

# 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 weighs 30,000Kg in air and has a volume of  $20\text{m}^3$  floats in a harbor. The submarine sank to the bottom of the harbor. What force do we need to apply to raise it from the bottom (assume the volume of the material the submarine is made off is negligible and that the density of water is  $1000\text{kg}/\text{m}^3$ )?

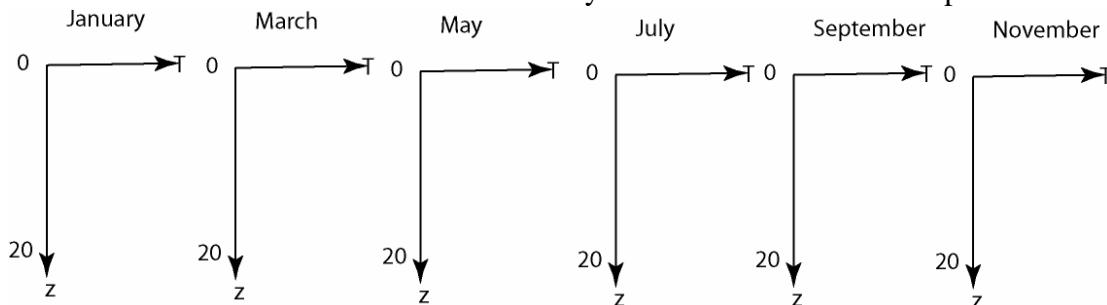
2. A fishing vessel cruises at a constant speed while trawling.

a. How many cubic meters of water enter the fishing net ( $100\text{m}^2$  area) each minute as it cruises through the water at  $10\text{ m s}^{-1}$ ?

b. How many fish can be caught if the concentration of fish is 1 per  $\text{m}^3$ ?

c. If each fish weighs 1kg, how many kg fish are caught per day?

3. Plot possible temperature profiles for a lake in Maine (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 is  $20^\circ\text{C}$  and the minimal is  $0^\circ\text{C}$  below the ice. Remember that water density is not monotonic with temperature.



4. What is the Reynolds number a 50cm long tuna swimming at 2m/s in water (kinematic viscosity =  $10^{-6} \text{m}^2/\text{s}$ )? What is it for a bacteria (1micron= $10^{-6}\text{m}$ ) swimming four body lengths a second?

5. You are asked by the US Geological Survey to measure the amount of sediments that is transported downstream by the Penobscot River near Bangor (sediment are measured in  $\text{Kg}/\text{m}^3$  dry weight). How would you go about determining the transport of sediment downstream? What properties do you need to measure? Provide an example of the units for sediment transport?

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

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

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

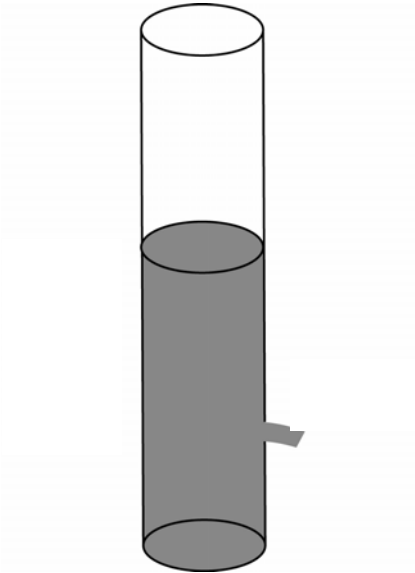
- a. In water, pressure decreases with depth. T F
- b. A submerged body experience an upward force equal to its volume times the density of water. T F
- c. Work and energy have the same units. T F
- d. A blue object absorbs preferentially in the blue. T F
- e. A solid object completely immersed in salty water experience more upward buoyant force than when it is immersed in fresh water of the same temperature. T F
- f. Surface tension can cause an object that would otherwise sink to float on water. T F
- g. The no-slip condition implies that swimming organisms experience drag. T F
- h.. Pressure and shear stress are two examples of force per unit area. T F
- i. In the absence of other forces, water flows from low pressure to high pressure. 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 warm. T F
- l. An object that floats on water on Earth may sink if the gravitational acceleration is changed. 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 relative to each other. T F
- n. The density of water is approximately  $1\text{kg/m}^3$ . T F
- o. 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

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

1. The no slip condition means that:
  - a. Wind over land is faster 10m above bottom than 1cm above bottom.
  - b. Currents in the ocean are faster 10m above bottom than 1cm above bottom.
  - c. A coffee cup will eventually come to rest after vigorous mixing.
  - d. All of the above.
2. On the moon, pressure on the bottom of a milk carton is:
  - a. Larger than on earth
  - b. Smaller than on Earth.
  - c. Equal to that on Earth.
  - d. Zero.
3. An object is unstable when:
  - a. Its center of gravity and buoyancy are close.
  - b. Its center of gravity and buoyancy are far.
  - c. Its center of buoyancy is above its center of gravity.
  - d. Its center of gravity is above its center of buoyancy.

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

1. Below is an illustration of an experiment you did in the lab. Does the speed of the water vary with the water height? Does it vary with the size of the hole?



2. Explain what phenomenon is illustrated in the figure below. What are some of the implications for the inhabitants of the Earth?

