Suggested teaching program

Chapter 6: The universe

Time allocation: 4–5 weeks

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| Context and overview |
| In Year 10, students explore systems at different scales and connect microscopic and macroscopic properties to explain phenomena. Students explore the physical evidence for different theories, such as the Big Bang theory. Students evaluate the validity and reliability of claims made in secondary sources with reference to currently held scientific views, and construct evidence-based arguments to communicate science ideas for specific purposes. |
| Syllabus outcomes addressed |
| • The universe contains features including galaxies, stars and solar systems, and the Big Bang theory can be used to explain the origin of the universe (ACSSU188)  • Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community [(ACSHE191)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSHE191)  • Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries [(ACSHE192)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSHE192)  People use scientific knowledge to [evaluate](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=evaluate) whether they accept claims, explanations or predictions, and advances in science can affect people’s lives, including generating new career opportunities [(ACSHE194)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSHE194)  • Values and needs of contemporary society can influence the focus of scientific [research](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=research) [(ACSHE230)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSHE230)  • Formulate questions or hypotheses that can be investigated scientifically [(ACSIS198)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS198)  • Plan, select and use appropriate [investigation](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=investigation) types, including field work and laboratory experimentation, to collect [reliable data](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=reliable+data); assess risk and address ethical issues associated with these methods [(ACSIS199)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS199)  • Select and use appropriate equipment, including [digital technologies](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=digital+technologies), to collect and record [data](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=data) systematically and accurately [(ACSIS200)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS200)  • [Analyse](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=analyse) patterns and trends in [data](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=data), including describing relationships between variables and identifying inconsistencies [(ACSIS203)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS203)  • Use knowledge of scientific concepts to draw conclusions that are consistent with [evidence](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=evidence) [(ACSIS204)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS204)  • [Evaluate](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=evaluate) conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the [data](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=data) [(ACSIS205)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS205)  • Critically [analyse](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=analyse) the [validity](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=validity) of information in primary and secondary sources, and [evaluate](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=evaluate) the approaches used to solve problems [(ACSIS206)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS206)  • Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate [scientific language](http://www.australiancurriculum.edu.au/glossary/popup?a=S&t=scientific+language), conventions and representations [(ACSIS208)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS208) |

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| Achievement standards |
| Students evaluate the evidence for scientific theories that explain the origin of the universe. Students analyse how the models and theories they use have developed over time and discuss the factors that prompted their review. Students develop questions and hypotheses and independently design and improve appropriate methods of investigation, including field work and laboratory experimentation. They explain how they have considered reliability, safety, fairness and ethical actions in their methods and identify where digital technologies can be used to enhance the quality of data. When analysing data, selecting evidence and developing and justifying conclusions, they identify alternative explanations for findings and explain any sources of uncertainty. Students evaluate the validity and reliability of claims made in secondary sources with reference to currently held scientific views, the quality of the methodology and the evidence cited. They construct evidence-based arguments and select appropriate representations and text types to communicate science ideas for specific purposes. |

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| Student book section | AC Syllabus links | Suggested indicators of learning and understanding | Suggested teaching and learning activities | Resources |
| 6.1  The universe was studied by early Australians    (pages 140–141) | Science understanding  ACSSU188  Science as a human endeavour  ACSHE191  ACSHE192  ACSHE194  ACSHE230  Science inquiry skills  ACSIS199  ACSIS200  ACSIS204  ACSIS208 | By the end of this unit, students should be able to:  • demonstrate an understanding of the significance of astronomy to the culture, spirituality and calendar of Indigenous Australians, which dates back thousands of years  • identify some stars and constellations in the night sky  • describe the work of some modern-day Australian astronomers. | What if?  Students compare distances travelled when moving at walking speed and the speed of light.  Skills lab 6.1  Using a star chart  Students are encouraged to locate various stars in the night sky for themselves using a sky chart from the skymaps website.  Challenge 6.1  Modern-day Australian astronomers  Students carry out research on two prominent Australian astronomers.  Australian Aboriginal Astronomy – The Emu in the sky  Students can find out about the importance of astronomy in Aboriginal cultures. | Oxford Science 10 resources  • What if? page 139  • Extend your understanding 6.1, page 141  • Skills lab 6.1, page 215  • Challenge 6.1, page 216 |
| Additional resources  <http://www.atnf.csiro.au/research/AboriginalAstronomy/Examples/emu.htm> |
| 6.2 The Earth is in the Milky Way  (pages 142–143) | Science understanding  ACSSU188  Science as a human endeavour  ACSHE191  ACSHE192  Science inquiry skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS205  ACSIS206  ACSIS208 | By the end of this unit, students should be able to:  • explain the process of nuclear fusion in stars  • relate the surface temperature of a star to its absolute magnitude  • describe the difference between relative magnitude, absolute magnitude and luminosity  • convert distances in light years to kilometres  • explain how stellar parallax can be used to calculate the distances to nearby stars  • describe the structure of the universe in terms of stars and galaxies. | Challenge 6.2  Understanding parallax  Students investigate stellar parallax in this in-class visual activity.  Experiment 6.2  Calculating the distance to the Sun  Students use a pinhole camera technique to calculate the distance from the Earth to the Sun. This activity also provides practice using scientific method skills: errors and relating the conclusion to the aim.  Star in a box  This is an interactive Hertzsprung-Russell diagram where students can animate the different stages of a star’s life and see how its brightness, size and mass change with time.  Space Maths  The Nasa Space Maths website includes a Light Travel Times worksheet. Other relevant worksheets are also available.  Galaxy Zoo  Students can actively contribute to this online live research project that makes use of volunteers to classify galaxies. Reliability of identification of galaxy types is achieved by multiple volunteers identifying the same image. More than 250 000 people have been involved with this project to date. | Oxford Science 10 resources  • Check your learning 6.2, page 143  • Challenge 6.2, page 216  • Experiment 6.2, page 217 |
| Additional resources  The interactive Hertzsprung-Russell diagram can be found at:  [http://starinabox.lco.global](http://starinabox.lco.global/)  The Problem 203: Light Travel Times worksheet can be found at:  <https://spacemath.gsfc.nasa.gov/algebra1.html>  Galaxy Zoo can be found at:  [https://www.galaxyzoo.org](https://www.galaxyzoo.org/)  Photographs showing the Sun compared to other larger stars (some much larger) can been seen at:  <http://sci.gallaudet.edu/Science/relativesizes.html>  Students may have problems visualising scale and hierarchy of structure in the universe, so presenting the information visually will help. The interactive version of *Powers of Ten* would be very useful here. Structures can be identified at different scales as the view zooms out away from Earth.  <http://apod.nasa.gov/apod/ap120312.html> |

