Module guide

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.

Contents

1 Welcome to S227

Welcome to S227 *Core physics*! The role of physics is to explain the behaviour of the Universe around us – from everyday objects to cosmic phenomena. This module introduces you to the fundamental physics concepts powering modern innovation. You'll explore motion mechanics and heat dynamics, investigate invisible fields and wave behaviour, and venture into the mind-bending realms of quantum physics and relativity. Through solving real-world physics problems, you'll sharpen your analytical thinking and mathematical abilities while developing essential communication skills. These foundations will prepare you to delve deeper into the fascinating universe of physical sciences.

S227 begins with *Maths for physicists*, a comprehensive resource to revise and refresh your mathematical skills. *Maths for physicists* isn't designed to be studied in its entirety, instead it is for you to identify and practise the parts that you need to refresh, and is a reference guide to refer to throughout the module as you need.

The module then presents concepts and principles in classical and modern physics in the following six topics:

- **Forces and motion** First, you'll explore the fundamental physics topic of force and motion, uncovering how objects move and interact. You'll learn to model and predict motion, describe the effects of different forces, and understand mechanical processes from tennis shots to planetary orbits.
- **Particle collisions** Equipped with an understanding of force and motion, you'll next examine what happens when objects collide. Using conservation laws, you'll describe complex mechanical processes and, with an introduction to relativity, understand how these ideas extend to situations involving incredibly high speeds, such as in particle accelerators.
- **Thermal physics** The third topic takes your understanding of a single particle's motion and interactions between a few particles, and looks at the collective behaviour of many particles. Using a theoretical 'ideal' gas as a model, you'll encounter the four laws of thermodynamics and understand their application in familiar devices, from engines to refrigerators and heat pumps.
- **Force fields** You'll next investigate the mysterious concepts of forces and fields. Gravity, electricity and magnetism all act at a distance, moving objects without contact. You'll learn how to visualise these unseen fields and understand how and why they work.
- **Waves and interference** Similar to fields, waves spread out from their point of origin. You'll learn about different wave types, how they interact, and how they can be harnessed and applied in the real world, from musical instruments to ultrasound scanners.
- **Quantum physics** The world around us may at first appear classical and certain, but it's built of microscopic quantum building blocks that are fundamentally unpredictable. In this topic, you'll explore this inherent quantum uncertainty and the blurring between particle and wave objects, particularly the photon, a particle of light, and investigate how it interacts with matter.

S227 is written as an online module to be studied on screen and we hope that as you study this module you will appreciate the multimedia and interactivity it offers. 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 are ready to study S227.

Activity 1 Am I ready to study S227?

Allow about 60 minutes.

Before you start, we would like you to consider carefully whether you are prepared to study S227. There are some essential maths skills you should be confident in before beginning. But the most important thing you will probably need to study S227 is time. Do think carefully about how you will fit the time to study into your life.

If you have not already done so, please take the time to complete the 'Are you ready for S227?' quiz on the Preparation for S227 Core physics website. Then come back and answer one further question below (note that this question is for your personal use and reflection only):

How ready do you feel to start studying S227?

Interactive content is not available in this format.

1.1 Learning outcomes

Core physics is designed to address a set of learning outcomes that specify the areas of knowledge and understanding, and the skills, that are developed through the module as a whole.

Table 1 Knowledge and understanding.

Outcome	Description
KU1	The fundamental concepts, principles, theories, and language used in physics such as, classical and quantum mechanics, waves and interference, force fields, thermodynamics, and statistical physics.

Table 2 Cognitive skills.

Outcome	Description
CS1	The ability to gather, analyse and interpret physical science data and information using appropriate searching, graphical, mathematical and presentational methods.
CS2	The ability to plan and implement strategies, devise and sustain arguments and solve problems in physics.

Table 3 Key skills.

Outcome	Description
KS1	Communicate physical science concepts, using different types of digital technologies, and a range of formats, including the written word, equations, diagrams and tables.
KS2	Identify and summarise key ideas and important physics information from a range of sources.
KS3	Apply mathematical techniques, such as estimation, diagramming, calculus, vectors and algebra, to solve problems in physical science.

Table 4 Practical and/or professional skills.

Outcome	Description
PPS1	Plan your learning, reflect on your development and use these reflections to inform your future work.

Note that the module assessment is explicitly linked to these general learning outcomes, as detailed in each assignment.

1.2 Assumed prior knowledge

This is an Open University (OU) Stage 2 module that builds on study skills and subject knowledge acquired from previous studies at OU Stage 1 (or suitable alternative study).

