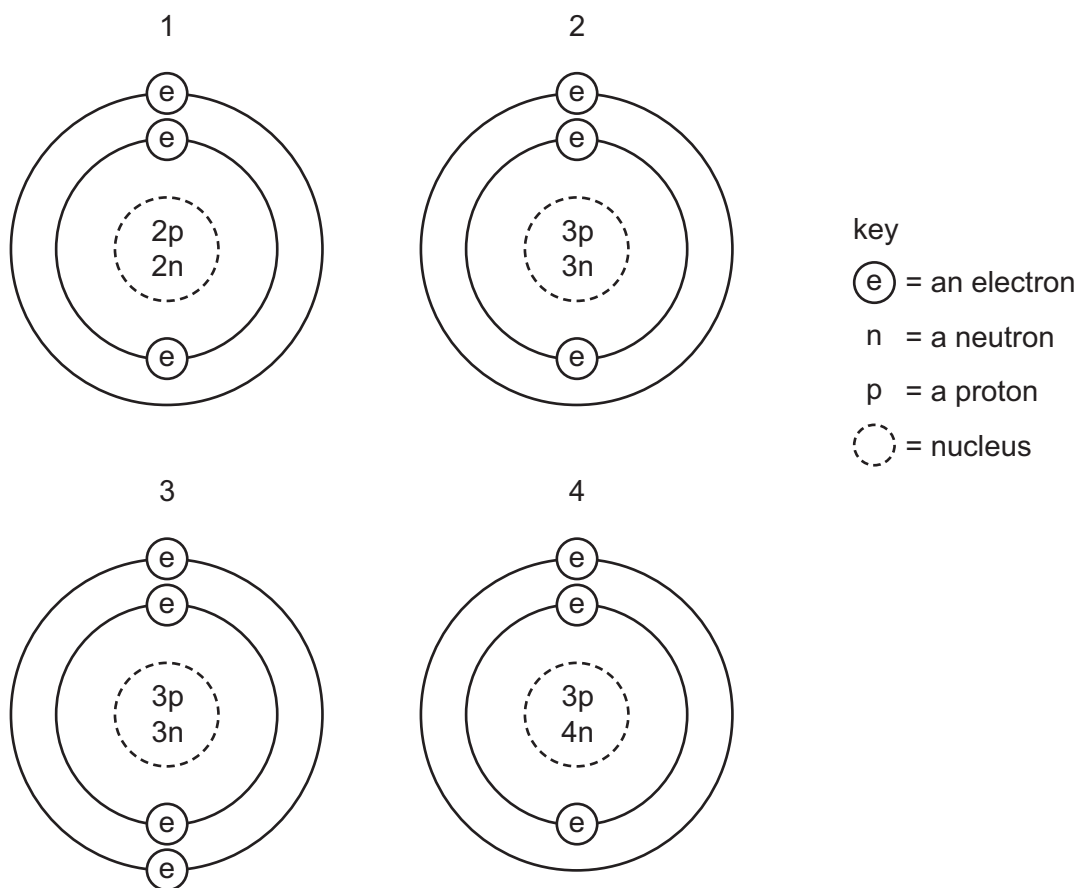
**A** 1 and 2      **B** 1 and 3      **C** 2 and 3      **D** 3 and 4

4 Which statements about a phosphorus atom,  $^{31}_{15}\text{P}$ , are correct?

- 1 The nucleon number is 16.
- 2 The number of outer electrons is 5.
- 3 The proton number is 15.

**A** 1, 2 and 3      **B** 1 and 2 only      **C** 1 and 3 only      **D** 2 and 3 only

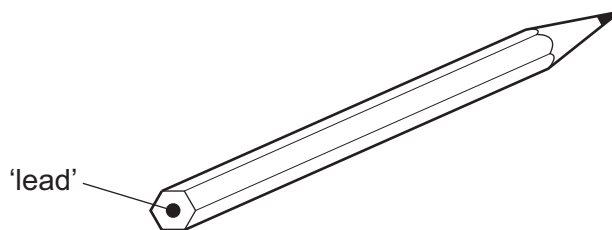
5 The diagrams show four particles.



Which two diagrams show **atoms** that are isotopes of each other?

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

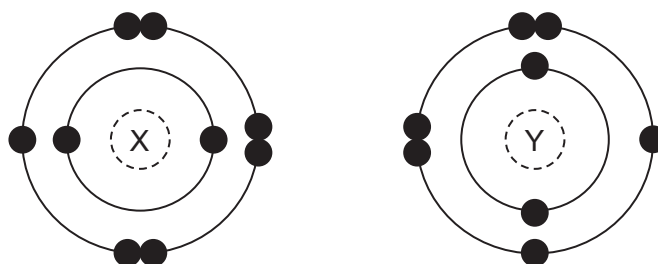
- 6 The 'lead' in a pencil is made of a mixture of graphite and clay.



