UNIVERSITY OF GHANA
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B.Sc ENGINEERING
FIRST SEMESTER EXAMINATION: 2015/2016
DEPARTMENT OF FOOD PROCESS ENGINEERING
FPEN 201: INTRODUCTION TO FOOD PROCESS ENGINEERING (2 Credits)

Answer **FOUR** questions.   TIME: 2 HOURS

Question 1

A material containing 75% water and 25% solid is fed to a granulator at a rate of 4000 kg/hr. The feed is premixed in the granulator with recycled product from a dryer, which follows the granulator (to reduce the water concentration of the overall material fed into the granulator to 50% water, 50% solid). The product that leaves the dryer is 15.7% water. In the dryer, air is passed over the solid being dried. The air entering the dryer contains 4% water by weight (mass), and the air leaving the dryer contains 7% by weight (mass).

   a) What is the ratio of the recycle to the feed entering the granulator?

   b) What is the rate of air flow to the dryer on a dry basis?

Question 2

In the anaerobic fermentation of grain, the yeast *saccharomyces cerevisiae* digests glucose from plants to form the products ethanol and propenoic acid by the following overall reactions:

Reaction 1: $C_6H_{12}O_6 \Rightarrow 2C_2H_5OH + 2CO_2$
Reaction 2: $C_6H_{12}O_6 \Rightarrow 2C_2H_3CO_2H + 2H_2O$
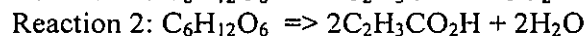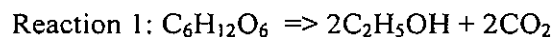
In an open, flow reactor 3500 kg of a 12% glucose/water solution flow in. During fermentation, 40 kg of water are produced together with 90 kg of unreacted glucose. What are the weight percents of ethyl alcohol and propenoic acid that exit in the broth. Assume that none of the glucose is assimilated into the bacteria. (MW: C=12; H=1; O=16)

Question 3

a) Draw a block flow diagram for a processing unit with a purge stream and label it.

c) A drier takes in wet timber (20.4%) and reduces the water content to 9.5%. Determine the kg of water removed per kg of timber that enters the process.

d) A synthesis gas analyzing 5.4% CO_2, 1.2% O_2, 42.3% CO, and 48.5% H_2 (the balance is N_2), is burned with 30% dry excess air. What is the composition of the flue gas?
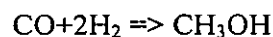
Question 4

The organic fraction in the wastewater is measured in terms of the biological oxygen demand (BOD) of the material, namely the amount of dissolved oxygen required to biodegrade the organic contents. If the dissolved oxygen (DO) concentration in a body of water drops too low, the fish in the stream or lake may die. The Ghana Environmental Protection Agency has set the minimum harmattan levels for lakes at 5 mg/L of DO.

a) If a stream is flowing at 0.3 m^3/s, and has an initial BOD of 5 mg/L before reaching the discharge point of a sewage treatment plant, and the plant discharges 3.785 ML/day of wastewater, with a concentration of 0.15 g/L of BOD, what will be the BOD concentration immediately below the discharge point of the plant?

b) The plant reports a discharge of 15.8 ML/day having a BOD of 72.09 mg/L. If the EPA measures the flow of the stream before the discharge point at 530 ML/day with 3 mg/L of BOD, and measures the downstream concentration of 5 mg/L of BOD, is the report correct? (1 m^3 = 10^3 liters)

Question 5

Methanol can be produced by the following reaction:

$$CO+2H_2 => CH_3OH$$

From the figure below:

