University of Colorado at Boulder GEOL. 4060/5060 Oceanography Mid Term Examination Feb 27, 2009, 2:00pm

Preamble:

You must answer all questions Q1-Q4, (but in some cases only parts A **or** B). Each question has equal value. This is a closed book, 50-minute exam. The listing of equations is provided for assistance only. Think and write clearly. Point form is fine, but use logical phrasing.

Q1.

A. Briefly describe **six** critical pieces of evidence which support the theory of Plate Tectonics (including the theory of Continental Drift).

B. With the aid of the following image of seabed topography, say what are the distinguishing geologic and topographic features of a spreading ridge as opposed to a fracture zone ?



Q2. What are these devices / conventions and what do they measure ?

- a. Niskin bottle
- b. Reversing thermometer
- c. ADCP
- d. CTD
- e. Practical Salinity Scale (PSS)
- f. Drifter Bouy

Q3.

a. Draw the arrangement of the Hadley, Ferrel and Polar cells, marking the latitudes they occur at and where the (surface) low and high pressure zones are.

b. Draw a small diagram of the Ekman Effect and state which hemisphere your diagram applies to.

c. What does the Boussinesq Approximation refer to ?

d. What is Dynamic Topography? What is the relationship between dynamic topography and geostrophic currents ?

e. Describe or sketch a Langmuir circulation pattern for water and wind.

Q4.

- a. Describe the operation and input variables for the Coriolis Effect equation.
- b. How does advection differ from diffusion ?
- c. What does the Reynolds Number provide a numerical scaling for ?

OR

d. What do the separate terms mean and physically refer to in the following equation:

$$\frac{\partial v}{\partial t} = -\frac{1}{\rho} \left[\frac{dp}{dy} - \rho f u - \frac{d\tau_y}{dz} - F_y \right] \,.$$

The coordinate scheme is the same as used in lectures and the textbook. Use a diagram if that is helpful.

e. Write on how this equation is used in physical oceanography ?

Equations from the course: For assistance only

$$u = g \tan \theta / f \qquad -u \frac{\partial C}{\partial x} - v \frac{\partial C}{\partial y} - w \frac{\partial C}{\partial z} + \lambda C = \frac{\partial C}{\partial t}$$

$$f = 2\Omega \sin \phi \qquad -\frac{\partial uS}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0 \qquad -\frac{\partial uS}{\partial x} - \frac{\partial vS}{\partial y} - \frac{\partial wS}{\partial z} + \frac{A_h}{\rho} \left[\frac{\partial^2 S}{\partial x^2} + \frac{\partial^2 S}{\partial y^2} \right] + \frac{A_z}{\rho} \left[\frac{\partial^2 S}{\partial z^2} \right] = \frac{\partial S}{\partial t}$$

$$F = ma \qquad \qquad \frac{\partial}{\partial x} \left[K \frac{\partial I}{\partial x} \right] + \frac{\partial}{\partial y} \left[K \frac{\partial I}{\partial y} \right] = \frac{\partial uI}{\partial x} + \frac{\partial uI}{\partial y} + \lambda I$$

$$F_x = A_x \frac{\partial^2 u}{\partial x^2} + A_y \frac{\partial^2 v}{\partial y^2} + A_z \frac{\partial^2 w}{\partial z^2}$$

$$Re = \frac{\rho VD}{\mu} \qquad \qquad \frac{\partial u}{\partial t} = -\frac{1}{\rho} \left[\frac{dp}{dx} - \rho f v - \frac{d\tau_x}{dz} - F_x \right]$$

$$Ri = \frac{g \frac{d\rho}{dz}}{\rho \left(\rho \frac{du}{dz}\right)^2} \qquad \qquad \frac{\partial w}{\partial t} = -\frac{1}{\rho} \left[\frac{dp}{dz} - \rho g - F_x \right]$$