Further guidance

Contents

C5 Chemicals of the natural environment – Foundation Workbook answers

1

- Atmosphere: argon, carbon dioxide, nitrogen, oxygen, water
- Lithosphere: chalk, crude oil, iron ore, granite, sandstone, sodium chloride
- Biosphere: DNA, fat, protein, starch, water
- Hydrosphere: water, sodium chloride, oxygen, carbon dioxide

2

Gas	Element/compound	Percentage by volume in dry air
nitrogen	element	78
oxygen	element	21
argon	element	1
carbon dioxide	compound	0.04

3 a

Name of chemical	Picture of molecule	Formula	Non-metallic element or compound of non-metal elements?	Produced by human activity?
nitrogen		N_2	non-metallic element	no
oxygen		O_2	non-metallic element	no
argon		Ar	non-metallic element	no
carbon dioxide		CO_2	compound of 2 non-metals	yes
sulfur dioxide		SO_2	compound of 2 non-metals	yes
carbon monoxide		CO	compound of 2 non-metals	yes
methane		CH_4	compound of 2 non-metals	no

b

- … the forces of attraction between the molecules are weak, so they freely move around.
- Missing word: larger

Further guidance

4

Chemical	Molecular model	Covalent bonds in the molecule	Molecular formula
hydrogen			H_2
oxygen			O_2
nitrogen			N_2
water			H_2O
carbon dioxide			CO_2
methane			CH_4

5

- Oxygen, nitrogen, and argon are gases in the air which… are non-metal elements.
- Carbon dioxide is a gas made up of … two non-metal elements joined together.
- Most non-metal elements have low melting and boiling points… because they consist of small molecules with weak forces attracting the molecules to each other.
- Water, carbon dioxide, and sulfur dioxide are … made up of small molecules.
- Pure molecular compounds do not conduct electricity… because they have no free electric charges that can carry a current.
- The Earth's hydrosphere… consists mainly of water.
- Sea water is salty… because it contains dissolved ionic compounds.
- Sea water conducts electricity… because it contains dissolved ions which are electrically charged and free to move.

6 **a**

Missing words: (left) giant, ions, (right) lose, electron, gain, one, attract, ionic

b

- All the crystals of each solid are the same shape… – The ions…are always arranged in the same regular way.
- The solution of an ionic compound in water is a good conductor of electricity. – In a solution of an ionic compound… ions can move around independently.
- Ionic compounds have relatively high melting points. – The giant ionic structure is held together by the strong attraction…
- When an ionic compound is heated… – In a molten ionic compound the positive and negative ions can move around independently.

7 **a**

Missing words: silicon dioxide, quartz, quartz

b

Missing words: (left) giant, two, four, (right) covalent*, SiO_2

* (Note: in the boxed list of words, 'strong' should be 'covalent'.)

c

Missing words from the table (rows 1–4):

- very hard
- giant structure of atoms strongly held together
- insoluble in water
- does not conduct electricity
  used as an electrical insulator

Further guidance

8	**a**	Diagrams coloured
	b	Missing word: oxygen
	c	Any two common compounds which contain oxygen: e.g. water, carbon dioxide, quartz, metal oxides
	d	Missing words: aluminium, iron
	e	Missing words: oxygen, carbon, hydrogen, nitrogen
	f	Any two elements in the body which are important to life: e.g. sodium, iron, potassium, phosphorus
	g	Missing words: carbon, hydrogen, oxygen
	h	Missing word: phosphorus
9		Missing from the table: • (row 1) formula: $C_5H_{10}O_5$ • (row 2) elements present: C H O S N formula: $C_3H_7O_2NS$ or similar (row 3) elements present: C H O N • (row 4) elements present: C H O formula: $C_4H_8O_2$
10		Diagram labelled: • atmosphere – sky, cloud • hydrosphere – lake • lithosphere – mountains, hills, rocks, ground • biosphere – trees, deer Arrows added, for example: • CO_2 from deer and trees to surrounding air (respiration) O_2 from trees to air (photosynthesis) • O_2 from air to deer and trees (respiration) • H_2O from lake to air (evaporation) • O_2 from air to lake (dissolving) • H_2O from cloud to mountains/rocks/ground (precipitation) • O_2 from air to rocks/mountains/ground (oxidation)
11	**a**	Gold (Au) - it is unreactive
	b	Zinc (Zn), iron (Fe), lead (Pb)
	c	$Fe_3O_4(s) + C(\mathbf{s}) \rightarrow Fe(s) + CO_2(\mathbf{g})$ Iron oxide is reduced, carbon is oxidized.
	d	Aluminium (Al) and potassium (K). These metals are so reactive that they will not give up the oxygen in their oxides to carbon to leave the pure metal. So they cannot be reduced by carbon. Electrolysis is used to extract these metals.

