Introduction

The S283 Multimedia guide provides information about each of the S283 activities and is used to start other packages provided on the S283 DVDs.

On the left-hand side you will see a list of folders corresponding to topics such as ‘The Solar System and internal structure’ and ‘The giant planets’. Click once on a folder and information about it will be displayed in this box (you may need to scroll down to read all the text). The list of activities relating to a particular topic can be seen by opening the folder (by double-clicking on the topic or by clicking once on the ‘**+**’ sign). Information about a particular activity can be viewed by selecting (i.e. clicking once on) the activity title (or icon). To start a DVD-based activity, choose the appropriate topic from the left-hand side, then click the **Start** button. The list of activities will be updated as you install each of the DVDs.

More information can be found in the top menu bar under **Help**.

The Solar System and internal structure

There are three activities associated with this part of the course. You should consult the S283 website:

- for advice on when you should undertake each activity
- to download the notes and comments for each activity.

The three activities involve the use of spreadsheets. If you are unfamiliar with spreadsheets then you should read the relevant sections of *Using your computer* before starting the activities.

The activities are:

- ‘Variation in planetary radii with density’. In this activity you will be introduced to the process of producing a log-linear graph in a spreadsheet package.
- ‘Meteorites and Spidergrams’. In this activity you will use a spreadsheet to compare the geochemistry of terrestrial materials and meteorites.
- ‘Peridotite to basalt alchemy’. In this activity you will use a spreadsheet to compare the geochemistry of terrestrial and extraterrestrial basalts with peridotite, a rock that represents the composition of the Earth’s mantle.

When you click on **Start**, a folder on the DVD-ROM with the spreadsheet for this activity will open. For each activity there are four files in total:

Activity_name.sxc (a spreadsheet of raw data for use in StarOffice)
Activity_name.xls (a spreadsheet of raw data for use in Microsoft Excel)

Activity_name_answer.sxc (a completed spreadsheet for use in StarOffice)
Activity_name_answer.xls (a completed spreadsheet for use in Microsoft Excel)

Before starting these activities you should ensure that you have an appropriate spreadsheet package installed on your computer – see the *Using your computer* guide for more details. You should use the files appropriate to your software.

Variation in planetary radii with density

This activity introduces you to one use of computer spreadsheets for the analysis of scientific data: the production of charts and graphs. You have already used the 'traditional' approach for producing a graph of scientific data in Question 1.1, namely plotting the data on a piece of graph paper. However, it is increasingly rare for scientists to use a pen and paper approach to data analysis, especially with extremely large datasets such as those derived from geochemical analyses or space missions. In this activity, you will reproduce the graph you constructed for Question 1.1 using the same data. The relevant raw data from Appendix A, Tables A1, A2 and A3 have already been entered into a spreadsheet.

If you are already familiar with using spreadsheets you may be able to complete the activity in a shorter time than that suggested in the online study guide on the S283 website.

Study time: 30 minutes

Meteorites and spidergrams

‘Spidergrams’ are a powerful technique for comparing the pattern of element abundances between different samples because they can show all differences and similarities at a glance. This technique is particularly useful in helping to decipher the processes that have led to differentiation within terrestrial planets.

In this activity, you will analyse terrestrial geochemical data from the Earth’s crust and mantle and compare it with the composition of a ‘primitive’ meteorite (i.e. a CI carbonaceous chondrite). This comparison takes the form of an arithmetical calculation that produces a ratio, or quotient, for each element. The process of producing such a ratio for a range of elements in this manner is known as ‘chondrite normalization’ and, when these data are plotted on a suitable graph, the resulting pattern provides a powerful technique of determining the fate of different elements during the evolution of our planet.

Before starting this activity you should:

- have read to the end of Section 2.2.1 of *The Solar System*. In attempting Question 2.2 of Chapter 2 you will already have manually completed a comparable series of exercises.
- ensure that you have an appropriate spreadsheet package installed on your computer - see the *Using your computer* guide for more details.

If you are already familiar with using spreadsheets you may be able to complete the activity in a shorter time than that suggested.

Study time: 90 minutes

Peridotite to basalt alchemy

As you have already seen, 'spidergrams' are a powerful means of comparing the pattern of element abundances between different materials because they can show all differences and similarities at a glance. This technique can also be employed to reveal similarities and differences in the basalt lavas from the Moon and Mars, and is particularly useful in helping decipher the processes that have led to differentiation within these bodies.

