

I、單選題。每一題僅有一個正確或最佳答案；請於答案卷作答(每題 3 分，共 45 分)。

Answer questions 1-5 according to abstract of the following article:

J. P. Severinghaus, R. Beaudette, M. A. Headly, K. Taylor, E. J. Brook, *Science* **324**, 1431-1434 (2009).

Photosynthesis and respiration occur widely on Earth's surface, and the $^{18}\text{O}/^{16}\text{O}$ ratio of the oxygen produced and consumed varies with climatic conditions. As a consequence, the history of climate is reflected in the deviation of the $^{18}\text{O}/^{16}\text{O}$ of air ($\delta^{18}\text{O}_{\text{atm}}$) from seawater $\delta^{18}\text{O}$ (known as the Dole effect). We report variations in $\delta^{18}\text{O}_{\text{atm}}$ over the past 60,000 years related to Heinrich and Dansgaard-Oeschger events, two modes of abrupt climate change observed during the last ice age. Correlations with cave records support the hypothesis that the Dole effect is primarily governed by the strength of the Asian and North African monsoons and confirm that widespread changes in low-latitude terrestrial rainfall accompanied abrupt climate change. The rapid $\delta^{18}\text{O}_{\text{atm}}$ changes can also be used to synchronize ice records by providing global time markers.

- In respect to the element oxygen, ^{18}O and ^{16}O are called (a) isotones; (b) isotopes; (c) isobars; (d) nuclear isomers; (e) isomorphs.
- What types of sample were most likely analyzed to reach the conclusion in this study? (a) Photosynthetic plants and plankton; (b) Seawater and air; (c) Ice core and stalagmite; (d) Monsoon and rainfall records; (e) Sediment core.
- What does "Dole effect" refer to? (a) Climate change observed during the last ice age; (b) Difference between photosynthesis and respiration; (c) Variation in oxygen consumption rate; (d) The history of climate; (e) Fractionation of oxygen isotopes between seawater and air.
- What time scale is the most appropriate to describe the authors' findings? (a) Seasonal; (b) Inter-annual; (c) Decadal; (d) Millennial; (e) m.y.
- According to the article, what geographic region was found to have more extensive climate change? (a) Canada; (b) Temperate zone; (c) Polar regions; (d) Asia and Africa; (e) Tropical regions.

Answer questions 6-10 according to abstract of the following article:

E. Martinez, D. Antoine, F. D'Ortenzio, B. Gentili, *Science* **326**, 1253-1256 (2009).

Phytoplankton—the microalgae that populate the upper lit layers of the ocean—fuel the oceanic food web and affect oceanic and atmospheric carbon dioxide levels through photosynthetic carbon fixation. Here, we show that multidecadal changes in global phytoplankton abundances are related to basin-scale oscillations of the physical ocean, specifically the Pacific Decadal Oscillation and the Atlantic Multidecadal Oscillation. This relationship is revealed in ~20 years of satellite observations of chlorophyll and sea surface temperature. Interaction between the main pycnocline and the upper ocean seasonal mixed layer is one mechanism behind this correlation. Our findings provide a context for the interpretation of contemporary changes in global phytoplankton and should improve predictions of their future evolution with climate change.

- Which term best describes the significance of phytoplankton in the marine food chain? (a) Primary production; (b) Secondary production; (c) New production; (d) Export production; (e) Primary predator.

7. What is the depth range where phytoplankton can most likely be found in the ocean? (a) 0-100 m; (b) 200-300 m; (c) 400-500 m; (d) 800-1000 m; (e) 1500-2000 m.
8. What process does carbon fixation refer to? (a) Formation of C-containing bonds; (b) Attachment of C onto other molecules; (c) Converting carbon dioxide into solid material; (d) Oxidation of reduced carbon; (e) Regeneration of utilized carbon.
9. What observatory tool was primarily used to collect data in this study? (a) Moored instruments; (b) Surface platforms; (c) Remote sensing; (d) Microscope; (e) Macrocosm.
10. Which set of key words best describes the research reported in this article? (a) Food web; ocean; temperature, multidecadal; (b) Pacific, Atlantic, satellite, chlorophyll; (c) Global, mixed layer depth, seasonal; phytoplankton; (d) Climate, ocean basin, decadal, phytoplankton; (e) Phytoplankton distribution, phytoplankton abundance; decadal, upper ocean.

