 Module 3 – energy transfers and transformations in the spheres

Year 11 Earth and Environmental Science

Duration – 3 weeks

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Description of unit

This sample unit of work references two subtopics within Module 3, including Geological Transformations: Earthquakes, Volcanoes and Mountain Ranges and Transformations in the Oceans, Biosphere and Cryosphere.

Earth’s processes require energy. This energy may be transformed from one form into another or transferred between objects. Energy from the Sun and the Earth’s interior control processes within and between the Earth’s spheres. Heat and gravitational energy in the Earth's interior also drives the movements of tectonic plates. Energy transfers that occur on different timescales between the atmosphere, oceans and land generate weather and climate phenomena. The influence of cyclic phenomena, including El Niño and La Niña, affect global weather patterns.

Knowledge of the Earth’s processes and of energy transfer allows scientists to explain phenomena and predict areas at risk.

Focus questions

* How do energy transfers and transformations alter the lithosphere? (ACSES055, ACSES056)
* How do energy transformations influence the atmosphere, oceans, biosphere and cryosphere?

Working scientifically skills

* EES 11/12-3 Conducts investigations to collect valid and reliable primary and secondary data and information
* EES 11/12-4 Selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media
* EES11/12-5 Analyses and evaluates primary and secondary data and information
* EES 11/12-6 Solves scientific problems using primary and secondary data, critical thinking skills and scientific processes

While all Working Scientifically outcomes mandated for Earth and Environmental Science Module 3 are listed above, teachers may embed the outcomes and corresponding skill descriptors students throughout the sample unit of work. If teachers choose to include a depth study in this unit, they must refer to [Depth Studies: Year 11 and 12](http://syllabus.nesa.nsw.edu.au/earth-and-environmental-science-stage6/depth-studies/) to make sure all requirements of depth studies are met. This includes adding the following Working scientifically skills:

* EES 11/12-1 Develops and evaluates questions and hypotheses for scientific investigation
* EES 11/12-7 Communicates scientific understanding using suitable language and terminology for a specific audience or purpose

Outcomes

* EES 11-10 Describes the factors that influence how energy is transferred and transformed in the Earth’s systems

