The Open University

Introduction to SM123

This item contains selected online content. It is for use alongside, not as a replacement for the module website, which is the primary study format and contains activities and resources that cannot be replicated in the printed versions.

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Contents

1   Welcome to SM123

Welcome to SM123 *Physics and Space*. This module provides an introduction to the physical sciences – specifically concepts in classical and quantum physics, in astronomy, planetary science and cosmology. The main theme of the module is an exploration of physics on different scales – the physics of everyday scales, the physics of very small scales, and the physics of very large scales. The module also includes some practical experiments – presented either online or via simple experiments that you can carry out at home – as well as an introduction to computer programming using the *Python* language. In addition, SM123 allows you to practise your maths skills, applied to topics in physics and space.

We expect that most students studying this module will already have passed an introductory general science module, such as S111 *Questions in Science*, and will be studying SM123 either soon after or alongside the introductory maths module MST124 *Essential Mathematics I*. This module therefore builds on your existing study skills, maths skills, practical skills and investigative skills.

SM123 follows a similar structure to the broader introductory science module S112, from which it also takes much of its content. It begins with a "space and time machine" to develop your understanding of the different size and time scales at which things function, including those that are either much larger or much smaller than the scales which will be familiar to you. The module then presents concepts and principles in classical and quantum physics and the space sciences using the following nine topics:

1. **Forces around you**: You will explore the types of forces encountered in everyday life, including elastic and frictional forces, electromagnetic and gravitational forces, and you will learn about Newton's laws of motion. There are also a number of simple experiments for you to carry out at home.

2. **An introduction to energy**: You will be introduced to the concept of energy and the idea of energy conservation. You will meet some of the different forms that energy can take, including kinetic energy and potential energy, as well as the concepts of work and power.

3. **Material worlds**: You will examine how the microscopic structure of materials at the level of atoms, ions, and electrons can be used to explain some of the ways in which materials behave, through the concept of chemical bonding.

4. **The quantum realm**: You will be introduced to the world of quantum phenomena, including the uncertainty principle, wave-particle duality and quantum numbers in atoms, leading to an understanding of the periodic table.

5. **Energy in society**: You will explore different fuel sources and look at how energy is used to heat our homes and in transport.

6. **Nuclei and particles**: You will learn about the subatomic components of the world around us, including radioactivity and the fundamental particles of matter, as well as the processes that govern their interactions.

7. **Components of the Universe**: You will explore the galaxies, stars and planets that make up the Universe and understand how astronomers are able to learn about objects that are very distant from Earth, including exoplanets and dark matter.

8. **Exploring the Solar System**: You will discover how the various planets, moons, asteroids and comets comprising our Solar System are explored using remote sensing spacecraft and planetary landers.

9. **How the Universe works**: You will learn about the expansion and cooling of the Universe and discover how it evolved from the big bang to the present day, as well as how it is likely to develop in the future.

Some of the science topics include home-based experiments for you to carry out using everyday equipment. As well as this, interspersed with these science topics are two online practical activities that you will carry out based on data from a weather station and using a radioactive particle detector called a cloud chamber. These experiments also provide you with opportunities for collaborative teamwork

Finally, the module provides you with an introduction to computer coding, using the *Python* programming language. Throughout the module, in a series of dedicated study weeks, you will develop your understanding of coding and apply your newly developed skills to write simple programs to solve physical science problems related to the topics studied.

SM123 is written as an online module to be studied onscreen and we hope that as you study this module you will appreciate the opportunities it offers in terms of multimedia and interactivity. We have enjoyed putting this module together and hope that you enjoy studying it, but before you go any further it is important to check that you really are ready to study SM123.

Activity 1 Am I ready to study SM123?

🕐 *You should allow about 1 hour for this activity.*

Before you start, we would like you to consider carefully whether or not you are prepared to study SM123. There are some essential maths and computing skills that you should be confident in before you study this module. But the most important thing you will probably need to study SM123 is time, so do think carefully about how you will fit the time to study into your life.

If you have note already done so, please take the time to complete the Are you ready to study SM123? Quiz. Then come back and answer one further question (note that this question is for your personal use and reflection only):

Interactive content is not available in this format.

2   Where to start

Working through this introduction will typically take about 7 hours, although this will vary depending on how much of the material is already familiar to you from other OU modules you have taken. If you need to undertake *all* the activities described in this introduction, you may need a few more hours than this; if you do not need to undertake many of them, you may need a few hours less. Doing the activities will prepare you well for your study of SM123 and will also give you a sense of what it will be like to study an online module, if you've not done so before.

Starting a new module or qualification can be both exciting and daunting, but don't worry – you will find plenty of help and support.

Your tutor should be in touch with you by telephone or email so make sure you check your OU email regularly and be prepared for telephone calls from an unknown phone number – it could be your tutor.

2.1   How to study

Although you've most likely studied with the OU already, it's worth reminding you of an important principle about how to study: you will find that you learn much better if you *interact* with the module material rather than simply *read* it. This includes:

- taking notes as you study
- undertaking practical experiments
- doing all of the activities
- engaging in discussion with your tutor and peers
- participating in tutorials.

Your study of SM123 will enable you to develop your independent learning skills. As you progress you will be able to ask questions and determine answers for yourself, based upon the concepts and knowledge you learn.

2.2   StudentHome

Every time you sign in to the OU website using your OUCU and password you should be automatically taken to StudentHome. Your StudentHome page is specifically tailored to your own needs and interests.

Activity 2 Exploring StudentHome

🕐 *You should allow about 15 minutes for this activity*

If you haven't done so already, take this opportunity to explore StudentHome and identify the following areas:

- **Profile** – here you will find your own personal information, such as contact details. Make sure this is all correct.
- **Dashboard** – this provides easy access to key study links and tools for the modules you are currently studying.

- **Study** – this where you find the SM123 module website.
- **Library** – your gateway to a wide range of online resources.
- **OU Community** – news and sites for online communities.
- **Help Centre** – a very useful 'one-stop shop' for general advice you may need for your studies.

You will cover some of the more important areas in StudentHome as you work through the material in this introductory week, including:

- help and support
- study skills
- computing skills
- notetaking techniques
- making notes online.

2.3   The SM123 module website

SM123 is studied online. There are no printed books or DVDs.

The SM123 module website is where you will find all of the online study materials, activities, material for practical experiments, and tutorial and assessment information specific to SM123.

Activity 3 Exploring the SM123 module website

🕐 *You should allow about 15 minutes for this activity.*

Take this opportunity to explore the SM123 module website. Identify and explore the areas listed, adding a tick to the checkbox when you have done so.