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| 6.3 Stars have a life cycle  (pages 144–145) | Science understanding  ACSSU188  Science as a human endeavour  ACSHE192  ACSHE230  Science inquiry skills  ACSIS203  ACSIS204  ACSIS208 | By the end of this unit, students should be able to:  • relate the formation of stars and galaxies to the force of gravity  • explain how hydrostatic equilibrium is attained in stars  • describe what happens to a star when hydrostatic equilibrium cannot be maintained  • list the steps, and describe the processes involved, in the life cycles of stars, resulting in either a white dwarf, neutron star or black hole  • demonstrate an understanding of the link between density and the composition and properties of neutron stars and black holes. | 60 second adventures in astronomy  Students can consolidate their understanding using this series of 12, one-minute cartoon videos explaining some important concepts in astronomy, including the Big Bang theory, black holes and dark matter.  Stars and galaxies  Students can revise and test themselves on their understanding of stars, galaxies and star life cycles at the BBC Bitesize website.  Supermassive black holes explained  Students can consolidate their understanding of black holes with this short and easy-to-understand video. Astrophysicist Julie Comerford and her group explain what supermassive black holes are and why they're so ‘awesome and mysterious’.  Space Book  Students can carry out research into the life cycle of stars using the ‘Space Book’ at the Las Cumbras Observatory website. The different possible life cycles could be presented on an A3 poster. | Oxford Science 10 resources  • Check your learning 6.3, page 145 |
| Additional resources  60 Second Adventures in Astronomy can be found at:  <http://www.open.edu/openlearn/science-maths-technology/science/physics-and-astronomy/astronomy/60-second-adventures-astronomy-the-big-bang?in_menu=31065>  The BBC Bitesize resources can be found at:  <http://www.bbc.co.uk/education/guides/z496fg8/revision>  The Supermassive Black Holes Explained video can be found at:  <http://www.nova.org.au/video/supermassive-black-holes> (5 minutes)  Space Book can be found at:  <https://lco.global/spacebook/life-cycle-stars> |

