ABE 201 (9/17/04) Exam I Name:_____

1. Take a deep breath and exhale. KEEP A COOL HEAD!

2. Note the point values for each problem and work accordingly.

3. If you are unsure about a problem, ask!

4. The most important thing is to correctly setup the problem, i.e. correct analysis of the problem and demonstration that you know how to get to the solution. Do NOT waste a lot of time crunching numbers unless you have completed the setup of all the rest of the problems.

5. Show all calculations in a clear, logical fashion. No partial credit will be given on solutions unless the methodology is clearly shown/outlined. Make sure to use clear nomenclature on compositional and flow variables. Draw diagrams when using a chart!!!!

6. **Circle your answers.**

7. Put your name on every sheet of paper turned in, including the test sheets.

8. Do your own work and keep your work to yourself.

I acknowledge that this work was solely my effort, and I am not aware of any academic misconduct occurring during this exam.

Signed: _____

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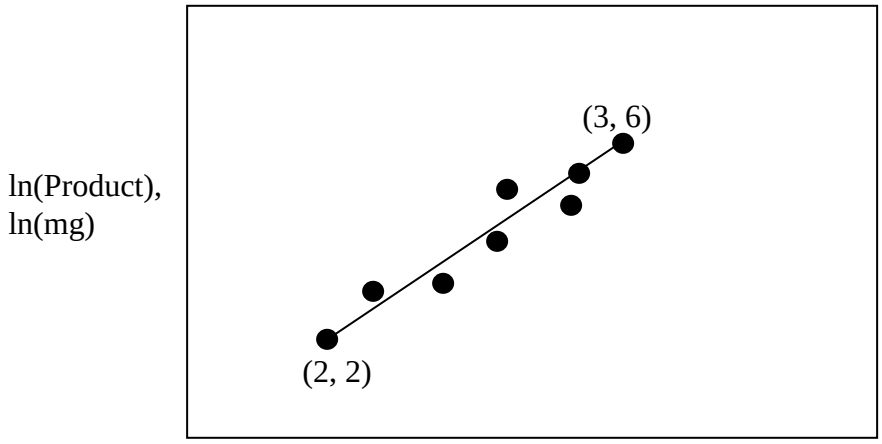
1. Cephalosporin is an antibiotic produced through fermentation. When the amount of antibiotic produced over time is displayed on a semi-log plot, the following results:



a) (5 points) Please circle the equation below that can represents the relationship between product (p) and time (t).

1. $p = m * t + b$

2. $p = t^{b*m}$

3. $p = b * e^{m*t}$

4. $m = b * e^{p*t}$

b) (10 points) Using the values given in the plot, determine the values for m & b for the equation from part a).

m = [ln(p2) – ln(p1)] / [t2 – t1] = [6 – 2] / [3 – 2] = 4/1 = 4

ln(b) = ln(p2) – m*t2 = 6 – 4*3 = 6 – 12 = - 6
b = e^-6 = 2.48E-3

p = 2.48E-3 * e^(4*t)

c) (10 points) From the information given, how many pounds of product can be produced in 300 minutes?
300 minutes (1 hr / 60 minutes) = 5

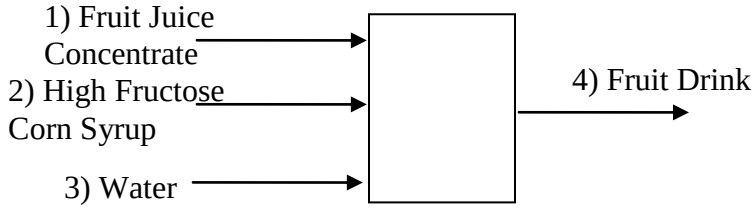
p (mg) = 2.48E-3 * e^(4*5) = 1.203e6 mg (1 kg / 10e6 mg) (2.20462 lbm / kg)
= 2.65 lbm

2. A process to produce a fruit drink utilizes fruit juice concentrate. Fruit juice concentrate (20% sugar by weight) is mixed with high fructose corn syrup (50% sugar by weight) and pure water to produce a stream with a final sugar concentration of 5% by weight.

a) (15 points) Draw a process flow diagram of the above fruit drink process and label the stream(s).
b) (15 points) Below your process flow diagram create a table that shows all of the variables in this mass balance with the appropriate common labels (m, v, x, y, etc.). Fill in the given values for the variables from the description.

Solution

a)



b)

1		**2**	
m1 =	**?**	**m2 =**	**?**
x1,sugar =	**0.20**	**x2,sugar =**	**0.50**
x1,water =	**? (or 0.80)**	**x2,water =**	**? (or 0.50)**
3		**4**	
m3 =	**?**	**m4 =**	**?**
x3,sugar =	**? (or 0.00)**	**x4,sugar =**	**0.05**
x3,water =	**1.00**	**x4,water =**	**? (or 0.95)**

3. An open-topped tank filled with water has two pressure gauges at the bottom, one on each side, and a level indicator (see diagram below). A statistical analysis of 10 readings from each gauge reveals the following:

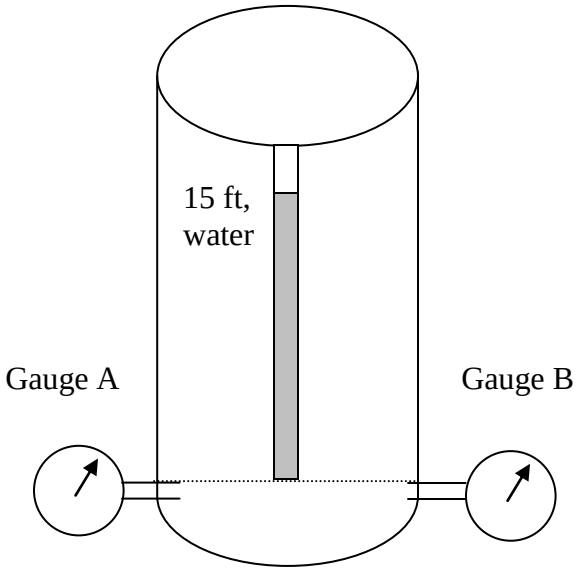
	Gauge A	Gauge B
Average	6.6 psi	5.8 psi
Standard Deviation	0.5 psi	0.6 psi

a) (10 points) What is the pressure at the bottom of the tank due to the head in psig (ignore atmospheric pressure)?

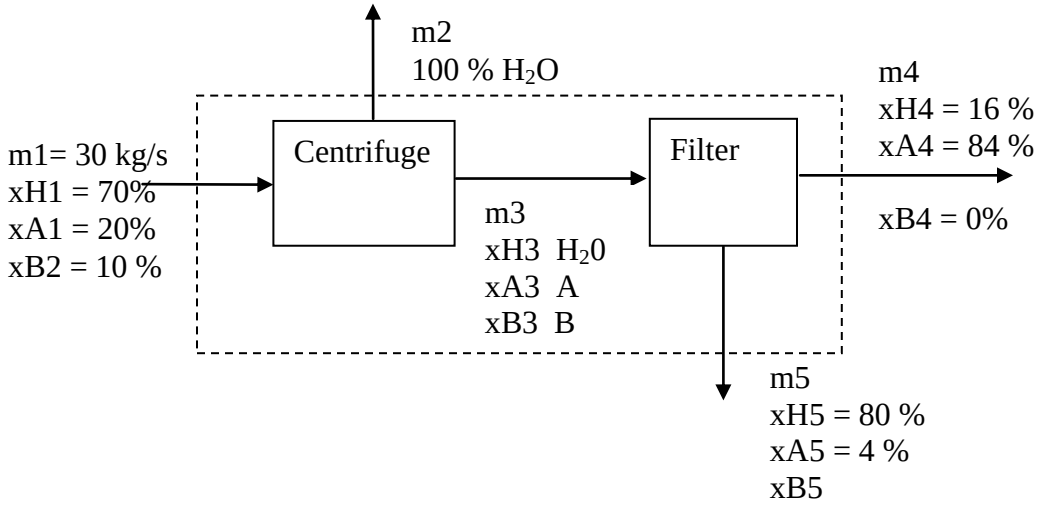
$$\frac{15 \text{ ft water}}{1}\frac{14.696 \text{ psi}}{33.9 \text{ ft water}} = 6.5 \text{ psig}$$

b) (5 points) Using the head as shown by the level indicator as the true pressure, which gauge is more <u>accurate</u>? Which gauge is more <u>precise</u>?

Gauge A is more accurate (closer to the true value).
Gauge A is also more precise (smaller standard deviation).



4. Below is a fully labeled flow diagram for a process.



a) (15 points) Determine the Degrees of Freedom for the entire process shown by the dashed system boundary. Be sure to explain each of the items in your calculation. Is this system solvable?

b) (15 points) Determine the Degrees of Freedom around the centrifuge only. Is this system solvable?

Solution

a)

V = m2, m4, m5, xB5 = 4
B = H20, A, B = 3
P = 0
C = xH5 + xA5 + xB5 = 1

DOF = 4 – 3 – 0 – 1 = 0
Solvable

b)

V = m2, m3, xH3, xA3, xB3 = 5
B = H20, A, B = 3
P = 0
C = xH3 + xA3 + xB3 = 1

DOF = 5 – 3 – 0 – 1 = 1
Not solvable

BONUS: 2 Points = Set up the problem, 3 Points = Correct Solution

If the label for the fruit drink from problem 2 says that the product is 10% (by weight) fruit juice, what percent (by weight) is high fructose in the final product?

Solution

Basis: m4 (fruit drink) = 1.00 kg

Given: m4 is 10% m1, m1 = 0.10 kg

In = Out

Total Mass Balance
m1 + m2 + m3 = m4
0.10 + m2 + m3 = 1.00

Water Mass Balance
x1,h * m1 + x2,h*m2 + x3,h*m3 = x4,h*m4
(0.80)*(0.10) + (0.50)*m2 + m3 = (0.95)*1.00

Sugar Mass Balance
x1,s * m1 + x2,s*m2 + x3,s*m3 = x4,s*m4
(0.20)*(0.10) + (0.50)*m2 + 0 = (0.05)*1.00
m2 = 0.06
The final product is 6% HFCS by weight