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93104R

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Scholarship 2016
Earth and Space Science

2.00 p.m. Friday 25 November 2016

RESOURCE BOOKLET

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

Check that this booklet has pages 2–7 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: SEAFLOOR METHANE HYDRATES AND GAS SEEPS

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

Permafrost is a frozen layer consisting of sediment particles stuck together by ice.

Around New Zealand, permafrost is found under the sea on parts of the continental shelf, including landslides, to a depth below the seafloor of about 500 metres. Such areas have a lot of dead organic material that is decomposed by microbes, resulting in methane being released. Over long periods of time and with the right combination of low temperatures and high pressure, the methane gas becomes trapped in water cages, forming frozen methane hydrates.

Methane hydrates occur naturally within and beneath permafrost.

Methane gas accumulates in the sediment, and is then released into the ocean by methane gas seeps, small regions in which methane gas bubbles up from the sea floor. Methane seeps at this depth indicate the presence of methane hydrates below the seafloor.

Methane hydrate cage

http://worldoceanreview.com/en/wor-3-overview/methane-hydrate/formation/flammable-ice-made-of-methane-and-water/

Diagram showing the research area of slow-moving landslides

http://www.radionz.co.nz/national/programmes/ourchangingworld/audio/2598266/methane-reserves-off-east-coast

During their first visit to the research area off the east coast of the North Island, scientists discovered 99 methane gas seeps in a 50 km^2 area. During their second visit, they remapped the same area in finer detail and identified about 766 gas seeps. The methane gas seeps rose up to 250 m above the ocean floor.

Sonar imaging showing methane seeps on the seafloor

www.niwa.co.nz/news/niwa-studies-spectacular-seabed-gas-flares

Methane can also form gas seeps in deeper areas in the ocean, but these are usually associated with large earthquake faults, and they do not affect landslides on the continental shelf.

Resource for
QUESTION TWO: LIQUID WATER ON MARS

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

Photos showing dark streaks of water running downhill

www.astronomycast.com/wp-content/uploads/2015/10/Mars-Before.jpg

Water on Mars exists mainly:

- in large amounts as ice
  - in the polar caps, where they are covered by a thin layer of frozen carbon dioxide except in summer
  - in glaciers, found between the latitudes of 30° and 50° in both hemispheres and covered by thick layers of dust
  - in the regolith (loose surface rock)
- in tiny amounts in the thin Martian atmosphere. The atmosphere is rarely saturated with water vapour, so liquid water easily evaporates
- chemically bound to minerals in the regolith, forming hydrated minerals such as perchlorates (a type of brine), which can lower the freezing point of water as much as –70°C
- as a thin film (adsorbed) on the surface of particles in the regolith.

Ice on Mars usually sublimes rather than melts.

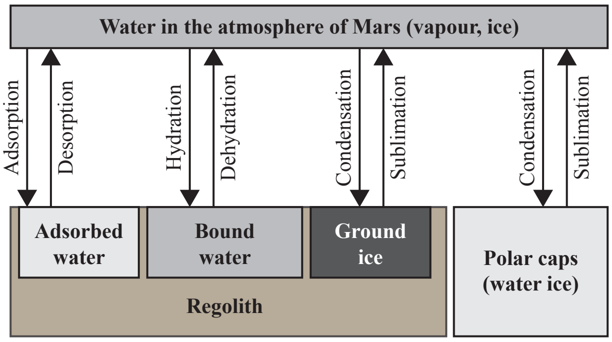
Dust storms on Mars vary in intensity from season to season and year to year.

An example of a geological feature on Mars is the massive Hellas Basin in the southern hemisphere, which is just over 7 km deep and 2 300 km across.

Water does not generally freeze when it is moving because it is harder for ice crystals to form.

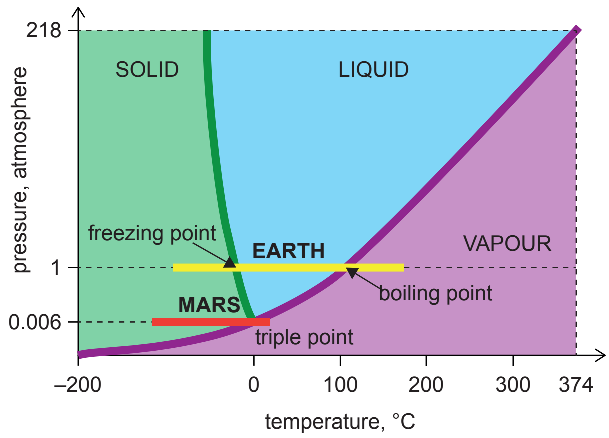
Liquid water and ice can co-exist under certain conditions in sub-zero temperatures, as found at Lake Vostok, a lake 4 km under ice in Antarctica.

