S112 Science: concepts and practice

Are you ready for S112?

Introduction

This module explores the interconnections between different science disciplines (physics, chemistry, biology, earth and environmental sciences). Before you begin the module, we would like you to consider very carefully whether you are ready to study S112.

Many of you will have already studied with the Open University before, on modules such as S111, SDK100 or U116. To enjoy the course, there are some basic skills that you should be sure of before you study this module. But the most important thing you will need is time. **S112 will take up to 20 hours of your time each week (around 14-16 hours for core study and 4-6 hours for self-directed study)** and runs from **October to June**. Think very carefully about how you will fit the time needed to study this module into your life.

Please take the time to work through this '*Are you ready for S112*?' resource, including the two quizzes on Understanding Science and Maths Skills. Please attempt all of the questions as this will help you assess whether you have the skills ready to start the module.

What you will be doing

This online activity will help you find out whether you are ready to study S112. It covers five areas, you can do the activity in one go, or do part of it and return to it later.

1. The **Understanding Science quiz** will ask you about the science you already know.

2. The **Maths Skills quiz** will help you decide whether you have the maths skills needed.

3. One thing to bear in mind is this module is completely **online**. Do you have the study skills to do this?

4. It may also be a while since you have written anything. Do you have the necessary **writing skills**?

5. Do you have the **time to study** this module and can you manage your time well?

This '*Are you ready for…*' should take you about two hours to complete.

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1 Understanding Science Quiz

This part should take you about 30 minutes.

If you are familiar with some of these key ideas before you start S112 it will really help you. Try the following self-assessment questions to find out how much you already know.

Answers are given at the end of this document… but don't be tempted to look until you have had a go at the questions!

Advice before you start

Some of the topics in this quiz may be unfamiliar to you – if so, don't worry. The whole point of this quiz is for you to have a go at answering each question and trying to solve them based on your current knowledge. It's also trying to tease out your ability to work with information presented in different ways (text, figures, tables and equations etc.) so that you can assess for yourself how ready you are to start on S112. There is some information in Part 6 to help you make that assessment. Don't forget that if you have any concerns you can speak with one of our friendly advisers (details are given at the end of Part 6). If you are an existing student you can speak with an adviser from your Student Support Team (details can be found on your StudentHome).

Question 1

Which of the following is the correct order for identifying magnitude, starting with the smallest and ending with the largest?

(a) milli, micro, nano, giga, mega, kilo.

(b) giga, mega, kilo, milli, micro, nano.

(c) nano, micro, milli, kilo, mega, giga.

(d) nano, micro, milli, giga, mega, kilo.

Question 2

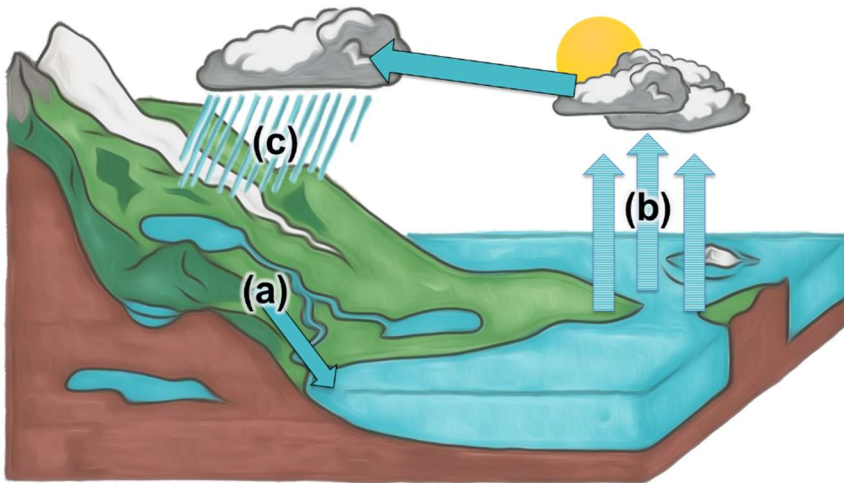A shopkeeper determines the price of their goods according to the following relationship:

$$\text{price} = \frac{\text{amount of money in } \pounds}{\text{mass of goods in kilograms}}$$

In which units is the price expressed?