In this activity, you will compare geochemical data of basalts from the Earth, Moon and Mars with the composition of Earth's mantle (i.e. peridotite). This comparison takes the form of an arithmetical calculation that produces a ratio, or quotient, for every element of each basalt type. This is similar to the process employed for 'chondrite normalization' in the earlier 'Meteorites and spidergrams' activity, but with the difference that it is the composition of peridotite that will be used to 'normalize' the basalt data. Such data are then said to be 'mantle normalized' and can be plotted on a suitable graph. The resulting pattern provides another useful interpretative technique to the geochemical 'toolkit'.

Before starting this activity you should:

- have read to the end of Section 3.1.4 of *The Solar System*. In attempting Question 3.2 you will already have qualitatively assessed similar data, and manually completed a comparable series of exercises.
- ensure that you have an appropriate spreadsheet package installed on your computer - see the *Using your computer* guide for more details.

If you are already familiar with using spreadsheets you may be able to complete the activity in a shorter time than that suggested.

Study time: 90 minutes

Planetary surface processes

There are three activities associated with this part of the course. You should consult the S283 website:

- for advice on when you should undertake each activity
- to download the notes and comments for each activity.

The activities are:

- ‘The nature of impacts and their impact on nature’. A short (25 minute) video introducing several of the concepts covered in chapter 4.
- ‘The crater calculator’. This activity will familiarize you with some of the parameters that affect crater size.
- ‘The terrestrial cratering rate’. In this activity you will manipulate cratering data to derive a cratering rate for a planetary surface – in this case the Earth.

Additional resources:

- Image Archive resources relevant to this part of the course.

The nature of impacts and their impact on nature

This video programme is concerned with the impact of asteroids and comets with Earth and the effect that such impacts might have had on the Earth's environment. Most of the planets of the Solar System with rocky or icy surfaces show large numbers of impact craters. On earth, the evidence of impacts is harder to find since geological processes such as weathering and erosion soon destroy the surface expression of an impact crater. Because of this lack of direct evidence, geologists have often been reluctant to accept that impacts may have played a role in the geological or biological evolution of the Earth. To date, however, around 170 weathered impact craters have been identified on Earth. This programme examines the evidence for an impact at one of these: the Ries crater in southern Germany. You'll examine this evidence in greater detail as you study Chapter 4 of *The Solar System*.

Study time: 30 minutes

The crater calculator

This activity will familiarize you with some of the parameters that affect crater size. Using a computer programme that compares a variety of crater scaling laws for impactor versus crater sizes you will analyse how density and velocity of the impactor, angle of impact, and density of the target, affect crater size. You will plot the results from these analyses using spreadsheet software.

Note: for this activity we have not provided a spreadsheet of raw data, you have to generate that data yourself using the crater calculator program. The activity notes contain examples of the type of plots that you should aim to obtain.

Study time: 2 hours

The terrestrial cratering rate

In this activity you will become familiar with how to manipulate cratering data to derive a cratering rate for a planetary surface – in this case, the rate at which large craters are formed at the Earth's surface. The activity uses a website that lists actual crater statistics for the Earth: location, sizes, and constraints on age. These ages are never absolute: some have large or small error bars associated with them, and some indicate a 'greater than', or 'less than' age. The difficulty in establishing accurate ages for craters contributes a significant error in using cratered surfaces as chronometers. The site is updated on a regular basis as new data become available. In this activity you use the data contained in this site to demonstrate the basic principles involved in determining the ages of cratered surfaces.

Note: Since the data for this activity are continually updated, the spreadsheet that you will use is provided on the S283 website and not on the DVD-ROM. You should download that spreadsheet and its associated activity notes and comments from the website.

Study time: 90 minutes

Image Archive: volcanoes, dunes and craters on planetary surfaces

In addition to the images reproduced in *The Solar System*, the Image Archive contains many more images obtained by spacecraft of planetary surface processes. You can access these in two ways.

1. By clicking on the **Planets** button, then browsing each planetary body to view images.
2. By clicking on the **Planets** button, then clicking on **Keyword Search** and entering keywords to look for specific features.

Useful keywords for this section of the course include: volcano, volcanoes, volcanic, crater, impact, dune, dust, river, valley, water.

Note: You can abbreviate a keyword, so entering ‘volcan’ will search for all keywords beginning with those letters.

Click on the **Image Archive** button to launch the Image Archive.

Atmospheres of the terrestrial planets

There are no activities associated with this part of the course.

