

ENGR 121 - Exam 2 Practice Problems (5 Point Questions)

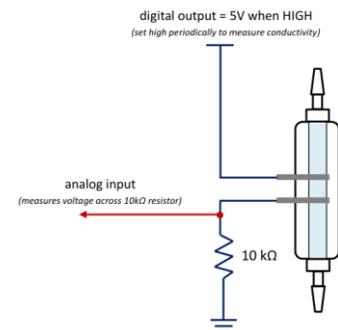
Below are practice problems for the five-point questions found on the exam. These questions come from past exams as well as additional questions created by faculty. Please note that these are just examples of questions and may not cover all concepts that could be asked in the 5-point section on your exam.

Chemical Reactions at Anode and Cathode

1. If 40g of NaCl is completely hydrated in water, the number of Cl⁻ ions in the resulting solution is closest to
 - a. $1.99 (10)^{23}$
 - b. $2.06 (10)^{23}$
 - c. $2.78 (10)^{23}$
 - d. $3.49 (10)^{23}$
 - e. $4.12 (10)^{23}$

2. A constant current of 5mA passes through the probes of a conductivity sensor. The number of Cl₂ molecules formed over a 10 second period is closest to . . .
 - a. $8.2(10)^{15}$ Cl₂ molecules
 - b. $4.7(10)^{16}$ Cl₂ molecules
 - c. $9.4(10)^{16}$ Cl₂ molecules
 - d. $1.6(10)^{17}$ Cl₂ molecules
 - e. $9.9(10)^{17}$ Cl₂ molecules

3. The circuit shown is set up to measure the conductivity of 0.05% salt water. For this salt concentration, the effective resistance across the electrodes of the conductivity sensor is 15kΩ. If 5V is supplied across the entire circuit as shown for 10 minutes, the number of moles of chlorine gas molecules that will be produced in the resulting electrochemical reaction is closest to:
 - a. 0.120
 - b. 7.5×10^{17}
 - c. 3.7×10^{17}
 - d. 1.24×10^{-6}
 - e. 6.2×10^{-7}
 - f. 1.04×10^{-6}
 - g. 1.55×10^{-6}
 - h. 1.04×10^{-8}

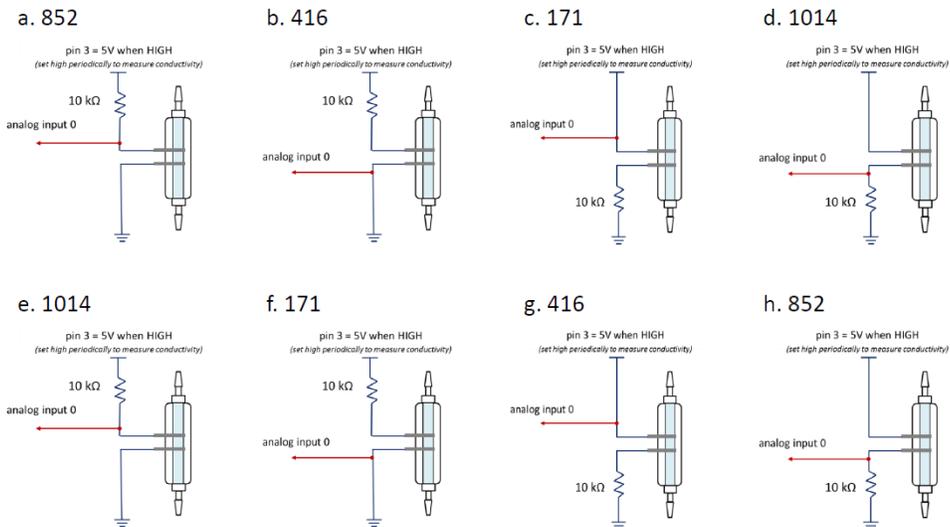


Salt Water Chemistry

4. If 14 oz. of salt are added to 5 gallons of water, then the % weight of salt in this mixture is closest to . . .
- 0.05%
 - 0.12%
 - 0.78%
 - 1.23%
 - 1.76%
 - 2.06%
 - 5.29%
 - 9.16%
5. You filled a large water bottle with 3.25 liters of deionized water. The amount of salt in grams that should be added to make a 3% by weight salt water solution is closest to...
- 51.2 g
 - 68.9 g
 - 95.3 g
 - 100.5 g
 - 106.4 g
 - 111.1 g
 - 130.0 g
 - 151.5 g
6. How many gallons of water would you need to mix with 20.5 grams of salt to create a concentration of 0.08% weight percent NaCl?
- 5.5 gal
 - 6.8 gal
 - 7.2 gal
 - 9.4 gal
 - 10.3 gal

