



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

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**CHEMISTRY**

**0620/12**

Paper 1 Multiple Choice

**May/June 2013**

**45 Minutes**

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



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**READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.

Do not use staples, paper clips, highlighters, 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.

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This document consists of **16** printed pages.



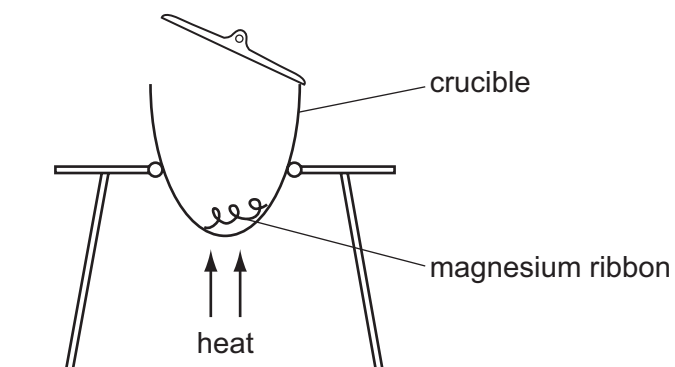
- 1 The diagram shows a cup of tea.



Which row describes the water particles in the air above the cup compared with the water particles in the cup?

|          | moving faster | closer together |
|----------|---------------|-----------------|
| <b>A</b> | ✓             | ✓               |
| <b>B</b> | ✓             | x               |
| <b>C</b> | x             | ✓               |
| <b>D</b> | x             | x               |

- 2 The diagram shows an experiment to find the formula of magnesium oxide.

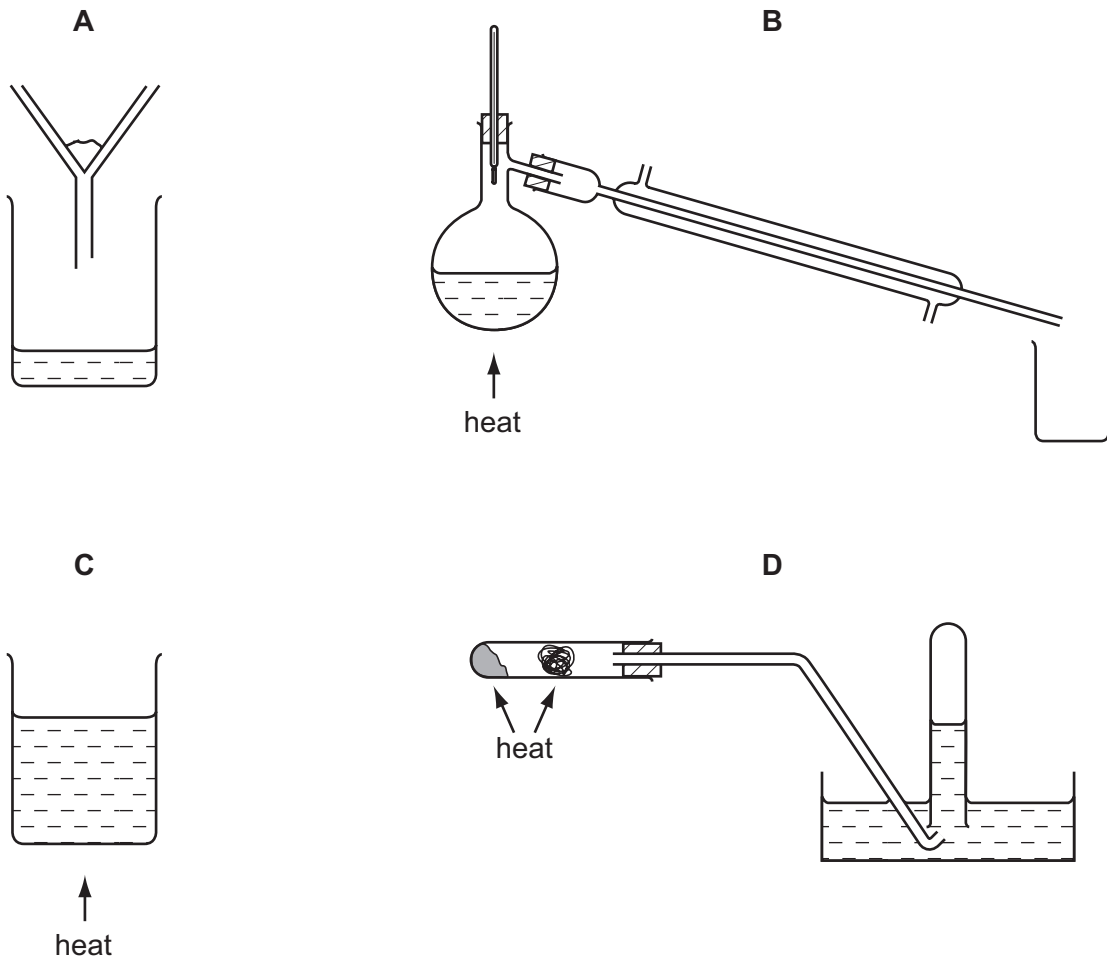


Which piece of apparatus would be needed in addition to those shown?

- A** a balance
- B** a measuring cylinder
- C** a spatula
- D** a thermometer

- 3 Methanol,  $\text{CH}_3\text{OH}$ , and ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , are miscible liquids.

Which diagram shows apparatus that is used to obtain methanol from a mixture of ethanol and methanol?

