Suggested teaching program

Chapter 7: Motion and energy

Time allocation: 6 weeks

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| Context and overview |
| In Year 10, students learn that motion and forces are related by applying physical laws. 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 |
| • Energy conservation in a system can be explained by describing energy transfers and transformations (ACSSU190)  • The motion of objects can be described and predicted using the laws of physics (ACSSU229)  • 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 [explain](http://www.australiancurriculum.edu.au/glossary/popup?a=F10AS&t=Explain) the concept of energy conservation and [represent](http://www.australiancurriculum.edu.au/glossary/popup?a=F10AS&t=Represent) energy transfer and transformation within systems. They [apply](http://www.australiancurriculum.edu.au/glossary/popup?a=F10AS&t=Apply) relationships between force, mass and acceleration to [predict](http://www.australiancurriculum.edu.au/glossary/popup?a=F10AS&t=Predict) changes in the motion of objects. 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 |
| 7.1  Displacement is change in position with direction    (pages 156–157) | Science understanding  ACSSU229  Science inquiry skills  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS206  ACSIS208 | By the end of this unit, students should be able to:  • explain the difference between distance and displacement using appropriate examples  • plot and interpret position/displacement–time graphs for linear motion. | What if?  Students measure time and distance to calculate the speed of vehicles on the road.  Challenge 7.1  Bringing graphs to life  Students ‘act out’ the motion shown on a graph.  Vector walk  In this interactive, students calculate the distance and displacement of various objects based on their animated motion.  Scalar or vector  Ask students to categorise various quantities that they are familiar with, as scalar or vector (e.g. power, time, mass, force, current, etc.). | Oxford Science 10 resources  • What if? Page 154  • Check your learning 7.1, page 157  • Challenge 7.1, page 219 |
| Additional resources  Vector walk can be found at:  <http://www.physicsclassroom.com/Physics-Interactives/1-D-Kinematics/Vector-Walk> |
| 7.2 Velocity is speed with direction  (pages 158–159) | Science understanding  ACSSU229  Science as a human endeavour  ACSHE230  Science inquiry skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS205  ACSIS206  ACSIS208 | By the end of this unit, students should be able to:  • explain the difference between speed and velocity using appropriate examples  • manipulate the formula, *s = d/t*, appropriately to determine the unknown variable: speed/velocity, distance/displacement or time  • determine the speed/velocity of an object from the gradient of a position/displacement–time graph  • plot and interpret speed/velocity–time graphs for linear motion. | Experiment 7.2A  The ticker timer  Students learn how to use a ticker timer and then use it to produce a speed–time graph.  Experiment 7.2B  Using a motion sensor  Students learn how to use a motion sensor and use it to produce motion graphs.  Graph sketching and recognition  Students can test their graphing skills by drawing and interpreting various motion graphs (with answers supplied) at the ‘Physics Classroom’ website. Questions test concepts covered in section 7.1 to 7.3.  What makes a cheetah run so fast?  Students can find out more about the physics underpinning a cheetah’s speed at the How Stuff Works website. | Oxford Science 10 resources  • Check your learning 7.2, page 159  • Experiment 7.2A, page 220  • Experiment 7.2B, page 221 |
| Additional resources  Graph sketching and recognition can be found at:  <http://www.physicsclassroom.com/morehelp/graphs>  What makes a cheetah run so fast can be found at:  <http://animals.howstuffworks.com/mammals/cheetah-speed2.htm>  A video demonstration of a ticker timer can be found at:  <https://vimeo.com/24822057> |

