

NATIONAL EXAMINATIONS

December 2013

07-MEC-B3 ENERGY CONVERSION AND POWER GENERATION

Three hours duration

Notes to Candidates

1. This is a **Closed Book** examination.
2. Examination paper consists of two Sections. **Section A is Calculative** with four (4) questions and **Section B is Descriptive** with two (2) questions. Descriptive questions must be comprehensively answered (in approximately 3 pages).
3. **Do three (3) questions (including all parts of each question) from Section A (Calculative) and one (1) question from Section B (Descriptive).**
4. **Four questions constitute a complete paper.** (Total 60 marks).
5. **All questions are of equal value.** (Each 15 marks).
6. If doubt exists as to the interpretation of any question or in the event of missing data, the candidate is urged to submit, with the answer paper, a clear statement of any assumptions made.
7. Candidates may use one of the approved **Casio** or **Sharp** calculators.
8. **Reference data** for particular questions are given on pages 8 to 11. **All pages used are to be returned with the answer booklet showing where data has been obtained.**
9. **Reference formulae and constants** are given on pages 12 to 15.
10. **Steam Tables** from "Thermodynamics and Heat Power" are provided.

SECTION A CALCULATIVE SECTION**QUESTION 1 PLANT ENERGY BALANCES****PART I COMBINED CYCLE CONFIGURATION**

Sketch a flow diagram for a simple combined cycle plant consisting of gas and steam turbines and a heat recovery boiler. Show all components including the combustion chamber, condenser, feedwater pump and electrical generators. If the gas turbine and steam turbine cycle efficiencies are both 30% and the heat recovery boiler efficiency is 90%, determine the following for a total electrical output of 250 MW:

- (a) Combined efficiency of plant
- (b) Gas turbine capacity
- (c) Steam turbine capacity

Show on the sketch: (i) the magnitudes of the heat flow rates (MJ/s) at key points, (ii) power outputs (MW) of the respective cycles and (iii) output of the plant as a whole.

(9 marks)

PART II CARBON DIOXIDE EMISSIONS

In the context of reducing carbon dioxide emissions, consider the replacement of a coal fired power plant by a natural gas fired combined cycle (gas-steam) power plant. If coal is assumed to be primarily pure carbon and natural gas primarily methane, determine the amount of carbon dioxide produced (as a percentage of that produced when burning coal) when burning natural gas to produce the same amount of electricity. Use the following data:

Fuel	Formula	Higher Heating Value (kJ/kg)	Lower Heating Value (kJ/kg)
Carbon	C	32 800	32 800
Methane	CH ₄	55 530	50 050

Coal fired plant thermal efficiency = 40%

Combined cycle plant thermal efficiency = 50%

Comment on the validity of the assumption that coal is primarily carbon and that natural gas is primarily methane. If this assumption is not valid, indicate how the answer would be affected.

(6 marks)

[15 marks]

QUESTION 2 POWER PLANT EFFICIENCY AND HEAT DISCHARGE**PART I POWER PLANT EFFICIENCY**

Refer to the Examination Paper Attachments Page 8 **Heat Balance Diagram** for a Fossil Fired Power Plant.

Using this diagram determine the following:

- (a) Steam Cycle Efficiency (electrical output / thermal input)
- (b) Power Output of High Pressure Turbine (calculated from steam properties)
- (c) Power Input to Boiler Feedwater Pump (calculated from steam properties)

(9 marks)

PART II HEAT DISCHARGE

Thermal power plants operating on a Rankine Cycle reject considerable quantities of heat to a cooling system via a condenser. If the cooling medium is water in an open loop with the environment, it can cause significant thermal pollution of a river or lake at the point of discharge. Consider (i) a CANDU Nuclear Plant, and (ii) a Coal Fired Fossil Plant each of 1000 MW electrical output.

- (a) Determine the total rate of heat discharge in the cooling water for each.
- (b) Find the total rate of heat loss to the atmosphere for each.

Assume that the reactor is water cooled and the electrical equipment air cooled. Use the data given below for efficiencies:

CANDU Nuclear Plant steam cycle efficiency	0.33
Coal Fired Fossil Plant steam cycle efficiency	0.41
CANDU Nuclear Plant reactor thermal efficiency	0.99
Coal Fired Fossil Plant boiler thermal efficiency	0.94
Electrical efficiency for both plants	0.96

Note: Boiler and reactor thermal efficiency is defined as heat output via steam or coolant over heat input from fuel.

(6 marks)

[15 marks]

QUESTION 3 STEAM PLANT TURBOMACHINERY**PART I TURBINE EXPANSION LINE**

Refer to the Examination Paper Attachments Page 9 **Mollier Diagram**.

Dry saturated steam is supplied to the high pressure turbine in a nuclear plant at 6 MPa. Under part load conditions this is throttled by a control valve to 3 MPa before entering the turbine. It then expands in the turbine to a pressure of 0.6 MPa before reheating. The steam temperature after reheating is 255°C and it then expands in the low pressure turbine to 0.004 MPa. Under these conditions the steam flow through the high pressure turbine is 600 kg/s and through the low pressure turbine 500 kg/s. Assuming a turbine internal efficiency of 80% for both the high pressure and low pressure turbines, plot the throttling and actual and ideal expansion processes on the attached Mollier Diagram and determine the power output. Label all points and determine the terminal conditions as defined below. Steam Tables may be used to verify values or to obtain better accuracy.

- (a) Plotting of processes on Mollier Diagram with key points identified and determination of enthalpies at those points. (5)
- (b) Terminal conditions (temperature and moisture) of the steam at the following points: (3)
- inlet of the high pressure turbine
 - exit of the high pressure turbine
 - exit of the low pressure turbine.
- (c) Power output of the whole turbine under the given conditions. (2)

Write the answers in the examination booklet.

(10 marks)

PART II FEEDWATER PUMP EFFICIENCY

A large boiler feedwater pump receives feedwater at 2.5 MPa and delivers it at 20 MPa. The flow rate is approximately 250 kg/s but cannot be measured accurately. Under test conditions the pressures were maintained as specified and the inlet and outlet temperatures measured as 210.0°C and 214.3°C respectively. Calculate the internal efficiency of the pump. Use Steam Tables.

(5 marks)

[15 marks]

QUESTION 4 AIRCRAFT GAS TURBINE ENGINE

An aircraft fitted with turbojet engines operates under the following conditions:

Flight Speed	1000 km/hr
Flight Altitude	9000 m
Ambient Air Pressure	30 kPa
Ambient Air Temperature	-23°C

The turbojet engines each consist of an inlet diffuser to reduce the inlet air velocity, a compressor, a combustion chamber, a turbine and an exhaust nozzle to expand the exhaust gases. The technical parameters are as follows:

Compressor inlet air velocity	100 m/s
Compressor pressure ratio	20
Maximum cycle temperature	1177°C
Diffuser inlet area	1 m ²
Nozzle outlet area	1 m ²

Assume that compression in the inlet diffuser and in the compressor as well as expansion in the turbine and in the exhaust nozzle are isentropic. Assume also that there is no pressure drop across the combustion chamber and no mechanical friction losses in the shaft. Expansion of the exhaust gases is down to ambient pressure. Assume a cold air standard cycle ($k = 1.4$).

Calculate the following and sketch the process on a temperature-entropy diagram referencing all points to the calculated values.

- | | | |
|-----|--|-----|
| (a) | Temperature and pressure at compressor inlet. | (2) |
| (b) | Temperature and pressure at compressor outlet. | (2) |
| (c) | Temperature and pressure at turbine exhaust. | (2) |
| (d) | Temperature at nozzle outlet. | (1) |
| (e) | Mass flow rate through engine | (2) |
| (f) | Thrust developed by engine | (2) |
| (g) | Thermal efficiency | (2) |
| (h) | Propulsion efficiency | (2) |

[15 marks]

SECTION B DESCRIPTIVE SECTION

Descriptive questions [Question 5 (b) and Question 6 (a), (b), (c)] should be answered in essay form with sketches, if appropriate, and taking approximately one full page for every 5 marks. A full page means approximately 250 words unless diagrams take the place of some words.

While each part of each question specifies several aspects, more emphasis may be put on one or more aspects and less on others provided an overall comprehensive answer is given as required by the above.

QUESTION 5 BRAYTON CYCLE MODIFICATIONS

Refer to the Examination Paper Attachments Pages 12 and 13 **Brayton Cycle Modifications**.

Part (a) must be done on the attachments which must be returned with the examination booklet.

- (a) For each of the following modifications to the basic cycle sketch, on a T-s diagram, the basic cycle and the modified cycle.
- (i) increased pressure ratio
 - (ii) regenerative heating
 - (iii) compressor intercooling
 - (iv) turbine reheating
 - (v) exhaust afterburning

In each case assume that the turbine inlet temperature is at its limiting (maximum) value (before and after the modification) and that the atmospheric air inlet temperature is constant.

(10 marks)

- (b) State with reasons what the advantages and disadvantages are of each modified cycle and how the efficiency and power output is likely to be affected. Where appropriate give examples of practical applications of the cycles to support the choice of particular modifications

(5 marks)

[15 marks]

QUESTION 6 SOLAR ENERGY

- (a) Explain the principles of solar energy with regard to intensity, incidence, duration and efficiency. Give an estimate of the amount of power that can be generated from a given sized array and how this is likely to vary on a daily and annual basis. Hence discuss the advantages and disadvantages of solar power for large scale generation.

(5 marks)

- (b) Sketch a practical solar power installation for the generation of electricity from solar heat via a steam cycle. Explain the relevance of all main components and describe how they operate. Estimate the overall efficiency of the installation and explain where the main energy losses occur.

