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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Scholarship 2017
Earth and Space Science

9.30 a.m. Thursday 30 November 2017

RESOURCE BOOKLET

Refer to this booklet to answer the questions for Scholarship Earth and Space Science 93104.

Check that this booklet has pages 2–8 in the correct order and that none of these pages is blank.

YOU MAY KEEP THIS BOOKLET AT THE END OF THE EXAMINATION.

Resource for
QUESTION ONE: THE ROLE OF PHYTOPLANKTON

Use this material to help you answer Question One on page 2 of your exam booklet.

Diagram One: The Rock Cycle

Adapted from: https://schmidtphysicalgeography.wikispaces.com/Week+Sixteen

Diagram Two: The Ocean Carbon Cycle

http://2011.polarhusky.com/media/cms/oceans/ocean-carbon-cycle.jpg

- Phytoplankton are microscopic plants. They are abundant along coastlines and continental shelves, the Equator in the Pacific and Atlantic oceans, and at high latitudes. These are areas where upwelling occurs, resulting in nutrient-rich deep water being pulled up to the surface.
- Phytoplankton are scarce in ocean gyres due to the lack of some key nutrients.
- Phytoplankton growth varies seasonally:
  - In high latitudes, phytoplankton blooms peak in the spring and summer. Vigorous winter mixing brings nutrients up from deeper waters into the sunlit layers.
  - In lower latitudes phytoplankton populations drop off in summer. Warm, buoyant water stays on top of cold, dense water below, and the water column does not easily mix. Phytoplankton use up the nutrients available, and growth falls off until winter storms cause mixing.
- The warmer that the surface water becomes, anywhere in the ocean, the harder it is for winds to mix the surface layers with the cooler deeper layers of the ocean through upwelling and downwelling. The ocean settles into layers which do not easily mix.
- Many types of phytoplankton, such as coccolithophores, build calcium carbonate platelets (also called shells and skeletons). When these organisms die, or are eaten, their platelets eventually become part of the ocean sediments.

Photo One: A species of phytoplankton showing the delicate calcium carbonate platelets.

http://www.sciencenutshell.com/rapid-growth-of-plankton-due-to-rising-carbon-dioxide-levels/

Resource for
QUESTION TWO: MONITORING THE ANTARCTIC CIRCUMPOLAR CURRENT

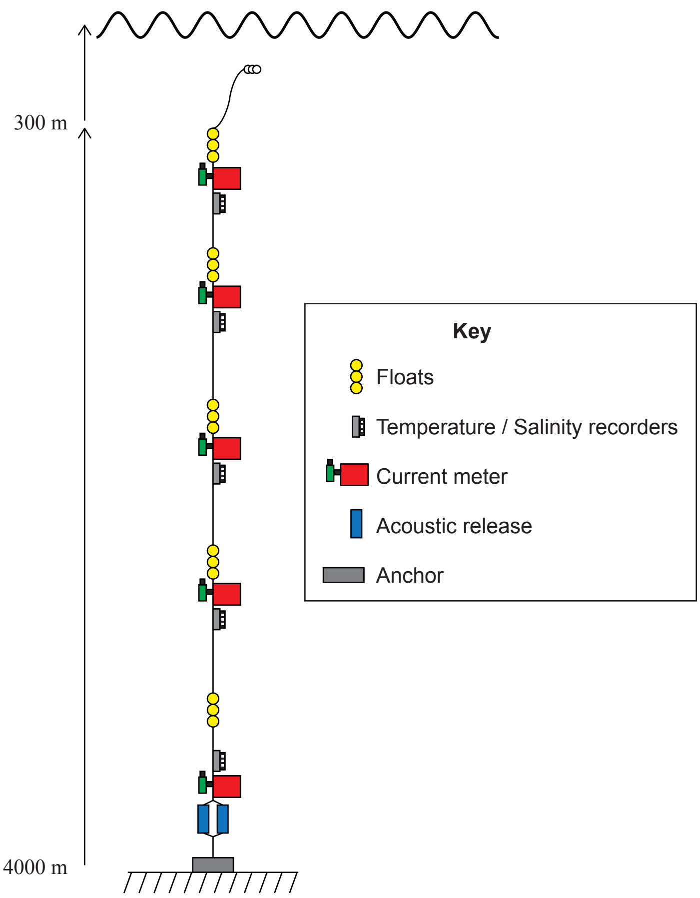
Use this material to help you answer Question Two on page 6 of your exam booklet.