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| 7.3 Acceleration is change in velocity over time  (pages 160–161) | Science understanding  ACSSU229  Science inquiry skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS208 | By the end of this unit, students should be able to:  • understand that acceleration is the rate of change of velocity  • manipulate the formula, *a = (v–u)/t* appropriately to determine the unknown variable: initial velocity, final velocity, acceleration or time  • apply appropriate units for acceleration  • recognise that acceleration due to gravity on earth is 9.8 m/s2  • determine the velocity of an object from the gradient of velocity–time graphs. | Challenge 7.3  Measuring acceleration by timing or using a motion sensor  Students carry out a simple experiment to determine an experimental value for acceleration due to gravity.  Speed, velocity and acceleration  Students can revise and test themselves on their understanding of speed, velocity and acceleration at the BBC Bitesize website. | Oxford Science 10 resources  • Check your learning 7.3, page 161  • Challenge 7.3, page 221 |
| Additional resources  The Bitesize resources can be found at:  <http://www.bbc.co.uk/education/guides/z3bqtfr/revision> |
| 7.4 An object in motion remains in motion until a force acts on it  (pages 162– 163) | Science understanding  ACSSU229  Science as a human endeavour  ACSHE192  Science inquiry skills  ACSIS198  ACSIS199  ACSIS200  ACSIS204  ACSIS208 | By the end of this unit, students should be able to:  • recognise, through observation and measurement, that forces cause changes to objects they act on  • describe how unbalanced forces cause a change in the velocity of an object  • state Newton’s first law of motion (inertia) and explain this law using appropriate examples. | Challenge 7.4A  Make an accelerometer  Students construct an accelerometer and observe what happens when it is subjected to different types of motion.  Challenge 7.4B  How do you like your eggs?  Students observe the motion of two eggs to determine which one is fresh!  How Newton’s laws of motion work?  Students can find out more about Newton’s laws of motion at the How Stuff Works website.  The moving man  Students can control the motion of the ‘moving man’, and view the resulting position, velocity and acceleration graphs simultaneously, using these interactive simulations at the Phet website.  Falling and stopping  Terminal velocity is a good example for demonstrating changing forces like air resitance. Students can investigate terminal velocity at the BBC Bitesize website.  Sky-diving interactive  Using this online interactive, students are presented with a falling object. They can alter the mass of the object and the amount of air resistance by adding a parachute of two different sizes to observe how the object’s acceleration alters. | Oxford Science 10 resources  • Check your learning 7.4, page 163  • Challenge 7.4A, page 222  • Challenge 7.4B, page 222 |
| Additional resources  How Newton’s laws of motion work can be found at:  <http://science.howstuffworks.com/innovation/scientific-experiments/newton-law-of-motion.htm>  The moving man can be found at:  <https://phet.colorado.edu/en/simulation/legacy/moving-man>  The Bitesize resources can be found at:  <http://www.bbc.co.uk/education/guides/zff82hv/revision>  The sky-diving interactive can be found at:  <http://www.physicsclassroom.com/Physics-Interactives/Newtons-Laws/Skydiving/Skydiving-Interactive> |
| 7.5 Force equals mass x acceleration  (pages 164– 165) | Science understanding  ACSSU229  Science inquiry skills  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS208 | By the end of this unit, students should be able to:  • describe how unbalanced forces acting on an object can cause it to accelerate or decelerate using appropriate examples  • state Newton’s second law of motion and explain this law using appropriate examples  • calculate the net (unbalanced) force acting on an object  • manipulate the formula *F = ma* appropriately, to determine the unknown variable: net force, mass or acceleration  • use Newton’s second law to connect the mass and weight of an object. | Experiment 7.5A  Resultant forces  Students use spring balances to produce force diagrams which are then turned into vector diagrams.  Experiment 7.5B  Accelerating masses  Students investigate the relationship between mass and acceleration by allowing a weight, attached to a trolley, to drop under the influence of gravity.  Forces and Motion lab  Students can investigate the relationship between forces and motion using interactive simulations at the Phet website.  Force diagrams  This online activity scaffolds force diagram drawing skills. Students are presented with a number of scenarios, and use buttons to add appropriate force arrows to the object. Clicking the arrows changes their size. Feedback is immediate and students are given the opportunity to correct mistakes. | Oxford Science 10 resources  • Check your learning 7.5, page 165  • Experiment 7.5A, page 223  • Experiment 7.5B, page 224 |