Reversible processes plus the main forms and states of water on Mars



Adapted from: http://l503.iki.rssi.ru/publish/hend/F2-23.large.jpg

The States of Water on Earth and Mars



A phase diagram showing the different phases of water as a function of temperature and pressure. Typical values for Earth and Mars are shown.

Adapted from: www.iceandclimate.nbi.ku.dk/images/images_research_sep_09/mars_phase_diagram.jpg

Mars data

Average air pressure	0.006 atmospheres
Thickness of atmosphere	100 times thinner than Earth
Average temperature	–55°C
Diurnal temperature range	Can be as much as 90°C
Annual temperature range	–133°C to 35°C
Melting point of water	0ºC
Maximum boiling point of water	10ºC
One rotation	24 hours 40 minutes
One orbit	687 days (with an eccentric orbit)
Tilt of axis	25.2º
Closest distance to Sun (perihelion)	207 million km
Farthest distance from Sun (aphelion)	249 million km

Eccentric (non-circular) orbit of Mars and the Martian seasons

http://www.britannica.com/place/Mars-planet/Basic-astronomical-data

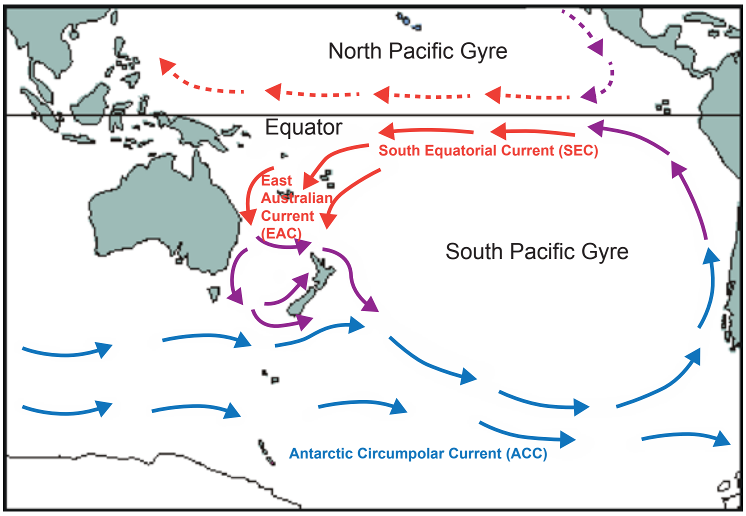
Unlike Earth, the seasonal temperature on Mars is influenced by its distance from the Sun.

Season	**Length**	**Relative temperature**
Northern spring, southern autumn	7 Earth months	The southern summer is warmer than the northern summer.
Northern summer, southern winter	6 months	
Northern autumn, southern spring	5.3 months	
Northern winter, southern summer	4 months	

Resource for
QUESTION THREE: THE WARMING OCEAN AND THE EFFECT ON NEW ZEALAND

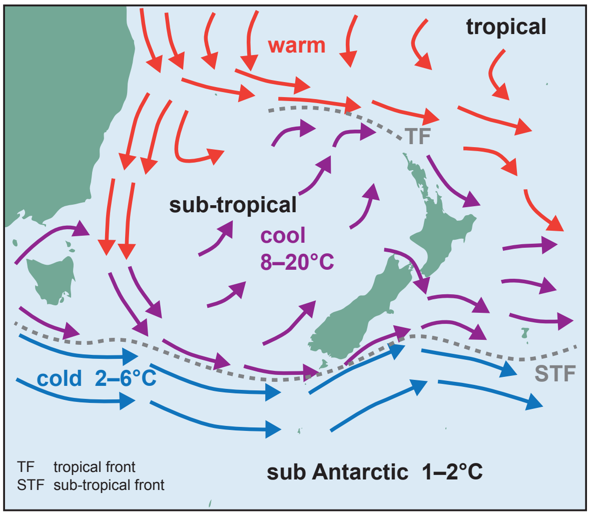
Use this material to help you answer Question Three on page 10 of your exam booklet.

Map 1: Currents around New Zealand relative to the South Pacific Gyre and the Antarctic Circumpolar Current



Adapted from: www.seafriends.org.nz/issues/res/pk/ecology.htm

Map 2: Currents around New Zealand in more detail



Adapted from: www.seafriends.org.nz/oceano/special.htm#Currents

The surface currents around New Zealand are influenced by many factors such as:

- the South Pacific Gyre, plus major currents such as Antarctic Circumpolar Current (ACC), South Equatorial Current (SEC) and the East Australian Current (EAC)
- the sub-tropical front (STF) and the tropical front (TF)
- topography such as the position of Tasmania and the landmass and underwater topography of New Zealand
- the Coriolis effect
- the Walker circulation.

