ASTR 104.3
Astronomy of Planets

Class Syllabus

UNIVERSITY OF SASKATCHEWAN

Term: Fall 2016
Course Sections: W01-W99
Delivery: Online
Start Date: September 6, 2016
End Date: December 8, 2016

Your Instructor

Dr. Daryl Janzen
Department of Physics and Engineering Physics

Contact Information
Phone: 306-966-6411
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Contact Hours
Tuesdays from 2pm-4pm in the online Collaborate room. Appointments outside of this time can be arranged by email. See Blackboard for details on accessing the online Collaborate room.

Click on the links to start reading the Class Syllabus.

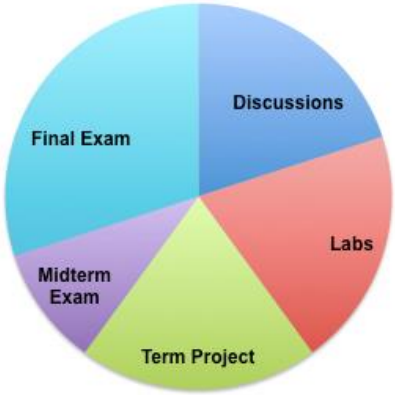
Class Syllabus Table of Contents

Class Schedule

Course Description

Students will explore physical properties and orbital behavior of planets, moons, asteroids and comets as revealed by telescopic observations and spacecraft missions. They will learn how the scientific method changed our understanding of orbital motions within the solar system. Recent astronomical techniques for studying exoplanets orbiting other star systems will be investigated. Techniques for operating telescopes and analyzing astronomical data will be examined with online access to computer-simulated laboratories.

Prerequisite(s): Foundations of Mathematics 20 or Pre-Calculus 20
Note: Students can take this course to fulfill 3 of the 18 credit units required for the Astronomy Minor offered by the College of Arts and Science in conjunction with the Department of Physics and Engineering Physics.



Grading Scheme

4 Discussions (5% each)	20%
4 Labs (5% each)	20%
Term Project	20%
Midterm Exam	10%
Final Exam	30%

Required Resources

Textbook

- Kay, Laura, Palen, Stacy and Blumenthal, George, *21st Century Astronomy: The Solar System*, 5th ed. W. W. Norton and Company (2016)

Other Required Materials

- *Galileoscope*, a 2-inch (50-mm) Refractor Telescope Kit
- Standard camera tripod

More details…

Please Note: This *Class Syllabus* is an important step in updating the format of our distance classes. If for any reason the *Class Syllabus* does not match the print *Course Guide* or online class information, the *Class Syllabus* shall be taken as correct.

Course Learning Outcomes

Upon completion of this course, students should be able to:

- Examine Solar System objects using a telescope
- Develop a research project, and share findings with peers
- Produce an informative web-based report showcasing collaborative research
- Identify how today's theory of the Solar System has been constrained by studying planets and applying the scientific method
- Explain how the study of objects in our Solar System, and the search for an explanation of Solar System phenomena, has transformed our cosmological perspective
- Apply knowledge gained through the study of our Solar System to follow the search for life-sustaining planets elsewhere

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Course Overview

The overall aim of this course is to gain detailed knowledge and a thorough understanding of the planets in our Solar System—from their orbital motion, to the physical properties that we've discovered mainly this past century, to the current picture we have of the origin of the Solar System. The first half of the course will concentrate on theoretical and observational foundations. After an introduction to some basic concepts and astronomical terminology you will explore the nature of science and the development of the scientific method through the earliest descriptions of celestial motions. You will examine how continued efforts to better describe and explain those motions revolutionised our understanding of Earth and its place in the Universe. You will then learn about telescopes and how these scientific instruments are used to collect a range of information from astronomical objects, and how that information is used to understand the nature of what astronomers observe. The second half of the course is a detailed study of all the planets, comets and asteroids in our Solar System, through which you will come to a picture of the origin of our Solar System and how we believe other star systems are formed. Finally, you will conclude with a discussion of the search for planets beyond our Solar System.