7. You filled a large water bottle with 1.75 liters of deionized water. The amount of salt in grams that should be added to make a 0.5% by weight salt water solution is closest to...
- a. 6.1 g
 - b. 8.8 g
 - c. 11.2 g
 - d. 14.6 g
 - e. 8.3 g
 - f. 22.5 g
 - g. 26.6 g
8. 12 gallons of DI water. Find: The amount of salt to add to this water to create a concentration of 0.15% by weight is closest to:
- a. 0.0782 grams
 - b. 0.0682 grams
 - c. 0.0582 grams
 - d. 0.0482 grams
 - e. 0.0382 grams
 - f. 38.2 grams
 - g. 48.2 grams
 - h. 58.2 grams
 - i. 68.2 grams
 - j. 78.2 grams
9. You are making a recipe that calls for 3 quarts of water and 2 oz. of salt as the first two ingredients. The percent weight salt in this mixture is closest to:
- a. 1.60%
 - b. 1.96%
 - c. 2.00%
 - d. 5.20%
 - e. 5.92%
 - f. 5.99%
 - g. 9.16%
 - h. 9.52%
 - i. 9.59%
 - j. 9.92%

10. Suppose that the salinity value of the fluid in the reservoir is stable and causes the conductivity sensor to behave like a $2\text{ k}\Omega$ resistor. Also suppose that it is desired that the conductivity sensor circuit is connected to the Arduino board so that an increase in the salinity value of the fluid will cause an increase in the voltage signal connected to analog input 0 (the same way we have connected our conductivity sensors in class). The proper connection and value generated by `analogRead(0)` is closest to...



11. A constant current of 1 A passes through the probes of a conductivity sensor for 20 seconds . The number of OH^- ions is closest to . . .

- 1.25×10^{20}
- 4.43×10^{20}
- 8.11×10^{21}
- 9.11×10^{21}
- 2.54×10^{22}
- 6.42×10^{24}

12. A constant current of 10 mA passes through the probes of a conductivity sensor. If $1.56(10)^{17}\text{ Cl}_2$ molecules are formed, then the length of time that the circuit was connected is closest to...

- 0.1 seconds
- 1 second
- 5 seconds
- 10 seconds
- 15 seconds
- 30 seconds
- 60 seconds
- 120 seconds

13. A cylindrical “fishtank” containing 4 in³ of salt water. The density of this water is 1000 kg/m³. The salt concentration of the water is 0.08% by weight. The NaCl is fully hydrated. Find: The number of sodium ions in this water is closest to:
- a. $5.4 * 10^{19}$
 - b. $5.4 * 10^{20}$
 - c. $5.4 * 10^{21}$
 - d. $5.4 * 10^{22}$
 - e. $5.4 * 10^{23}$
 - f. $5.4 * 10^{24}$
14. A constant current passes through the probes of a conductivity sensor for 15 seconds. If $9.9(10)^{17}$ Cl₂ molecules are formed, then the value of this current is closest to . . .
- a. 1.65 mA
 - b. 5.23 mA
 - c. 13.48 mA
 - d. 21.15 mA
 - e. 51.39 mA
 - f. 75.99 mA
 - g. 100.23 mA
 - h. 212.54 mA

Mass Balance

15. A student has 20 kg of a salt water solution with an unknown concentration of salt. After adding 5 kg of DI water, she measures the concentration of the final solution to be 2% NaCl by mass. The percentage by mass of salt in the initial solution must be:
- a. 0.0%
 - b. 0.5%
 - c. 1.0%
 - d. 1.5%
 - e. 2.0%
 - f. 2.5%
 - g. 3.0%

