

**45 minutes**

\* 9 0 0 7 8 8 8 8 \*  

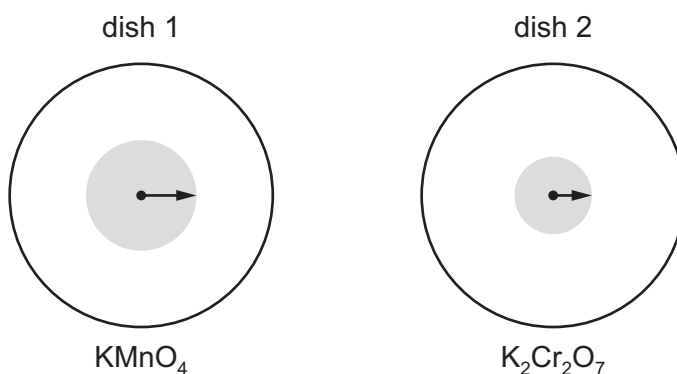

Electronic calculators may be used.

**[Turn over**

## 2

- 1 Small crystals of purple  $\text{KMnO}_4$  ( $M_r = 158$ ) and orange  $\text{K}_2\text{Cr}_2\text{O}_7$  ( $M_r = 294$ ) were placed at the centres of separate petri dishes filled with agar jelly. They were left to stand under the same physical conditions.

After some time, the colour of each substance had spread out as shown.



The lengths of the arrows indicate the relative distances travelled by particles of each substance.

Which statement is correct?

- A** Diffusion is faster in dish 1 because the mass of the particles is greater.  
**B** Diffusion is faster in dish 2 because the mass of the particles is greater.  
**C** Diffusion is slower in dish 1 because the mass of the particles is smaller.  
**D** Diffusion is slower in dish 2 because the mass of the particles is greater.
- 2 Pure water has a boiling point of  $100^\circ\text{C}$  and a freezing point of  $0^\circ\text{C}$ .

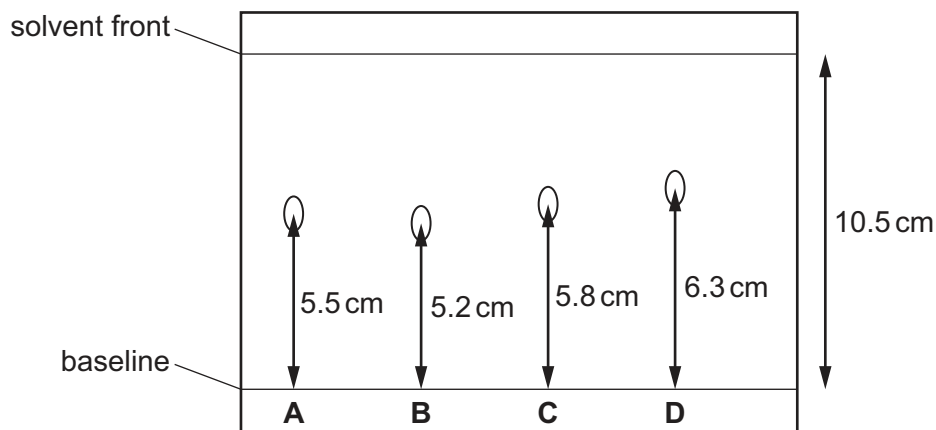
What is the boiling point and freezing point of a sample of aqueous sodium chloride?

|          | boiling point/ $^\circ\text{C}$ | freezing point/ $^\circ\text{C}$ |
|----------|---------------------------------|----------------------------------|
| <b>A</b> | 98                              | -2                               |
| <b>B</b> | 98                              | 2                                |
| <b>C</b> | 102                             | -2                               |
| <b>D</b> | 102                             | 2                                |

3

- 3 A chromatogram obtained from the chromatography of four substances is shown.

Which substance has an  $R_f$  value of 0.6?



- 4 Sodium reacts with chlorine to form sodium chloride.

