



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0620/31

May/June 2024

1 hour 15 minutes

No additional materials are needed.

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

This document has **20** pages. Any blank pages are indicated.

1 Fig. 1.1 shows the structures of seven substances, **A**, **B**, **C**, **D**, **E**, **F** and **G**.

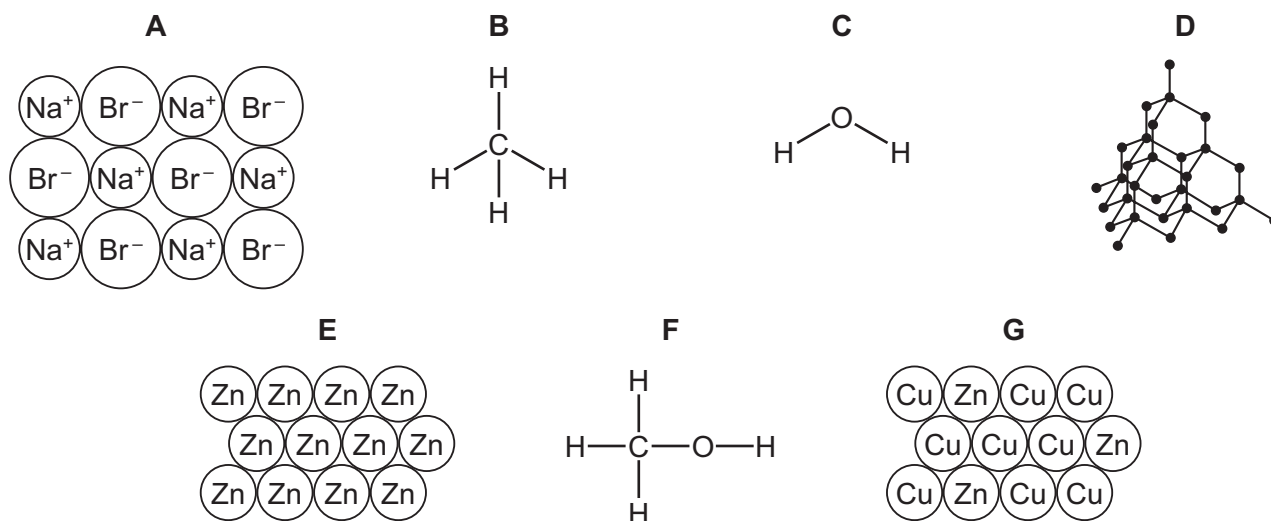


Fig. 1.1

- (a) Answer the following questions using only the structures in Fig. 1.1.
Each structure may be used once, more than once or not at all.

State which structure represents:

- (i) an alloy

..... [1]

- (ii) a substance that only conducts electricity when molten or in aqueous solution

..... [1]

- (iii) a giant covalent structure

..... [1]

- (iv) a compound that is a product formed in a hydrogen–oxygen fuel cell

..... [1]

- (v) a compound with a high melting point

..... [1]

- (vi) a gas that is responsible for increased global warming.

..... [1]

- (b) Complete Fig. 1.2 to show the dot-and-cross diagram for structure **C**. Show the outer shell electrons only.

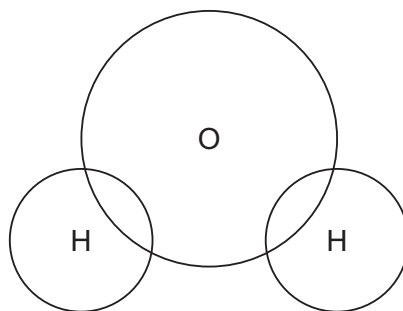


Fig. 1.2

[2]

[Total: 8]

- 2 (a) Table 2.1 shows the percentages by mass of the elements present in the human body.

Table 2.1

element	percentage by mass of element
calcium	1.50
carbon	18.00
chlorine	0.15
hydrogen	10.00
magnesium	0.05
nitrogen	3.00
oxygen	65.00
phosphorus	1.00
potassium	0.35
sodium	0.15
sulfur	0.25
other elements	0.55

Answer these questions using information from Table 2.1.

- (i) Name the non-metallic element in Table 2.1 that has the lowest percentage by mass.

..... [1]

- (ii) Name an element in Table 2.1 that is in Period 4 of the Periodic Table.

..... [1]

- (b) Some medicines contain a compound made of Mg^{2+} ions and OH^- ions.

