第一大題選擇題 1～2 (6 points each, total 12 points) ※ 注意：請於試卷內之「非選擇題作答區」標明題號依序作答。

1. Which of the listed cations have the highest average concentration found in the ocean? (A) Ca^{2+} (B) Ba^{2+} (C) K^{+} (D) Na^{+} (E) Mg^{2+}

2. Which of the listed anions have the highest average concentration found in the ocean? (A) Cl^{-} (B) SO_4^{2-} (C) HCO_3^{-} (D) Br^{-} (E) I^{-}

第二大題問答題 3～8

3. Seawater is salty. (4 points each, total 12 points)
(1) Please define salinity.
(2) List at least four factors regulating seawater salinity in the ocean.
(3) Why is the study of the salinity variations important for chemical oceanography?

4. About the Redfield ratio. (4 points each, total 12 points)
4a. Please write down the Redfield ratio as C: N: P: O.
4b. The N:P of the Yangtze River (Changjiang) measures over 100:1. Which of the two (N or P) is more likely to be the limiting element?
4c. The N:P of the Taiwan Strait measures to be less than 10:1. Which of the two (N or P) is more likely to be the limiting element?

5. Why does the increase in atmospheric CO_2 result in ocean acidification? Please write down the chemical reaction equation(s) to explain. (6 points)

6. Please use Figure 1 below to describe and explain the patterns of the dissolved silicate distributions in the three ocean basins. (Hint: compare the high and low concentrations; total 14 points)
6a. Vertical distributions (4 points)
6b. Differences among the basins (4 points)
6c. Explain how a chemical oceanographer can use the dissolved silicate distribution to support thermohaline circulation. (6 points)

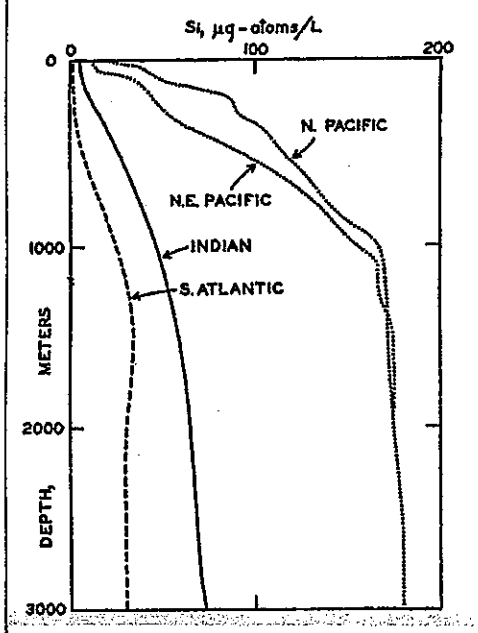

Figure 1. Dissolved silicate concentrations in the Atlantic, Indian, and Pacific Oceans.

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7. Please use Figure 2 below and answer the following questions. (total 20 points)

(1) What are the possible units for the various symbols in the subfigures? (2 points each, total 8 points)

(1)a. Vertical bar (|) & filled square (■):

(1)b. Triangle (Δ):

(1)c. Open circle (○):

(1)d. Open square (□):

(2) Describe the pattern for a nutrient-type element in the ocean. (2 points)

(3) List three nutrient-type elements. (2 points)

(4) Describe the pattern for a conservative element in the ocean. (2 points)

(5) List three conservative elements. (2 points)

(6) Explain possible reasons leading Al distribution pattern. (4 points)