We recommend you have a working knowledge of basic physics, equivalent to SM123 *Physics and space*. The scientific skills developed in S111 *Questions in science* will also be beneficial to your study in S227.

In S227, you will use mathematics to formalise physical relationships and manipulate these mathematical expressions to deepen your understanding of physics. It's crucial that you can apply and work with a broad range of mathematical techniques as developed in a Stage 1 mathematics course. We strongly recommend you have previously studied MST124 *Essential mathematics 1* (or equivalent) before commencing your study of S227.

Recommended prior study: MST124

We cannot overemphasise the importance of a strong mathematical foundation for success in studying physics at an undergraduate level and beyond.

MST124 *Essential mathematics 1* is recommended prior study for S227 *Core physics* and will equip you with the necessary mathematical skills required to succeed in this module, including:

- algebra and algebraic manipulations
- plotting and interpreting graphs of functions
- coordinate systems and vectors

- calculus, including differentiation and integration.

A comprehensive summary of these techniques is provided in *Maths for physicists* and you can practice these skills in the 'Are you ready for S227?' quiz on the Preparation for S227 Core physics website.

1.3 Employability and personal development planning

A key thing that you will develop by completing S227 is a broad set of employability skills.

Throughout S227 you will develop many different skills, as well as enhancing your physics knowledge and skills. But when it comes to applying for a new job or a promotion (perhaps even during your studies), making a career change when you graduate, or even applying for a Masters or PhD programme, significant emphasis is also often placed on your so-called 'soft' skills.

These are transferable skills that are vital to university study as well as the workplace, almost regardless of what you are studying or the job you are doing. You may be expected to demonstrate where and when you have learned or successfully applied these soft skills:

- on your CV
- by giving examples in application forms or covering letters
- perhaps in interviews.

Recalling examples of such skills can be difficult – even if you've practised them and applied them many times before without thinking about it. Each topic in S227 contains activities to help develop employability skills, and each tutor-marked assignment (TMA) provides an opportunity for you to demonstrate these skills. The employability skills developed in S227 include:

- problem solving
- communication
- numeracy
- digital and information literacy
- taking initiative
- planning.

These skills are also highlighted in the OU Employability Framework, as described in the introduction to the OU's FutureYOU Personal Development Planning (PDP) tool. You may like to link what you are learning in S227 to your PDP record described there.

The employability skills you develop throughout S227 are also linked with the United Nations Educational, Scientific and Cultural Organization's (UNESCO) key competencies for sustainability which will be described in more detail in the next section.

1.4 Sustainability

As you reach this section, you may wonder: why does a physics module include content on environmental sustainability? And what is Education for Sustainability (EfS)? Read on to find out as you will encounter references to sustainability through S227.

Physics and sustainability

It is hard to overstate the impact that physics has on our daily lives. Therefore, it is unsurprising to find that physics is deeply connected to today's sustainability issues as well. For instance, internal combustion engines, a major contributor to greenhouse gas emissions, can be studied using mechanics and thermodynamics, and aircraft designers must understand thrust and gravity. However, physics can also be part of the solution. The Institute of Physics suggests that 'physics can help us solve the challenges facing current and future generations' (IoP, 2024). Hence, your study of S227 will give you the opportunity to engage with physical principles in some depth, but it is up to you to use your knowledge ethically.

Education for Sustainability

For the OU, education is much more than transferring knowledge to pass assessments: the OU's vision is to provide life-changing learning and enrich society. This aligns well with UNESCO's (2024) understanding of EfS, also known as Education for Sustainable Development (ESD), which is a holistic approach to education covering the elements shown in Figure 1. The purpose of EfS is to motivate students to act responsibly to protect the environment and promote just societies. In essence, EfS should equip society, including every S227 student, to deal with the present and upcoming massive environmental problems and their ramifications in an effective, yet human way.

