UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2002/2003

Februari/Mac 2003

EKC 221 – Termodinamik Kejuruteraan Kimia

Masa : 3 jam

Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH mukasurat yang bercetak dan TIGA mukasurat Lampiran sebelum anda memulakan peperiksaan ini.

Kertas soalan ini mengandungi ENAM soalan. Jawab LIMA soalan.
Jawab soalan 1 dan mana-mana EMPAT soalan dari soalan yang seterusnya.

Untuk soalan 1, tuliskan jawapan yang betul dalam buku jawapan.

Para pelajar boleh menjawab semua soalan dalam Bahasa Malaysia. Jika anda ingin menjawab dalam Bahasa Inggeris, anda hendaklah menjawab sekurang-kurangnya SATU soalan dalam Bahasa Malaysia.

...2/-

1. Pilih jawapan yang betul dan paling sesuai daripada pilihan-pilihan yang diberikan untuk setiap penyataan yang berikut. Setiap jawapan yang betul membawa DUA markah.

[a] Sistem yang mengandungi dua ketul pepejal $CaCO_3$, , satu ketul pepejal CaO, dan gas CO_2 dalam keseimbangan mempunyai _____ fasa.

[i] satu

[ii] dua

[iii] tiga

[iv] empat

[b] Suhu _____ ialah suhu tertinggi di mana fasa wap dan cecair bagi bahan tulen wujud bersama-sama pada keseimbangan.

[i] kritikal

[ii] titik didih

[iii] titik kembar tiga

[iv] azeotrop

[c] Untuk tindakbalas berbalik dan eksotermik, penukaran keseimbangan _____ apabila suhu tindakbalas meningkat.

[i] meningkat

[ii] menurun

[iii] menjadi sifar

[iv] tidak berubah

[d] Untuk perubahan fasa berbalik bagi bahan tulen pada suhu dan tekanan malar, ΔG ialah _____

[i] sifar

[ii] positif

[iii] □uperson

[iv] malar

[e] Untuk satu supersonik yang mengandungi dua □upers boleh larut dan tidak bertindakbalas yang wujud sebagai azeotrop dalam keseimbangan wap-cecair, nombor darjah kebebasan ialah _____

[i] sifar

[ii] satu

[iii] dua

[iv] tiga

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[f] Proses pendikitan adalah _____

[i] Seentropi

[ii] Seentalpi

[iii] Setekanan

[iv] Sesuhu

[g] Aliran mengalir melalui muncung halus adalah _____

[i] seentropi

[ii] seentalpi

[iii] setekanan

[iv] sesuhu

[h] Perbezaan penting di antara peti sejuk pemampatan wap dan peti sejuk penyerapan ialah cara yang digunakan untuk _____

[i] Pengewapan

[ii] Pemeluwapan

[iii] Pemampatan

[iv] Pendikitan

[i] Untuk halaju supersonik bagi aliran melalui paip berkeratan rentas seragam, halaju aliran _____ dengan arah aliran.

[i] meningkat

[ii] menurun

[iii] malar

[iv] terbalik

[j] Entropi bagi campuran bahan tulen ialah _____ hasil tambah entropi-entropi bahan tulen campuran tersebut.

[i] kurang dari

[ii] lebih sama

[iii] sama dengan

[iv] tidak sama dengan

[20 markah]

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1. *Select the correct and most suitable answer from the given choices for each of the following statements. Each correct statement carries TWO marks.*

[a] *The system containing two pieces of solid $CaCO_3$, one piece of solid CaO, and CO_2 gas in equilibrium has _____ phases.*

[i] *one*

[ii] *two*

[iii] *three*

[iv] *four*

[b] *The _____ temperature is the highest temperature at which vapor and liquid phases of a pure substance coexist at equilibrium.*

[i] *critical*

[ii] *boiling point*

[iii] *triple point*

[iv] *azeotropic*

[c] *For a reversible and exothermic reaction, the equilibrium conversion _____ when the reaction temperature increases.*

[i] *increases*

[ii] *decreases*

[iii] *becomes zero*

[iv] *remains constant*

[d] *For a reversible phase change of a pure substance at constant temperature and pressure, ΔG is _____ .*

[i] *zero*

[ii] *positive*

[iii] *negative*

[iv] *constant*

[e] *For a system of two miscible nonreacting species which exists as an azeotrope in vapor-liquid equilibrium, the number of degrees of freedom is _____ .*