(5 marks)

- (c) Describe with the aid of sketches a typical photovoltaic solar installation. Explain how solar radiation is converted into electricity and how a sufficiently high voltage can be obtained for electrical power transmission. Estimate the overall efficiency of the installation and explain where the main energy losses occur.

(5 marks)

[15 marks]

QUESTION 2 HEAT BALANCE DIAGRAM

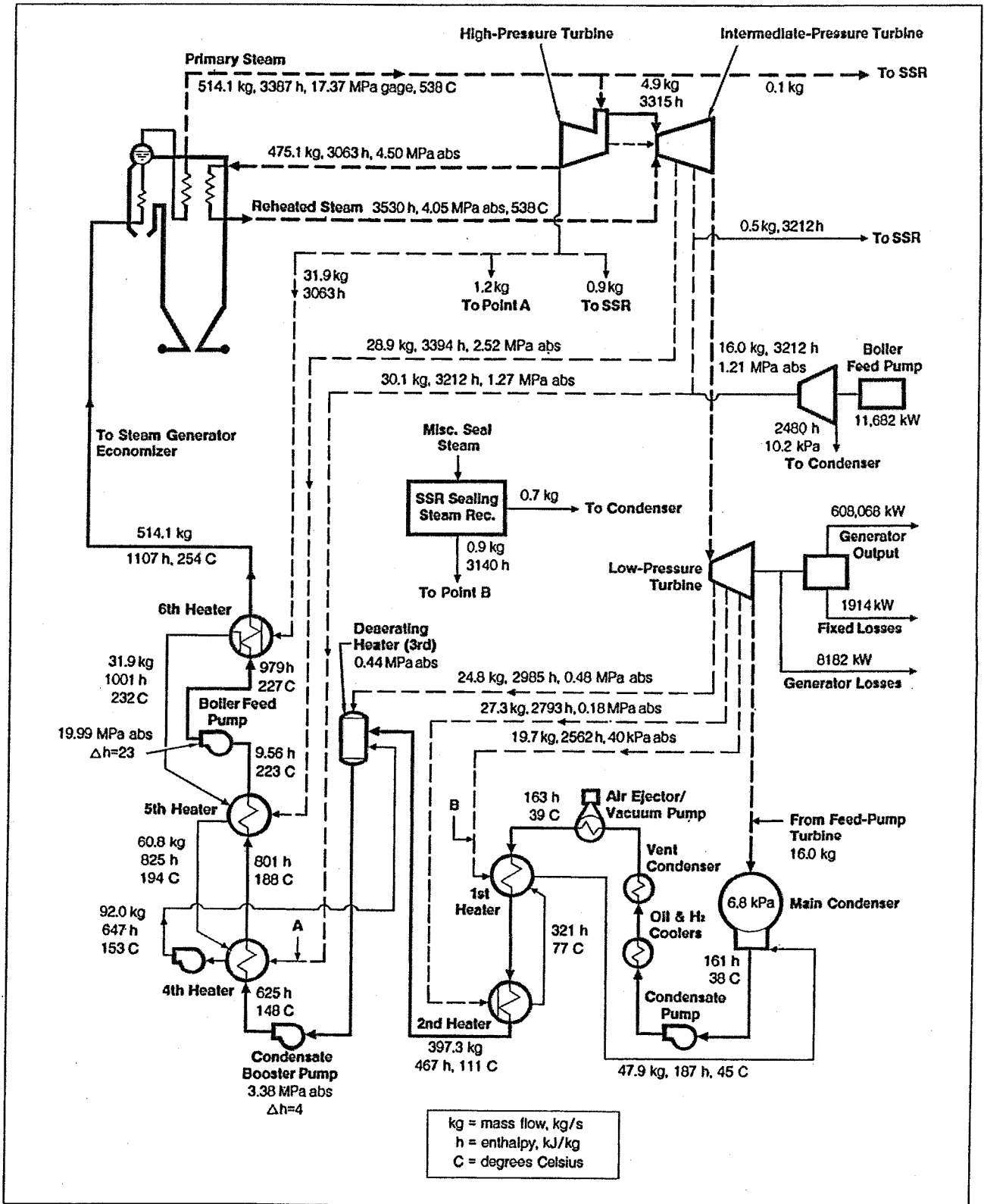
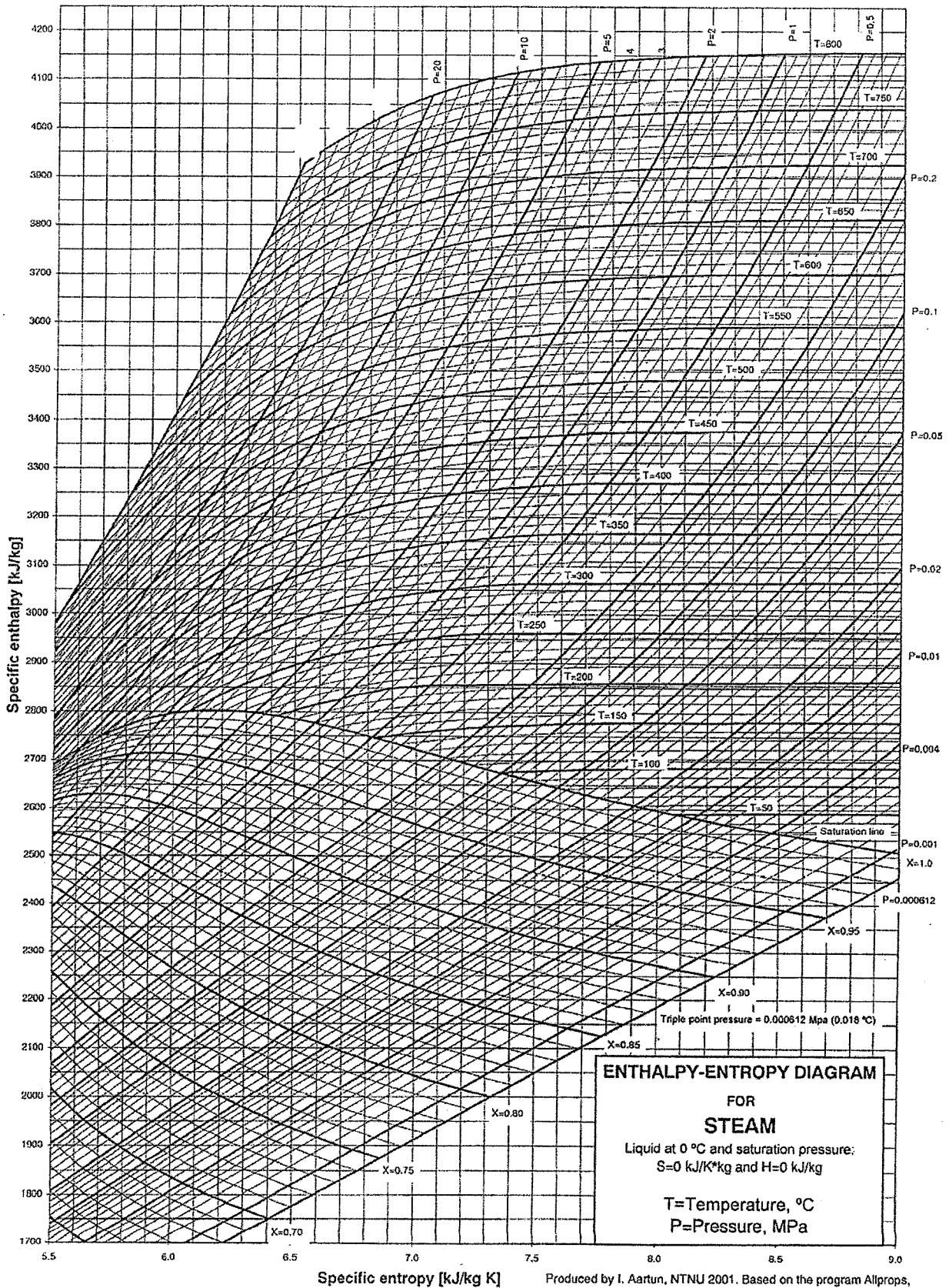


Fig. 7 Reheat regenerative cycle, 600-MW subcritical-pressure fossil power plant (SI-metric units)

QUESTION 3 MOLLIER DIAGRAM

NAME



EXAMINATION PAPER ATTACHMENTS

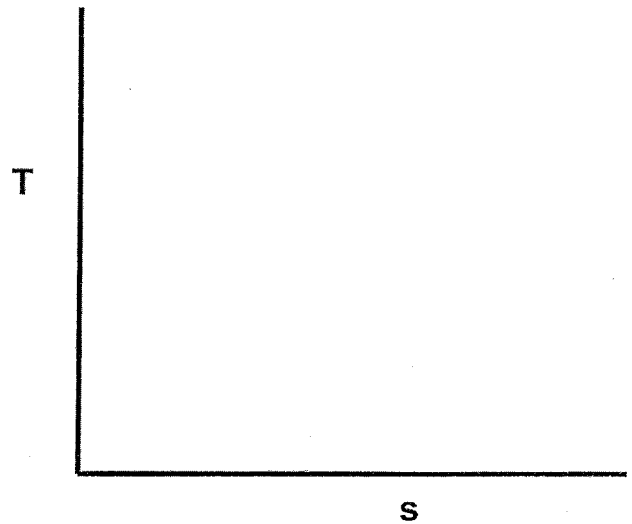
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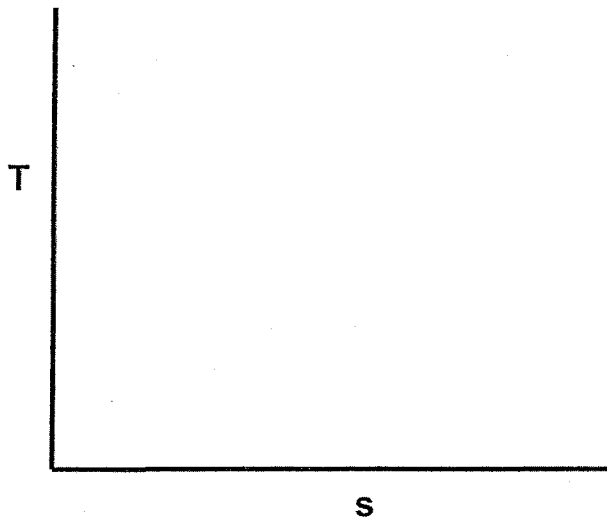
QUESTION 5 BRAYTON CYCLE MODIFICATIONS

(a) On each T-s diagram sketch a basic Brayton Cycle and show how it is modified in each case (with fixed compressor and turbine inlet temperatures).