Further guidance

	e	The metal ore is mixed up with lots of low-value rock.
12	**a**	• $PbO \rightarrow Pb$ loses oxygen and is reduced $C \rightarrow CO$ gains oxygen and is oxidized • $Fe_3O_4 \rightarrow 3Fe$ loses oxygen and is reduced $4CO \rightarrow 4CO_2$ gains oxygen and is oxidized • $Cr_2O_3 \rightarrow 2Cr$ loses oxygen and is reduced $2Al \rightarrow Al_2O_3$ gains oxygen and is oxidized
	b	• $\mathbf{2}ZnS(\mathbf{s}) + \mathbf{3}O_2(\mathbf{g}) \rightarrow 2ZnO(\mathbf{s}) + \mathbf{2}SO_2(\mathbf{g})$ • $C(\mathbf{s}) + CO_2(\mathbf{g}) \rightarrow \mathbf{2}CO(\mathbf{g})$ • $Fe_2O_3(\mathbf{s}) + \mathbf{3}CO(\mathbf{g}) \rightarrow \mathbf{2}Fe(\mathbf{s}) + \mathbf{3}CO_2(\mathbf{g})$ • $2CuFeS_2(\mathbf{s}) + \mathbf{4}O_2(\mathbf{g}) \rightarrow Cu_2S(\mathbf{s}) + \mathbf{2}FeO(\mathbf{s}) + \mathbf{3}SO_2(\mathbf{g})$ • $2Cu_2S(\mathbf{s}) + \mathbf{3}O_2(\mathbf{g}) \rightarrow \mathbf{2}Cu_2O(\mathbf{s}) + \mathbf{2}SO_2(\mathbf{g})$ • $Cu_2S(\mathbf{s}) + \mathbf{2}Cu_2O(\mathbf{s}) \rightarrow \mathbf{6}Cu(\mathbf{s}) + SO_2(\mathbf{g})$
13	**a**	Missing words: (diagram) chloride, sodium, (text) positively, electrode, ions, positive
	b	Missing words: (left) ions, conduct, (right) melts, around, conducts
14	**a**	Labels (clockwise from the top): carbon anodes, negative electrode, molten aluminium oxide, tapping hole, molten aluminium, carbon lining
	b	E C G I B D/F F/D A H
15	**a**	strong, difficult to melt, malleable, good conductors of electricity
	b	

Property	**Explanation**
strong	The atoms are held together by strong metallic bonds.
difficult to melt	The atoms are held together by strong metallic bonds.
malleable	The atoms can be moved around without the structure losing its strength.
good conductors of electricity	The outer electrons are not bound to the atoms but are free to move around within the metal structure.

16		Flow diagram (clockwise, not including the central answer rules): mining the ore → separating and purifying the mineral with the metal → extracting the metal from the mineral → shaping the metal into sheets, wires, or bars → making products from the metal → metal in use → end of useful life → rubbish to waste tip (centre top) separating and recycling waste metal, (centre bottom) recycling scrap metal

C5 Chemicals of the natural environment – Higher Workbook answers

1

- Atmosphere: argon, carbon dioxide, nitrogen, oxygen, water
- Lithosphere: chalk, crude oil, iron ore, granite, sandstone, sodium chloride
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carbon dioxide			CO_2
methane			CH_4
chlorine			Cl_2
hydrogen chloride			HCl
ammonia			NH_3
ethene			C_2H_4

5 Diagram and text coloured as instructed (see Additional Science textbook page 125 or the GCSE Chemistry textbook page 125).

6 a Missing words: (left) giant, ions, (right) lose, electron, gain, one, attract, ionic

b
- All the crystals of each solid are the same shape… – The ions…are always arranged in the same regular way.
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7 a Missing words: silicon dioxide, quartz, quartz

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c Missing words from the table (rows 1–4):
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8 a Diagrams coloured

b Missing word: oxygen

Further guidance

	c	Any two common compounds which contain oxygen: e.g. water, carbon dioxide, quartz, metal oxides
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	e	The metal ore is mixed up with lots of low-value rock.

Further guidance

<table>
<tr><td>12</td><td>a</td><td>

The atoms: Fe Fe Fe O O O O
The relative atomic masses: 56 56 56 16 16 16 16
The relative formula masses of iron oxide = (56 x 3) + (16 x 4) = 168 + 64 = 232
In this formula there are 3 atoms of iron, Fe
The relative mass of 3 Fe = 168
This means that in 232 kg of Fe_3O_4 there are 168 kg of Fe.
So 1 kg of Fe_3O_4 contains 0.72 kg of Fe (168/232)
So 100 kg of Fe_3O_4 contains 72 kg of Fe
Another way of saying this is that the percentage of Fe in Fe_3O_4 = 72%

</td></tr>
<tr><td></td><td>b</td><td>

Bornite, Cu_5FeS_4, relative formula mass = (64 x 5) + 56 + (32 x 4) = 320 + 56 + 128 = 504
Relative formula mass of copper in the RFM = 320
This means that in 504 kg of Cu_5FeS_4 there are 320 kg of Fe.
So 1 kg of Cu_5FeS_4 contains 0.63 kg of Cu (320/504)
So 100 kg of Cu_5FeS_4 contains 63 kg Cu.
So the percentage of Cu in Cu_5FeS_4 is 63%

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<tr><td></td><td>b</td><td>In solid aluminium oxide the ions are held closely together, but when molten the ions are free to move around.</td></tr>
<tr><td></td><td>c</td><td>Al^{3+} and O^{2-}</td></tr>
<tr><td></td><td>d</td><td>$\mathbf{Al^{3+}} + 3e^- \rightarrow Al$</td></tr>
<tr><td></td><td>e</td><td>$\mathbf{O^{2-}} \rightarrow O + 2e^-$
$\mathbf{O} + \mathbf{O} \rightarrow O_2$</td></tr>
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