

Key
Name

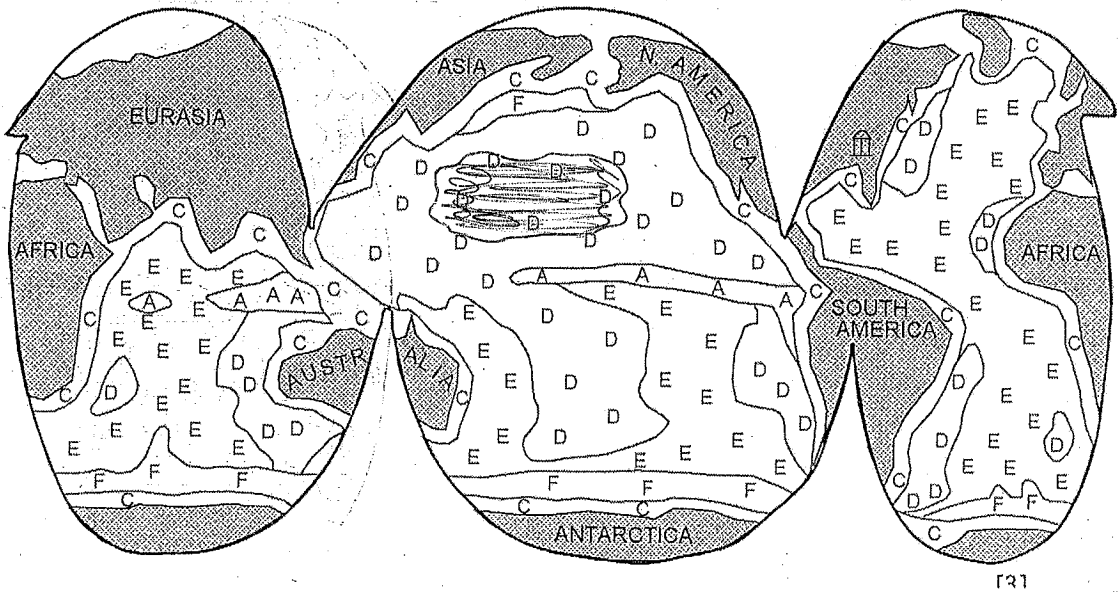
Part I

1. Deep-sea sediments are significant in part because they serve as records of how the oceans and Earth have changed. Check all of the things of which they provide a record. [4]

- | | | |
|---|--|---|
| <input checked="" type="checkbox"/> Biological productivity | <input checked="" type="checkbox"/> Volcanic activity | <input checked="" type="checkbox"/> Plate motions |
| <input checked="" type="checkbox"/> Changes in marine life | <input checked="" type="checkbox"/> Seawater chemistry | <input checked="" type="checkbox"/> Climate change |
| <input checked="" type="checkbox"/> Ocean circulation | <input type="checkbox"/> Hominid evolution | <input checked="" type="checkbox"/> Atmospheric CO ₂ |

2. Indicate the kinds of sediments found in the areas labeled on the map below. [9]

- A. Radiolarian ooze
 B. Turbidites
 C. Carbonate ooze
 D. Red Clay
 E. Diatom ooze



3. On the map above, circle and shade in the specific area where most manganese nodules are found. [3]

4. Deep-sea clays or red clays are the result of [3]

- Q A. Deposition of turbidites. B. Evaporation of seawater at high latitudes
 C. Sinking of tests of radiolarians. D. Undersea volcanism at mid-ocean ridges.
 E. Wind transport of volcanic ash F. Wind transport of desert dust
 J. A and D M. A and C Q. E and F S. None of the above

5. The physics of settling particles tells us that it should take decades for a coccolithophore disk or a diatom test to sink from surface waters to the abyssal sea floor. Most sediment generated by organisms in surface waters of the open oceans nonetheless reaches the abyssal seafloor in a few weeks. What explains the rapid descent of such material? [3]

- C A. The particles sink in areas of downwelling.
 B. The particles' electrostatic attraction draws them together into large particles that sink more rapidly than small particles.
 C. The particles are clustered in fecal pellets made by larger organisms.
 D. The particles sink in areas of low-viscosity water.
 E. The particles sink over areas of seafloor where the gravitational field is greater.

6a. Use checkmarks to indicate the six most abundant dissolved constituents of seawater. [4]

2

- Ca²⁺ ___ Mn³⁺ ___ Br⁻ K⁺ ___ Ra²⁺
 ___ NO₃⁻ ___ F⁻ Cl⁻ Mg²⁺ ___ SiO_{2(aq)} (i.e., H₄SiO₄)
 Na⁺ ___ Fe³⁺ ___ Li⁺ ___ Ar SO₄²⁻

6b. Of the dissolved constituents in seawater listed above, circle the two most abundant. [2]

7. The six most abundant dissolved constituents in seawater make up what proportion of all the dissolved material in seawater? [3]

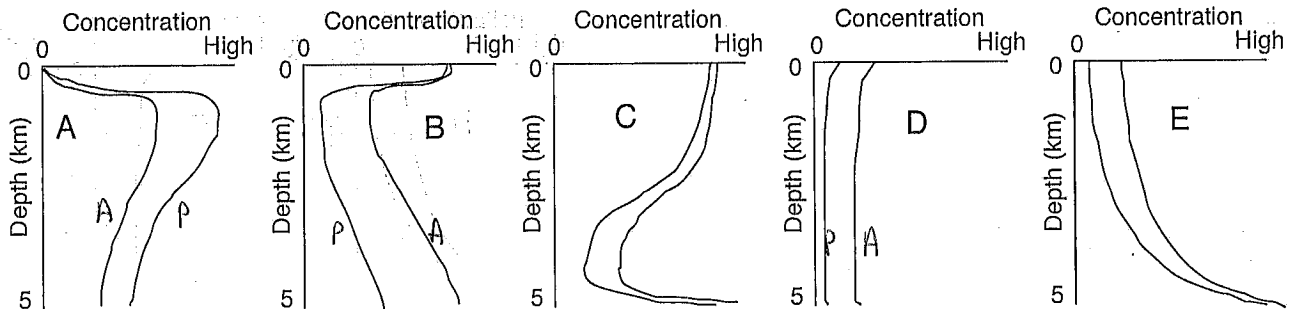
- F A. Less than 5% B. between 5% and 30% C. between 30% and 60%
 D. between 60% and 90% E. between 95% and 98% F. more than 98%

8. For each of the following, indicate whether it is a biologically controlled dissolved constituent of seawater with a "B", a conservative dissolved constituent of seawater with a "C", or a scavenged dissolved constituent of seawater with a "S": [6]

- C Ca²⁺ S Mn³⁺ B O₂ C K⁺ B PO₄³⁻
C Na⁺ S Fe³⁺ B CO₂ S Al³⁺ C SO₄²⁻
B NO₃⁻ S Co³⁺ C Cl⁻ C Mg²⁺ B SiO_{2(aq)} (i.e., H₄SiO₄)

9. Several possible profiles of concentrations are shown below. Indicate in the blanks the profile that most likely represents each of the following constituents. [6]

- Al³⁺ or Fe³⁺ D NO₃⁻ A O₂ B



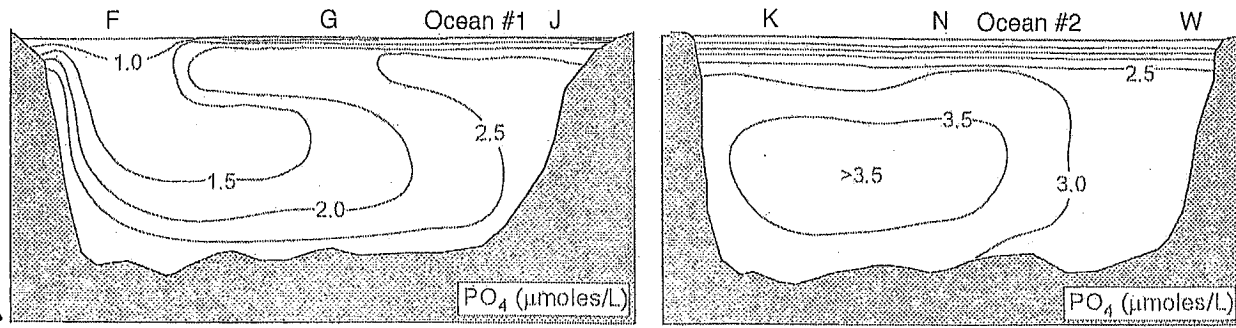
10. For each of the three profiles you chose in #9, label (on the diagram) the curve most reasonable for the Atlantic with an "A" and the curve most reasonable for the Pacific with a "P". [3]

11. If an element has a residence time in the oceans of 600 years, that element is probably a S [3]
 C. Conservative element B. Biologically-controlled element S. Scavenged element

12. Which of the following is a true statement about the Black Sea? [3]

- Its deep water is anoxic (has no dissolved O₂).
 At least some of the Black Sea's seafloor is oceanic crust.
 It has a strong pycnocline because it has dilute surface water.
 It has organic-rich sediments, which are rarely found in the open oceans.
 ___ The Black Sea is very shallow, and nowhere is it more than 100 meters deep.
 The Black Sea has a very narrow and shallow connection the rest of the Earth's ocean.
 ___ Like the Dead Sea, the Black Sea is really a hypersaline lake completely isolated from Earth's ocean.

13. Consider the profiles below through two hypothetical linked ocean basins on a hypothetical world. The contours show concentration of dissolved PO_4^{3-} . [5]



1
F
2
1

Which ocean basin (#1 or #2) is likely to be the ocean in which more downwelling occurs? (Put a "1" or "2" in the blank at left)

At which of the six labeled sea-surface locations does the most downwelling probably occur? (Put a letter in the blank at left)

Which ocean basin (#1 or #2) probably has the greater biological productivity? (Put a "1" or "2" in the blank at left)

Which ocean basin (#1 or #2) probably has a greater proportion of its seafloor covered by carbonate oozes? (Put a "1" or "2" in the blank at left)

14. Studies of Cretaceous (~100 million-year-old) deep-sea sediments have revealed [3]

- J A. That organic-rich sediments were surprisingly abundant. E. A and B
- B. That turbidites were surprisingly scarce. H. B and C
- C. That deep waters were almost as warm as surface waters. J. A and C
- D. That surface waters had more nitrate than phosphate. L. C and D

15. One hypothesis that we discussed to explain the oddities in Question 14 was [3]

- A A. that Cretaceous deep waters were warm and saline.
- B. that Cretaceous deep waters were devoid of nutrients.
- C. that Cretaceous oceans were exceptionally shallow.
- D. that Cretaceous surface waters were exceptionally dilute.

16. Twenty thousand (20,000) years ago, during the Last Glacial Maximum, the oceans are thought to have been different from their present condition. Which of the following differences did we discuss in GEOL 3030? [3]

- G A. Production of Mediterranean Intermediate Water was much greater.
 - B. Production of Mediterranean Intermediate Water was much less.
 - C. The Black Sea was a lake with no connection to the global ocean.
 - D. Circulation in the Atlantic was reversed, with deep water moving south to north.
 - E. The monsoons of the Arabian Sea were reversed, with eastward transport in winter.
- F. B & C G. C & D H. D & E J. A & C K. B & D L. B & E M. C & E

17. Present estimates suggest that the Arctic Ocean will be ice-free in the summer by [2]

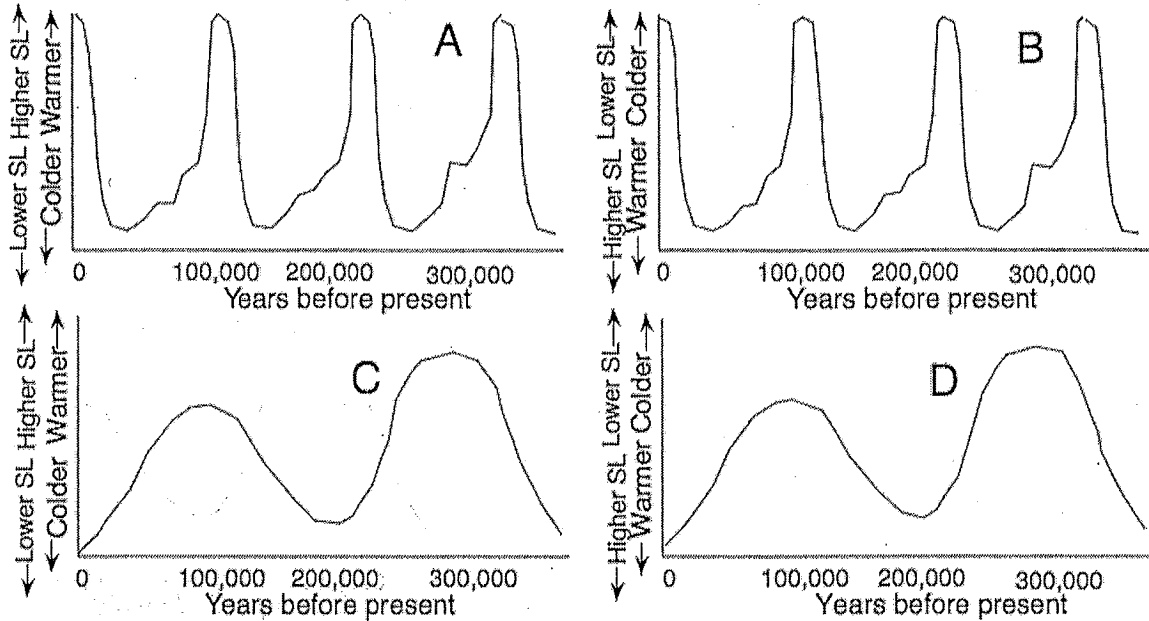
- B A) 2020 B) 2030 to 2050 C) 2100 D) 2250 E) 2400
- F) Trick question!: It's already ice-free in the summer!

18. One concern about increased concentrations of CO_2 in Earth's atmosphere is [3]

- D A. This will make the ocean more saline, exceeding the salinity tolerances of many organisms.
- B. This will make the ocean less saline, falling below the salinity tolerances of many organisms.
- C. This will make seawater more alkaline (less acidic), making organisms' precipitation of siliceous (Si-bearing) tests less likely.
- D. This will make seawater more acidic (less alkaline), making organisms' precipitation of carbonate ($CaCO_3$) skeletons less likely.

19. Which of the following is the best graphic expression of our understanding of changes in sea level (SL) and climate in the last 400,000 years? [3]

4



20. Which of the following is true regarding the central Pacific in the 2000s? [2]

- A. Warming of the central Pacific sea surface has led to decreased photosynthesis, which means less potential to remove the carbon of CO₂ to deep-sea sediments.
- B. Warming of the central Pacific sea surface has led to increased photosynthesis, which means greater potential to remove the carbon of CO₂ to deep-sea sediments.

21. Why is global warming a special concern to coastal cities? Your answer should include two linked reasons. [3]

Stronger storms
or
Higher sea levels → Bigger storm surges

22. For the map on the screen, give the letter or number requested. Note that the last three questions are extra-credit questions, so that they do not count off if left empty.

M Letter indicating the location of this planet's youngest deep seawater. [3]

Z Letter indicating the location of this planet's oldest deep seawater. [2]

Z Letter indicating the location of this planet's deep seawater richest in nutrients. [3]

H Letter indicating the location of this planet's most saline seawater. [3]

T Letter indicating the likely location of this planet's most anoxic seawater. [2]

8 Number indicating the most likely place for deposition of carbonate ooze. [2]

7 Number indicating the most likely place for widespread formation of manganese nodules. [2]

6 Number indicating the most likely location of a convergent plate boundary. [3]

N Letter indicating the location of this planet's most saline *surface* water. 1 pt extra credit

2 Number indicating the most likely location of a transform plate boundary. 1 pt extra credit

J Letter indicating the location of this planet's deepest lake. 1 pt extra credit

