SMS-204: Integrative Marine Sciences II (2014).

Final examination (physics part)

Name:

Please answer all questions (total time 50min): Please provide a short 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.

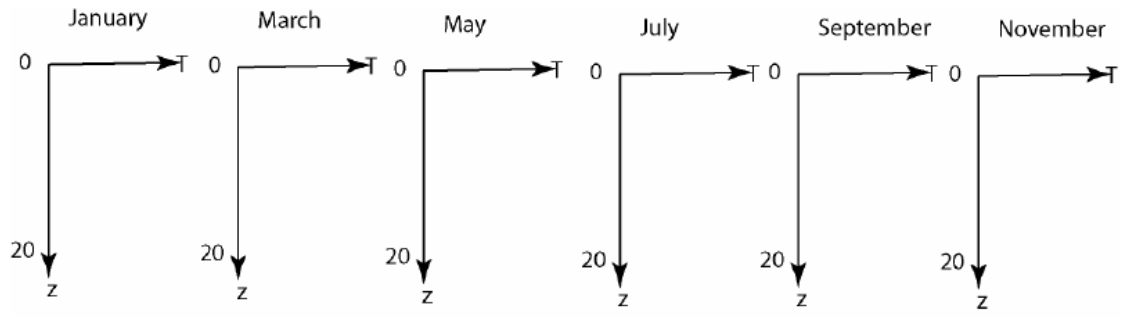
1. You free dive to spearfish off your boat. You fill your lungs to capacity (4 liters) at the surface and jump in. At 10m you exhale 1 liter of air. Assuming you do not exhale any more, what will your lung volume be when you surface following the dive? (Ideal gas law: $PV=nRT$, atmospheric pressure~10^5Pa)?

2. You are fishing with a net that has an area of $10m^2$ in calm water. Your boat is steaming at 50cm/s:
   A. How much water volume flows through your net per hour?
   B. If the water density is $1.02g/cm^3$, how many Kg's of water flow through the net in 1 minute?
   C. If the density of fish is 1 every m^3, how many will you catch in an eight hour workday?

3. Name the three mechanisms for heat transfer. Give one example for each that may be relevant to a marine organism?

4. Describe how streamlining affects drag at low and high Re numbers compared to a sphere of the same volume.

5. Plot likely temperature profiles (T-temperature as function of depth, Z) for a lake in Maine (maximal depth 20m) as function of time (one plot every two months, starting in January, a total of 6 plots). Assume the lake is covered with ice from December to March. Provide the temperature values at the surface and at depth (maximum temperature of the lake's water is 20°C and the minimal is 0°C just below the ice, the ice reaches a temperature of -10°C and 1m thickness. Assume 0m depth denotes the surface of the water. Remember: fresh water density is not monotonic with temperature.



6. You are asked by the Environmental Protection Agency to measure the amount of fecal bacteria that are transported downstream by the Penobscot River near Bangor. How would you go about determining the transport of these bacteria downstream? What properties do you need to measure? Provide an example of the units for bacterial transport down the river (that is their flux)?

7. An iceberg is floating in the ocean. Its density is 0.97 g cm^{-3} while the density of the ocean water is 1022 kg m^{-3}. How much of the iceberg's volume is *above* the water surface (give you answer in percent)?

True/False questions (2pts each):

1. Liquid water is least dense near 4°C. T/F

2. Buoyancy force acting on an immersed object is larger in the ocean compared to a lake. T/F

3. Flagella is effective for micro-organisms because it allow them to glide. T/F

4. Gravitational force acting on an immersed object is larger in the ocean compared to a lake. T/F

5. In the absence of other forces, water flows from low to high pressure. T/F

6. The no-slip condition implies that at high Re number organisms cannot glide. T/F

7. Two particles with the same density are settling in a fluid. The largest will sink faster. T/F

8. The density of liquid water is approximately 1000Kg m^{-3}. T/F

9. Units of pressure in MKS are equivalent to Kg m^{-1} s^{-2} T/F

10. The hotter an object the longer the wavelength or the radiation it emits. T/F

11. The median is the 50^{th} percentile. T/F

12. A stable submerged object is one for which the center of buoyancy is above the center of gravity. T/F

13. Condensation of water vapors to form drops cools the atmosphere. T/F

Multiple-choice questions (6pts each):

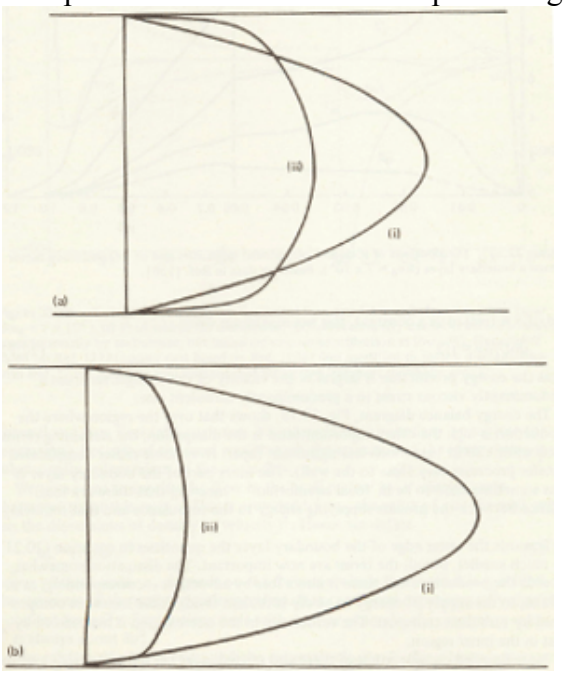
1. The coldest day of the year:
a. Is near the shortest day of the year.
b. Is near the day when the most net heat is lost.
c. Is near the day when least net heat is lost.
d. Is near the day when most NIR is emitted.

2. When swimming at large Re:
a. Drag increases linearly with viscosity.
b. Drag increases linearly with the square of velocity.
c. Drag increases linearly with size.
d. All of the above.

3. Radiative heat transfer:
a. is ineffective in empty space.
b. transfers heat through contact.
c. increases in water compared to air.
d. None of the above.

Please provide short answers to the following questions (7pts for questions associated with each picture):

1. What is the difference between the two flows depicted in this picture? Which will transport more fluid for the same pressure gradient?



2. What situation is depicted in this picture? If the wind were to stop, what will happen to the dark fluid?