[i] *zero*

[ii] *one*

[iii] *two*

[iv] *three*

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[f] *Throttling process is _____.*

[i] *Isentropic*

[ii] *Isenthalpic*

[iii] *Isobaric*

[iv] *Isothermal*

[g] *Flow across a smooth nozzle is _____.*

[i] *Isentropic*

[ii] *Isenthalpic*

[iii] *Isobaric*

[iv] *Isothermal*

[h] *The essential difference between a vapor compression refrigerator and an absorption refrigerator is in the different means employed for _____.*

[i] *Evaporation*

[ii] *Condensation*

[iii] *Compression*

[iv] *Throttling*

[i] *For supersonic velocity of flow through a pipe of uniform cross section, the velocity of flow _____ with the direction of flow.*

[i] *increases*

[ii] *decreases*

[iii] *remains constant*

[iv] *reverses*

[j] *The entropy of a mixture of pure components is _____ the sum of entropies of the pure components of the mixture.*

[i] *less than*

[ii] *greater than*

[iii] *equal to*

[iv] *not equal to*

[20 marks]

...6/-

2. Tekanan wap benzena dalam fungsi suhu diberikan oleh persamaan:

$$\ln P^{sat} = 13.8858 - \frac{3{,}330}{T}$$

di mana P^{sat} dalam kPa

T dalam K

Untuk pengewapan benzena pada 50°C, anggarkan yang berikut:

[a] Entalpi dan entropi pengewapan dengan menggunakan persamaan Clausius-Clapeyron

[8 markah]

[b] Isipadu molar wap tepu dengan menggunakan persamaan keadaan Peng-Robinson.

[8 markah]

[c] Entalpi pengewapan jika isipadu wap tepu dianggarkan dalam bahagian [b] digunakan dalam persamaan Clausius-Clapeyron.

[4 markah]

2. *The vapor pressure of benzene as a function of temperature is given by the equation:*

$$\ln P^{sat} = 13.8858 - \frac{3{,}330}{T}$$

where P^{sat} *in kPa*

T in K

For the vaporatization of benzene at 50°C, estimate the following:

[a] The enthalpy and entropy of vaporization, using the Clausius-Clapeyron equation.

[8 marks]

[b] The molar volume of saturated vapor by the Peng-Robinson equation of state.

[8 marks]

[c] The enthalpy of vaporization if the saturated vapor volume estimated in part [b] is used in the Clausius-Clapeyron equation.

[4 marks]

...7/-

3. Untuk larutan penduaan aseton (1)/metanol (2), persamaan-persamaan berikut memberikan anggaran yang baik untuk pekali aktiviti.

$$\ln\gamma_1 = 0.64x_2^2 \qquad \ln\gamma_2 = 0.64x_1^2$$

Sebagai tambahan, persamaan-persamaan Antoines berikut memberikan tekanan wap

$$\ln P_1^{sat} = 14.3916 - \frac{2{,}795.85}{t + 230.00}$$

$$\ln P_2^{sat} = 16.5983 - \frac{3{,}644.30}{t + 239.76}$$

di mana P_1^{sat} dan P_2^{sat} dalam kPa

t dalam ^oC

Andaikan kesahihan hukum Roults terubahsuai mengambil kira ketakunggulan fasa cecair.

[a] Kira komposisi fasa cecair dan wap pada 60°C dan 100 kPa.
(Untuk lelaran, mulakan dengan nilai awal $x_1 = 0.2$)

[6 markah]

[b] Jika larutan mengandungi pecahan mol 0.5 aseton dan pecahan mol 0.5 metanol dipanaskan pada tekanan malar 100 kPa, pada suhu berapakah buih pertama bagi wap dihasilkan, dan apakah komposisinya.

[10 markah]

[c] Untuk bahagian [a], jika pecahan mol keseluruhan aseton ialah 0.20, tentukan nisbah mol wap kepada cecair.

[4 markah]

3. *For the binary solution of acetone (1)/methanol (2), the following equations provide a good approximation for the activity coefficients:*

$$ln\gamma_1 = 0.64x_2^2 \qquad ln\gamma_2 = 0.64x_1^2$$

In addition, the following Antoines equations provide vapor pressures:

$$ln P_1^{sat} = 14.3916 - \frac{2{,}795.85}{t + 230.00}$$

$$ln P_2^{sat} = 16.5983 - \frac{3{,}644.30}{t + 239.76}$$

where P_1^{sat} *and* P_2^{sat} *in kPa*

t in ^oC

...8/-

Assume the validity of the modified Raoult's law that takes into account nonideality of the liquid phase.

