

SMS-204: Integrative Marine Sciences II (2018).

Final examination (physics part), Version 1

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 wood log is floating on a river. Its density is 0.95 g cm^{-3} while the density of the river's water is 998 kg m^{-3} . How much of the log's volume is below the water surface (give you answer in percent)?

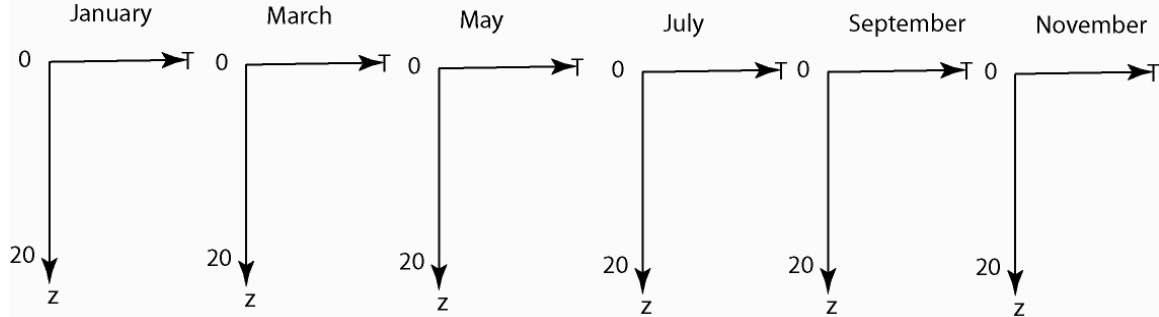
2. You are asked by your supervisor at a USGS internship to measure the volume flux of water at a stream nearby at a certain time of the day.

a. What measurements will you do and how will you use them to obtain the volume flux of water?

b. It turns out that the stream is a salmon run. What additional information will you need to obtain the salmon flux in the stream and how would you compute it given that this information is collected?

3. In the first class we discussed how the physical aspects of the ocean affect marine organisms. Choose a micro-organism ($<0.1\text{mm}$) and a macro-organism ($>1\text{m}$) and three physical properties of ocean waters. For each physical property describe how it may affect either reproduction or foraging or predation of each organism.

4. 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 at the surface is 20°C and the minimal is 0°C (below the ice)). Remember that water density is not monotonic with temperature.



5. A clam is buried near the sediment water interface pumping approximately 6ml of water each minute and filtering it of its nutritious particles.

- How many cubic meters of water does it filter in a day?
- Assuming a concentration of food particles of 30 per cm^3 , how many particles does it filter in a day?
- If each food particle has a nutritional value of 2 Calories, how many Calories does the clam ingest in one minute?

6. You are asked to relocate a sunken boat to be used as an artificial reef. The boat's weight in air is 200,000N (e.g. mass of ~20,000Kg) and the volume of its solid parts is 8m^3 . Approximately what minimal volume of an air bag should be attached to it so it can be lifted under water to be moved to its new location?

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

True/False questions (2pts each):

- a. Water in a tube with a hole at a given height will squirt further on the moon than on the Earth (the gravitational acceleration is less on the moon) T F
- b. A solid object completely immersed in oil will experience the same upward buoyant force as when it is immersed in water (oil is less dense than water). T F
- c. The hotter an object the longer the wavelength of the radiation it emits. T F
- d. Units of pressure in MKS are equivalent to $\text{Kg m}^{-2} \text{s}^{-2}$ T F
- e. The density of liquid water is approximately 1Kg m^{-3} . T F
- f. To determine if an object will float in a fluid we need to know the gravitational acceleration. T F
- g. Two solid beads of the same material are sinking in a fluid at constant speed. The larger will sink faster. T F
- h. The no-slip condition implies that a particle next to a stationary wall will sink slower than one further from that wall. T F
- i. Light and sound wave increase in speed when propagating from air to water. T F
- j. A low Reynolds number swimmer will swim faster if it changes its shape to one that is more hydrodynamic (e.g. like a torpedo). T F
- k. In the absence of other forces, fluids flow from high to low pressure. T F
- l. Algae are green because they absorb green light. T F
- m. Convection refers to passage of heat through contact. T F

Multiple choice questions (6pts each):

1. The 'greenhouse' effect:

- a. Is mostly due to reflection/emission of visible radiation by the atmospheric greenhouse gases to the Earth's surface.
- b. Is mostly due to absorption of visible radiation by the atmosphere greenhouse gases
- c. Is mostly due to scattering of infrared radiation by the atmosphere greenhouse gases.
- d. Is mostly due to absorption and reflection/emission of infrared radiation by the atmosphere greenhouse gases to the Earth's surface.

2. An object is unstable when:

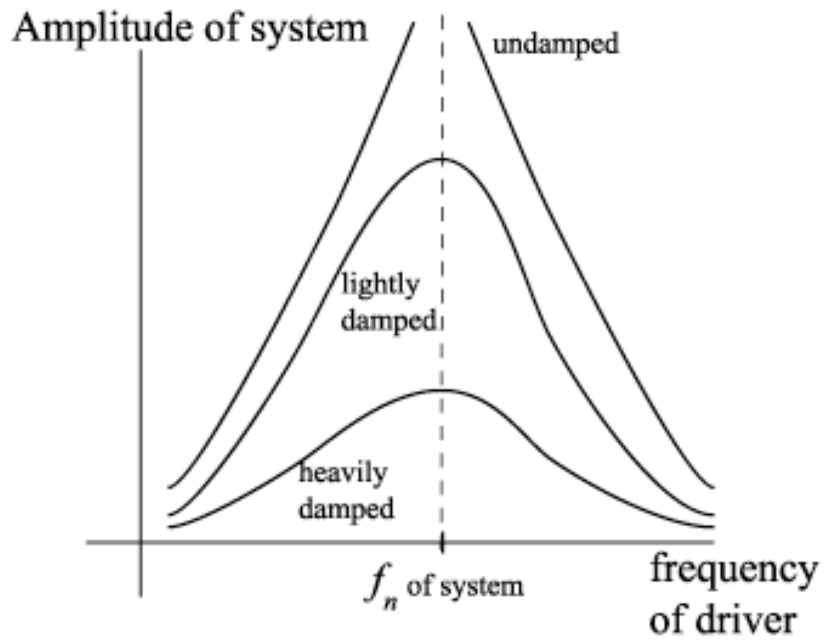
- a. Its center of gravity and buoyancy are close.
- b. Its center of gravity and buoyancy are far.
- c. Its center of buoyancy is above its center of gravity.
- d. Its center of gravity is above its center of buoyancy.

3. An object floats in water because:

- a. It is lighter than water.
- b. Its mass is less than that of water.
- c. It has a smaller volume than water.
- d. It is less dense than water.

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

1. What phenomena does this figure represent? How does it relate to the relationship between the size of an organism and the frequency (or wavelength) of sound it emits?



2. What is the principle associated with fluid motion that is illustrated below? How would you expect the pressure to change within this pipe (what other principle did you use to get the pressure distribution)?