| Additional resources  The Forces and Motion lab interactives can be found at:  <https://phet.colorado.edu/en/simulation/forces-and-motion-basics>  and  <https://phet.colorado.edu/en/simulation/legacy/forces-and-motion>  Force diagrams can be found at:  http://www.physicsclassroom.com/Physics-Interactives/Newtons-Laws/Free-Body-Diagrams |
| 7.6 Each action has an equal and opposite reaction  (pages 166–167) | Science understanding  ACSSU229  Science as a human endeavour  ACSHE191  ACSHE192  ACSHE230  Science inquiry skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS208 | By the end of this unit, students should be able to:  • state Newton’s third law of motion and explain this law using appropriate examples of action-reaction pairs  • understand that action and reaction pairs always act on different objects  • explain how Newton’s third law explains the operation of rockets, missiles and jet engines. | Experiment 7.6  What if forces were changed on Newton’s rocket?  Students investigate how Newton’s third law explains the motion of a balloon rocket.  Forces and Newton’s laws  Students can revise and test themselves on their understanding of forces and Newton’s laws at the BBC Bitesize website.  Newton’s third law misconception video  This video helps students clarify a common misconception which appears to contradict Newton’s third law – that the pull of the Earth on the Moon is greater than the pull of the Moon on the Earth.  Water rockets  Linked to the water rockets ‘additional activity’, NASA is a good source of information. It starts with rocket research 101. | Oxford Science 10 resources  • Check your learning 7.6, page 167  • Experiment 7.6, page 225 |
| Additional resources  The Bitesize resources can be found at:  <http://www.bbc.co.uk/education/guides/zgn82hv/revision/9>  Newton’s third law video can be found at:  https://www.youtube.com/watch?v=8bTdMmNZm2M  NASA’s water rocket activity can be found at:  <https://spaceflightsystems.grc.nasa.gov/education/rocket/BottleRocket/journey101.htm> |
| 7.7 Momentum is conserved in a collision  (pages 168–169) | Science understanding  ACSSU190  ACSSU229  Science inquiry skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS208 | By the end of this unit, students should be able to:  • explain what momentum is using appropriate examples  • manipulate the formula, *p = mv*, appropriately to determine the unknown variable: momentum, mass or velocity  • state the law of conservation of momentum and explain this law using appropriate examples  • manipulate the formula *m1u1 + m2u2 =* *m1v1 + m2v2*(where 1 and 2 represents two colliding objects and *u* and *v* are their velocities before and after a collision) to find the unknown value. | Experiment 7.7  Colliding trolleys  Students investigate the law of conservation of momentum using dynamic trolleys.  Momentum and forces  Students can revise and test themselves on their understanding of momentum and forces at the BBC Bitesize website.  Collision lab  Students can investigate momentum in collisions using an interactive simulation of an air hockey table at the Phet website.  Momentum and collisions  In this online activity, students are presented with a number of collision scenarios to investigate the momentum before and after a collision. | Oxford Science 10 resources  • Check your learning 7.7, page 169  • Experiment 7.7, page 226 |
| Additional resources  The Bitesize resources can be found at:  <http://www.bbc.co.uk/education/guides/zv3j6sg/revision>  Collision lab can be found at:  <https://phet.colorado.edu/en/simulation/collision-lab>  The momentum and collisions interactive can be found at:  <http://www.physicsclassroom.com/Physics-Interactives/Momentum-and-Collisions> |
| 7.8 Work occurs when an object is moved or rearranged. Energy can be calculated  (pages 170–171) | Science understanding  ACSSU190  ACSSU229  Science as a human endeavour  ACSHE191  ACSHE192  Science inquiry skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS208 | By the end of this unit, students should be able to:  • explain work, kinetic energy, gravitational potential energy and elastic potential energy using appropriate examples  • calculate work using the formula, *W = Fs*  • calculate kinetic energy using the formula, *Ek = ½ mv2*  • calculate gravitational potential energy using the formula, *Ep = mgh*  • calculate elastic potential energy using the formula, *Ep = ½ kx2*  • manipulate these formulas appropriately to determine the relevant unknown variable. | Experiment 7.8  What if an elastic band was stretched further?  