



Are you ready for S206/SXF206?

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1 Introduction

Welcome to *Are you ready for S206/SXF206?* This quiz will help you assess whether you have the necessary background knowledge and skills to be able to enjoy S206 or SXF206 fully and give yourself the best possible chance of completing them successfully. Working through the questions below will serve as a reminder of some of the facts, skills and conceptual knowledge which it is assumed that you will bring from earlier studies.

Before attempting the quiz, we'll take a look at the Open University (OU) modules that we recommend you to have studied before coming to S206 or SXF206.

2 Suggested prior OU study

In S206 and SXF206 it is assumed that you have a certain amount of existing scientific knowledge from your earlier studies.

If you're studying towards the environmental science (Q52) qualification or the Diploma of Higher Education in Environmental Science (W47), you need to register for SXF206. For this module, you should have studied the OU level 1 module [Science: concepts and practice \(S112\)](#) – or the discontinued module [Exploring science \(S104\)](#) – to make sure your scientific knowledge and skills are at the right level for SXF206. You should also have studied [Environment: journeys through a changing world \(U116\)](#) as this teaches many of the skills and scientific concepts developed in SXF206, and gives you an appreciation of how to approach issues from a multidisciplinary perspective.

For all qualifications apart from Q52 and W47, you should register for S206. For this module we recommend that you've passed [Science: concepts and practice \(S112\)](#), as it gives a broad foundation in the relevant science, maths and IT skills. [Questions in Science \(S111\)](#) and [Environment: journeys through a changing world \(U116\)](#) are also appropriate if you're confident in your maths skills. If you are unsure about your maths skills, [Maths for science \(S151\)](#) will prepare you with the maths knowledge you need to study S206.

If it has been a while since you studied an OU level 1 science module, we advise you to buy [The Sciences Good Study Guide](#) by A. Northedge et al. (2003, The Open University – ISBN 978-0749234119).

3 Mathematical skills quiz

Being comfortable with basic mathematical and graphical skills is the single most important way you can be prepared for S206 or SXF206. Please be certain that you can:

- use a *scientific calculator*
- understand *scientific notation* using *powers of ten* (e.g. 10^3 , 10^{-5} , 6.2×10^{-1}) and perform calculations using scientific notation
- perform simple *unit conversions* (e.g. μm to mm; mm to m; m to km)
- manipulate *equations*, involving addition, subtraction, division or multiplication, to find an unknown
- plot data on *graphs*, choosing appropriate scales and axes, and interpret graphical data correctly
- express quantities as *ratios*, *fractions* or *percentages*
- calculate *areas* or *volumes* using given formulae
- quote values to an appropriate number of *significant figures*.

If you are uncertain about any of these concepts, you can review them in the *Sciences Good Study Guide*, or via the [S206/SXF206 Preparation website](#).

Self-assessed quiz for numeracy

Try the following questions to test your mathematical skills. (The answers are in Section 6.) Some of these questions have multiple choice answers, and some do not. It is essential that you are comfortable with the skills tested in these questions before you start S206 or SXF206. You should spend no more than 2 hours on this part.

Question 1 Work out the answers to the following sums, using your calculator as appropriate:

- (a) $6998 - 15\,774$
- (b) $(-5) + (-9)$
- (c) $(8 + 6) \times (5 - 2)$
- (d) Find x and express its value to three significant figures. ($a = 15$ and $b = 81$)

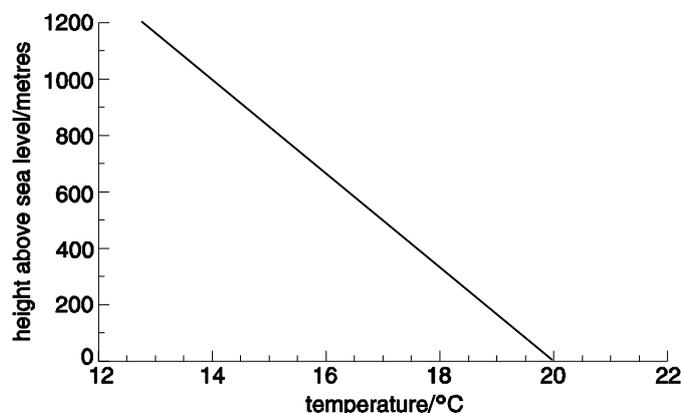
$$x = \frac{a}{b} \times 100\%$$

Question 2 Calculate to two significant figures the volumes of boxes with the following dimensions:

- (a) $2.0\text{ m} \times 8.0\text{ cm} \times 9.0\text{ mm}$ (express the answer in cm^3)
- (b) $87\text{ cm} \times 9.0\text{ cm} \times 8.0\text{ m}$ (express the answer in m^3).

Question 3 The following figure shows a general plot of temperature change with altitude where the temperature at sea level is 20.0 °C.

- (a) What is the temperature at a height of 300 m above sea level?
 (b) How much would you expect temperature to drop when ascending from sea level to a height of 1 km?



Question 4 If the amount of rainfall collected in a rain gauge, expressed in mm, for five consecutive days is 22.4, 13.5, 12.6, 23.3, and 4.0, what is the average (mean) rainfall over these five days, to one decimal place?

Question 5 Rearrange the following equation in terms of y :

$$2x + 3y = 4(x + y)$$

Question 6 Rearrange the following equation in terms of v :

$$f = \frac{8gRs}{v^2}$$

Question 7 The volume V of a sphere of radius a is given by the formula:

$$V = \frac{4}{3}\pi a^3$$

Which of the options below is the correct value for the volume of a sphere of radius 5 m?

- (a) 105 m³
 (b) 167 m³
 (c) 500 m³
 (d) 524 m³

Question 8 The age of the Earth is calculated as 4 600 000 000 years. Express this number in scientific notation.

Question 9 The diameter of the common marine phytoplankton *Emiliana huxleyi* is 0.000 000 15 m. Express this number in scientific notation.

Question 10 In science, the Kelvin temperature scale (abbreviated to K) is often used in preference to the more well-known Celsius temperature scale. A value of 0 K is equivalent to -273.15 °C, and a change in temperature of 1 K is equal to a change of 1 °C. Which one of the following values is equivalent to 10 °C?

- (a) -283.15 K (c) 263.15 K
 (b) -263.15 K (d) 283.15 K

Question 11 A substance contains 3.5×10^{-2} particles per cubic metre. How many particles will there be in a volume of 10^4 m^3 ? Select your answer from one of the four options below.

- (a) 3.5×10^{-2}
- (b) 350
- (c) 35
- (d) 3.5

Question 12 The global cycle of water or important biological elements like carbon and nitrogen comprises two main parts:

- reservoirs where the molecules or atoms are stored for various lengths of time,
- and transfers between the reservoirs.

Dividing the mass of a substance in a reservoir by its rate of transfer through that reservoir gives us its residence time:

$$\text{residence time} = \frac{\text{mass of substance in reservoir}}{\text{rate at which substance enters (and/or leaves) reservoir}}$$

or the *average* time that a substance spends in a reservoir.

The atmosphere contains $1.5 \times 10^{16} \text{ kg}$ of water (H_2O), mostly as water vapour, and precipitation and evaporation are balanced, transferring $5.05 \times 10^{17} \text{ kg}$ of H_2O per year between the atmosphere and the oceans/land.

What is the residence time of H_2O in the atmosphere, to the nearest day?

4 Key concepts and self-assessed quiz

This section outlines some of the concepts that are developed in S206 and SXF206 and for which prior knowledge is either essential or helpful. Your knowledge of each of the concepts is tested in one or more of the questions in the self-assessed quiz.