Additional resources:

- Image archive resources relevant to this part of the course.

Image Archive: atmospheres of the terrestrial planets

In addition to the images reproduced in *The Solar System*, the Image Archive contains many more images of the atmospheres of Venus, Earth and Mars. You can access these in two ways.

1. By clicking on the **Planets** button, then browsing each planet to view images.
2. By clicking on the **Planets** button, then clicking on **Keyword Search** and entering keywords to look for specific features.

Useful keywords for this section of the course are: cloud, atmosphere, infrared.

Click on the **Image Archive** button to launch the Image Archive.

The giant planets

There are two activities associated with this part of the course. You should consult the S283 website:

- for advice on when you should undertake each activity
- to download the notes and comments for each activity.

The activities are:

- 'Wind speed on Jupiter'. This activity uses images of clouds on Jupiter to calculate wind velocity.
- 'Interiors of the giant planets'. This activity examines the interior structure of the giant planets.

Additional resources:

- Image Archive resources relevant to this part of the course.

Wind speed on Jupiter

In this exercise you will be calculating a wind velocity at a particular latitude on Jupiter by tracking the movement of a cloud. This is the method by which wind velocities on Jupiter, Saturn, Uranus and Neptune were obtained by Voyager and from later telescope observations. The only direct measurement of wind speed for these planets so far has come from the Galileo probe which sampled the atmosphere of Jupiter.
A NASA movie of Jupiter is provided and you will be asked to determine the position of the cloud initially and after a given time. From your measurements you can obtain the distance travelled by the cloud in the time given and hence the speed of the cloud relative to an observer (you) outside the planet. You will then convert this to a wind velocity as would be experienced by an observer in the planet. We use wind velocity here because you are determining not only the magnitude of the wind but also its direction – denoted by a positive or negative sign. Finally you will be asked to consider the sources of errors in such determinations.
You will find it useful to have read Book 1 Chapter 6 Section 6.3.3 before starting this exercise.

Study time: 1 hour

Interiors of giant planets

This activity is designed to give you some insight into why there is so much uncertainty surrounding the composition of the interiors of the giant planets. You will use a spreadsheet to explore the density of mixtures of rock and gas as a function of pressure. You will then compare your results with the variation of the density of a standard icy materials mixture with pressure.

Study time: 1 hour

Image Archive: the giant planets

In addition to the images reproduced in *The Solar System*, the Image Archive contains many more images of the giant planets and their satellites. You can access these in two ways.

1. By clicking on the **Planets** button, then browsing each planet to view images.
2. By clicking on the **Planets** button, then clicking on **Keyword Search** and entering keywords to look for specific features.

Click on the **Image Archive** button to launch the Image Archive.

Minor bodies of the Solar System

There are two activities associated with this part of the course. You should consult the S283 website:

- for advice on when you should undertake each activity
- to download the notes and comments for each activity.

The activities are:

- 'Kepler's laws'. A computer program that allows to explore orbital parameters.
- 'Tidal heating'. A short (12 minute) video that looks at tidal heating.

Additional resources:

- Image Archive resources relevant to this part of the course.

Kepler's laws

This activity will allow you to familiarize yourself with the parameters of an orbit, and to see Kepler's laws in action. You will be running a computer program where you can define an orbit, and then view a particle moving around that orbit. The program can also define two orbits, and run them simultaneously in order to simulate the effects of orbital resonance.

Study time: 1 hour

Tidal heating

One heat source known to be generated within planetary bodies is tidal heating, which is created by the distortion of shape resulting from mutual gravitational attraction between two planetary bodies. This short video looks at this process in more detail with the aid of animations.

Study time: 12 mins

Image Archive: minor bodies

In addition to the images reproduced in *The Solar System*, the Image Archive contains many more images of the giant planets and their satellites. You can access these in two ways.

1. By clicking on the **Planets** button, then browsing each planet to view images.
2. By clicking on the **Planets** button, then clicking on **Keyword Search** and entering keywords to look for specific features.

Suitable keywords for the section of the course, would be the names of minor bodies, e.g. Gaspra, Ida, Phobos or browse the minor bodies section of the archive.

Click on the **Image Archive** button to launch the Image Archive.

Solar System origins and meteorites

The activities for this section will follow in a later mailing.

Origin of life and the early Earth

The activities for this section will follow in a later mailing.

The living Universe: Mars, Europa and Titan

The activities for this section will follow in a later mailing.

The living Universe: Exoplanets

The activities for this section will follow in a later mailing.

SETI, the Search for Extraterrestrial Intelligence

The activities for this section will follow in a later mailing.

Background science

This section contains educational software programs that may be of use in revising some of the important scientific concepts that are required for S282 *Astronomy* or S283 *Planetary Science and the Search for Life.*

Note that these programs are supplied as an *additional resource*: they are to help provide background information that some students might need before studying specific topics in S282 or S283. Guidance on when it might be appropriate to study these packages will be given on the respective course websites.

Most of these software packages were originally developed for the Level 1 course S103 *Discovering Science*.

Electrons in atoms

In this activity, you will investigate the quantum world of atoms. You will compare and contrast the energy level diagrams, spectra and electron probability clouds of the hydrogen atom, the helium ion He^{+} and the lithium ion Li^{2+}. Your task is to investigate how these properties depend on the atomic number Z of the atom or ion.

Study time: 30 minutes

Nucleons in nuclei

In this activity, you will investigate the quantum world of nuclei. You will look at which nuclei exist, and of those, which are stable, which are unstable, and how the unstable ones decay. The activity includes a database of the properties of all the possible nuclei in the Universe. Learning how to navigate around this database is an important skill that you will develop here.

You will also carry out some simulated experiments involving unstable nuclei, which will enable you to discover the law of radioactive decay.

Study time: 90 minutes

Quarks

In this activity, you will investigate the quantum world of quarks. You will see that reactions involving quarks are of two types, known as strong interactions and weak interactions. Using a ‘virtual particle accelerator’ you will discover the rules underlying such interactions, and then using a ‘quark fruit machine’ you will build hadrons from quarks, again following a few simple quantum rules.

Study time: 30 minutes

Balancing equations

This activity gives you practice at balancing chemical equations. Note: The final set of equations is rather difficult.

Study time: 30 minutes

Surveying the Periodic Table

This activity consists of seven sections. One of them is an introduction in which you will see how the Periodic Table can be broken down into four smaller blocks of elements. In four other sections, you are given the chance to visit each of these blocks in turn, and at each stage, you will find videos, photographs and information. Another section shows you how the blocks fit together to produce a periodicity in the distribution of metals, semi-metals and non-metals that extends over the whole table. Finally, there is a section which derives a widely recommended form of the Periodic Table.

Study time: 1 hour

Chemical periodicity and electron structure

This activity is concerned with the link between the electron configurations of atoms and the Periodic Table. You will see how the correct procedure for writing electron configurations, and the use of electron structure to explain chemical periodicity, can be developed together in a mutually supportive way.

There are five sections. Sections 1 and 2 deal with the labelling of the sub-shells of electrons, and their capacities. In Section 3, you move through the Periodic Table, allocating electrons to the sub-shells of atoms. In Sections 4 and 5, you will write electron configurations for atoms from different parts of the Periodic Table and outer electron configurations for atoms of the typical elements.

Study time: 40 minutes

Chemical equilibrium

This activity introduces you to chemical equilibrium at the molecular level and then asks you to explore how changing reaction conditions lead to changes in the mixture of chemicals present at equilibrium.

There are four sections. In the first, you will observe the behaviour of molecules in chemical equilibrium for a chemical reaction between gases. In the next two sections, you will develop an understanding of how yields of reactions can be changed by adjusting the pressure and temperature. The last section deals with chemical equilibrium for reactions in solution, and you will use your observations to find a relationship between concentrations in an equilibrium mixture.

Study time: 1 hour

Rocks digital kit

This package provides a digital kit of specimens of some of the common rock types referred to in S283. You should look at it in conjunction with the section on rocks and minerals in the *Background science* booklet. Note: You need to have the Adobe Acrobat reader software installed on your machine to run this package.

Click the **Start** button to run this package.

e-books

The course books are provided in electronic form as e-books. These can be viewed using the Adobe Acrobat software that is provided with the course (see the *Using your computer* guide).

The e-books can be used:

- with 'screen reader' software, i.e. software that can read the text aloud
- for searching for a particular word or phrase

The Solar System - Part 1

The Solar System considers the incredible diversity of our own Solar System that has been made accessible by planetary missions.

Part 1 of the book starts by examining the layout of the Solar System before discussing the internal structure and surface processes of the terrestrial planets.

Press the **Start** button to open the e-book.

The Solar System - Part 2

This e-book will follow in a later mailing.