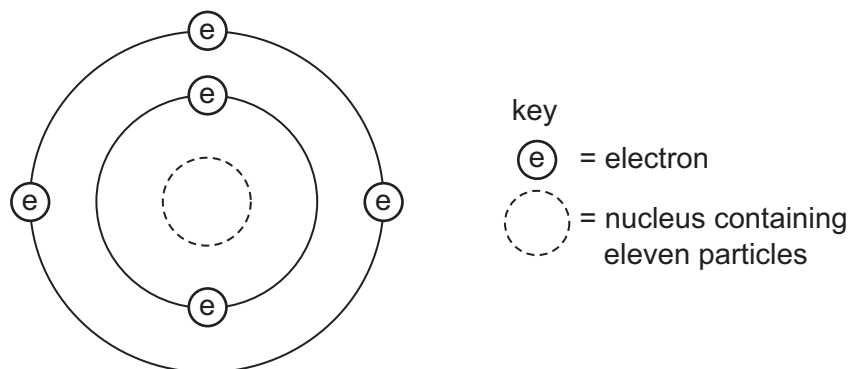


- 4 The positions of four elements are shown on the outline of the Periodic Table.

Which element forms a coloured oxide?

|  |  |          |  |  |  |  |  |  |  |  |  |          |  |  |  |  |  |          |  |  |  |  |  |  |  |
|--|--|----------|--|--|--|--|--|--|--|--|--|----------|--|--|--|--|--|----------|--|--|--|--|--|--|--|
|  |  |          |  |  |  |  |  |  |  |  |  |          |  |  |  |  |  | <b>A</b> |  |  |  |  |  |  |  |
|  |  | <b>B</b> |  |  |  |  |  |  |  |  |  |          |  |  |  |  |  | <b>C</b> |  |  |  |  |  |  |  |
|  |  |          |  |  |  |  |  |  |  |  |  | <b>D</b> |  |  |  |  |  |          |  |  |  |  |  |  |  |
|  |  |          |  |  |  |  |  |  |  |  |  |          |  |  |  |  |  |          |  |  |  |  |  |  |  |

5 The diagram shows an atom of an element.



How many protons and neutrons are in the nucleus of the atom and in which group and period of the Periodic Table is the element found?

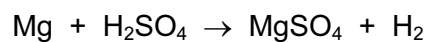
|          | number of protons | number of neutrons | group number | period number |
|----------|-------------------|--------------------|--------------|---------------|
| <b>A</b> | 5                 | 6                  | 3            | 2             |
| <b>B</b> | 5                 | 11                 | 2            | 3             |
| <b>C</b> | 6                 | 5                  | 3            | 2             |
| <b>D</b> | 6                 | 11                 | 2            | 3             |

6 Electrons from each element are shared by both of the elements in a compound.

Which compound matches this description?

- A** lead bromide
- B** sodium chloride
- C** water
- D** zinc oxide

7 The equation shows the reaction between magnesium and sulfuric acid.

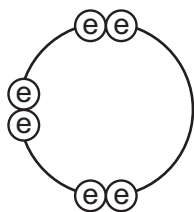



$$(\text{Mg} = 24, \text{H} = 1, \text{S} = 32, \text{O} = 16)$$

In this reaction, what mass of magnesium sulfate will be formed when 6 g of magnesium reacts with excess sulfuric acid?

- A** 8
- B** 24
- C** 30
- D** 60

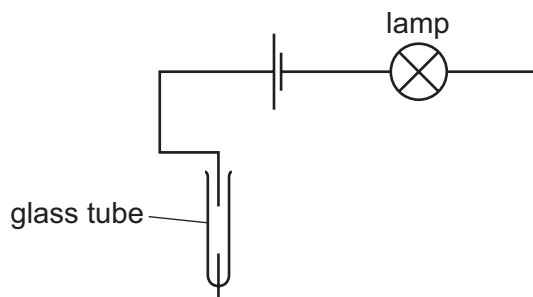
- 8 Element X has six electrons in its outer shell.



key  
 = electron

How could the element react?

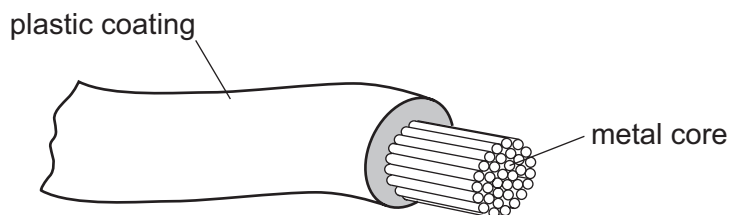
- A** by gaining two electrons to form a positive ion  
**B** by losing six electrons to form a negative ion  
**C** by sharing two electrons with two electrons from another element to form two covalent bonds  
**D** by sharing two electrons with two electrons from another element to form four covalent bonds
- 9 The diagram shows an incomplete circuit.



Which substance causes the lamp to light when added to the glass tube?

- A** aqueous sodium chloride  
**B** aqueous sugar  
**C** solid sodium chloride  
**D** solid sugar
- 10 What is the balanced chemical equation for the reaction between calcium and water?
- A**  $\text{Ca} + \text{H}_2\text{O} \rightarrow \text{CaOH} + \text{H}_2$   
**B**  $\text{Ca} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2 + \text{H}_2$   
**C**  $\text{Ca} + 2\text{H}_2\text{O} \rightarrow \text{CaOH} + \text{H}_2$   
**D**  $\text{Ca} + 2\text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2 + \text{H}_2$

11 The diagram shows an electrical cable.



Which statement about the substances used is correct?