(a) £/kg

(b) kg/£

(c) £

(d) kg

Question 3

Take a look at this simplified representation of the water cycle:

(Source: Adapted from lcallard210/Pixabay (CC0))

Figure 1   Simplified representation of the water cycle with three processes marked (a)-(c) (for use with Question 3)

Match the appropriate word for each of (a), (b) and (c) from the list below.

- Evaporation
- Flow
- Precipitation

Question 4

Here is a diagram that shows the presence of pollens from five species of tree in a core taken from a lake sediment. The depth in the core is shown on the left of the diagram and the amount of pollen at any depth is shown by the shaded area. Which species was the last to colonise this particular site?
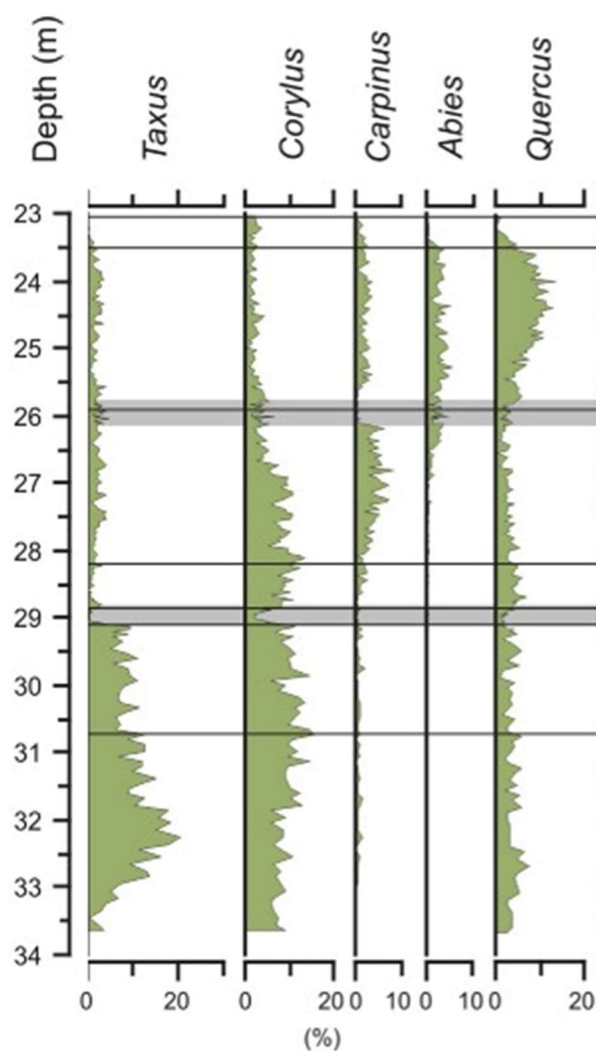

(Source: unknown)

Figure 2 Abundance of different species of tree pollen by depth as found in a lake sediment core sample (for use with Question 4)

(a) *Taxus*

(b) *Corylus*

(c) *Carpinus*

(d) *Abies*

(e) *Quercus*

Question 5

Take a look at the following picture of a rock sequence. Which is the correct order for the age of the rocks, with the oldest first and the youngest last? You should be able to answer this question by deduction, rather than having a knowledge of Earth sciences.
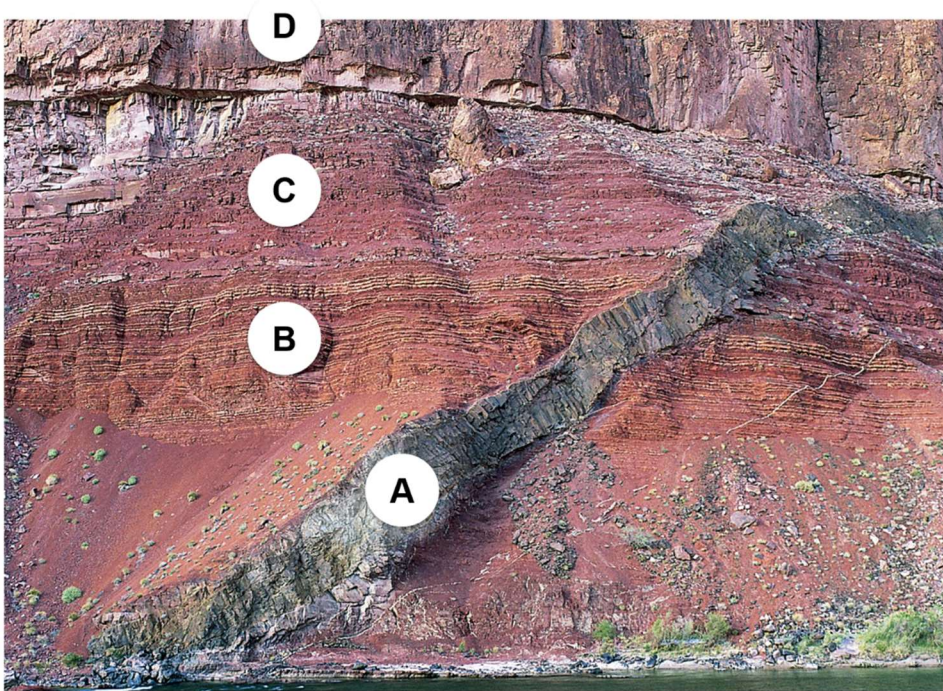
(Source: Adapted from Tom Bean / Alamy Stock Photo)

