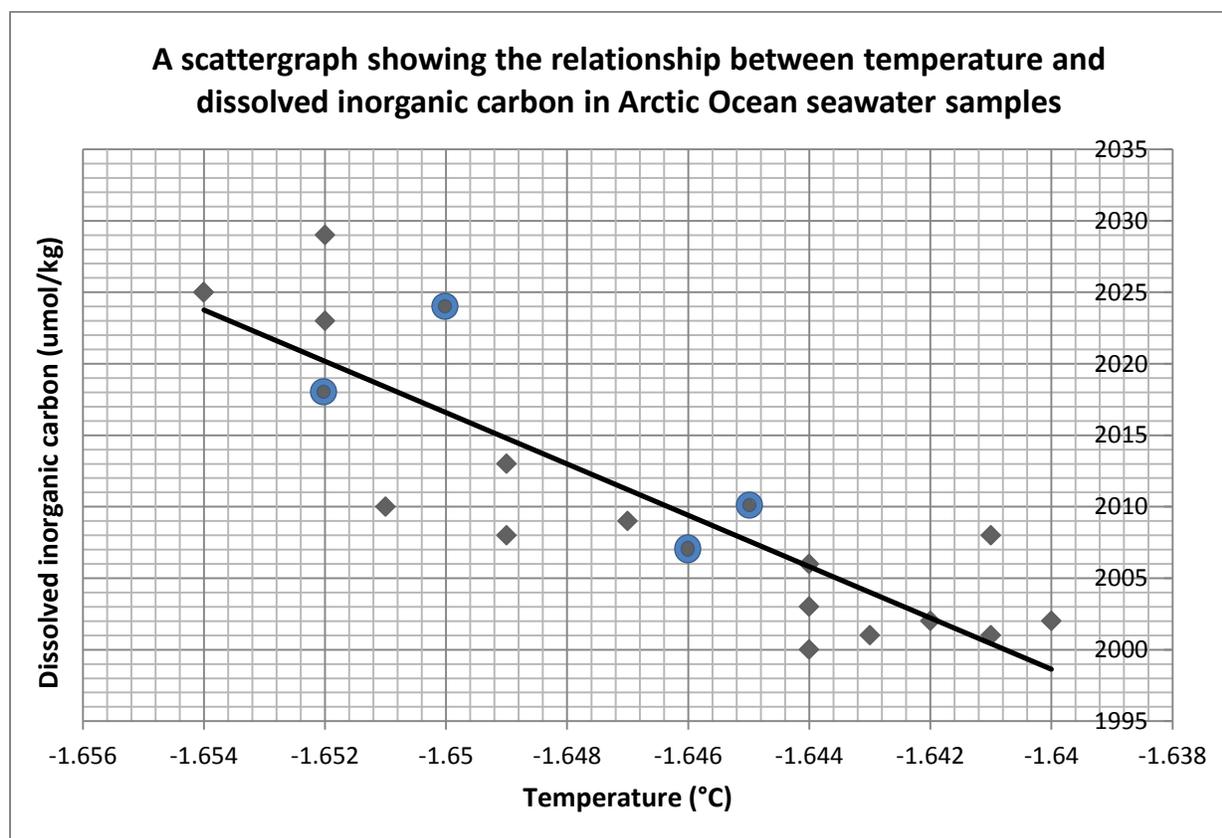


Mark scheme for Ocean Acidification Lesson 2 main activity

1 (a) (i)	1 mark for each accurate plot (see highlighted points on graph below)	<i>(4 marks)</i>
1 (a) (ii)	1 mark for straight line through the middle of the plots, approximating that shown below. There should be an even number of plots above and below the line.	<i>(1 mark)</i>
1 (a) (iii)	1 mark per valid point with additional credit for correct use of data from the graph (maximum 1 mark for this), e.g. As temperature decreases, dissolved inorganic carbon increases. Suggestion of a negative correlation between the variables. Distribution of points suggests this is a relatively strong but not perfect correlation. Examples given, e.g. at -1.640°C dissolved inorganic carbon at a level of 2002 $\mu\text{mol/kg}$ whereas at -1.654°C the level is 2025 $\mu\text{mol/kg}$.	<i>(3 marks)</i>
1 (a) (iv)	1 mark for mention of both sets of data, 1 mark for Maximum 1 mark for incorrectly worded hypothesis. e.g. There is a significant negative correlation between the temperature and dissolved inorganic carbon content of Arctic Ocean seawater samples, meaning that as temperature decreases, the dissolved carbon content decreases.	<i>(2 marks)</i>



<p>1 (b) (i)</p>	<p>1 mark for each correct stage (shown by workings – see overleaf) in the calculation (maximum 4 marks). Alternative approaches to workings permitted, as long as they are accurate and logical. 1 mark for correct answer given to 2 decimal places.</p>	<p>(5 marks)</p>
<p>1 (b) (ii)</p>	<p>1 mark per valid stage in the process of establishing the strength and validity of a correlation, e.g. The process requires a graph which plots r against degrees of freedom. Degrees of freedom are the number of pairs in the sample minus 2 (i.e. $n - 2$). Graph indicates significance levels of 0.1%, 1% and 5%. Plotting value of r against degrees of freedom determines whether hypothesis can be accepted at 99.9% / 99% / 95% level, or must be rejected. Levels mean there is a 0.1% / 1% / 5% likelihood that the correlation occurred by chance. If value of r falls below the 5% level, hypothesis is rejected. No result can prove a causal relationship between variables.</p>	<p>(4 marks)</p>
<p>1 (b) (iii)</p>	<p>Notes for answers</p> <p>Responses should link the significance of the temperature/dissolved carbon relationship to an awareness and understanding of the process of ocean acidification, and of the implications of this for the Arctic Ocean.</p> <p>Ocean acidification is the process by which carbon dioxide from the atmosphere is absorbed by the oceans, where it reacts with seawater to form carbonic acid. As the concentration of carbon dioxide in the atmosphere increases, so to does the amount absorbed by the oceans. As a result, the acidity of oceans globally is increasing (the pH is decreasing). The results of the correlation suggest that colder water contains more dissolved carbon, hence has more potential to become acidic. This has serious implications for the Arctic Ocean because it is in the cold Polar regions that the effects and impacts of ocean acidification are being observed, and are likely to increase the most.</p> <p>Ocean acidification has the potential to impact on the whole Arctic ecosystem. The increased acidity of the water can start to dissolve the calcium carbonate shells of microscopic plankton, reducing their resilience and reducing population numbers. This affects the food supply for consumers and impacts on the entire foodweb.</p>	<p>(6 marks)</p>

	<p>Level 1 (1 – 4 marks) Ranging from no real understanding of the science behind ocean acidification (1-2 marks) to some inaccuracies (3-4 marks). No clear explanation of the importance of the relationship to the Arctic Region. Simplistic comments. Predominantly descriptive. Lacking explanation.</p> <p>Level 2 (5 – 6 marks) Accurate description of the process of ocean acidification. Clear explanation of the relationship indicated by the data. Links made between the data and the implications for the Arctic region. Mention of specific impacts of ocean acidification on the ecosystem for full marks.</p>	
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Calculations for Question 1 (b) (i):

$r = 1 - \frac{6 \sum d^2}{n^3 - n}$		
Step 1:	$\sum d^2 = 2455.5$	
Step 2:	$1 - \frac{6 \times 2455.5}{8000 - 20}$	Answer correct to 2 decimal places: <div style="border: 1px solid black; padding: 5px; display: inline-block;"> $r = -0.85$ </div>
Step 3:	$1 - \frac{14733}{7980}$	
Step 4:	$1 - 1.846$	