Past-paper walk-through

Ocean Acidification ▪ 9.7

eXercise

Questions in this set

- 2019 Q3

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 3

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The graph shows measurements of atmospheric levels of carbon dioxide (CO_2) at Mauna Loa Observatory, Hawaii, and the measurements of pH levels in the ocean nearby at Station ALOHA. Measurements of pH began in 1992.

ATMOSPHERIC CARBON DIOXIDE AT MAUNA LOA AND OCEANIC pH AT STATION ALOHA, HAWAII

[Dual-axis line graph, x-axis "Year" from 1965 to 2015. Left y-axis "CO_2 (ppm)" from 275 to 400 in steps of 25 (275, 300, 325, 350, 375, 400). Right y-axis "pH" from 8.00 to 8.37 in steps of 0.07 (8.00, 8.08, 8.16, 8.23, 8.30, 8.37). Solid line = Mauna Loa Atmospheric CO_2 (ppm): a steadily rising, seasonally oscillating (sawtooth) curve starting at about 315 ppm in the early 1960s and rising to about 400 ppm by 2015. Dashed line = Station ALOHA Ocean pH: begins around 1992 near pH 8.11, oscillates with high-frequency noise, and shows an overall gradual downward trend to about pH

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8.07 by 2015 (with a fitted trend line sloping downward from left to right over that span).]

(a)(i) Use the graph above to answer the following questions.

Determine the concentration of CO_2 (in ppm) recorded at Mauna Loa in 2005.

(a)(ii) Determine the pH recorded at Station ALOHA in 2005.

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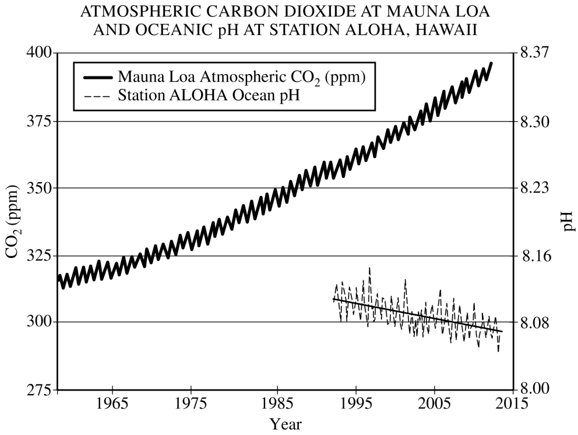
began in 1992.



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downward trend to about pH 8.07 by 2015 (with a fitted trend line sloping downward from left to right over that span).]

(b)(i) Changes in atmospheric carbon dioxide affect Earth's oceans.
Predict the effect of increased concentration of atmospheric CO_2 on the concentration of CO_2 in the ocean.

(b)(ii) Based on the data, identify the relationship between the concentration of atmospheric CO_2 and the pH of ocean water.

(b)(iii) Provide the complete chemical equation that represents the reaction between oceanic carbon dioxide (CO_2) and water (H_2O).

(b)(iv) Identify the specific environmental problem that directly results from the decrease in pH of Earth's oceans.

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(c)(i) Changes in pH in the world's oceans pose a risk to many marine organisms. Explain why certain organisms, in particular those with calcium carbonate shells or exoskeletons, are threatened by the decreasing pH levels measured in seawater.

(c)(ii) Other than threats posed by decreasing pH, identify an additional anthropogenic threat to the world's coral reef ecosystems and describe how the threat damages the coral reefs and coral reef ecosystems.

Solution 3

(a)(i)

Mark scheme

- CO_2 concentration at Mauna Loa in 2005: 380 ppm (accept 375–385 ppm, i.e. ± 5 ppm read from the graph).

(a)(ii)

Mark scheme

- pH recorded at Station ALOHA in 2005: 8.08 (accept 8.06–8.10, i.e. ± 0.02 read from the graph).

Solution 3

(b)(i)

Mark scheme

- Predicted effect of increased atmospheric CO_2 on oceanic CO_2: oceanic (dissolved) CO_2 will increase. Full credit for stating that oceanic CO_2 increases as atmospheric CO_2 increases.

Solution 3

(b)(ii)

Mark scheme

- Relationship between atmospheric CO_2 and ocean pH: as atmospheric CO_2 increases, pH decreases (equivalently: as more CO_2 dissolves in the water it becomes more acidic/less alkaline; or H_3O^+/H^+ ion concentration increases as atmospheric CO_2 increases). Full credit for correctly identifying the inverse relationship.

Solution 3

(b)(iii)

Mark scheme

- Balanced chemical equation for the reaction between oceanic CO_2 and water — any one of: $CO_2 + H_2O \rightarrow H_2CO_3$ (carbon dioxide plus water produces carbonic acid); $CO_2 + H_2O \rightarrow H^+ + HCO_3^-$ (produces one hydrogen ion and one bicarbonate ion); $CO_2 + H_2O \rightarrow 2H^+ + CO_3^{2-}$ (produces two hydrogen ions and one carbonate ion). Full credit for any one correctly balanced equation.

Solution 3

(b)(iv)

Mark scheme

- Specific environmental problem resulting directly from the decrease in ocean pH: Ocean Acidification.

Solution 3

(c)(i) Mark scheme

- 2 points — 1 point for explaining the chemical impact of decreased pH on shell/coral formation, and 1 point for describing the resulting impact on organism survival. Chemical impact examples: a decrease in pH could cause shells/exoskeletons to dissolve; prevent the growth of new coral/shells; prevent renewal/maintenance of existing coral/shells. Survival impact examples: organisms such as mollusks and coral would be threatened with reduced fitness/decreased number of offspring; increased predation risk; increased threat of disease. Both a valid chemical-impact idea and a valid survival-impact idea are needed for full 2 points; either alone earns 1 point.

Solution 3

(c)(ii) Mark scheme

- 2 points — 1 point for identifying an anthropogenic threat to coral reefs other than decreasing pH, 1 point for describing how it damages coral reefs/reef ecosystems. Acceptable paired examples: Increased ocean temperature $\rightarrow$ coral bleaching (loss of the algal symbiont), reduction of dissolved oxygen concentration; Recreational activities (watercraft, scuba, snorkeling, swimming, etc.) $\rightarrow$ physical damage to/destruction of coral reefs; Fishing practices (bottom trawling, dynamite fishing, overfishing, etc.) $\rightarrow$ physical damage to/destruction of coral reefs, removal of key species disrupts the food web/causes a trophic cascade; Nutrient pollution (agricultural runoff, wastewater treatment plants) $\rightarrow$ cultural eutrophication and eventual decrease in dissolved oxygen levels, excessive algal

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growth reduces light penetration; Sediment pollution (logging operations, mining, etc.) $\rightarrow$ increased turbidity/reduction in light penetration, deposited sediments cover/smother coral reefs; Chemical pollution (oil spills, pesticide runoff, sunscreen, etc.) $\rightarrow$ disruption of reproduction and growth cycles, disruption of metabolic processes, endocrine disruption/DNA damage, reduction in light penetration; Plastic/solid waste pollution $\rightarrow$ physical damage to/destruction of members of the coral reef ecosystem, reduction in light penetration; Introduction of invasive species (lionfish/turkey fish, Philippine mantis shrimp, etc.) $\rightarrow$ invasive species can outcompete native species. Award 1 point for a valid threat, 1 point for a correctly linked description of damage.