Name the compound made of Mg^{2+} ions and OH^- ions.

..... [1]

- (c) Describe the observations when aqueous sodium hydroxide is added dropwise to a solution containing calcium ions until the sodium hydroxide is in excess.

observations with dropwise addition of sodium hydroxide

.....

observations with excess sodium hydroxide

.....

[2]

(d) Name a calcium salt that is soluble in water.

..... [1]

(e) Table 2.2 shows some properties of the Group I metals.

Table 2.2

metal	melting point / °C	observations on reaction with water
lithium	181	
sodium	98	bubbles form rapidly but no flame
potassium		bubbles form very rapidly and flame
rubidium	39	explodes

Use the information in Table 2.2 to predict:

- the melting point of potassium

.....

- the observations when lithium reacts with water.

.....

[2]

(f) State how the density of the Group I elements changes down the group.

..... [1]

(g) Sodium reacts with water to produce sodium hydroxide and a gas which pops with a lighted splint.

Complete the symbol equation for this reaction.



[2]

[Total: 11]

3 Aluminium is extracted by electrolysis of its purified ore.

(a) Name the main ore of aluminium.

..... [1]

(b) Fig. 3.1 shows the apparatus used in the extraction of aluminium.

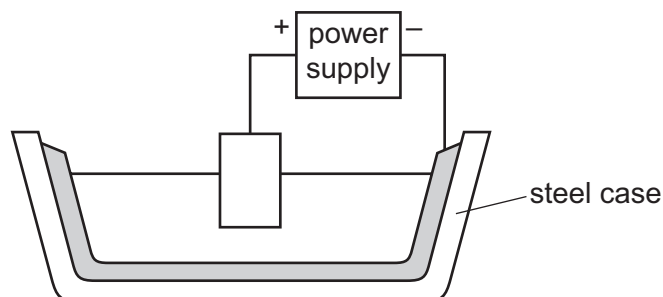


Fig. 3.1

(i) Label the cathode in Fig. 3.1. [1]

(ii) The electrolyte contains molten aluminium oxide.

State the product formed at each electrode.

positive electrode

negative electrode

[2]

(c) State **two** physical properties that explain why aluminium is used in overhead electrical cables.

1

2

[2]

(d) Aluminium ore is purified by reacting it with sodium hydroxide.
Sodium hydroxide is an alkali.

(i) State the meaning of the term alkali.

..... [1]

(ii) Describe how to find the pH of a dilute solution of sodium hydroxide using universal indicator paper.

.....

..... [2]

- (iii) A dilute solution of sodium hydroxide is added to a solution of methyl orange in acid until the sodium hydroxide is in excess.

State the colour change of the methyl orange.

from to [2]

[Total: 11]

- 4 (a) Fig. 4.1 shows the displayed formula of a compound extracted from a plant.

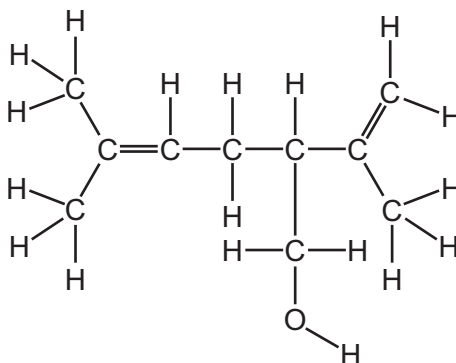


Fig. 4.1

On Fig. 4.1, draw a circle around **one** functional group that makes this compound unsaturated. [1]

- (b) A student extracts mixtures of coloured compounds from four different plants, **Q**, **R**, **S** and **T**.

Fig. 4.2 shows the results of chromatography of these mixtures using an organic solvent.

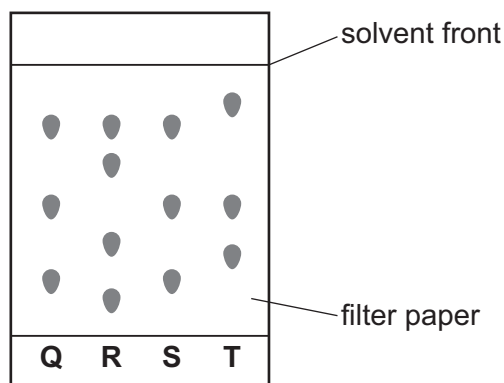
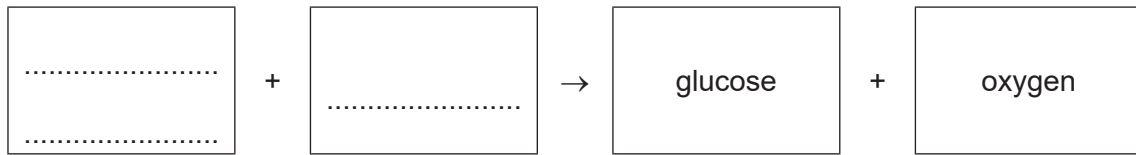