> Interactive content is not available in this format.

3   Support while you study

There is a lot of support available to you while you study SM123, via:

- your tutor
- your Student Support Team
- tutorials
- forums
- library services
- computing support.

Do make the most of this support.

3.1   Your tutor

Your tutor will be in contact by phone and email, if they haven't already, to introduce themselves and welcome you to the module. So do watch out for an unknown number calling you, as it may well be your tutor.

You are one of about 20 students allocated to your tutor. You can contact your tutor by email, phone or by posting a message on your tutor group forum. They will:

- support your learning throughout the module
- mark your assignments and provide feedback
- provide tuition at tutorials
- help you achieve your potential in your SM123 studies.

> Your tutor is your first point of contact for any queries directly related to the content of SM123, including assignments and tutorials.

OU tutors are extremely dedicated and want to help you with your studies, so don't hesitate to contact them for help or advice. Do be aware, though, that OU tutors often teach on several modules or at other universities and therefore only spend part of their working week supporting this module. Please have realistic expectations about how quickly your tutor can respond to any queries. Tutors are asked to check their email at least two or three times a week, and to let you know if they will be away from their email for more than three days. Often the response will be much quicker than this, though.

It is very important that you let your tutor know if there are any difficult or unexpected circumstances affecting your studies as soon as possible. They will be able to offer guidance and support to help you keep on track.

> You can contact your tutor at any point during your studies for help with the study materials and for module-specific queries. For more general queries about OU study choices, student loans, etc. contact your Student Support Team.

3.2   Your Student Support Team

Your Student Support Team works with tutors to provide information, administrative support and specialist advice to students on a wide range of issues, including:

- getting started with your studies, e.g. how to prepare and gain confidence
- disability, health problems or learning difficulties affecting your studies
- planning a program of study, such as what module to take next
- studying with English as an additional language
- any query you have regarding deferring or stopping your study of SM123.

Further information about the role of your [Student Support Team](#) is available from the Help Centre.

3.3   Tutorials

Tutorial support on SM123 is offered through online tutorials. There are different types of tutorials designed to support you throughout your study:

- **Tutor group tutorial** in your **online tutor group room** – this is an online introductory tutorial for you, your tutor and other students in your tutor group. You will see this tutorial advertised in the tutorial booking system once you have been allocated to your tutor.
- Other **online tutorials** in your **online tutorial room** –these tutorials are open to students across a cluster of tutor groups. Some will be focussed on particular science topics, others will focus on the practical work or computer programming activities, and there will also be tutorials focussing on preparation for the TMAs and the exam. These tutorials may be delivered by your own tutor, or by another tutor in the cluster of tutor groups to which yours belongs.
- **Module-wide tutorials** – these tutorials are expected to be large in terms of number of students attending. They will be more in the style of a lecture than facilitative, due to the number of students expected to book. They may be delivered by one of the tutors or by a member of the Module team.

You will need to check the booking system for details of these tutorials.

> Online tutorials will typically be 1–1.5 hours long and use an online audio conferencing system. You will need to have access to a computer with a headset (i.e. headphones with integrated microphone) for your tutorials.

Tutorials are a valuable part of our modules and we encourage you to participate in as many as you can; you will find it invaluable to meet up with other students and share experiences and knowledge.

Activity 4 Booking onto tutorials

🕐 *You should allow about 15 minutes for this activity.*

If you haven't already booked in for tutorials then please do so now. You can find the tutorial booking system from your StudentHome page. All tutorials have a written description and purpose and there should be a number of possible options for you to book.

Make a note in your diary or online calendar so that you can plan ahead for tutorials that you have booked.

3.4   Online tutorials

Online tutorials take place in online rooms and allow you to talk 'live' over the internet to your tutor and other students from your module. Tutors can use online tutorials to give live presentations on an electronic whiteboard and explain concepts. You can use the other features – audio, chat, written messages and an on-screen whiteboard – to work together with other students and share software applications.

Activity 5 Getting set up for online tutorials

🕐 *You should allow about 30 minutes for this activity.*

To make the best use of your online tutorials you should acquire a simple, inexpensive headset that incorporates headphones and a microphone, if you don't have one already. These are available at most large supermarkets, any computing store or online for around £10-£15. A webcam is not required.

Before your first visit to an online tutorial you may need to download and install the relevant software onto your computer. This process could take about 15 minutes or longer depending on your internet connection. You will also need to allow time to set up your audio equipment for the tutorial.

> Go to the Tutorials tab on the SM123 website and click into one of the tutorial rooms to find instructions on installing the necessary software, should you need to. This page also contains instructions on how to join online rooms, so familiarise yourself with this process now so that you are ready for your first online tutorial. If you have problems you should contact the OU computing helpdesk (see Section 3.7).

While you can join an online tutorial via a tablet or smartphone, they have only very limited functionality, so you may not be able to participate in several aspects of the tutorial. To ensure you get the most from the tutorial, we recommend you join online tutorials using your laptop or computer with a headset.

3.5   Forums

While studying SM123 you will have access to electronic forums where you can post messages to ask questions or discuss the module or online activities. Forums are rather like a group email system or social networking site; you can send messages to a forum and these can be read by all members of the forum.

There are three types of forum in SM123; they are accessible from the link in the top banner of the module website.

1.   **Tutor group forum**
     - your tutor posts messages here and you can communicate with your tutor and other students in your tutor group
     - this forum is accessible only to your tutor group (about 20 students) and your tutor
     - it opens shortly before module start and you should check the forum at least a couple of times each week.
2.   **Cluster forum**
     - tutors post tutorial information
     - you can ask questions relating to the tutorials
3.   **Module-wide forums**
     - there will be a number of different module-wide forums that you can see, including several topic-specific forums, as well as a forum for the computer programming work and a forum for maths support.
     - tutors and students post messages here for a number of student groups studying SM123
     - you can chat informally with students other than those in your tutor group.

> You may find it useful to subscribe to these forums by selecting the 'Subscribe' button at the end of the page. By subscribing, any forum posts will be sent to your chosen email account, so you can easily keep track of any new messages. However, if the forums are very busy this may overload your personal inbox, so you may prefer just to visit them at least once a week, rather than subscribing.

Please remember that the OU has a responsibility to maintain a friendly, supportive educational online environment where all students feel confident about participating in tutorials and forums. When working in shared online spaces, it is important that you respect and follow the guidance for appropriate conduct and content online in the OU Computing Guide.