When the percentage of graphite is increased, the pencil slides across the paper more easily.

Which statement explains this observation?

- A Graphite has a high melting point.
  - B Graphite is a form of carbon.
  - C Graphite is a lubricant.
  - D Graphite is a non-metal.
- 7 The electronic structures of two atoms, X and Y, are shown.

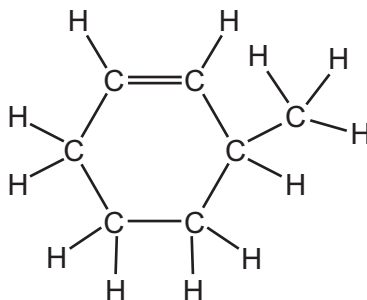


X and Y combine together to form a compound.

What is the type of bonding in the compound and what is the formula of the compound?

|          | type of bonding | formula |
|----------|-----------------|---------|
| <b>A</b> | covalent        | $X_2Y$  |
| <b>B</b> | covalent        | $XY_2$  |
| <b>C</b> | ionic           | $XY_2$  |
| <b>D</b> | ionic           | $X_2Y$  |

- 8 The structure of an organic compound, X, is shown.



What is the molecular formula of X?

- A  $C_6H_9$       B  $C_6H_{12}$       C  $C_7H_{12}$       D  $C_7H_{14}$
- 9 What is the relative molecular mass,  $M_r$ , of nitrogen dioxide?
- A 15      B 23      C 30      D 46
- 10 Electrical cables are made from either .....1....., because it is a very good conductor of electricity, or from.....2....., because it has a low density. Overhead cables have a .....3..... core in order to give the cable strength.

Which words correctly complete gaps 1, 2 and 3?

|          | 1         | 2         | 3         |
|----------|-----------|-----------|-----------|
| <b>A</b> | aluminium | copper    | magnesium |
| <b>B</b> | copper    | aluminium | magnesium |
| <b>C</b> | copper    | aluminium | steel     |
| <b>D</b> | magnesium | copper    | steel     |

- 11 What will be produced at the anode and at the cathode, if molten potassium chloride is electrolysed?

|          | anode (+) | cathode (-) |
|----------|-----------|-------------|
| <b>A</b> | chlorine  | hydrogen    |
| <b>B</b> | chlorine  | potassium   |
| <b>C</b> | hydrogen  | chlorine    |
| <b>D</b> | potassium | chlorine    |

12 Solutions of two chemicals are mixed.

A reaction occurs and the temperature change is measured.

Which statement is correct?

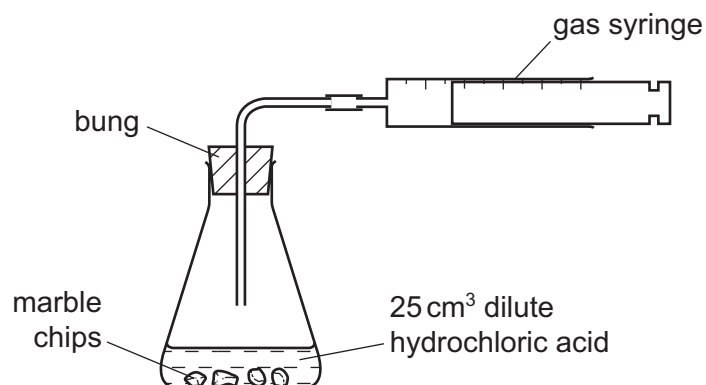
- A If the reaction is endothermic, the temperature decreases and energy is taken in.
- B If the reaction is endothermic, the temperature increases and energy is given out.
- C If the reaction is exothermic, the temperature decreases and energy is given out.
- D If the reaction is exothermic, the temperature increases and energy is taken in.

13 Power stations produce electrical energy from different fuels.

Which fuel causes least pollution to the atmosphere?

- A coal
- B fuel oil
- C natural gas
- D radioactive isotopes

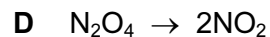
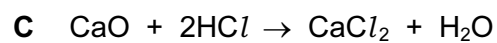
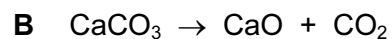
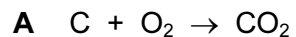
14 A student was investigating the reaction between marble chips and dilute hydrochloric acid.