Fig. 4.2

- (i) Deduce which plant, **Q**, **R**, **S** or **T**, contains the greatest number of coloured compounds.
..... [1]
- (ii) Deduce which **two** plants, **Q**, **R**, **S** or **T**, contain exactly the same coloured compounds.
..... and [1]
- (iii) State the meaning of the term solvent.
..... [1]

(c) (i) Plants produce glucose and oxygen by photosynthesis.

Complete the word equation for photosynthesis.



[2]

(ii) Name one **other** substance that is essential for photosynthesis.

..... [1]

[Total: 7]

- 5 (a) An atom of carbon is represented by the symbol shown.



Describe this atom of carbon in terms of:

- the position of the electrons, neutrons and protons in this atom

.....

.....

.....

- the number of neutrons and number of protons

.....

.....

- the electronic configuration.

..... [5]

- (b) (i) Complete the symbol equation for the incomplete combustion of carbon to produce carbon monoxide.



- (ii) State **one** adverse effect of carbon monoxide.

..... [1]

- (c) Fig. 5.1 shows the displayed formula of chromium carbonyl.

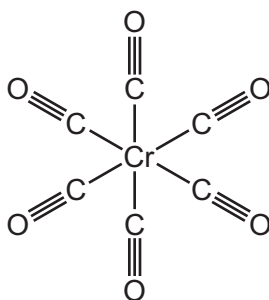


Fig. 5.1

Deduce the molecular formula of chromium carbonyl.

..... [1]

- (d) Another compound of chromium has the formula $\text{Na}_2\text{Cr}_2\text{C}_{10}\text{O}_{10}$.

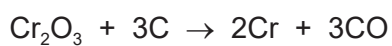
Complete Table 5.1 to calculate the relative molecular mass of $\text{Na}_2\text{Cr}_2\text{C}_{10}\text{O}_{10}$.

Table 5.1

type of atom	number of atoms	relative atomic mass	
sodium	2	23	$2 \times 23 = 46$
chromium		52	
carbon		12	
oxygen		16	

relative molecular mass = [2]

- (e) Chromium can be produced by heating chromium(III) oxide, Cr_2O_3 , with carbon.



Describe how this equation shows that chromium(III) oxide is reduced.

.....
 [1]

[Total: 12]

6 Large pieces of solid sulfur burn in excess oxygen to produce sulfur dioxide gas.

(a) Complete the equation by adding the missing state symbol.



(b) Fig. 6.1 shows how the mass of sulfur changes as the reaction proceeds.