Using a stretched elastic band, students investigate the relationship between elastic potential energy and kinetic energy.  Motion and energy changes  Students can revise and test themselves on their understanding of work, energy changes and the conservation of energy at the BBC Bitesize website.  Collide a ball energy transfer experiment  Students can carry out a simple experiment using a small and large ball to demonstrate energy transfer using this activity found at the CSIRO website.  Rollercoaster model interactive  Students are required to modify the track of a rollercoaster before letting the carriage go. The changes of energy throughout the motion are graphed beside the track in real time. Students can also add vector arrows to the carriage to indicate the changes in force and velocity as well. | Oxford Science 10 resources  • Check your learning 7.8, page 171  • Experiment 7.8, page 227 |
| Additional resources  The Bitesize resources can be found at:  [http://www.bbc.co.uk/schools/gcsebitesize/science/add\_ocr\_21c/explaining\_motion](http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_21c/explaining_motion/)  Collide a ball energy transfer experiment can be found at:  <https://www.csiro.au/en/Education/DIY-science/Physics/Collide-a-ball>  The rollercoaster model interactive can be found at:  <http://www.physicsclassroom.com/Physics-Interactives/Work-and-Energy/Roller-Coaster-Model/Roller-Coaster-Model-Interactive> |
| 7.9 Energy is always conserved  (pages 172–173) | Science understanding  ACSSU190  ACSSU229  Science as a human endeavour  ACSHE194  Science inquiry skills  ACSIS198  ACSIS199  ACSIS200  ACSIS203  ACSIS204  ACSIS208 | By the end of this unit, students should be able to:  • explain the law of conservation of energy using appropriate examples  • describe total mechanical energy using appropriate examples  • calculate total mechanical energy using the formula, *ET = Ep + Ek = mgh + ½ mv2*  • explain the principal of energy efficiency and apply the formula:  *Efficiency = useful energy x 100*  *total energy* | Challenge 7.9  Conservation in action  Students investigate energy efficiency using a swinging pendulum.  Energy skate park  Students can investigate the conservation of energy using an interactive simulation at the Phet website.  The physics of perpetual motion video  Students can consolidate their understanding of the principle of conservation of energy by examining the impossibility of perpetual motion machines. | Oxford Science 10 resources  • Check your learning 7.9, page 173  • Challenge 7.9, page 228 |
| Additional resources  Energy skate park can be found at:  <https://phet.colorado.edu/en/simulation/energy-skate-park>  The physics of perpetual motion video can be found at:  [https://futurism.com/what-physics-says-about-perpetual-motion-machines-free-energy-r](https://futurism.com/what-physics-says-about-perpetual-motion-machines-free-energy-r/) |
| 7.10 Car safety features require an understanding of Newton’s Laws and momentum  (pages 174–175) | Science understanding  ACSSU190  ACSSU229  Science as a human endeavour  ACSHE192  ACSHE194  ACSHE230  Science inquiry skills  ACSIS199  ACSIS203  ACSIS204 | By the end of this unit, students should be able to:  • relate their understanding of Newton’s laws and momentum to the function of car safety features including seatbelts, child safety seats, rear facing child restraints, air bags and crumple zones. | How airbags and crumple zones work  Students can find out more about how airbags and crumple zones work at the How Stuff Works website.  Death defying design car features  Students can use the information on the Nova website to research the latest safety design features of modern cars. | Oxford Science 10 resources  • Extend your understanding 7.10, page 175 |
| Additional resources  How airbags work can be found at:  <http://auto.howstuffworks.com/car-driving-safety/safety-regulatory-devices/airbag.htm>  How crumple zones work can be found at:  <http://auto.howstuffworks.com/car-driving-safety/safety-regulatory-devices/crumple-zone.htm>  Death defying design car features can be found at:  <http://www.nova.org.au/technology-future/death-defying-designs-car-safety> |
| 7 Review  (pages 176–177) | Science understanding  ACSSU190  ACSSU229  Science as a human endeavour  ACSHE192  ACSHE230  Science inquiry skills  ACSIS203  ACSIS204  ACSIS208 | By the end of this unit, students should be able to:  • define and explain all Key Words listed on page 178  • 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 176–177  • Key word list, page 178 |