

# Are You Ready For S201



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# 1 Introduction

S201 *Science and Society* covers five diverse scientific topics:

- Topic 1 – Food: security and safety
- Topic 2 – Water
- Topic 3 – Engineering the climate
- Topic 4 – Energy
- Topic 5 – Personalised medicine

These topics draw upon the knowledge, understanding and skills which would be gained through successful study of one or more of the Open University's Level 1 science modules:

- S104 Exploring science
- S141 Investigative and mathematical skills in science
- S142 Topics in science
- S111 Questions in science.
- SDK100 Science and health: an evidence-based approach.
- U116 Environment: journeys through a changing world.

The module takes an interdisciplinary approach to science, and there should be material of interest to students of all areas of science, and those who wish to focus their studies on an interdisciplinary approach.

As with any study of science, a certain level of competence in numeracy and other mathematical skills is required to study S201. Again, this level is indicated by the treatment of these skills in the level 1 science modules.

As suggested by its title, S201 addresses science in a broad societal context. This means that, in addition to knowledge and understanding of the underlying science, it is also necessary to consider matters from perspectives that are more usually associated with the social sciences. This is reflected in the four themes that permeate S201:

- communication (of science)
- risk
- ethical issues
- decision making

These four themes are explained in the *Orientation week* which forms the first week of study. They are then developed throughout the module in the context of the various scientific topics. Thus, in contrast to the basic science that underpins the topics, it is *not* assumed that you are already familiar with the themes except in the most general terms.

Since aspects of all the topics are controversial to some extent, a range of opinions is bound to be held by students, tutors and module authors. It is therefore essential that you are prepared to work with other students and your tutor to test and clarify your own understanding and opinions. An important aspect of studying S201 will be participation in computer-mediated conferences. Through online collaboration with others, you will be able develop yours skills in this area as you study S201.

You are expected to be able to write clearly, correctly and logically about important contemporary issues that have an underlying scientific basis, drawing upon both the science itself and the module themes. Activities embedded within the topics and tutor-marked assignment (TMA) questions provide opportunities to develop this important skill, which will be particularly important in the End-of-Module Assessment (EMA).

Thus, in order to assess whether you are ready for S201, you need to consider a number of questions:

- 1 Do you have the necessary knowledge and understanding of science?
- 2 Do you have the necessary skills of numeracy and mathematics?
- 3 Are you willing to study a range of scientific disciplines?
- 4 Are you interested in an interdisciplinary approach to science?
- 5 Do you accept that disciplines outside the natural sciences have legitimate contributions to make to many topics that have an underlying scientific basis?
- 6 Are you prepared to work with others to test and clarify your own understanding of such topics?
- 7 Are you comfortable that S201 puts greater emphasis on written communication skills than many other science modules?

Sections 2–6 provide opportunities for you to test whether your current knowledge and understanding of the individual scientific disciplines and your skills of numeracy and mathematics are at least at the level assumed at the start of S201. The answers are given in Section 8. In addition to deciding which answers are correct, you ought to consider whether the questions and answers include more than just a few technical terms whose meanings elude you.

If you have passed one or more of the modules listed above then you should have little or no difficulty in understanding and answering the questions. If you have a different background in science, these questions should help you judge whether you do have the appropriate skills and understanding.

Some or all the material here may be familiar to you but, in trying to answer the questions, you might discover that you are a little ‘rusty’. If this is the case, then it would be as well to look back over the relevant parts of your previous studies and then try the questions again. However, wherever possible, S201 includes very succinct “primer” material *outlining* aspects of science that are essential for your studies. You should be aware that any time spent revising material in the module primer is not included in the time we estimate it will take you to study the module.

Assuming that you are academically ready to commence S201, Section 7 makes some suggestions about further reading that you might undertake while you wait for the module to begin.

## 2 Biology

Biological concepts are relevant to the study of many of the topics in S201. You should be familiar with the basics of cell structure, cell division, genes, inheritance and molecular biology. It is also advantageous to possess some knowledge of evolution and natural selection and of how organisms are named and classified.

### Question 2.1

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Use the list of words below to fill in the gaps in the following passage.