3.6   Library services

As an OU student, you have exclusive access to a collection of online information resources via the Library Services website. These include academic books and journals, newspapers, encyclopaedias and dictionaries that will help you with your assignments, along with material to help you develop your general study skills (see below). If you are unsure about where to start looking for information, browse through the list of sources selected for your subject area in the 'Library Resources' section of the module website.

You can access the online library resources 24 hours a day, seven days a week, through your module website or directly through the Library Services website. You will need your Open University Computer Username (OUCU) and password to log in. We recommend that you explore the website as soon as possible to familiarise yourself with what is available.

Improving your skills

If you are new to using online information resources and would like advice about where to start then you may find the 'Getting started' section on the Library website useful.

There is a range of online training sessions available if you would like to make better use of Library resources in your studies. These include a session on how to find information for your assignments.

Getting advice and guidance

The 'Help and Support' section on the Library Services website includes a series of guides about using the online library resources, which provide clear answers to the questions that students most commonly ask.

The Library Services helpdesk is also available seven days a week to help you use their website and to advise you on finding and using information for your studies. Outside office hours, the helpdesk is staffed by librarians in the United States. Full contact details for the Library Helpdesk, including a link to 'chat with a librarian', are available on the home page of the Library Services website.

3.7   Computing support

You will find information about most aspects of using a computer for OU study from the *Computing help* link in the Help Centre. We particularly recommend exploring the sections on *Choosing hardware and software for your studies* and *Computing tips and techniques*.

Your computer may already have many of the general applications you need for SM123 but, if not, the OU Computing Guide explains how to get a variety of software downloads and discounts. For SM123 you may need to download the following:

- a compatible web browser, such as Mozilla Firefox or Google Chrome
- Apache OpenOffice, a free programme that includes a word processor and spreadsheet software
- Adobe Reader, which enables you to read files in PDF format.

If you can't find the answer to an IT problem in the Help Centre on StudentHome, the Computing Helpdesk may be able to help with:

- installing and running module software
- other OU IT services and applications
- usernames or passwords
- access to module websites and other online facilities.

4   Studying SM123

SM123 is delivered entirely online and this may be a new and different way of studying for you. There are a number of skills that you can develop to help and later in this introduction you will learn techniques for reading and making notes online. The Computing requirements section in the module description provides key information regarding studying SM123 online; in addition, there are some key tips for online modules:

Do you have a good enough internet connection?

You will require a reasonably fast internet connection. If you're still using dial-up (with a noisy modem that connects your computer to the phone line to use the internet), you should upgrade to broadband if you can, because a dial-up connection is too slow and will delay your study progress.

Search online for 'internet speed test' to find a website to test your connection, and follow the instructions. Make sure that there's no other activity on the line when you do the test. If the result is less than 1 Mbps you should investigate how you can improve things. For more information on your options see Choosing an ISP.

Two screens are better than one

Consider getting a second monitor or a larger computer screen. It isn't essential, but you'll frequently have both your web browser and your word processor open at once as you take notes on the module material or when you write an assignment. Many modern laptops, and some desktop machines can run a second monitor, and it's worth checking if yours does. You will need to be able to use the *extended desktop display* as the mirrored desktop mode simply shows the same material on both screens. You might be able to use an old monitor from a previous computer, or buy one second hand. Older monitors sometimes need an adapter to connect to your machine, and other technical problems might arise, so do some checking first.

If you have a small screen and can see only one window at a time you'll find yourself constantly switching from one application to another. See the article on Switching between open applications for efficient methods of moving between open applications. This site also gives advice on switching between apps on a tablet or other devices.

4.1   Organising your study time

SM123 is a 30-credit module equivalent to 300 hours of study, or 10 hours of study per week for 30 weeks. To help you pace yourself, each of the nine science topics has been designed to consist of 20 hours study in total, spread over two weeks. The two major practical experiments and the four sessions of computer programming are each scheduled for 10 hours study, or one week. In addition, a week is set-aside for you to prepare your answers to each of the four TMAs.

Your pace of study may be different to that suggested, and different to your fellow students; for example, you may find some areas less or more challenging, or you may have to fit your study around other commitments. However, the 'timetable' set out should provide a well-paced progression through the material. Try not to fall too far behind the advised schedule. If you have any concerns about your study, contact your tutor straight away – **don't wait until it's too late**!

The study planner on the module website will help you to progress through your studies so that you don't miss anything.

An important thing to do when starting a new module is to get organised. If you have done an Open University module before, you will already have some experience with distance learning and are probably aware of the challenges that it sometimes poses. You will also know that to make the most of an Open University module it is necessary to try to keep things under control, plan and manage time well.

Do not worry if you sometimes struggle to get organised. Studying with the OU will help you develop time management and organisational skills, which will not only aid you in your studies, but will be of use in other areas of your life, such as in your workplace or at home. The important thing to remember is that planning your time and getting things in order is worth thinking about – the more control you take of your learning, the more likely you will be to succeed in your studies.

There are some things that you will need to study in addition to your computer and these are listed below:

- pens, pencils, eraser
- ruler
- notebook – this could be a paper notebook or electronic (see Section 6.2)
- file paper, or note paper
- scientific calculator
- digital camera or mobile phone with camera for taking photos
- various items for practicals.

4.2   Planning your study time

The amount of time each week that you will need to devote to your studies will vary slightly from week to week. In most weeks, you need to set aside around **10 hours** for your studies. This figure includes the time needed to complete both the **core (or directed) study** and the **self-directed study** tasks for each week. It is worth noting that the directed study to self-directed study ratio is about 6.5 hours directed and 3.5 hours self-directed in the weeks dedicated to science topics, practical work and programming. In the weeks when you are preparing your TMA answers or preparing for the exam, most of your time will be self-directed.

Core study

The bulk of your study time each week (apart from assessment weeks) – **around 6.5 hours** – will be taken up with online SM123 learning material, including all the activities. This core study includes:

- reading the online content
- completing the online activities
- listening to and/or viewing audio and video material on the website
- undertaking practical experiments
- writing computer programs
- taking notes while you study
- engaging in collaborative activities via the online forums
- time spent in tutorials.

Self-directed study

In addition to your core study you should expect to spend up to **3.5 hours** each week (apart from assessment weeks where it will be more) undertaking self-directed study that includes:

- the time it takes to access the SM123 website (e.g. setting up your computer and going online)
- communicating with your tutor or tutor group, or communicating with other students either via email or on the online discussion forums
- the time it takes to sort out and collate your files and notes at the end of a week's study
- reflecting on your study, such as assessment feedback
- brushing up on any study or maths skills
- any additional activities you may undertake associated with your Open University study of SM123

The aim of the next activity is to give you some tips on how to get organised and keep things under control with some forward planning using the study planner.