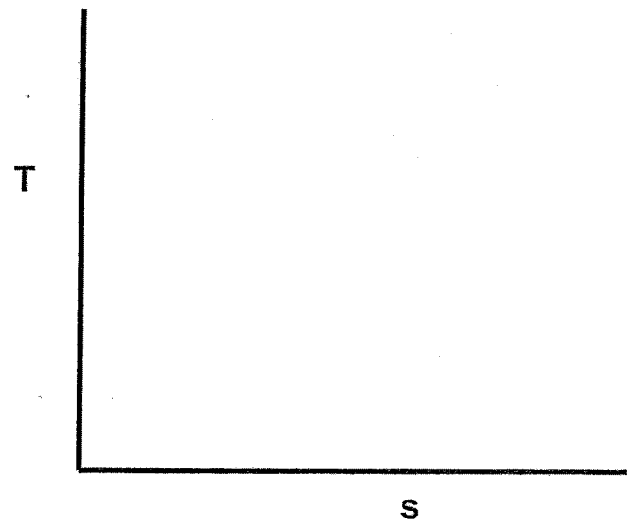
(i) Increased Pressure Ratio



(ii) Regenerative Heating



(iii) Compressor Intercooling



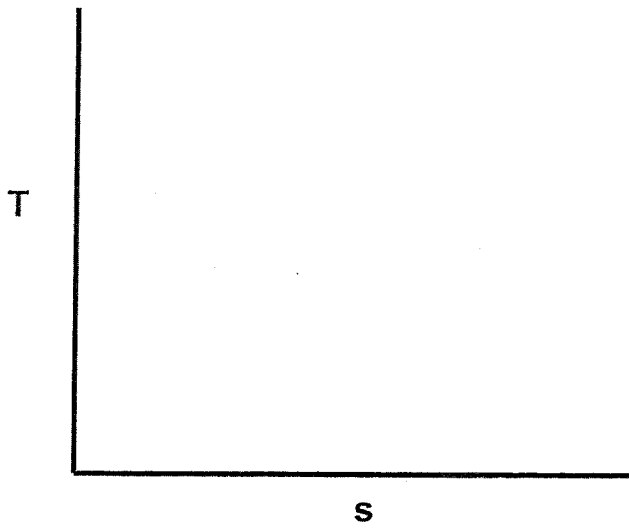
EXAMINATION PAPER ATTACHMENTS

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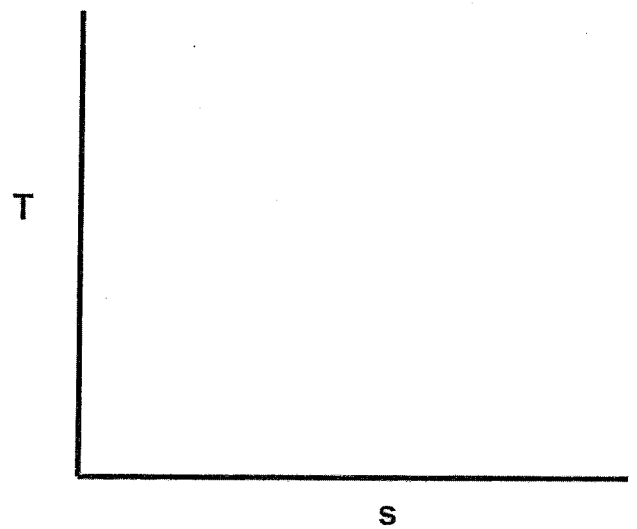
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QUESTION 5 CONTINUED

(iv) Turbine Reheating



(v) Exhaust Afterburning



NOMENCLATURE FOR REFERENCE EQUATIONS (SI UNITS)

A	Flow area, Surface area	m^2
c_p	Specific heat at constant pressure	$J/kg^\circ C$
c_v	Specific heat at constant volume	$J/kg^\circ C$
D	Diameter	m
E	Energy	J
g	Gravitational acceleration	m/s^2
h	Specific enthalpy	J/kg
k	Ratio of specific heats	
L	Length	m
m	Fractional mass flow rate	
M	Mass flow rate	kg/s
p	Pressure	$Pa(N/m^2)$
q	Heat transferred	J/kg
Q	Heat	J
R	Specific gas constant	$J/kg K$
s	Entropy	$J/kg K$
T	Temperature	K
u	Specific internal energy	J/kg
v	Specific volume	m^3/kg
V	Velocity	m/s
w	Specific work	J/kg
W	Work	J
x	Length	m
z	Elevation	m
η	Efficiency	
θ	Nozzle angle	
μ	Dynamic viscosity	Ns/m^2
ν	Kinematic viscosity	m^2/s
ρ	Density	kg/m^3
τ	Thrust	N
Ω	Heat transfer rate	J/s

GENERAL CONSTANTS

Acceleration due to gravity: $g = 9.81 \text{ m/s}^2$	Specific heat of air: $c_p = 1.005 \text{ kJ/kg}^\circ\text{C}$
Atmospheric pressure: $p_{\text{atm}} = 100 \text{ kPa}$	Specific heat of air: $c_v = 0.718 \text{ kJ/kg}^\circ\text{C}$
Density of water: $\rho_{\text{water}} = 1000 \text{ kg/m}^3$	Specific heat of helium: $c_p = 5.193 \text{ kJ/kg}^\circ\text{C}$
Specific heat of water: $c_p = 4.190 \text{ kJ/kg}^\circ\text{C}$	Specific heat of helium: $c_v = 3.117 \text{ kJ/kg}^\circ\text{C}$

THERMODYNAMICS REFERENCE EQUATIONS**Basic Thermodynamics**

First Law:	$dE = \delta Q - \delta W$
Enthalpy:	$h = u + pv$
Continuity:	$\rho VA = \text{constant}$
Flow Work:	$w = \Delta(pv)$
Energy Equation:	$zg + V^2/2 + u + pv + \Delta w + \Delta q = \text{constant}$
Entropy:	$\Delta s = \sum \delta q / T$ (reversible conditions)

Ideal Gas Relationships

Gas Law:	$pv = RT$
Specific Heat at Constant Pressure:	$c_p = \Delta h / \Delta T$
Specific Heat at Constant Volume:	$c_v = \Delta u / \Delta T$
Gas Constant:	$R = c_p - c_v$
Specific Heat Ratio:	$k = c_p / c_v$
Isentropic Relations:	$p_1 / p_2 = (v_2 / v_1)^k = (T_1 / T_2)^{k/(k-1)}$

FLUID MECHANICS REFERENCE EQUATIONS

Fluid Mechanics

Continuity Equation: $\rho_1 V_1 A_1 = \rho_2 V_2 A_2 = M$

Bernoulli's Equation: $p_1/\rho g + z_1 + V_1^2/2g = p_2/\rho g + z_2 + V_2^2/2g$

Momentum Equation: $F = p_1 A_1 - p_2 A_2 - \rho V A (V_2 - V_1)$ (one dimensional)

Steam Turbines

Nozzle Equation: $h_1 - h_2 = (V_2^2 - V_1^2) / 2$

Work: $w = [(V_1^2_{\text{absolute}} - V_2^2_{\text{absolute}}) + (V_2^2_{\text{relative}} - V_1^2_{\text{relative}})] / 2$

Gas Turbines

State Equation: $p v = R T$

Isentropic Equation: $(T_2/T_1) = (p_2/p_1)^{(k-1)/k}$

Enthalpy Change: $h_1 - h_2 = c_p(T_1 - T_2)$ (ideal gas)

Nozzle Equation: $h_1 - h_2 = (V_2^2 - V_1^2) / 2$

Jet Propulsion

Thrust: $T = M(V_{\text{jet}} - V_{\text{aircraft}})$

Thrust Power: $T V_{\text{aircraft}} = M(V_{\text{jet}} - V_{\text{aircraft}}) V_{\text{aircraft}}$

Jet Power: $P = M(V_{\text{jet}}^2 - V_{\text{aircraft}}^2) / 2$

Propulsion Efficiency: $\eta_p = 2V_{\text{aircraft}} / (V_{\text{jet}} + V_{\text{aircraft}})$

Wind Turbine

Maximum Ideal Power: $P_{\text{max}} = 8 \rho A V_1^3 / 27$

NUCLEAR REFERENCE EQUATIONS

Number of nuclei per gram of material

$$N = N_A / M$$

Number of fissile nuclei per cm³ of material

$$N_f = \gamma (N_A / M) \rho$$

Heat release rate in nuclear fuel

$$q^* = \phi N_f \sigma_f E_f$$

Nomenclature

N	=	number of nuclei (number/g)
N _A	=	Avogadro's Number
M	=	molecular weight
γ	=	fuel enrichment
ρ	=	density (g/cm ³)
q*	=	heat release rate (J/cm ³)
φ	=	neutron flux (neutrons/cm ² s)
N _f	=	number of fissile nuclei (number/cm ³)
σ _f	=	cross section (barn) (1 barn = 10 ⁻²⁴ cm ²)
E _f	=	energy release per fission of one atom