Which changes would reduce the rate of reaction?

|          | temperature of acid | concentration of acid | surface area of marble chips |
|----------|---------------------|-----------------------|------------------------------|
| <b>A</b> | decrease            | decrease              | decrease                     |
| <b>B</b> | decrease            | decrease              | increase                     |
| <b>C</b> | increase            | decrease              | decrease                     |
| <b>D</b> | increase            | increase              | increase                     |

15 Which equation shows an oxidation reaction?



16 In separate experiments, a catalyst is added to a reaction mixture and the temperature of the mixture is decreased.

What are the effects of these changes on the rate of the reaction?

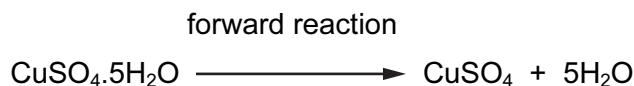
|          | catalyst added | temperature decreased |
|----------|----------------|-----------------------|
| <b>A</b> | faster         | faster                |
| <b>B</b> | faster         | slower                |
| <b>C</b> | slower         | faster                |
| <b>D</b> | slower         | slower                |

17 Different plants grow best under different pH conditions.

Which plant grows best in alkaline soil?

|          | plant      | grows best in soil at pH |
|----------|------------|--------------------------|
| <b>A</b> | cabbage    | 6-8                      |
| <b>B</b> | potato     | 4-7                      |
| <b>C</b> | strawberry | 5-7                      |
| <b>D</b> | wheat      | 6-7                      |

- 18 The equation shows a reaction that is reversed by changing the conditions.



How can the forward reaction be reversed?

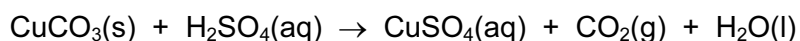
|          | by adding water | by heating |
|----------|-----------------|------------|
| <b>A</b> | ✓               | ✓          |
| <b>B</b> | ✓               | x          |
| <b>C</b> | x               | ✓          |
| <b>D</b> | x               | x          |

- 19 Element X forms an oxide, XO, that neutralises sulfuric acid.

Which row describes X and XO?

|          | element X | nature of oxide, XO |
|----------|-----------|---------------------|
| <b>A</b> | metal     | acidic              |
| <b>B</b> | metal     | basic               |
| <b>C</b> | non-metal | acidic              |
| <b>D</b> | non-metal | basic               |

- 20 Copper carbonate reacts with dilute sulfuric acid to make copper sulfate.



Which row gives the correct order of steps for making copper sulfate crystals?

|          | step 1                                  | step 2                                | step 3   | step 4        |
|----------|---|---------------------------------------|--|---------------|
| <b>A</b> | add excess acid to the copper carbonate | filter                                | evaporate filtrate to point of crystallisation | leave to cool |
| <b>B</b> | add excess acid to the copper carbonate | filter                                | evaporate to dryness                           | leave to cool |
| <b>C</b> | add excess copper carbonate to the acid | evaporate to point of crystallisation | leave to cool                                  | filter        |
| <b>D</b> | add excess copper carbonate to the acid | filter                                | evaporate filtrate to point of crystallisation | leave to cool |



21 Element X is a non-metal.

In which position of the Periodic Table could element X be found?

- A at the bottom of Group I
- B at the top of Group 0
- C at the top of Group I
- D in the transition elements

22 Aqueous sodium hydroxide is added to solid X and the mixture is heated.

A green precipitate is formed and an alkaline gas is given off.

Which ions are present in X?

- A  $\text{NH}_4^+$  and  $\text{Fe}^{2+}$
- B  $\text{NH}_4^+$  and  $\text{Fe}^{3+}$
- C  $\text{OH}^-$  and  $\text{Fe}^{2+}$
- D  $\text{OH}^-$  and  $\text{Fe}^{3+}$

23 A student carried out an experiment to find the order of reactivity of five metals. They were tested with cold water, hot water and steam and the results recorded in a table.

| metal | cold water        | hot water          | steam             |
|-------|-------------------|--------------------|-------------------|
| V     | no reaction       | reacts slowly      | vigorous reaction |
| W     | no reaction       | no reaction        | slow reaction     |
| X     | reacts slowly     | vigorous reaction  | not attempted     |
| Y     | no reaction       | no reaction        | no reaction       |
| Z     | vigorous reaction | explosive reaction | not attempted     |

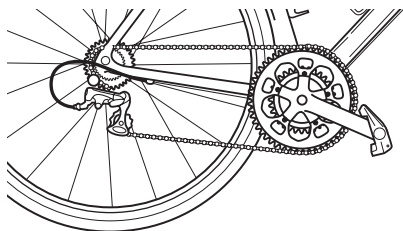
What is the order of reactivity of these metals?

|   | most reactive |   | → | least reactive |   |
|---|---------------|---|---|----------------|---|
| A | V             | W |   | X              | Z |
| B | W             | X |   | V              | Y |
| C | Z             | X |   | W              | Y |
| D | Z             | X |   | W              | V |



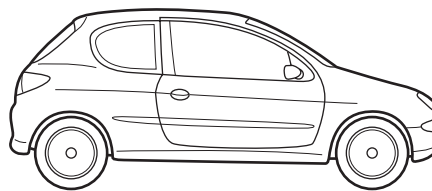
27 Which object is likely to be made from stainless steel?