Figure 3   Rock sequence labelled A-D showing dykes (for use with Question 5)

(a) A, B, C, D.

(b) D, C, A, B.

(c) B, C, A, D.

Question 6

What kind of feature is show (from bottom right to middle left) in the following photograph?

(Source: Rob Young/ Flickr (CC BY 2.0))

Figure 4   Photograph of a topographical feature (for use with Question 6)

Question 7

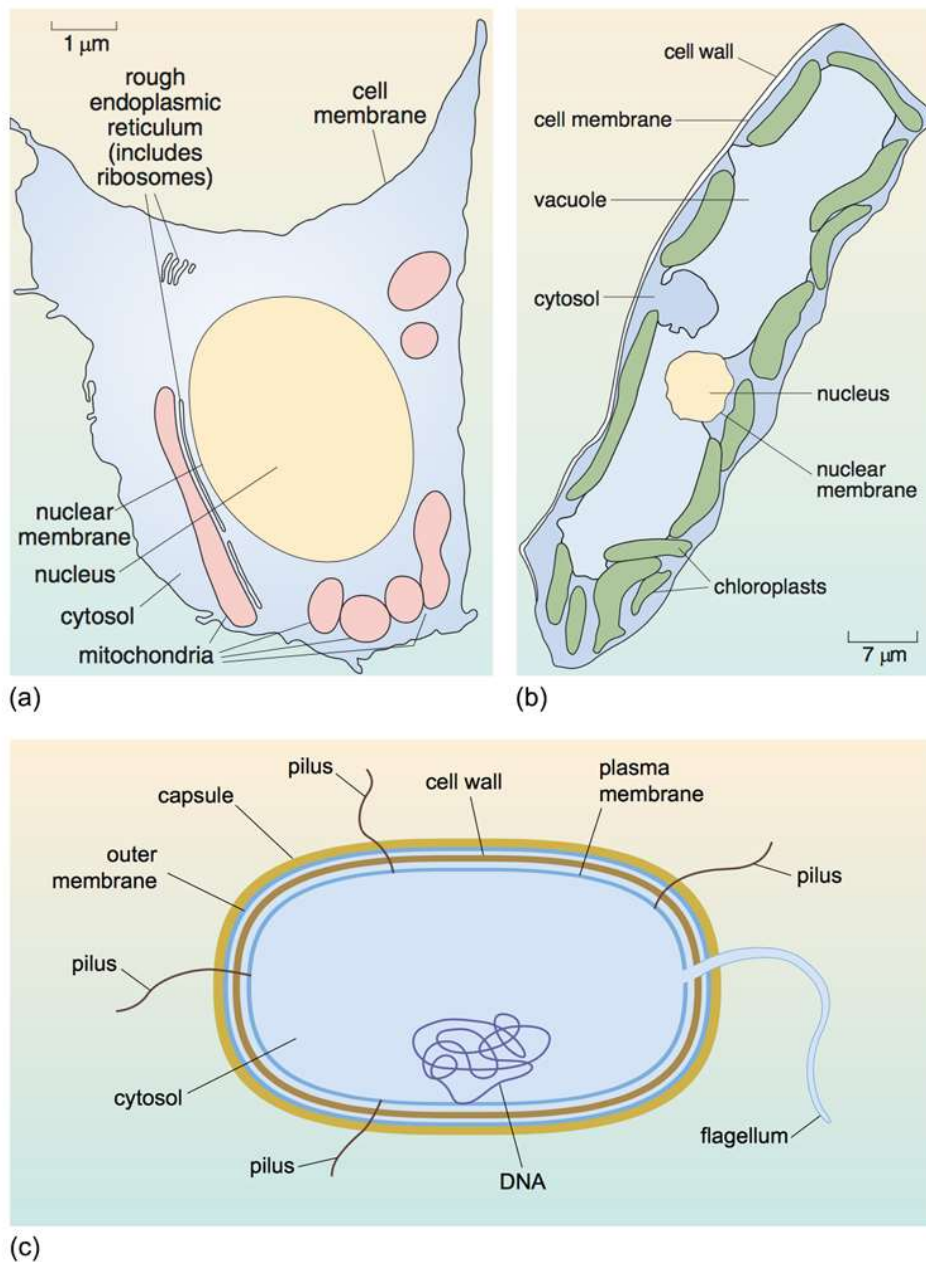In which environment do you think the following rock was formed?