Activity 6 Noting key dates

⏱ *You should allow 20 minutes for this activity.*

In planning your studies, it is very important first of all to look ahead and think of the module as a whole. SM123 is spread over approximately 8 months.

In order for you to plan for the weeks ahead, it would be useful to think about events in your life coming up and consider how they might affect your studies. Planning ahead helps you organise your time, enabling you to meet the needs of your studies while simultaneously managing your other commitments.

- Have a look at the online study planner or print a copy (scroll to the end of the study planner and select the printer icon.
- Highlight key TMA cut-off dates.
- Add these key cut-off dates to your personal diary or calendar.
- Make a note of any personal significant events and commitments over the next eight months that may impact on your studies.

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Discussion

Here are some of the things that you might want to consider:

- holidays (do you have holidays planned already and how long will you be away?)
- significant events at work (such as deadlines or business trips)
- family birthdays
- medical appointments (either your own or those of close family members)
- weekends away visiting family or friends
- school holidays and half-term breaks
- computer availability at critical times such as TMA submission (e.g. if you have shared access to a computer).

Try to identify which events have flexible dates. While you can't change some dates, such as birthdays or a hospital appointment, you might be able to shift a visit to friends by a week or postpone a day out if they happen to clash with a key assignment deadline. Alternatively, you can complete your study ahead of schedule to stay on top of the cut-off dates.

4.3   Learning outcomes

The module has been designed to address ten objectives or 'learning outcomes'.

Universities and colleges, including the OU, use learning outcomes (LOs) to guide the development of their teaching materials and to help students get the most out of their learning experience.

LOs are statements of what you are expected to know, understand and be able to do after studying a module. The module LOs are aligned to qualification pathways and to the formal assessment of the module; you will have the opportunity to demonstrate them in the assessment of the module. Clearly stated module LOs allow both you and your tutor to monitor your achievements – your tutor will refer to your achievement of relevant learning outcomes in their feedback on your assignments, which will help you to map your progress as you work through the module. Table 1 summarises the specific module learning outcomes for SM123.

Table 1 Module learning outcomes.

Categories	Description	On successful completion of SM123, you will be able to demonstrate the following module learning outcomes
Knowledge and understanding (KU)	Knowledge and understanding relates to an understanding of the main concepts, theories or principles associated with the subject.	**KU1** Understand key ideas, concepts and principles in classical and quantum physics, astronomy, planetary science and cosmology developed in SM123.
Cognitive skills (CS)	Cognitive skills are mental skills used in the process of acquiring knowledge and understanding and analysing information.	**CS1** Use appropriate searching, graphical, mathematical and presentational methods to gather, analyse and interpret physical science data and information. **CS2** Apply basic mathematics, developed in MST124, to solve problems in physical science. **CS3** Analyse problems in physical science and design logical plans for the development of software solutions to them.

Key skills (KS)	Key skills concern your ability to communicate or use relevant information – essential skills that everyone needs to succeed in education and training and which are also very useful for work and life in general.	**KS1** Apply your understanding of the scientific method, through formulating questions, making observations, devising experiments and acquiring information, to support or refute a hypothesis or argument. **KS2** Communicate physical science ideas, using different types of technology, and using a range of formats including the written word, pictures, diagrams, tables and computer programs.
Practical and/or professional skills (PPS)	Practical and/or professional skills relate to your awareness and ability of practical skills related to science and to management of personal development.	**PPS1** Carry out practical physical science; make and accurately record observations, and use these to draw informed conclusions about the subject of the investigation. **PPS2** Work collaboratively and flexibly with others through sharing knowledge, information and data to solve problems and/or obtain a common outcome. **PPS3** Plan your learning, reflect on your development and use these reflections to inform your future work. **PPS4** Implement software solutions in *Python* to simple problems in physical science

4.4   SM123 Topics and skills

SM123 consists of nine science topics that introduce and develop important concepts in the areas of classical and quantum physics, astronomy, planetary science and cosmology.

However, before embarking on those topics, the first week of study sets the scene by introducing you to the very small and very large length and time scales that are encountered in the realms of quantum physics and cosmology respectively, illustrating the breadth of physical science and the main theme of the module.

The first three topics explore the classical physics of forces and energy, and introduce you to the world of atoms. This is where you will see how physics explains phenomena in the everyday world, including mechanical motion, electricity and magnetism. You will also begin to understand how atoms bind together to form various materials in the world around us.

Moving to the atomic realm and smaller, the middle three topics of the module explore how the behaviour of atoms may be understood in terms of quantum physics and revisit concepts in energy relevant to society. This trio of topics finishes with a look at nuclei and particles and how fundamental interactions govern their behaviour.

The final three science topics move beyond the Earth, beginning with an overview of astronomy and an examination of how astronomers learn about the distant Universe

including phenomena such as exoplanets and dark matter. Focussing first of the exploration of the Solar System and finally on the wide ranging question of how the Universe works on the largest scales, your introduction to the physical sciences finishes with planetary science and cosmology.

Accompanying each science topic are maths resources which will enable you to practice the sort of maths skills you will learn in MST124, as applied to the physics and space topics presented here.

There are two major week-long practical experiments in the module. The first uses remote sensing data from a weather station on the OU campus and weather records from around the UK. You will learn how to make and record scientific measurements and how to interpret the results. The second experiment uses a particle detector known as a cloud chamber which you will view remotely, and make deductions about background radioactivity.

Interspersed with all this are four weeks devoted to introducing computer programming. We will teach you to code using the *Python* programming language, and you will develop your own small computer programs to address specific problems in physical science related to the topics studied here. The programs will be run from within your web browser, there is no other software to install.

5   Assessment in SM123

There are two parts to the assessment in SM123; between them they assess the skills and knowledge that you acquire as you study the module:

- **Tutor-marked assignments** (TMAs): there are five TMAs which are written work that you send to your tutor via the electronic TMA (eTMA) system. The first TMA, i.e. TMA00, is a 'dummy TMA' that carries no marks, but allows you to practise using the eTMA system and starts you off in your ongoing study relationship with your tutor. There is a short but important activity for you to undertake for TMA00. The remaining TMAs are worth 7%, 6%, 13% and 13% respectively of the overall mark for the module (i.e. the first two add up to the same mark as each of the latter two; you may think of them as two halves of a single TMA if you like). Each of TMAs 02, 03 and 04 require you to submit results from several of the Activities that you have completed in the most recent three science topics; TMA01 and TMA03 each contain a task related to one of the major experimental activities; whilst TMA02 and TMA04 contains tasks related to the programming activities. A dedicated week of the Study Calendar is allocated to completing each TMA.