[a] Calculate the composition of the vapor and liquid phases at 60°C and 100 kPa (For the iteration, start with initial value of $x_1 = 0.2$)

[6 marks]

[b] If a solution containing 0.5 mol fraction acetone and 0.5 mole fraction methanol is heated at constant pressure of 100 kPa, at what temperature will the first bubble of vapor appear, and what will be its composition?

[10 marks]

[c] For part [a], if the overall mole fraction of acetone is 0.20, determine the mole ratio of vapor to liquid.

[4 marks]

4. Satu muncung yang licin digunakan untuk mengembangkan stim daripada 700 kPa pada 400°C kepada tekanan 475 kPa. Kadar aliran stim ialah 0.75 kg s^{-1}. Halaju stim masuk ialah 5 m/s. Anggarkan yang berikut:

[a] Halaju stim dan luas keratan rentas pada salur keluar muncung.

[10 markah]

[b] Suhu dan entalpi stim yang meninggalkan muncung.
(Bahagian berkaitan mengenai jadual stim diberikan)

[10 markah]

4. A smooth nozzle is used to expand steam from 700 kPa at 400°C to a pressure of 475 kPa. The flow rate of steam is 0.75 kg s^{-1}. The velocity of steam at the inlet is 5m/s. Estimate the following:

[a] The velocity of steam and the area of cross section at the exit of the nozzle.

[10 marks]

[b] The temperature and the enthalpy of steam leaving the nozzle.
(Relevant sections of the steam table are attached)

[10 marks]

5. Sebuah peti sejuk pemampatan wap berasaskan bahan pendingin 'A' menghasilkan penyejukan 20 kW. Aliran-aliran yang meninggalkan pengewap dan pemeluwap masing-masing ialah pada -10°C dan 40°C. Cecair tepu yang meninggalkan pemeluwap mengalir melalui sebuah injap pengembangan memasuki pengewap. Aliran yang meninggalkan pengewap ialah wap tepu.

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[a] Lukiskan gambarajah aliran bagi sistem tersebut.

[6 markah]

[b] Lakarkan proses tersebut di atas carta tekanan-entalpi bahan pendingin yang disediakan. (Kepilkan carta tersebut dalam buku jawapan)

[8 markah]

[c] Anggarkan kadar aliran bahan pedingin.
(Gambarajah P-H untuk bahan pendingin 'A' disediakan)

[6 markah]

5. *A vapor compression refrigerator based on a refrigerant 'A' produces 20 kW of cooling. Streams leaving the evaporator and the condenser are at -10°C and 40°C, respectively. Saturated liquid leaves the condenser which flows through an expansion valve into the evaporator. The stream leaving the evaporator is saturated vapor.*

[a] Draw the flow diagram of the system.

[6 marks]

[b] Sketch the process on the pressure-enthalpy chart of the refrigerant provided. (Attach the chart to the answering book)

[8 marks]

[c] Estimate the flow rate of the refrigerant.
(P-H diagram for the refrigerant 'A' is attached)

[6 marks]

6. [a] Etilena dihasilkan melalui dehidrogenasi etana:

$$C_2H_6(g) \rightleftharpoons C_2H_4(g) + H_2(g)$$

Tindakbalas mencapai keseimbangan pada 1,100 K dan 1 bar. Pada keadaan ini pemalar keseimbangan ialah 1.81. Andaikan bahawa semua gas adalah unggul

[i] Jika sistem pada awalnya mengandungi 1 mol etana, berapakah komposisi gas produk.

[4 markah]

[ii] Jika 0.5 mol stim (bahan pencair lengai) ditambahkan kepada bahan suapan per mol etana, berapakah komposisi keseimbangan gas keluaran berasaskan bebas-air.

[4 markah]

...10/-

[iii] Dengan membandingkan komposisi produk yang didapati dalam bahagian [i] dan [ii], bincangkan kesan stim pada keseimbangan untuk tindakbalas di atas.

[2 markah]

[b] Berapakah kerja minima yang diperlukan untuk pemisahan bagi campuran keseimbangan yang diperolehi daripada bahagian [a] [i] ke dalam aliran gas-gas tulen setiap satu pada keadaan ambien (25°C dan 1 bar).

