Australian Islamic College 2021

ATAR Chemistry Units 3 and 4

Task 2
(Weighting: 1% for Holiday Homework; 4% for this Validation Test)

Ocean Equilibrium

Test Time: 35 minutes

Please do not turn this page until instructed to do so.

First Name	Surname
Answers	

Teacher

Mark / 35	Percentage

Equipment allowed: Pens, pencils, erasers, whiteout, rulers and non-programmable calculators permitted by the Schools Curriculum and Standards Authority.

Special condition: 2 marks will be deducted for failing to write your full name on this test paper.

Teacher help: Your teacher cannot help you during the test. Do not ask the teacher questions about the questions.

Questions must be answered in this booklet, in the spaces provided.

Special conditions regarding questions involving calculations.

- For all questions involving calculations, final answers must be stated to the correct number of significant figures, unless otherwise stated. 1 mark will be subtracted for failing to do this.
- For all questions involving calculations, final answers must be stated with the correct units. 1 mark will be subtracted for failing to do this.
- Follow-on marks will not be paid for calculations.
- For all questions involving calculations, calculations must be shown. Calculations must be explicit and logically set-out in the opinion of the marker. Marks will not be awarded for calculations that are not set out in a manner that can not be easily followed by the marker.

Total marks: 35

1. For the last few decades, the climate change debate has been taking place between the scientists, governments, companies and citizens of our planet. Rising carbon dioxide levels are thought to have contributed significantly to this climate change, including the phenomenon known as 'ocean acidification'. Some of the chemistry behind carbon dioxide and its link to ocean acidification is represented in the equations below.

Equation 1: $CO_2(g) + H_2O(l) \rightleftharpoons H_2CO_3(aq)$
Equation 2: $H_2CO_3(aq) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$
Equation 3: $HCO_3^-(aq) \rightleftharpoons H^+(aq) + CO_3^{2-}(aq)$

a) Explain how an increase in atmospheric carbon dioxide, $CO_2(g)$, levels can cause a change in the pH of our oceans. (3 marks)

- **Some atmospheric carbon dioxide dissolves in ocean water to produce the weak carbonic acid (equation 1)**
- **The carbonic acid then ionises to produce H_3O^+ (equation 2 and 3)**
- **Since pH = -log[H_3O^+], the presence of additional H_3O^+ in our oceans lowers the pH and causes acidification**

b) The ocean is not acidic, and researchers say the oceans won't ever become acidic. So why is it called ocean acidification? (2 marks)

- **Ocean acidification refers to the process of lowering the oceans' pH (that is, increasing the concentration of hydrogen ions) (1) by dissolving additional carbon dioxide in seawater from the atmosphere. (1)/becoming less alkaline**

c) What are two very important biological and chemical processes, happening in the oceans that are dependent on carbonate ions? Explain. (4 marks)

- **First, some marine organisms use carbonate to form calcium carbonate (CaCO3). (1)**
- **For example Shell formation, exoskeleton formation, coral reef formation any one (1)**

- **Second, carbonate ions regulate the pH of seawater. If an acid is added to seawater, the carbonate ion reacts with excess hydrogen ions to produce bicarbonate. (1)**
- **If a base is added to seawater, this bicarbonate will donate hydrogen ions to neutralize the Base (1)**

d) Is ocean acidification just another name for climate change? (2 marks)

No. While ocean acidification and climate change share a common cause (increases in CO_2 in the atmosphere), climate change encompasses the effects associated with changes in the Earth's heat budget (due to the greenhouse effect of CO_2 and to a lesser extent other climate reactive gases), which cause global warming and changes in weather patterns. (1)
Ocean acidification specifically refers to the lowering of ocean pH resulting from its absorption of human-released CO_2 from the atmosphere. Ocean acidification does not include the warming of the ocean.(1)
Or any other similar explanation.
No marks foe just writing the 'No'

e) Other than using the fossils fuels what other human activities are contributing towards ocean acidification? State any three. (3 Marks)

- **industrial and agricultural wastes that have acidic compounds are very dangerous as they lower the PH of the ocean water.**
- **Improper land management- Chemicals used in farming**
- **Industrialization- causing acid rains**
- **Or any other relevant answer.**

2. Bio-methane is a naturally occurring gas which is produced by the anaerobic digestion of organic matter such as dead animal and plant material, manure, sewage, organic waste, etc.
   Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane.
   Though they both contain methane which is a greenhouse gas, however, use of bio-methane is a cleaner and greener fuel as compared to natural gas. Explain why?

