

# SMS-204: Integrative Marine Sciences.

## Mid-term 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. A submarine that weighs 17,500Kg in air and has a volume of  $20\text{m}^3$  floats in a harbor. How much of its volume do we need to flood in order to just begin sinking it in fresh water with density  $1000\text{kg/m}^3$ ?

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

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

b. How many zooplankton can the whale ingest per second if the zooplankton concentration is 1 per liter?

c. If each zooplankton provides the whale with 2 calories, how many calories does the whale ingest in a day?

3. In Maine the shortest day of the year is in late December yet the coldest day of the year (on land and in the surface waters) is close to the beginning of March. Why?

4. The following water vessel contains water. How is the hydrostatic pressure distributed within this vessel as function of depth (feel free to ignore the atmospheric pressure)? Sketch a graph if you find it useful.



5. You are asked by the US Geological Survey to measure the amount of mercury that is transported downstream by the Penobscot River near Bangor. How would you go about determining the transport of mercury downstream? What properties do you need to measure? Provide an example of the units for mercury transport (flux)?

6. Why is a deep snorkel not a practical tool for sub-surface diving?

7. What is the Re number? What is its dimension? What is it useful for?

**True/False questions (2pts each):**

- a. In water, pressure increases with depth. T F
- b. Light is attenuated less than sound in the oceans. T F
- c. Force=work / distance T F
- d. A red objects absorbs preferentially in the red. T F
- e. A solid object completely immersed in cold water (10°C) experience more upward buoyant force than when it is immersed in warm water (20°C). T F
- f. An object that floats on water may sink if its shape is changed. T F
- g. The no-slip condition implies that for a pipe full of moving fluid the fluid near the pipe wall flows less fast than at the pipe's center. T F
- h. A boat is most stable when its center of gravity is as low as possible below its center of buoyancy. T F
- i. The Reynolds number of a swimming bacterium is much smaller than that of a Tuna fish. T F
- j. When a fluid is cooled from above and become unstable the heat flux to depth that is transported by the fluid is termed convective heat flux. T F
- k. Evaporation of water from the surface of a lake causes the remaining surface waters to cool down. T F
- l. An example for a unit of force is  $\text{Kg m s}^{-1}$  T F
- m. The Doppler Effect implies that the frequency of the sound an observer hears changes if the observer or the sound source are moving at the same speed and direction. T F
- n. For the same volume, material, internal temperature and outside conditions, a round object loses less heat than any other shaped object. T F
- o. Two beads of the same material as sinking in a fluid at constant speed. The larger of the two will sink faster. T F

**Multiple choice questions (6pts each):**

A. When we calculate the pressure at the base of a fluid column:

- a. the gravitational acceleration does not matter.
- b. the height of the column does not matter.
- c. the density of the fluid does not matter.
- d. none of the above.

B. You are asked to evaluate whether a boat can float? What do you need to measure?

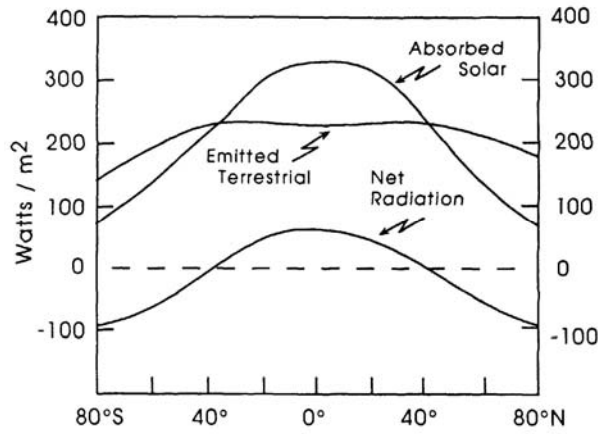
- a. the weight of the boat;
- b. the volume of the boat;
- c. the viscosity of the water;
- d. a and b;
- e. a, b, and c.

C. Which of the following is not a high Re number swimming strategy?

- 1. Jet propulsion
- 2. Appendage propulsion
- 3. Flagella propulsion

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

1. Below is a graph providing the yearly average absorbed and emitted radiation by the earth as function of latitude. How come the difference between the two radiations (the net radiation) is not zero at each latitude? ( Note it is approximately zero when summed over all latitudes).



2. Use the concepts of accuracy and precision with respect to the cartoon below.