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Your Instructor

Dr. Daryl Janzen

Profile

I have been studying astronomy since 2000, when I enrolled as a student at the University of Saskatchewan. Out of interest, I took an astronomy course and was immediately captivated by the things that I learned. In 2012, I earned my PhD in cosmology, which is the science that studies the origin and evolution of the Universe. I have been doing research and teaching since then. In the Department of Physics and Engineering Physics at the U of S, I have taught classes

ranging from an introductory course in galaxies and cosmology, to first-year physics, to senior/graduate level general relativity and cosmology.

I think the mark of a good student lies in an ability to not just absorb, but to question and critically assess information that you encounter. This, combined with a reasonable amount of hard work and dedication to completing assignments and learning the course material, should earn you a good grade in this course.

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Required Resources

Textbook

- Kay, Laura, Palen, Stacy and Blumenthal, George, *21st Century Astronomy: The Solar System*, 5th ed. W. W. Norton and Company (2016). ISBN: 978-0-393-60335-4

Textbooks are available from the University of Saskatchewan Bookstore: www.usask.ca/consumer_services/bookstore/textbooks

Other Required Materials

- *Galileoscope*, a 2-inch (50-mm) Refractor Telescope Kit

The Galileoscope is also available at the U of S Bookstore or through http://galileoscope.org/

- Standard camera tripod

The Galileoscope does not come with its own tripod. Tripods are also available at the U of S Bookstore. If you already own a camera tripod or have access to one, it should be sufficient. The main features to look for are: sturdiness, extends to at least 5 feet, has a pan head so that it swivels in all directions.

Supplementary Resources

See the modules in Blackboard.

Electronic Resources

Some readings in this course will be available electronically. The links and PDFs will be provided for you in your online course.

Downloads

Some downloads may require Adobe Reader. To install this software, click this link and follow the download and installation instructions: http://get.adobe.com/reader.

Stellarium is an open source planetarium for your computer (or mobile device, although the mobile app is not free) that is available for multiple platforms. To install this software, click the following link and follow the download and installation instructions: http://www.stellarium.org/

Mobile Access

Blackboard Mobile Learn™ is an app that is available on many devices including iOS® and Android™ for those occasional times when you may want mobile access. It is still recommended that you use a laptop or desktop computer for the majority of your online studies.

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Class Schedule

Week	Module	Readings	Evaluation Due Date
September 6-16, 2016	Module 1 Here and Now	Kay, L, Palen, S and Blumenthal, G, *21st Century Astronomy*, Chapter 1 and Sections 2.1-2.2. The magnitude scale is described in *Working It Out 13.2*.	Discussion 1 initial post due **noon September 14**; responses to others' posts due **noon September 16**. See Blackboard for Research Coach meeting schedule.
September 19-23, 2016	Module 2 Origins of Astronomy and the Scientific Method	Plato's Cave Allegory, from Book VII of *The Republic* (514a–517a). **[PDF in Blackboard]** Kay, L, Palen, S and Blumenthal, G, *21st Century Astronomy*, Chapter 3.	Discussion 2 initial post due **noon September 21**; responses to others' posts due **noon September 23**
September 26-October 7, 2016	Module 3 Scientific Revolutions	Kay, L, Palen, S and Blumenthal, G, *21st Century Astronomy*, Chapter 4.	Term Project Research Proposal due **noon October 3**. See the Timeline of Term Project Deliverables in the description of this evaluation component for Research Coach meeting schedule. Discussion 3 initial post due **noon October 5**; responses to others' posts due **noon October 7**
October 10, 2016		**No Classes-Thanksgiving Day**	**No Evaluations Due**
October 11-14, 2016	Module 4 Light and Telescopes	Kay, L, Palen, S and Blumenthal, G, *21st Century Astronomy*, Section 5.1 and Chapter 6.	Lab 1 due **noon October 14**
October 17-21, 2016	Module 5 Atoms, Spectra and the Sun	Kay, L, Palen, S and Blumenthal, G, *21st Century Astronomy*, Sections 5.2-5.5 and Chapter 14.	Term Project Outline due **noon October 21**. See the Timeline of Term Project Deliverables in the description of this evaluation component for Research Coach meeting schedule.
October 25, 2016	**MID-TERM EXAM**	**Covers material from Modules 1–5.**	**6:00-7:00 pm**