- **Exam**: In addition to the TMA's, which are collectively worth 39%, there is also a final exam worth 61% which you will sit at the end of the module. The questions and tasks in the exam will be based on material that you will already have seen. The ten questions will include one question per Topic (worth 6 marks each), plus one question about Python programming (worth 7 marks). The various pieces of text, data tables, reactions, graphs and images on which the exam is based will be available for you to study in the weeks before the exam itself, so giving you chance to prepare for it. Any equations you need will also be provided in the exam itself; there is no need to memorise any of them. A specimen exam paper and solutions will also be available for you to use as practise.

The TMAs provide an opportunity for you to demonstrate the skills gained in each topic and get feedback on whether you need to spend more time working through certain skills.

The marks you gain from each assessment go towards your final score, so you can see how you are progressing with each assessment you submit.

Table 2 Assessment information.

Assignment	Covering	Percentage
TMA 00	Skills audit	0%
TMA 01	Scales + practical #1	7%
TMA 02	Topics 1, 2 & 3 + programming	6%
TMA 03	Topics 4, 5 & 6 + practical #2	13%
TMA 04	Topics 7, 8 & 9 + programming	13%
Exam	All nine topics + programming	61%

As a level 1 module, SM123 awards two grades of pass: a Pass or a Distinction. In order to pass the module you must achieve 40% of the marks available. Your level 1 grades do not count towards the classification of your degree. However, clearly the higher the grade you get in SM123, the better prepared you have shown yourself to be for your next module at level 2. Students who get over 85% are awarded a distinction in recognition of their achievement.

The OU has a wide range of support on study skills to help you with your assessment, accessible from the Help Centre tab on StudentHome.

5.1   TMAs

You can find a link to each TMA (once it is available) in the 'Assessment' area of the module website. The cut-off date by which you must return each TMA to your tutor is in the study planner and on your StudentHome page. The week immediately prior to each TMA submission date is left free in the study planner (no other compulsory study is scheduled in that assessment week), so that you can focus on completing and submitting your TMA, though we recommend working on relevant TMA questions as you study if possible (as discussed below).

> Note that TMA cut-off dates, i.e. the dates by which you must submit your work, normally fall on a Monday, apart from the last TMA, which falls on the Friday *within* the TMA preparation week. Be sure to plan for this in advance.

Engaging with *all* the TMAs is necessary to demonstrate that you are actively studying the module and achieving the module learning outcomes. Completing all the assignments also helps to reinforce your understanding of the module material and will help you to achieve a better mark for the exam. You will also be encouraged if you complete your TMAs as you will be able to calculate that your overall mark for SM123 is gradually increasing.

5.2   Plagiarism checking

The purpose of assignments is to assess your understanding and this can only be done if you submit your own work and you use your own words. For this reason, the following are deemed *plagiarism* and regarded as cheating:

- getting other people to provide you with TMA answers
- copying from other students
- copying from books, articles or the internet
- copying text directly from the module materials.

It will be important for you to ensure that anyone who reads your work can easily identify your thoughts and ideas on a subject, and can distinguish these from the thoughts and ideas of others. This is known as 'good academic practice' (see Section 6.3). You will develop your own writing skills and learn how to avoid plagiarism and reference your work during your study of SM123.

> You should be aware that the OU uses text-comparison software to detect potential cases of plagiarism in work that is submitted for marking.

6   Skills developed in SM123

As well as gaining knowledge of the sciences through the topics you will also develop a wide range of skills.

Table 3 Skills developed in SM123.

Skills	Description
Study skills	Study skills include: • general computing skills • notetaking skills • good academic practice • digital literacy skills, i.e. using a computer to locate information and for studying online
Programming skills	Computer programming skills are very important for physical science, and practising physicists and astronomers frequently write computer code to solve problems or analyse data.
Maths skills	Maths is an essential component of science and throughout SM123 you have opportunities to practice and apply the sort of maths you have learnt in MST124 to topics in physical science.
Practical skills	In SM123, there are two major practical experiments, plus other smaller experiments which vary from being 'hands-on', for you to do yourself at home, to virtual on-screen experiments. These practical skills are an essential foundation for your development as a scientist.
Personal development planning (PDP) and employability skills	PDP and employability skills include self-management, communicating and collaborating with others (including tutors and fellow students), critical thinking, computing skills, and recognising and reflecting on your strengths, which includes setting achievable goals for self-development.

As you study SM123, your independence and confidence in your ability to study physical science will provide a firm foundation for your future progress towards your qualification, career or personal goals.

6.1   Computing skills

SM123 is delivered entirely online. If you are relatively new to working with computers, you will find useful advice on computing skills in StudentHome. If you have not studied online before, please attempt the next activity.

Activity 7 Improving your computer skills

⏱ *You should allow about 20 minutes for this activity.*

1.   Go to StudentHome Help Centre.
2.   Select *Computing Help* and then *computing tips and techniques* to bring up a really useful set of information to support your computer skills.
3.   Reflect on your existing computer skills, knowledge and experience. Three key computer skills for SM123 are:
     ○   safe and secure computing: it's important to be well informed and careful about computer security. Save your work regularly to guard against loss of your files and take action to keep internet-based intruders at bay
     ○   improving your use of email: most communications from the University to students are by email and they'll often require you to take some action, so it's important that we have your current email address. You can check and update it on the Profile page of StudentHome
     ○   how to organise your computer files: keeping files organised is an essential discipline if you don't want to waste time looking for lost files or having to redo work.
4.   Are these areas that you need to brush up on? Make a note of resources that you may find useful in these or other areas, and either explore them now or come back to them when you need them.

Make the most of the tools on your computer to develop study habits such as:

•   reading your module materials on your computer or mobile device, rather than printing them out.
•   taking notes online as you study.

6.1.1   Computer health and safety

As for any task that means being in one position for some time, it's important to make yourself as comfortable as possible when you use your computer to prevent discomfort and long-term problems. If you have not studied online before, please attempt the next activity.

Activity 8 Safe study at your computer

⏱ *You should allow about 20 minutes for this activity.*

As you will need to study for extended periods at your computer, it is really important for you to assess and make sure that your computer workstation area is safe for your needs. This is particularly important if you share your computer workstation with others in the household or if you have limited space around your computer.