Diagram One: The Antarctic Circumpolar Current

Adapted from: https://openparachute.files.wordpress.com/2012/09/acc.jpg

- The Antarctic Circumpolar Current (ACC) is the world's largest current; it is up to 5000 metres deep and 2000 km wide. Every second it transports 135 times the amount of water in all the world's rivers. The ACC flows eastward, or clockwise around Antarctica, for 24 000 km between 65°S and 40°S, and connects the Southern Ocean with the Atlantic, Pacific and Indian oceans.
- The water of the ACC is layered according to density, with each layer having a specific density. As the ACC circulates, the water layers with similar density from all four oceans mix together.
- The ACC is the primary means by which water, heat, and matter are exchanged between the four oceans.
- The ACC is part of the global thermohaline circulation (THC). Very dense water from the North Atlantic and Antarctica joins the ACC, forming the deepest layers at 2 – 5 km below the surface. Branches of the ACC, called Deep Western Boundary Currents (DWBC), carry this deep water into the Indian, Atlantic, and Pacific oceans. The largest of the DWBC flows north-eastwards past New Zealand and into the North Pacific.
- Specialised instruments on moorings placed in the gaps in the Macquarie Ridge continuously measure the flow of the current and other oceanic properties, such as density. These moorings help establish baseline data.
- The other place that such moorings have been used is in the Drake Passage (see **Diagram One** above).

Diagram Two: One of the types of moorings used in scientific research on the ACC



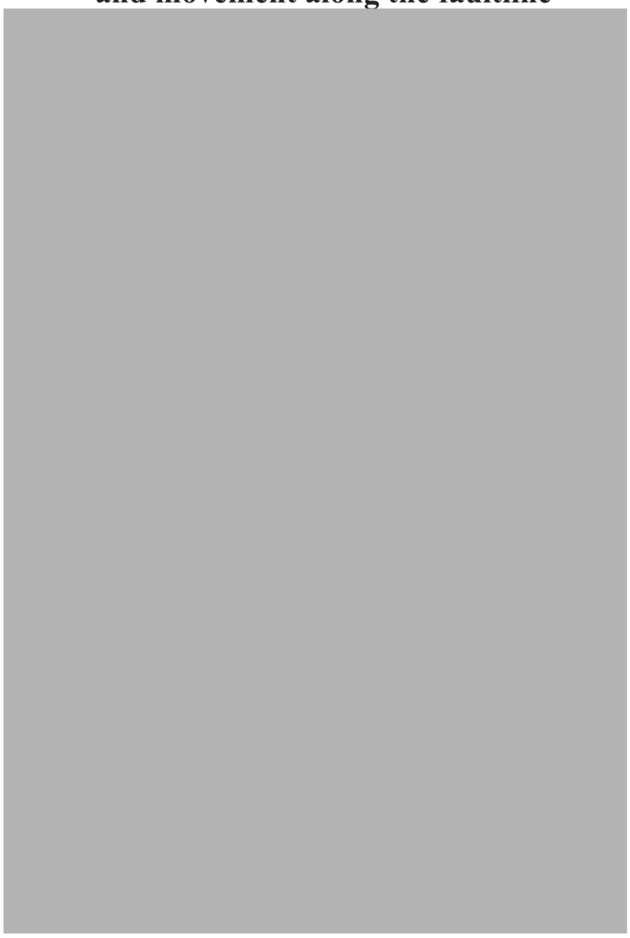
These moorings stay in place until the required data has been collected. The acoustic release responds to a sonar signal from the research vessel, and releases the mooring to enable it to float to the surface and be collected. The mooring is not immediately reused, but is taken back to shore, so that data can be taken from the instruments. The anchor is an old railway wheel, which stays on the bottom of the ocean.

Table One: Major shallow earthquakes on the Macquarie Ridge 1924 – 2008

Date	Magnitude
26/06/1924	7.8
24/07/1924	7.5
03/10/1926	7.5
22/02/1936	7.2
06/09/1943	7.8
13/12/1960	7.3
03/09/1987	7.2
23/05/1989	8.1
23/12/2004	8.1
30/09/2007	7.4
12/04/2008	7.4

Adapted from: www.aees.org.au/wp-content/uploads/2013/11/37-McCue1.pdf

Map One: Macquarie Ridge showing gaps through which the ACC flows and movement along the faultline



The Macquarie Ridge is part of the **Macquarie Fault Zone**, which is a major right lateral-moving transform fault with a small amount of compressional (convergence) movement. Only one part is above the surface, forming the small Macquarie Island.

www.niwa.co.nz/sites/niwa.co.nz/files/styles/large/public/sites/default/files/images/underseanz_2012_a4_150dpi.jpg?itok=Th6ix_Xc

Resource for
QUESTION THREE: USING ALBEDO TO INVESTIGATE EXOPLANETS

Use this material to help you answer Question Three on page 10 of your exam booklet.