16. Your fishtank has a salinity of 0.30 wt% NaCl. You are interested in opening the DI solenoid valve to bring the concentration of the tank closer to the setpoint of 0.11 wt% NaCl. The target concentration if you have a gain of 0.60 (60%) is closest to ...
- a. 0.044 wt% NaCl
 - b. 0.054 wt% NaCl
 - c. 0.087 wt% NaCl
 - d. 0.110 wt% NaCl
 - e. 0.186 wt% NaCl
 - f. 0.190 wt% NaC
 - g. 0.414 wt% NaC
 - h. 0.447 wt% NaCl
 - i. 0.546 wt% NaCl

17. The picture to the right shows a chlorine generator for use with salt-water pools. Its job is to electrolyze the salty water to produce chlorine gas (which stays in solution in the water). The model shown here produces up to 1.40 pounds of chlorine per day. If the chlorine generator runs all the time and produces 1.40 pounds of chlorine per day, the electrical current required between its electrodes is closest to...



- a. 1.895A
 - b. 5.918A
 - c. 8.519A
 - d. 15.89A
 - e. 18.59A
 - f. 19.85A
 - g. 51.98A
 - h. 81.95A
 - i. 98.15A
18. How much DI water must be added to a container with 50 kg of a 2% NaCl solution to achieve a 0.10% NaCl solution?
- a. 10 kg
 - b. 50 kg
 - c. 100 kg
 - d. 500 kg
 - e. 667 kg
 - f. 895 kg
 - g. 950 kg
 - h. 1000 kg

19. A batch of masonry cement is made by mixing 15 gallons of wet sand with one 70 lb. bag of masonry mix and 2 gallons of water. The sand used in the mix is partially wet, containing an unknown amount of water. If the final batch of “mud” contains 13% water when the desired consistency is reached, then how many gallons of water did the sand used in the mixture contain? Assume that the density of dry sand is 111 lbs/ft³ and that wet sand and dry sand occupy the same volume.
- 1.7 gal
 - 2.1 gal
 - 2.9 gal
 - 3.2 gal
 - 4.4 gal
20. Broken Bow, Oklahoma, primarily gets its water supply from the local water tower. The water is collected in a large tank and processed through a filtration system before being distributed through the town’s Water Works Division. It’s known that the rain water collected in the tank consists of 97% pure water, 1% minerals, and 2% other materials (such as leaves). Some water is lost through evaporation. The filtration process creates a waste consisting of 30% water, 2% minerals, and 68% other materials. The drinkable water remaining after filtration consists of 99% pure water and 1% minerals. If the town needs 90,000 lb of water each week, how much rain water (by mass) must be collected weekly in the water tower?
- 90,800 lbs
 - 92,400 lbs
 - 95,600 lbs
 - 97,300 lbs
 - 99,900 lbs

21. A chamber with a diameter of 100mm is filled to depth of 200mm with water containing 0.1% wt NaCl. We wish to increase the salinity to 0.15% by adding salt water from a "salty tank" with a 5% wt NaCl solution. When water from the "salty tank" is added, an equal volume of water must leave the chamber through the overflow; please assume that the same mass of water that enters from the "salty tank" leaves through the overflow. If 50% of the water leaving through the overflow comes directly from the "salty tank" and the remainder that leaves is 0.1% wt NaCl, then the mass of "salty tank" water that should be added is closest to . . .
- a. 32g
 - b. 37g
 - c. 41g
 - d. 45g
 - e. 49g
22. 20 kg of water is evaporated from a vat that contains 200 kg of an 11% brine solution (11% salt; 89% water). 5 kg of salt is then added to the brine. The brine solution that results from this process will contain what percentage of salt?
- a. 13%
 - b. 10%
 - c. 12%
 - d. 15%
 - e. 18%
 - f. 29%
 - g. 35%
 - h. 89%
 - i. 100%

23. The nutritional facts for Gatorade sports drink are shown below for a 0.24L serving. The human body's absorption efficiency, body content for a 70kg person, and mineral loss due to sweating are summarized in the table to the right. In this problem, we will assume that sweat and Gatorade both have density of 1kg/L. If a 70kg athlete with loses 4L of fluids through sweating while taking in 1L of Gatorade. We would like to estimate the athlete's sodium content after sweating. Assume that the absorption efficiency for sodium is 90% (only count the portion that is absorbed) and that the sweat leaving the athlete has a concentration of 1500 mg/L. The athlete's final content of sodium is closest to . . .