- **Hydrological and chemical cycles:** investigating how water, carbon and other biologically important elements are stored, and move at or near the Earth's surface and in the oceans. Question 12.
- **Factors affecting species distribution:** the role of the physical environment in determining vegetation type and wildlife habitat. Questions 13–16.
- **Chemical formulae, equations and simple calculations** Questions 17 and 20.
- **Nature of gases:** density, pressure and temperature. Question 18.
- **Energy:** conservation of energy and its various forms. Question 19.
- **Igneous, metamorphic and sedimentary rocks:** identification of these three major groups, processes of formation and characteristics. Question 21.

Self-assessed quiz for key concepts

Try the following questions. (The answers are in Section 6.) You should spend no more than 1 hour on this part. Questions marked with an asterisk (*) cover concepts that are most important to understand before starting S206 or SXF206.

Biosphere (Questions 13–16)

***Question 13** Which gas is consumed by photosynthesis?

- (a) O₂
- (b) N₂
- (c) CO₂
- (d) CH₄
- (e) H₂

Question 14 Which of the following pairs of plant species are most closely related? *Note: you do not have to know anything about these organisms to answer the question.*

- (a) *Festuca rubra* and *Bellis perennis*
- (b) *Festuca rubra* and *Quercus rubra*
- (c) *Festuca rubra* and *Festuca pratensis*
- (d) *Bellis perennis* and *Quercus rubra*

Note: the following two questions refer to the list of cells below:

- 1 Animal cells
- 2 Plant cells
- 3 Fungal cells
- 4 Bacterial cells

***Question 15** Which of these types of cell respire?

- (a) 1 only
- (b) 1 and 2 only
- (c) 1 and 3 only
- (d) 1, 3 and 4 only
- (e) All of them

Question 16 Which cells are from organisms within the same Kingdom?

- (a) 2 and 3
- (b) 2 and 4
- (c) 1 and 5
- (d) 3 and 4
- (e) None of them

Atmosphere and hydrosphere (Questions 17–20)

***Question 17** Carbon dioxide has the chemical formula CO_2 . Which one of the following statements is correct?

- (a) The carbon dioxide molecule has two carbon atoms and one oxygen atoms.
- (b) The carbon dioxide molecule has one carbon atom and two oxygen atoms.
- (c) The carbon dioxide atom always comes in pairs.
- (d) The carbon dioxide atom is made up of a carbon atom and an oxygen molecule.

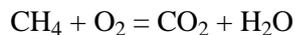
***Question 18** The temperature of a gas is a measure of:

- (a) the amount of gas present.
- (b) the constituents of the gas.
- (c) the kinetic energy of atoms or molecules in the gas.

***Question 19** Pressure is defined as a force per unit area. If the pressure is $1.01 \times 10^5 \text{ Pa}$, what is the force acting on an area of 100 cm^2 ? ($1 \text{ Pa} = 1 \text{ N m}^{-2}$)

- (a) 1.01 N
- (b) 10.1 N
- (c) 101 N
- (d) 1010 N

***Question 20** Methane (CH_4), also known as natural gas, burns in the presence of oxygen (O_2) to yield carbon dioxide (CO_2) and water (H_2O). The reaction also releases energy. Balance the overall chemical equation for this reaction:



Lithosphere (Questions 21–23)

Question 21 Which of the following are examples of igneous rocks?

- (a) Gneiss
- (b) Granite
- (c) Sandstone
- (d) Basalt
- (e) Limestone

Question 22 Which of the following processes might form sedimentary rock?

- (a) Cooling and crystallization of magma
- (b) Accumulation and burial of calcite shells on the sea floor
- (c) Metamorphism of a mudstone to form slate
- (d) Burial and compaction of sand dunes

Question 23 The dissolution of limestone by slightly acidic rainwater is an example of which of the following processes?

- (a) Physical weathering
- (b) Fractional crystallisation
- (c) Chemical weathering
- (d) Abrasion
- (e) Sediment transport

5 Preparation for S206/SXF206

We have produced an [S206/SXF206 Preparation website](#) to help students to prepare properly for their studies on the module. If you find the ‘Are you ready for?’ questions hard, then we would strongly advise you to spend some time looking through this website, focussing on those areas that you need most help with. Even if you did well in the quiz, it would still be a good idea to take a look at the Preparation website. The quiz cannot cover all of the skills that you need, so there may well be topics there that you would find it useful to revise.