> Before you start studying, ensure you have considered your computer setup and your health and safety.

Study the figure below which shows a safe working environment for computing work. Then sit at your own computer and complete the checklist, clicking on the box for a 'yes'. (Note: there is further information about adjusting your screen settings in the next section.)
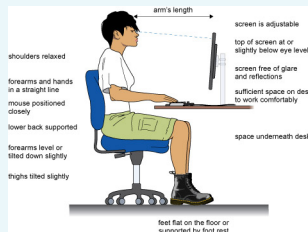

Figure 1   Safe study at your computer.

For a laptop or desktop computer

- Are you in a comfortable position? (There should be enough room for your arms and legs, with your feet flat on the floor or on a footrest).
- Are your forearms roughly horizontal and supported when using the keyboard? (Work with your wrists in a neutral position when typing and keep your hands as relaxed as possible).
- Is your screen at the correct height? (You should look at the screen without bending your neck forward or backward excessively).
- Do you regularly clean your screen?
- Is your screen free from glare from windows or lights?
- Have you ensured your screen settings (e.g. brightness, contrast, size and colour of text) are adjusted to suit your needs?
- Do you have space around you to work comfortably?
- Do you take frequent breaks and vary your work activity by physically changing position and looking away from the computer regularly?
- Do you perform stretch exercises or take a break by going for a walk on an hourly basis to reduce muscle strain and increase circulation?

Additional advice for laptops:

- only use laptops for short periods of time (up to an hour, unless the laptop is set up as a normal workstation with peripherals such as a separate mouse, keyboard or laptop raiser)
- limit the use of the laptop if you do not have a separate mouse, as excessive use of the trackball or glide pad may increase the risk of musculoskeletal injury.

Don't forget that if you share your computer with others then you may need to adjust your computer every time you study to ensure you are comfortable. More information and support is available through the Computing Guide on Protecting yourself.

6.1.2   Techniques for reading online material

There's a lot of online reading to do in SM123 and you need to make the process as comfortable as you can for yourself. If you have not studied online before, please attempt the next activity.

Activity 9 Techniques for reading online material

🕐 *You should allow 20 minutes for this activity.*

Having adjusted your computer set-up to ensure maximum comfort, the next step is to customise your screen settings to improve legibility for reading online. Techniques for reading online material provides valuable resources: explore the materials and make a note of your top three tips for reading online, then take a look at the discussion below.

....

Discussion

Some of the top tips for reading online material may include:

• controlling the type size and font in web browsers, ebooks and PDFs
• adjusting page size
• setting special reader modes in internet browsers
• setting optimal screen brightness: a super-bright screen is not necessarily best as it may affect your sleep.

6.2   Notetaking skills

Taking notes is an important part of an active study strategy. By developing your techniques you can make sure that the time you spend on taking notes is really worthwhile.

If you just read passively while you study, you risk 'glazing over' – your eyes seem to skate over the text without registering what it says. In contrast, material you have thought about and made notes on is much easier to remember.

There is no right or wrong way of taking notes and it is really important that you choose a method of notetaking that works best for you. If you are not used to taking notes as you study, please work through the following activity.

Activity 10 Notetaking techniques

🕐 *You should allow about 30 minutes for this activity.*

We strongly recommend that you work through the Notetaking techniques in the Help Centre of StudentHome. Make a list of the techniques and note next to each item on your list whether it is one you have tried it in the past and found helpful or that you might like to try while studying SM123. Then have a look at the discussion below, which summarises the list of notetaking techniques.

....

Discussion

Useful notetaking techniques for recording and recalling information may include:

• mind maps
• line diagrams
• index or flash cards

- tables
- highlighting or annotating.

You may decide that you want to make your SM123 notes online rather than in a handwritten form. Electronic notes have the advantage of being searchable and can include links to video and other resources. However, the danger of making electronic notes is that it is easy to fall into the habit of copying and pasting chunks of text into another file and calling them notes.

Active reading, with *active* notetaking (i.e. thinking about what you are reading and writing) is critical to understanding and retention. Try to rewrite the text in your own words so you're sure you understand it and are more likely to remember it. If you are not used to making notes online, please work through the following activity.

Activity 11   Making notes online

🕐 *You should allow about 30 minutes for this activity.*

'Making notes online' under the Help Centre of StudentHome tells you about making notes in browsers and PDFs, and describes some of the software that can help you. Included in the 'Making notes in browsers' section is some information on how you can use a variety of current online annotation tools to mark web pages with highlights and comments. Spend about 30 minutes working through the 'Making notes online' article.

6.3   Good academic practice

You will be required to write answers to questions as part of your assessment in SM123. While you won't be required to write lengthy amounts of text you will be required to write answers that are clear to your tutor who will be marking your work.

You will need to develop your academic English language skills in order to:

- understand and make the most effective use of your study of SM123
- develop scientific language
- interpret assignment questions
- write well-structured and coherently presented assignments, without plagiarism
- communicate your needs to your tutor and work collaboratively with other students.

The following are essential key skills for communicating clearly in writing:

- punctuation
- using the right words
- writing concisely.

For more information on these skills see: Punctuation, using the right words and writing concisely.

You will develop and practice your academic English skills as you study SM123. Helpful information including:

- a description of the level of English that is expected of you during your studies
- tips and activities for developing your basic English
- tips and activities to help you express your ideas well

can be found at Developing academic English in the Help Centre of StudentHome.

A key skill in developing good academic practice is avoiding plagiarism. If you have not previously learned about avoiding plagiarism, please work through the following activity.

Activity 12 Avoiding plagiarisim

🕐 *You should allow about 20 minutes for this activity.*

In the Avoiding plagiarism pathway you will learn to recognise what plagiarism is, the forms it can take and how to avoid it by developing your skills. There is a quiz included to test your knowledge.

6.4   Programming skills

The ability to write simple computer programs to solve problems or analyse data is a vital skill for a physical scientist. To introduce you to the fundamentals of computer programming, in SM123 we teach you the basics of a computer programming language called *Python*. This is currently a popular language both for teaching and for professional software development.

The way we teach this will be for you to run simple programs and to modify or create simple programs for yourself, using a window embedded within your web browser. There is no specialist software to install on your computer.

You will learn the fundamentals of coding that may be applied to almost any computer programming language and use your newly developed skills to address tasks that are related to the science topics you study in this module. The last TMA includes tasks which are used to assess your progress in this area.