$1,000,000 \text{ mg} = 1,000 \text{ g} = 1 \text{ kg}$ and $1,000 \text{ mL} = 1 \text{ L}$ (ml from the Gatorade label = mL)

- a. 83,200 mg sodium
- b. 84,400 mg sodium
- c. 85,600 mg sodium
- d. 87,200 mg sodium
- e. 88,900 mg sodium

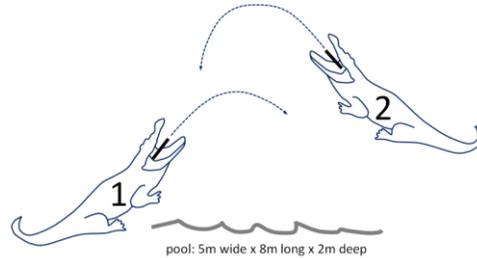
Nutrition Facts	
Serving Size 8 fl oz (240ml)	
Servings Per Container 4	
Amount Per Serving	
Calories 50	
% Daily Value*	
Total Fat 0g	0%
Sodium 110mg	5%
Potassium 30mg	1%
Total Carbohydrate 14g	5%
Sugars 14g	
Protein 0g	
Not a significant source of Calories From Fat, Saturated Fat, Cholesterol, Dietary Fiber, Vitamin A, Vitamin C, Calcium, Iron.	
* Percent Daily Values are based on a 2,000 calorie diet.	

Mineral	Absorption Efficiency	Body Content mg/70kg	Sweat mg/L
Calcium	30%	1,400,000	28
Iron	10-35%	4,000	0.1-0.4
Magnesium	10-70%	25,000	8.3-14.2
Manganese	5%	20	0.0025-0.0045
Phosphorus	55-70%	700,000	40
Potassium	>90%	250,000	150
Sodium	>90%	90,000	230-1,700
Zinc	<40-90%	2,000	0.36-0.68

24. A batch of concrete has been mixed in a container. The mass of concrete (mix and water) in the container is 46.25 kg. The concrete is composed of 75% mix and 25% water, by weight, and is too wet. The desired composition is 85% mix and 15% water. Assuming you could remove the excess water, the amount of water that you would remove to achieve the desired composition is closest to ...
- a. 34.69 kg
 - b. 7.21 kg
 - c. 6.12 kg
 - d. 11.56 kg
 - e. 5.44 kg
 - f. 6.94 kg
 - g. 4.625 kg
 - h. 2.76 kg
25. Assume that a cylindrical tank of water 1 meter in diameter and 2 meters tall contains salt water with a concentration of 0.11% NaCl by weight. You would like to add the correct amount of 1% NaCl to bring the concentration to 0.15% NaCl. However, when you add a certain mass of salt water, and equal mass of water leaves the system through an overflow. If 15% of the overflow is 1% NaCl and the rest is 0.11% NaCl, then the amount of 1% NaCl salt water that you should add to your system is closest to . . .
- a. 1.2 kg
 - b. 4.8 kg
 - c. 9.1 kg
 - d. 18.7 kg
 - e. 29.0 kg
 - f. 52.8 kg
 - g. 83.1 kg
 - h. 157.1 kg

26. Two small fresh water streams are routed through alligator sculptures so they dump into the salt water pool of a wealthy engineering professor; pool dimensions are shown below. Assume that the target salinity of the water is 0.5% NaCl by weight, the flow rate of stream 1 is 5kg/min, and the flow rate of stream 2 is 6 kg/min. Water drains from an overflow so that the level in the pool remains constant; assume that the overflow has a concentration of 0.45% NaCl. The rate that dry salt must be added to the pool to maintain the target salinity is closest to . . .