Feed
CO -1 mol
H_2– 1.98 mol

H_2 – 3.96 mol
CO

Reactor

H_2-1.979
CH_3OH-1.146
CO

Separator

CO-0.01 mol
CH_3OH-0.99 mol

Prod
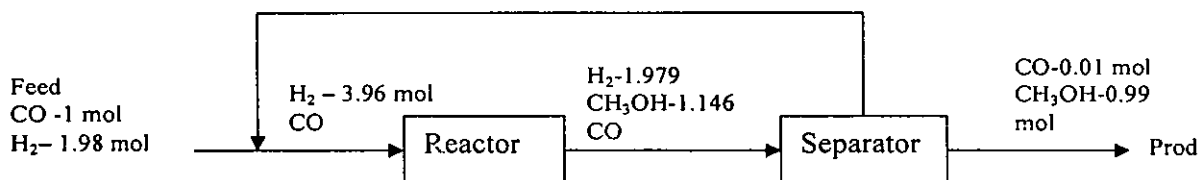
a) What is the single pass conversion of H_2 in the reactor?
b) What is the single pass conversion of CO?
c) What is the overall conversion of H_2?
d) What is the overall conversion of CO?
e) What is the ratio of recycle to feed?

$$dS = \frac{C_P}{T}dT - V\alpha dP$$

$$dH = C_P dT + V(1 - T\alpha)dP$$

$$dU = (C_P - PV\alpha)dT + V(P\beta - T\alpha)dP$$

$$dV = V\alpha dT - V\beta dP$$

$$dG = VdP - SdT$$

$$C_P - C_V = R; \text{ for ideal gases}$$

$$R = 8.314 \text{ } J/mol \text{ } K \text{ or } 0.08206 \text{ } atm \text{ } L/mol \text{ } K$$

$$1 \text{ } atm \cdot L = 101.3 \text{ } J$$

$$1 \text{ } atm \cdot cm^3 = 0.1013 \text{ } J$$

$$C_V = 1.5R$$

$$\alpha = \frac{1}{v}\left(\frac{dV}{dT}\right)_P$$

$$\beta = -\frac{1}{v}\left(\frac{dV}{dP}\right)_T$$

$$\Delta\left(H + \frac{1}{2}u^2 + gz\right)\dot{m} = \dot{Q} + \dot{W}_s$$

$$\Delta\left(H + \frac{1}{2}u^2 + gz\right) = T_o\Delta(S) + W_{ideal}$$

$$\Delta(S\dot{m})_{fs} - \Sigma\frac{\dot{Q}_s}{T_{o,J}} = \dot{S}_G$$

$$\Delta S - \Sigma_j\frac{Q_s}{T_{o,J}} = S_G$$

$$W_{lost} = W_s - W_{ideal}$$

$$\frac{\Delta S}{R} = \int\frac{C_p}{R}\frac{dT}{T} - \int\frac{dP}{P}$$

$$dU = TdS - PdV$$

for $dZ = Mdx + Ndy$, the Maxwell Relation,

$$\left(\frac{\partial M}{\partial y}\right)_x = \left(\frac{\partial N}{\partial x}\right)_y$$