(Source: Daniel Mayer (CC BY-SA 2.5))

Figure 5 Photograph of a rock formation (for use with Question 7)

(a) A river.

(b) A beach.

(c) A desert.

Question 8

Identify the following as animal, plant or bacterial cells.

Figure 6 Diagrams showing three different types of cell labelled (a)-(c) (for use with Question 8)

Question 9

The key feature of DNA is that:

(a) It is a very long molecule.

(b) It is capable of replicating itself.

(c) It is chemically stable.

Question 10

Which of the following are properties of an enzyme?

(a) It is a protein.

(b) It conveys genetic information.

(c) It speeds up biochemical reactions.

Question 11

Choose the correct options to complete this sentence:

Potential energy is the energy associated with **movement/position** while kinetic energy is the energy associated with **movement/position**.

Question 12

Right now, you are exerting a force on the surface of the Earth due to your weight. Why do you not sink into the earth?

(a) There is not enough space between the atoms making up the surface of the Earth.

(b) The surface of the Earth exerts a force on you that is greater than the force you exert on the Earth.

(c) The surface of the Earth exerts a force on you that is equal to the force you exert on the Earth.

Question 13

The upper spectrum below is white light split up into its component wavelengths. The lower spectrum is obtained by viewing the white light after it has passed through an atmosphere of hydrogen.

(Source: JasonKnowsScience (CC BY-SA 3.0))

Figure 7 The spectrum of white light (top) and the same spectrum viewed after passing through an atmosphere of hydrogen (bottom) (for use with Question 13).

Which of the following statements is true?

(a) Hydrogen absorbs all wavelengths of white light.

(b) Hydrogen does not absorb any wavelengths of the white light.

(c) Hydrogen absorbs green and yellow light.

(d) Hydrogen absorbs red and blue light.

Question 14

Using *only* the information in Figure 8, determine how many electrons are there in a sodium atom.

atomic number	11	
	Na	symbol
relative atomic mass	23	

Figure 8 Annotated representation of sodium atom from the periodic table (for use with Question 14).
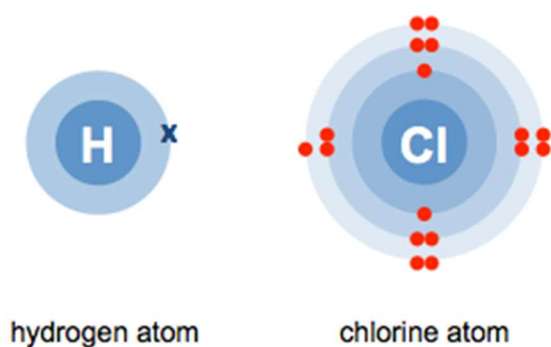
Question 15

Which of the following is a balanced chemical reaction?

(a) $H_2 + O_2 = H_2O$

(b) $H_2 + O_2 = 2H_2O$

(c) $2H_2 + O_2 = 2H_2O$

(d) $H_2 + 2O_2 = 2H_2O$

Question 16

Which of the following represents a covalent molecule?