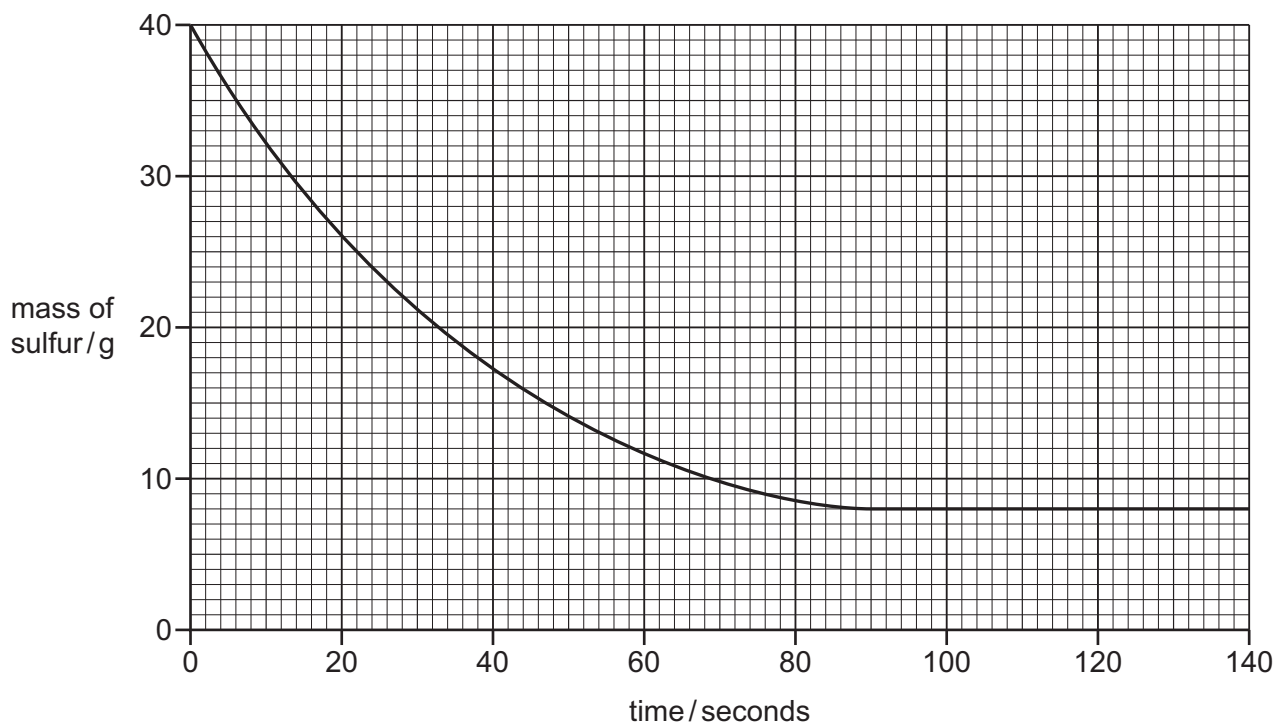


Fig. 6.1

Deduce the time taken for the reaction to finish.

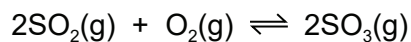
..... [1]

(c) The experiment is repeated using powdered sulfur.

Describe the effect on the rate of reaction of using powdered sulfur rather than large pieces of sulfur.

..... [1]

(d) Sulfur dioxide reacts with oxygen in a closed container.



(i) Describe the effect, if any, each of the following has on the rate of this reaction.

All other conditions stay the same.

- The temperature is decreased.

.....

- The pressure of the gases is increased.

.....

[2]

(ii) Changing concentration changes the rate of a reaction.

Choose the correct unit of concentration from the list.

Draw a circle around your chosen answer.

dm³/mol

mol/dm

mol/dm²

mol/dm³

[1]

(e) Sulfur dioxide is an air pollutant.

(i) State **one** adverse effect of sulfur dioxide.

..... [1]

(ii) Emissions of sulfur dioxide can be reduced by using low-sulfur fossil fuels.

State one **other** way of reducing sulfur dioxide emissions from fossil fuels.

..... [1]

- (f) Aqueous sodium hydrogen sulfite releases sulfur dioxide gas at room temperature.

Sulfur dioxide changes the colour of acidified potassium manganate(VII) from purple to colourless.

Fig. 6.2 shows a sealed tube with a small volume of aqueous sodium hydrogen sulfite at the bottom. A piece of filter paper soaked in acidified potassium manganate(VII) is attached to the top of the tube.

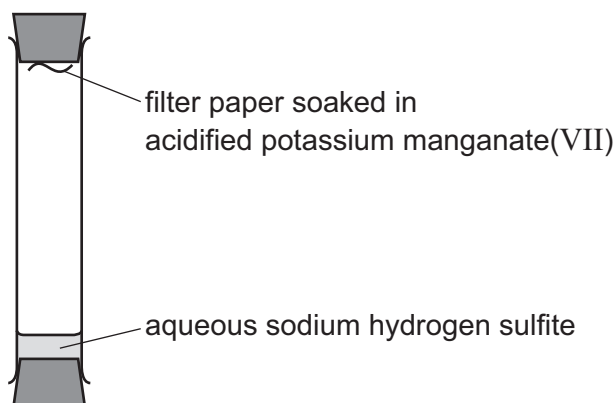


Fig. 6.2

The filter paper remains purple at first.

The filter paper becomes colourless after a short time.

Explain these results in terms of kinetic particle theory.

.....

.....

.....

..... [3]

[Total: 11]

7 Iron is a metal. Iron has a high density, a high melting point and a high boiling point.

(a) State three **other** physical properties of iron.