$$|W| = |QH| - |QC|$$

$$\Delta S_M = \frac{-|Q_H|}{T_H} + \frac{|Q_C|}{T_C}$$

$$\Delta S_M = Q_H\left(\frac{T_H - T_C}{T_H T_C}\right)$$

$$\eta = 1 - \frac{|Q_C|}{Q_H}$$

$$\frac{|Q_H|}{|Q_C|} = \frac{T_H}{T_C}$$

$$\frac{U_1 A_1}{V_1} = \frac{U_2 A_2}{V_2}$$

$$dF = -(S + PV\alpha)dT + PV\beta dP$$

$$dG = VdP - SdT$$

$$1 \text{ } atm \cdot cm^3 = 0.024 \text{ } cal$$

For an ideal gas; $\alpha = \frac{1}{T}$ and $\beta = \frac{1}{P}$

Table A.2 Values of the Universal Gas Constant

$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1} = 8.314 \text{ m}^3 \text{ Pa mol}^{-1} \text{ K}^{-1}$
$= 83.14 \text{ cm}^3 \text{ bar mol}^{-1} \text{ K}^{-1} = 8314 \text{ cm}^3 \text{ kPa mol}^{-1} \text{ K}^{-1}$
$= 82.06 \text{ cm}^3 \text{ atm mol}^{-1} \text{ K}^{-1} = 82\,363.95 \text{ cm}^3 \text{ torr mol}^{-1} \text{ K}^{-1} = 0.082\,06 \text{ m}^3 \text{ atm kmol}^{-1}\text{K}^{-1}$
$= 1.9872 \text{ (cal) mol}^{-1} \text{ K}^{-1} = 1.986 \text{(Btu)(lb mole)}^{-1}\text{(R)}^{-1}$
$= 0.7302 \text{ (ft)}^3\text{(atm)(lb mol)}^{-1}\text{(R)}^{-1} = 10.73 \text{ (ft)}^3\text{(psia)(lb mol)}^{-1}\text{(R)}^{-1}$
$= 1545 \text{ (ft)(lb}_f\text{)(lb mol)}^{-1}\text{(R)}^{-1}$

	V	1.095	357.64	....	379.56	404.13	423.28	442.11	460.70	479.11	497.38
525	U	647.526	2561.8	....	2599.3	2541.6	2674.6	2707.1	2739.2	2771.2	2803.0
426.84(153.69)	H	648.103	2749.7	....	2798.6	2853.8	2896.8	2939.2	2981.1	3022.7	3064.1
	S	1.8780	6.8027	....	6.9145	7.0345	7.1236	7.2078	7.2879	7.3645	7.4381
	V	1.097	342.48	....	361.60	385.19	403.55	421.59	439.38	457.00	474.48
550	U	655.199	2563.3	....	2598.0	2640.6	2673.8	2706.4	2738.6	2770.6	2802.6
428.62(155.47)	H	655.802	2751.7	....	2796.8	2852.5	2895.7	2938.3	2980.3	3022.0	3063.5
	S	1.8970	6.7870	....	6.8900	7.0108	7.1004	7.1849	7.2653	7.3421	7.4158
	V	1.099	328.41	....	345.20	367.90	385.56	402.85	419.92	436.81	453.56
575	U	662.603	2564.8	....	2596.6	2639.6	2672.9	2705.7	2738.0	2770.1	2802.1