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| 6.4 The galaxies are moving apart  (pages 146–147) | Science understanding  ACSSU188  Science as a human endeavour  ACSHE191  ACSHE192  ACSHE194  Science inquiry skills  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS208 | By the end of this unit, students should be able to:  • explain how absorption and emission spectra are produced by stars and nebulae and how these spectral patterns indicate which elements are present  • using familiar examples, describe how the Doppler effect changes the apparent frequency and wavelength of sound waves  • describe how the Doppler effect can help explain the change in wavelength of light from distant galaxies  • explain how a red or blue shifted absorption or emission spectra indicates the motion of galaxies  • relate the amount of red shift of a galaxy to its speed and distance from Earth  • explain how Hubble’s law provides evidence for the Big Bang theory. | Challenge 6.4  Exploring the Doppler effect  Students investigate the Doppler effect using a sound source spun on a rope. They then relate this to the red shift or blue shift of starlight.  Experiment 6.4  Investigating emission spectra  Students use a spectroscope to produce emission spectra for various elements. Then they relate their findings to the spectral analysis of distant stars.  Edwin Hubble quiz  A short video biography of Edwin Hubble, available from the Space Telescope website, can be used as the basis of a quiz.  The Doppler effect  Students will better understand the Doppler effect using interactives and animations found on the internet. | Oxford Science 10 resources  • Check your learning 6.4, page 147  • Challenge 6.4, page 218  • Experiment 6.4, page 218 |
| Additional resources  The Edwin Hubble video can be found at:  [http://www.spacetelescope.org/videos/archive/category/hubblecast](http://www.spacetelescope.org/videos/archive/category/hubblecast/) (6 minutes)  (Choose Hubblecast 89.)  Interactives and animations to illustrate the Doppler effect can be found at:  <http://zonalandeducation.com/mstm/physics/waves/dopplerEffect/dopplerEffect.html>  and  <http://www.animations.physics.unsw.edu.au/jw/doppler.htm>  This NASA weblink, ‘What do Spectra Tell Us?’, has more information on the analysis of spectra from stars:  <https://imagine.gsfc.nasa.gov/features/yba/M31_velocity/spectrum/spectra_info.html> |
| 6.5 The Big Bang theory is supported by evidence  (pages 148–149) | Science understanding  ACSSU188  Science as a human endeavour  ACSHE191  ACSHE192  ACSHE194  Science inquiry skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS208 | By the end of this unit, students should be able to:  • explain how the Big Bang theory provides an explanation for the expansion of the universe from a single point  • describe how cosmic microwave background radiation provides evidence to support the Big Bang theory  • explain how small fluctuations in temperature throughout the universe is consistent with the formation of galaxies and is further evidence for the Big Bang theory  • understand that evidence for the Big Bang theory has also been used to estimate the age of the universe. | Challenge 6.5  The expanding universe  Students inflate a balloon with markings on it to model the expansion of the universe following the Big Bang.  Stars and galaxies  Students can revise and test themselves on their understanding of evidence for the Big Bang theory at the BBC Bitesize website.  Big Bang ideas  Students will have all sorts of ideas about what the Big Bang is. Many of them will be wrong. Even if they have watched documentaries on it, there are many errors in those, as misconceptions abound, or accuracy gives way to entertainment. Collect students’ ideas and revisit them later to see if they have changed their minds.  The Planck mission  The Planck satellite was launched in 2009 to measure CMBR. Students can investigate the latest findings at The Planck mission website. | Oxford Science 10 resources  • Check your learning 6.5, page 149  • Challenge 6.5, page 219 |
| Additional resources  The BBC Bitesize resources can be found at:  <http://www.bbc.co.uk/education/guides/z496fg8/revision>  The Planck mission website can be found at:  <http://planck.cf.ac.uk/>  This short video – Evidence for the Big Bang – includes a recent interview with CMBR co-discoverer, Robert Wilson.  [http://www.pbslearningmedia.org/resource/ess05.sci.ess.eiu.microwave/evidence-for-the-big-bang-theory](http://www.pbslearningmedia.org/resource/ess05.sci.ess.eiu.microwave/evidence-for-the-big-bang-theory/) (5 minutes) |
| 6.6 Technology aids cosmological research  (pages 150–151) | Science understanding  ACSSU188  Science as a human endeavour  ACSHE191  ACSHE192  ACSHE194  ACSHE230  Science inquiry skills  ACSIS208 | By the end of this unit, students should be able to:  • explain what the Australian Square Kilometre Array Pathfinder and the Square Kilometre Array are  • identify some possible benefits of the Square Kilometre Array to furthering our understanding of the cosmos  • describe some other examples of how technology has aided cosmological research. | Exploring the unknown with the Square Kilometre Array  Students can use the information on the Nova website to research the Square Kilometre Array radio telescope.  Technology article  ‘16 Ways Technology is Mapping the Universe’ is an interesting article for students to learn more about how technology is advancing our understanding of the cosmos. | Oxford Science 10 resources  • Expanding your understanding 6.6, page 151 |
| Additional resources  Exploring the unknown with the Square Kilometre Array can be found at:  <http://www.nova.org.au/space-time/exploring-unknown-square-kilometre-array>  16 Ways Technology is Mapping the Universe can be found at:  [https://matadornetwork.com/bnt/16-ways-technology-is-mapping-the-universe](https://matadornetwork.com/bnt/16-ways-technology-is-mapping-the-universe/) |
| 6 Review  (pages 152–153) | Science understanding  ACSSU188  Science as a human endeavour  ACSHE192  ACSHE230 | By the end of this unit, students should be able to:  • define and explain all Key Words listed on page 154  • identify areas of personal strengths and weaknesses in their knowledge and understanding of the topic. | Revision activities  • Students could play ‘celebrity heads’ with the Key Words list.  • Students can make dominoes with Key Words on one end and definitions/diagrams/examples on the other end.  • Students can create mind maps, Venn diagrams or other graphic organisers to summarise the key concepts of this chapter.  • Peer teaching: students can work in groups to reteach the content of the unit to the class for the purpose of revision. Each group could be allocated a double-page spread to summarise. | Oxford Science 10 resources  • Review questions, page 152–153  • Key word list, page 154 |