- 1
- 2
- 3 [3]

(b) (i) State the conditions needed for iron to rust.

.....

..... [2]

(ii) Rust is hydrated iron(III) oxide.

State if iron(III) oxide is an acidic or basic oxide.
Give a reason for your answer.

.....

..... [1]

(iii) Complete this sentence about methods of preventing rusting.

Rusting can be prevented by painting or

..... [1]

(c) The list shows five metals.

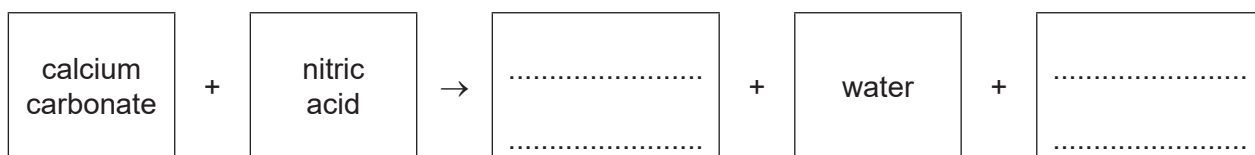
calcium copper iron silver sodium

Put these metals in order of their reactivity.
Put the most reactive metal at the top.

most reactive	
least reactive	

[2]

(d) Complete the word equation for the reaction of calcium carbonate with nitric acid.



[2]

[Total: 11]

- 8 (a) Fig. 8.1 shows the displayed formulae of five organic compounds, **V**, **W**, **X**, **Y** and **Z**.

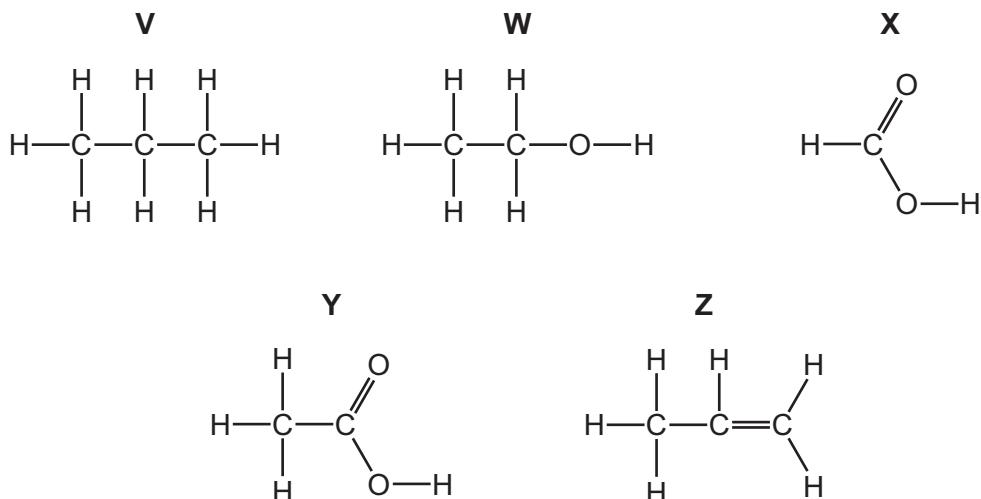


Fig. 8.1

- (i) State which **two** of the compounds, **V**, **W**, **X**, **Y** and **Z**, are in the same homologous series.
 and [1]
- (ii) Explain why compound **V** is an alkane.

 [2]
- (iii) State the name of the homologous series to which compound **X** belongs.
 [1]
- (b) Ethanol can be manufactured by the catalytic addition of steam to ethene.
- (i) State the temperature and pressure required for this reaction.
 temperature °C
 pressure atm [2]
- (ii) Name one **other** method of manufacturing ethanol.
 [1]
- (c) Describe how alkenes are manufactured from petroleum fractions.