A



bicycle chain

B



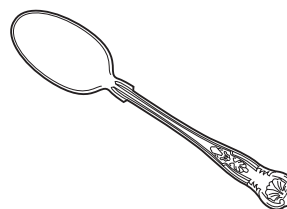
car body

C



can of beans

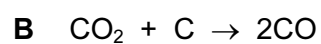
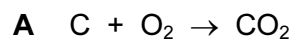
D



teaspoon

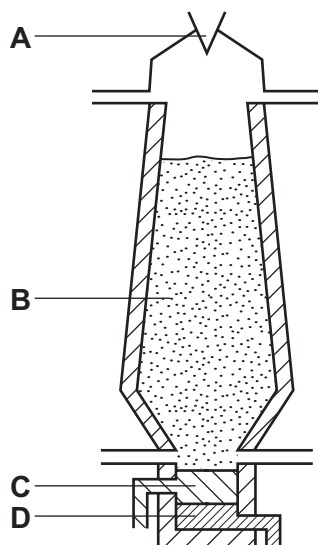
28 Four reactions that take place in the blast furnace to produce iron are shown.

Which reaction is used to keep the furnace hot?

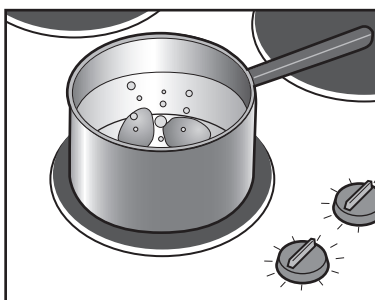


29 The diagram shows a blast furnace.

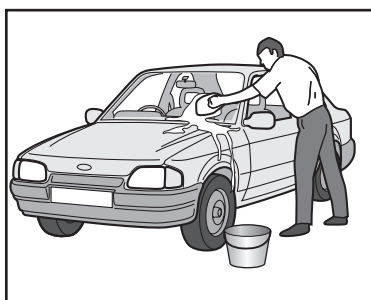
In which part is iron ore changed to iron?



30 The diagram shows some uses of water in the home.



1



2



3

For which uses is it important for the water to have been treated?

- A** 1 only      **B** 2 only      **C** 3 only      **D** 1, 2 and 3

31 A piece of uncoated iron and three pieces of iron with various coatings were left exposed to the air.

Which piece of iron would rust?

- A** the painted piece  
**B** the tin-coated piece  
**C** the uncoated piece  
**D** the zinc-coated piece

32 Which compound would **not** be an effective fertiliser?

- A ammonium nitrate,  $\text{NH}_4\text{NO}_3$
- B calcium oxide,  $\text{CaO}$
- C calcium phosphate,  $\text{Ca}_3(\text{PO}_4)_2$
- D potassium nitrate,  $\text{KNO}_3$

33 Sulfur dioxide,  $\text{SO}_2$ , nitrogen dioxide,  $\text{NO}_2$ , and carbon monoxide,  $\text{CO}$ , are air pollutants.

Which row correctly shows their major source?

|          | motor car engines             | power stations                |
|----------|-------------------------------|-------------------------------|
| <b>A</b> | CO                            | $\text{NO}_2$ , $\text{SO}_2$ |
| <b>B</b> | $\text{NO}_2$ , CO            | $\text{SO}_2$                 |
| <b>C</b> | $\text{SO}_2$ , $\text{NO}_2$ | CO                            |
| <b>D</b> | $\text{SO}_2$                 | $\text{NO}_2$ , CO            |