All living cells are surrounded by a selectively permeable \_\_\_\_\_. Most cells in \_\_\_\_\_ organisms possess an organelle called the \_\_\_\_\_ in which are located the \_\_\_\_\_ that carry most of the genetic information of the organism. These structures consist of a long double-stranded molecule called \_\_\_\_\_ (abbreviated to \_\_\_\_\_) and various \_\_\_\_\_ molecules. In \_\_\_\_\_ organisms (such as bacteria) the circular molecules that carry the genetic information lie naked in the \_\_\_\_\_. Another type of organelle found in organisms other than bacteria, etc. are \_\_\_\_\_ which are responsible for the process of \_\_\_\_\_ whereby energy is released by \_\_\_\_\_ of organic molecules under the control of organic catalysts known as \_\_\_\_\_. Each plant cell is enclosed in a \_\_\_\_\_. Many plant cells possess organelles called \_\_\_\_\_, in which some of the energy in light is captured during the process of \_\_\_\_\_.

cell membrane, cell wall, chloroplasts, chromosomes, cytoplasm, deoxyribonucleic acid, DNA, enzymes, eukaryotic, mitochondria, nucleus, oxidation, photosynthesis, prokaryotic, protein, respiration

### Question 2.2

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Identify and correct the *two* wrong statements among the following.

- (a) Mitosis is the process of cell division that gives rise to gametes.
- (b) Gametes are haploid.
- (c) A homozygote possesses two copies of the same allele of a particular gene.
- (d) Translation is the copying of part of a DNA molecule into a molecule of mRNA.
- (e) Protein molecules are assembled from amino acids at ribosomes in the cytoplasm.

### Question 2.3

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Identify and correct the *two* wrong statements among the following.

- (a) Adenine, cytosine, guanine and thymine (A, C, G and T) are RNA nucleotides.
- (b) The 'central dogma' in biology is 'DNA makes RNA makes protein'.
- (c) The appearance of an organism is one aspect of its phenotype.
- (d) The scientific label of our own species is *Homo sapiens*.
- (e) In classification, the species is a more inclusive group than the genus.

### 3 Chemistry

An understanding of basic chemical concepts is needed for almost all the topics covered in S201. You should therefore be familiar with chemical formulae and equations, oxidation and reduction, pH and be able to work with concentrations of solutions.

#### Question 3.1

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Use the list of words below to fill in the gaps in the following passage.

A chemical \_\_\_\_\_ is a substance that consists of one type of \_\_\_\_\_ that has a unique \_\_\_\_\_ corresponding to the number of \_\_\_\_\_ charged \_\_\_\_\_ in its nucleus. A neutral atom has the same number of \_\_\_\_\_ charged \_\_\_\_\_. Atomic \_\_\_\_\_ also contain varying numbers of uncharged \_\_\_\_\_. Atoms with the same numbers of protons and neutrons belong to the same \_\_\_\_\_ of an element. The total number of protons and neutrons (which together are called \_\_\_\_\_) in an atom gives its \_\_\_\_\_. A \_\_\_\_\_ is created by the \_\_\_\_\_ of one or more electrons from a neutral atom. If an atom should \_\_\_\_\_ one or more electrons it becomes a \_\_\_\_\_.

atom, atomic number, electrons, element, gain, isotope, loss, mass number, negative ion, negatively, nuclei, neutrons, nucleons, positive ion, positively, protons

#### Question 3.2

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Propane ( $\text{C}_3\text{H}_8$ ) burns in oxygen to give carbon dioxide and water. Write a balanced chemical equation for this reaction including symbols for the state of each reactant and product.

#### Question 3.3

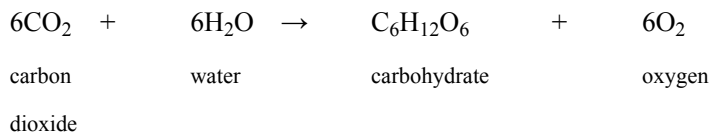
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Barium chloride ( $\text{BaCl}_2$ ) is an ionic compound readily soluble in water. On adding a solution of sodium sulphate ( $\text{Na}_2\text{SO}_4$ ), a white, insoluble precipitate (barium sulphate) is formed. Write a balanced ionic equation for this reaction including symbols for the state of each reactant and product.