(a)

hydrogen atom   chlorine atom

(b) $H^+ Cl^-$

(c) H–Cl

2   Maths skills

This part should take you about 30 minutes.

Basic mathematical skills of addition, subtraction, division and multiplication are required for this module plus the following ideas;

- **Understanding scale and changing units of measurement**

Units look at the scale of something. The metre (m) and the kilogram (kg) are units of measurement we use in our everyday lives. In this module, you will also come across units measuring the very small, from the size of an atom, to the very large, the size of the sun.

For very big or very small numbers it is often more appropriate to change the units of measurement, to something that is more easily understood.

Can you convert different units of measurement? For example millimetre (mm) to kilometre (km).

- **Understanding percentages**

A percentage is a way of saying "how many out of one hundred", e.g.

$$\frac{30}{100} = 30\%$$

They are also used to look at how values change, a percentage increase or decrease compared with the original value.

- **Understanding areas and volumes**

Are you able to calculate the areas or volumes of different shapes?

- **Understanding equations**

An equation is a mathematical statement where both sides must be balanced. The values either side of an equals sign must be the same.

Are you able to re-arrange equations so you can work out the unknown variable?

- **Understanding very large or small numbers**

It often gets confusing writing out all those zeros in big and small numbers. Do you understand the idea of the **powers of 10** notation for very big or small numbers?

The distance from the earth to the sun is about 150 000 000 km or 1.5×10^8 km.

The size of a red blood cell is about 0.000 008 m or 8×10^{-6} m.

A positive power of ten denotes how many times a number is *multiplied* by 10 while a negative power of ten denotes how many times a number is *divided* by 10.

- **Handling data**

Can you collect information (or data)? Work out what it is telling you? And show it to someone else?

2.1 Maths Quiz

Try the following maths quiz to see if you have the maths skills to start S112.

As before, answers are given at the end of this document… but don't be tempted to look until you have had a go at the questions!

Question 1

The price of a cup of coffee increases from £2.00 to £2.30. What is the percentage increase in the price of a cup coffee?

Question 2

When it rains, the number of children walking to school decreases from 150 to 90. What is the percentage decrease in the number of children walking to school?

Question 3

What is the area of a rectangle measuring 78 cm by 1.5 m? (Express your answer in m^2.)

Question 4

To how many significant figures should your answer to the previous question be quoted? (The previous question asked you to calculate the area of a rectangle measuring 78 cm by 1.5 m.)

Question 5

What is the volume of a cuboid measuring 1.2 m by 2.0 m by 3.5 m? (Express your answer in m^3 and cm^3.)

Question 6

Re-arrange the following equation so that B is the subject.

$$A = BC$$

Question 7

What is 240 000 written in scientific notation (using powers of 10)?

Question 8

If you walk 3.5×10^3 m and have a rest, then walk a further 4.2×10^3 m, how far have you walked in total?

Question 9

Power is the rate at which energy is transformed:

$$\text{power} = \frac{\text{energy}}{\text{time}}$$

If energy is measured in joules, symbol J, and time in seconds, symbol s, what are the units of power?

(a) $J\,s$

(b) $\dfrac{J}{s}$

(c) $\dfrac{s}{J}$

Question 10

Look at the following table of data, and identify the dependent and independent variables.

Table 1 A sample table of data (for use with Question 10).

Month	Sales (1000s)	Advertising Pounds (1000s)
January	100	5.5
February	110	5.8
March	112	6
April	115	5.9
May	117	6.2
June	116	6.3
July	118	6.5
August	120	6.6
September	121	6.4
October	120	6.5
November	117	6.7
December	123	6.8

(Source: Table adapted from Columbia University)