Week	Module	Readings	Evaluation Due Date
October 24-28, 2016	Module 6 Moon and Mercury	Kay, L, Palen, S and Blumenthal, G, *21st Century Astronomy*, Sections 2.3-2.5 and Chapter 8.	Lab 2 due **noon October 28**
October 31-November 4, 2016	Module 7 The Habitable Zone – Venus, Earth and Mars	Kay, L, Palen, S and Blumenthal, G, *21st Century Astronomy*, Chapter 9.	Lab 3 due **noon November 4**
November 7-11, 2016		**No Classes - Fall Mid-Term Break**	**No Evaluations Due**
November 14-18, 2016	Module 8 Jupiter and Saturn	Kay, L, Palen, S and Blumenthal, G, *21st Century Astronomy*, Sections 10.1-10.4 & Chapter 11.	Term project final draft due **noon November 18**. See the Timeline of Term Project Deliverables in the description of this evaluation component for Research Coach meeting schedule.
November 21-25, 2016	Module 9 Uranus, Neptune and the Kuiper Belt	Kay, L, Palen, S and Blumenthal, G, *21st Century Astronomy*, Section 12.1.	Lab 4 due **noon November 25**
November 28-December 2, 2016	Module 10 Asteroids, Comets, and the Origin of the Solar System	Kay, L, Palen, S and Blumenthal, G, *21st Century Astronomy*, Sections 12.2-12.5 and 7.1-7.4.	Term Project webpage and group evaluation due **noon December 2**
December 5-8, 2016	Module 11 Onward and Upward	Kay, L, Palen, S and Blumenthal, G, *21st Century Astronomy*, Sections 7.5 and 10.5. Witze, Alexandra, The mountain-top battle over the Thirty Meter Telescope, *Nature* **526** 24-28 (2015). **[PDF in Blackboard]** Clery, Daniel, Forbidden Planets, *Science* **353** 438-441 (2016). **[PDF in Blackboard]**	Discussion 4 due **noon December 7**; responses to others' posts due **noon December 8**
	FINAL EXAM	**Online**	**Dec. 9 – 23 (Exact Time/Date TBA)**

Note: If for any reason the Class Syllabus Reading List does not match the Module Reading List, the Class Syllabus shall be taken as correct. **Back**

Evaluation Components

DEU Writing Centre - Quality writing help for free!

Anyone taking a distance class (online, independent studies, televised, or multi–mode delivery) administered by the DEU can use this free service. The Writing Centre provides tools and support to help you write effective essays, reports, or reviews. Simply submit a project draft, and a qualified tutor will assess your work and offer advice to improve your project. Contact the DEU Writing Centre at http://distanceeducation.usask.ca/support/writing-centre.php

Participation in Discussion Forum

Value: 20% of final grade
Due Date: See Class Schedule

Purpose: The purpose of the discussion forums is to promote your engagement with the course learning material and promote a deeper understanding of the issues confronting science.

Description: In the early part of the course (Modules 1-3), when you are examining the nature of science and the nature of doing science, you will use the class discussion forum to engage with the learning material as you explore it with a group of classmates. There will be one final discussion in Module 11, where you will examine the current search for extrasolar planets and the practical issues involved with erecting billion-dollar observatories to do this on sacred mountains. For each discussion, you will be placed in a group of 6-10 where you are expected to submit one original post in response to the Discussion topic and respond at least twice to your peers' posts. In each of the four Discussions you will receive a grade out of 5, for a total of 20% of your final grade. Grades for each Discussion will be determined as follows:

- Up to 1 point (by increments of 0.5) for clarity, concision and originality in your primary response to the Discussion topic (make the purpose of your post clear; think 'thesis statement'),
- Up to 1 point (by increments of 0.5) for development of thought in your primary response to the Discussion topic (summarise, explain, analyse; a full explanation should involve both supporting details and insight; normally this will require at least a couple of paragraphs to achieve),
- Up to 1 point (by increments of 0.5) for mechanics (punctuation, capitalisation, spelling) and usage (sentence structure, grammar and word usage),
- Up to 2 points (by increments of 0.5) for meaningful responses to the posting of others.

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Observing Labs

Value: 20% of final grade

Due Date: See Class Schedule

Purpose: The purpose of the observing labs is for you to gain practical experience in two important areas of astronomy:

i. using a telescope to observe astronomical objects, and
ii. analysing your observations.

Description: Throughout history, astronomers have made amazing discoveries about the world in which we live. In the first three modules of this course, you will learn how the search to understand the motions of planets in our night sky, combined with the earliest telescope observations, led to the discovery that the Earth is a planet orbiting the Sun along with five other

planets that were known at the time. However, knowing what happened—particularly the observations that were made—and seeing the observed objects with your own eyes, are two very different things.

While knowing the implications of observations you might make, actually seeing for yourself the mountains and craters on the Moon, the rings on Saturn, the moons of Jupiter, or the phases of Venus can be a truly transformative experience. In this class, you will explore the sky using your own telescope on your own time. The telescope you are required to purchase is a Galileoscope (galileoscope.org), an inexpensive instrument with high-quality optics which is suitable for observing all the Solar System phenomena that Galileo discovered 400 years ago when the telescope was first invented.

Learning to use a telescope to make astronomical observations on your own is not trivial. One lesson you must inevitably learn is that *you can't plan on doing your observations when it is most convenient for you*. If you leave your observations to be done the night before a due date, there is a good chance it will be cloudy not only that night, but for the whole next week, and your lab will be very late. The observing labs are designed so that your observations can be done in a few clear evenings, and it is recommended that you do them as early as possible, since there may be very few clear nights before the first lab is due.

The other challenge you will face is that using a telescope is a skill that needs to be developed. Having to focus your telescope and aim it at a point-like object such as a planet is not trivial. For this reason, the labs are designed to take a scaffolded approach that eases you towards observing planets. In the first lab, you will set up your telescope and learn to focus it, and then, when you go to use it, your aim will not have to be any better than pointing it somewhere at the night sky. The next two objects you'll observe, in the second and third labs, will be the Moon and Pleiades (a cluster of stars which is about the size of the Moon). In the last lab, you'll finally have to train your telescope on a planet—but at that point, you'll have gained more than enough practical experience with your telescope to be able to point it at some of the brightest point-like objects in the sky.

Beyond these observations, the outcome will be that you will own your own telescope, you'll know how to use it, and you will therefore have all you need to explore the sky on your own. You may then use your telescope to view other celestial wonders like planets that are not in the sky this semester, or a number of spectacular star clusters, nebulae and even the Andromeda Galaxy!

Each of the four lab reports you submit will be marked out of 5, for a total of 20% of your final grade. See the Lab Manual for assignment submission instructions.

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Term Project

Value: 20% of final grade

Due Date: See Class Schedule

Purpose: The purpose of the term project is for you to gain experience in conducting collaborative research in the area of planetary astronomy, both on a topic and in a collaborative role of your own choosing.

Description: Understanding how science works is a major component of this course. In Modules 2 and 3, you'll explore all the details of how we came to understand that the Earth and all the planets of our Solar System orbit the Sun. The scientific method is the tool that we use to explore phenomena and understand their cause; it is by following this method that we have come to know much of what we now know about the world.