Which statements describe what happens to the sodium atoms in this reaction?

- 1 Sodium atoms form positive ions.
- 2 Sodium atoms form negative ions.
- 3 Sodium atoms gain electrons.
- 4 Sodium atoms lose electrons.

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

- 5 Diamond is extremely hard and does not conduct electricity.

Which statement explains these properties?

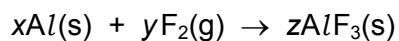
- A** It has a lattice of positive carbon ions in a 'sea of electrons'.
- B** It has delocalised electrons and each carbon atom forms three covalent bonds with other carbon atoms.
- C** It has no delocalised electrons and each carbon atom forms four covalent bonds with other carbon atoms.
- D** It has strong ionic bonds between each carbon atom.

- 6 Which statement about metals is **not** correct?

- A** Metals are malleable because the metal ions can slide over one another.
- B** Metals conduct electricity because electrons can move through the lattice.
- C** Metals consist of a giant lattice of metal ions in a 'sea of electrons'.
- D** Metals have high melting points because of the strong attraction between the metal ions.

**4**

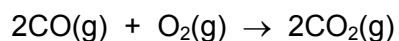
- 7** Aluminium reacts with fluorine.



Which values of  $x$ ,  $y$  and  $z$  balance the equation?

|          | $x$ | $y$ | $z$ |
|----------|-----|-----|-----|
| <b>A</b> | 1   | 2   | 1   |
| <b>B</b> | 2   | 3   | 2   |
| <b>C</b> | 3   | 2   | 3   |
| <b>D</b> | 4   | 3   | 4   |

- 8** Carbon monoxide burns in oxygen to produce carbon dioxide.



Which mass of carbon dioxide is produced from 14 g of carbon monoxide?

- A** 22 g                      **B** 28 g                      **C** 44 g                      **D** 88 g

- 9** Which statement about electrolysis is correct?

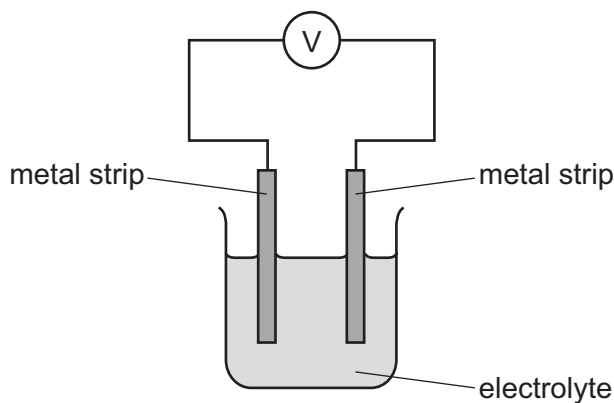
- A** Electrons move through the electrolyte from the cathode to the anode.  
**B** Electrons move towards the cathode in the external circuit.  
**C** Negative ions move towards the anode in the external circuit.  
**D** Positive ions move through the electrolyte towards the anode during electrolysis.

5

10 The reactivity series for a number of different metals is shown.

|               |      |      |        |                |          |
|---------------|------|------|--------|----------------|----------|
| most reactive |      | →    |        | least reactive |          |
| magnesium     | zinc | iron | copper | silver         | platinum |

The diagram shows different metal strips dipped into an electrolyte.



Which pair of metals produces the highest voltage?

- A copper and magnesium
- B magnesium and platinum
- C magnesium and zinc
- D silver and platinum

11 Some properties of four fuels are shown in the table.

Which fuel is a gas at room temperature and makes two products when it burns in a plentiful supply of air?