#### Question 3.4

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This balanced equation summarises the overall reaction involved in photosynthesis.



Use appropriate words to fill the gaps in the following passage.

The carbon dioxide is \_\_\_\_\_ to carbohydrate by the addition of \_\_\_\_\_ and by the \_\_\_\_\_ of oxygen. At the same time, the water is \_\_\_\_\_ to oxygen by the \_\_\_\_\_ of oxygen and by the loss of \_\_\_\_\_.

### Question 3.5

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Identify and correct the *two* wrong statements among the following.

- (a) A neutral solution has a pH of 7.
- (b) pH is a measure of the concentration of hydrogen ions ( $H^+$ ) in a solution.
- (c) Acidic solutions have a higher pH than solutions that are alkaline.
- (d) A solution can be made less alkaline by the addition of an acid.
- (e) If carbon dioxide ( $CO_2$ ) dissolves in water, the water becomes more alkaline.

## 4 Earth and environmental sciences

Earth and environmental sciences are integral to almost all the topics in S201. You are expected to have a working knowledge of the fundamentals of Earth materials (i.e. rocks and minerals), the rock cycle and plate tectonics.

### Question 4.1

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Identify and correct the *two* wrong statements among the following.

- (a) Rocks are categorised as igneous, sedimentary or metamorphic.
- (b) Igneous rocks have had their minerals altered by high temperature and/or pressure.
- (c) Magma extruded at mid-oceanic ridges forms new oceanic crust.
- (d) The Himalaya resulted from the collision of India with Asia.
- (e) Chemical weathering of minerals is promoted by cold, dry conditions.

### Question 4.2

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Identify and correct the *two* wrong statements among the following.

- (a) The Earth is about 4600 billion years old.
- (b) The more rapidly magma cools, the larger the resulting crystals.
- (c) Lithospheric plates move over the underlying asthenosphere.
- (d) Quartz, feldspar and mica are the principal minerals of granite.
- (e) Peridotite is the main rock type found in the upper mantle.

## 5 Physics

The discipline of physics features mainly in the *Energy* topic.

### Question 5.1

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Use appropriate words to fill the gaps in the following passage.

A moving object always possesses \_\_\_\_\_ energy. This energy depends on both the object's \_\_\_\_\_ and the square of its \_\_\_\_\_. The SI unit of energy is the \_\_\_\_\_.

## Question 5.2

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Identify and correct the *two* wrong statements among the following.

- (a) Monochromatic light consists of photons, all of which have exactly the same energy.
- (b) The energy of a photon of light is proportional to the frequency of the light.
- (c) If an atom undergoes a transition from one energy state to a lower energy state, a photon will be absorbed.
- (d) When an atom is in its ground state, it has its maximum possible energy.
- (e) The atomic spectrum of each element is unique.

## 6 Numeracy and mathematics

S201 does not call for high-level skills in numeracy or mathematics. However, you must be able to:

- carry out straightforward calculations (using a calculator)
- work with powers of ten, scientific notation and significant figures
- work with scientific units
- re-arrange and solve straightforward algebraic equations
- extract information from data presented in tables, graphs and charts
- draw up tables and plot simple graphs and charts.

### Question 6.1

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Express the following quantities in scientific notation to 3 significant figures:

- (a) 1472
- (b) 0.009348
- (c)  $53.45 \times 10^3$
- (d)  $(1.595 \times 10^4 \text{ N}) \times (7.60 \times 10^2 \text{ m})$

### Question 6.2

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Express the answers to the following calculations as powers of ten:

- (a)  $10^2 \text{ m} \times 10^3 \text{ m}$
- (b)  $(10^2 \text{ m})^3$
- (c)  $\frac{10^2 \text{ m}}{10^3 \text{ s}}$

### Question 6.3

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In each of the following, express your answer to an appropriate number of significant figures.

- (a) Given that the circumference of a circle is  $2\pi r$ , calculate the circumference of a circle of radius ( $r$ ) 2.5 m.
- (b) Given that the area of a circle is  $\pi r^2$ , calculate the radius ( $r$ ) of a circle of area  $2.4 \times 10^2 \text{ m}^2$ .
- (c) Given that the volume of a sphere is  $\frac{4}{3}\pi r^3$ , calculate the volume of a sphere of radius 5.2 m.

