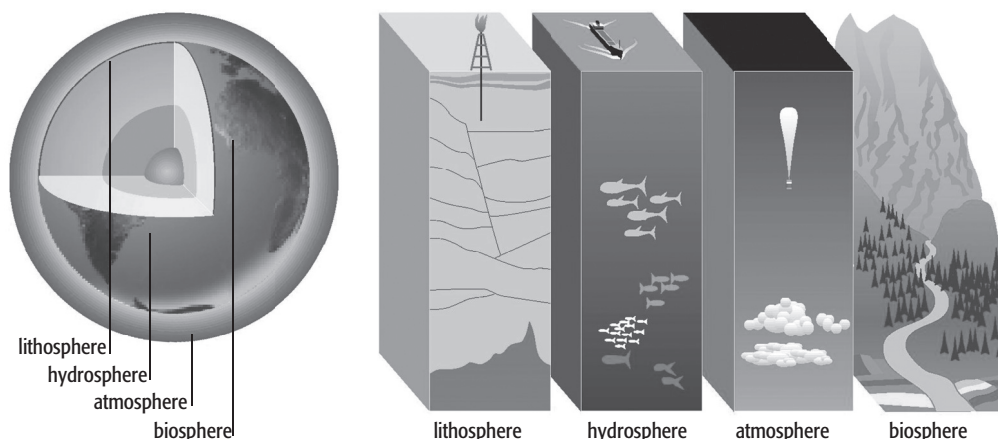


# Worksheet 1.5

## The chemistry of the Earth's layers



When discussing the chemistry of the Earth, it is often useful to divide it into four sections or 'spheres'. These surface layers are:

- ◆ the **lithosphere** – this consists of the solid rock and soil component of the crust and upper mantle
- ◆ the **hydrosphere** – the water on, in and around the Earth
- ◆ the **atmosphere** – the gases surrounding the Earth
- ◆ the **biosphere** – the living things on the Earth.

The detailed chemistry of each of these areas is complex, but the following very broad generalisations are sometimes made.

- 1** The chemistry of the lithosphere is essentially that of **giant ionic structures**.
- 2** The hydrosphere consists of **small molecules with dissolved ions**.
- 3** The atmosphere is made up of **simple molecular substances**.
- 4** The biosphere involves the chemistry of **long-chain condensation polymers**.

### The lithosphere

**1** Give the chemical names for the following mineral resources found in the Earth's crust.

- a hematite .....
- b bauxite .....
- c limestone .....
- d common salt .....

2 Complete the following table by giving the chemical formula of the minerals listed.

Mineral	Chemical name	Ions present	Chemical formula
malachite	copper(II) carbonate	$\text{Cu}^{2+}$ and $\text{CO}_3^{2-}$	
galena	lead(II) sulfide	$\text{Pb}^{2+}$ and $\text{S}^{2-}$	
quartz	calcium silicate	$\text{Ca}^{2+}$ and $\text{SiO}_3^{2-}$	
bauxite	aluminium oxide	$\text{Al}^{3+}$ and $\text{O}^{2-}$	
cryolite	sodium aluminium fluoride	$\text{Na}^+$ and $\text{AlF}_6^{3-}$	

3 Galena (lead(II) sulfide) forms cubic crystals similar in structure to those of sodium chloride. Sketch the arrangement of the lead ions and sulfide ions in such a cubic crystal.

Use the symbol ● for the  $\text{Pb}^{2+}$  ions and ○ for the  $\text{S}^{2-}$  ions.

### The hydrosphere

The oceans and seas cover about 72% of the Earth's surface. They contain 97% of the available water on the planet. However, this is not drinking water as it contains, on average, about 3.5% dissolved solids. The most obvious of these dissolved salts is sodium chloride but there are others present. The table below shows the ten commonest ions present in seawater.

Positive ions	Concentration / $\text{mol/dm}^3$	Negative ions	Concentration / $\text{mol/dm}^3$
sodium	0.46	chloride	0.54
magnesium	0.06	sulfate	0.03
calcium	0.01	carbonate	0.002
potassium	0.001	bromide	0.0008
		borate	0.0003
		silicate	0.0001

Answer the following questions using information from the table.

1 From which **two** groups of the Periodic Table do all the metal ions come? Suggest why this is so.

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2 What elements are present in the borate ions? Explain how the name tells you what elements are present.

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3 Which ion,  $\text{Na}^+$  or  $\text{Cl}^-$ , is present in excess in seawater? Therefore what is the effective concentration of sodium chloride in seawater?

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4 What is the maximum mass of sodium chloride that could be extracted from  $1 \text{ dm}^3$  of seawater?

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5 'Sea salt' is sometimes recommended for cooking. Apart from sodium chloride, what other metal chloride is most likely to be found in 'sea salt'?

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### Variations in the saltiness of different seas

Although, on average, the % of dissolved solids in seawater is 3.5, there is considerable variation in different parts of the world.

Location	Percentage of dissolved solids / %
open ocean	3.5
Mediterranean Sea	3.9
Red Sea (northern end)	4.1
Dead Sea	27.0

1 What sort of climates do the Mediterranean Sea, the Red Sea and the Dead Sea have? What sort of geographical surroundings do they have? (You could use an atlas or an internet search to help you find this information.)

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**2** Suggest why these seas (especially the Dead Sea) are saltier than the open ocean.

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