SMS-204: Integrative Marine Sciences II (2011).

Final examination (physics part)

Name:

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

1. A 2.5m^3 box has a mass of 3000kg. How much will it weigh in water (assume a realistic density for the water, g=9.81 m s^{-2}, and remember that weight is a force)? Approximately what *minimal* volume of an air bag should we attach to it so it floats in water?

2. A jelly fish sinks at a constant speed while feeding on plankton.
   a. How many cubic meters of water does it filter as function of time through its tentacle (0.05m^2 area) if it sinks through the water at 0.05 m s^{-1}?
   b. How many plankton can the jelly fish ingest per minute if the plankton concentration is 1,000 per m^3?
   c. Each plankton provides 0.01 Calories to the jelly fish. How many Calories does the whale ingest each day?

3. An iceberg is floating on the ocean. Its density is 920 kg m^{-3} while the density of the Ocean's water is 1020 kg m^{-3}. How much of the iceberg's volume is above the water surface (in percent)?

4. What is the Reynolds number (*Re*) for a swimming organism (write its expression as function of properties of the swimmer and the fluid)? How is the *Re* useful when we analyze the swimming behavior of organisms? Give an example of a low and high *Re* swimmer.

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

6. When are the longest and shortest days of the year in Maine? How do they come about (plot a cartoon of the Sun and Earth during these days)? How are they related to the warmest and coldest days of the year and why?

True/False questions (2pts each):

a. As water warm in a graduated cylinder the hydrostatic pressure at its bottom decreases. T F
b. A swimming organism imparts momentum to the fluid around it. T F
c. Radiation is a mechanism to transfer energy without physical contact. T F
d. Units of energy in MKS are equivalent to Kg m^2 s^{-2} T F
e. A Galileo thermometer works because glass density changes with temperature. T F
f. For the same pressure gradient across a hose, turbulence decreases momentum compared to a laminar flow. T F
g. Water flows from low to high pressure. T F
h. To determine the pressure at a given depth in a fluid we need to know the gravitational acceleration. T F
i. A solid object completely immersed in salty water experience less upward buoyant force than when it is immersed in fresh water of the same temperature. T F
j. The density of water is approximately 1000g m^{-3}. T F
k. Two beads of the same material are sinking in a fluid each at its own terminal speed. The larger of the two will sink faster. T F
l. Jet propulsion is a swimming strategy that works for low *Re* swimmers. T F

Multiple choice questions (6pts each):

1. The primary reason for the contrast of temperature between the poles and equator is:

    a. Sun radiation spreads over a larger area at the poles.
    b. Poles are further away from the sun than the equator.
    c. Winds and current transport heat from poles to the equator.
    d. Winds and current transport heat from equator to poles.

2. We record uncertainties of all measured physical quantities because:

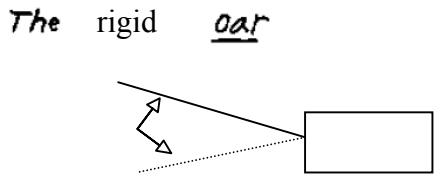
    a. It gives us a sense of certainty.
    b. It looks professional.
    c. No physical quantity can be obtained exactly.
    d. All of the above.

3. An object less dense than the lake water is within a boat floating on a lake. When the object is thrown over the side the water level in the lake will:

    a. Rise.
    b. Stay the same.
    c. Fall.
    d. There is not enough data in the question to answer it.

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

1. Below is a picture of two possible swimming strategies bacteria may adopt. Which is likely to work and why?



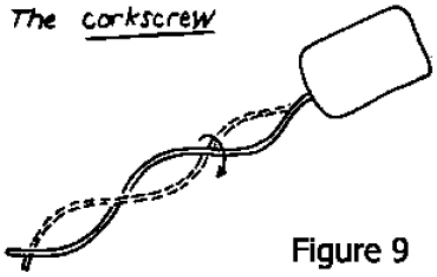


Figure 9

2. What is the principle associated with fluid motion that is illustrated below?