Albedo, in astronomy, is the measurement of the amount of visible light reflected from the surface of a celestial object, such as a planet or moon. Albedo is the ratio of the reflected light to the incident light:

$$A = \frac{\text{reflected light}}{\text{incident light}}$$

and has values between:

- 0: a black object that absorbs all visible light and reflects none; and
- 1: a white object that reflects all visible light and absorbs none.

Diagram One: Albedo

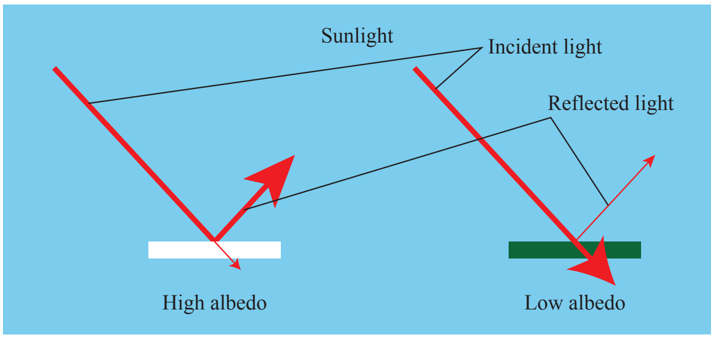


Table One: Albedo of selected known planets and moons

Note: The albedo will vary over the surface of a body, so an average measure is given.

Earth	0.30
Venus	0.75
Moon	0.12
Enceladus	0.99
Hyperion	0.30
Iapetus	0.05 – 0.50

Table Two: Albedo of various surfaces and substances

Fresh snow / ice	0.80 – 0.95
Old or dirty snow / ice	0.30 – 0.40
Thick clouds	0.60 – 0.90
Thin clouds	0.30 – 0.50
Water – direct sunlight	0.03 – 0.10
Water – indirect sunlight	0.01 – 1.00
Basalt rock	0.11
Soot	0.01

Earth, Venus, and the Moon

Photo One: Earth from space

www.nasa.gov/sites/default/files/images/115334main_image_feature_329_ys_full.jpg

This planet contains clouds, water, ice sheets, desert, forests, and other features, all of which have different albedo.

Photo Two: Venus as seen using visible light

https://commons.wikimedia.org/w/index.php?curid=338424

The solid surface of Venus cannot be seen as it is obscured by thick sulfuric acid clouds.

Photo Three: The Moon

https://commons.wikimedia.org/wiki/File:FullMoon2010.jpg

The darker areas (called maria) on the Moon are made from basalt rock which have filled up ancient impact sites. The lighter areas are called the highlands (terrae) and are made from the much paler anorthosite rock.

Three moons of Saturn

Photo One: The surface of Enceladus

https://www.wired.com/wp-content/uploads/2015/10/543564main_pia07800-full_full1-1024x812.jpg

Enceladus has a mostly smooth, icy surface, and contains more than 100 geysers at its south pole.

Photo Two: Enceladus showing geysers at its south pole

www.seeker.com/saturns-moon-enceladus-has-underground-ocean-1768440899.html?slide=tSLYWz

Photo Three: Hyperion

https://en.wikipedia.org/wiki/Hyperion_(moon)#/media/File:Hyperion_true.jpg

Hyperion is a small moon made of ice and rock, which has a very irregular shape, a rough surface, and a chaotic rotation around Saturn.

This resource continues on the following page.

Three moons of Saturn (cont.)

Photo Four: Iapetus showing the leading and trailing sides

http://photojournal.jpl.nasa.gov/jpegMod/PIA08384_modest.jpg

Photo Five: Iapetus's leading side showing the extent of the large dark patch.

www.nasa.gov/images/content/139197main_pia07766-350.jpg

Iapetus has distinctly light and dark surfaces. Iapetus's leading side (the side going first around Saturn) is dark, while its trailing side is bright. The dark surface is probably a thin layer of carbon-based material that was either swept up from space or oozed from the moon's interior. The light part is the underlying surface of rock and ice.

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