Avogadro's Number

$$N_A = 0.602 \times 10^{24} \text{ atoms/mole}$$

Thermodynamics and Heat Power

SIXTH EDITION

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TABLE A.1 (SI)

Saturation: Temperature (Steam)

Temp. °C T	Press. kPa P	Specific Volume (m³/kg)		Internal Energy (kJ/kg)				Enthalpy (kJ/kg)				Entropy (kJ/kg·°K)	
		Sat. Liquid v_f	Sat. Vapor v_g	Sat. Liquid u_f	Sat. Vapor u_g	Evap. u_{fg}	Sat. Vapor u_g	Sat. Liquid h_f	Sat. Vapor h_g	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Sat. Vapor s_g
0.01	0.6113	0.001 000	206.14	.00	2375.3	2375.3	2375.3	.01	2501.3	2501.3	2501.4	.0000	9.1562
5	0.8721	0.001 000	147.12	20.97	2361.3	2382.3	2382.3	20.98	2489.6	2510.6	2510.6	.0761	8.9496
10	1.2276	0.001 000	106.38	42.00	2347.2	2389.2	2389.2	42.01	2477.7	2519.8	2519.8	.1510	8.7498
15	1.7051	0.001 001	77.93	62.99	2333.1	2396.1	2396.1	62.99	2465.9	2528.9	2528.9	.2245	8.5569
20	2.339	0.001 002	57.79	83.95	2319.0	2402.9	2402.9	83.96	2454.1	2538.1	2538.1	.2966	8.3706
25	3.169	0.001 003	43.36	104.88	2304.9	2409.8	2409.8	104.89	2442.3	2547.2	2547.2	.3674	8.1905
30	4.246	0.001 004	32.89	125.78	2290.8	2416.6	2416.6	125.79	2430.5	2556.3	2556.3	.4369	8.0164
35	5.628	0.001 006	25.22	146.67	2276.7	2423.4	2423.4	146.68	2418.6	2565.3	2565.3	.5053	7.8478
40	7.384	0.001 008	19.52	167.56	2262.6	2430.1	2430.1	167.57	2406.7	2574.3	2574.3	.5725	7.6845
45	9.593	0.001 010	15.26	188.44	2248.4	2436.8	2436.8	188.45	2394.8	2583.2	2583.2	.6387	7.5261
50	12.349	0.001 012	12.03	209.32	2234.2	2443.5	2443.5	209.33	2382.7	2592.1	2592.1	.7038	7.3725
55	15.758	0.001 015	9.568	230.21	2219.9	2450.1	2450.1	230.23	2370.7	2600.9	2600.9	.7679	7.2234
60	19.940	0.001 017	7.671	251.11	2205.5	2456.6	2456.6	251.13	2358.5	2609.6	2609.6	.8312	7.0784
65	25.03	0.001 020	6.197	272.02	2191.1	2463.1	2463.1	272.06	2346.2	2618.3	2618.3	.8935	6.9375
70	31.19	0.001 023	5.042	292.95	2176.6	2469.6	2469.6	292.98	2333.8	2626.8	2626.8	.9549	6.8004
75	38.58	0.001 026	4.131	313.90	2162.0	2475.9	2475.9	313.93	2321.4	2635.3	2635.3	1.0155	6.6669
80	47.39	0.001 029	3.407	334.86	2147.4	2482.2	2482.2	334.91	2308.8	2643.7	2643.7	1.0753	6.5369
85	57.83	0.001 033	2.828	355.84	2132.6	2488.4	2488.4	355.90	2296.0	2651.9	2651.9	1.1343	6.4102
90	70.14	0.001 036	2.361	376.85	2117.7	2494.5	2494.5	376.92	2283.2	2660.1	2660.1	1.1925	6.2866
95	84.55	0.001 040	1.982	397.88	2102.7	2500.6	2500.6	397.96	2270.2	2668.1	2668.1	1.2500	6.1659

TABLE A.1 (SI) (cont'd.)

Temp. °C <i>T</i>	Press. kPa <i>P</i>	Specific Volume (m ³ /kg)				Internal Energy (kJ/kg)				Enthalpy (kJ/kg)				Entropy (kJ/kg·K)			
		Sat. Liquid		Sat. Vapor		Sat. Liquid		Sat. Vapor		Sat. Liquid		Sat. Vapor		Sat. Liquid		Sat. Vapor	
		<i>v_f</i>	<i>v_g</i>	<i>u_f</i>	<i>u_g</i>	<i>u_f</i>	<i>u_g</i>	<i>h_f</i>	<i>h_g</i>	<i>h_f</i>	<i>h_g</i>	<i>s_f</i>	<i>s_g</i>	<i>s_f</i>	<i>s_g</i>	<i>s_f</i>	<i>s_g</i>
		MPa															
100	0.101 35	0.001 044	1.6729	418.94	2087.6	2506.5	419.04	2257.0	2676.1	1.3069	6.0480	7.3549					
105	0.120 82	0.001 048	1.4194	440.02	2072.3	2512.4	440.15	2249.7	2683.8	1.3630	5.9328	7.2958					
110	0.143 27	0.001 052	1.2102	461.14	2057.0	2518.1	461.30	2230.2	2691.5	1.4185	5.8202	7.2387					
115	0.169 06	0.001 056	1.0366	482.30	2041.4	2523.7	482.48	2216.5	2699.0	1.4734	5.7100	7.1833					
120	0.198 53	0.001 060	0.8919	503.50	2025.8	2529.3	503.71	2202.6	2706.3	1.5276	5.6020	7.1296					
125	0.2321	0.001 065	0.7706	524.74	2009.9	2534.6	524.99	2188.5	2713.5	1.5813	5.4962	7.0775					
130	0.2701	0.001 070	0.6685	546.02	1993.9	2539.9	546.31	2174.2	2720.5	1.6344	5.3925	7.0269					
135	0.3130	0.001 075	0.5822	567.35	1977.7	2545.0	567.69	2159.6	2727.3	1.6870	5.2907	6.9777					
140	0.3613	0.001 080	0.5089	588.74	1961.3	2550.0	589.13	2144.7	2733.9	1.7391	5.1908	6.9299					
145	0.4154	0.001 085	0.4463	610.18	1944.7	2554.9	610.63	2129.6	2740.3	1.7907	5.0926	6.8833					
150	0.4758	0.001 091	0.3928	631.68	1927.9	2559.5	632.20	2114.3	2746.5	1.8418	4.9960	6.8379					
155	0.5431	0.001 096	0.3468	653.24	1910.8	2564.1	653.84	2098.6	2752.4	1.8925	4.9010	6.7935					
160	0.6178	0.001 102	0.3071	674.87	1893.5	2568.4	675.55	2082.6	2758.1	1.9427	4.8075	6.7502					
165	0.7005	0.001 108	0.2727	696.56	1876.0	2572.5	697.34	2066.2	2763.5	1.9925	4.7153	6.7078					
170	0.7917	0.001 114	0.2428	718.33	1858.1	2576.5	719.21	2049.5	2768.7	2.0419	4.6244	6.6663					
175	0.8920	0.001 121	0.2168	740.17	1840.0	2580.2	741.17	2032.4	2773.6	2.0909	4.5347	6.6256					
180	1.0021	0.001 127	0.194 05	762.09	1821.6	2583.7	763.22	2015.0	2778.2	2.1396	4.4461	6.5857					
185	1.1227	0.001 134	0.174 09	784.10	1802.9	2587.0	785.37	1997.1	2782.4	2.1879	4.3586	6.5465					
190	1.2544	0.001 141	0.156 54	806.19	1783.8	2590.0	807.62	1978.8	2786.4	2.2359	4.2720	6.5079					
195	1.3978	0.001 149	0.141 05	828.37	1764.4	2592.8	829.98	1960.0	2790.0	2.2835	4.1863	6.4698					
200	1.5538	0.001 157	0.127 36	850.65	1744.7	2595.3	852.45	1940.7	2793.2	2.3309	4.1014	6.4323					
205	1.7230	0.001 164	0.115 21	873.04	1724.5	2597.5	875.04	1921.0	2796.0	2.3780	4.0172	6.3952					
210	1.9062	0.001 173	0.104 41	895.53	1703.9	2599.5	897.76	1900.7	2798.5	2.4248	3.9337	6.3585					
215	2.104	0.001 181	0.094 79	918.14	1682.9	2601.1	920.62	1879.9	2800.5	2.4714	3.8507	6.3221					
220	2.318	0.001 190	0.086 19	940.87	1661.5	2602.4	943.62	1858.5	2802.1	2.5178	3.7683	6.2861					
225	2.548	0.001 199	0.078 49	963.73	1639.6	2603.3	966.78	1836.5	2803.3	2.5639	3.6863	6.2503					
230	2.795	0.001 209	0.071 58	986.74	1617.2	2603.9	990.12	1813.8	2804.0	2.6099	3.6047	6.2146					
235	3.060	0.001 219	0.065 37	1009.89	1594.2	2604.1	1013.62	1790.5	2804.2	2.6558	3.5233	6.1791					
240	3.344	0.001 229	0.059 76	1033.21	1570.8	2604.0	1037.32	1766.5	2803.8	2.7015	3.4422	6.1437					
245	3.648	0.001 240	0.054 71	1056.71	1546.7	2603.4	1061.23	1741.7	2803.0	2.7472	3.3612	6.1083					

TABLE A.1 (SI) (cont'd.)