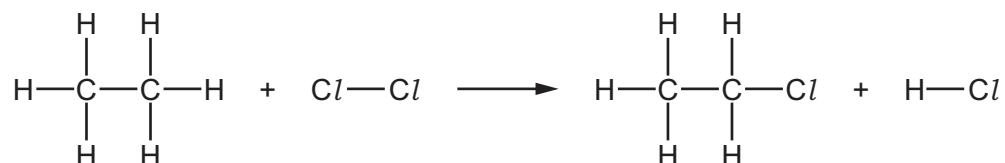
|   | fuel     | formula                         | melting point<br>/ °C | boiling point<br>/ °C |
|---|----------|---------------------------------|-----------------------|-----------------------|
| A | hydrogen | H <sub>2</sub>                  | -259                  | -253                  |
| B | methane  | CH <sub>4</sub>                 | -182                  | -164                  |
| C | octane   | C <sub>8</sub> H <sub>18</sub>  | -57                   | 126                   |
| D | wax      | C <sub>31</sub> H <sub>64</sub> | 60                    | 400                   |

**12** Which statements about exothermic and endothermic reactions are correct?

- 1 During an exothermic reaction, heat is given out.
- 2 The temperature of an endothermic reaction goes up because heat is taken in.
- 3 Burning methane in the air is an exothermic reaction.

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

**13** Chlorine reacts with ethane to produce chloroethane and hydrogen chloride.



The reaction is exothermic.

The bond energies are shown in the table.

| bond  | bond energy<br>in kJ/mol |
|-------|--------------------------|
| C–Cl  | +340                     |
| C–C   | +350                     |
| C–H   | +410                     |
| Cl–Cl | +240                     |
| H–Cl  | +430                     |

What is the energy change for the reaction?

- A** –1420 kJ/mol  
**B** –120 kJ/mol  
**C** +120 kJ/mol  
**D** +1420 kJ/mol

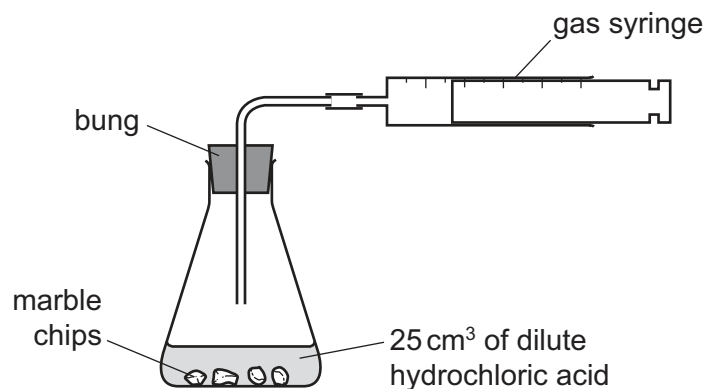
**14** When sulfur is heated it undergoes a .....1..... change as it melts.

Further heating causes the sulfur to undergo a .....2..... change and form sulfur dioxide.

Which words complete gaps 1 and 2?

|          | 1        | 2        |
|----------|----------|----------|
| <b>A</b> | chemical | chemical |
| <b>B</b> | chemical | physical |
| <b>C</b> | physical | chemical |
| <b>D</b> | physical | physical |

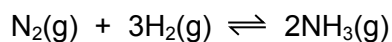
**15** A student was investigating the reaction between marble chips and dilute hydrochloric acid.



Which changes slow down the rate of reaction?

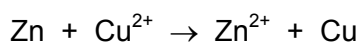
|          | temperature of acid | concentration of acid | surface area of marble chips |
|----------|---------------------|-----------------------|------------------------------|
| <b>A</b> | decrease            | decrease              | decrease                     |
| <b>B</b> | decrease         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

- 16** Nitrogen, hydrogen and ammonia gases are placed inside a container. The container is then sealed. After some time, an equilibrium forms.



Which statement describes the equilibrium in this container?

- A** The amount of ammonia remains constant from the moment the container is sealed.
  - B** The amounts of ammonia, nitrogen and hydrogen in the container are always equal.
  - C** The rate of formation of ammonia is equal to the rate of decomposition of ammonia.
  - D** The rate of formation of ammonia is faster than the rate of decomposition of ammonia.
- 17** An example of a redox reaction is shown.