 [2]

[Total: 9]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
3 Li lithium 7 11 Na sodium 23		1 H hydrogen 1 2 He helium 4															
		4 Be beryllium 9 12 Mg magnesium 24															
19 K potassium 39 37 Rb rubidium 85		21 Sc scandium 45 39 Y yttrium 89 57–71 lanthanoids															
20 Ca calcium 40 38 Sr strontium 88		22 Ti titanium 48 40 Zr zirconium 91 72 Hf hafnium 178															
25 Mn manganese 55 43 Tc technetium —		23 V vanadium 51 41 Nb niobium 93 73 Ta tantalum 181															
24 Cr chromium 52 42 Mo molybdenum 96		24 W tungsten 184 74 Re rhenium 186															
26 Fe iron 56 44 Ru ruthenium 101		25 Mn manganese 55 43 Tc technetium — 75 Re rhenium 186															
27 Co cobalt 59 45 Rh rhodium 103		26 Fe iron 56 44 Ru ruthenium 101 76 Os osmium 190															
28 Ni nickel 59 46 Pd palladium 106		27 Co cobalt 59 45 Rh rhodium 103 77 Ir iridium 192															
29 Cu copper 64 47 Ag silver 108		28 Ni nickel 59 46 Pd palladium 106 78 Pt platinum 195															
30 Zn zinc 65 48 Cd cadmium 112		29 Cu copper 64 47 Ag silver 108 79 Au gold 197															
31 Ga gallium 70 49 In indium 115		30 Zn zinc 65 48 Cd cadmium 112 80 Hg mercury 201															
32 Ge germanium 73 50 Sn tin 119		31 Ga gallium 70 49 In indium 115 81 Tl thallium 204															
33 As arsenic 75 51 Sb antimony 122		32 Ge germanium 73 50 Sn tin 119 82 Pb lead 207															
34 Se selenium 79 52 Te tellurium 128		33 As arsenic 75 51 Sb antimony 122 83 Bi bismuth 209															
35 Br bromine 80 53 I iodine 127		34 Se selenium 79 52 Te tellurium 128 84 Po polonium —															
36 Kr krypton 84 54 Xe xenon 131		35 Br bromine 80 53 I iodine 127 85 At astatine —															
37 Ar argon 40 55 Cl chlorine 35.5		36 Kr krypton 84 54 Xe xenon 131 86 Rn radon —															
38 S sulfur 32 56 Se selenium 79		37 Ar argon 40 55 Cl chlorine 35.5 87 Og oganesson —															
39 P phosphorus 31 57 As arsenic 75		38 S sulfur 32 56 Se selenium 79 88 Lv livermorium —															
40 N nitrogen 14 58 Nb niobium 93		39 P phosphorus 31 57 As arsenic 75 89 Og oganesson —															
41 O oxygen 16 59 Sb antimony 122		40 N nitrogen 14 58 Nb niobium 93 90 Og oganesson —															
42 F fluorine 19 60 Te tellurium 128		41 O oxygen 16 59 Sb antimony 122 91 Og oganesson —															
43 Ne neon 20 61 I iodine 127		42 F fluorine 19 60 Te tellurium 128 92 Og oganesson —															
44 Ar argon 40 62 At astatine —		43 Ne neon 20 61 I iodine 127 93 Og oganesson —															
45 Cl chlorine 35.5 63 Po polonium —		44 Ar argon 40 62 At astatine — 94 Og oganesson —															
46 S sulfur 32 64 At astatine —		45 Cl chlorine 35.5 63 Po polonium — 95 Og oganesson —															
47 P phosphorus 31 65 Po polonium —		46 S sulfur 32 64 At astatine — 96 Og oganesson —															
48 N nitrogen 14 66 Po polonium —		47 P phosphorus 31 65 Po polonium — 97 Og oganesson —															
49 O oxygen 16 67 Po polonium —		48 N nitrogen 14 66 Po polonium — 98 Og oganesson —															
50 F fluorine 19 68 Po polonium —		49 O oxygen 16 67 Po polonium — 99 Og oganesson —															
51 Ne neon 20 69 Po polonium —		50 F fluorine 19 68 Po polonium — 100 Og oganesson —															
52 Ar argon 40 70 Po polonium —		51 Ne neon 20 69 Po polonium — 101 Og oganesson —															
53 Cl chlorine 35.5 71 Po polonium —		52 Ar argon 40 70 Po polonium — 102 Og oganesson —															
54 S sulfur 32 72 Po polonium —		53 Cl chlorine 35.5 71 Po polonium — 103 Og oganesson —															
55 P phosphorus 31 73 Po polonium —		54 S sulfur 32 72 Po polonium — 104 Og oganesson —															