[10 markah]

6. *[a] Ethylene is produced by the dehydrogenation of ethane:*

$$C_2H_6(g) \rightleftharpoons C_2H_4(g) + H_2(g)$$

The reaction reaches equilibrium at 1,100 K and 1 bar. At this condition, the equilibrium constant is 1.81. Assume that all gases are ideal.

[i] If the system initially contains 1 mole of ethane, what is the composition of the product gas?

[4 marks]

[ii] If 0.5 mole of steam (inert diluent) is added to the feed per mole of ethane, what is the equilibrium composition of the products gas on a water-free basis?

[4 marks]

[iii] By comparing the product compositions obtained in part [i] and part [ii], discuss the effect of steam on the equilibrium of the above reaction?

[2 marks]

[b] What is the minimum work required for the separation of the equilibrium mixture obtained in part [a][i] into streams of pure gases each at ambient condition (25°C and 1 bar).

[10 marks]

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Lampiran

DATA AND EQUATION SHEET

The Peng-Robins EOS in term of compressibility factor suitable for vapor root:

$$Z = 1 + \beta - q\beta \frac{Z - \beta}{Z^2 + 2\beta Z - \beta^2}$$

where $\beta = 0.07779 \frac{P_r}{T_r}$ $\qquad q = \frac{0.45724\,\alpha(T_r, \omega)}{0.07779 T_r}$

$$\alpha(T_r, \omega) = \left[1 + (0.37464 + 1.54226\,\omega - 0.26992\omega^2)\left(1 - T_r^{1/2}\right)\right]^2$$

The critical constants for benzene : $T_c = 562.2$ K $\qquad P_c = 48.98$ bar $\qquad \omega = 0.210$

The Clausius-Clapeyron Equation : $\frac{dP^{sat}}{dT} = \frac{\Delta H^{lv}}{TV^v} = \frac{\Delta H^{lv}}{RT^2 / P^{sat}}$

The mean heat capacities of ideal gases between the temperatures T_0 and T :

$$\frac{\left\langle C_P^{ig} \right\rangle_H}{R} = A + \frac{B}{2} T_0 (\tau + 1) + \frac{C}{3} T_0^2 (\tau^2 + \tau + 1) + \frac{D}{\tau T_0^2}$$

$$\frac{\left\langle C_P^{ig} \right\rangle_S}{R} = A + \left[BT_0 + \left(CT_0^2 + \frac{D}{\tau 2T_0^2} \right)\left(\frac{\tau + 1}{2} \right) \right]\left(\frac{\tau - 1}{\ln \tau} \right)$$

where $\tau = \frac{T}{T_0}$

For ethane:	$A = 1.131$	$B = 19.225 \times 10^{-3}$	$C = -5.561 \times 10^{-6}$	$D = 0$
For ethylene:	$A = 1.424$	$B = 14.394 \times 10^{-3}$	$C = -4.392 \times 10^{-6}$	$D = 0$
For hydrogen:	$A = 3.249$	$B = 0.422 \times 10^{-3}$	$C = 0$	$D = 0.83$

Entropy change of ideal gas with T and P:

$$\Delta S^{ig} = \left\langle C_P^{ig} \right\rangle_S \ln\left(\frac{T_2}{T_1}\right) - R \ln\left(\frac{P_2}{P_1}\right)$$

Entropy change of mixing:

$$\Delta S^{id} = -R \sum y_i \ln y_i$$

Universal gas constant $\qquad R = 8.314$ J mol^{-1} K^{-1}

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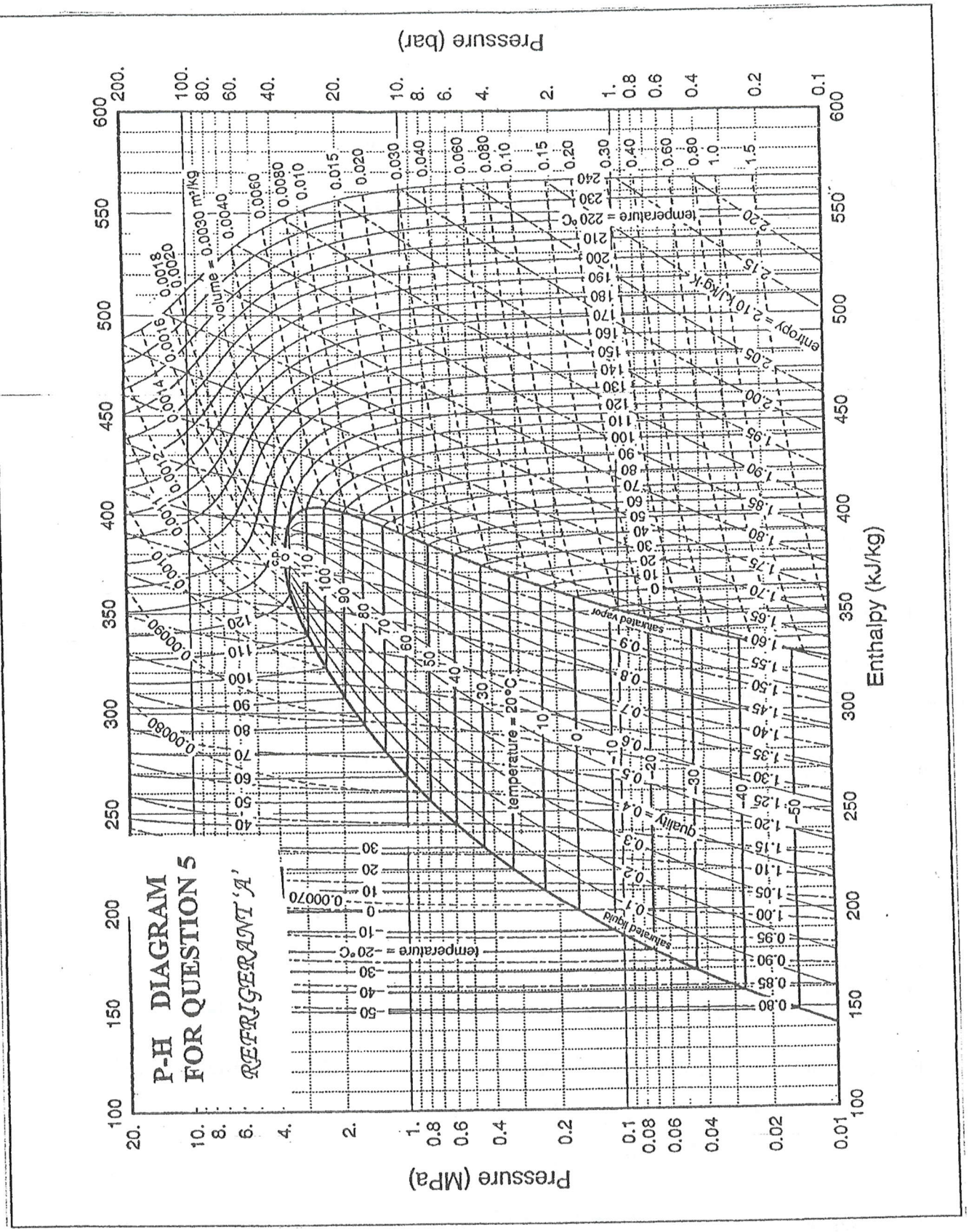
P-H DIAGRAM
FOR QUESTION 5
REFRIGERANT 'A'
Pressure (MPa)
Pressure (bar)
Enthalpy (kJ/kg)
volume = 0.0030 m³/kg
temperature = 220 °C
entropy = 2.10 kJ/kg·K
temperature = -20 °C
temperature = 20 °C
quality = 0.4
Saturated liquid
Saturated vapor

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Table Superheated Steam, SI Units (Continued)

V = SPECIFIC VOLUME $cm^3\ g^{-1}$
U = SPECIFIC INTERNAL ENERGY $kJ\ kg^{-1}$
H = SPECIFIC ENTHALPY $kJ\ kg^{-1}$
S = SPECIFIC ENTROPY $kJ\ kg^{-1}\ K^{-1}$