The effects surface currents have on New Zealand are:

- New Zealand's climate is at least 2°C warmer than it would be without the warm currents, but the large differences in water temperature from north to south cause highly changeable weather.
- New Zealand's climate does not have extremes of droughts and floods, but rain can fall in any season.
- Nutrients are circulated to the surface along fronts such as the STF and the TF, resulting in rich plankton blooms and fish production. Nutrients are also transported from Australia.

"Fronts" are major convergence zones where currents of different salinity and temperature meet. Fronts act as "walls" between two currents, preventing the easy exchange of water and matter.

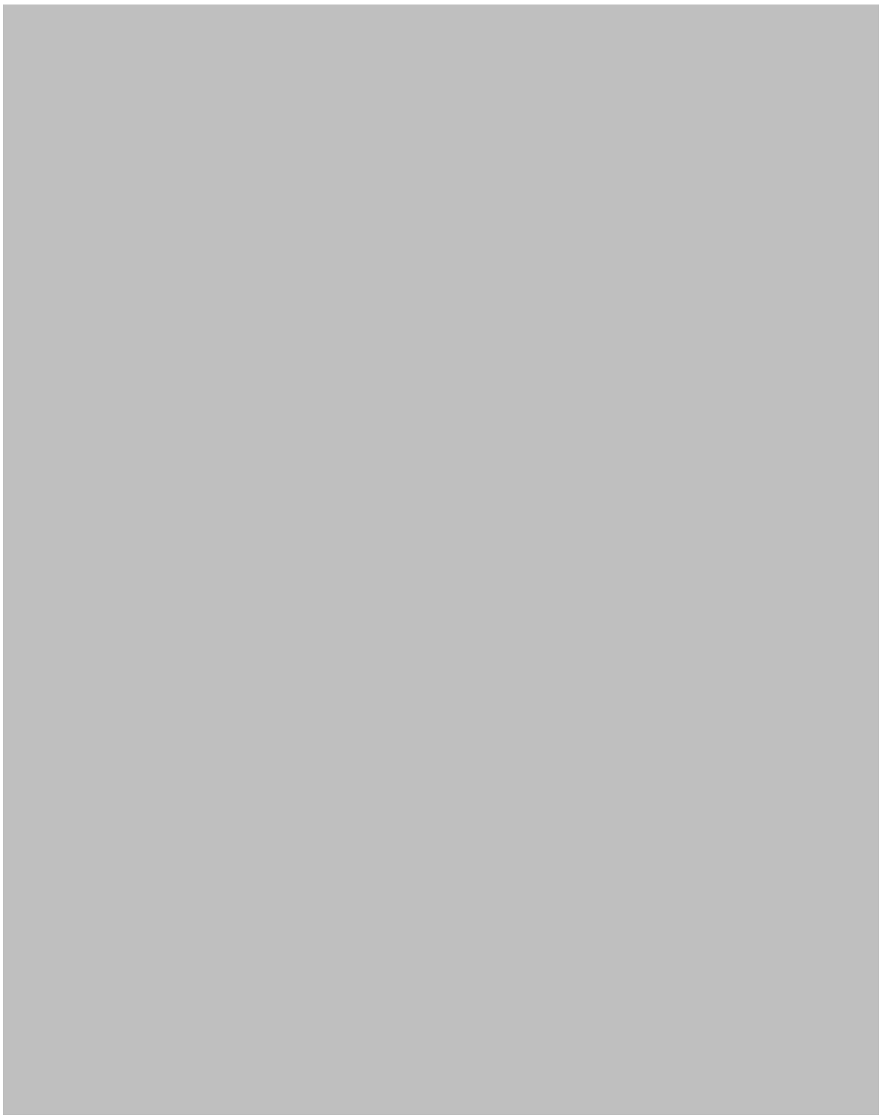
In the tropics, there are two big atmospheric circulation patterns. The Hadley circulation transports air north and south both sides of the Equator, and the Walker circulation transports air east and west across the Pacific. Together they influence the direction of the trade winds and cause warm surface waters to pile up in the Western Pacific. Warm water in the west and cool water in the east cause the Walker circulation.

In 2014, research showed that the Walker circulation was strengthening.

Walker circulation

www.southwestclimatechange.org/files/cc/figures/walker_circulation.jpg

Map 3: New Zealand's underwater topography



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

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