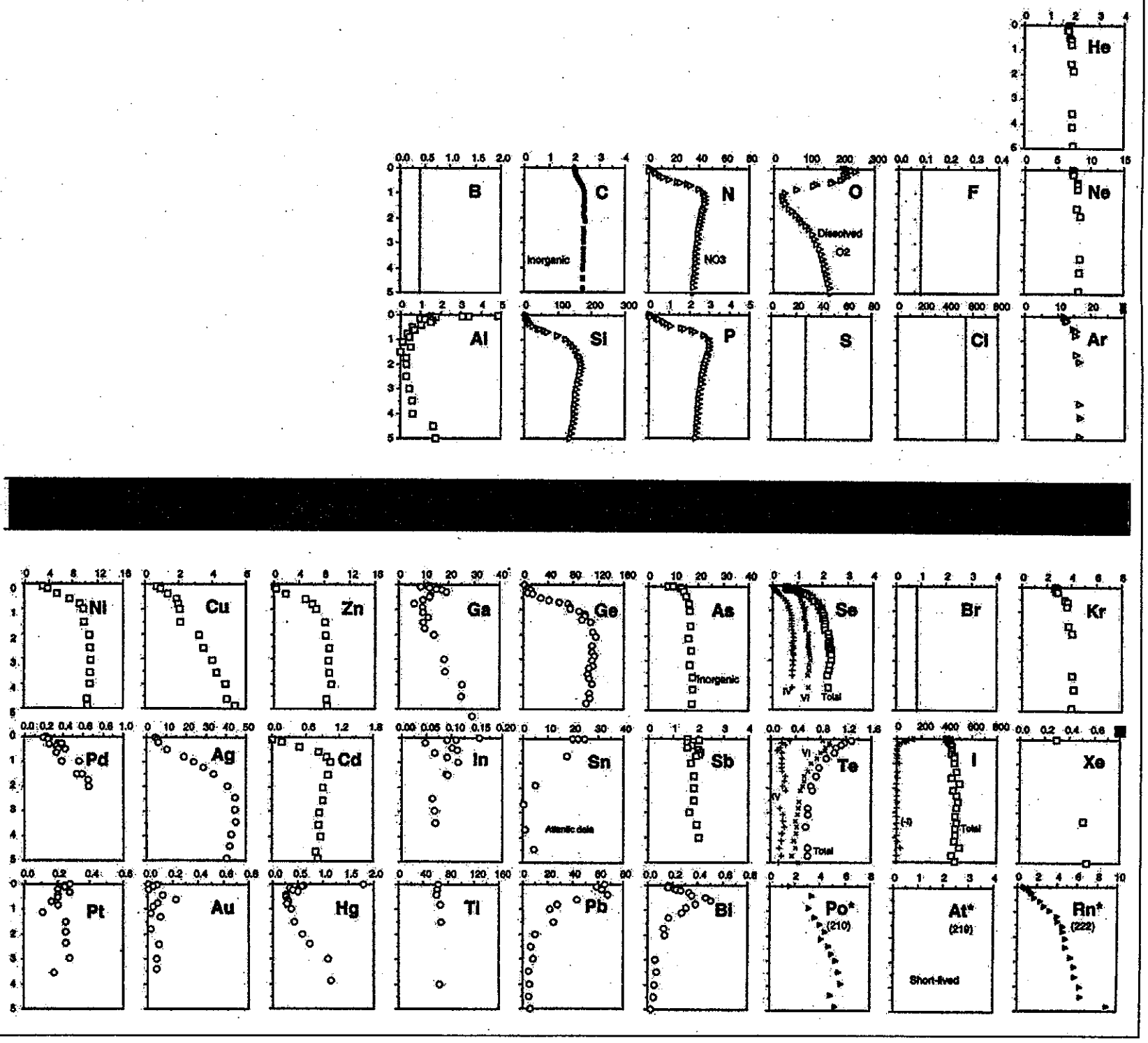

Figure 2. Vertical profiles of elements from the Pacific Ocean as in the periodic table of elements (Nozaki, 1997).

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8. Inorganic carbon chemistry (4 points each, total 24 points)

8a. Define total alkalinity.

8b. List any three factors that can lead to a change in the total alkalinity.

8c. What is the main constituent of dissolved inorganic carbon (DIC) in the ocean?

8d. List two other constituents of DIC in the ocean.

8e. In Figure 3 below, please explain why CO_2 invasion changes DIC but not total alkalinity (TA)?

8f. In Figure 3 below, please explain why dissolution results in a 1:1 DIC: TA variation?

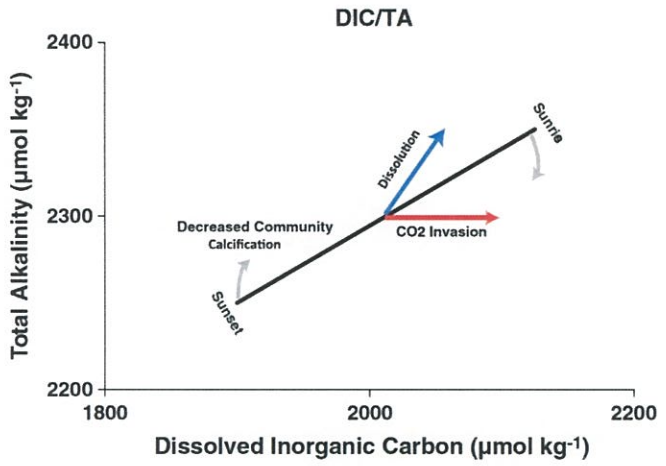

Figure 3. Changes in the theoretical TA-DIC slope given different ocean acidification scenarios. The ***solid black line*** represents the theoretical slope for a coral reef (0.33). The *red arrow* represents the change in midpoint in response to the continued addition of CO_{2atm} to open-ocean waters; the *blue arrow* represents the change in midpoint in response to enhanced local dissolution. The ***gray bolded arrows*** represent the change in slope in response to decreases in rates of coral reef calcification (from Lantz et al., *Coral Reefs*, 2014).

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