Which statement about the reaction is correct?

- A** Zn is the oxidising agent and it oxidises  $\text{Cu}^{2+}$ .
  - B** Zn is the oxidising agent and it reduces  $\text{Cu}^{2+}$ .
  - C** Zn is the reducing agent and it oxidises  $\text{Cu}^{2+}$ .
  - D** Zn is the reducing agent and it reduces  $\text{Cu}^{2+}$ .
- 18** Zinc oxide is amphoteric.

Which row describes the reactions of zinc oxide?

|          | reaction with hydrochloric acid | reaction with aqueous sodium hydroxide |
|----------|---------------------------------|----------------------------------------|
| <b>A</b> | ✓                               | ✓                                      |
| <b>B</b> | ✓                               | x                                      |
| <b>C</b> | x                               | ✓                                      |
| <b>D</b> | x                               | x                                      |

key

✓ = reaction occurs

x = reaction does not occur

- 19 Which row shows how the hydrogen ion concentration and pH of ethanoic acid compare to those of hydrochloric acid of the same concentration?

| ethanoic acid compared to hydrochloric acid |                            |        |
|---------------------------------------------|----------------------------|--------|
|                                             | hydrogen ion concentration | pH     |
| A                                           | higher                     | higher |
| B                                           | higher                     | lower  |
| C                                           | lower                      | higher |
| D                                           | lower                      | lower  |

- 20 A pure sample of the insoluble salt barium carbonate can be made using the method given.

- step 1 Dissolve barium chloride in water.  
step 2 Separately dissolve sodium carbonate in water.  
step 3 Mix the two solutions together.  
step 4 Filter the mixture.  
step 5  
step 6 Dry the residue between two sheets of filter paper.

Which instruction is missing from step 5?

- A Heat the residue to dryness.  
B Heat the residue to the point of crystallisation.  
C Place the filtrate in an evaporating basin.  
D Wash the residue with water.
- 21 Substance X reacts with warm dilute hydrochloric acid to produce a gas which decolourises acidified aqueous potassium manganate(VII).

Substance X gives a yellow flame in a flame test.

What is X?

- A potassium chloride  
B potassium sulfite  
C sodium chloride  
D sodium sulfite

**22** Which element is less reactive than the other members of its group in the Periodic Table?

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

**23** The elements in Group IV of the Periodic Table are shown.

carbon  
silicon  
germanium  
tin  
lead  
flerovium

What does **not** occur in Group IV as it is descended?

- A** The proton number of the elements increases.
- B** The elements become more metallic.
- C** The elements have more electrons in their outer shells.
- D** The elements have more electron shells.

**24** Why are weather balloons sometimes filled with helium rather than hydrogen?

- A** Helium is found in air.
- B** Helium is less dense than hydrogen.
- C** Helium is more dense than hydrogen.
- D** Helium is unreactive.

**25** Metal X is added to a colourless aqueous solution of the sulfate of metal Y.

A coloured solution is formed and metal Y is deposited at the bottom of the beaker.

Which row describes elements X and Y and their relative reactivity?

|          | type of element           | relative reactivity       |
|----------|---------------------------|---------------------------|
| <b>A</b> | X is a transition element | X is more reactive than Y |
| <b>B</b> | X is a transition element | Y is more reactive than X |
| <b>C</b> | Y is a transition element | X is more reactive than Y |
| <b>D</b> | Y is a transition element | Y is more reactive than X |

**26** Element E:

- forms an alloy
- has a basic oxide
- is below hydrogen in the reactivity series.

What is E?

- A** carbon
- B** copper
- C** sulfur
- D** zinc

**27** Zinc metal is extracted from its ore zinc blende in a similar method to that used to extract iron from hematite.

In which way is zinc extraction different from iron extraction?

