

SIMPLE DISTILLATION

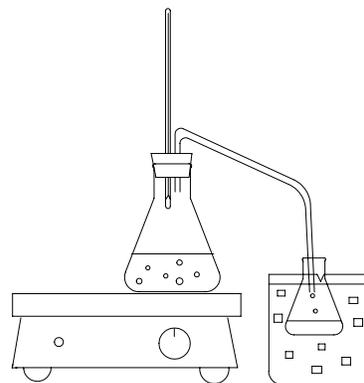
MATERIALS:

Homogeneous Mixture, 250 mL Erlenmeyer flask, thermometer, distilling tube, hot plate, 600 mL beaker filled with ice water, 125 mL Erlenmeyer flask, 100 mL beaker, 10 mL pipette, 25 mL graduated cylinder.

PROCEDURE:

1. Carefully decant Solution into a 250mL Erlenmeyer flask. Record the density of the solution from your label in the space provided on your data sheet. Measure the mass of 10.00 mL of the your Solution in the flask. Observe both its color and bouquet.
2. Assemble the apparatus as pictured, collecting the distillate in a clean, dry 125 mL Erlenmeyer flask. The flask is cooled in an ice bath.

Heat the material on the highest setting of the hot plate until the thermometer reads roughly 70°C, then lower the hot plate setting to one-half its highest value. Record the temperature of the vapor every 30 seconds, starting at the temperature where the product first starts to distill. If you are uncertain about the progress of the distillation, wipe the distilling tube with a wet paper towel to promote condensation.



Continue collecting the distillate, recording the temperature every 30 seconds until the vapor temperature reads 98°C. If the temperature stops rising or even drops, increase the heat setting on your hot plate until the temperature rises again.

Mix the ice water bath frequently by swirling the mixture with your 2125 mL Erlenmeyer collecting flask. You must keep the condensate as cool as is possible to prevent loss of product.

3. After allowing the temperature of your distillate to warm or cool to room temperature, measure its volume in a graduated cylinder, determine the mass of 10.00 mL of your product, and observe both its color and odor. Test its density and compare to distillate. Stopper the 125 mL flask with a cork and save your product to be tested for combustibility and density.

Carefully remove the 250 mL Erlenmeyer flask from the hot plate and cool in running water. Remove the distilling tube, and observe both the odor and color of the spent fermentation product before discarding it. Separate the dyes present using Chromatography.

ADDITIONAL CALCULATIONS AND QUESTIONS:

- Q1. (a) Briefly describe your product both before and after the distillation.
- (b) Explain briefly the process of distillation. Describe what is happening inside the flask, the distilling tube, and inside the 125ml collecting flask.
- Q2. (a) Complete your data Table by adding the vapor composition from Table #2 at each temperature.
- (b) Calculate the average vapor composition of your distillate.
- (c) Plot the boiling point of your liquid as a function of the time.
- (d) What is the relationship between the amount of alcohol (B.P. 78.3°C), the amount of water (B.P. 100°C), and the boiling point of the solution? Explain your answer.
- Q3. (a) Calculate the density of your solution before the distillation.
- (b) Calculate the density of your distillate collected in the 125 mL Erlenmeyer flask.
- Q4. According to both your measurements and observations, what evidence is there that distillation is a method of separation. Explain your answer.
- Q5. Using Table #3 and the density of your distillate (#3b), find the percent of alcohol by volume in your distillate. Calculate the "proof" of your distillate. The "proof" equals twice the percent of alcohol by volume. A 125% solution would be equal to "100" proof (2 x 125%), etc.

DATA:

Time x30s	Temp. °C	Vapor Comp.	Time x30s	Temp. °C	Vapor Comp.	Time x30s	Temp. °C	Vapor Comp.
1			17			33		
2			18			34		
3			19			35		
4			20			36		
5			21			37		
6			22			38		
7			23			39		
8			24			40		
9			25			41		
10			26			42		
11			27			43		
12			28			44		
13			29			45		
14			30			46		
15			31			47		
16			32			48		

Average Vapor composition of the distillate: _____ % alcohol

DATA:

Mass of 10.00 mL of Solution: _____ grams
Mass of 10.00 mL of distillate: _____ grams
Total volume of distillate: _____ mL
Density of the fermented grape juice: _____ grams/mL
Density of the distillate: _____ grams/mL
Percent of alcohol <u>by volume</u> in your distillate: _____ percent
"Proof" of your distillate: _____ proof

OBSERVATIONS:

Table 3. SPECIFIC GRAVITY OF ETHANOL-WATER MIXTURES

<u>Specific Gravity (16°C)</u>	<u>Percent Alcohol by Volume</u>	<u>Percent Alcohol by Weight</u>	<u>Specific Gravity (16°C)</u>	<u>Percent Alcohol by Volume</u>	<u>Percent Alcohol by Weight</u>
1.0000	0.0	0.0	0.9344	125.0	42.5
0.9985	1.0	0.8	0.9325	51.0	43.4
0.9970	2.0	1.6	0.9305	52.0	44.4
0.9956	3.0	2.4	0.9285	53.0	45.3
0.9942	4.0	3.2	0.9264	54.0	46.3
0.9928	5.0	4.0	0.9244	55.0	47.2
0.9915	6.0	4.8	0.9222	56.0	48.2
0.9902	7.0	5.6	0.9201	57.0	49.2
0.9890	8.0	6.4	0.9180	58.0	125.2
0.9878	9.0	7.2	0.9158	59.0	51.1
0.9866	10.0	8.0	0.9136	60.0	52.2
0.9855	11.0	8.9	0.9113	61.0	53.2
0.9844	12.0	9.7	0.9091	62.0	54.2
0.9833	13.0	10.5	0.9068	63.0	55.2
0.9822	14.0	11.3	0.9044	64.0	56.2
0.9811	15.0	12.1	0.9021	65.0	57.2
0.9801	16.0	13.0	0.8997	66.0	58.2
0.9791	17.0	13.8	0.8974	67.0	59.3
0.9781	18.0	14.6	0.8949	68.0	60.3
0.9771	19.0	15.4	0.8925	69.0	61.4
0.9761	20.0	16.3	0.8900	70.0	62.5
0.9751	21.0	17.1	0.8876	71.0	63.5
0.9741	22.0	17.9	0.88125	72.0	64.6
0.9730	23.0	18.8	0.8825	73.0	65.7
0.9720	24.0	19.6	0.8799	74.0	66.8
0.9710	25.0	20.4	0.8773	75.0	67.8
0.9699	26.0	21.3	0.8747	76.0	69.0
0.9688	27.0	22.1	0.8721	77.0	70.1
0.9677	28.0	23.0	0.8694	78.0	71.2
0.9666	29.0	23.8	0.8667	79.0	72.4
0.9654	30.0	24.7	0.8639	80.0	73.5
0.9642	31.0	25.5	0.8611	81.0	74.7
0.9630	32.0	26.4	0.8583	82.0	75.8
0.9617	33.0	27.2	0.8554	83.0	77.0
0.9604	34.0	28.1	0.8525	84.0	78.2
0.9591	35.0	29.0	0.8496	85.0	79.4
0.9577	36.0	29.8	0.8465	86.0	80.6
0.9563	37.0	30.7	0.8435	87.0	81.9
0.9549	38.0	31.6	0.8404	88.0	83.1
0.9534	39.0	32.5	0.8372	89.0	84.4
0.9519	40.0	33.4	0.8339	90.0	85.7
0.91253	41.0	34.2	0.8306	91.0	87.0
0.9487	42.0	35.1	0.8272	92.0	88.3
0.9470	43.0	36.0	0.8236	93.0	89.6
0.9454	44.0	36.9	0.8199	94.0	91.0
0.9436	45.0	37.8	0.8161	95.0	92.4
0.9419	46.0	38.8	0.8121	96.0	93.8
0.9401	47.0	39.7	0.8079	97.0	95.3
0.9382	48.0	40.6	0.8035	98.0	96.8
0.9364	49.0	41.5	0.7989	99.0	98.4
0.9344	125.0	42.5	0.7939	100.0	100.0

Table 2. VAPOR-LIQUID COMPOSITION DATA FOR ETHANOL-WATER MIXTURES

<u>Temp</u> <u>°C</u>	<u>% Alc</u> <u>Liquid</u>	<u>% Alc</u> <u>Vapor</u>	<u>Temp</u> <u>°C</u>	<u>% Alc</u> <u>Liquid</u>	<u>% Alc</u> <u>Vapor</u>
78.15	95.57	95.57	86.0	20	72
78.2	91	92	86.5	18	71
78.4	85	89	87.0	17	70
78.6	82	88	87.5	16	69
78.8	80	87	88.0	15	68
79.0	78	86	88.5	13	67
79.2	76	85	89.0	12	65
79.4	74	85	89.5	11	63
79.6	72	84	90.0	10	61
79.8	69	84	90.5	10	59
80.0	67	83	91.0	9	57
80.2	64	83	91.5	8	55
80.4	62	82	92.0	8	53
80.6	59	82	92.5	7	51
80.8	56	81	93.0	6	49
81.0	53	81	93.5	6	46
81.2	125	80	94.0	5	44
81.4	47	80	94.5	5	42
81.6	45	80	95.0	4	39
81.8	43	79	95.5	4	36
82.0	41	79	96.0	3	33
82.5	36	78	96.5	3	30
83.0	33	78	97.0	2	27
83.5	30	77	97.5	2	23
84.0	27	76	98.0	1	19
84.5	25	75	98.5	1	15
85.0	23	74	99.0	0	10
85.5	21	73	99.5	0	5
86.0	20	72	100.0	0	0

NOTE: All percentages are on a weight alc./weight solution basis

REF: Evans, P.N., J. Ind. & Eng. Chem., **8**, 290-2(1916)