6 Answers to questions

Question 1

- (a) -8776
- (b) -14
- (c) 42 ($8 + 6 = 14$; $5 - 2 = 3$; $14 \times 3 = 42$)
- (d) $x = \frac{15}{81} \times 100\% = 0.1852 \times 100\% = 18.52\%$

So $x = 18.5\%$ (to three significant figures)

Question 2

- (a) $200 \text{ cm} \times 8 \text{ cm} \times 0.90 \text{ cm} = 1440 \text{ cm}^3$. To two significant figures, this is 1400 cm^3 .
- (b) $0.87 \text{ m} \times 0.09 \text{ m} \times 8.0 \text{ m} = 0.6264 \text{ m}^3$, which is 0.63 m^3 when expressed as two significant figures.

Question 3

- (a) Reading off the plot, the temperature at 300 m is between 18.0 and 18.5 °C.
- (b) Again reading off the plot, the temperature at the surface is 20 °C and the temperature at 1 km (1000 m) is 14 °C. You would therefore expect the temperature to drop by
 $20 - 14 = 6$ °C.

Question 4

Using the rainfall data supplied

$$\frac{22.4 + 13.5 + 12.6 + 23.3 + 4.0}{5} = 15.16$$

So the mean rainfall for the period is 15.2 mm (to one decimal place)

Question 5

The answer is $y = -2x$. A method for obtaining this equation is outlined below.

Starting with:

$$2x + 3y = 4(x + y)$$

First, multiply the 4 through the right-hand side of the equation:

$$2x + 3y = 4x + 4y$$

Then, add $-4y$ to each side. By doing this all of the y variables are on the left-hand side:

$$2x + (3y - 4y) = 4x + (4y - 4y), \text{ which simplifies to:}$$

$$2x - y = 4x$$

Then, add $-2x$ to each side so all the x variables are on the right-hand side:

$$(2x - 2x) - y = (4x - 2x), \text{ which simplifies to:}$$

$$-y = 2x$$

multiplying through by (-1) gives us:

$$y = -2x$$

Question 6

The answer is:

$$v = \sqrt{\frac{8gRs}{f}}$$

A method for obtaining this equation is outlined below.

Starting with:

$$f = \frac{8gRs}{v^2}$$

First, multiply both sides by v^2 :

$$fv^2 = 8gRs$$

Then, divide both sides by f :

$$v^2 = \frac{8gRs}{f}$$

Then, take the square root of each side to achieve the final answer in terms of v :

$$v^2 = \left(\frac{8gRs}{f}\right)^{\frac{1}{2}} \text{ or } v = \sqrt{\frac{8gRs}{f}}$$

Question 7

Option (d), 524 m^3 , is the correct volume for a sphere of radius 5 m , because:

$$V = \frac{4}{3}\pi 5^3$$

$$= \frac{4}{3}\pi(125)$$

$$= 523.60, \text{ which is the same as } 524 \text{ to three significant figures.}$$

Question 8

4.6×10^9 years.

The superscript '9' in the notation shows how many times 4.6 has been *multiplied* by 10 .

Question 9

1.5×10^{-7} m.

The superscript ‘ -7 ’ shows how many times 1.5 has been *divided* by 10.

Question 10

The correct option is (d), 283.15 K.