Answer questions 11-15 according to abstract of the following article:

D. Vance, D. A. H. Teagle, G. L. Foster, *Nature* **458**, 493-496 (2009).

Rivers are the dominant source of many elements and isotopes to the ocean. But this input from the continents is not balanced by the loss of the elements and isotopes through hydrothermal and sedimentary exchange with the oceanic crust, or by temporal changes in the marine inventory for elements that are demonstrably not in steady state. To resolve the problem of the observed imbalance in marine geochemical budgets, attention has been focused on uncertainties in the hydrothermal and sedimentary fluxes. In recent Earth history, temporally dynamic chemical weathering fluxes from the continents are an inevitable consequence of periodic glaciations. Chemical weathering rates on modern Earth are likely to remain far from equilibrium owing to the physical production of finely ground material at glacial terminations that acts as a fertile substrate for chemical weathering. Here we explore the implications of temporal changes in the riverine chemical weathering flux for oceanic geochemical budgets. We contend that the riverine flux obtained from observations of modern rivers is broadly accurate, but not representative of timescales appropriate for elements with oceanic residence longer than Quaternary glacial-interglacial cycles. We suggest that the pulse of rapid chemical weathering initiated at the last deglaciation has not yet decayed away and that weathering rates remain about two to three times the average for an entire late Quaternary glacial cycle. Taking into account the effect of the suggested non-steady-state process on the silicate weathering flux helps to reconcile the modelled marine strontium isotope budget with available data. Overall, we conclude that consideration of the temporal variability in riverine fluxes largely ameliorates long-standing problems with chemical and isotopic mass balances in the ocean.

11. Regarding terrestrial material in the ocean, rivers are (a) transporting routes; (b) entrapment; (c) important sink; (d) of equal size in volume with the ocean; (e) primary producers.
12. What does "chemical weathering" refer to? (a) pH of precipitation; (b) Chemical decomposition of rocks and minerals; (c) Breaking down rocks to small fragments; (d) Global warming; (e) Deglaciation.
13. Within the time frame of the Quaternary period, chemical weathering rate on Earth is considered to be (a) stagnant; (b) constant; (c) increasing; (d) variable with time; (e) peaked during glacier.

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科目：科學英文【海地化所碩士班】

14. For a specific element, its riverine input to the ocean equals to the loss to its sedimentary and hydrothermal exchanges, the chemical budget of this element in the ocean is (a) imbalanced; (b) in steady state; (c) deficient; (d) enriched; (e) saturated.
15. According to the article, isotopes of which element have seen application in modeling the element's oceanic geochemical budget? (a) Ti; (b) Fe; (c) Ge; (d) Sr; (e) N.

II、寫出下列各英文項的中文名詞(每題2分，共10分)。

1. Fossil fuel; 2. Ocean acidification; 3. Thermodynamics; 4. Biosphere;
5. Corel reef.

III、寫出下列各中文名詞的英文(每題2分，共10分)。

1. 全球暖化; 2. 北極震盪; 3. 海嘯; 4. 火成岩;
5. 溶解有機碳。

IV、將下列段落文字以大意(非逐字)方式翻寫為中文;文中專有名詞若無法利用已知中文俗名,則以原始英文字取代,評分以理解及文句通順程度為標準(共35分)。

(Source of articles: 1. A. J. Watson *et al.*, *Science* **326**, 1391-1393 (2009). 2. H. W. Pearl, *Estuaries and Coasts* **32**, 593-601 (2009).)

1. *The oceans are a major sink for atmospheric carbon dioxide (CO₂). Historically, observations have been too sparse to allow accurate tracking of changes in rates of CO₂ uptake over ocean basins, so little is known about how these vary. Here, we show observations indicating substantial variability in the CO₂ uptake by the North Atlantic on time scales of a few years. Further, we use measurements from a coordinated network of instrumented commercial ships to define the annual flux into the North Atlantic, for the year 2005, to a precision of about 10%. This approach offers the prospect of accurately monitoring the changing ocean CO₂ sink for those ocean basins that are well covered by shipping routes.* (15分)