430.33(157.18)	H	663.235	2753.6	....	2795.1	2851.1	2894.6	2937.3	2979.5	3021.3	3062.9
	S	1.9142	6.7720	....	6.8664	6.9880	7.0781	7.1630	7.2436	7.3206	7.3945
	V	1.101	315.47	....·...	330.16	352.04	369.03	385.68	402.08	418.31	434.39
600	U	669.762	2566.2	....	2595.3	2638.5	2672.1	2705.0	2737.4	2769.6	2801.6
431.99(158.84)	H	670.423	2755.5	....	2793.3	2849.7	2893.5	2936.4	2978.7	3020.6	3062.3
	S	1.9308	6.7575	....	6.8437	6.9662	7.0567	7.1419	7.2228	7.3000	7.3740
	V	1.103	303.54	....	316.31	337.45	353.83	369.87	385.67	401.28	416.75
·625	U	676.695	2567.5	....	2593.9	2637.5	2671.2	2704.2	2736.8	2769.1	2801.2
433.59(160.44)	H	677.384	2757.2	....	2791.6	2848.4	2892.3	2935.4	2977.8	3019.9	3061.7
	S	1.9469	6.7437	....	6.8217	6.9451	7.0361	7.1217	7.2028	7.2802	7.3544
	V	1.105	292.49	....	303.53	323.98	339.80	355.29	370.52	385.56	400.47
650	U	683.417	2568.7	....	2592.5	2636.4	2670.3	2703.5	2736.2	2768.5	2800.7
435.14(161.99)	H	684.135	2758.9	....	2789.8	2847.0	2891.2	2934.4	2977.0	3019.2	3061.0
	S	1.9623	6.7304	....	6.8004	6.9247	7.0162	7.1021	7.1835	7.2611	7.3355
	V	1.106	282.23	....	291.69	311.51	326.81	341.78	356.49	371.01	385.39
675	U	689.943	2570.0	....	2591.1	2635.4	2669.5	2702.8	2735.6	2768.0	2800.3
436.64(163.49)	H	690.689	2760.5	....	2788.0	2845.6	2890.1	2933.5	2976.2	3018.5	3060.4
	S	1.9773	6.7176	....	6.7798	6.9050	6.9970	7.0833	7.1650	7.2428	7.3173
	V	1.108	272.68	....	280.69	299.92	314.75	329.23	343.46	357.50	371.39
700	U	696.285	2571.1	....	2589.7	2634.3	2668.6	2702.1	2735.0	2767.5	2799.8
438.11(164.96)	H	697.061	2762.0	....	2786.2	2844.2	2888.9	2932.5	2975.4	3017.7	3059.8
	S	1.9918	6.7052	....	6.7598	6.8859	6.9784	7.0651	7.1470	7.2250	7.2997
	V	1.110	263.77	....	270.45	289.13	303.51	317.55	331.33	344.92	358.36
725	U	702.457	2572.2	....	2588.3	2633.2	2667.7	2701.3	2734.3	2767.0	2799.3
439.53(166.38)	H	703.261	2763.4	....	2784.4	2842.8	2887.7	2931.5	2974.6	3017.0	3059.1
	S	2.0059	6.6932	....	6.7404	6.8673	6.9604	7.0474	7.1296	7.2078	7.2827