The relationship is that temperature in Kelvin (T_k) is equal to temperature in Celsius (T_c) plus 273.15. That is:

$$T_k = T_c + 273.15$$

Therefore, for a temperature in Celsius (T_c) of 10 °C:

$$T_k = 10 + 273.15$$

$$T_k = 283.15$$

Question 11

The correct answer is (b), 350, because:

$$3.5 \times 10^{-2} \text{ particles m}^{-3} \times 10^4 \text{ m}^3 =$$

$$3.5 \times 10^{-2} \times 10^4 \text{ particles}$$

$$= 3.5 \times 10^2 \text{ particles}$$

$$= 350 \text{ particles.}$$

Question 12

The residence time of H₂O in the atmosphere is 11 days, because:

$$\text{residence time} = \frac{\text{mass of substance in reservoir}}{\text{rate at which substance enters (and/or leaves) reservoir}}$$

$$= \frac{1.5 \times 10^{16} \text{ kg H}_2\text{O}}{5.05 \times 10^{17} \text{ kg H}_2\text{O y}^{-1}}$$

$$= (2.97 \times 10^{-2} \text{ y}) \frac{1}{\text{y}^{-1}}$$

$$= 2.97 \times 10^{-2} \text{ y}$$

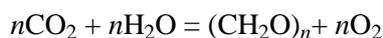
$$= 0.0297 \text{ y} \times 365.4 \text{ days y}^{-1}$$

$$= 11 \text{ days (to the nearest day)}$$

Question 13

The correct answer is (c), CO₂.

During the process of photosynthesis green plants use atmospheric carbon dioxide (CO₂) and water (H₂O) to produce hydrocarbons (CH₂O)_n and oxygen (O₂):

**Question 14**

(c) *Festuca rubra* and *Festuca pratensis* are the most closely related. They share the same genus, *Festuca*. *Rubra* and *pratensis* are descriptive names given to the particular species, in this case meaning ‘red’ and ‘meadow’, respectively.

Question 15

The correct answer is (e): All of them

All living organisms (and therefore all cells) respire.

Question 16

The correct answer is (e), none of them belong to the same Kingdom.

All organisms belong to one of five Kingdoms: the four listed, plus another named Protocista, which includes amoebae and algae.

Question 17

Answer (b) is correct. A molecule of CO₂ has one carbon atom and two oxygen atoms.

Question 18

Answer (c) is correct. The temperature of a gas is a measure of the kinetic energy of atoms or molecules within it.

Question 19

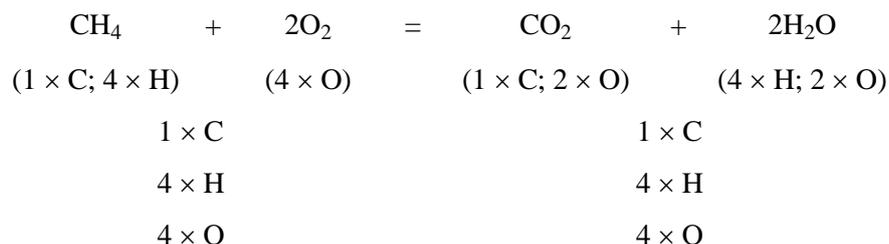
Answer (d), 1010 N, is correct, because:

$$100 \text{ cm}^2 = 0.1 \text{ m} \times 0.1 \text{ m} = 0.01 \text{ m}^2, \text{ or } 1 \times 10^{-2} \text{ m}^2$$

$$1.01 \times 10^5 \text{ N m}^{-2} \times 1 \times 10^{-2} \text{ m}^2 = 1.01 \times 10^3 \text{ N} = 1010 \text{ N}$$

Question 20

The balanced equation is:

**Question 21**

Answers (b) and (d) are correct. Sandstone and limestone are sedimentary rocks and gneiss is a metamorphic rock.

Question 22

Answers (b) and (d) are correct. Burial and compaction of sand dunes would lead to the formation of sandstone; accumulation and burial of calcite shells on the sea floor would lead to the formation of limestone; both sandstones and limestones are sedimentary rocks. The change from mudstone to slate is a metamorphic process, so slate is a metamorphic rock. Magma cools and crystallizes to form igneous rocks.

Question 23

Answer (c) is correct. The dissolution of limestone by slightly acidic rainwater involves a chemical reaction, so this is a chemical weathering process. Physical weathering, abrasion and sediment transport are all mechanical processes. Fractional crystallisation is a process operating during the formation of igneous rocks.