Assessment Schedule – 2013

Earth and Space Science: Demonstrate understanding of processes in the ocean system (91413)

Evidence Statement

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
ONE	Ocean surface currents form large circular patterns in large masses of water. They flow clockwise / east / right in Northern Hemisphere oceans and anticlockwise / west / left in Southern Hemisphere oceans because of the Coriolis effect. The Coriolis effect is a result of the rotation of the Earth. The Coriolis effect is the apparent deflection of objects, such as ocean currents, moving in a straight path relative to Earth's surface. The surface circulations are stronger at the equator and weakest at the poles. As the winds blow (*may have specific information about westerlies and trade winds but not required*) over the ocean, energy is transferred to the ocean. The **transfer of energy** results in surface waves and small-scale circulation. Due to the forces of gravity, the Coriolis effect, solar energy, and solar winds, water often moves in giant circular patterns called gyres. (*Gyre terminology not required.)* In the Northern Hemisphere the Coriolis forces deflect the flow to the right and in the Southern Hemisphere it is to the left. Surface ocean currents carry heat (warmer water) from place to place in the Earth system. Heat always travels from a warmer region to a colder region. This affects regional climates. The Sun warms water at the equator more than it does at the high latitude polar regions. The heat travels in surface currents to higher latitudes. Discusses upwelling / down-welling in terms of nutrients / matter and temperature. Western boundary currents, eg East Australian and Gulf Stream are deep and fast moving, and are among the largest and strongest ocean currents. They occur at the western side of an ocean basin and carry water, and therefore heat, from the equator towards the poles.	• Description of rotation of the earth as cause of Coriolis effect (can be diagram). • Description of surface circulation in each hemisphere (can be diagram). • Describes movement of energy (heat toward poles) OR matter.	• Explanation of how the Coriolis effect and surface winds result in surface circulation with reference to **energy transfer**. • Explanation of the transport of matter / nutrients and energy.	• Discussion of how the Coriolis effect and surface winds result in surface circulation, and how the surface circulation results in the transport of matter / nutrients and energy.

NØ = no response or no relevant evidence.	N1 = 1 partial point, eg one definition / incomplete diagram.	N2 = 1 point from Achievement or 2 partial points.	A3 = 2 points	A4 = 3 points	M5 = 1 point	M6 = 2 points	E7 = Full discussion but some detail less developed.	E8 = Full detailed discussion.