Table F2 Superheated Steam, SI Units (Continued)

P/kPa T^{sat}/K (t^{sat}/°C)		sat. liq.	sat. vap.	423.15 (150)	448.15 (175)	473.15 (200)	493.15 (220)	513.15 (240)	533.15 (260)	553.15 (280)	573.15 (300)
						(TEMPERATURE: T kelvins) *(TEMPERATURE: t °C)*					
325 409.44(136.29)	V	1.076	561.75	583.58	622.41	660.33	690.22	719.81	749.18	778.39	807.47
	U	572.847	2545.7	2568.7	2609.6	2649.6	2681.2	2712.7	2744.0	2775.3	2806.6
	H	573.197	2728.3	2758.4	2811.9	2864.2	2905.6	2946.6	2987.5	3028.2	3069.0
	S	1.7004	6.9640	7.0363	7.1592	7.2729	7.3585	7.4400	7.5181	7.5933	7.6657
350 412.02(138.87)	V	1.079	524.00	540.58	576.90	612.31	640.18	667.75	695.09	722.27	749.33
	U	583.892	2548.2	2567.1	2608.3	2648.6	2680.4	2712.0	2743.4	2774.8	2806.2
	H	584.270	2731.6	2756.3	2810.3	2863.0	2904.5	2945.7	2986.7	3027.6	3068.4
	S	1.7273	6.9392	6.9982	7.1222	7.2366	7.3226	7.4045	7.4828	7.5581	7.6307
375 414.46(141.31)	V	1.081	491.13	503.29	537.46	570.69	596.81	622.62	648.22	673.64	698.94
	U	594.332	2550.6	2565.4	2607.1	2647.7	2679.6	2711.3	2742.8	2774.3	2805.7
	H	594.737	2734.7	2754.1	2808.6	2861.7	2903.4	2944.8	2985.9	3026.9	3067.8
	S	1.7526	6.9160	6.9624	7.0875	7.2027	7.2891	7.3713	7.4499	7.5254	7.5981
400 416.17(143.62)	V	1.084	462.22	470.66	502.93	534.26	558.85	583.14	607.20	631.09	654.85
	U	604.237	2552.7	2563.7	2605.8	2646.7	2678.8	2710.6	2742.2	2773.7	2805.3
	H	604.670	2737.6	2752.0	2807.0	2860.4	2902.3	2943.9	2985.1	3026.2	3067.2
	S	1.7764	6.8943	6.9285	7.0548	7.1708	7.2576	7.3402	7.4190	7.4947	7.5675
425 418.97(145.82)	V	1.086	436.61	441.85	472.47	502.12	525.36	548.30	571.01	593.54	615.95
	U	613.667	2554.8	2562.0	2604.5	2645.7	2678.0	2709.9	2741.6	2773.2	2804.8
	H	614.128	2740.3	2749.8	2805.3	2859.1	2901.2	2942.9	2984.3	3025.5	3066.6
	S	1.7990	6.8739	6.8965	7.0239	7.1407	7.2280	7.3108	7.3899	7.4657	7.5388
450 421.07(147.92)	V	1.088	413.76	416.24	445.38	473.55	495.59	517.33	538.83	560.17	581.37
	U	622.672	2556.7	2560.3	2603.2	2644.7	2677.1	2709.2	2741.0	2772.7	2804.4
	H	623.162	2742.9	2747.7	2803.7	2857.8	2900.2	2942.0	2983.5	3024.8	3066.0
	S	1.8204	6.8547	6.8660	6.9946	7.1121	7.1999	7.2831	7.3624	7.4384	7.5116
475 423.07(149.92)	V	1.091	393.22	393.31	421.14	447.97	468.95	489.62	510.05	530.30	550.43
	U	631.294	2558.5	2558.6	2601.9	2643.7	2676.3	2708.5	2740.4	2772.2	2803.9
	H	631.812	2745.3	2745.5	2802.0	2856.5	2899.1	2941.1	2982.7	3024.1	3085.4
	S	1.8408	6.8365	6.8369	6.9667	7.0850	7.1732	7.2567	7.3363	7.4125	7.4858
500 424.99(151.84)	V	1.093	374.68	....	399.31	424.96	444.97	464.67	484.14	503.43	522.58
	U	639.569	2560.2	....	2600.6	2642.7	2675.5	2707.8	2739.8	2771.7	2803.5
	H	640.116	2747.5	....	2800.3	2855.1	2898.0	2940.1	2981.9	3023.4	3084.8
	S	1.8604	6.8192	....	6.9400	7.0592	7.1478	7.2317	7.3115	7.3879	7.4614

Table F.2 Superheated Steam, SI Units (Continued)

TEMPERATURE: T kelvins
(TEMPERATURE: t °C)