Temp. °C T	Press. MPa P	Specific Volume (m ³ /kg)				Internal Energy (kJ/kg)				Enthalpy (kJ/kg)				Entropy (kJ/kg · °K)			
		Sat. Liquid v_f	Sat. Vapor v_g	Sat. Liquid u_f	Sat. Vapor u_g	Evap. u_{fg}	Sat. Vapor u_g	Sat. Liquid h_f	Sat. Vapor h_g	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Sat. Vapor s_g	Evap. s_{fg}	Sat. Vapor s_g		
250	3.973	0.001 251	0.050 13	1080.39	1522.0	2602.4	1085.36	2801.5	1716.2	2801.5	2.7927	2.7927	3.2802	6.0730			
255	4.319	0.001 263	0.045 98	1104.28	1496.7	2600.9	1109.73	2799.5	1689.8	2799.5	2.8383	2.8383	3.1992	6.0375			
260	4.688	0.001 276	0.042 21	1128.39	1470.6	2599.0	1134.37	2796.9	1662.5	2796.9	2.8838	2.8838	3.1181	6.0019			
265	5.081	0.001 289	0.038 77	1152.74	1443.9	2596.6	1159.28	2793.6	1634.4	2793.6	2.9294	2.9294	3.0368	5.9662			
270	5.499	0.001 302	0.035 64	1177.36	1416.3	2593.7	1184.51	2789.7	1605.2	2789.7	2.9751	2.9751	2.9551	5.9301			
275	5.942	0.001 317	0.032 79	1202.25	1387.9	2590.2	1210.07	2785.0	1574.9	2785.0	3.0208	3.0208	2.8730	5.8938			
280	6.412	0.001 332	0.030 17	1227.46	1358.7	2586.1	1235.99	2779.6	1543.6	2779.6	3.0668	3.0668	2.7903	5.8571			
285	6.909	0.001 348	0.027 77	1253.00	1328.4	2581.4	1262.31	2773.3	1511.0	2773.3	3.1130	3.1130	2.7070	5.8199			
290	7.436	0.001 366	0.025 57	1278.92	1297.1	2576.0	1289.07	2766.2	1477.1	2766.2	3.1594	3.1594	2.6227	5.7821			
295	7.993	0.001 384	0.023 54	1305.2	1264.7	2569.9	1316.3	2758.1	1441.8	2758.1	3.2062	3.2062	2.5375	5.7437			
300	8.581	0.001 404	0.021 67	1332.0	1231.0	2563.0	1344.0	2749.0	1404.9	2749.0	3.2534	3.2534	2.4511	5.7045			
305	9.202	0.001 425	0.019 948	1359.3	1195.9	2555.2	1372.4	2738.7	1366.4	2738.7	3.3010	3.3010	2.3633	5.6643			
310	9.856	0.001 447	0.018 350	1387.1	1159.4	2546.4	1401.3	2727.3	1326.0	2727.3	3.3493	3.3493	2.2737	5.6230			
315	10.547	0.001 472	0.016 867	1415.5	1121.1	2536.6	1431.0	2714.5	1283.5	2714.5	3.3982	3.3982	2.1821	5.5804			
320	11.274	0.001 499	0.015 488	1444.6	1080.9	2525.5	1461.5	2700.1	1238.6	2700.1	3.4480	3.4480	2.0882	5.5362			
330	12.845	0.001 561	0.012 996	1505.3	993.7	2498.9	1525.3	2665.9	1140.6	2665.9	3.5507	3.5507	1.8909	5.4417			
340	14.586	0.001 638	0.010 797	1570.3	894.3	2464.6	1594.2	2622.0	1027.9	2622.0	3.6594	3.6594	1.6763	5.3357			
350	16.513	0.001 740	0.008 813	1641.9	776.6	2418.4	1670.6	2563.9	893.4	2563.9	3.7777	3.7777	1.4335	5.2112			
360	18.651	0.001 893	0.006 945	1725.2	626.3	2351.5	1760.5	2481.0	720.5	2481.0	3.9147	3.9147	1.1379	5.0526			
370	21.03	0.002 213	0.004 925	1844.0	384.5	2228.5	1890.5	2332.1	441.6	2332.1	4.1106	4.1106	.6865	4.7971			
374.14	22.09	0.003 155	0.003 155	2029.6	0	2029.6	2099.3	2099.3	0	2099.3	4.4298	4.4298	0	4.4298			

TABLE A.2 (SI)
Saturation Pressures (Steam)

Press. kPa <i>P</i>	Temp. °C <i>T</i>	Specific Volume (m ³ /kg)		Internal Energy (kJ/kg)		Enthalpy (kJ/kg)		Entropy (kJ/kg · °K)	
		Sat. Liquid <i>v_f</i>	Sat. Vapor <i>v_g</i>	Sat. Liquid <i>u_f</i>	Sat. Vapor <i>u_g</i>	Sat. Liquid <i>h_f</i>	Sat. Vapor <i>h_g</i>	Sat. Liquid <i>s_f</i>	Sat. Vapor <i>s_g</i>
0.6113	0.01	0.001 000	206.14	.00	2375.3	.01	2501.3	.0000	9.1562
1.0	6.98	0.001 000	129.21	29.30	2355.7	29.30	2484.9	.1059	8.8697
1.5	13.03	0.001 001	87.98	54.71	2338.6	54.71	2470.6	.1957	8.6322
2.0	17.50	0.001 001	67.00	73.48	2326.0	73.48	2460.0	.2607	8.4629
2.5	21.08	0.001 002	54.25	88.48	2315.9	88.49	2451.6	.3120	8.3311
3.0	24.08	0.001 003	45.67	101.04	2307.5	101.05	2444.5	.3545	8.2231
4.0	28.96	0.001 004	34.80	121.45	2293.7	121.46	2432.9	.4226	8.0520
5.0	32.88	0.001 005	28.19	137.81	2282.7	137.82	2423.7	.4764	7.9187
7.5	40.29	0.001 008	19.24	168.78	2261.7	168.79	2406.0	.5764	7.6750
10	45.81	0.001 010	14.67	191.82	2246.1	191.83	2392.8	.6493	7.5009
15	53.97	0.001 014	10.02	225.92	2222.8	225.94	2373.1	.7549	7.2536
20	60.06	0.001 017	7.649	251.38	2205.4	251.40	2358.3	.8320	7.0766
25	64.97	0.001 020	6.204	271.90	2191.2	271.93	2346.3	.8931	6.9383
30	69.10	0.001 022	5.229	289.20	2179.2	289.23	2336.1	.9439	6.8247
40	75.87	0.001 027	3.993	317.53	2159.5	317.58	2319.2	1.0259	6.6441
50	81.33	0.001 030	3.240	340.44	2143.4	340.49	2305.4	1.0910	6.5029
75	91.78	0.001 037	2.217	384.31	2112.4	384.39	2278.6	1.2130	6.2434
MPa									
0.100	99.63	0.001 043	1.6940	417.36	2088.7	417.46	2258.0	1.3026	6.0568
0.125	105.99	0.001 048	1.3749	444.19	2069.3	444.32	2241.0	1.3740	5.9104
0.150	111.37	0.001 053	1.1593	466.94	2052.7	467.11	2226.5	1.4336	5.7897
0.175	116.06	0.001 057	1.0036	486.80	2038.1	486.99	2213.6	1.4849	5.6868
0.200	120.23	0.001 061	0.8857	504.49	2025.0	504.70	2201.9	1.5301	5.5970
0.225	124.00	0.001 064	0.7933	520.47	2013.1	520.72	2191.3	1.5706	5.5173
									7.3594
									7.2844
									7.2233
									7.1717
									7.1271
									7.0878

TABLE A.2 (SI) (cont'd.)

Press. MPa <i>P</i>	Temp. °C <i>T</i>	Specific Volume		Internal Energy				Enthalpy				Entropy	
		Sat. Liquid <i>v_f</i>	Sat. Vapor <i>v_g</i>	Sat. Liquid <i>u_f</i>	Evap. <i>u_{fg}</i>	Sat. Vapor <i>u_g</i>	Sat. Liquid <i>h_f</i>	Evap. <i>h_{fg}</i>	Sat. Vapor <i>h_g</i>	Sat. Liquid <i>s_f</i>	Evap. <i>s_{fg}</i>	Sat. Vapor <i>s_g</i>	
0.250	127.44	0.001 067	0.7187	535.10	2002.1	2537.2	535.37	2181.5	2716.9	1.6072	5.4455	7.0527	
0.275	130.60	0.001 070	0.6573	548.59	1991.9	2540.5	548.89	2172.4	2721.3	1.6408	5.3801	7.0209	
0.300	133.55	0.001 073	0.6058	561.15	1982.4	2543.6	561.47	2163.8	2725.3	1.6718	5.3201	6.9919	
0.325	136.30	0.001 076	0.5620	572.90	1973.5	2546.4	573.25	2155.8	2729.0	1.7006	5.2646	6.9652	
0.350	138.88	0.001 079	0.5243	583.95	1965.0	2548.9	584.33	2148.1	2732.4	1.7275	5.2130	6.9405	
0.375	141.32	0.001 081	0.4914	594.40	1956.9	2551.3	594.81	2140.8	2735.6	1.7528	5.1647	6.9175	
0.40	143.63	0.001 084	0.4625	604.31	1949.3	2553.6	604.74	2133.8	2738.6	1.7766	5.1193	6.8959	
0.45	147.93	0.001 088	0.4140	622.77	1934.9	2557.6	623.25	2120.7	2743.9	1.8207	5.0359	6.8565	
0.50	151.86	0.001 093	0.3749	639.68	1921.6	2561.2	640.23	2108.5	2748.7	1.8607	4.9606	6.8213	
0.55	155.48	0.001 097	0.3427	655.32	1909.2	2564.5	655.93	2097.0	2753.0	1.8973	4.8920	6.7893	
0.60	158.85	0.001 101	0.3157	669.90	1897.5	2567.4	670.56	2086.3	2756.8	1.9312	4.8288	6.7600	
0.65	162.01	0.001 104	0.2927	683.56	1886.5	2570.1	684.28	2076.0	2760.3	1.9627	4.7703	6.7331	
0.70	164.97	0.001 108	0.2729	696.44	1876.1	2572.5	697.22	2066.3	2763.5	1.9922	4.7158	6.7080	
0.75	167.78	0.001 112	0.2556	708.64	1866.1	2574.7	709.47	2057.0	2766.4	2.0200	4.6647	6.6847	
0.80	170.43	0.001 115	0.2404	720.22	1856.6	2576.8	721.11	2048.0	2769.1	2.0462	4.6166	6.6628	
0.85	172.96	0.001 118	0.2270	731.27	1847.4	2578.7	732.22	2039.4	2771.6	2.0710	4.5711	6.6421	
0.90	175.38	0.001 121	0.2150	741.83	1838.6	2580.5	742.83	2031.1	2773.9	2.0946	4.5280	6.6226	
0.95	177.69	0.001 124	0.2042	751.95	1830.2	2582.1	753.02	2023.1	2776.1	2.1172	4.4869	6.6041	
1.00	179.91	0.001 127	0.1944	761.68	1822.0	2583.6	762.81	2015.3	2778.1	2.1387	4.4478	6.5865	
1.10	184.09	0.001 133	0.1775	780.09	1806.3	2586.4	781.34	2000.4	2781.7	2.1792	4.3744	6.5536	
1.20	187.99	0.001 139	0.1633	797.29	1791.5	2588.8	798.65	1986.2	2784.8	2.2166	4.3067	6.5233	
1.30	191.64	0.001 144	0.1512	813.44	1777.5	2591.0	814.93	1972.7	2787.6	2.2515	4.2438	6.4953	
1.40	195.07	0.001 149	0.1408	828.70	1764.1	2592.8	830.30	1959.7	2790.0	2.2842	4.1850	6.4693	