Question 11

The figure shows UK energy use by type of source. When did gas first become the most important source of energy use?
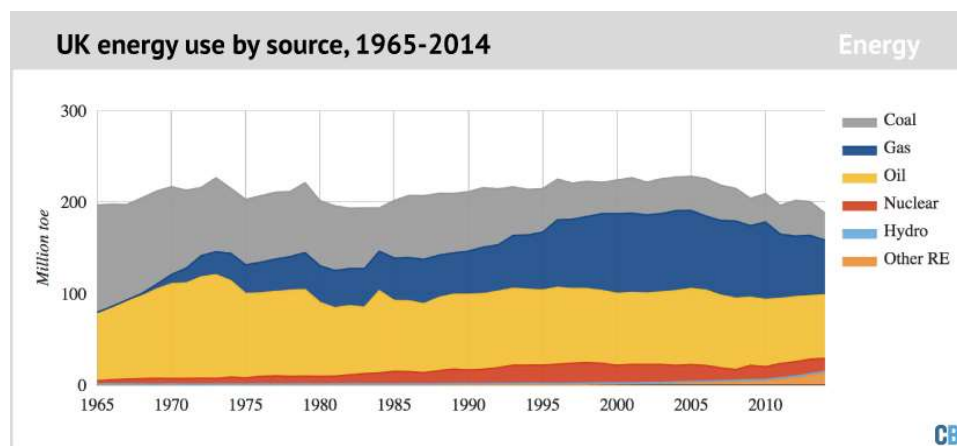
(Source: CarbonBrief (CC BY-NC-NC 4.0))

Figure 9 Graph of global energy use by type of source (for use with Question 11).

(a) Between 1975-1980.

(b) Between 1985-1990.

(c) Between 1995-2000.

(d) Between 2005-2010.

3 Online study

One thing to bear in mind is this module is completely online. For some of you this maybe a completely new way of studying. Do you have the study skills to do this?

Effective Reading and note-making

As all the study material is online, you might have to think about developing new study skills for an online course and also think about when you need to be online to complete activities or questions within the topic. If you have already studied an online module with the Open University before (such as S111 or SDK100) or a module with some online materials (such as U116), S112 will further develop your online study skills.

Effective reading and note-making is a key skill you need. Reading and making notes should be an active and creative process. Your goal is to have a useful and memorable set of notes that that is easy to refer to and improves your learning.

Notetaking techniques

This Activity should take you 35 minutes.

Go to the study guide on different note-taking techniques and complete the activity to explore the techniques that suit you:

Notetaking techniques

(To view the videos, existing OU students will need to be logged on)

You will also find lots of useful advice and guidance for studying online in the Study skills for online learning section of the Help Centre on StudentHome. We recommend that you take some time now to review this.

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4   Writing skills

It may also be a while since you have written anything. Do you have the necessary writing skills?

English for OU study

This Activity should take you 20 minutes to complete.

Complete the following writing activity:

English for OU study writing activity

If you find this activity easy you should have the necessary writing skills required to start on S112. As the module progresses your tutor will assist you further with your writing skills through feedback on your tutor-marked assignment (TMA). That is one reason why it is important to submit your assignments and pay close attention to the feedback you receive. If you feel you need further help with your writing skills before starting on S112 we recommend that you take a look through the Skills for study section on OpenLearn. In particular the free badged open course *English: skills for learning* contains a wealth of useful guidance to help develop reading and writing skills in order to tackle university assignments.

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5   Time management

How many hours a week do you work? Or do you have caring responsibilities? Everyone is different.

Plan out an average week as a simple table with days along the top and hourly timeslots along the side. You can do this on paper, using word processing software or a spreadsheet. (There is a useful time management spreadsheet as part of the S111 'Are you ready for …' which you may like to download and use. Existing OU students can use the online time planner, too.) Think carefully about the time you have available for study. Be realistic and allow time for any commitments such as work, family or caring responsibilities, plus downtime for yourself (don't forget that you need to eat and sleep!).

Managing your study time

This Activity should take you 25 minutes to complete.

S112 will take about 14 hours of your time each week and officially runs from October to June. Do you have the time to study for nine months?

Can you manage your time well and organise the time you have for study? If you have studied with the OU before, how well did you organise your time? Have a look at the following activity:

Time-management skills

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6   What to do next?

Having now completed this '*Are you ready for S112?*' resource, you should be in a position to judge for yourself how ready you feel to start S112.

Begin by checking your answers to the Understanding Science and Maths Skills quizzes which are given in the next sections. There are no formal marks or a score system, however if you answered most of these questions correctly on the first go then you should be well prepared academically to start on S112. The module will help you build on these skills as you progress towards science studies at higher levels.

Don't forget to consider the important advice on online study (Section 3), writing skills (Section 4) and time management (Section 5) when assessing your preparedness.

In deciding what to do next, you may find it helpful to reflect on the following question and the advice that follows.

