SMS-204: Integrative Marine Sciences II (2008).

Final examination (physics part)

Name:

Please answer all questions (total time 50min): Please provide a <u>short</u> answer to the 7 following questions (6pts each). Please provide your derivations so I can provide you with partial credit in case the answer is not correct.

1. A log floats on fresh water (ρ =1 g cm^{-3}) with 1/4 of its volume outside the water. What is the density of the log in kg m^{-3}?

2. The ocean's volume is approximately 328,000,000 cubic miles. What is the ocean's volume in cubic kilometers (1 mi =1.6093 km)? Given that the ocean is about 70% of the Earth's surface area and that the Earth's radius is 6400km, what is the average depth of the world's ocean (assume the ocean to be rectangular)?

3. A whale swims at a constant speed while feeding on plankton.

a. How many cubic meters of water enter the open mouth (5m^2 area) of the whale each minute as it swims through the water at 2 m s^{-1}?

b. How many plankton can the whale ingest per second if the plankton concentration is 2,000 per m^3?

c. Each plankton provides 2 Calories to the whale. How many Calories does the whale ingest each day?

4. When you reduce the opening of a garden hose it squirts farther than when you don't. Why? Extra credit (2pts): How is it different from reducing the opening of the faucet the garden hose is connected to at its other end?

5. Phytoplankton, photosynthetic microorganisms, are observed to have many different shapes. Some scientists think that shape makes a difference in their ability to stay in the near-surface sunlit zone of the oceans. Based on what you learned in class, will their sinking speed increase, decrease or stay the same as a sphere of the same mass and volume? Base your answer on what you learned about drag and the hydrodynamic regime these organisms are experiencing.

6. Describe the three mechanisms of heat transfer. Using a marine organism of your choice, provide examples of these mechanisms at work influencing how it gains or loses heat.

7. You free dive to spearfish off your boat. You fill your lungs to capacity (4.5 liters) at the surface and jump in. At 10m you exhale 1 liter of air. Assuming you do not exhale any more, what will your lung volume be when you surface following the dive? (Ideal gas law: $PV=nRT$, atmospheric pressure~10^5Pa)?

True/False questions (2pts each):

a. Liquid water is denser than ice. T F
b. An object whose center of gravity is below its center of buoyancy is unstable. T F
c. A larger object on the Earth's surface feels a larger pressure than a smaller object. T F
d. A blue object absorbs blue wavelengths. T F
e. Solute flux equals the Mass flux of water times solute concentration. T F
f. Some Microorganisms use jet propulsion as a mechanism to propel themselves. T F
g. The no-slip condition implies that swimming organisms will *always* experience drag while swimming. T F
h. Streamlining reduces pressure (rather than viscous) drag for high Reynolds number swimmers. T F
i. Objects radiate heat according to their color. T F
j. Light and sound wave both change speed as they move from air to water. T F
k. To determine the pressure at a given depth in a fluid we need to know the gravitational acceleration. T F
l. A solid object that sinks in warm seawater may float in cold seawater. T F
m. Force has a dimension of ML^2T^{-2}, in MKS its units are: Kgm^2s^{-2}. T F
n. Conduction refers to passage of heat through contact. T F
o. At high Reynolds number, viscosity is not a primary contributor to drag . T F

Multiple choice questions (6pts each):

1. How can an organism under water change the buoyancy force acting on it?
   a. Change its mass (e.g. burn energy, get rid of waste products).
   b. Change its volume (e.g. using musculature).
   c. Change its temperature (e.g. work harder).
   d. All of the above.

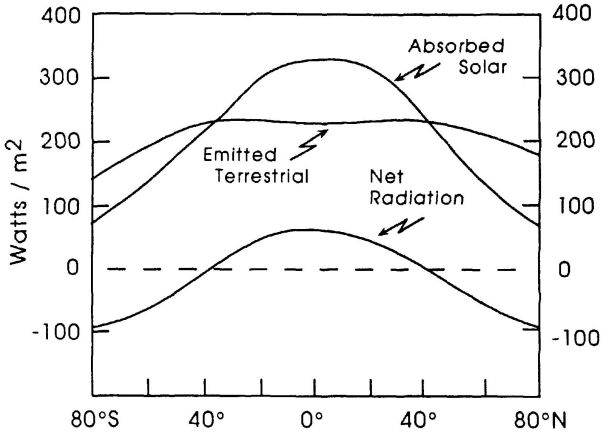
B. You are asked to measure the volume flux of the Penobscot. Which measurement will you conduct (circle all that apply)?

   a. water depth;
   b. water temperature;
   c. water speed;
   d. water pressure;
   e. width of the river;

3. The drag force in low Reynolds number on a sinking particle is proportional to:
   a. Fluid density (ρ).
   b. Square of the diameter (D^2).
   c. Viscosity of the fluid (μ).
   d. b and c.
   e. a, b and c.

Please provide short answers to the following questions (5pts for questions associated with each picture):

1. How is the following graph related to concepts associated with the Earth heat balance? How can we explain the Polar Regions not getting continuously colder given the data in this graph?



2. Below is a figure of the temperature distribution in the upper ocean along the Equatorial Pacific. Assuming it reflects the density structure as well, how would you expect it to be if no force were acting on the fluid other than gravity? Extra credit (2 pts): What is a likely process giving rise to this observed distribution?