TABLE A.2 (SI) (cont'd.)

Press. MPa <i>P</i>	Temp. °C <i>T</i>	Specific Volume (m ³ /kg)		Internal Energy (kJ/kg)		Enthalpy (kJ/kg)		Entropy (kJ/kg·°K)				
		Sat. Liquid <i>v_f</i>	Sat. Vapor <i>v_g</i>	Sat. Liquid <i>u_f</i>	Evap. <i>u_{fg}</i>	Sat. Vapor <i>u_g</i>	Sat. Liquid <i>h_f</i>	Evap. <i>h_{fg}</i>	Sat. Vapor <i>h_g</i>	Sat. Liquid <i>s_f</i>	Evap. <i>s_{fg}</i>	Sat. Vapor <i>s_g</i>
1.50	198.32	0.001 154	0.131 77	843.16	1751.3	2594.5	844.89	1947.3	2792.2	2.3150	4.1298	6.4448
1.75	205.76	0.001 166	0.113 49	876.46	1721.4	2597.8	878.50	1917.9	2796.4	2.3851	4.0044	6.3896
2.00	212.42	0.001 177	0.099 63	906.44	1693.8	2600.3	908.79	1890.7	2799.5	2.4474	3.8935	6.3409
2.25	218.45	0.001 187	0.088 75	933.83	1668.2	2602.0	936.49	1865.2	2801.7	2.5035	3.7937	6.2972
2.5	223.99	0.001 197	0.079 98	959.11	1644.0	2603.1	962.11	1841.0	2803.1	2.5547	3.7028	6.2575
3.0	233.90	0.001 217	0.066 68	1004.78	1599.3	2604.1	1008.42	1795.7	2804.2	2.6457	3.5412	6.1869
3.5	242.60	0.001 235	0.057 07	1045.43	1558.3	2603.7	1049.75	1753.7	2803.4	2.7253	3.4000	6.1253
4	250.40	0.001 252	0.049 78	1082.31	1520.0	2602.3	1087.31	1714.1	2801.4	2.7964	3.2737	6.0701
5	263.99	0.001 286	0.039 44	1147.81	1449.3	2597.1	1154.23	1640.1	2794.3	2.9202	3.0532	5.9734
6	275.64	0.001 319	0.032 44	1205.44	1384.3	2589.7	1213.35	1571.0	2784.3	3.0267	2.8625	5.8892
7	285.88	0.001 351	0.027 37	1257.55	1323.0	2580.5	1267.00	1505.1	2772.1	3.1211	2.6922	5.8133
8	295.06	0.001 384	0.023 52	1305.57	1264.2	2569.8	1316.64	1441.3	2758.0	3.2068	2.5364	5.7432
9	303.40	0.001 418	0.020 48	1350.51	1207.3	2557.8	1363.26	1378.9	2742.1	3.2858	2.3915	5.6772
10	311.06	0.001 452	0.018 026	1393.04	1151.4	2544.4	1407.56	1317.1	2724.7	3.3596	2.2544	5.6141
11	318.15	0.001 489	0.015 987	1433.7	1096.0	2529.8	1450.1	1255.5	2705.6	3.4295	2.1233	5.5527
12	324.75	0.001 527	0.014 263	1473.0	1040.7	2513.7	1491.3	1193.6	2684.9	3.4962	1.9962	5.4924
13	330.93	0.001 567	0.012 780	1511.1	985.0	2496.1	1531.5	1130.7	2662.2	3.5606	1.8718	5.4323
14	336.75	0.001 611	0.011 485	1548.6	928.2	2476.8	1571.1	1066.5	2637.6	3.6232	1.7485	5.3717
15	342.24	0.001 658	0.010 337	1585.6	869.8	2455.5	1610.5	1000.0	2610.5	3.6848	1.6249	5.3098
16	347.44	0.001 711	0.009 306	1622.7	809.0	2431.7	1650.1	930.6	2580.6	3.7461	1.4994	5.2455
17	352.37	0.001 770	0.008 364	1660.2	744.8	2405.0	1690.3	856.9	2547.2	3.8079	1.3698	5.1777
18	357.06	0.001 840	0.007 489	1698.9	675.4	2374.3	1732.0	777.1	2509.1	3.8715	1.2329	5.1044
19	361.54	0.001 924	0.006 657	1739.9	598.1	2338.1	1776.5	688.0	2464.5	3.9388	1.0839	5.0228
20	365.81	0.002 036	0.005 834	1785.6	507.5	2293.0	1826.3	583.4	2409.7	4.0139	.9130	4.9269
21	369.89	0.002 207	0.004 952	1842.1	388.5	2230.6	1888.4	446.2	2334.6	4.1075	.6938	4.8013
22	373.80	0.002 742	0.003 568	1961.9	125.2	2087.1	2022.2	143.4	2165.6	4.3110	.2216	4.5327
22.09	374.14	0.003 155	0.003 155	2029.6	0	2029.6	2099.3	0	2099.3	4.4298	0	4.4298

TABLE A.3 (SI)
Properties of Superheated Steam

T	P = .010 MPa (45.81)					P = .050 MPa (81.33)					P = .10 MPa (99.63)								
	v	u	h	s	s	v	u	h	s	s	v	u	h	s	s				
Sat.	14.674	2437.9	2584.7	8.1502	3.240	2483.9	2645.9	7.5939	1.6940	2506.1	2675.5	7.3594							
50	14.869	2443.9	2592.6	8.1749	3.418	2511.6	2682.5	7.6947	1.6958	2506.7	2676.2	7.3614							
100	17.196	2515.5	2687.5	8.4479	3.889	2585.6	2780.1	7.9401	1.9364	2582.8	2776.4	7.6134							
150	19.512	2587.9	2783.0	8.6882	4.356	2659.9	2877.7	8.1580	2.172	2658.1	2875.3	7.8343							
200	21.825	2661.3	2879.5	8.9038	4.820	2735.0	2976.0	8.3556	2.406	2733.7	2974.3	8.0333							
250	24.136	2736.0	2977.3	9.1002	5.284	2811.3	3075.5	8.5373	2.639	2810.4	3074.3	8.2158							
300	26.445	2812.1	3076.5	9.2813	6.209	2968.5	3278.9	8.8642	3.103	2967.9	3278.2	8.5435							
400	31.063	2968.9	3279.6	9.6077	7.134	3132.0	3488.7	9.1546	3.565	3131.6	3488.1	8.8342							
500	35.679	3132.3	3489.1	9.8978	8.057	3302.2	3705.1	9.4178	4.028	3301.9	3704.7	9.0976							
600	40.295	3302.5	3705.4	10.1608	8.981	3479.4	3928.5	9.6599	4.490	3479.2	3928.2	9.3398							
700	44.911	3479.6	3928.7	10.4028	9.904	3663.6	4158.9	9.8852	4.952	3663.5	4158.6	9.5652							
800	49.526	3663.8	4159.0	10.6281	10.828	3854.9	4396.3	10.0967	5.414	3854.8	4396.1	9.7767							
900	54.141	3855.0	4396.4	10.8396	11.751	4052.9	4640.5	10.2964	5.875	4052.8	4640.3	9.9764							
1000	58.757	4053.0	4640.6	11.0393	12.674	4257.4	4891.1	10.4859	6.337	4257.3	4891.0	10.1659							
1100	63.372	4257.5	4891.2	11.2287	13.597	4467.8	5147.7	10.6662	6.799	4467.7	5147.6	10.3463							
1200	67.987	4467.9	5147.8	11.4091	14.521	4683.6	5409.6	10.8382	7.260	4683.5	5409.5	10.5183							
1300	72.602	4683.7	5409.7	11.5811															
					P = .20 MPa (120.23)					P = .30 MPa (133.55)					P = .40 MPa (143.63)				
Sat.	.8857	2529.5	2706.7	7.1272	.6058	2543.6	2725.3	6.9919	.4625	2553.6	2738.6	6.8959							
150	.9596	2576.9	2768.8	7.2795	.6339	2570.8	2761.0	7.0778	.4708	2564.5	2752.8	6.9299							
200	1.0803	2654.4	2870.5	7.5066	.7163	2650.7	2865.6	7.3115	.5342	2646.8	2860.5	7.1706							
250	1.1988	2731.2	2971.0	7.7086	.7964	2728.7	2967.6	7.5166	.5951	2726.1	2964.2	7.3789							
300	1.3162	2808.6	3071.8	7.8926	.8753	2806.7	3069.3	7.7022	.6548	2804.8	3066.8	7.5662							
400	1.5493	2966.7	3276.6	8.2218	1.0315	2965.6	3275.0	8.0330	.7726	2964.4	3273.4	7.8985							

TABLE A.3 (SI) (cont'd.)