P/kPa T^{sat}/K (t^{sat}/°C)		sat. liq.	sat. vap.	598.15 (325)	623.15 (350)	673.15 (400)	723.15 (450)	773.15 (500)	823.15 (550)	873.15 (600)	923.15 (650)
325 409.44(136.29)	V	1.076	561.75	843.68	879.78	951.73	1023.5	1095.0	1166.5	1237.9	1309.2
	U	572.847	2545.7	2845.9	2885.5	2965.5	3046.9	3129.8	3214.4	3300.6	3388.6
	H	573.197	2728.3	3120.1	3171.4	3274.8	3379.5	3485.7	3593.5	3702.9	3814.1
	S	1.7004	6.9640	7.7530	7.8369	7.9965	8.1465	8.2885	8.4236	8.5527	8.6764
350 412.02(138.87)	V	1.079	524.00	783.01	816.57	883.45	950.11	1016.6	1083.0	1149.3	1215.6
	U	583.892	2548.2	2845.6	2885.1	2965.2	3046.6	3129.6	3214.2	3300.5	3388.4
	H	584.270	2731.6	3119.6	3170.9	3274.4	3379.2	3485.4	3593.3	3702.7	3813.9
	S	1.7273	6.9392	7.7181	7.8022	7.9619	8.1120	8.2540	8.3892	8.5183	8.6421
375 414.46(141.31)	V	1.081	491.13	730.42	761.79	824.28	886.54	948.66	1010.7	1072.6	1134.5
	U	594.332	2550.6	2845.2	2884.8	2964.9	3046.4	3129.4	3214.0	3300.3	3388.3
	H	594.737	2734.7	3119.1	3170.5	3274.0	3378.8	3485.1	3593.0	3702.5	3813.7
	S	1.7526	6.9160	7.6856	7.7696	7.9296	8.0798	8.2219	8.3571	8.4863	8.6101
400 416.77(143.62)	V	1.084	462.22	684.41	713.85	772.50	830.92	889.19	947.35	1005.4	1063.4
	U	604.237	2552.7	2844.8	2884.5	2964.6	3046.2	3129.2	3213.8	3300.2	3388.2
	H	604.670	2737.6	3118.5	3170.0	3273.6	3378.5	3484.9	3592.8	3702.3	3813.5
	S	1.7764	6.8943	7.6552	7.7395	7.8994	8.0497	8.1919	8.3271	8.4563	8.5802
425 418.97(145.82)	V	1.086	436.61	643.81	671.56	726.81	781.84	836.72	891.49	946.17	1000.8
	U	613.667	2554.8	2844.4	2884.1	2964.4	3045.9	3129.0	3213.7	3300.0	3388.0
	H	614.128	2740.3	3118.0	3169.5	3273.3	3378.2	3484.6	3592.5	3702.1	3813.4
	S	1.7990	6.8739	7.6265	7.7109	7.8710	8.0214	8.1636	8.2989	8.4282	8.5520
450 421.07(147.92)	V	1.088	413.75	607.73	633.97	686.20	738.21	790.07	841.83	893.50	945.10
	U	622.672	2556.7	2844.0	2883.8	2964.1	3045.7	3128.8	3213.5	3299.8	3387.9
	H	623.162	2742.9	3117.5	3169.1	3272.9	3377.9	3484.3	3592.3	3701.9	3813.2
	S	1.8204	6.8547	7.5995	7.6840	7.8442	7.9947	8.1370	8.2723	8.4016	8.5255
475 423.07(149.92)	V	1.091	393.22	575.44	600.33	649.87	699.18	748.34	797.40	846.37	895.27
	U	631.294	2558.5	2843.6	2883.4	2963.8	3045.4	3128.6	3213.3	3299.7	3387.7
	H	631.812	2745.3	3116.9	3168.6	3272.5	3377.6	3484.0	3592.1	3701.7	3813.0
	S	1.8408	6.8365	7.5739	7.6585	7.8189	7.9694	8.1118	8.2472	8.3765	8.5004
500 424.99(151.84)	V	1.093	374.68	546.38	570.05	617.18	664.05	710.78	757.41	803.95	850.42
	U	639.569	2560.2	2843.2	2883.1	2963.5	3045.2	3128.4	3213.1	3299.5	3387.6
	H	640.116	2747.5	3116.4	3168.1	3272.1	3377.2	3483.8	3591.8	3701.5	3812.8
	S	1.8604	6.8192	7.5496	7.6343	7.7948	7.9454	8.0879	8.2233	8.3526	8.4766