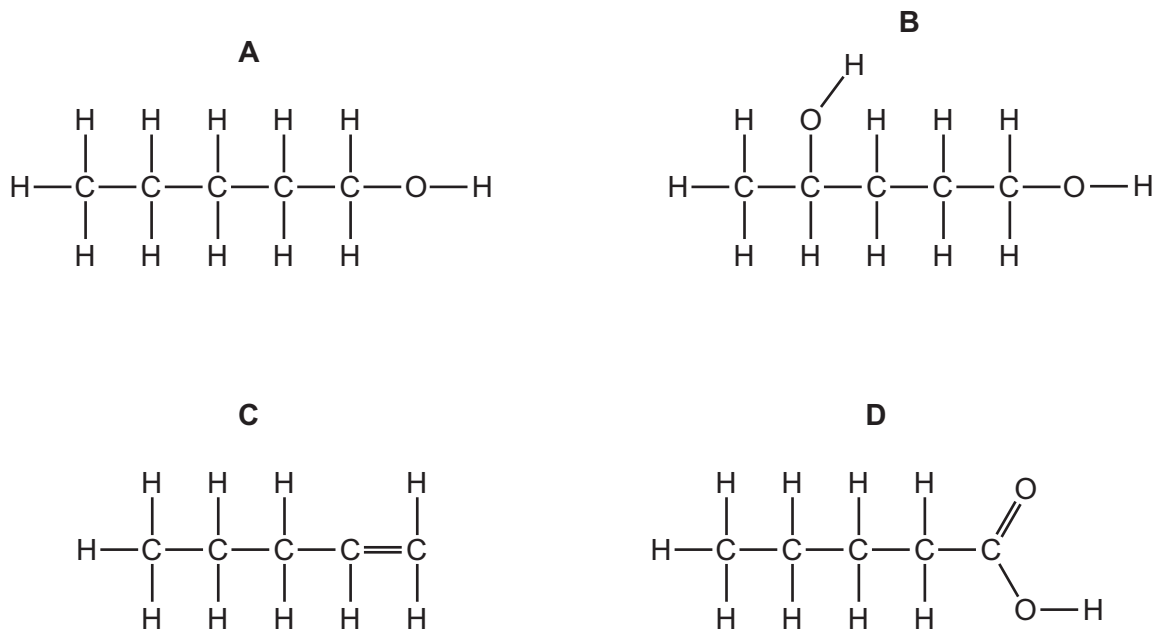
34 Which process does **not** produce carbon dioxide?

- A combustion of methane
- B fermentation of sugar
- C polymerisation of ethene
- D respiration

35 Which pollutant gas is produced by the decomposition of vegetation?

- A carbon monoxide
- B methane
- C nitrogen oxide
- D sulfur dioxide

36 Which diagram shows the structure of pentanoic acid?



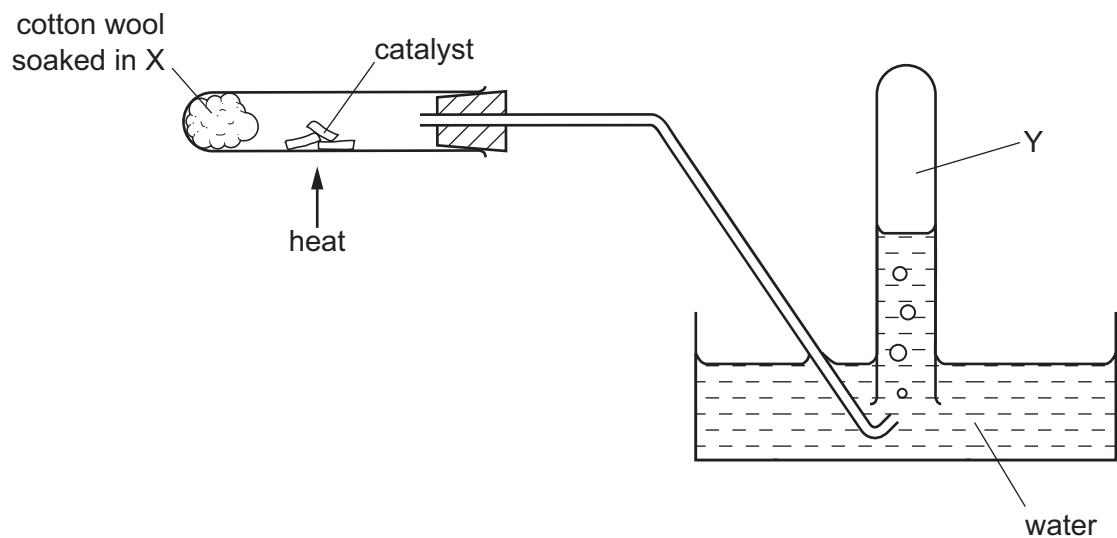
37 The table shows the composition of four different types of petroleum (crude oil).

| fraction   | Arabian Heavy<br>/% | Arabian Light<br>/% | Iranian Heavy<br>/% | North Sea<br>/% |
|------------|---------------------|---------------------|---------------------|-----------------|
| gasoline   | 18                  | 21                  | 21                  | 23              |
| kerosene   | 11.5                | 13                  | 13                  | 15              |
| diesel oil | 18                  | 20                  | 20                  | 24              |
| fuel oil   | 52.5                | 46                  | 46                  | 38              |

Which type of petroleum is best for the motor vehicle industry?

- A** Arabian Heavy
- B** Arabian Light
- C** Iranian Heavy
- D** North Sea

38 The diagram shows the cracking of substance X.



Which type of organic compound is found in Y, which is **not** present in X?

- A** acid
- B** alcohol
- C** alkane
- D** alkene
- 39 In which reaction could one of the products belong to the same homologous series as the organic reactant?
- A** addition of steam to ethene
- B** combustion of an alkane
- C** cracking of an alkane
- D** polymerisation of ethene
- 40 Ethanol is produced from either ethene or sugar.

Which type of chemical reaction is used in each case?

|          | ethene → ethanol | sugar → ethanol         |
|----------|------------------|-------------------------|
| <b>A</b> | addition         | fermentation            |
| <b>B</b> | addition         | fractional distillation |
| <b>C</b> | distillation     | fermentation            |
| <b>D</b> | distillation     | fractional distillation |

**DATA SHEET**  
**The Periodic Table of the Elements**

|                       |                        | Group                          |                        |                      |                         |                         |                        |                      |                        |                        |                      |                        |                    |                       |                        |                       |                      |                       |                       |                        |                       |                           |                        |                         |                       |                       |                         |                      |                         |                      |                       |                      |                        |                       |                       |                     |                       |                      |                           |                     |                        |                        |                        |                     |                        |                          |                          |                      |                          |                       |                         |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     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|                       |                        | 1<br><b>H</b><br>Hydrogen<br>1 |                        |                      |                         |                         |                        |                      |                        |                        |                      |                        |                    |                       |                        |                       |                      |                       |                       |                        |                       |                           |                        |                         |                       |                       |                         |                      |                         |                      |                       |                      |                        |                       |                       |                     |                       |                      |                           |                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  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |  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|                       |                        | 4<br><b>He</b><br>Helium<br>2  |                        |                      |                         |                         |                        |                      |                        |                        |                      |                        |                    |                       |                        |                       |                      |                       |                       |                        |                       |                           |                        |                         |                       |                       |                         |                      |                         |                      |                       |                      |                        |                       |                       |                     |                       |                      |                           |                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| 7                     | 9                      | 3                              | 4                      | 5                    | 6                       | 7                       | 8                      | 9                    | 10                     | 11                     | 12                   | 13                     | 14                 | 15                    | 16                     | 17                    | 18                   | 19                    | 20                    |                        |                       |                           |                        |                         |                       |                       |                         |                      |                         |                      |                       |                      |                        |                       |                       |                     |                       |                      |                           |                     |                        |                        |                        |                     |                        |                          |                          |                      |                          |                       |                         |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Li</b><br>Lithium  | <b>Be</b><br>Beryllium | <b>B</b><br>Boron              | <b>C</b><br>Carbon     | <b>N</b><br>Nitrogen | <b>O</b><br>Oxygen      | <b>F</b><br>Fluorine    | <b>Ne</b><br>Neon      | <b>Na</b><br>Sodium  | <b>Mg</b><br>Magnesium | <b>Al</b><br>Aluminium | <b>Si</b><br>Silicon | <b>P</b><br>Phosphorus | <b>S</b><br>Sulfur | <b>Cl</b><br>Chlorine | <b>Ar</b><br>Argon     | <b>K</b><br>Potassium | <b>Ca</b><br>Calcium | <b>Sc</b><br>Scandium | <b>Ti</b><br>Titanium | <b>V</b><br>Vanadium   | <b>Cr</b><br>Chromium | <b>Mn</b><br>Manganese    | <b>Fe</b><br>Iron      | <b>Co</b><br>Cobalt     | <b>Ni</b><br>Nickel   | <b>Cu</b><br>Copper   | <b>Zn</b><br>Zinc       | <b>Ga</b><br>Gallium | <b>Ge</b><br>Germanium  | <b>As</b><br>Arsenic | <b>Se</b><br>Selenium | <b>Br</b><br>Bromine | <b>Kr</b><br>Krypton   |                       |                       |                     |                       |                      |                           |                     |                        |                        |                        |                     |                        |                          |                          |                      |                          |                       |                         |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |      |
| 19                    | 37                     | 39                             | 40                     | 41                   | 42                      | 43                      | 44                     | 45                   | 46                     | 47                     | 48                   | 49                     | 50                 | 51                    | 52                     | 53                    | 54                   | 55                    | 56                    | 57                     | 58                    | 59                        | 60                     | 61                      | 62                    | 63                    | 64                      | 65                   | 66                      | 67                   | 68                    | 69                   | 70                     | 71                    | 72                    | 73                  | 74                    | 75                   | 76                        | 77                  | 78                     | 79                     | 80                     | 81                  | 82                     | 83                       | 84                       | 85                   | 86                       |                       |                         |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |      |
| <b>Rb</b><br>Rubidium | <b>Sr</b><br>Strontium | <b>Y</b><br>Yttrium            | <b>Zr</b><br>Zirconium | <b>Nb</b><br>Niobium | <b>Mo</b><br>Molybdenum | <b>Tc</b><br>Technetium | <b>Ru</b><br>Ruthenium | <b>Rh</b><br>Rhodium | <b>Pd</b><br>Palladium | <b>Ag</b><br>Silver    | <b>Cd</b><br>Cadmium | <b>In</b><br>Indium    | <b>Sn</b><br>Tin   | <b>Sb</b><br>Antimony | <b>Te</b><br>Tellurium | <b>I</b><br>Iodine    | <b>Xe</b><br>Xenon   | <b>Cs</b><br>Caesium  | <b>Ba</b><br>Barium   | <b>La</b><br>Lanthanum | <b>Ce</b><br>Cerium   | <b>Pr</b><br>Praseodymium | <b>Nd</b><br>Neodymium | <b>Pm</b><br>Promethium | <b>Sm</b><br>Samarium | <b>Eu</b><br>Europium | <b>Gd</b><br>Gadolinium | <b>Tb</b><br>Terbium | <b>Dy</b><br>Dysprosium | <b>Ho</b><br>Holmium | <b>Er</b><br>Erbium   | <b>Tm</b><br>Thulium | <b>Yb</b><br>Ytterbium | <b>Lu</b><br>Lutetium | <b>Fr</b><br>Francium | <b>Ra</b><br>Radium | <b>Ac</b><br>Actinium | <b>Th</b><br>Thorium | <b>Pa</b><br>Protactinium | <b>U</b><br>Uranium | <b>Np</b><br>Neptunium | <b>Pu</b><br>Plutonium | <b>Am</b><br>Americium | <b>Cm</b><br>Curium | <b>Bk</b><br>Berkelium | <b>Cf</b><br>Californium | <b>Es</b><br>Einsteinium | <b>Fm</b><br>Fermium | <b>Md</b><br>Mendelevium | <b>No</b><br>Nobelium | <b>Lr</b><br>Lawrencium |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |      |
