**Year 12 ATAR Chemistry**

Task 1 – Ocean Equilibria

Extended Response Assessment

NAME: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ TEACHER: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ MARKS: \_\_\_\_\_ /35

**Instructions:**

* You will then be given 50 minutes to complete the test.
* Short response questions should be written in the spaces provided.
* Any calculations must be stated to the correct number of significant figures.
* Scientific calculators are permitted for this test.
* A Chemistry Data Sheet will be provided with this test.

**Questions:**

*Answer all questions in the spaces provided. Full working must be shown for calculations. Final answers must be given to the correct number significant figures.*

The health of aquatic ecosystems is dependent on pH. pH affects both aquatic plant and animal life and pH often needs to be kept within a specific narrow range in order to maintain the health of these aquatic organisms.

The pH of sea water is maintained by a buffer system set up by a series of equilibrium equations (see below). This buffer systems works by shifting the equilibria represented by these equations in order keep the pH of the sea water between 8.0 - 8.3 and fresh water between 5.5 – 7.0.

CO2 *(g)* ↔ CO2 *(aq)* [equation 1]

CO2 *(aq)* + H2O *(l)* ↔ H2CO3 *(aq)* [equation 2]

H2CO3 *(aq)* + H2O *(l)* ↔ H3O+ *(aq)* + HCO3- *(aq)* [equation 3]

H3O+ *(aq)* + CO32- *(aq)* ↔ HCO3- *(aq)* + H2O *(l)* [equation 4]

1. Write an equilibrium constant expression for each of equations above. [8 marks]

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| Equation 1 |
| Equation 2 |
| Equation 3 |
| Equation 4 |

Chart, line chart

Description automatically generatedPhytoplankton are an important aquatic animal found in aquatic ecosystems. They are able to utilise dissolved carbon dioxide to undergo photosynthesis. Overgrowth of these phytoplankton is one of the organisms responsible for algal blooms that occur in water bodies such as the Swan-Canning estuary.

Recent atmospheric results published by the National Oceanic and Atmospheric Administration (Retrieved from <http://www.esrl.noaa.gov/gmd/ccgg/trends/>global.html [21 November, 2016]) are shown below.

1. What trend is shown in the graph above? And how will this impact on the population of phytoplankton in the surrounding water bodies? Explain your answer with reference to the relevant equations above. [3 marks]

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1. What effect does this trend have on the [H3O+] and the pH of water bodies? [2 marks]

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1. With reference to Collision theory explain how the pH of the Swan-Canning estuary changes as a result of phytoplankton photosynthesis during an algae bloom. Refer to the equations above to support your answer. [5 marks]

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The enhanced greenhouse effect is caused by an increase in atmospheric CO2. The reasons behind increased atmospheric CO2 levels have been linked to many human behaviours. For example, combustion of petrol, burning of coal to produce electricity and the clearing of forests.

1. Sketch a graph showing the rate of the forward reaction and reverse reactions for equation 1 above, as the system in local water bodies re-establishes equilibrium following the purposefully lit bushfires in Wooroloo, West of Perth on Boxing Day 2021. [3 marks]

A picture containing shape

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The graph below represents the chemical species in equation one, originally at equilibrium. A change occurs at time point A and equilibrium is re-established by time point B.

Diagram

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1. Describe an event that could have occurred at A? [1 mark]

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1. Continue the above graph through time point B to time point C, showing the effect this event will have on the concentration of each of the species shown in equation 1. [4 marks]
2. Using information in the graph below, predict the effect the enhanced greenhouse effect will have on the value of Keq equation 1. [1 mark]

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Chart, line chart

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Shells and skeletons of coral reefs are formed by CaCO3(s). Although, CaCO3 is considered insoluble, a very small amount is able to dissolve and as such an equilibrium exists which has a very small Keq value.

CaCO3*(s)* ↔ Ca2+*(aq)* + CO32-*(aq)* Keq = 5.0 x 10-9 at 298K [equation 5]

1. Calculate the [Ca2+*(aq)*] and [CO32-*(aq)*] of the saturated solution at equilibrium. [3 marks]

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A saturated solution of calcium carbonate (CaCO3) is achievable in the ocean due to the very low concentrations required to establish a saturated solution. Any excess ions are then used to form the CaCO3*(s)* needed for shells, coral and the exoskeletons of aquatic animals.

On the next page is a table published in the 2015 Australian Energy Update by the Department of Industry and Science.



1. With reference to the positions of equilibria shown in all of the equations above explain how Australia’s energy consumption between 2003 and 2008 would have affect the strength of local aquatic animals’ skeletons. (Assume all other contributing factors remain constant). [5 marks]

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**End of Assessment**

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