6.5   Maths skills

As noted already, we expect that you will already have completed a general science level 1 module (such as S111) and will be taking this module either alongside or soon after a maths module, such as MST124. You will already therefore have developed some maths skills that are appropriate for your study of physics and space.

Alongside each of the science topics in this module, we provide some additional exercises and problems to tackle that will allow you to practice your maths skills from MST124 in the content of the science topics in SM123.

Also note that you will need a calculator to study SM123. It is very tempting to use the calculator on your phone, tablet or computer. However, when it comes to sitting the exam

for this module, you will find that you cannot take a phone, tablet or PC into the exam with you. All calculators are slightly different, and you will make far fewer mistakes if you are familiar with the one you are using in your exam.

If you don't already have a separate calculator then it makes sense to buy one now and start using it. You can get the type of calculator you need in any big supermarket or stationers. It should not be a programmable or graphic calculator, just a scientific calculator described as suitable for GCSE/A Level/Higher, etc.

6.6   Practical skills

There are a few practical experiments in SM123; some are 'hands on' experiments that you perform in your kitchen at home and some are virtual experiments that you undertake on the computer.

If you are unable to undertake the experiments, an alternative way is usually provided to allow you to still achieve the same learning outcome associated with the experiment. However, we strongly advise that you do undertake the experiments because one of the key ways of learning is by *doing*. There is nothing quite like performing an experiment for yourself and getting your own results.

> It will be important to consider your health and safety as you undertake the experiments in SM123. You will learn how to assess risks and hazards and to ensure that you minimise any possible dangers.

Keeping a good record of your experimental work, whether online activities, or home-based, is an important skill for scientists, and a well-kept notebook is important for good scientific practice. It is important that experimental work is written up in sufficient detail in a notebook such that another scientist could follow and reproduce the work.

An experimental notebook is a diary of your activities and thought processes as you performed an experiment, from planning through to recording observations, to drawing conclusions, and noting any particular issues that have arisen. Record-keeping will allow you to demonstrate exactly what was done to arrive at the conclusion drawn.

Notebooks

In SM123 we recommend that you use OpenStudio to store your experimental notes. This is an online notebook, which is linked from the various Activities in the module. Pre-prepared 'slots' are available to store the notes from each Activity. If instead you prefer to use a paper version, it should be of good quality, and preferably hardback, but note that you will then need to scan pages from your paper notebook in order to submit evidence concerning Activities as part of your TMA answers.

A well-maintained and properly documented notebook establishes a permanent record of methods and results that can be used in the preparation of reports and scientific papers and is an invaluable source of information. For example:

- professional scientists often use detailed notes to prove claims of discovery where new inventions or patents are concerned, and will use the notes to show that standards such as ethical integrity and good practice have been followed

- for commercial laboratories, detailed notes are essential for client checks and good record-keeping ensures that the integrity of the data will withstand any legal scrutiny

- managers overseeing scientific experimentation or processes may need to audit the work of others.

A full understanding of the relevance and utility of notebooks is therefore also a key employability skill.

In SM123, a well-kept practical notebook will have benefits when you have to produce reports of experiments or investigations. This will be much easier to do if you have a written record of the important information in an easily located place.

It is perfectly acceptable to use a digital camera to make a digital image (jpg/jpeg) for insertion in electronic documents, or to print the images and stick them into a paper notebook – it is worth spending a little time to make sure that you get a good quality image that shows sufficient detail; bright natural light and a device to steady the camera are often helpful.

6.7   Personal development planning (PDP)

Studying at university will allow you to develop study and transferable skills, while gaining experience and confidence and advancing your knowledge and abilities in your chosen subject area. These skills will enhance your employability.
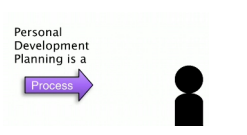
Having studied a previous level 1 science module, you will already have been introduced to Personal Development Planning (PDP), which is a process of recognising and reflecting on your strengths and skills and setting yourself achievable goals for self-development. If you need reminding about PDP, work through the following sections and the activities they contain. If you are already familiar with the PDP concepts and principles, remember to continually monitor your progress and development as you work through SM123.

6.7.1   What is PDP?

If you need reminding about PDP, the following video introduces you to the process and highlights how it can be used to develop different aspects of your life.

Video content is not available in this format.
Video 1 What is Personal Development Planning?

Every time you recognise your achievements to date, identify areas for development and plan how to meet future goals, you are planning your personal development. PDP is something you probably do on an informal basis all the time, without really thinking about it.

Think of something you feel proud of having recently achieved, for example getting a new job, learning to drive or organising an event.

■ What kind of things did you have to do to achieve your goal?

■   •   You probably had to do one or more of the following:
        ◦   find information

- break down the task into smaller pieces and plan what you needed to do
- use your organisation skills to meet your goals, manage your time and work to deadlines
- communicate with others
- cope with responsibilities.

These 'transferable skills' can be used in lots of different situations, including supporting your studies. SM123 will give you the opportunity to develop a range of transferable and study skills, including: numeracy, writing, IT and investigative science skills.

The OU provides guidance and a variety of opportunities to plan your own learning and personal development in a structured way as you progress through your qualification. It is **your** personal development and it is **your** responsibility to engage with this process.

6.7.2 Why is PDP important?

Each one of you will have decided to study SM123 for individual reasons and have different goals. You may be studying for your personal interest, to change career, to further advance in your current career, or perhaps you will decide what your longer term goals are as you study. Whichever of these applies to you, PDP can help you get the most from your time at the OU. PDP will help you to:

- identify and work towards personal goals
- make you more aware of your abilities so that you can articulate and evidence these to others
- increase your confidence
- help you recognise opportunities
- improve your employability by gaining and developing skills and applying these to different situations and roles.

The Confederation of British Industry has worked with the National Union of Students to develop a definition of the employability skills that employers most value.

Table 4 Key employability skills (CBI, 2011)

Self management	readiness to accept responsibility, flexibility, time management, readiness to improve own performance
Teamworking	respecting others, cooperating, negotiations/persuading, contributing to discussions
Business and customer awareness	basic understanding of the key drivers for business success and the need to provide customer satisfaction
Problem solving	analysing facts and circumstances and applying creative thinking to develop appropriate solutions
Communication and literacy	application of literacy, ability to produce clear, structured written work and oral literacy, including listening and questioning

| Application of numeracy | manipulation of numbers, general mathematical awareness and its applications in practical contexts |
| Application of information technology | basic IT skills, including familiarity with word processing, spreadsheets, file management and use of internet search engines |

Many of the employability skills listed above overlap with the SM123 module learning outcomes, which you will have the opportunity to develop throughout your studies and demonstrate in module activities and assignments.

