4. The element carbon is contained in all organic compounds.
   (a) **Discuss** the role of photosynthesis and cellular respiration in carbon cycling in the biosphere.
   (b) For THREE of the following, **predict** and **explain** the effect on the carbon cycle if:
      - decomposers were absent
      - deforestation occurred
      - volcanic dust accumulated in the atmosphere
      - the average ocean temperature increased
   (c) **Explain** how increased CO_2 in the atmosphere results in greater acidification of oceans and **describe** the effect on marine organisms. **Include** in your discussion TWO examples of how human activity can increase atmospheric CO_2.

STOP

END OF EXAM

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Question 4

Note: At least 1 point must be earned from each of parts (a), (b), and (c) in order to earn a maximum score of 10.

The element carbon is contained in all organic compounds.

(a) **Discuss** the role of photosynthesis and cellular respiration in carbon cycling in the biosphere. *(2 points maximum)*

	Discussion (1 point per box)
Photosynthesis	• Removes CO_2 from the atmosphere. • Reduces (or uses) CO_2. • Fixes carbon into organic molecules (sugars).
Cellular respiration	• Metabolizes (oxidizes, catabolizes) organic molecules (sugars). • Returns CO_2 to the atmosphere. • Releases CO_2.

(b) For THREE of the following, **predict** and **explain** the effect on the carbon cycle if:

- decomposers were absent
- deforestation occurred
- volcanic dust accumulated in the atmosphere
- the average ocean temperature increased

(6 points maximum)

	Prediction (1 point per box; 3 points maximum)	**Explanation (1 point per box; 3 points maximum)**
Decomposers absent	• Less CO_2 in atmosphere. • More carbon stored in dead organisms.	• CO_2 is not released. • Organic material is not degraded.
Deforestation	• More CO_2 in atmosphere. • Fewer carbon compounds in organisms.	• Decreased photosynthesis.
Volcanic dust in atmosphere	• More CO_2 in atmosphere. • Fewer carbon compounds in organisms.	• Less solar radiation causes less photosynthesis.
Average ocean temperature increased	• More CO_2 in atmosphere. • Less CO_2 in ocean.	• Increased decomposition/rate of respiration. • Decreased CO_2 solubility (less photosynthesis).
	• Less CO_2 in atmosphere.	• Increased photosynthesis (e.g., algae blooms). • Decreased O_2 solubility, resulting in decreased respiration.
	• No net change in CO_2 reservoirs.	• Increased photosynthesis **AND** respiration.

Question 4 (continued)

(c) **Explain** how increased CO_2 in the atmosphere results in greater acidification of oceans and **describe** the effect on marine organisms. **Include** in your discussion TWO examples of how human activity can increase atmospheric CO_2.
(4 points maximum)

Explanation (1 point)	• CO_2 dissolves, forming an acid (carbonic acid); the release of H^+ ions decreases pH. ($CO_2 + H_2O \rightleftarrows H_2CO_3 \rightleftarrows H^+ + HCO_3^-$)
Effect (1 point)	• Decreases ability to make corals/shells/exoskeletons. • Decreases availability of CO_3^{2-} for formation of $CaCO_3$ because more H^+ combines with CO_3^{2-}. • Decreases efficiency of enzymes in suboptimal pH.
Examples (1 point each; 2 points maximum)	• Combustion of gasoline/diesel. • Combustion of coal. • Combustion of natural gas. } **OR** Combustion of fossil fuels. • Combustion of wood. • Combustion/decomposition of wastes. • Deforestation reduces photosynthesis.