- A The coating is plastic because it conducts electricity well.
- B The core is copper because it conducts electricity well.
- C The core is copper because it is cheap and strong.
- D The core is iron because it is cheap and strong.

12 Statement 1 Hydrogen is used as a fuel.

Statement 2 When hydrogen burns in the air to form water, heat energy is produced.

Which is correct?

- A Both statements are correct and statement 2 explains statement 1.
- B Both statements are correct but statement 2 does not explain statement 1.
- C Statement 1 is correct but statement 2 is incorrect.
- D Statement 2 is correct but statement 1 is incorrect.

13 Which substance does **not** require oxygen in order to produce energy?

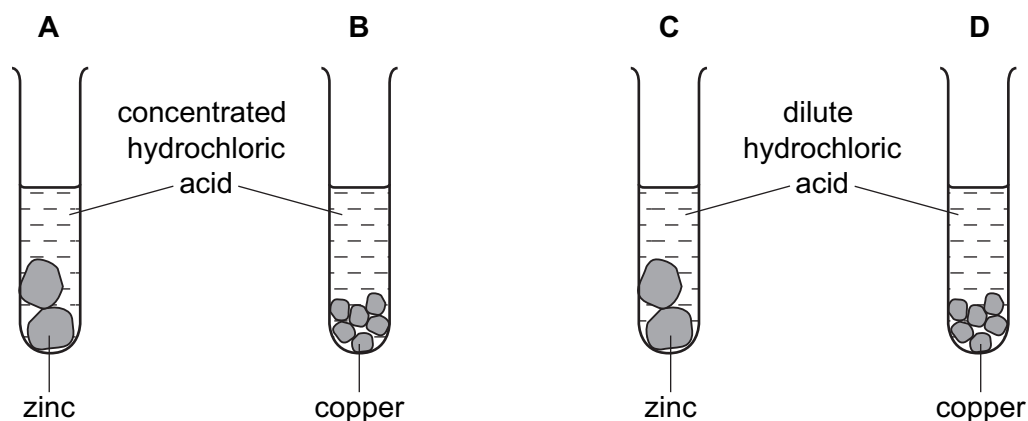
- A coal
- B hydrogen
- C natural gas
- D  $^{235}\text{U}$

14 In which equation is the underlined substance acting as a reducing agent?

- A 3CO + Fe<sub>2</sub>O<sub>3</sub> → 2Fe + 3CO<sub>2</sub>
- B CO<sub>2</sub> + C → 2CO
- C CuO + H<sub>2</sub> → Cu + H<sub>2</sub>O
- D CaO + H<sub>2</sub>O → Ca(OH)<sub>2</sub>

- 15 The diagram shows an experiment to compare the rate of reaction when a metal is added to hydrochloric acid.

In which test-tube is the reaction fastest?



- 16 Two oxides, X and Y, are added separately to dilute sulfuric acid and dilute sodium hydroxide.

X reacts with dilute sulfuric acid but Y does not react.

Y reacts with aqueous sodium hydroxide but X does not react.

Which type of oxide are X and Y?

|          | acidic oxide | basic oxide | metallic oxide |
|----------|--------------|-------------|----------------|
| <b>A</b> | X            | Y           | X              |
| <b>B</b> | X            | Y           | Y              |
| <b>C</b> | Y            | X           | X              |
| <b>D</b> | Y            | X           | Y              |