These transferable skills are also important in voluntary work, study, hobbies and your personal life. The information you gather during the PDP process will help you to start identifying your employability skills.

6.7.3   The PDP process

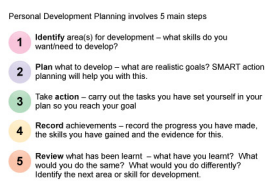The figure below outlines the steps in the PDP process.

Personal Development Planning involves 5 main steps

1 **Identify** area(s) for development – what skills do you want/need to develop?

2 **Plan** what to develop – what are realistic goals? SMART action planning will help you with this.

3 Take **action** – carry out the tasks you have set yourself in your plan so you reach your goal

4 **Record** achievements – record the progress you have made, the skills you have gained and the evidence for this.

5 **Review** what has been learnt – what have you learnt? What would you do the same? What would you do differently? Identify the next area or skill for development.

Figure 2   The five steps to personal development planning (note that SMART action planning is described below).

Step 1 Identifying area(s) for development

If you need to make the first step in the PDP process, you should complete the following short survey that focuses on some skills you will need for your studies. As well as identifying your current skills level, completing this survey will help you identify key skills for you to develop and goals for you to work on. These may form the basis of short- or medium-term goals to help you progress your long-term personal goals. They could be fairly small and specific, such as improving your skills in maths, IT, time management, communication, organisation or notetaking.

Activity 13 PDP skills survey

🕐 *You should allow about 20 minutes for this activity.*

For this activity, you will carry out a short PDP Skills Survey. It is best to be honest, but not to over-think this.

The skills in the left-hand column of the table are ones that you will be developing throughout your studies on SM123. Think about your experience – how confident are you in using these skills?

Keep your survey safe so that you can revisit it later in the module.

Step 2   Action planning

Once areas have been identified for development, the next step is action planning. IF you have note previously done so, carry out the following activity to plan your development.

Activity 14 Your personal development plan

🕐 *You should allow 20 minutes for this activity.*

Save the Personal Development Action Plan to your computer. Fill in the form with two or three goals (or more if you wish) that you would like to achieve in relation to improving your study skills during SM123.

When you fill in your action plan, you will be more likely to achieve your targets if you use an approach called **SMART**.

Table 5   Developing SMART targets.

SMART		Example
S	**Specific** – make the target well defined.	I will improve my timekeeping and organisational skills.
M	**Measurable** – decide how you will know when you've achieved your target.	I will submit my first TMA on time.
A	**Achievable** – can you achieve your target? Do you have the resources in place to achieve your target?	I will print out the study planner to help me achieve this goal so I am aware of the deadlines. I will allocate time each week in my diary for my studies.
R	**Realistic** – how important is the target, and is it really achievable right now, or do you need to break it down into smaller steps first?	I feel this is realistic. To help me ensure it is achievable, I will review how I am getting on each week and allocate more time as required.
T	**Time-limited** – give a deadline for achieving your target.	Deadline – 1st TMA submission date.

Resources are available from the Student Help Centre to help support you achieve your goals with advice on study skills and careers.

Step 3 Take action

Once you have written your action plan, don't just file it away and forget about it. Now it is time to take action and follow your plan. For short-term goals, you may want to look at your plan each week to check you are on track. For medium and longer-term goals, the action plan can be checked less frequently, say once a month.

Check your action plan regularly to add new goals as needed and make changes if required.

Step 4 Recording achievements

An important part of the PDP process is keeping a set of personal records of your achievements. These help you monitor your own progress and also provide you with evidence that demonstrates your skills and experience.

When you attend interviews for jobs or training places, or provide a CV, you will be asked how you have demonstrated the required skills. You can use the evidence you have collated in your personal records to provide practical evidence of your skills, such as your ability to communicate well, solve problems, collaborate with other people or plan and report on a project.

It's worth starting a personal record folder where you can keep evidence of your progress and skills. This allows you to add to, update and find this information quickly and easily. The following records will be useful:

- **PDP:** your regularly updated action plans
- **study/education information:** feedback from your tutor, activities from modules, other education courses, informal learning
- **employment:** work experience, employment history for paid or voluntary work, job descriptions, notes for your CV
- **about you as a person:** skills, experiences, achievements and responsibilities. End of Study Note

You might already have a number of these items, and you will add to them during your studies. The important thing is to know where they are, so you have the evidence to hand when you need it.

Step 5 Reviewing your development

As you progress through SM123, you should go back regularly to your PDP action plan to record your new skills and achievements and check that you are still on track to reach your targets within the time you specified in your plan. The following questions will help you review your development:

- What actions have you taken so far to achieve your targets?
- How well have your actions met your targets?
- How realistic were the targets and do they need to be changed?
- What feedback have you received from other people, and how have you used it?

Remember, targets and goals are not fixed, they should be monitored, reviewed, changed and added to over time as your plans change.

Actively reflecting on your own performance in this way is the first step to becoming an independent, self-motivated learner.

Later in the module we will ask you to reflect briefly on the skills you have gained as a result of your studies, and your progress towards your goals.

If you are interested, Further resources to support PDP are available.

7   Accessibility

We have tried, wherever possible, to make module materials accessible to all students. Some students with visual impairment may need assistance with some of the activities, particularly the investigative activities requiring the collection of data.

General information on accessibility of module websites is available from the Computing Guide.

If you have a disability and require materials in a specific, accessible format that is not provided through the module website, visit the Services for disabled students website (also available via the link on StudentHome), where you can find out what further support and formats are available. You can also contact your tutor or your Student Support Team to discuss your requirements.

> It is your responsibility to ensure that information regarding any additional requirements you may have is known to the University and associated with your student record so your tutor can be aware of your needs.

Further details regarding accessibility issues may be found in the SM123 Accessibility Guide.

8   Contributors

SM123 draws to a large extent on the broader science module S112. The module team responsible for producing S112, particularly module chair Jim Iley, curriculum manger Nick Adams, and physics authors Jim Hague and Calum MacCormick, are therefore gratefully acknowledged for all that they did to make SM123 possible.

Other content of SM123 is based on material that was originally written for earlier science modules (including S103, S104 and S197) and their module teams are also thanked.

Finally, the Python programming material in SM123 was inspired by the "Simple Coding" material written for Open Learn by Michel Wermelinger, and he too is warmly thanked.

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