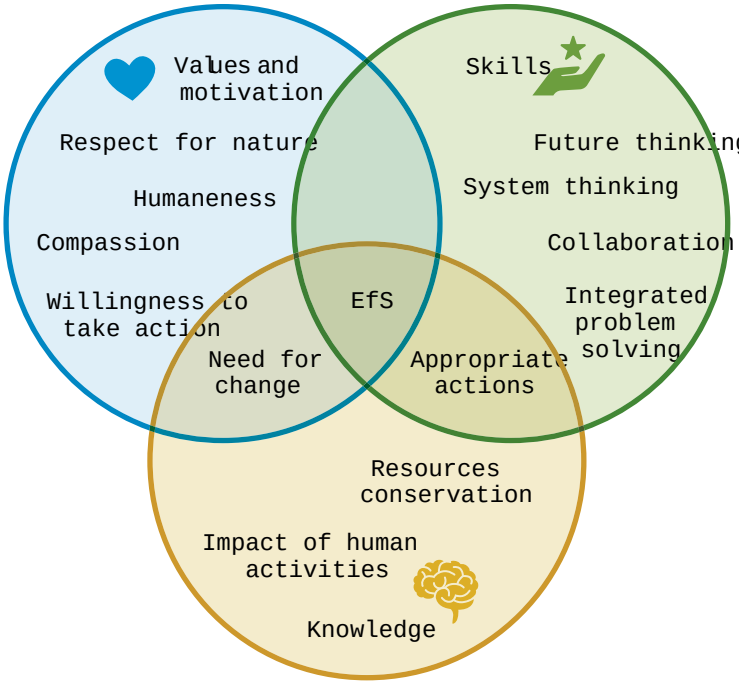

Figure 1 Venn diagram showing some examples of values covered by EfS.

S227 and EfS

As you progress through *Core physics*, you will find boxes highlighting content related to EfS. These will point to connections with the 17 UN sustainable development goals (SDGs) (UN, n.d.) and UNESCO's key sustainability competencies (KSCs) (UNESCO, 2017).

Highlighting sustainability content and competencies

You will find a box like this one near module content that aligns with the 17 UN sustainable development goals (SDGs) and/or KSCs. These boxes can be identified by the sustainable physics icon:

Each box labelled as ‘Sustainability concept’ will give a short explanation of how the highlighted module content aligns with the UNESCO SDGs and/or KSCs.

Below is a list of the UNESCO key sustainability competencies (KSCs) that you may encounter throughout your study of *Core physics* (adapted from UNESCO, 2017):

- **Systems thinking:** the capacity to identify and interpret relationships and to analyse intricate systems.
- **Future thinking:** this refers to the ability to understand and evaluate multiple scenarios for the future – possible, probable and desirable – and to assess the consequences of actions.
- **Normative competency:** for this you should be able to examine and reflect on the norms and principles that guide your own actions especially as related to sustainability.
- **Strategic thinking:** this is the ability to collaboratively design and carry out initiatives that advance sustainability at the local community, national and international levels.
- **Collaboration:** this competency refers to the capability (and willingness) to learn from others, which includes understanding and respecting other people’s needs, perspectives and actions. This should result in joint and inclusive problem solving.
- **Critical thinking:** the ability to question standard practices and views, and to examine your own opinions, perceptions and actions, especially when it comes to sustainability.
- **Self-awareness:** the ability to think about your own place in society – locally and globally – and to reflect on what drives your behaviours.
- **Integrated problem solving:** this competency builds on the others as it is an overall ability to apply different problem-solving frameworks to interdisciplinary sustainability problems and develop workable solutions that are inclusive and fair.

2 Study resources

The following sections explore various aspects of studying S227 in more detail. Please read these for details of studying S227, for information about relevant library services and accessibility.

2.1 Studying S227

S227 *Core physics* is delivered online, through the module website.

The module begins with a single-week *Maths for physicists* topic, which is provided to support the development of your mathematical skills.

The bulk of the module content is structured into six topics, each of three to four weeks duration.

After each of the first five main topics, there is a dedicated week for you to focus on consolidating your learning and attempt the associated tutor-marked assignment (TMA).

The module concludes with an exam that tests understanding of, and links between, all topics.

Table 5 S227 topics.

Topic	Duration	Study calendar weeks
Maths for physicists	1 week	1
Forces and motion	4 weeks	2–5
Particle collisions	4 weeks	7–10
Thermal physics	4 weeks	13–16
Force fields	3 weeks	18–20
Waves and interference	3 weeks	22–24
Quantum physics	4 weeks	26–29

The core information in the module materials is presented as text, with supporting equations, diagrams, tables and images. It is important to realise that the most important aspect of the module is *doing* physics, not just reading about physics. For this reason, each topic incorporates many additional elements designed to support your learning, including:

- **Worked examples**, where a question and its answer are displayed to illustrate a particular technique. Often an example will be followed by a similar question for you to try yourself.
- **Exercises**, which provide opportunities to practise concepts and methods. You will be able to compare your solution with a model answer to check your working.
- **Interactive quizzes** that provide opportunities to practise problem solving with immediate personalised feedback.

- **Videos** are provided to help visualise key concepts and develop problem-solving strategies.
- **Interactive diagrams**, allowing a deep exploration of concepts.
- **Interactive Python notebooks**, which allow a structured and deep exploration of concepts using the Python™ programming language.[1] No previous programming experience is required to use the Python notebooks. These notebooks focus primarily on physical understanding, using the outputs of pre-programmed simulations to explore physical concepts is the primary objective and understanding the Python code is an optional secondary objective.
- **Activities** are longer investigations into a topic that will help you to develop valuable transferable skills alongside your understanding of physics.

Module handbook

The module handbook is available on the Resources tab of the module website. The module handbook contains detailed summaries of each topic, as well as key tables, figures and diagrams. Furthermore, the handbook provides a table of physical constants and other useful reference material.

Note taking

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.

Activity 2 Note-taking techniques

Allow about 30 minutes.

We strongly recommend that you work through the Note-taking techniques in the Help Centre of StudentHome.

As you work through, make a list of the techniques and note whether it is one you have tried in the past and found helpful or that you might like to try while studying S227. Then have a look at the discussion below, which summarises the list of note-taking techniques.

Discussion

Useful note-taking techniques for recording and recalling information may include:

- mind maps
- line diagrams
- index or flash cards
- tables
- annotating

You may decide that you want to make your S227 notes online rather than in a handwritten form. Electronic notes have the advantage of being searchable and can

[1] Python and the Python logos are trademarks or registered trademarks of the Python Software Foundation

include links to videos 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 note taking (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 you're more likely to remember it. If you are not used to making notes online, then please work through the following activity.

Activity 3 Making notes online

Allow about 30 minutes.

Read Making notes online in the Help Centre of StudentHome, which tells you about making notes in browsers and PDFs, and describes some of the software that can help you.

2.2 Library services

The OU Library contains a huge wealth of resources, both in terms of academic works, and skills advice and guidance to help you make the most of your time on the module. Do take time to look at the resources on the Introduction to Library Services website, including the live sessions run by expert staff.

The Library also runs different training and skills events throughout the year, which are available for you to sign up to. More information can be found at the Training and events page of the Library website.

At specific points in S227, you will be directed to Library resources to help develop your employability skills.

2.3 Accessibility

Information regarding accessibility on S227 can be found in the Accessibility guide, which is available on the Resources tab of the module website.

3 Planning your study time

S227 is a 60-credit, Stage 2 module equivalent to 600 hours of study or about 20 hours of study per week. Approximately 12 hours each week are required to study the module materials. The remaining hours are for you to use for your own preparations for study and for consolidating and reflecting on what you have learned.

You may find that your pace of study is different to that suggested and different to your fellow students. For example, some topics may be less or more challenging than others, depending on your previous knowledge. You may also have to fit your study around other commitments. However, the study planner we have set out should provide most students with a well-paced progression through the material. You should try not to fall too far behind the advised planner.

Don’t wait to reach out

If you have any concerns about your study, contact your tutor straight away – don’t wait until it’s too late!

Core study

The bulk of your study time each week (around 12 hours – apart from assessment weeks) will be taken up with working your way through the online S227 materials. This core study includes:

- reading the online content
- completing the associated exercises and activities
- viewing and listening to video material on the website
- taking notes while you study
- engaging in live and/or recorded workshops.

Self-directed study

In addition to your core directed study, you should spend around eight hours each week undertaking self-directed study that includes:

- reflecting on and consolidating your learning of the information and methods studied in the module material
- communicating with students and tutors via the online discussion forums
- collating your files and notes at the end of a week’s study
- reflecting on your study, such as assessment feedback
- brushing up on any maths or study skills that will enhance your engagement with the module materials
- any additional activities you may undertake associated with your study of S227.

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.

When planning your studies, it is very important to first look ahead and think about the module as a whole. S227 is spread over approximately eight months.

The next activity helps you to think about upcoming events in your life 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.

Activity 4 Noting key dates

Allow about 20 minutes.

a. Have a look at the online study planner.
b. Identify the key TMA cut-off dates.
c. Add these key cut-off dates to your personal diary or calendar.
d. Make a note of any personal significant events and commitments over the next eight months that may impact your studies.

Discussion

Here are some things you might want to consider for part (d):

- 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
- 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.

Estimating study time

To help you understand how long exercises and other module activities are likely to take you, we have indicated this as the start of each activity. At the start of Activity 4, you will see there is a note to 'Allow about 20 minutes' for the activity. For the core module content, we have made use of a visual guide – pencil icons – to indicate the estimated time.

We expect 1, 2, and 3 pencils to equate to up roughly 10, 20 and 30 minutes of study time, respectively.

Table 6 Icons indicating study time.

Icon	Study time estimate
	Up to about 10 minutes
	Probably more than 10 minutes and up to about 20 minutes
	Probably more than 20 minutes and up to about 30 minutes

Of course, not everyone studies at the same rate. Some students will take longer than 10 minutes to study a ‘1 pencil’ activity, while others will take less time than this – everyone is different.

In *Forces and motion* Part 1, you will first encounter activities and exercises with pencil-based timings. After completing several activities/exercises you will be prompted to think about how long each unit of study time is for you. This will help you gauge your own study speed, and help plan your study time.

4 Study support

You will receive support from the module team and your assigned tutor in a number of ways.

Your tutor will be your main point of contact and will provide you with academic support. You are strongly encouraged to contact your tutor by email with any queries you might have about the module, and your tutor may follow up with a phone call. Your tutor will also mark your assignments.

In addition to providing you with individual support, your tutor will lead an online tutor-group forum. You will also have access to module-wide tutorials and module-wide forums. These are described in Section 5 of this guide.

The rationale for using online tuition is to provide as much opportunity as possible for students to interact directly with, and benefit from, experienced academic support. It is also analogous to the way in which professional scientists often work in large international collaborations, which rely heavily on electronic communication rather than face-to-face discussion. Therefore, the skills that you develop through online tuition are those needed to practise science in the modern world.

Forums are available at any time and are known as asynchronous communication. Online sessions occur at specific times and will not be recorded. You will receive notification of the times of the online tuition sessions at the start of the module.

4.1 IT support

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

Your computer may already have many of the general applications you need for S227 but, if not, the OU Computing Guide explains how to get a variety of software downloads and discounts. For S227 you may need to download the following:

- a compatible web browser, such as Mozilla Firefox or Google Chrome
- Microsoft 365 that includes Word for word processing, the spreadsheet Excel, cloud file storage and a lot more – look for the Microsoft 365 link on StudentHome for free access to this software.
- Adobe Reader, which enables you to read files in PDF format.

Python

For some activities in the module, you will need to be able to run the Python scripts that are provided. No previous experience with Python, or programming in general, is required to fully engage with these activities. You will be given access to a virtual computing environment through the OpenComputing Laboratory (OCL), so no Python installation is required.

However, if you still wish to run Python locally we recommend that you install the Anaconda™ distribution. The site is well documented and there are clear instructions. A detailed guide to installing Python using the Anaconda distribution can be found on the Programming for Physical Sciences website, under ‘Installing the Anaconda distribution’.

The OCL is recommended for Python activities

Note that the S227 Python activities are designed to be opened and run in the web-based application Jupyter Notebook, which you will access through the OU's bespoke OCL. Jupyter Notebook allows you to access and run interactive files called notebooks directly through your web browser and therefore avoids the need to install any additional software on your personal computer. These notebooks contain the Python code. This is particularly beneficial for those new to Python.

Anaconda is a free third-party platform that facilitates running the Jupyter Notebook software on a personal computer. However, this process could be challenging for students unfamiliar with Python, particularly since different operating systems (e.g., Windows, Mac) and versions of Anaconda created inconsistencies. The OCL removes these barriers, offering a uniform experience. While the notebooks in this module are compatible with Anaconda, and you can download and run them independently if you prefer, please note that the module team will not provide IT support for issues arising from this approach. If you are new to Python, we strongly recommend using the OCL for a smoother experience.

It is a good idea to prepare the applications early on, so any issues with the installation can be resolved with time to spare.

Computing helpdesk

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.

4.2 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, for example how to prepare and gain confidence
- disability, health problems or learning difficulties affecting your studies
- planning a programme 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 S227, or seeking a discretionary postponement of your exam.

Further information about the role of your Student Support Team is available from the Help Centre.

5 Tuition

The following sections explore various aspects of tuition available to you while studying S227. Please read these for details of your tutor, tutorials, forums, and assessment.

5.1 Your tutor

You have a tutor who will help and support you as you work through S227.

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 S227 studies.

Your tutor is your first point of contact for any queries directly related to S227 content, 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, though often the response will be much quicker than this.

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 contact your Student Support Team.

5.2 Tutorials and workshops

Tuition support on S227 is offered through online workshops. There are different types of workshops 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.
- **Module-wide workshops** in your **online tutorial room** – these tutorials are open to students across the module. Some will be focused on particular physics topics, others will focus on problem-solving, and there will also be tutorials focusing on exam preparation. These tutorials may be delivered by one of the tutors or by a member of the module team.

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

IT requirements for tutorials

Online tutorials will typically be one hour 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.