2. *Expanding human activities along the freshwater to marine continuum of coastal watersheds increasingly impact nutrient inputs, nutrient limitation of primary production, and efforts to reduce nutrient over-enrichment and eutrophication. Historically, phosphorus (P) has been the priority nutrient controlling upstream freshwater productivity, whereas nitrogen (N) limitation has characterized coastal waters. However, changing anthropogenic activities have caused imbalances in N and P loading, making it difficult to control eutrophication by reducing only one nutrient. Furthermore, upstream nutrient reduction controls can impact downstream nutrient limitation characteristics. Recently, it was suggested that only reducing P will effectively control eutrophication in both freshwater and coastal ecosystems. However, controls on production and nutrient cycling in estuarine and coastal systems are physically and chemically distinct from those in freshwater counterparts, and upstream nutrient management actions (exclusive P controls) have exacerbated N-limited downstream eutrophication. Controls on both nutrients are needed for long-term management of eutrophication along the continuum.* (20分)

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科目：化學【海地化所碩士班甲組】

一、寫出下列元素或化合物之英文全名。(10%)

- (1) Mn (2) Al (3) CO
- ₂
- (4) CH
- ₄
- (5) Fe
- ₂
- O
- ₃

二、寫出下列濃度或總量單位實際大小。(10%)

- (1) pM (2) Gmole (3) μM (4) Tg (5) nM

三、解釋下列名詞：(30%)

- (1) Half-life ($t_{1/2}$) (for radioisotope)
- (2) Hard water
- (3) Nernst equation
- (4) Solubility product and conditional solubility product
- (5) Xenobiotic
- (6) Zeeman effect
- (7) Zero order reaction
- (8) Significant figures
- (9) Precision and Accuracy
- (10) Gibbs free energy

四、海水 pH 值測定看似簡單，要測得準確卻是相當困難，若利用玻璃電極法測定海水 pH 時，請回答下列問題：(15%)

- (1) pH 測定為何要在恆溫下進行？
- (2) pH 測定前為何至少要用 2 種不同 buffer solution 事先校正 pH 測定儀？
- (3) 何謂 junction potential？如何產生？其對玻璃電極法測定 pH 值有何影響？

五、為定量 0.5 克鐵礦中含鐵(Fe)的百分比，一般常用強酸將鐵礦溶解，然後再將溶解的 Fe³⁺ 還原成 Fe²⁺，假若你使用 0.015M 高錳酸鉀(KMnO₄)進行 Fe²⁺ 濃度滴定，發現滴定至終點時共消耗 50ml 的 KMnO₄，請問：(Fe : 55.8 g/mole) (15%)

- (i) 平衡滴定反應之氧化還原反應式
- (ii) 鐵礦中含 Fe 百分比為何？
- (iii) 鐵礦中 Fe₂O₃ 含量百分比為何？

六、簡答下列問題 (20%)

- (1) 原子吸收光譜及分子吸收光譜的差異為何？各舉例解釋其應用。
- (2) 氣體的溶解度受溫度及壓力的影響為何？若以海水溶解氧氣為例，你預期溶氧隨深度變化之情形為何？
- (3) 氣相層析儀測定有機化合物的原理為何？何種有機物適合用氣相層析儀測定？
- (4) 當你進入微量分析化學實驗室時有哪些因應的態度？你是否知道目前有哪些儀器可用於微量元素之測定？

一、名詞解釋 (30%)

1. fracture zone (3%)
2. fault (3%)
3. epicenter (3%)
4. barrier island (3%)
5. gravity flow (3%)
6. hyperpycnal flow (3%)
7. sediment (3%)
8. unconformity (3%)
9. weathering (3%)
10. uniformitarianism (3%)

二、試描述岩石的種類及其成因。並指出不同種類的岩石在地質學上所代表的構造環境意義為何。(20%)

三、試說明造成地震發生的機制為何？為何台灣發生地震的機率較為頻繁？(20%)

四、試說明板塊構造(plate tectonics)學說的內涵，並解釋大陸地殼(continentaI crust)與海洋地殼(oceanic crust)的差異之處。(20%)

五、民國98年8月8日莫拉克颱風帶來大量的降雨造成高雄縣甲仙鄉小林村的滅村慘劇，請以地質學的角度出發，討論可能的成災機制並說明未來的因應及防治之道。(10%)