| 55                    | 87                     | 89                             | 91                     | 93                   | 96                      | 101                     | 106                    | 112                  | 115                    | 119                    | 122                  | 127                    | 131                | 133                   | 137                    | 140                   | 141                  | 144                   | 146                   | 147                    | 150                   | 152                       | 157                    | 162                     | 165                   | 167                   | 169                     | 173                  | 175                     | 178                  | 181                   | 183                  | 186                    | 188                   | 190                   | 192                 | 195                   | 197                  | 201                       | 204                 | 207                    | 209                    | 210                    | 211                 | 212                    | 213                      | 214                      | 215                  | 216                      | 217                   | 218                     | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 | 376 | 377 | 378 | 379 | 380 | 381 | 382 | 383 | 384 | 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 | 395 | 396 | 397 | 398 | 399 | 400 | 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 | 417 | 418 | 419 | 420 | 421 | 422 | 423 | 424 | 425 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | 433 | 434 | 435 | 436 | 437 | 438 | 439 | 440 | 441 | 442 | 443 | 444 | 445 | 446 | 447 | 448 | 449 | 450 | 451 | 452 | 453 | 454 | 455 | 456 | 457 | 458 | 459 | 460 | 461 | 462 | 463 | 464 | 465 | 466 | 467 | 468 | 469 | 470 | 471 | 472 | 473 | 474 | 475 | 476 | 477 | 478 | 479 | 480 | 481 | 482 | 483 | 484 | 485 | 486 | 487 | 488 | 489 | 490 | 491 | 492 | 493 | 494 | 495 | 496 | 497 | 498 | 499 | 500 | 501 | 502 | 503 | 504 | 505 | 506 | 507 | 508 | 509 | 510 | 511 | 512 | 513 | 514 | 515 | 516 | 517 | 518 | 519 | 520 | 521 | 522 | 523 | 524 | 525 | 526 | 527 | 528 | 529 | 530 | 531 | 532 | 533 | 534 | 535 | 536 | 537 | 538 | 539 | 540 | 541 | 542 | 543 | 544 | 545 | 546 | 547 | 548 | 549 | 550 | 551 | 552 | 553 | 554 | 555 | 556 | 557 | 558 | 559 | 560 | 561 | 562 | 563 | 564 | 565 | 566 | 567 | 568 | 569 | 570 | 571 | 572 | 573 | 574 | 575 | 576 | 577 | 578 | 579 | 580 | 581 | 582 | 583 | 584 | 585 | 586 | 587 | 588 | 589 | 590 | 591 | 592 | 593 | 594 | 595 | 596 | 597 | 598 | 599 | 600 | 601 | 602 | 603 | 604 | 605 | 606 | 607 | 608 | 609 | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 617 | 618 | 619 | 620 | 621 | 622 | 623 | 624 | 625 | 626 | 627 | 628 | 629 | 630 | 631 | 632 | 633 | 634 | 635 | 636 | 637 | 638 | 639 | 640 | 641 | 642 | 643 | 644 | 645 | 646 | 647 | 648 | 649 | 650 | 651 | 652 | 653 | 654 | 655 | 656 | 657 | 658 | 659 | 660 | 661 | 662 | 663 | 664 | 665 | 666 | 667 | 668 | 669 | 670 | 671 | 672 | 673 | 674 | 675 | 676 | 677 | 678 | 679 | 680 | 681 | 682 | 683 | 684 | 685 | 686 | 687 | 688 | 689 | 690 | 691 | 692 | 693 | 694 | 695 | 696 | 697 | 698 | 699 | 700 | 701 | 702 | 703 | 704 | 705 | 706 | 707 | 708 | 709 | 710 | 711 | 712 | 713 | 714 | 715 | 716 | 717 | 718 | 719 | 720 | 721 | 722 | 723 | 724 | 725 | 726 | 727 | 728 | 729 | 730 | 731 | 732 | 733 | 734 | 735 | 736 | 737 | 738 | 739 | 740 | 741 | 742 | 743 | 744 | 745 | 746 | 747 | 748 | 749 | 750 | 751 | 752 | 753 | 754 | 755 | 756 | 757 | 758 | 759 | 760 | 761 | 762 | 763 | 764 | 765 | 766 | 767 | 768 | 769 | 770 | 771 | 772 | 773 | 774 | 775 | 776 | 777 | 778 | 779 | 780 | 781 | 782 | 783 | 784 | 785 | 786 | 787 | 788 | 789 | 790 | 791 | 792 | 793 | 794 | 795 | 796 | 797 | 798 | 799 | 800 | 801 | 802 | 803 | 804 | 805 | 806 | 807 | 808 | 809 | 810 | 811 | 812 | 813 | 814 | 815 | 816 | 817 | 818 | 819 | 820 | 821 | 822 | 823 | 824 | 825 | 826 | 827 | 828 | 829 | 830 | 831 | 832 | 833 | 834 | 835 | 836 | 837 | 838 | 839 | 840 | 841 | 842 | 843 | 844 | 845 | 846 | 847 | 848 | 849 | 850 | 851 | 852 | 853 | 854 | 855 | 856 | 857 | 858 | 859 | 860 | 861 | 862 | 863 | 864 | 865 | 866 | 867 | 868 | 869 | 870 | 871 | 872 | 873 | 874 | 875 | 876 | 877 | 878 | 879 | 880 | 881 | 882 | 883 | 884 | 885 | 886 | 887 | 888 | 889 | 890 | 891 | 892 | 893 | 894 | 895 | 896 | 897 | 898 | 899 | 900 | 901 | 902 | 903 | 904 | 905 | 906 | 907 | 908 | 909 | 910 | 911 | 912 | 913 | 914 | 915 | 916 | 917 | 918 | 919 | 920 | 921 | 922 | 923 | 924 | 925 | 926 | 927 | 928 | 929 | 930 | 931 | 932 | 933 | 934 | 935 | 936 | 937 | 938 | 939 | 940 | 941 | 942 | 943 | 944 | 945 | 946 | 947 | 948 | 949 | 950 | 951 | 952 | 953 | 954 | 955 | 956 | 957 | 958 | 959 | 960 | 961 | 962 | 963 | 964 | 965 | 966 | 967 | 968 | 969 | 970 | 971 | 972 | 973 | 974 | 975 | 976 | 977 | 978 | 979 | 980 | 981 | 982 | 983 | 984 | 985 | 986 | 987 | 988 | 989 | 990 | 991 | 992 | 993 | 994 | 995 | 996 | 997 | 998 | 999 | 1000 |

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

|     |                          |                   |                            |
|-----|--------------------------|-------------------|----------------------------|
|     | <b>a</b>                 | <b>X</b>          | <b>b</b>                   |
| Key | a = relative atomic mass | X = atomic symbol | b = proton (atomic) number |

\*58-71 Lanthanoid series  
†90-103 Actinoid series

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