When you read news articles about scientific research, normally you only encounter the conclusions of that research. It is less common to encounter explanations of why we've drawn the conclusions we have, rather than the possible alternatives. Most sources of information you come across will tell you *what* we know, but not *how* it is that we think we know it, nor to what degree we are confident in the conclusions being drawn.

For instance, the answer to the question 'How do we know that the planets follow elliptical orbits around the Sun with certain specific properties?' involves many elements, from the inventions of things like the telescope and trigonometry, to the development of precise, detailed maps of the night sky, to personal distaste for previous descriptions, to the discovery of science itself. The picture is a complex mosaic of facts that come together as a cohesive whole.

Since the discovery that the Earth and other planets orbit the Sun, the scientific method has been applied countless times in the discovery of all that we now know about our Solar System, its origins and beyond. There is a scientific basis for everything that we know about our Solar System—from how we know that the ocean tides are caused by the Moon's gravity, to how we know the chemical compositions of the gas giants (without having to go out and collect samples).

The purpose of the term project is for you to gain experience in conducting collaborative research in the area of planetary astronomy, to investigate how we know something that we have learned about our Solar System. A number of groups have been set up in Blackboard covering a wide range of topics. Your job is to join one of those groups, decide on something interesting that we know about your group's topic, and investigate how we know it.

Your group work will follow a standard research arc:

1. You will develop a question that you want to investigate, which is to be of the form 'How do we know Y(X)?', where X is your group's topic, and Y is something we've learned about it by doing science;
2. You will then investigate the detailed scientific explanation that answers your question; and, finally,
3. You will share the results of your investigation as a page on the class website, http://sites.usask.ca/astr104/. (Please feel free to explore the site for examples of projects that were done by past students in the class).

The project is organised so that you will complete it in five stages. In the first stage, you will join your group, brainstorm ideas for the project as part of your Module 1 Discussion, and meet with a Research Coach who will guide your group project throughout the term. In stage 2, you will

submit a short proposal, in stage 3 an outline (rough draft with figures, section headings, references, etc. laid out), in stage 4 a final draft document, and in stage 5 you'll submit your completed webpage to the site, along with a group evaluation.

Timeline of Term Project Deliverables

Module 1 Discussion (5% of final grade)	Sep 12-16
1st meeting with Research Coach	Sep 19-21
Hand in Research Proposal to Research Coach	by noon on Sep 27
2nd meeting with Research Coach	Sep 28-30
Submit Research Proposal for grading (5% of final grade)	by noon on Oct 3
Hand in Webpage Outline to Research Coach	by noon on Oct 16
3rd meeting with Research Coach	Oct 17-19
Submit Webpage Outline for grading (3% of final grade)	by noon on Oct 21
Hand in Webpage Draft to Research Coach	by noon on Nov 13
4th meeting with Research Coach	Nov 14-16
Submit Webpage Draft for grading (2% of final grade)	by noon on Nov 18
Submit Webpage to Class Website and hand in group evaluation (10% of final grade)	by noon on Dec 2

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Mid-Term Exam

Value: 10% of final grade

Date: See Class Schedule

Length: 1 hour

Purpose: The midterm will examine your knowledge and ability to apply the concepts covered in Modules 1-5.

Description: This will be a non-invigilated, online (administered through Blackboard) open book multiple-choice test, which you are to work through independently, without any outside consultation.

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Final Exam

Value: 30% of final grade

Date: See Class Schedule

Length: 3 hours

Purpose: The final exam is a comprehensive test of your understanding and ability to apply the content covered throughout the entire ASTR 104 course.

Description: This will be a non-invigilated, online (administered through Blackboard) open book multiple-choice test, which you are to work through independently, without any outside consultation.

Please note that online exams are viewed and treated the same as any other exam. Online exams are tracked and monitored for irregularities.

Any collusion, collaborating, copying, cheating or any form of academic misconduct is a very serious offence at the University of Saskatchewan and could result in suspension or expulsion from the university.

It is your responsibility to be familiar with the University of Saskatchewan *Guidelines for Academic Conduct.* More information is available at http://www.usask.ca/secretariat/student-conduct-appeals/IntegrityDefined.pdf

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Submitting Assignments

Electronically to your instructor in the Blackboard Learn system, following the instructions given in Blackboard.

You should keep a personal copy of all assignments submitted.

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Additional Information

Must Pass Information

Students must write the Final Exam in order to be considered for a pass in this class.

Late Assignments

Discussions are to be completed by noon on the dates listed in the Class Schedule. Late submissions will be allowed, but only submissions made on or before the due date will count towards your grade.

Late labs and term projects will be subject to a late penalty of 5% per day, including weekends and holidays. Any extensions must be discussed with the instructor prior to the due date.

Note that lab reports submitted ten or more days after the due date will be assigned a grade of 0%.

No assignments will be accepted after December 8, 2016.

Understanding Your Grades

Information on literal descriptors for grading at the University of Saskatchewan can be found at: https://students.usask.ca/academics/grading/grading-system.php

Please note: There are different literal descriptors for undergraduate and graduate students.

More information on the Academic Courses Policy on course delivery, examinations and assessment of student learning can be found at: http://policies.usask.ca/policies/academic-affairs/academic-courses.php

The University of Saskatchewan Learning Charter is intended to define aspirations about the learning experience that the University aims to provide, and the roles to be played in realizing these aspirations by students, instructors and the institution. A copy of the Learning Charter can be found at: http://policies.usask.ca/documents/LearningCharter.pdf

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Students with Disabilities

Students who have disabilities (learning, medical, physical, or mental health) are strongly encouraged to register with Disability Services for Students (DSS) if they have not already done so. Students who suspect they may have disabilities should contact DSS for advice and referrals. In order to access DSS programs and supports, students must follow DSS policy and procedures. For more information, check http://www.students.usask.ca/disability/, or contact DSS at 966-7273 or dss@usask.ca.

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Integrity Defined (from the Office of the University Secretary)

“Integrity is expected of all students in their academic work – class participation, examinations, assignments, research, practica – and in their non-academic interactions and activities as well.” (Office of the University Secretary)

It is your responsibility to be familiar with the University of Saskatchewan *Guidelines for Academic Conduct.* More information is available at http://www.usask.ca/secretariat/student-conduct-appeals/IntegrityDefined.pdf

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Module Objectives

Module 1: Here and Now – Human Curiosity and the Night Sky

1. Develop a sense of here and now in relation to astronomical observables.
2. Identify why humans study astronomy, incorporating the scientific method in principle and in practice.
3. Explore the celestial sphere, the naming of stars and constellations, and the magnitude scale.
4. Explain the daily and annual cycles, and the cause of seasons on Earth.

Module 2: Origins of Astronomy and the Scientific Method

1. Relate how astronomy developed as a science up to the Ptolemaic model.
2. Discriminate between “observable phenomena” and “things that happen or exist,” and explain why multiple hypotheses, such as geocentrism and heliocentrism, can potentially explain a particular phenomenon.
3. Draw on empirical evidence in order to assess the validity of hypotheses.
4. Demonstrate the phenomenon of parallax, explain its importance in astronomy, and use it to illustrate the vastness of space.
5. Use empirical evidence to show that the Earth is spherical, and describe Eratosthenes’ method of measuring its radius/circumference.
6. Assess the difficulty in obtaining precise astronomical measurements, and examine subsequent steps that may be taken in formulating scientific models.
7. Describe the different elements of the Ptolemaic model and relate the particular function of each.
8. Critically examine the scientific method, evaluating its strengths and limitations.