<table>
<tr><td>TWO</td><td colspan="3">Because CO_2 is relatively soluble in water, it enters the oceans. There, a very small amount of it reacts with water to form carbonic acid, which is a weak acid.
1. $H_2O + CO_2(g) \rightleftharpoons H^+ + HCO_3^-$
If more CO_2 is present and absorbed by the ocean the reaction is driven to the right, therefore increasing the amount of H^+ ions. This lowers the pH.
If CO_2 is being released to the atmosphere, then the reaction moves to the left and therefore produces fewer H^+ ions; the pH rises.
Historically the concentration of CO_2 in the oceans was relatively constant. There were slight fluctuations in CO_2 levels but the pH of the ocean didn't alter by much, because there is a further reaction involving carbon compounds that causes a phenomenon called buffering.
2. $CO_2 + CO_3^{2-} + H_2O \rightleftharpoons 2HCO_3^-$
As more CO_2 was added, more HCO_3^- formed. This affects equation 1 above and means although a rise in acidity would be expected, the extra HCO_3^- forces equation 1 to the left, lowering acidity (increasing pH).
The ocean, especially the southern ocean, up until recently, absorbed all the CO_2 through this balancing / buffering / equilibrium system without a change in acidity / pH.
With industrialisation, there is a lot more atmospheric CO_2, which results in a lot more CO_2 entering the oceans. This increase is more than the equilibrium in the ocean can handle, and therefore there is an increase in the acidity of the oceans.
(May also refer to decreased solubility of gases with increasing temperature as a competing factor.)</td><td>• Describes formation of carbonic acid (sentence / word / symbol equation).
OR
Statement that ocean acidity (pH) is affected by CO_2 in the atmosphere.
• Statement that increasing CO_2 in atmosphere increases CO_2 in ocean (physical or chemical).
• Increase in fossil fuels has led to an increase in CO_2 in ocean.</td><td>• Explains acidity in terms of H^+ linking to atmospheric CO_2.
• Explanation of why ocean acidity (pH) remained constant in the past.
OR
Explanation of why ocean acidity is now rising (pH falling).</td><td>• Discussion of why the ocean acidity remained constant in the past but is now rising, with reference to the role of buffering / balance on the equilibrium equation showing H_2O / CO_2 reaction.
OR
CO_2 / CO_3^{2-} / H_2O reaction.</td></tr>
<tr><td></td><td>NØ = no response or no relevant evidence.</td><td>N1 = 1 partial point, eg mentions carbonic acid.</td><td>N2 = 1 point from Achievement.</td><td>A3 = 2 points</td><td>A4 = 3 points</td><td>M5 = 1 point</td><td>M6 = 2 points</td><td>E7 = Full discussion but some detail less developed.</td><td>E8 = Full detailed discussion.</td></tr>
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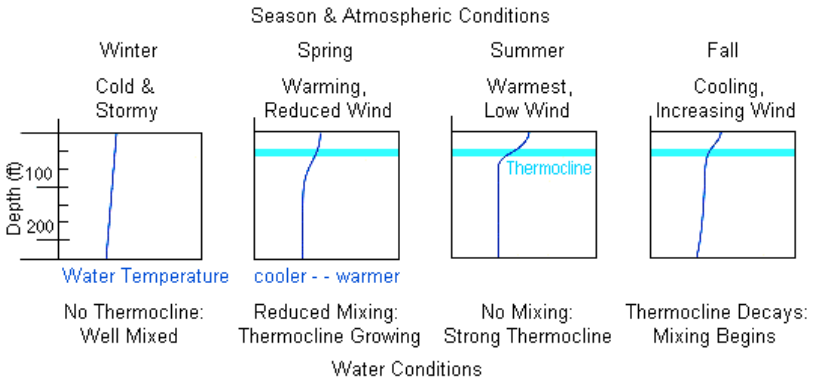
<td>THREE</td>
<td>The thermocline layer is the (transition) layer between the mixed layer (may not refer specifically to “mixed layer”) at the surface, and the deep water layer in an ocean. These layers are based on the temperature of the water.
The mixed layer is near the surface where the temperature is roughly that of the surface water. In the thermocline layer, the temperature decreases rapidly from the mixed layer temperature to the much colder deep water temperature. The thermocline layer acts as a barrier between the two layers.
The mixed layer and the deep water layer are relatively uniform in temperature, while the thermocline layer represents the transition zone between the two.
A thermocline layer forms in the summer due to an increase in the amount of solar radiation. This solar energy is transferred to the top 2–3 cm of the water in the mixed layer of water which increases the temperature. Waves mix the top 25–50 m (approximately) of the ocean, which makes a fairly uniform temperature in the mixed layer. The deep water layer does not directly receive the energy, and the temperature gradually decreases with increased depth. Because of the difference between the two layers, a temperature gradient is set up.
In the winter, the amount of solar radiation decreases and therefore the mixed layer temperature drops. This results in a more consistent temperature gradient between the layers, and therefore the thermocline ceases to exist.
 

http: / / njscuba.net / biology / misc_water.html</td>
<td>• Description / diagram of a thermocline in the ocean different to that in the question. eg describes 2 of the 3 layers with reference to the thermocline as preventing mixing / barrier (accept pycnocline).
• Description of the relationship between TWO seasons and the change in the thermocline (mixing).
• Description of the transport of heat (energy / light) or matter (water) with reference to TWO seasons.</td>
<td>• Explanation of formation of thermocline.
• Explanation of the transport of heat (energy) from the sun and matter (water).
• Explanation of the effect of TWO seasons and the thermocline with reference to mixing by wind.</td>
<td>• Discussion of the formation of the thermocline off the coast of Mexico in relation to THREE seasons in terms of energy and mixing.</td>
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<td>NØ = no evidence or no relevant evidence</td>
<td>N1 = 1 partial point, eg Thermocline is the barrier.</td>
<td>N2 = 2 partial points OR 1 point from Achievement, eg describes any one seasonal relationship.</td>
<td>A3 = 1 point from achievement.</td>
<td>A4 = 2 points from achievement.</td>
<td>M5 = 1 point</td>
<td>M6 = 2 points</td>
<td>E7 = Full discussion but some detail less developed.</td>
<td>E8 = Full detailed discussion.</td>
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Judgement Statement

	Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
Score range	0 – 7	8 – 12	13 – 18	19 – 24