P/kPa (t^{sat}/°C)		sat. liq.	sat. vap.	TEMPERATURE: t °C (TEMPERATURE: T kelvins) 325 (598.15)	350 (623.15)	400 (673.15)	450 (723.15)	500 (773.15)	550 (823.15)	600 (873.15)	650 (923.15)
	V	1.076	561.75	643.68	879.78	951.73	1023.5	1095.0	1166.5	1237.9	1309.2
325	U	572.847	2545.7	2845.9	2885.5	2965.5	3046.9	3129.8	3214.4	3300.6	3388.6
(136.29)	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
	V	1.079	524.00	783.01	816.57	883.45	950.11	1016.6	1083.0	1149.3	1215.6
350	U	583.892	2548.2	2845.6	2885.1	2965.2	3046.6	3129.6	3214.2	3300.5	3388.4
(138.87)	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
	V	1.081	491.13	730.42	761.79	824.28	886.54	948.66	1010.7	1072.6	1134.5
375	U	594.332	2550.6	2845.2	2884.8	2964.9	3046.4	3129.4	3214.0	3300.3	3388.3
(141.31)	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	7.7698	7.9296	8.0798	8.2219	8.3571	8.4863	8.6101
	V	1.084	462.22	684.41	713.85	772.50	830.92	889.19	947.35	1005.4	1063.4
400	U	604.237	2552.7	2844.8	2884.5	2964.6	3046.2	3129.2	3213.8	3300.2	3388.2
(143.62)	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
	V	1.086	436.61	643.81	671.56	726.81	781.84	836.72	891.49	946.17	1000.8
425	U	613.667	2554.8	2844.4	2884.1	2964.4	3045.9	3129.0	3213.7	3300.0	3388.0
(145.82)	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
	V	1.088	413.75	607.73	633.97	686.20	738.21	790.07	841.83	893.50	945.10
450	U	622.672	2556.7	2844.0	2883.8	2964.1	3045.7	3128.8	3213.5	3299.8	3387.9
(147.92)	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
	V	1.091	393.22	575.44	600.33	649.87	699.18	748.34	797.40	846.37	895.27
475	U	631.294	2558.5	2843.6	2883.4	2963.8	3045.4	3128.6	3213.3	3299.7	3387.7
(149.92)	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
	V	1.093	374.68	546.38	570.05	617.16	664.05	710.78	757.41	803.95	850.42
500	U	639.569	2560.2	2843.2	2883.1	2963.5	3045.2	3128.4	3213.1	3299.5	3387.6
(151.84)	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
	V	1.095	357.84	520.08	542.66	587.58	632.26	676.80	721.23	765.57	809.85
525	U	647.528	2561.8	2842.8	2882.7	2963.2	3045.0	3128.2	3213.0	3299.4	3387.5
(153.69)	H	648.103	2749.7	3115.9	3167.6	3271.7	3376.9	3483.5	3591.6	3701.3	3812.6
	S	1.8790	6.8027	7.5264	7.6112	7.7719	7.9226	8.0651	8.2006	8.3299	8.4539
	V	1.097	342.48	496.18	517.76	560.68	603.37	645.91	688.34	730.68	772.96
550	U	655.199	2563.3	2842.4	2882.4	2963.0	3044.7	3128.0	3212.8	3299.2	3387.3
(155.47)	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
	V	1.099	328.41	474.36	495.03	536.12	576.98	617.70	658.30	698.83	739.28
575	U	662.603	2564.8	2842.0	2882.1	2962.7	3044.5	3127.8	3212.6	3299.1	3387.2
(157.18)	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
	V	1.101	315.47	454.35	474.19	513.61	552.80	591.84	630.78	669.63	708.41
600	U	669.762	2566.2	2841.6	2881.7	2962.4	3044.3	3127.6	3212.4	3298.9	3387.1
(158.84)	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
	V	1.103	303.54	435.94	455.01	492.89	530.55	568.05	605.45	642.76	680.01
625	U	676.695	2567.5	2841.2	2881.4	2962.1	3044.0	3127.4	3212.2	3298.8	3386.9
(160.44)	H	677.384	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
	V	1.105	292.49	418.95	437.31	473.78	510.01	546.10	582.07	617.96	653.79
650	U	683.417	2568.7	2840.9	2881.0	2961.8	3043.8	3127.2	3212.1	3298.6	3386.8
(161.99)	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
	V	1.106	282.23	403.22	420.92	456.07	491.00	525.77	560.43	595.00	629.51
675	U	689.943	2570.0	2840.5	2880.7	2961.6	3043.6	3127.0	3211.9	3298.5	3386.7
(163.49)	H	690.689	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
	V	1.108	272.68	388.61	405.71	439.64	473.34	506.89	540.33	573.68	606.97
700	U	696.285	2571.1	2840.1	2880.3	2961.3	3043.3	3126.8	3211.7	3298.3	3386.5
(164.96)	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	7.3890	7.4745	7.6362	7.7875	7.9305	8.0663	8.1959	8.3201
	V	1.110	263.77	375.01	391.54	424.33	456.90	489.31	521.61	553.83	585.99
725	U	702.457	2572.2	2839.7	2880.0	2961.0	3043.1	3126.6	3211.5	3298.1	3386.4
(166.38)	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