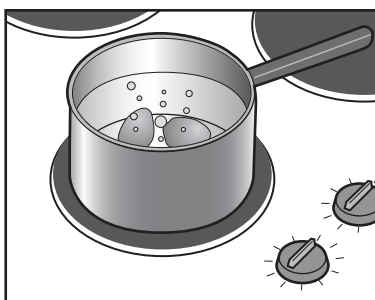
- A** Carbon and carbon monoxide are the main reducing agents.
- B** Hot air at the base of the furnace reacts with coke to keep the furnace hot.
- C** The metal is removed as a vapour at the top of the furnace.
- D** The metal oxide is added into the top of the furnace.

- 28** Stainless steel is an alloy of iron and other metals. It is strong and does not rust but it costs much more than normal steel.

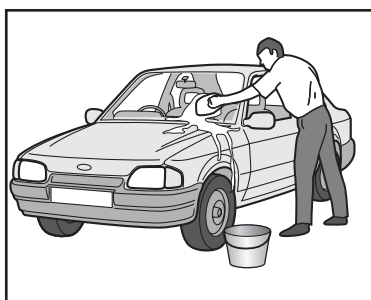
What is **not** made from stainless steel?

- A** cutlery
- B** pipes in a chemical factory
- C** railway lines
- D** saucepans

- 29** 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
- 30** Oxides of nitrogen are found in polluted air.

Which statement about oxides of nitrogen is correct?

- A** Oxides of nitrogen are formed by the reaction of nitrogen with oxygen during the fractional distillation of liquid air.
- B** Oxides of nitrogen are formed in a car engine by the reaction of petrol with nitrogen from the air.
- C** Oxides of nitrogen are removed from exhaust gases by reaction with carbon dioxide in a catalytic converter.
- D** Oxides of nitrogen are removed from exhaust gases by reduction in a catalytic converter.

31 Photosynthesis and respiration are important natural processes.

Which statement is correct?

- A Carbon dioxide is formed by the reaction of glucose with water during photosynthesis.
- B Carbon dioxide is removed from the air by respiration.
- C Glucose reacts with water to form oxygen during respiration.
- D Photosynthesis produces glucose and oxygen.

32 Which row gives the conditions for the Haber process?

|   | temperature / °C | pressure / atm | catalyst                      |
|---|------------------|----------------|-------------------------------|
| A | 200              | 2              | V <sub>2</sub> O <sub>5</sub> |
| B | 200              | 450            | Fe                            |
| C | 450              | 200            | Fe                            |
| D | 500              | 250            | V <sub>2</sub> O <sub>5</sub> |

33 Which statement about sulfuric acid is correct?

- A It is made by the Haber process.
- B It is made in the atmosphere by the action of lightning.
- C It reacts with ammonia to produce a fertiliser.
- D It reacts with copper metal to produce hydrogen gas.

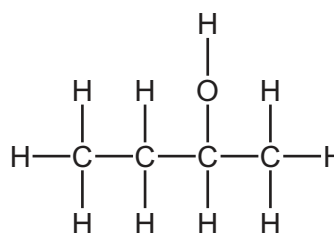
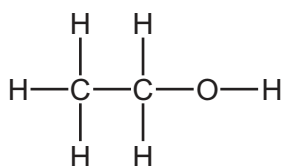
34 Which statement is **not** correct?

- A Converting limestone into lime is a thermal decomposition reaction.
- B Flue gas desulfurisation is a neutralisation reaction.
- C In the extraction of iron, calcium carbonate is converted into calcium oxide.
- D Slaked lime is added to soil as a fertiliser.

35 Which fraction of petroleum is **not** matched to its correct use?

|          | fraction | use               |
|----------|----------|-------------------|
| <b>A</b> | bitumen  | making roads      |
| <b>B</b> | gasoline | fuel for cars     |
| <b>C</b> | kerosene | fuel for ships    |
| <b>D</b> | naphtha  | chemical industry |

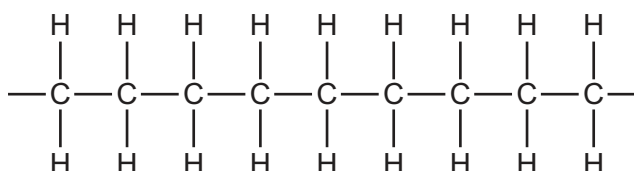
36 The diagram shows the structures of two organic molecules.



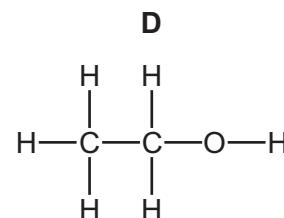
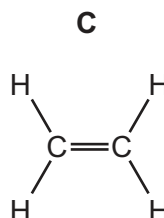
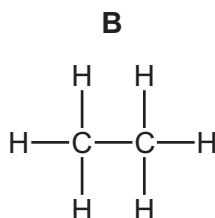
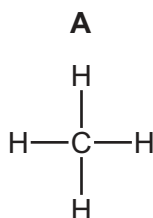
Which statement about these molecules is **not** correct?

- A** They are both alcohols.
- B** They both produce carbon dioxide and water when they burn in oxygen.
- C** They contain different functional groups.
- D** They have the same general formula.

37 The diagram shows part of the molecule of a polymer.



Which diagram shows the monomer from which this polymer could be manufactured?

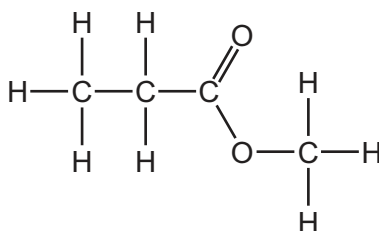


**38** Ethanol is manufactured by fermentation or by the catalytic addition of steam to ethene.

Which statement is correct?

- A** Fermentation uses a higher temperature than the catalytic addition of steam to ethene.
- B** Fermentation uses a non-renewable resource.
- C** The catalytic addition of steam to ethene produces purer ethanol than fermentation.
- D** The catalytic addition of steam to ethene uses a biological catalyst.

**39** The structure of an ester is shown.



Which row is correct?

|          | name of ester     | names of the carboxylic acid and the alcohol used to form the ester |
|----------|-------------------|---------------------------------------------------------------------|
| <b>A</b> | methyl propanoate | methanoic acid and propanol                                         |
| <b>B</b> | methyl propanoate | methanol and propanoic acid                                         |
| <b>C</b> | propyl methanoate | methanoic acid and propanol                                         |
| <b>D</b> | propyl methanoate | methanol and propanoic acid                                         |

**40** Keratin is a protein that is found in human hair.

Keratin is chemically broken down to produce amino acids.

What is the name of this chemical process?

- A** catalysis
- B** hydration
- C** hydrolysis
- D** polymerisation

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The Periodic Table of Elements

| Group                      |                             |                                                                           |                             |                                 |                              |                              |                              |                              |                                |                               |                               |                                       |                             |                             |                               |                           |                           |
|----------------------------|-----------------------------|---------------------------------------------------------------------------|-----------------------------|---------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|--------------------------------|-------------------------------|-------------------------------|---------------------------------------|-----------------------------|-----------------------------|-------------------------------|---------------------------|---------------------------|
| I                          | II                          |                                                                           |                             |                                 |                              |                              |                              |                              |                                |                               |                               | III                                   | IV                          | V                           | VI                            | VII                       | VIII                      |
| 3<br>Li<br>lithium<br>7    | 4<br>Be<br>beryllium<br>9   | <div>Key</div> <div>atomic number<br/>name<br/>relative atomic mass</div> |                             |                                 |                              |                              |                              |                              |                                |                               |                               | <div>1<br/>H<br/>hydrogen<br/>1</div> |                             |                             |                               |                           |                           |
|                            |                             |                                                                           |                             |                                 |                              |                              |                              |                              |                                |                               |                               |                                       |                             |                             |                               |                           |                           |
| 11<br>Na<br>sodium<br>23   | 12<br>Mg<br>magnesium<br>24 |                                                                           |                             |                                 |                              |                              |                              |                              |                                |                               |                               | 5<br>B<br>boron<br>11                 | 6<br>C<br>carbon<br>12      | 7<br>N<br>nitrogen<br>14    | 8<br>O<br>oxygen<br>16        | 9<br>F<br>fluorine<br>19  | 10<br>Ne<br>neon<br>20    |
| 19<br>K<br>potassium<br>39 | 20<br>Ca<br>calcium<br>40   | 21<br>Sc<br>scandium<br>45                                                | 22<br>Ti<br>titanium<br>48  | 23<br>V<br>vanadium<br>51       | 24<br>Cr<br>chromium<br>52   | 25<br>Mn<br>manganese<br>55  | 26<br>Fe<br>iron<br>56       | 27<br>Co<br>cobalt<br>59     | 28<br>Ni<br>nickel<br>59       | 29<br>Cu<br>copper<br>64      | 30<br>Zn<br>zinc<br>65        | 31<br>Ga<br>gallium<br>70             | 32<br>Ge<br>germanium<br>73 | 33<br>As<br>arsenic<br>75   | 34<br>Se<br>selenium<br>79    | 35<br>Br<br>bromine<br>80 | 36<br>Kr<br>krypton<br>84 |
| 37<br>Rb<br>rubidium<br>85 | 38<br>Sr<br>strontium<br>88 | 39<br>Y<br>yttrium<br>89                                                  | 40<br>Zr<br>zirconium<br>91 | 41<br>Nb<br>niobium<br>93       | 42<br>Mo<br>molybdenum<br>96 | 43<br>Tc<br>technetium<br>—  | 44<br>Ru<br>ruthenium<br>101 | 45<br>Rh<br>rhodium<br>103   | 46<br>Pd<br>palladium<br>106   | 47<br>Ag<br>silver<br>108     | 48<br>Cd<br>cadmium<br>112    | 49<br>In<br>indium<br>115             | 50<br>Sn<br>tin<br>119      | 51<br>Sb<br>antimony<br>122 | 52<br>Te<br>tellurium<br>128  | 53<br>I<br>iodine<br>127  | 54<br>Xe<br>xenon<br>131  |
| 55<br>Cs<br>caesium<br>133 | 56<br>Ba<br>barium<br>137   | 57–71<br>lanthanoids                                                      |                             | 72<br>Hf<br>hafnium<br>178      | 73<br>Ta<br>tantalum<br>181  | 74<br>W<br>tungsten<br>184   | 76<br>Os<br>osmium<br>190    | 77<br>Ir<br>iridium<br>192   | 78<br>Pt<br>platinum<br>195    | 79<br>Au<br>gold<br>197       | 80<br>Hg<br>mercury<br>201    | 81<br>Tl<br>thallium<br>204           | 82<br>Pb<br>lead<br>207     | 83<br>Bi<br>bismuth<br>209  | 84<br>Po<br>polonium<br>—     | 85<br>At<br>astatine<br>— | 86<br>Rn<br>radon<br>—    |
| 87<br>Fr<br>francium<br>—  | 88<br>Ra<br>radium<br>—     | 89–103<br>actinoids                                                       |                             | 104<br>Rf<br>rutherfordium<br>— | 105<br>Db<br>dubnium<br>—    | 106<br>Sg<br>seaborgium<br>— | 108<br>Hs<br>hassium<br>—    | 109<br>Mt<br>meitnerium<br>— | 110<br>Ds<br>darmstadtium<br>— | 111<br>Rg<br>roentgenium<br>— | 112<br>Cn<br>copernicium<br>— |                                       | 114<br>Fl<br>flerovium<br>— |                             | 116<br>Lv<br>livermorium<br>— |                           |                           |

lanthanoids

actinoids

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

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).