Relaxed workshops

Some repeats of workshops are labelled as **relaxed** versions. In a relaxed workshop, there is less expectation to engage with your peers and you will be able to leave your microphone off. The content covered in a relaxed workshop will be the same as in any repeat of the workshop.

Activity 5 Booking onto workshops

Allow about 15 minutes.

If you haven't already booked in for workshops then please do so now. You can find the tutorial booking system from your StudentHome page. All workshops 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 booked workshops.

5.3 Forums

When studying S227 you will have access to online forums where you can post messages to ask questions or discuss the module and its activities.

There are two types of forums in S227 and they are accessible from the link in the top banner of the module website.

a. **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 you, 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

b. **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 maths support

- tutors and students post messages here for a number of student groups studying S227
- you can chat informally with students other than those in your tutor group.

Subscribing to forums and posts

You may find it useful to subscribe to these forums by selecting the ‘Subscribe’ button at the top 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.

You can also subscribe to specific posts in a forum, rather than subscribing to the forum.

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.

6 Assessment

The following sections detail how you will be assessed on the knowledge and skills you will develop in studying S227.

Assessment is one of the most important aspects of a module. This guide gives a general overview of the module assessment but specific detailed information about individual assessments is found in the respective assessment documents, which can be accessed from within the study planner or from the Assessment section of the module website.

To ensure you fully understand the requirements for each assessment, regularly refer to this guide and to the information provided in individual assessment documents.

6.1 Assessment strategy

The assessment of S227 is structured to give you regular practice in key skills, such as problem solving, which you will develop through your study of S227. These skills are assessed in the context of the new knowledge you will develop in the topic block preceding each tutor-marked assignment (TMA). At the end of the module, you will be able to demonstrate your skills in an exam that will draw from content across S227.

Tutor-marked assignments (TMAs)

You will have five TMAs throughout S227. A TMA will follow each of the first five topics. Each TMA assesses problem-solving and other skills you will develop during the module. The questions within each TMA are set in the context of the preceding topic.

In the study planner, a whole week after each topic is dedicated solely for consolidation of your learning and preparation for the TMA. Each TMA is designed such that you should be able to complete it in the dedicated week. However, it may be helpful to read through the TMA earlier. You will be able to attempt at least one problem-solving question in each TMA after studying Part 1 of the associated topic, so you may want to start working on the TMA from that point. Then, you can attempt questions when you are ready as you go along.

You can take as long as you need to complete each assessment, but you must submit them by 12 noon (UK time) on the cut-off date for that assignment. For further details about submitting TMAs, please see the When to submit page on the Help Centre.

If you can't submit a TMA by the cut-off date due to circumstances beyond your control, you can ask your tutor for extra time but you should agree an extension with them before the cut-off date. In exceptional cases a retrospective extension can be granted, but this would depend on the circumstances (for example, something beyond your control that prevented you from completing the TMA and getting in touch with your tutor).

Each TMA is worth 10% of your module score. So the five TMAs combined are worth 50% of your module score. Attempting and submitting all TMAs and engaging with the feedback you will receive for each TMA is important preparation for the end-of-module exam and to help prepare you for your future studies.

Your tutors will aim to give you feedback on your TMA submission within ten working days of the cut-off date. Reviewing your feedback and reflecting on it will help you become a more effective learner.

End-of-module exam

The end-of-module exam is delivered as a remote exam, which you take at home or in another location of your choice, using your own equipment and computer software. You do not need to attend an exam centre.

The exam is designed to be completed in three hours. You will find more information explaining the timing on the Assessment tab.

The exam will be 'open book', meaning you can use your module materials to help answer the questions. We recommend making use of the Module Handbook in the exam. Attempting to make use of other, more robust module materials in the exam may result in time pressures and difficulties in completing the exam.

It is not possible to include all content from a 60-credit module, such as S227, in a single three-hour exam, and challenging for you to revise all of the module content in preparation for the exam. The exam is divided into two parts:

- Part A, which contains 40 marks of short questions on content from any topic of S227
- Part B, which contains 60 marks of longer, in-depth questions from *four out of six* S227 topics.

Content of long exam questions

The S227 Topics that will be included in the long-form, Part B, exam questions will be announced approximately 1 week prior to the start of the revision period (Weeks 30 and 31), and will be announced via the module forums, email, and communicated through tutors and exam revision/preparation events. You will need to become familiar with all of the module content as you work through it and for completing your TMAs. For the exam, you should have a basic understanding of all Topics, but you should ensure you revise to a deeper level the four topics that will be the focus of the Part B questions. Part B will always include a question based on the *Quantum physics* topic.