56 N nitrogen 14 74 Po polonium —		55 P phosphorus 31 73 Po polonium — 105 Og oganesson —															
57 O oxygen 16 75 Po polonium —		56 N nitrogen 14 74 Po polonium — 106 Og oganesson —															
58 F fluorine 19 76 Po polonium —		57 O oxygen 16 75 Po polonium — 107 Og oganesson —															
59 Ne neon 20 77 Po polonium —		58 F fluorine 19 76 Po polonium — 108 Og oganesson —															
60 Ar argon 40 78 Po polonium —		59 Ne neon 20 77 Po polonium — 109 Og oganesson —															
61 Cl chlorine 35.5 79 Po polonium —		60 Ar argon 40 78 Po polonium — 110 Og oganesson —															
62 S sulfur 32 80 Po polonium —		61 Cl chlorine 35.5 79 Po polonium — 111 Og oganesson —															
63 P phosphorus 31 81 Po polonium —		62 S sulfur 32 80 Po polonium — 112 Og oganesson —															
64 N nitrogen 14 82 Po polonium —		63 P phosphorus 31 81 Po polonium — 113 Og oganesson —															
65 O oxygen 16 83 Po polonium —		64 N nitrogen 14 82 Po polonium — 114 Og oganesson —															
66 F fluorine 19 84 Po polonium —		65 O oxygen 16 83 Po polonium — 115 Og oganesson —															
67 Ne neon 20 85 Po polonium —		66 F fluorine 19 84 Po polonium — 116 Og oganesson —															
68 Ar argon 40 86 Po polonium —		67 Ne neon 20 85 Po polonium — 117 Og oganesson —															
69 Cl chlorine 35.5 87 Po polonium —		68 Ar argon 40 86 Po polonium — 118 Og oganesson —															
70 S sulfur 32 88 Po polonium —		69 Cl chlorine 35.5 87 Po polonium — 119 Og oganesson —															
71 P phosphorus 31 89 Po polonium —		70 S sulfur 32 88 Po polonium — 120 Og oganesson —															
72 N nitrogen 14 90 Po polonium —		71 P phosphorus 31 89 Po polonium — 121 Og oganesson —															
73 O oxygen 16 91 Po polonium —		72 N nitrogen 14 90 Po polonium — 122 Og oganesson —															
74 F fluorine 19 92 Po polonium —		73 O oxygen 16 91 Po polonium — 123 Og oganesson —															
75 Ne neon 20 93 Po polonium —		74 F fluorine 19 92 Po polonium — 124 Og oganesson —															
76 Ar argon 40 94 Po polonium —		75 Ne neon 20 93 Po polonium — 125 Og oganesson —															
77 Cl chlorine 35.5 95 Po polonium —		76 Ar argon 40 94 Po polonium — 126 Og oganesson —															
78 S sulfur 32 96 Po polonium —		77 Cl chlorine 35.5 95 Po polonium — 127 Og oganesson —															
79 P phosphorus 31 97 Po polonium —		78 S sulfur 32 96 Po polonium — 128 Og oganesson —															
80 N nitrogen 14 98 Po polonium —		79 P phosphorus 31 97 Po polonium — 129 Og oganesson —															
81 O oxygen 16 99 Po polonium —		80 N nitrogen 14 98 Po polonium — 130 Og oganesson —															
82 F fluorine 19 100 Po polonium —		81 O oxygen 16 99 Po polonium — 131 Og oganesson —															
83 Ne neon 20 101 Po polonium —		82 F fluorine 19 100 Po polonium — 132 Og oganesson —															
84 Ar argon 40 102 Po polonium —		83 Ne neon 20 101 Po polonium — 133 Og oganesson —															
85 Cl chlorine 35.5 103 Po polonium —		84 Ar argon 40 102 Po polonium — 134 Og oganesson —															
86 S sulfur 32 104 Po polonium —		85 Cl chlorine 35.5 103 Po polonium — 135 Og oganesson —															
87 P phosphorus 31 105 Po polonium —		86 S sulfur 32 104 Po polonium — 136 Og oganesson —															
88 N nitrogen 14 106 Po polonium —		87 P phosphorus 31 105 Po polonium — 137 Og oganesson —															
89 O oxygen 16 107 Po polonium —		88 N nitrogen 14 106 Po polonium — 138 Og oganesson —															
90 F fluorine 19 108 Po polonium —		89 O oxygen 16 107 Po polonium — 139 Og oganesson —															
91 Ne neon 20 109 Po polonium —		90 F fluorine 19 108 Po polonium — 140 Og oganesson —															
92 Ar argon 40 <																	