<i>T</i>	<i>P</i> = .20 MPa (120.23)					<i>P</i> = .30 MPa (133.55)					<i>P</i> = .40 MPa (143.63)							
	<i>v</i>	<i>u</i>	<i>h</i>	<i>s</i>	<i>s</i>	<i>v</i>	<i>u</i>	<i>h</i>	<i>s</i>	<i>s</i>	<i>v</i>	<i>u</i>	<i>h</i>	<i>s</i>	<i>v</i>	<i>u</i>	<i>h</i>	<i>s</i>
500	1.7814	3130.8	3487.1	8.5133	1.1867	3130.0	3486.0	8.3251	.8893	3129.2	3484.9	8.1913						
600	2.013	3301.4	3704.0	8.7770	1.3414	3300.8	3703.2	8.5892	1.0055	3300.2	3702.4	8.4558						
700	2.244	3478.8	3927.6	9.0194	1.4957	3478.4	3927.1	8.8319	1.1215	3477.9	3926.5	8.6987						
800	2.475	3663.1	4158.2	9.2449	1.6499	3662.9	4157.8	9.0576	1.2372	3662.4	4157.3	8.9244						
900	2.706	3854.5	4395.8	9.4566	1.8041	3854.2	4395.4	9.2692	1.3529	3853.9	4395.1	9.1362						
1000	2.937	4052.5	4640.0	9.6563	1.9581	4052.3	4639.7	9.4690	1.4685	4052.0	4639.4	9.3360						
1100	3.168	4257.0	4890.7	9.8458	2.1121	4256.8	4890.4	9.6585	1.5840	4256.5	4890.2	9.5256						
1200	3.399	4467.5	5147.3	10.0262	2.2661	4467.2	5147.1	9.8389	1.6996	4467.0	5146.8	9.7060						
1300	3.630	4683.2	5409.3	10.1982	2.4201	4683.0	5409.0	10.0110	1.8151	4682.8	5408.8	9.8780						
<i>P</i> = .50 MPa (151.86)																		
Sat.	.3749	2561.2	2748.7	6.8213	.3157	2567.4	2756.8	6.7600	.2404	2576.8	2769.1	6.6628						
200	.4249	2642.9	2855.4	7.0592	.3520	2638.9	2850.1	6.9665	.2608	2630.6	2839.3	6.8158						
250	.4744	2723.5	2960.7	7.2709	.3938	2720.9	2957.2	7.1816	.2931	2715.5	2950.0	7.0384						
300	.5226	2802.9	3064.2	7.4599	.4344	2801.0	3061.6	7.3724	.3241	2797.2	3056.5	7.2328						
350	.5701	2882.6	3167.7	7.6329	.4742	2881.2	3165.7	7.5464	.3544	2878.2	3161.7	7.4089						
400	.6173	2963.2	3271.9	7.7938	.5137	2962.1	3270.3	7.7079	.3843	2959.7	3267.1	7.5716						
500	.7109	3128.4	3483.9	8.0873	.5920	3127.6	3482.8	8.0021	.4433	3126.0	3480.6	7.8673						
600	.8041	3299.6	3701.7	7.3522	.6697	3299.1	3700.9	8.2674	.5018	3297.9	3699.4	8.1333						
700	.8969	3477.5	3925.9	8.5952	.7472	3477.0	3925.3	8.5107	.5601	3476.2	3924.2	8.3770						
800	.9896	3662.1	4156.9	8.8211	.8245	3661.8	4156.5	8.7367	.6181	3661.1	4155.6	8.6033						
900	1.0822	3853.6	4394.7	9.0329	.9017	3853.4	4394.4	8.9486	.6761	3852.8	4393.7	8.8153						
1000	1.1747	4051.8	4639.1	9.2328	.9788	4051.5	4638.8	9.1485	.7340	4051.0	4638.2	9.0153						
1100	1.2672	4256.3	4889.9	9.4224	1.0559	4256.1	4889.6	9.3381	.7919	4255.6	4889.1	9.2050						
1200	1.3596	4466.8	5146.6	9.6029	1.1330	4466.5	5146.3	9.5185	.8497	4466.1	5145.9	9.3855						
1300	1.4521	4682.5	5408.6	9.7749	1.2101	4682.3	5408.3	9.6906	.9076	4681.8	5407.9	9.5575						
<i>P</i> = .80 MPa (170.43)																		

TABLE A.3 (SI) (cont'd.)

T	P = 1.00 MPa (179.91)					P = 1.20 MPa (187.99)					P = 1.40 MPa (195.07)				
	v	u	h	s	s	v	u	h	s	s	v	u	h	s	s
Sat.	.194 44	2583.6	2778.1	6.5865	6.5865	.163 33	2588.8	2784.8	6.5233	6.5233	.140 84	2592.8	2790.0	6.4693	6.4693
200	.2060	2621.9	2827.9	6.6940	6.6940	.169 30	2612.8	2815.9	6.5898	6.5898	.143 02	2603.1	2803.3	6.4975	6.4975
250	.2327	2709.9	2942.6	6.9247	6.9247	.192 34	2704.2	2935.0	6.8294	6.8294	.163 50	2698.3	2927.2	6.7467	6.7467
300	.2579	2793.2	3051.2	7.1229	7.1229	.2138	2789.2	3045.8	7.0317	7.0317	.182 28	2785.2	3040.4	6.9534	6.9534
350	.2825	2875.2	3157.7	7.3011	7.3011	.2345	2872.2	3153.6	7.2121	7.2121	.2003	2869.2	3149.5	7.1360	7.1360
400	.3066	2957.3	3263.9	7.4651	7.4651	.2548	2954.9	3260.7	7.3774	7.3774	.2178	2952.5	3257.5	7.3026	7.3026
450	.3541	3124.4	3478.5	7.7622	7.7622	.2946	3122.8	3476.3	7.6759	7.6759	.2521	3121.1	3474.1	7.6027	7.6027
500	.4011	3296.8	3697.9	8.0290	8.0290	.3339	3295.6	3696.3	7.9435	7.9435	.2860	3294.4	3694.8	7.8710	7.8710
600	.4478	3475.3	3923.1	8.2731	8.2731	.3729	3474.4	3922.0	8.1881	8.1881	.3195	3473.6	3920.8	8.1160	8.1160
700	.4943	3660.4	4154.7	8.4996	8.4996	.4118	3659.7	4153.8	8.4148	8.4148	.3528	3659.0	4153.0	8.3431	8.3431
800	.5407	3852.2	4392.9	8.7118	8.7118	.4505	3851.6	4392.2	8.6272	8.6272	.3861	3851.1	4391.5	8.5556	8.5556
900	.5871	4050.5	4637.6	8.9119	8.9119	.4892	4050.0	4637.0	8.8274	8.8274	.4192	4049.5	4636.4	8.7559	8.7559
1000	.6335	4255.1	4888.6	9.1017	9.1017	.5278	4254.6	4888.0	9.0172	9.0172	.4524	4254.1	4887.5	8.9457	8.9457
1100	.6798	4465.6	5145.4	9.2822	9.2822	.5665	4465.1	5144.9	9.1977	9.1977	.4855	4464.7	5144.4	9.1262	9.1262
1200	.7261	4681.3	5407.4	9.4543	9.4543	.6051	4680.9	5407.0	9.3698	9.3698	.5186	4680.4	5406.5	9.2984	9.2984
P = 1.60 MPa (201.41)															
Sat.	.123 80	2596.0	2794.0	6.4218	6.4218	.110 42	2598.4	2797.1	6.3794	6.3794	.099 63	2600.3	2799.5	6.3409	6.3409
225	.132 87	2644.7	2857.3	6.5518	6.5518	.116 73	2636.6	2846.7	6.4808	6.4808	.103 77	2628.3	2835.8	6.4147	6.4147
250	.141 84	2692.3	2919.2	6.6732	6.6732	.124 97	2686.0	2911.0	6.6066	6.6066	.111 44	2679.6	2902.5	6.5453	6.5453
300	.158 62	2781.1	3034.8	6.8844	6.8844	.140 21	2776.9	3029.2	6.8226	6.8226	.125 47	2772.6	3023.5	6.7664	6.7664
350	.174 56	2866.1	3145.4	7.0694	7.0694	.154 57	2863.0	3141.2	7.0100	7.0100	.138 57	2859.8	3137.0	6.9563	6.9563
400	.190 05	2950.1	3254.2	7.2374	7.2374	.168 47	2947.7	3250.9	7.1794	7.1794	.151 20	2945.2	3247.6	7.1271	7.1271
450	.2203	3119.5	3472.0	7.5390	7.5390	.195 50	3117.9	3469.8	7.4825	7.4825	.175 68	3116.2	3467.6	7.4317	7.4317
500	.2500	3293.3	3693.2	7.8080	7.8080	.2220	3292.1	3691.7	7.7523	7.7523	.199 60	3290.9	3690.1	7.7024	7.7024
600	.2794	3472.7	3919.7	8.0535	8.0535	.2482	3471.8	3918.5	7.9983	7.9983	.2292	3470.9	3917.4	7.9487	7.9487
P = 1.80 MPa (207.15)															
P = 2.00 MPa (212.42)															

TABLE A.3 (SI) (cont'd.)