If you have an additional requirement based on a disability or illness, you may be able to request reasonable adjustments – such as extra time or rest breaks – to complete your remote exam. You need to submit a request for reasonable adjustments using a form along with supporting evidence as soon as you can, and there are set deadlines by which your form and evidence must be submitted. You should discuss the arrangements you need with your Student Support Team.

The end-of-module exam is worth 50% of your module score. To pass the module, you must achieve a minimum score of 30% in the end-of-module exam and a minimum score of 40% averaged over all module assessments.

Table 7 outlines key information about S227 assessments.

Table 7 Assessment timeline.

Assessment	Dedicated study week	Weighting	Relevant topics
TMA 01	6	10%	Forces and motion

TMA 02	12	10%	Particle collisions
TMA 03	17	10%	Thermal physics
TMA 04	21	10%	Force fields
TMA 05	25	10%	Waves and interference
End-of-module exam	32	50%	All

6.2 Learning outcomes and assessment

Each assessment will allow you to demonstrate that you have met the learning outcomes of the module.

Table 8 indicates which learning outcomes (from Section 1.1) are evaluated in each assessment.

Table 8 Assessments and their relation to learning outcomes. A tick indicates that a learning outcome is covered.

Learning outcome	TMA 01	TMA 02	TMA 03	TMA 04	TMA 05	Exam
KU1	✓	✓	✓	✓	✓	✓
CS1	✓	✓	✓	✓	✓	
CS2	✓	✓	✓	✓	✓	✓
KS1	✓	✓	✓	✓	✓	✓
KS2	✓	✓	✓	✓	✓	
KS3	✓	✓	✓	✓	✓	✓
PPS1	✓	✓	✓	✓	✓	

6.3 Your tutor’s role in assessment

Your tutor’s evaluation and grading of assignments, and their written comments on your work are a very important resource for you. It is strongly recommended that you retain your tutor’s comments for reference throughout the module – they will be useful for your subsequent work.

Your tutor will make detailed comments on your work, respond to your ideas, identify particular strengths and make suggestions for areas in which you can improve. Their

comments will provide guidance on how to become proficient at setting out your ideas and arguments in writing and mathematics – an important skill in university study. If you feel you need further clarification or explanation of these comments, or of your grades for an assignment, you should contact your tutor as soon as possible after receiving the marked assignment. If you feel there are grounds for appealing your grade, there is an appeals procedure, details of which can be found in the Assessment Policies.

Feedback on your assignments

If you submit your assignment by the deadline, you can normally expect to receive it back within ten working days after the cut-off date. If you have not received it back after 15 working days, contact your tutor.

6.4 Planning and writing your assessments

The following section contains advice and good practice to follow when completing your S227 assessments.

Writing your assessment

The majority of your assessment will involve problem solving and you will need to lay out your arguments and solutions using words, mathematics and scientific notation. Your solutions can be either handwritten (written physically on paper then digitally scanned, or written digitally using a tablet) or typed (using software such as Microsoft Word or LaTeX).

We strongly recommend you handwrite mathematical content where possible. Typeset mathematics may look nicer, but is time consuming (especially in the timed end-of-module exam). You will be graded on the clarity of your arguments, not on how pretty they look.

Good academic practice

Good academic practice is about making sure 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.

Developing good academic practice includes:

- writing in your own words
- referencing accurately
- avoiding plagiarism
- avoiding collusion (copying or sharing work with other students, even with their agreement).

In addition to demonstrating your knowledge of the module materials, part of the assessment strategy involves evaluating your development in these broader academic skills.

To help you build good academic practice and communicate your ideas clearly through mathematical arguments, part of your TMA feedback will include a ‘maths communication’ grid highlighting aspects of good practice and areas for improvement across the TMA as a whole. For more information, please see the Good mathematical communication guide.

For additional resources and support, see The Open University's free OpenLearn course Developing good academic practice.

Academic integrity

Academic integrity is about demonstrating that your work is your own, even where it draws on the ideas of others. To do this, you must avoid *plagiarism* and *collusion*, and you should use *referencing* to show your sources.

Plagiarism and collusion

- *'Plagiarism'* is using someone else's work (including text generated by AI) without appropriate attribution.
- *'Collusion'* is sharing or copying work from other students, even with consent, and presenting it as your own.
- The University checks assignments with anti-plagiarism software such as Turnitin, which compares your submission to a wide database of sources.