How ready do you feel to start S112?

■   <u>Very ready</u> – Great you have all the skills necessary to start this module, register now if you haven't already!

■   <u>Reasonably ready</u> – but want to know more before it starts.

If you would like to brush up on your science skills before you start S112 then there are many courses on Open Learn you may want to have a look at. For example, the chemistry page on <u>Open Learn Chemistry</u> has many activities and videos you might want to explore.

■   <u>Not sure</u> – think about which of the five areas on this '*Are you ready for…*' that you are unsure about.

Are you unsure about the science you already know or your maths skills?

There are many courses on Open Learn you can have a look at if you are uncertain. These are just some of those available:

   Geological timescales will give you an insight into the geological history of Earth.

   Water for Life is a level one introductory course on atoms, elements and molecules.

   Introducing the Environment: Ecology and Ecosystems explores the effect humans are having on the environment.

   Basic science: understanding numbers may be useful if it has been a little while since you studied any maths, to brush up on the basic maths skills needed for S112.

   Another useful resource is the Maths skills study booklet. You might want to focus on Chapter 5; Units of measurement, Chapter 7; Scientific notation or Chapter 9; Significant figures, if you found these areas more difficult in the Maths quiz.

If you are you unsure because the course is completely online and/or it has been a while since you did any writing

There are many resources you can access that can help you with online study skills and writing skills before you start S112.

The OU's study skills website contains useful tips for studying online such as Study tips for online modules. There are also specific tips on Making notes online and Active reading. Learn Higher also offer a free-to-download mind map of Top ten note-making tips.

If you want to improve your writing skills, then you could follow the Developing Academic English Guide (it will take about 5 hours to complete).

You don't think you have the time to study this course

If you don't think you have the time to study, start by reviewing your responses to the 'Managing your study time' activity in Part 5. Although 14 hours per week can seem like a lot of time to find to study, it is surprising how quickly small chunks of time add up. With S112 being an online only module you will have easy access to your study materials wherever you have an internet connection. So you may find that you can fit in some study on the go, such as during lunch breaks or whilst commuting. Most of your available time for study though is likely to come in blocks such as evenings or weekends. This is particularly important for larger activities in S112 such as practical work. Be honest with yourself about how much time you can devote to studying. *You may find that it helps to talk through your study intentions and time available with one of our advisers. Details of how to contact an adviser are given below.*

If you really don't think you have the time to study now, and decide not to register for S112, bear in mind that the time you have available for study may change in the future. So you may like to run through this '*Are you ready for S112?*' guidance again and/or speak with one of our friendly advisers about returning to formal study. In the meantime, we offer a range of informal study options that require less time commitment, such as free courses on OpenLearn.

If you're not sure S112 is the right module for you

Whatever the reason, if you really are unsure about studying S112 you may find that it helps to speak with one of our friendly advisers. They're there to help and can talk through any concerns or questions you may have. After doing so, if you are still unsure, then S112 is probably not for you at this time.

Call us

Don't forget that you can speak to one of our friendly advisers on **0300 303 5303** (Monday to Friday 8am to 8pm, Saturday 9am to 5pm UK Time Excluding Bank Holidays) if you have any questions about the module or your preparedness.

If you are an existing Open University student you can contact an adviser at your Student Support Team using the contact details that you will find on StudentHome.

Answers to Understanding Science Quiz

Question 1

The answer is (c). Nano means a billionth; micro a millionth; milli a thousandth; kilo one thousand; mega one million and giga one billion.

Question 2

The answer is (a). The units for the price are obtained by dividing the units for the money (£) by the units for the mass (kg) so the units are £ per kg or £/kg.

Question 3

The appropriate words are:

(a) Flow.

(b) Evaporation.

(c) Precipitation.

Question 4

The answer is (d).

Abies pollen is only found at depths less than 26.5m whereas all the others are present at greater depth. So *Abies* are the most recent colonisers.

Question 5

The answer is B, C, A, D.

Rock B underlies Rocks C and D and is cut through by Rock A, so Rock B must be the oldest. Similarly, Rock C underlies Rock D and is cut through by Rock A, so Rock C is the next oldest. Rock A does not cut through Rock D so Rock D must be the youngest. Putting this all together B is the oldest, then C, then A and then D.

Question 6

The answer is (b) Fault.