### Question 6.4

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The concentration of a chemical in solution is  $50 \mu\text{g l}^{-1}$ . Given that a cubic metre is equivalent to 1000 litres, express this concentration in  $\text{mg m}^{-3}$ .

### Question 6.5

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Rearrange the following equation:

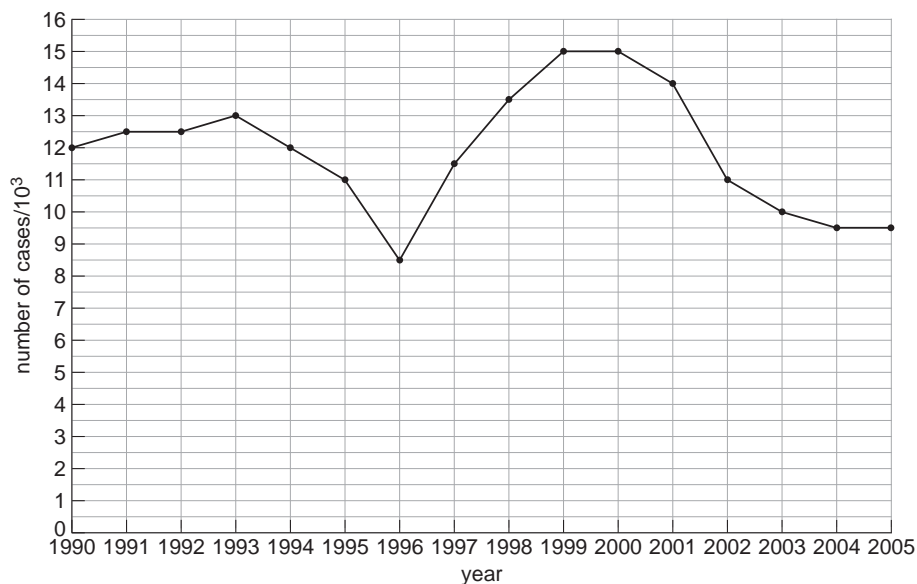
$$h = gk - f$$

to give an equation for  $g$ .

### Question 6.6

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Reading from the following graph:



- (a) How many cases were there in 1993?
- (b) In which year was there the lowest number of cases?
- (c) What was the mean rate of change in the number of cases between 1996 and 2001 inclusive?



## 7 What to do next?

If you had trouble correctly answering many of the questions in Sections 2–6 or were unfamiliar with more than a few of the technical terms used in the questions, then you should probably formally study one of the Open University's Level 1 science modules listed in the introduction before embarking on S201.

If you had difficulty mainly with one or two of the science disciplines, then it may be sufficient to re-read the relevant material from your earlier studies.

If you find yourself well-prepared to study S201 both scientifically and mathematically, then it would be useful to develop the habit of reading popular science periodicals – such as *New Scientist* and *Scientific American* – regularly and also looking to see how science is reported in the more serious newspapers. You will find that many of the scientific topics covered in S201 frequently come up in these publications. There are also many popular books on aspects of science relevant to S201. If there is sufficient time before S201 begins, then you might also consider visiting [openlearn.open.ac.uk](http://openlearn.open.ac.uk) where there are various free online modules covering a number of science subjects.

## 8 Answers to questions

### Question 2.1

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All living cells are surrounded by a selectively permeable cell membrane. Most cells in eukaryotic organisms possess an organelle called the nucleus in which are located the chromosomes that carry most of the genetic information of the organism. These structures consist of a long double-stranded molecule called deoxyribonucleic acid (abbreviated to DNA) and various protein molecules. In prokaryotic organisms (such as bacteria) the circular molecules that carry the genetic information lie naked in the cytoplasm. Another type of organelle found in organisms other than bacteria, etc. are mitochondria which are responsible for the process of respiration whereby energy is released by oxidation of organic molecules under the control of organic catalysts known as enzymes. Each plant cell is enclosed in a cell wall. Many plant cells possess organelles called chloroplasts, in which some of the energy in light is captured during the process of photosynthesis.