Module 3: Scientific Revolutions

1. Explore the strengths and weaknesses of the Ptolemaic model, the Copernican model, and the Tychonic model prior to Kepler and Galileo.
2. Investigate Kepler’s theoretical accomplishments and Galileo’s empirical accomplishments, and interpret within the context of scientific explanation.
3. Examine Galileo’s investigation of motion and inertia, and its influence on Newton.
4. Explore Newton's explanation of both orbital motion and tides as gravitational phenomena.
5. Compare Newton's universal law of gravitation and Einstein's general theory of relativity, as two explanations of the same phenomenon, and describe the tests that show general relativity describes gravitation more accurately.
6. Assess the historical revolutions that have occurred in astronomy, and identify common themes in the works of revolutionary scientists.

Module 4: Light and Telescopes

1. Explore the nature of light as electromagnetic radiation.
2. Examine how telescopes work and prepare a telescope for observation.
3. Investigate the powers and limitations of telescopes.
4. Explore instrumentation used to record and analyse light gathered by telescopes.
5. Compare ground-based and space telescopes in terms of their strengths and limitations.

Module 5: Atoms, Spectra and the Sun

1. Describe the basic properties of atoms and molecules.
2. Explain how radiation is produced by all objects with temperatures above absolute zero.
3. Compare different types of spectra and explain how they are produced.
4. Explore what can be learned from spectra of celestial objects (temperature, chemical composition, radial velocity).
5. Apply theory of atoms and spectra to the Sun and analyse its physical properties such as its temperature and luminosity, and chemical composition, and explain the source of solar energy.

Module 6: Moon and Mercury

1. Explain the Moon's phases and the cause of solar and lunar eclipses.
2. Compare the Moon and Mercury in terms of orbits, observational aspects, atmosphere, temperature, impact craters, and evidence of water ice in their polar regions.
3. Explore the results of missions sent to study the Moon and Mercury.

Module 7: The Habitable Zone – Venus, Earth and Mars

1. Examine the observational histories of Mars and Venus.
2. Investigate the conditions necessary for sustained liquid water on a planet's surface.
3. Contrast Earth's atmosphere with the atmospheres of Venus and Mars, and evaluate the evidence that Venus and Mars once had atmospheres similar to Earth.
4. Explore the evolution and physical properties of Venus, Earth, and Mars.

Module 8: Jupiter and Saturn

1. Compare Jovian planets with Terrestrial planets in terms of physical characteristics, rings, and moons.
2. Investigate the formation and evolution of Jupiter's and Saturn's moons and rings, along with the evidence that some moons have been geologically active.
3. Explore scientific results from missions sent to study Jupiter and Saturn.

Module 9: Uranus, Neptune and the Kuiper Belt

1. Outline the discoveries of Uranus, Neptune, Pluto and other Kuiper belt objects.
2. Explain Pluto's status as a dwarf planet.
3. Investigate the physical characteristics of Uranus and Neptune.
4. Explore scientific results from missions sent to study Uranus, Neptune, and Pluto.

Module 10: Asteroids, Comets, and the Origin of the Solar System

1. Explain what asteroids and comets are, and where they come from.
2. Explore scientific results from missions sent to study comets and asteroids.
3. Distinguish between meteors, meteorites and meteoroids, and explain where they come from.
4. Examine the ways in which prior knowledge of individual elements of our Solar System are incorporated into the theory of its formation and evolution in order to explain the observed properties.

Module 11: Onward and Upward – Human Interests, The Search for Extrasolar Planets, and the Future of Astronomy

1. Examine the current status of our search for extrasolar planets, in terms of both confirmed numbers and properties and current and planned observatories.
2. Explore techniques for detecting planets orbiting other stars.
3. Reflect on the development of knowledge in astronomy through the scientific method.
4. Critique tension between astronomy, its goals and current practices, and the values and rights of traditional knowledge seekers.

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Acknowledgements

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