Assessment

* Investigating the properties of water practical task

| Outcomes/content | Teaching and learning | Evidence of learning |
| --- | --- | --- |
| Explain how the release of elastic potential energy in rock leads to earthquakes (ACSES044, ACSES047) | Inquiry question: How do energy transfers and transformations alter the lithosphere?   * Introduce inquiry question, provoke discussion on types of energy found in the lithosphere * Revise student understanding of elastic potential energy (EPE) using [video demonstrations](https://www.youtube.com/watch?v=0BObd3DsNFM) with rubber bands. Students to discuss what energy transfer and transformation they can see occurring * [Introduce idea of rocks’ elastic rebound](https://www.youtube.com/watch?v=wUwpHGNRGOY) * Teacher demonstration/student practical of rock elastic rebound. Discuss the energy transfer and transformation that happens when rocks release their EPE and how this leads to earthquakes. [Ideas from this resource](https://www.iris.edu/hq/inclass/video/earthquake_machine_elastic_rebound__the_rock_demonstration) * Students to create flowchart of the types and changes of energy that occur along fault lines to cause an earthquake | * Student observations (oral and written) and inferences of changes in EPE to kinetic/heat/sound * Observations/diagrams from demonstration/practical * Student flowchart and summary of change in energy leading to an earthquake |
| describe the role of heat and its interactions with the lithosphere in creating different types of volcanic eruptions and magma compositions, including but not limited to: (ACSES099)   * thermal plumes resulting in effusive mafic eruptions * partial melting of subducted oceanic plates resulting in explosive felsic eruptions * interactions of magma and overlying ice resulting in ash clouds | * Engage students with [video on volcanic eruptions](https://www.youtube.com/watch?v=VBTAcACmcgo). Students deconstruct the eruptions seen - some leading questions “were all these eruptions the same? Why/why not?” (Trigger discussion about colour, plumage, height, ferocity, etc.) * Pose question “what makes them different?” Students to investigate different eruptions to begin looking at [different compositions/types of volcanoes](https://www.nationalgeographic.org/interactive/forces-nature/%20https:/laulima.hawaii.edu/access/content/group/2c084cc1-8f08-442b-80e8-ed89faa22c33/book/chapter10/volcanoes.htm) * Students to create a table identifying different types of volcanoes and their properties (such as types of magma produced, composition, formation temperature, typical location, colour of ash cloud) * Students to create a “volcano profile” for a known volcano, including its properties and an explanation of how the role of heat has affected its certain properties. | * table of volcanoes and properties * Known volcano profile, relating its properties to the role of heat in forming it. |
| represent these energy transformations in the formation of mountains due to:   * thermal expansion * deformation of the lithosphere (ACSES035) | * Recall learning from Module 2 - Plate Tectonics, regarding formation of mountains   Watch this [video about different ways mountains are formed](https://www.youtube.com/watch?v=W8Cr_pplBIo)  Students to summarise the different processes involved.  Students separate those formed due to thermal expansion with those formed from plate movements (i.e. volcanic mountains, dome mountains, fold mountains, block mountains)   * Some more videos/resources on formations of mountains:   + [Plate tectonics](https://www.youtube.com/watch?v=d9bKXY0OMxc)   + [The Himalayas forming](https://www.youtube.com/watch?v=HuSHOQ6gv5Y)   + [Crustal Deformation](https://www.uwgb.edu/dutchs/EarthSC102Notes/102Orogeny.htm) * Students undergo a case study on a known mountain and discuss in detail the energy behind the processes (e.g. transantarctic mountains, the Himalayas, Mt Everest, Black dome mountain, the Harz Mountains, Mt Fuji). Students to share knowledge gained about their different mountains and the processes undergone to form them. | * Student descriptions of mountain building processes, concentrating on the energy processes involved * Mountain case study, detailing process of building and energy transfer and transformations responsible |
| Revise inquiry question How do energy transfers and transformations alter the lithosphere? (ACSES055,  ACSES056) | Summarise/revision/concept map   * Students create a concept map around inquiry question, detailing their learning about energy transfers and transformation that occur in the lithosphere and what geological formations they lead to. * Extension: students to use concept map to write mini-essay style answer using evidence gathered.   Alternative - this could lead into a depth study for students to work through. | * Concept map detailing energy transfers and transformations that result in earthquakes, volcanoes and formation of mountains |
| investigate the unique properties of water that make it such an important component of the Earth’s systems, including: (ACSES024)   * boiling point * ability to act as a solvent * density * thermal capacity * surface tension | Inquiry question: How do energy transformations influence the atmosphere, oceans, biosphere and cryosphere?  Practical assessment task – properties of water.  The following is an alternative teaching and learning sequence which can be used instead of the properties of water assessment task. The sequence involves students engaging in practical investigations which have simple instructions and build skills in conducting investigations and makeing observations.   * [Useful teacher background notes](http://www.chemistry.unsw.edu.au/sites/all/files/water.pdf) * [Referral website for students](https://water.usgs.gov/edu/solvent.html) * Students watch [Crash Course video on properties of water](https://www.youtube.com/watch?v=HVT3Y3_gHGg) * Students undergo first-hand investigations to investigate water’s unique properties, such as those indicated below. Students may wish to state one biological significance for each property.   + Polarity   Generate a charge of static electricity on a comb by rubbing a plastic rod with a piece of flannel or wool. Place the comb next to the stream of water coming out of a faucet. Record your observations.   * + Surface tension   Try and float a paperclip on the surface of water. Use a magnifying glass to observe and describe the appearance of the water’s surface around the paper clip. Add a drop of detergent to the water with a floating paperclip and make observations.   * + Density   Place an ice cube in a beaker filled with 100ml of water. Observe and record observations.  Fill a beaker with 200ml of water. Add a tablespoon of honey. Observe and record observations. Add 50 ml of kerosene. Observe and record observations.   * + Cohesion and adhesion   How many drops of water do you think will fit on the head of a 5 cent coin?  Place a drop of water on a glass slide. Cover the slide with a second glass slide. Separate the two slides. What do you observe?  You are provided with a beaker of coloured water and three glass tubes. Place each of the glass tubes into the beaker of coloured water. Measure and record the length of the column of water that moves up the tube. What pattern do you see in the results?   * + Hydrophilic/phobic interactions   Place several drops of coloured water on a piece of wax paper. What happens to the water droplets as you roll them around on the wax paper? What does this activity tell you about one of water’s properties? Place a toothpick in soap and dip it into the water droplet. What effect does soap have on water?   * + Universal solvent   Add a quarter teaspoon of citric acid to a dry test tube. Add one quarter teaspoon of sodium bicarbonate to the same test tube. Observe and record observations. Add a few drops of water. Observe and record observations.  Add a teaspoon of oil to a dry test tube. Add water to try and dissolve the oil. Observe and record observations.   * + Specific heat capacity   Pour 50ml of water, alcohol and oil into separate beakers. Record the temperature of each and record. Place each of the beakers into a water bath (warm to hot). Leave for 1 minute and record temperature again. Calculate the change in temperature for each solution.   * Some extra ideas are provided   + [Investigating surface tension and viscosity](http://www.taylorscience.com.au/chem11/Water/Water_files/M3_w08.pdf)   + Density comparison of ice in water and ice in acetone   + Boiling point/thermal heat capacity comparison of water, 20% ethylene glycol, 30% ethylene glycol and 50% ethylene glycol solutions   + [Water as a solvent](https://www.ppps.org/cms/lib04/MI01000504/Centricity/Domain/231/Activity%2059.pdf) | * Student report/first-hand investigation write up detailing findings on water’s properties * Students link property of water to a biological significance. |
| outline the roles of energy, water masses and salinity in producing ocean currents (ACSES051) | * Students undertake [this secondary source investigation](http://www.classzone.com/books/earth_science/terc/content/investigations/es2202/es2202page01.cfm?chapter_no=22) to examine the relationship between temperature and salinity in the oceans and how both of these qualities affect the density of seawater. Complete the set questions. * Students use [this investigation on the gulf stream](http://www.classzone.com/books/earth_science/terc/navigation/chapter24.cfm) * Relate findings from first-hand investigation on water properties to the knowledge gained from these two online investigations. Students to brainstorm together to come up with conclusion on the role of heat (energy) and salinity on water’s density and hence its movement. | * Student responses to questions and discussions * Conclusion conclusions on the role of heat and salinity on water’s density and movement. |
| explain the role of heat transfer by ocean currents and atmospheric movement in causing phenomena, eg El Niño and La Niña (ACSES052) | This content descriptor could be an extension from the above descriptor as a depth study to further investigate the movements of ocean currents and their effect on atmospheric movement.  The following is an alternative teaching and learning sequence which can be used.   * Students research the different conditions of ocean currents and atmospheric movement that lead to changes in weather and climate (such as El Niño and La Niña)   + [Understanding ENSO](https://schoolsequella.det.nsw.edu.au/file/188573bd-c197-4299-a46b-7407b5bde08d/1/o%09https:/youtu.be/dzat16LMtQk?list=PLbKuJrA7Vp7naJL31deES8QAV5E0q6U_H)   + [When do El Niño and La Niña occur](http://www.bom.gov.au/climate/enso/history/ln-2010-12/ENSO-when.shtml)   + [The ENSO outlook](http://www.bom.gov.au/climate/enso/outlook/archive/20170606.archive.shtml#tabs=Outlook) is a useful recording tool that analyses weekly the condition in and over the Pacific Ocean * Using research and information collected students create a poster/flow diagram detailing the conditions that lead to both El Niño and La Niña, identifying the transfer of heat and its role in causing these phenomena | * Depth study conducted by students independently * Notes from research used to create poster/flow diagram detailing the conditions that lead to both El Niño and La Niña, identifying the transfer of heat and its role in causing these phenomena |
| extract information from secondary sources to document and investigate changes in the cryosphere (ACSES034) | * Engage/introduce idea of cryosphere and its changes with [NASA video](https://www.youtube.com/watch?v=PjAXoETeVIc) * [Students to complete lab 1, 4 and 5](https://serc.carleton.edu/eslabs/cryosphere/lab_overviews.html) * Students to individually choose a named ice shelf/glacier etc. and create a timeline detailing changes in the cryosphere over time. | * Student responses to lab questions and discussions * Student timeline on specific part of cryosphere and its changes that have been occurring. |

Reflection and evaluation: