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NATIONAL UNIVERSITY OF IRELAND, GALWAY

SUMMER EXAMINATIONS, 2004

Third Year (Denominated B.Sc. Degree in Marine Science)

MR 315: Chemical and Physical Oceanography

Prof. M.J. Dring
and the internal examiners

Time allowed: *Three hours.*
Answer *four* questions, at least **ONE** from each section.

Use a **SEPARATE** answer book for each section.

SECTION A

1. Answer all sections.

a. Draw the concentration *vs.* depth profiles for elements exhibiting conservative, nutrient-like and scavenged behaviour. Give an example of each. Which type is likely to be most useful as a tracer of ocean circulation.

b. Complete the following formula for denitrification

$5CH_2O + 4NO_3^- \rightarrow$

c. Write brief notes explaining (i) photosynthesis (ii) chemosynthesis

2. Answer all sections.

a. How do changes in (i) temperature (ii) salinity and (iii) pressure affect the solubility of gases in seawater?

b. Draw the ideal concentration vs. salinity plot for a typical estuary, assuming the substance of interest to be at higher concentration in river water than in seawater, and showing its profile if

i. It acts conservatively;

ii. It is removed from solution at low salinities.

c. Write a brief note on partition coefficients.

3. Answer all sections.

a. What is meant by the 'effective concentration' of a substance in seawater? How might this differ from the absolute concentration?

b. What major constituent is removed from seawater as it circulates through hydrothermal systems? What is the name given to the process by which rocks are altered by interacting with seawater at elevated temperatures? What gas is produced by this process?

c. Describe how the constancy of composition of seawater is maintained in spite of the continuous inputs of dissolved salts from the world's rivers.

4. Answer all sections.

a. List, in descending order of energy yield, the electron acceptors used by microbial organisms during the breakdown of organic matter in marine sediments, beginning with oxygen.

b. Give 2 examples of each of the following:

i. Natural chemical tracers of water mass movements;

ii. Chemical tracers introduced by human activity.

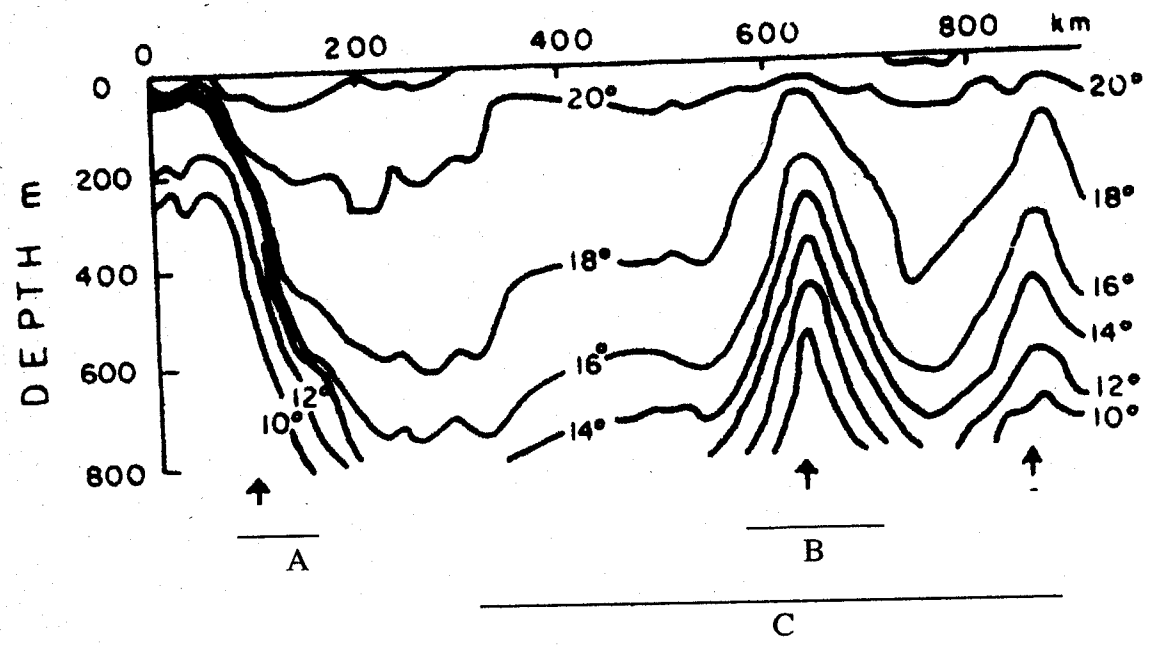
c. Write a brief note on radioactive substances in the marine environment.

P.T.O.

SECTION B

5. The figure below shows a vertical section of temperature running from west to east across the western N Atlantic. Using the thermal wind arguments, and assuming that the north-south velocity is zero at 1000 m depth, describe the north-south surface circulation across the section (assuming warm temperatures indicate less dense water), with particular reference to areas A, B and C.

Draw a west-east section of sea surface height that might be expected across the region, indicating relative sea surface slopes in regions A, B and C.



6. What is the balance of forces involved in Ekman's theory of wind driven circulation? Assuming such a balance, and that the vertical eddy viscosity, A_z=1, estimate the depth of the frictional surface layer.

Describe how Ekman's theory can explain coastal upwelling. Why are the upwelling regions in the Atlantic and Pacific on the eastern boundaries of the two oceans?

7. Define the terms **planetary**, **relative** and **potential vorticity**.

Using the conservation of **potential vorticity**, explain why currents tend to flow along isobaths (lines of equal depth) and hence why most deep overflow water into the northern North Atlantic flows southward along the western boundary of the North Atlantic.

(P.T.O.)

8. **a.** Why is friction important in the shallower shelf seas? Illustrate your example by taking typical velocities and depths found for the shelf and deep ocean to scale the frictional forces expected.

AND

b. Briefly describe shelf sea horizontal temperature fronts and the ways they may be generated.