### Question 2.2

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The two wrong statements are (a) and (d). Meiosis is the type of cell division that gives rise to gametes. Transcription is the process by which part of a DNA molecule is copied into a molecule of mRNA. Translation is the process whereby polypeptide chains (i.e. amino acid sequences) are synthesised at ribosomes according to information encoded in mRNA molecules.

### Question 2.3

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The two wrong statements are (a) and (e). A, C, G and T are DNA nucleotides; in RNA, T is replaced by U (uracil). Since a genus may include several or many species, the former is a more inclusive group than the latter.

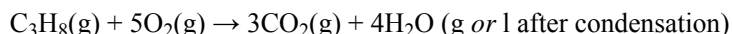
### Question 3.1

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A chemical element is a substance that consists of one type of atom that has a unique atomic number corresponding to the number of positively charged protons in its nucleus. A neutral atom has the same number of negatively charged electrons. Atomic nuclei also contain varying numbers of uncharged neutrons. Atoms with the same numbers of protons and neutrons belong to the same isotope of an element. The total number of protons and neutrons (which together are called nucleons) in an atom gives its mass number. A positive ion is created by the loss of one or more electrons from a neutral atom. If an atom should gain one or more electrons it becomes a negative ion. [Although the last two sentences *could* be exchanged, where the electrons might be gained *from* to create a negative ion is not particularly relevant.]

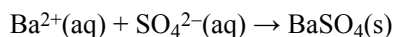
### Question 3.2

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### Question 3.3

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### Question 3.4

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The carbon dioxide is reduced to carbohydrate by the addition of hydrogen and by the loss of oxygen [relative to the number of carbon atoms in the molecules]. At the same time, the water is oxidised to oxygen by the addition of oxygen and by the loss of hydrogen.

### Question 3.5

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The two wrong statements are (c) and (e). The more acidic a solution, the lower its pH (in particular, the pH of acidic solutions is below 7 and that of alkaline solutions is above 7). When  $\text{CO}_2$  dissolves in water, carbonic acid is formed ( $\text{CO}_2 + \text{H}_2\text{O} \rightarrow 2\text{H}^+ + \text{CO}_3^{2-}$ ) which makes the water more acidic.

### Question 4.1

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The two wrong statements are (b) and (e). Metamorphic rocks are those whose minerals have been altered by high temperature and/or pressure. Igneous rocks crystallise from molten magma (relatively rapidly at the Earth's surface in the case of volcanic rocks or relatively slowly at depth in the case of plutonic rocks). Chemical weathering is promoted by warm, moist conditions.

### Question 4.2

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The two wrong statements are (a) and (b). The Earth is about 4600 million (or 4.6 billion) years old. The more slowly magma cools (for instance, at depth), the larger the resulting crystals; rapid cooling (for instance, at the Earth's surface) produces small crystals or even glass.

### Question 5.1

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A moving object always possesses kinetic energy. This energy depends on both the object's mass and the square of its speed. The SI unit of energy is the joule.

### Question 5.2

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The two wrong statements are (c) and (d). A photon is emitted when an atom undergoes a transition from one energy state to a lower energy state. An atom in its ground state has its minimum possible energy.

### Question 6.1

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- (a)  $1.47 \times 10^3$
- (b)  $9.35 \times 10^{-3}$
- (c)  $5.35 \times 10^4$
- (d)  $1.21 \times 10^7 \text{ N m (or J)}$

### Question 6.2

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- (a)  $10^5 \text{ m}^2$
- (b)  $10^6 \text{ m}^3$
- (c)  $10^{-1} \text{ m s}^{-1}$

### Question 6.3

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- (a) 16 m
- (b) 8.7 m
- (c)  $5.9 \times 10^2 \text{ m}^3$

### Question 6.4

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$50 \text{ mg m}^{-3}$ .

### Question 6.5

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$$g = \frac{h + f}{k}$$

### Question 6.6

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- (a)  $1.3 \times 10^4$
- (b) 1996
- (c)  $(+)1.1 \times 10^3 \text{ cases yr}^{-1}$