(5 marks)

When natural gas is used as a fuel it is burnt/combusted (1) which produces carbon dioxide (1) which causes global warming / is a greenhouse gas (1).
When biomethane is used as a fuel (it is also burnt and) carbon dioxide is produced (1) however the carbon dioxide is used up again / taken back out of the atmosphere when the next crop is grown (1).

3. The following sequence of reactions summarise ocean acidification.

Reaction 1	$CO_{2(g)} \rightleftharpoons CO_{2(aq)}$
Reaction 2	$CO_{2(aq)} + H_2O_{(l)} \rightleftharpoons H_2CO_{3(aq)}$
Reaction 3	$H_2CO_{3(aq)} \rightleftharpoons H^+_{(aq)} + HCO_3^-{}_{(aq)}$
Reaction 4	$HCO_3^-{}_{(aq)} \rightleftharpoons H^+_{(aq)} + CO_3^-{}_{(aq)}$

Given that the first three reactions in this sequence are being pushed to the right by the increasing concentrations of carbon dioxide in the atmosphere, reaction 4 is being pushed to the left.

Zooplankton are tiny organisms that build shells made of calcium carbonate. They are tiny but they are big players in the food webs of the oceans as they are an important part of a food chain.

a. Explain how reaction 4 being pushed to the left could directly adversely affect survival of zooplanktons and then indirectly affect land animals such as Sea gulls.

(4 marks)

(When reaction 4 is pushed to the left) the concentration of CO_3^{2-} in the ocean decreases (1)
which means there is less CO_3^{2-} available for zooplankton to build their shells (1)
These organisms at (or near) the bottom of food chains (1)
Sea Gulls are at the top (or near) of food chains suffer from lack of food available lower down the food chain

4. In December 2013, Cairo and other parts of Egypt experienced their first snowfall in over a century. In Israel, the same storm was described as the heaviest snowfall in over 60 years. People argue, world is getting hotter, yet we experience these sort of rare events, which contribute towards the non-occurrence of global warming.

These rare events could be due to deforestation. Is deforestation an example of positive-feedback cycles that are exacerbating global warming and/or ocean acidification. Explain.

(3 marks)

Yes. Deforestation results in fewer trees to absorb CO2 gas. (1)
Also, when plants are cut down and burnt or left to rot, the carbon that makes up their organic tissue is released as carbon dioxide. (1)
A significant amount of carbon is stored below ground in the soil and roots as well, and this too can be released following the disturbance of deforestation. (1)

Stoichiometry Question (9 Marks)

Under laboratory conditions of 1 kPa and 20 ^{o}C, 50.00 mL of 2.50 mol L^{-1} hydrochloric acid was placed in a container. 4.500 g of cleaned magnesium ribbon was added to the container and the hydrogen gas produced was collected.

(a) Write the equation for this reaction. (1 mark)
(b) Determine which reactant is the limiting reagent. (3 Marks)
(c) Determine the mass of the excess reagent remaining at the end of the experiment. (2 marks)
(d) Calculate the concentration of the magnesium ion in the final solution. (3 marks)

(a) **$2HCl(aq) + Mg(s) \rightarrow MgCl_2(aq) + H_2(g)$**
or $2H^+(aq) + Mg(s) \rightarrow Mg^{2+}(aq) + H_2(g)$ **(1)**

(b) **n(HCl) = c.V = 2.5 x 0.05 = 0.125 mol HCl**
n(Mg) = m / M = 4.5 / 24.31 = 0.1851 mol Mg **(1)**
SR n(HCl) / n(Mg) = 2 / 1 = 2
AMR n(HCl) / nMg) = 0.125 / 0.1851 = 0.675 **(1)**
Clearly, SR > AMR Hence, HCl is the limiting reagent. **(1)**

(c) **from equation, n(Mg) reacting = 1/2 n(HCl) = 0.0625 mol Mg reacting**
(1)
n(Mg) left over = n(Mg) original - n(Mg) reacting = 0.1851 - 0.0625 = 0.12261
m(Mg) = n x M = 2.9806 Hence, the mass of Mg remaining = 2.98 g **(1)**

(d) **from equation, $n(MgCl_2)$ = 1/2 n(HCl) = 0.0625 mol $MgCl_2$** **(1)**
from formula, $n(Mg^{2+})$ = $n(MgCl_2)$ = 0.0625 mol Mg^{2+} **(1)**
$c(Mg^{2+})$ = n / V = 0.0625 / 0.05 = 1.25 mol L^{-1} $Mg^{2+}(aq)$ **(1)**