- a. 0.04 kg/min
- b. 0.05 kg/min
- c. 0.06 kg/min
- d. 0.10 kg/min
- e. 0.20 kg/min
- f. 0.50 kg/min
- g. 1.0 kg/min



27. Suppose you want your car to produce hydrogen gas to mix with other fuel that the engine in your car burns. You plan to use electrical current from the alternator of the car to electrolyze salt water (the same reactions as the ones that take place at the electrodes of your conductivity sensor). If you want to produce 0.18 grams of hydrogen gas every minute, the electrical current required from the alternator is closest to:

- a. 7.28A
- b. 28.7A
- c. 72.8A
- d. 287A
- e. 728A

28. You are drying your clothes and realize that this is a material balance problem! So for your next load you decide to calculate how much water is removed from your T-shirts as they dry. You have 10 shirts and your pocket hydrometer tells you that they are 27% water when you take them out of the washing machines spin cycle. After drying, your hydrometer tells you that the T-shirts are only 2% water and a Google search tells you that the average T-shirt weighs 150 grams. The amount of water removed from the T-shirts during the drying process is closest to:
- a. 0.514 gallons
 - b. 2.514 gallons
 - c. 0.136 gallons
 - d. 2.136 gallons
 - e. 0.832 gallons
 - f. 2.832 gallons

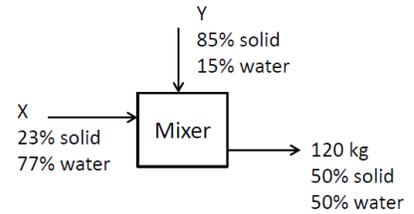
29. You are trying to eat healthier as part of your New Year's resolution. So you decided that you will replace any whole milk in your diet with skim milk. Looking into the process you find that Skim milk is made by removing some of the fat from whole milk. The skim milk at your local store is 90.9% water, 9% protein and carbohydrates, and 0.1% fat. If the original milk contained 4.5% fat, then the percentage of water in the whole milk is closest to:
(Assume an amount of 1 kg of skim milk and assume that only fat was removed from the whole milk.)

- a. 92.9% water
- b. 90.9% water
- c. 88.9% water
- d. 86.9% water
- e. 84.0% water
- f. 82.9% water
- g. 80.9% water
- h. 78.9% water
- i. 76.9% water

30. A nearby plant separates whole milk at 4% fat into skim milk at 0.35% fat and cream at 55% fat. The plant uses a giant centrifuge to accomplish the separation. In a typical 8 hour day they will run 50,000 kg of whole milk through the continuous centrifuge. If this rate is maintained, the amount of cream you expect this plant to produce each hour is closest to:
- a. 46,660 kg/hr
 - b. 5,833 kg/hr
 - c. 3,340 kg/hr
 - d. 1,270 kg/hr
 - e. 418 kg/hr
 - f. 132 kg/hr
 - g. 33 kg/hr
 - h. 6 kg/hr

31. Given the information below, the mass of X is closest to...

- a. 13.7 kg
- b. 24.8 kg
- c. 44.2 kg
- d. 59.5 kg
- e. 67.7 kg
- f. 82.2 kg
- g. 98.7 kg
- h. 112.6 kg
- i. 118.9 kg
- j. 154.7 kg



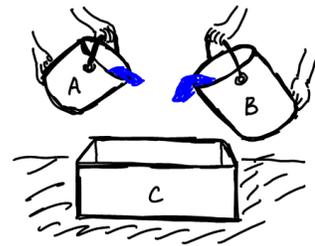
32. You have 10 gallons water with a salt concentration of 0.32% by weight. Find: The amount of DI water to add to this solution to create a 0.18% salt solution is closest to:

Assume: The density of the original salt water is 1000 kg/m^3

- a. 2.78 gallons
- b. 3.78 gallons
- c. 4.78 gallons
- d. 5.78 gallons
- e. 6.78 gallons
- f. 7.78 gallons

33. Bucket A contains an unknown mass of 3.0 percent weight salt water. Bucket B contains an unknown mass of 5.4 percent weight salt water. The entire contents of both buckets are poured into empty container C and mixed thoroughly. If container C then contains 14.6lb of 4.4 percent weight salt water, the original mass of salt water in bucket B was closest to:

- a. 1.578 lb
- b. 1.875 lb
- c. 5.187 lb
- d. 5.817 lb
- e. 7.158 lb
- f. 7.581 lb
- g. 7.815 lb
- h. 8.175 lb
- i. 8.517 lb
- j. 8.751 lb



34. Often used for gardening, compost is organic matter that has been decomposed and recycled as fertilizer. In certain climates, compost decays best when it is 65% nitrogen-rich “green” waste (e.g., grass clippings, coffee grounds, kitchen scraps) and 35% carbon-rich “brown” waste (e.g., newspaper, sawdust, pine needles). If your instructor’s compost pile has 675 lbs of material that he has analyzed to be 85% “green” materials and 15% “brown” materials, the amount of “brown” materials (in lbs) that should be added to the compost heap prior to mixing to insure optimal decomposition is closest to...

- a. 11 lb
- b. 43 lb
- c. 79 lb
- d. 107 lb
- e. 156 lb
- f. 192 lb
- g. 208 lb
- h. 275 lb
- i. 361 lb

35. A 10 gallon aquarium is filled with 3% salt by weight solution and placed by a sunny window. Over several weeks, an undetermined amount of water has evaporated (note: no salt evaporates). The owner, without thinking, adds freshly mixed 3% by weight salt solution to return the aquarium water amount back to 10 gallons. After testing the salinity, he finds that the aquarium has a 4.2% salt by weight solution. The amount of water that evaporated is closest to...

(Assume that the low concentration of salt does not significantly influence the density of water)

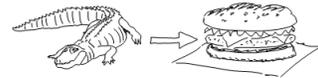
- a. 1 gal
- b. 2 gal
- c. 3 gal
- d. 4 gal
- e. 5 gal
- f. 6 gal
- g. 7 gal
- h. 8 gal

36. You have decided you will start a business making ground alligator meat patties as an alternative to hamburger patties. You expect your patties to sell for \$15/lb. You do some research about unprocessed alligator meat and find that it contains 74.6% water, 21.2% protein and 4.2% fat. Buying in bulk, this unprocessed meat will cost you \$6.55/lb.

To reduce the cost of making the patties, you decide to add alligator fat with a moisture content of 8% (i.e. 92% fat, 8% water, 0% protein) which you can procure for \$0.20/lb. You will add enough of this alligator fat to bring the percentage of fat in the patties to 11%.

By adding fat instead of making the patties entirely from the unprocessed meat, your cost savings per pound of patties produced is closest to:

- a. 24.9 ¢/lb
- b. 29.4 ¢/lb
- c. 42.9 ¢/lb
- d. 49.2 ¢/lb
- e. 92.4 ¢/lb
- f. 94.2 ¢/lb
- g. \$2.49/lb
- h. \$2.94/lb
- i. \$4.29/lb
- j. \$9.24/lb



37. Dr. Cronk accidentally spilled the entire supply of 2% wt NaCl solution. Before Dr. Hall found out, Dr. Cronk decided to make a new solution by adding 0.5 kg of pure salt to 20 kg of 0.15% wt NaCl solution. Fortunately, Dr. Barker came to the rescue and added enough DI water to get the concentration of the new solution to 2% wt NaCl. How much DI water did Dr. Barker add?

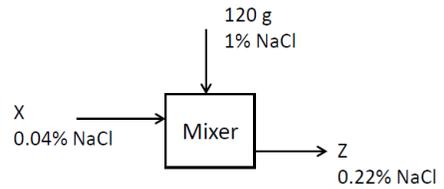
38. Dr. Hall maintains a fish tank for his exotic fish collection. The tank measures .8m by 1.3m by 1m; however, the tank has .25 m³ of sand and coral taking up space. Dr. Hall wants to maintain the salinity in the tank to be close to that of sea water, which is 3.5%. Due to evaporation, the tank is losing 1 g/s of pure water. Also, the tank has sprung a leak, and is losing 10 cm³ of the salty water every minute. What mass of water does Dr. Hall need to add every hour to maintain the same mass of water at the 3.5% salinity level? What concentration of salt does the added water require? Assume that the salinity of water lost through the leak is also 3.5%. As before, you can calculate the density of salt water with the equation:

$$\rho(\% \text{ wt NaCl}) = 998.21 \text{ kg/m}^3 + 7.14 * (\% \text{ wt NaCl}) \text{ kg/m}^3$$

39. You are back at the milk plant and it has become apparent that you need to expand your product line to include chocolate milk. You have been asked to create 100 liters per hour of a low-fat chocolate milk that has a 5% fat content. You decide to use skim milk with 0.5% fat and 5% carbohydrates and mix it with a low-fat cocoa that contains 10% fat and 50% carbohydrates. The density of the resulting chocolate milk will be 1.05kg/L. The rate of skim milk required will be closest to...
- a. 40 kg/hr
 - b. 45 kg/hr
 - c. 50 kg/hr
 - d. 55 kg/hr
 - e. 60 kg/hr
 - f. 65 kg/hr
40. An intravenous (I.V.) bag containing 1000 mL of a salt and water solution with a weight % of 0.09% salt will soon be infused into a patient. The physician in charge of the patient is displeased with the current salt solution of 0.09% weight salt and would like to lower the salt concentration to 0.07% because the patient requires a lower sodium intake. The physician wants to add deionized water to the salt solution to lower the overall salt concentration to 0.07%. The amount of DI water that must be added to the original solution is closest to...
- a. 50 mL
 - b. 150 mL
 - c. 280 mL
 - d. 420 mL
 - e. 550 mL

41. Given the information below (note: percentages are % weight in water), the mass of Z is closest to...

- a. 0.12 kg
- b. 0.20 kg
- c. 0.34 kg
- d. 0.42 kg
- e. 0.58 kg
- f. 0.64 kg
- g. 0.76 kg
- h. 0.82 kg

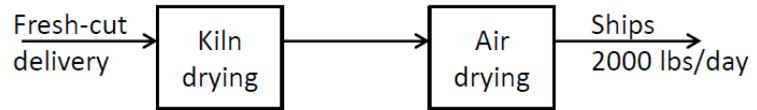


42. Your fishtank reservoir initially contains 65.9 g of water with a salinity of 0.08% NaCl by weight. The salty solenoid valve is then opened adding an unknown amount of 1% NaCl solution. Unfortunately, the end of your overflow tube is clogged so that no water leaves the reservoir (it accumulates mass since there is no overflow drainage). Your salinity reading stabilizes at 0.18%. The mass of 1% NaCl solution that was introduced to the reservoir is closest to...

- a. 1 g
- b. 2 g
- c. 3 g
- d. 4 g
- e. 5 g
- f. 6 g
- g. 7 g
- h. 8 g
- i. 9 g

43. A local sawmill preparing the 2in-by-4in piece of lumber for your fishtank project dries its freshly cut lumber in a kiln and stores it before shipping. The freshly cut lumber has 50% by weight water content. The heating process in the kiln results in wood with 35% by weight water content. Subsequent air-drying during storage results in the moisture content dropping to 24% by weight water. If the sawmill ships an average of 2000 lbs/day of the air-dried lumber, the amount of freshly cut lumber delivered to the sawmill is closest to...

- a. 2660 lbs/day
- b. 2830 lbs/day
- c. 3040 lbs/day
- d. 3290 lbs/day
- e. 3470lbs/day
- f. 3620lbs/day
- g. 3810lbs/day



Fishtank System

44. Assume the setpoint for your salinity control system is 0.08 wt% NaCl, the UCL is 0.10 wt% NaCl, and the LCL is 0.06 wt% NaCl. Assuming the current salinity is 0.19 wt% NaCl and you operate your control system with a gain of 0.7, then the target salinity is closest to . . .

- a. 0.060 wt% NaCl
- b. 0.072 wt% NaCl
- c. 0.100 wt% NaCl
- d. 0.113 wt% NaCl
- e. 0.138 wt% NaCl
- f. 0.151 wt% NaCl
- g. 0.180 wt% NaCl

45. The average value of a set of salinity readings is 375. The standard deviation of these values is 10. The minimum value of the readings is 351 and the maximum value of the readings is 397. If the target salinity is set to 375, then the UCL is closest to . . .

- a. 315
- b. 375
- c. 385
- d. 395
- e. 405
- f. 415
- g. 475