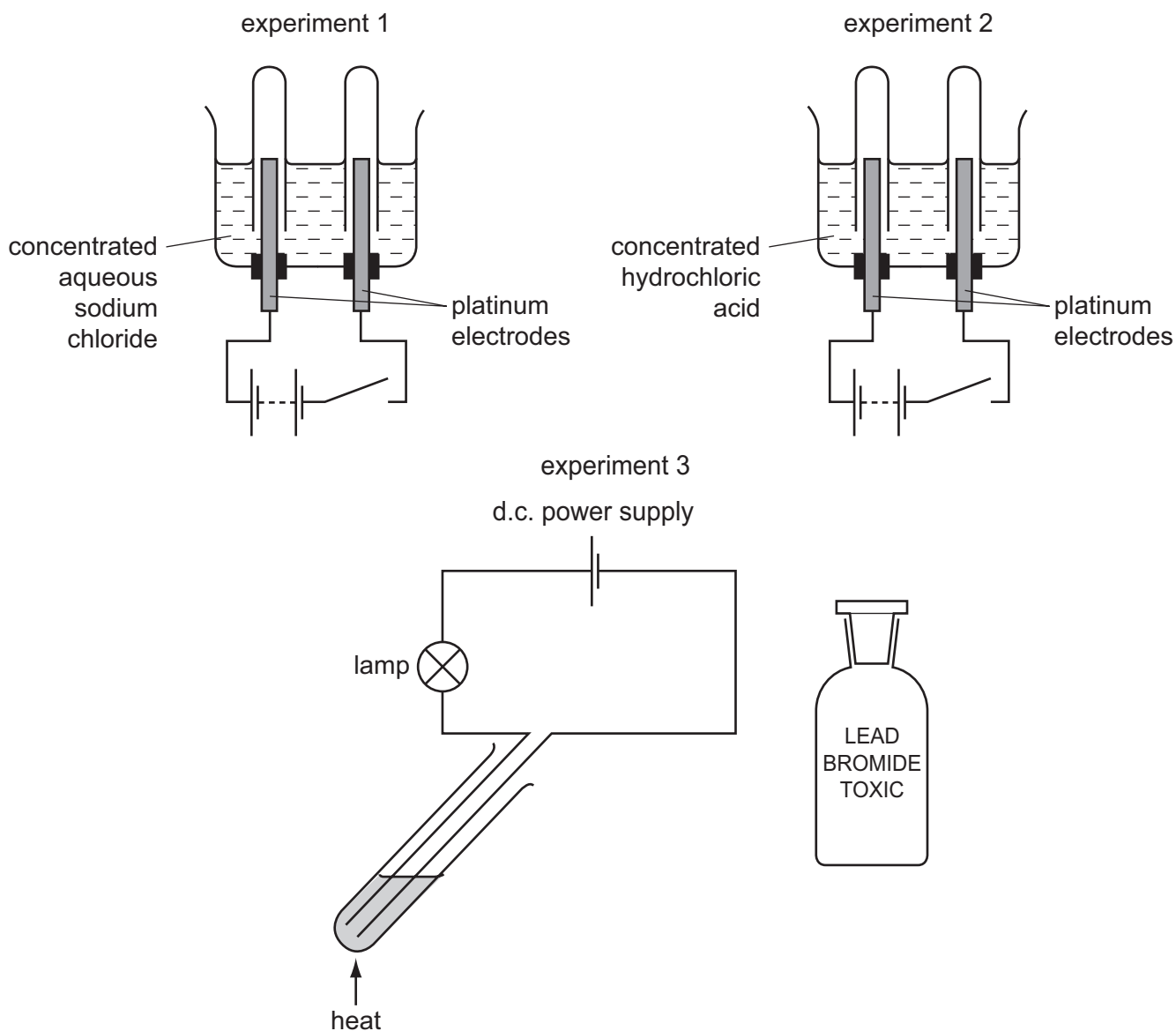
- 17 Heating pink cobalt(II) chloride crystals forms a blue solid and steam.

The blue solid turns pink when water is added.

Which terms describe the pink cobalt(II) chloride and the reaction?

|          | pink cobalt(II) chloride is | the reaction is reversible |
|----------|-----------------------------|----------------------------|
| <b>A</b> | anhydrous                   | yes                        |
| <b>B</b> | anhydrous                   | no                         |
| <b>C</b> | hydrated                    | yes                        |
| <b>D</b> | hydrated                    | no                         |

- 18 Concentrated aqueous sodium chloride, concentrated hydrochloric acid and molten lead bromide were separately electrolysed in experiments 1, 2 and 3.

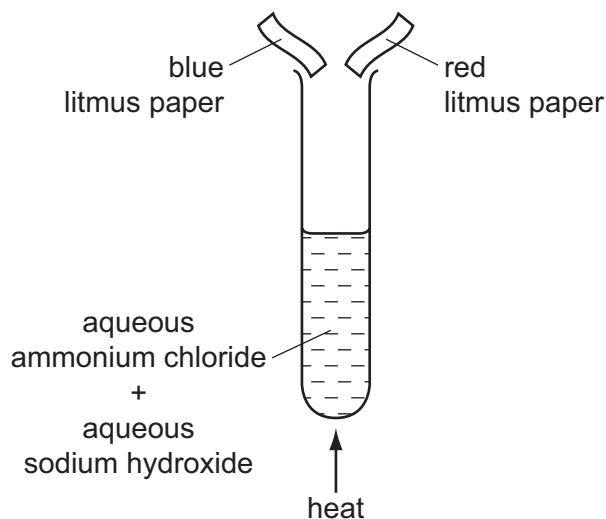


Which statement about the electrode products is correct?

- A** Gases were given off at the anode in experiments 2 and 3 only.
- B** Gases were given off at the cathode in experiments 1 and 2 only.
- C** Metals were formed at the anode in experiments 1 and 3 only.
- D** Metals were formed at the cathode in experiments 1 and 3 only.
- 19 Which statement about the reaction of acids is correct?
- A** They react with ammonium salts to form a salt and ammonia only.
- B** They react with metal carbonates to give a salt and carbon dioxide only.
- C** They react with metal hydroxides to give a salt and water only.
- D** They react with metals to give a salt, hydrogen and water only.



20 The diagram shows an experiment.



What happens to the pieces of litmus paper?

|          | blue litmus paper | red litmus paper |
|----------|-------------------|------------------|
| <b>A</b> | changes colour    | changes colour   |
| <b>B</b> | changes colour    | no colour change |
| <b>C</b> | no colour change  | changes colour   |
| <b>D</b> | no colour change  | no colour change |

21 Two indicators, bromophenol blue and Congo red, show the following colours in acidic solutions and in alkaline solutions.

| indicator        | acid   | alkali |
|------------------|--------|--------|
| bromophenol blue | yellow | blue   |
| Congo red        | violet | red    |

A few drops of each indicator are added to separate samples of a solution of pH 2.

What are the colours of the indicators in this solution?

|          | in a solution of pH 2 |              |
|----------|-----------------------|--------------|
|          | bromophenol blue is   | Congo red is |
| <b>A</b> | blue                  | red          |
| <b>B</b> | blue                  | violet       |
| <b>C</b> | yellow                | red          |
| <b>D</b> | yellow                | violet       |

22 W, X, Y and Z are elements in the same period in the Periodic Table.

W and Y are metals. X and Z are non-metals.

