SIO 210 Introduction to Physical Oceanography
Mid-term Examination, Fall, 2003

October 27, 2003
11 – 11:50 AM
This is a closed book exam - no notes, no books.

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1. Of the following terms, state which pair forms the primary balance for each of the following approximations.

Terms: Pressure Gradient Force,
Temporal change in velocity,
Coriolis 'Force'
Gravity
Tidal Potential
Centrifugal force

A) Hydrostatic Balance: _____ and _____

B) Geostrophic Balance: _____ and _____

C) Inertial Oscillations: _____ and _____

D) Surface Waves: _____ and _____

2. Consider the concentration in a volume of the ocean of a conservative tracer (call it chlorofluorocarbon or CFC). The units of concentration are (moles tracer)/(kg seawater), that is, moles/kg.

(A) Explain what it means for a *tracer* to be conservative: (short answer)

(B) What does it mean for *mass* to be conserved? (short answer)

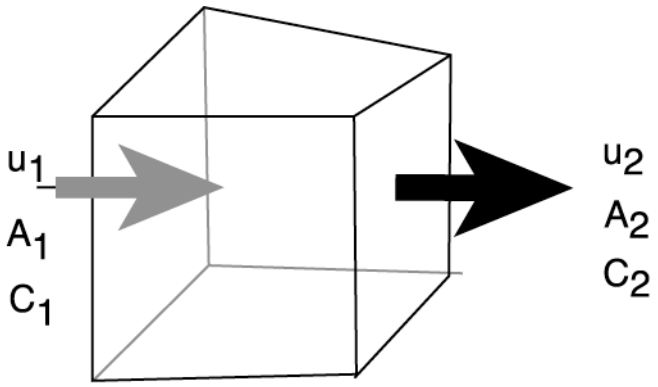
C) Is it possible for the concentration of tracer within a volume of water to change while the mass in the volume does not change? YES or NO (circle one)

Explain.

D) Consider the volume in the figure. There is flow into the left side of the volume and flow out of the right side of the volume. The inflow has a tracer concentration C_1 and velocity u_1. The outflow has a tracer concentration C_2 and velocity u_2. The area of the inflow is A_1 and the area of the outflow is A_2.

u_1 = 0.1 m/sec	u_2 = ???
A_1 = 10 kilometers x 100 meters	A_2 = 5 kilometers x 100 m,
C_1 = 1 pmol/kg,	C_2 = 0.8 pmol/kg

To make calculations easy, use a density of 1000 kg/m^3



D.1) Given that mass is conserved, what can you say about u_2, if you are told the values of u_1, A_1 and A_2?

D.2) If u_1 = 0.1 m/sec, A_1 = 10 kilometers x 100 meters, A_2 = 5 kilometers x 100 m, Calculate u_2:

D.3) What is the FLUX of tracer on the left side (where the values are C_1, u_1, A_1)?

D.4) What is the TRANSPORT of tracer on the left side (C_1, u_1, A_1)?

D.5) What is the TRANSPORT of tracer on the right side (at C_2, u_2, A_2)?

D.6) Do you expect the tracer concentration within the volume to (circle one)
INCREASE DECREASE REMAIN THE SAME

Due to the shortness of the time for the test, *please don't calculate anything* for this part, unless you have a lot of extra time.

3. A parcel of water, starting at the surface of the ocean, is adiabatically transported to a depth of 4 km. For each of the following, CIRCLE whether the property is conserved or not conserved (circle correct answer)

A) Temperature: CONSERVED or NOT CONSERVED

B) Potential Temperature: CONSERVED or NOT CONSERVED

C) Salinity: CONSERVED or NOT CONSERVED

D) Pressure: CONSERVED or NOT CONSERVED

E) Density: CONSERVED or NOT CONSERVED

F) Speed of Sound: CONSERVED or NOT CONSERVED

G) Mass: CONSERVED or NOT CONSERVED

True or false questions:

4. For <u>surface gravity waves</u> whose wavelength is much less then the ocean depth, (circle either TRUE or FALSE):

A) Waves can transport energy across long distances: TRUE or FALSE

B) Propagation speed of the wave depends on the wavelength: TRUE or FALSE

C) Depend on the compressibility of water for propagation: TRUE or FALSE

D) Are primarily generated by wind stress: TRUE or FALSE

5. For Internal waves in the ocean (circle either TRUE or FALSE):

A) They cannot transport energy: TRUE or FALSE

B) They can only exist in stratified water: TRUE or FALSE

C) Cannot be detected by surface observations: TRUE or FALSE

D) Typically have a period which is much shorter than surface gravity waves: TRUE or FALSE

6. The observed tides never quite equal the gravitational tidal potential because of

A) the large distance between the Earth and Moon: TRUE or FALSE

B) frictional dissipation of energy in the ocean inertia: TRUE or FALSE

C) Spatial variations of the earth's geoid: TRUE or FALSE

D) The inclination of the Earth's rotation: TRUE or FALSE

7. The Hadley Circulation in the atmosphere

A) transports heat poleward: TRUE or FALSE

B) Is symmetric about the equator: TRUE or FALSE

C) Is limited to the tropics/subtropics because of the Coriolis effect: TRUE or FALSE.

D) Is responsible for the easterly trade winds. TRUE or FALSE

8. Refraction of surface gravity waves in the ocean is responsible for all of the following but:

A) relatively low wave heights in bays and harbors.: TRUE or FALSE

B) concentration of wave energy at headlands : TRUE or FALSE

C) breaking wavecrests oriented parallel to the beach : TRUE or FALSE

D) ability of waves to propagate over long distances. : TRUE or FALSE

9. The Atmospheric Jet Stream

A) flows from east to west: TRUE or FALSE

B) is geostrophically balanced: TRUE or FALSE

C) is strongest in the summer hemisphere: TRUE or FALSE

D) is concentrated at an altitude of about 20km: TRUE or FALSE

10. Surface Geostrophic currents in the ocean...

A) Flow with low pressure to the left in the southern hemisphere: TRUE or FALSE

B) ALWAYS are associated with gradients of sea surface topography: TRUE or FALSE

C) constantly convert gravitational potential energy to kinetic energy: TRUE or FALSE

D) Require larger pressure gradients (for same speed of flow) as one approaches the equator: TRUE or FALSE