Referencing

Occasionally in S227, you may be asked to find and review external sources of information. Referencing shows where you found the ideas, research findings or direct quotations you have used in your work. It also indicates how well you have engaged with the module materials and any relevant external sources.

- The *Cite Them Right* version of Harvard referencing is commonly used across the OU. The Library's provides a Quick guide to Harvard referencing (Cite Them Right) and detailed examples on the Referencing and plagiarism pages.

Generative AI and assessment

- If you use generative AI (e.g. ChatGPT, Bing Chat) to brainstorm or draft ideas, you *must* reference the generative AI tool you have used.
- It's best practice to include an *appendix* with your assignment that contains your prompts entered into generative AI tool, the date used, and a brief explanation of how you used or adapted the AI output.
- *Never* share OU materials or assessment questions within AI tools for this module.
- Read the OU guidance on Generative AI for students

S227 TMAs are in Generative AI Category 2

You *may* use Generative AI to assist you in completing S227 TMAs.

Even when allowed to use Generative AI, you should avoid relying too much on it, as this will prevent you from developing the higher-level skills (concise and clear oral and written communication, critical thinking, problem-solving, creativity, etc.) needed for studying subsequent modules, for employment and for making a new contribution to your field (if you are a PhD student). Also remember that if a module permits you to use Generative AI, this does not mean you are required to use it.

The S227 end-of-module exam is in Generative AI Category 1

You *cannot* use Generative AI to complete the S227 exam.

For assessments in this category, you must not make any use of Generative AI. This category typically applies when the use of AI tools would prevent you from acquiring, practising and demonstrating basic knowledge and skills (including the application of concepts, developing arguments and following procedures) needed for your study and employment. Using Generative AI for this category is subject to academic conduct procedures.

Practicalities

- Keep track of sources as you write; note full URLs or page numbers and access dates.
- Ensure every in-text citation has a corresponding entry in your References list, in alphabetical order by author name.
- If your assignment requires a separate bibliography or additional documentation, follow the instructions carefully.

6.5 Submitting your assessments

You will submit your TMAs and the end-of-module exam through the eTMA system.

Your submission should be a PDF file (.pdf) or Microsoft Word file (.doc, .docx, .rtf) regardless of what software or other means you have used to prepare the submission. A PDF file is the preferred submission format as many tutors mark with tablet computers. Note that image files of scanned handwritten submissions can be embedded in a Microsoft Word file for submission.

6.6 Assessment policies

The relevant institutional assessment policies can be found in the OU Assessment policies and regulations list.

6.7 Additional support

For additional support with, or advice on S227 assessment, please contact your tutor or the Student Support Team.

Your tutor can answer your queries to clarify what a question is asking for. They will be leading a tutor group tutorial after TMA 01 that will include general feedback to the group. Tutors will be running exam preparation workshops (discussing things like resources available, how the exam will be run, advice for completing the exam etc) and revision workshops (using exam-style questions that revise physics concepts and approaches to problem solving.

If you think you'll have difficulty completing any part of the TMAs for reasons related to your disability or other study support need, you should let your tutor know as soon as possible. You must tell them before the assessment submission date. Reasonable

adjustments can be made but the earlier you request them the better. Please see the S227 Accessibility guide for more information.

7 Next steps

You have almost completed the first part of S227 and are nearly ready to begin your studies!

Before getting in to the main module content, we suggest you complete the following tasks to help prepare.

Book onto tutorials

If you have not already done so, please do book in for tutorials. You can find the tutorial booking system from your StudentHome page.

Begin Topic 0 Maths for physicists

Week 1 of the module is dedicated to revising and refreshing maths skills you have developed in previous Stage 1 study. The maths skills you will need to apply in your study of S227 has been compiled into *Maths for physicists*.

Maths for physicists is a comprehensive resource with lots of exercises and is designed to allow you to identify and focus on the parts you need to revise. *Maths for physicists* is not designed to be studied from start to end. When studying *Maths for physicists*, remember that you are familiar with a lot of the content. If you feel that you have a good understanding of a section, quickly move on to the next section and spend your time on the sections that you are not as confident with. Remember also that *Maths for physicists* is a resource that you can return to at any point in the module as required. It is there to support your learning throughout your study of *Core physics*.

8 Contributors

We thank all colleagues for their contributions to the production and presentation of S227. Contributions are listed in Tables 9 and 10.

Table 9 S227 module team (presentation).

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Deputy chair	Sam Eden
Curriculum manager	Eddine Benalla
Curriculum assistant	Shelah Surgey
Members	Martin Braun
	Ben Dryer
	Andrew James
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Table 10 S227 module team (production).

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