Which shows the correct order of these elements across the period?

**A**

|   |  |   |  |   |  |   |  |
|---|--|---|--|---|--|---|--|
| W |  | X |  | Y |  | Z |  |
|---|--|---|--|---|--|---|--|

**B**

|   |   |  |  |  |   |  |   |
|---|---|--|--|--|---|--|---|
| X | Z |  |  |  | W |  | Y |
|---|---|--|--|--|---|--|---|

**C**

|   |  |  |  |  |   |   |   |
|---|--|--|--|--|---|---|---|
| Y |  |  |  |  | W | X | Z |
|---|--|--|--|--|---|---|---|

**D**

|   |  |   |  |  |  |   |   |
|---|--|---|--|--|--|---|---|
| W |  | Y |  |  |  | X | Z |
|---|--|---|--|--|--|---|---|

23 Platinum is a transition metal.

Which statement about platinum is correct?

- A** It does not catalyse reactions.
- B** It forms coloured compounds.
- C** It has a low density.
- D** It has a low melting point.

24 Which element will be less reactive than the other members of its group in the Periodic Table?

- A** astatine
- B** caesium
- C** fluorine
- D** rubidium

25 Bromine is in Group VII on the Periodic Table.

Which describes the appearance of bromine at room temperature?

- A** grey solid
- B** purple fumes
- C** red-brown liquid
- D** yellow gas

26 A substance, X, has the following properties.

- 1 It has a high melting point.
- 2 It conducts electricity in the solid and liquid states.
- 3 It is malleable.
- 4 It had a high density.

What is X?

- A a ceramic
- B copper
- C graphite
- D sodium chloride

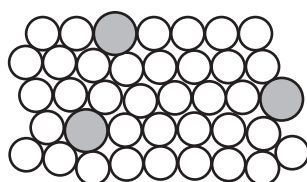
27 Why is aluminium used to make food containers?

- A It has a low density.
- B It is strong.
- C It keeps the food hot.
- D It resists corrosion.

28 Which statement is incorrect?

- A Carbon dioxide is a waste product in the extraction of iron.
- B Carbon monoxide is a reducing agent.
- C The extraction of iron from hematite involves reduction.
- D When iron is converted into steel, oxygen is used to oxidise the iron.

29 The diagram represents the structure of substance S.



What is S?

- A an alloy
- B an ionic solid
- C a macromolecule
- D a pure metal

30 Q, R, S and T are four metals.

Q is found naturally as the metal.

R reacts with steam but not with cold water.

S reacts violently with cold water.

The oxide of T is reduced to T by heating with carbon.

What is the order of reactivity of the four metals, starting with the most reactive first?

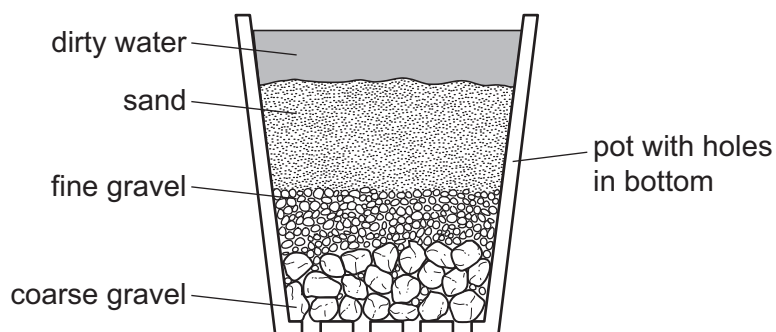
A  $Q \rightarrow R \rightarrow T \rightarrow S$

B  $Q \rightarrow T \rightarrow R \rightarrow S$

C  $S \rightarrow R \rightarrow Q \rightarrow T$

D  $S \rightarrow R \rightarrow T \rightarrow Q$

31 The diagram shows a stage in the purification of dirty water.



Which process does this apparatus show?

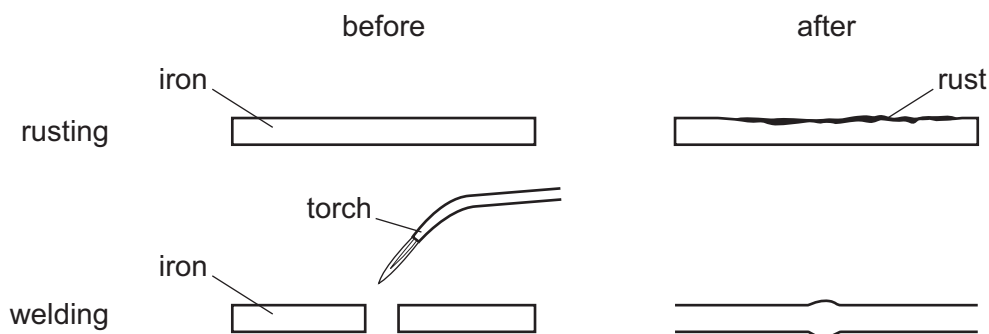
A chlorination

B condensation

C distillation

D filtration

32 The diagrams show two processes.



For which processes is oxygen involved?

|          | rusting | welding |
|----------|---------|---------|
| <b>A</b> | ✓       | ✓       |
| <b>B</b> | ✓       | x       |
| <b>C</b> | x       | ✓       |
| <b>D</b> | x       | x       |

33 Which substance would make the best general fertiliser?

|          | relative amount |    |    | solubility in water |
|----------|-----------------|----|----|---------------------|
|          | P               | K  | N  |                     |
| <b>A</b> | 5               | 0  | 5  | soluble             |
| <b>B</b> | 5               | 5  | 20 | insoluble           |
| <b>C</b> | 5               | 10 | 15 | soluble             |
| <b>D</b> | 10              | 5  | 10 | insoluble           |

34 Which information about carbon dioxide and methane is correct?

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

key  
 ✓ = true  
 x = false

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

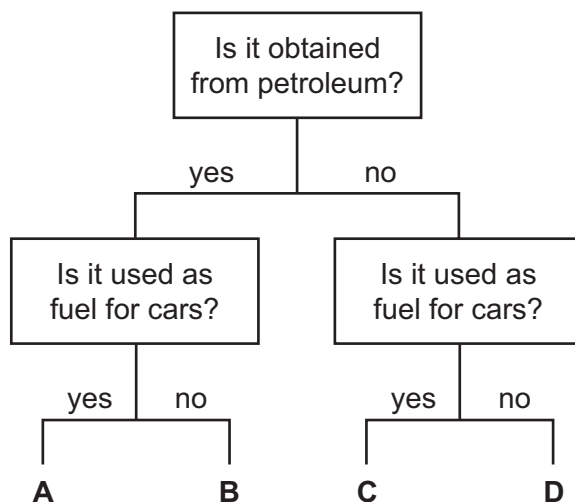
- A fermentation
- B respiration
- C the production of lime from limestone
- D the treatment of acidic soil with lime

36 Organic compounds may have names ending in -ane, -ene, -ol or -oic acid.

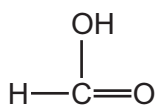
How many of these endings indicate the compounds contain double bonds in their molecules?

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

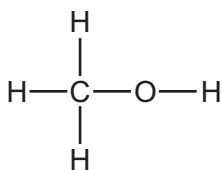
37 In the flow chart, which fuel could be gasoline?



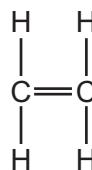
38 The structures of four molecules are shown.



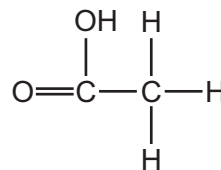
P



Q



R



S

Which two molecules belong to the same homologous series?

- A P and Q
- B P and S
- C Q and R
- D R and S

39 Which columns describe the hydrocarbons ethane and ethene?

|                               | 1           | 2                    | 3           | 4                    |
|-------------------------------|-------------|----------------------|-------------|----------------------|
| state at room temperature     | gas         | gas                  | liquid      | liquid               |
| reaction with oxygen          | burns       | burns                | burns       | burns                |
| reaction with aqueous bromine | no reaction | decolourises bromine | no reaction | decolourises bromine |

- A 1 (ethane) and 2 (ethene)
- B 1 (ethane) and 4 (ethene)
- C 2 (ethene) and 3 (ethane)
- D 3 (ethane) and 4 (ethene)

40 Which process is **not** used during the production of ethanol?

- A addition of steam to ethene
- B fermentation
- C fractional distillation
- D reacting ethane with oxygen

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

|   |                                    | Group   |  |                                     |                                     |                                     |                                      |                                      |                                       |                                    |  |                                     |                                       |                                  |                                  |   |          |                                  |  |                                     |                                    |                                    |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |
|---|------------------------------------|---|--|-------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|--------------------------------------|---------------------------------------|------------------------------------|--|-------------------------------------|---------------------------------------|----------------------------------|----------------------------------|---|----------|----------------------------------|--|-------------------------------------|------------------------------------|------------------------------------|--------------------------------------|--------------------------------------|-----------------------------------|----------------------------------|-----------------------------------|-------------------------------------|------------------------------------|--|--|---|----------|-----------------------------------|--|----------------------------------|-------------------------------------|-------------------------------------|----------------------------------|-------------------------------------|---------------------------------------|------------------------------------|--|-------------------------------------|---------------------------------------|--|--|
|   |                                    | I   | II                                     | III                                 | IV                                  | V                                   | VI                                   | VII                                  | 0                                     |                                    |  |                                     |                                       |                                  |                                  |   |          |                                  |  |                                     |                                    |                                    |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |
|   |                                    | <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%; text-align: center;">1</td> <td style="width: 10%; text-align: center;"><b>H</b><br/>Hydrogen<br/>1</td> <td colspan="8"></td> <td style="width: 10%; text-align: center;">4<br/><b>He</b><br/>Helium<br/>2</td> </tr> </table> |  |                                     |                                     |                                     |                                      |                                      |                                       |                                    |  | 1                                   | <b>H</b><br>Hydrogen<br>1             |                                  |                                  |   |          |                                  |  |                                     |                                    | 4<br><b>He</b><br>Helium<br>2      |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |
| 1   | <b>H</b><br>Hydrogen<br>1          |   |  |                                     |                                     |                                     |                                      |                                      |                                       | 4<br><b>He</b><br>Helium<br>2      |  |                                     |                                       |                                  |                                  |   |          |                                  |  |                                     |                                    |                                    |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |
| 7<br><b>Li</b><br>Lithium<br>3  | 9<br><b>Be</b><br>Beryllium<br>4   |   |  |                                     |                                     |                                     |                                      |                                      |                                       |                                    |  | 19<br><b>F</b><br>Fluorine<br>9     |                                       |                                  |                                  |   |          |                                  |  |                                     |                                    |                                    |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |
| 23<br><b>Na</b><br>Sodium<br>11   | 24<br><b>Mg</b><br>Magnesium<br>12 | 27<br><b>Al</b><br>Aluminium<br>13  | 28<br><b>Si</b><br>Silicon<br>14       | 31<br><b>P</b><br>Phosphorus<br>15  | 32<br><b>S</b><br>Sulfur<br>16      | 35.5<br><b>Cl</b><br>Chlorine<br>17 | 40<br><b>Ar</b><br>Argon<br>18       |                                      |                                       |                                    |  | 20<br><b>Ne</b><br>Neon<br>10       |                                       |                                  |                                  |   |          |                                  |  |                                     |                                    |                                    |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |
| 39<br><b>K</b><br>Potassium<br>19   | 40<br><b>Ca</b><br>Calcium<br>20   | 51<br><b>V</b><br>Vanadium<br>23  | 52<br><b>Cr</b><br>Chromium<br>24      | 55<br><b>Mn</b><br>Manganese<br>25  | 56<br><b>Fe</b><br>Iron<br>26       | 59<br><b>Co</b><br>Cobalt<br>27     | 59<br><b>Ni</b><br>Nickel<br>28      | 64<br><b>Cu</b><br>Copper<br>29      | 65<br><b>Zn</b><br>Zinc<br>30         | 70<br><b>Ga</b><br>Gallium<br>31   | 73<br><b>Ge</b><br>Germanium<br>32     | 75<br><b>As</b><br>Arsenic<br>33    | 79<br><b>Se</b><br>Selenium<br>34     | 80<br><b>Br</b><br>Bromine<br>35 | 84<br><b>Kr</b><br>Krypton<br>36 |   |          |                                  |  |                                     |                                    |                                    |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |
| 85<br><b>Rb</b><br>Rubidium<br>37   | 88<br><b>Sr</b><br>Strontium<br>38 | 91<br><b>Zr</b><br>Zirconium<br>40  | 96<br><b>Mo</b><br>Molybdenum<br>42    | 101<br><b>Ru</b><br>Ruthenium<br>44 | 106<br><b>Pd</b><br>Palladium<br>46 | 108<br><b>Ag</b><br>Silver<br>47    | 112<br><b>Cd</b><br>Cadmium<br>48    | 115<br><b>In</b><br>Indium<br>49     | 119<br><b>Sn</b><br>Tin<br>50         | 122<br><b>Sb</b><br>Antimony<br>51 | 128<br><b>Te</b><br>Tellurium<br>52    | 127<br><b>I</b><br>Iodine<br>53     | 131<br><b>Xe</b><br>Xenon<br>54       |                                  |                                  |   |          |                                  |  |                                     |                                    |                                    |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |
| 133<br><b>Cs</b><br>Caesium<br>55   | 137<br><b>Ba</b><br>Barium<br>56   | 181<br><b>Ta</b><br>Tantalum<br>73  | 184<br><b>W</b><br>Tungsten<br>74      | 190<br><b>Os</b><br>Osmium<br>76    | 195<br><b>Pt</b><br>Platinum<br>78  | 197<br><b>Au</b><br>Gold<br>79      | 201<br><b>Hg</b><br>Mercury<br>80    | 204<br><b>Tl</b><br>Thallium<br>81   | 207<br><b>Pb</b><br>Lead<br>82        | 209<br><b>Bi</b><br>Bismuth<br>83  | 210<br><b>Po</b><br>Polonium<br>84     | 210<br><b>At</b><br>Astatine<br>85  | 210<br><b>Rn</b><br>Radon<br>86       |                                  |                                  |   |          |                                  |  |                                     |                                    |                                    |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |
| 226<br><b>Ra</b><br>Radium<br>88  | 227<br><b>Ac</b><br>Actinium<br>89 |   |  |                                     |                                     |                                     |                                      |                                      |                                       |                                    |  | 227<br><b>Fr</b><br>Francium<br>87  |                                       |                                  |                                  |   |          |                                  |  |                                     |                                    |                                    |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |
| *58-71 Lanthanoid series  |                                    |   |  |                                     |                                     |                                     |                                      |                                      |                                       |                                    |  |                                     |                                       |                                  |                                  |   |          |                                  |  |                                     |                                    |                                    |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |
| †90-103 Actinoid series   |                                    |   |  |                                     |                                     |                                     |                                      |                                      |                                       |                                    |  |                                     |                                       |                                  |                                  |   |          |                                  |  |                                     |                                    |                                    |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |
| <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%; text-align: center;">a</td> <td style="width: 10%; text-align: center;"><b>X</b></td> <td style="width: 10%; text-align: center;">140<br/><b>Ce</b><br/>Cerium<br/>58</td> <td style="width: 10%; text-align: center;">141<br/><b>Pr</b><br/>Praseodymium<br/>59</td> <td style="width: 10%; text-align: center;">144<br/><b>Nd</b><br/>Neodymium<br/>60</td> <td style="width: 10%; text-align: center;">150<br/><b>Sm</b><br/>Samarium<br/>62</td> <td style="width: 10%; text-align: center;">152<br/><b>Eu</b><br/>Europium<br/>63</td> <td style="width: 10%; text-align: center;">157<br/><b>Gd</b><br/>Gadolinium<br/>64</td> <td style="width: 10%; text-align: center;">162<br/><b>Dy</b><br/>Dysprosium<br/>66</td> <td style="width: 10%; text-align: center;">165<br/><b>Ho</b><br/>Holmium<br/>67</td> <td style="width: 10%; text-align: center;">167<br/><b>Er</b><br/>Erbium<br/>68</td> <td style="width: 10%; text-align: center;">169<br/><b>Tm</b><br/>Thulium<br/>69</td> <td style="width: 10%; text-align: center;">173<br/><b>Yb</b><br/>Ytterbium<br/>70</td> <td style="width: 10%; text-align: center;">175<br/><b>Lu</b><br/>Lutetium<br/>71</td> <td colspan="2"></td> </tr> <tr> <td style="width: 10%; text-align: center;">b</td> <td style="width: 10%; text-align: center;"><b>X</b></td> <td style="width: 10%; text-align: center;">232<br/><b>Th</b><br/>Thorium<br/>90</td> <td style="width: 10%; text-align: center;">238<br/><b>Pa</b><br/>Protactinium<br/>91</td> <td style="width: 10%; text-align: center;">238<br/><b>U</b><br/>Uranium<br/>92</td> <td style="width: 10%; text-align: center;">238<br/><b>Np</b><br/>Neptunium<br/>93</td> <td style="width: 10%; text-align: center;">238<br/><b>Am</b><br/>Americium<br/>95</td> <td style="width: 10%; text-align: center;">238<br/><b>Cm</b><br/>Curium<br/>96</td> <td style="width: 10%; text-align: center;">238<br/><b>Bk</b><br/>Berkelium<br/>97</td> <td style="width: 10%; text-align: center;">238<br/><b>Cf</b><br/>Californium<br/>98</td> <td style="width: 10%; text-align: center;">238<br/><b>Fm</b><br/>Fermium<br/>100</td> <td style="width: 10%; text-align: center;">238<br/><b>Md</b><br/>Mendelevium<br/>101</td> <td style="width: 10%; text-align: center;">238<br/><b>No</b><br/>Nobelium<br/>102</td> <td style="width: 10%; text-align: center;">238<br/><b>Lr</b><br/>Lawrencium<br/>103</td> <td colspan="2"></td> </tr> </table> |                                    |   |  |                                     |                                     |                                     |                                      |                                      |                                       |                                    |  |                                     |                                       |                                  |                                  | a | <b>X</b> | 140<br><b>Ce</b><br>Cerium<br>58 | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63 | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67 | 167<br><b>Er</b><br>Erbium<br>68 | 169<br><b>Tm</b><br>Thulium<br>69 | 173<br><b>Yb</b><br>Ytterbium<br>70 | 175<br><b>Lu</b><br>Lutetium<br>71 |  |  | b | <b>X</b> | 232<br><b>Th</b><br>Thorium<br>90 | 238<br><b>Pa</b><br>Protactinium<br>91 | 238<br><b>U</b><br>Uranium<br>92 | 238<br><b>Np</b><br>Neptunium<br>93 | 238<br><b>Am</b><br>Americium<br>95 | 238<br><b>Cm</b><br>Curium<br>96 | 238<br><b>Bk</b><br>Berkelium<br>97 | 238<br><b>Cf</b><br>Californium<br>98 | 238<br><b>Fm</b><br>Fermium<br>100 | 238<br><b>Md</b><br>Mendelevium<br>101 | 238<br><b>No</b><br>Nobelium<br>102 | 238<br><b>Lr</b><br>Lawrencium<br>103 |  |  |
| a   | <b>X</b>                           | 140<br><b>Ce</b><br>Cerium<br>58  | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62  | 152<br><b>Eu</b><br>Europium<br>63  | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67     | 167<br><b>Er</b><br>Erbium<br>68   | 169<br><b>Tm</b><br>Thulium<br>69      | 173<br><b>Yb</b><br>Ytterbium<br>70 | 175<br><b>Lu</b><br>Lutetium<br>71    |                                  |                                  |   |          |                                  |  |                                     |                                    |                                    |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |
| b   | <b>X</b>                           | 232<br><b>Th</b><br>Thorium<br>90   | 238<br><b>Pa</b><br>Protactinium<br>91 | 238<br><b>U</b><br>Uranium<br>92    | 238<br><b>Np</b><br>Neptunium<br>93 | 238<br><b>Am</b><br>Americium<br>95 | 238<br><b>Cm</b><br>Curium<br>96     | 238<br><b>Bk</b><br>Berkelium<br>97  | 238<br><b>Cf</b><br>Californium<br>98 | 238<br><b>Fm</b><br>Fermium<br>100 | 238<br><b>Md</b><br>Mendelevium<br>101 | 238<br><b>No</b><br>Nobelium<br>102 | 238<br><b>Lr</b><br>Lawrencium<br>103 |                                  |                                  |   |          |                                  |  |                                     |                                    |                                    |                                      |                                      |                                   |                                  |                                   |                                     |                                    |  |  |   |          |                                   |  |                                  |                                     |                                     |                                  |                                     |                                       |                                    |  |                                     |                                       |  |  |

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

**Key**  
a = relative atomic mass  
X = atomic symbol  
b = proton (atomic) number

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