1066

OLLSCOIL NA hÉIREANN

NATIONAL UNIVERSITY OF IRELAND, GALWAY

SUMMER EXAMINATIONS, 2005

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. Chemical processes in deep sea sediments generally occur much more slowly than in coastal sediments. Give the three main reasons for this. Describe the global distribution of clays, calcareous sediments and siliceous sediments on the deep sea floor and explain the reasons for this distribution pattern.

2. Explain with the aid of a diagram (i) a typical nutrient profile (ii) a typical oxygen profile, from surface to deep ocean in mid-latitudes in the N. Atlantic in summer. Explain the various processes causing the profiles to be shaped as they are, from surface to deep waters.

3. Estuaries have very complex chemistry. Describe the processes that might affect a parcel of river water containing some suspended material on its journey from the river mouth through an estuary to the sea.

4. Studies of deep and intermediate water in the N. E. Atlantic e.g. van Aken (2000) have shown how a number of water masses can be discriminated by their chemical properties. Describe the differences between the component water masses making up (a) deep and (b) intermediate waters, with reference to nutrients, dissolved oxygen and salinity. Explain how the different properties of the 4 component water masses making up deep water may have come about.

(continued)

SECTION B

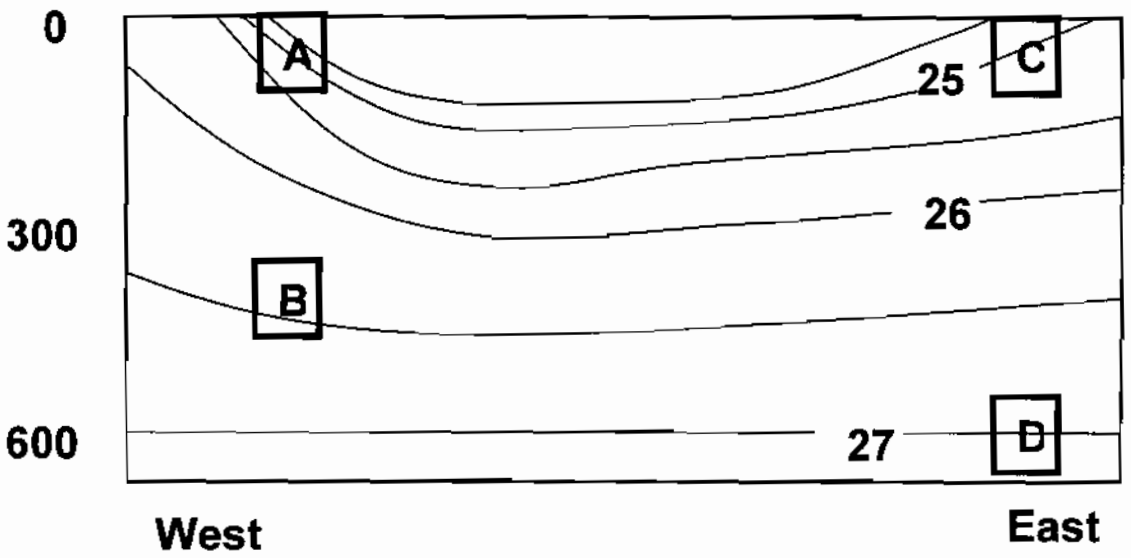
5. What is the principal balance of forces for the estimation of geostrophic currents and what assumptions are made? Are the currents horizontal or vertical?

The diagram below shows water density in a a west-east section across the mid N Atlantic. (The density contours are or σ_t, i.e. density -1000 kg m^{-3}). Assuming a level of no motion at 600m depth, describe the following (with brief reasons why);

(i) The direction of the currents at locations A, B , C and D

(ii) The strength of the currents at A relative to B

Draw a west-east section of sea surface height that might be expected to result from such a density structure, emphasising the relative slope of the sea surface at the western and eastern end of the section.



6. Define the terms (i) planetary vorticity, (ii) relative vorticity and (iii) potential vorticity.

There are two currents flowing along the latitude of the equator in a constant depth ocean. Using the conservation of potential vorticity, explain why if either of the currents are deflected away from the equator (north or south)

a) the eastward flowing current will tend to return back towards the equator latitude and

b) the westward flowing current will keep moving away from the latitude of the equator.

What is the importance of beta (β=df/dy), i.e. the change in the Coriolis parameter with latitude, at the equatorial latitude?

(continued)

7. (i) Explain the concept of a wave resonator as it pertains to the possible amplification of shelf tides.
   (ii) The deep ocean tide at a particular location where the water depth is 2000m is 0.5m in amplitude. As the oceanic tide moves onto a shelf of depth 100m, estimate the amplitude of this tide on the shelf using the conservation of wave energy and the shallow water wave velocity equation (assume $g=10\text{m s}^{-2}$).
   (iii) Explain, using Kelvin wave theory, why the tidal amplitude on the French side of the English Channel is about twice that on the English side.

8. (i) Explain briefly why we use a 'turbulent' eddy viscosity instead of the molecular viscosity when considering frictional forces in the ocean
   (ii) A wind stress of 0.1Pa blows over an initially stationary fresh water lake (density 1000kg m^{-3}) of depth 10m. By balancing the wind stress force with the local flow acceleration, estimate approximately how long the wind will take to generate a flow of 10 cm s^{-1} in the lake.
   (iii) If the same wind force as in (ii) is balanced by the internal friction (in the vertical only) and a steady current of 10cm s^{-1} flows in the lake, estimate the value of the turbulent vertical eddy viscosity.