Question 7

The answer is (b). The ripples in the rock resemble the ripples you can see on a beach.

Question 8

(a) is an **animal** cell

(b) is a **plant** cell

(c) is a **bacterial** cell.

Plant cells have chloroplasts, a cell wall and a vacuole (which animal cells do not have). Both plant and animal cells have a cell membrane, nucleus, nuclear membrane, mitrochondria (not shown in Figure 6) and cytosol.

Question 9

The answer is (b). As it is the material by which information is inherited, the key feature of DNA is that it is capable of replicating itself.

Question 10

The answers are (a) and (c). It is DNA that conveys genetic information, not enzymes/proteins.

Question 11

Potential energy is the energy associated with **position** while kinetic energy is the energy associated with **movement**.

Question 12

The answer is (c). The surface of the Earth exerts a force on you that is equal to the force you exert on the Earth. If the Earth exerted a force greater than the one you exert on the Earth you would be pushed upwards.

Question 13

The answer is (d). The black lines reveal the wavelengths that are missing when the light travels through hydrogen, so hydrogen must have absorbed them. These lines are in the red, blue and violet regions of the spectrum.

Question 14

The atomic number is the number of protons in the nucleus of an atom. Atoms are neutrally charged, so the number of negatively charged electrons is equal to the number of positively charged protons. Sodium has an atomic number of 11 so the number of protons and therefore electrons in a sodium atom is 11.

Question 15

The answer is (c).

The key here is to ensure there are the same number of atoms of each element on both sides of the equation. In answer (c), on the left-hand side there are two lots of H_2, each H_2 containing two hydrogen atoms. So that's four hydrogen atoms in total. There is also one lot of O_2, which contains two oxygen atoms. On the right-hand side, there are two lots of H_2O each H_2O containing two hydrogen atoms and one oxygen atom; that's four H atoms and two O atoms in total.

In (a), the O atoms are not balanced (fewer O atoms on the right-hand side compared to the left-hand side); in (b), the H atoms are unbalanced (fewer on the left-hand side compared to the right-hand side); in (d), neither the H nor the O atoms are balanced (fewer H atoms and more O atoms on the left-hand side).

Question 16

The answer is (c). A covalent bond is the link between atoms where electrons are shared between two nuclei as represented by the line between the H and Cl. Answer (a), represents separate H and Cl atoms, whereas answer (b), shows two ions as represented by the + and – symbols.

Answers to Maths Quiz

Question 1

$$\text{percentage increase} = \frac{\text{increase in value}}{\text{original value}} \times 100$$

$$= \frac{£2.30 - £2.00}{£2.00} \times 100$$

$$= \frac{0.30}{2.00} \times 100 \text{ (note: £ units cancel out)}$$

$$= 15\%$$

Question 2

$$\text{percentage decrease} = \frac{\text{decrease in value}}{\text{original value}} \times 100$$

$$= \frac{150 - 90}{150} \times 100$$

$$= \frac{60}{150} \times 100$$

$$= 40\%$$

Question 3

The answer is 1.17 m^2.

The first step is to get both values in units of metres (m). There are 100 cm in 1 m, so 78 cm is 0.78 m.

0.78 m × 1.5 m = 1.17 m^2.

Question 4

The answer is (b) – to 2 significant figures.

Each number is quoted to two significant figures so the answer should also be quoted to two significant figures.

Question 5

8.4 m^3 or 8 400 000 cm^3 (can also be expressed as 8.4 × 10^6 cm^3)

(There are 100 cm × 100 cm × 100 cm = 1 000 000 cm^3 in 1 m^3)

Question 6

The answer is $B = \dfrac{A}{C}$

To rearrange $A = BC$ to make B the subject, both sides of the equation are divided by C. This cancels out the C on the right hand side leaving just B and $\dfrac{A}{C}$ on the left hand side.

Question 7

The answer is 2.4 × 10^5.

Question 8

The answer is 7.7 × 10^3 m.

Question 9

The answer is $\dfrac{J}{s}$

Question 10

"Sales" is the <u>dependent</u> variable as it is being used to measure the effect of the independent variable, the advertising spend.

"Advertising Pounds" is the <u>independent</u> variable as it is the variable that is being investigated.

Question 11

The answer is (c) between 1995-2000.

Acknowledgements