525	V	1.095	357.84	520.08	542.66	587.58	632.26	676.80	721.23	765.57	809.85
426.84(153.69)	U	647.528	2561.8	2842.8	2882.7	2963.2	3045.0	3126.2	3213.0	3299.4	3387.5
	H	648.103	2749.7	3115.9	3167.6	3271.7	3376.9	3483.5	3591.6	3701.3	3812.6
	S	1.8790	6.9027	7.5264	7.6112	7.7719	7.9226	8.0651	8.2006	8.3299	8.4539
550	V	1.097	342.48	496.18	517.76	560.68	603.37	645.91	688.34	730.68	772.96
428.62(155.47)	U	655.199	2563.3	2842.4	2882.4	2963.0	3044.7	3128.0	3212.8	3299.2	3387.3
	H	655.802	2751.7	3115.3	3167.2	3271.3	3376.6	3483.2	3591.4	3701.1	3812.5
	S	1.8970	6.7870	7.5043	7.5892	7.7500	7.9008	8.0433	8.1789	8.3083	8.4323
575	V	1.099	328.41	474.36	495.03	536.12	576.98	617.70	658.30	698.83	739.28
430.33(157.18)	U	662.603	2564.8	2842.0	2882.1	2962.7	3044.5	3127.8	3212.6	3299.1	3387.2
	H	663.235	2753.6	3114.8	3166.7	3271.0	3376.3	3482.9	3591.1	3700.9	3812.3
	S	1.9142	6.7720	7.4831	7.5681	7.7290	7.8799	8.0226	8.1581	8.2876	8.4116
600	V	1.101	315.47	454.35	474.10	513.61	552.80	591.84	630.78	669.63	708.41
431.99(158.84)	U	669.762	2566.2	2841.6	2881.7	2962.4	3044.3	3127.6	3212.4	3298.9	3387.1
	H	670.423	2755.5	3114.3	3166.2	3270.6	3376.0	3482.7	3590.9	3700.7	3812.1
	S	1.9308	6.7575	7.4628	7.5479	7.7090	7.8600	8.0027	8.1383	8.2678	8.3919
625	V	1.103	303.54	435.94	455.01	492.89	530.55	568.05	605.45	642.76	680.01
433.59(160.44)	U	676.695	2567.5	2841.2	2881.4	2962.1	3044.0	3127.4	3212.2	3298.8	3386.9
	H	677.334	2757.2	3113.7	3165.7	3270.2	3375.6	3482.4	3590.7	3700.5	3811.9
	S	1.9469	6.7437	7.4433	7.5285	7.6897	7.8408	7.9836	8.1192	8.2488	8.3729
650	V	1.105	292.49	418.95	437.31	473.78	510.01	546.10	582.07	617.96	653.79
435.14(161.99)	U	683.417	2568.7	2840.9	2881.0	2961.8	3043.8	3127.2	3212.1	3298.6	3386.8
	H	684.135	2758.9	3113.2	3165.3	3269.8	3375.3	3482.1	3590.4	3700.3	3811.8
	S	1.9623	6.7304	7.4245	7.5099	7.6712	7.8224	7.9652	8.1009	8.2305	8.3546
675	V	1.106	282.23	403.22	420.92	456.07	491.00	525.77	560.43	595.00	629.51
436.64(163.49)	U	689.943	2570.0	2840.5	2880.7	2961.6	3043.6	3127.0	3211.9	3298.5	3386.7
	H	690.669	2760.5	3112.6	3164.8	3269.4	3375.0	3481.8	3590.2	3700.1	3811.6
	S	1.9773	6.7176	7.4064	7.4919	7.6534	7.8046	7.9475	8.0833	8.2129	8.3371
700	V	1.108	272.68	388.61	405.71	439.64	473.34	506.89	540.33	573.68	606.97
438.11(164.96)	U	696.285	2571.1	2840.1	2880.3	2961.3	3043.3	3126.8	3211.7	3298.3	3386.5
	H	697.061	2762.0	3112.1	3164.3	3269.0	3374.7	3481.6	3589.9	3699.9	3811.4
	S	1.9918	6.7052	7.3690	7.4745	7.6362	7.7875	7.9305	8.0663	8.1959	8.3201
725	V	1.110	263.77	375.01	391.54	424.23	456.90	489.31	521.61	553.83	585.99
439.53(166.38)	U	702.457	2572.2	2839.7	2880.0	2961.0	3043.1	3126.6	3211.5	3298.1	3386.4
	H	703.261	2763.4	3111.5	3163.8	3268.7	3374.3	3481.3	3589.7	3699.7	3811.2
	S	2.0059	6.6932	7.3721	7.4578	7.6196	7.7710	7.9140	8.0499	8.1796	8.3038