T	P = 4.0 MPa (250.40)					P = 4.5 MPa (257.49)					P = 5.0 MPa (263.99)				
	v	u	h	s	s	v	u	h	s	s	v	u	h	s	s
Sat.	.049 78	2602.3	2801.4	6.0701	6.0701	.044 06	2600.1	2798.3	6.0198	6.0198	.039 44	2597.1	2794.3	5.9734	5.9734
275	.054 57	2667.9	2886.2	6.2285	6.2285	.047 30	2650.3	2863.2	6.1401	6.1401	.041 41	2631.3	2838.3	6.0544	6.0544
300	.058 84	2725.3	2960.7	6.3615	6.3615	.051 35	2712.0	2943.1	6.2828	6.2828	.045 32	2698.0	2924.5	6.2084	6.2084
350	.066 45	2826.7	3092.5	6.5821	6.5821	.058 40	2817.8	3080.6	6.5131	6.5131	.051 94	2808.7	3068.4	6.4493	6.4493
400	.073 41	2919.9	3213.6	6.7690	6.7690	.064 75	2913.3	3204.7	6.7047	6.7047	.057 81	2906.6	3195.7	6.6459	6.6459
450	.080 02	3010.2	3330.3	6.9363	6.9363	.070 74	3005.0	3323.3	6.8746	6.8746	.063 30	2999.7	3316.2	6.8186	6.8186
500	.086 43	3099.5	3445.3	7.0901	7.0901	.076 51	3095.3	3439.6	7.0301	7.0301	.068 57	3091.0	3433.8	6.9759	6.9759
600	.098 85	3279.1	3674.4	7.3688	7.3688	.087 65	3276.0	3670.5	7.3110	7.3110	.078 69	3273.0	3666.5	7.2589	7.2589
700	.110 95	3462.1	3905.9	7.6198	7.6198	.098 47	3459.9	3903.0	7.5631	7.5631	.088 49	3457.6	3900.1	7.5122	7.5122
800	.122 87	3650.0	4141.5	7.8502	7.8502	.109 11	3648.3	4139.3	7.7942	7.7942	.098 11	3646.6	4137.1	7.7440	7.7440
900	.134 69	3843.6	4382.3	8.0647	8.0647	.119 65	3842.2	4380.6	8.0091	8.0091	.107 62	3840.7	4378.8	7.9593	7.9593
1000	.146 45	4042.9	4628.7	8.2662	8.2662	.130 13	4041.6	4627.2	8.2108	8.2108	.117 07	4040.4	4625.7	8.1612	8.1612
1100	.158 17	4248.0	4880.6	8.4567	8.4567	.140 56	4246.8	4879.3	8.4015	8.4015	.126 48	4245.6	4878.0	8.3520	8.3520
1200	.169 87	4458.6	5138.1	8.6376	8.6376	.150 98	4457.5	5136.9	8.5825	8.5825	.135 87	4456.3	5135.7	8.5331	8.5331
1300	.181 56	4674.3	5400.5	8.8100	8.8100	.161 39	4673.1	5399.4	8.7549	8.7549	.145 26	4672.0	5398.2	8.7055	8.7055
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<p>P = 6.0 MPa (275.64)</p>															
Sat.	.032 44	2589.7	2784.3	5.8892	5.8892	.027 37	2580.5	2772.1	5.8133	5.8133	.023 52	2569.8	2758.0	5.7432	5.7432
300	.036 16	2667.2	2884.2	6.0674	6.0674	.029 47	2632.2	2838.4	5.9305	5.9305	.024 26	2590.9	2785.0	5.7906	5.7906
350	.042 93	2789.6	3043.0	6.3335	6.3335	.035 24	2769.4	3016.0	6.2283	6.2283	.029 95	2747.7	2987.3	6.1301	6.1301
400	.047 39	2892.9	3177.2	6.5408	6.5408	.039 93	2878.6	3158.1	6.4478	6.4478	.034 32	2863.8	3138.3	6.3634	6.3634
450	.052 14	2988.9	3301.8	6.7193	6.7193	.044 16	2978.0	3287.1	6.6327	6.6327	.038 17	2966.7	3272.0	6.5551	6.5551
500	.056 65	3082.2	3422.2	6.8803	6.8803	.048 14	3073.4	3410.3	6.7975	6.7975	.041 75	3064.3	3398.3	6.7240	6.7240
550	.061 01	3174.6	3540.6	7.0288	7.0288	.051 95	3167.2	3530.9	6.9486	6.9486	.045 16	3159.8	3521.0	6.8778	6.8778
600	.065 25	3266.9	3658.4	7.1677	7.1677	.055 65	3260.7	3650.3	7.0894	7.0894	.048 45	3254.4	3642.0	7.0206	7.0206
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<p>P = 8.0 MPa (295.06)</p>															

TABLE A.3 (SI) (cont'd.)

T	P = 6.0 MPa (275.64)					P = 7.0 MPa (285.88)					P = 8.0 MPa (295.06)				
	v	u	h	s	s	v	u	h	s	s	v	u	h	s	s
700	.073 52	3453.1	3894.2	7.4234	7.4234	.062 83	3448.5	3888.3	7.3476	7.3476	.054 81	3443.9	3882.4	7.2812	7.2812
800	.081 60	3643.1	4132.7	7.6566	7.6566	.069 81	3639.5	4128.2	7.5822	7.5822	.060 97	3636.0	4123.8	7.5173	7.5173
900	.089 58	3837.8	4375.3	7.8727	7.8727	.076 69	3835.0	4371.8	7.7991	7.7991	.067 02	3832.1	4368.3	7.7351	7.7351
1000	.097 49	4037.8	4622.7	8.0751	8.0751	.083 50	4035.3	4619.8	8.0020	8.0020	.073 01	4032.8	4616.9	7.9384	7.9384
1100	.105 36	4243.3	4875.4	8.2661	8.2661	.090 27	4240.9	4872.8	8.1933	8.1933	.078 96	4238.6	4870.3	8.1300	8.1300
1200	.113 21	4454.0	5133.3	8.4474	8.4474	.097 03	4451.7	5130.9	8.3747	8.3747	.084 89	4449.5	5128.5	8.3115	8.3115
1300	.121 06	4669.6	5396.0	8.6199	8.6199	.103 77	4667.3	5393.7	8.5473	8.5473	.090 80	4665.0	5391.5	8.4842	8.4842

T	P = 9.0 MPa (303.40)					P = 10.0 MPa (311.06)					P = 12.5 MPa (327.89)				
	v	u	h	s	s	v	u	h	s	s	v	u	h	s	s
Sat.	.020 48	2557.8	2742.1	5.6772	5.6772	.018 026	2544.4	2724.7	5.6141	5.6141	.013 495	2505.1	2673.8	5.4624	5.4624
325	.023 27	2646.6	2856.0	5.8712	5.8712	.019 861	2610.4	2809.1	5.7568	5.7568	.016 126	2624.6	2826.2	5.7118	5.7118
350	.025 80	2724.4	2956.6	6.0361	6.0361	.022 42	2699.2	2923.4	5.9443	5.9443	.020 00	2789.3	3039.3	6.0417	6.0417
400	.029 93	2848.4	3117.8	6.2854	6.2854	.026 41	2832.4	3096.5	6.2120	6.2120	.022 99	2912.5	3199.8	6.2719	6.2719
450	.033 50	2955.2	3256.6	6.4844	6.4844	.029 75	2943.4	3240.9	6.4190	6.4190	.025 60	3021.7	3341.8	6.4618	6.4618
500	.036 77	3055.2	3386.1	6.6576	6.6576	.032 79	3045.8	3373.7	6.5966	6.5966	.028 01	3125.0	3475.2	6.6290	6.6290
550	.039 87	3152.2	3511.0	6.8142	6.8142	.035 64	3144.6	3500.9	6.7561	6.7561	.030 29	3225.4	3604.0	6.7810	6.7810
600	.042 85	3248.1	3633.7	6.9589	6.9589	.038 37	3241.7	3625.3	6.9029	6.9029	.032 48	3324.4	3730.4	6.9218	6.9218
650	.045 74	3343.6	3755.3	7.0943	7.0943	.041 01	3338.2	3748.2	7.0398	7.0398	.034 60	3422.9	3855.3	7.0536	7.0536
700	.048 57	3439.3	3876.5	7.2221	7.2221	.043 58	3434.7	3870.5	7.1687	7.1687	.038 69	3620.0	4103.6	7.2965	7.2965
800	.054 09	3632.5	4119.3	7.4596	7.4596	.048 59	3628.9	4114.8	7.4077	7.4077	.042 67	3819.1	4352.5	7.5182	7.5182
900	.059 50	3829.2	4364.8	7.6783	7.6783	.053 49	3826.3	4361.2	7.6272	7.6272	.046 58	4021.6	4603.8	7.7237	7.7237
1000	.064 85	4030.3	4614.0	7.8821	7.8821	.058 32	4027.8	4611.0	7.8315	7.8315	.050 45	4228.2	4858.8	7.9165	7.9165
1100	.070 16	4236.3	4867.7	8.0740	8.0740	.063 12	4234.0	4865.1	8.0237	8.0237	.054 30	4439.3	5118.0	8.0987	8.0987
1200	.075 44	4447.2	5126.2	8.2556	8.2556	.067 89	4444.9	5123.8	8.2055	8.2055	.058 13	4654.8	5381.4	8.2717	8.2717
1300	.080 72	4662.7	5389.2	8.4284	8.4284	.072 65	4460.5	5387.0	8.3783	8.3783					

TABLE A.3 (SI) (cont'd.)

T	P = 15.0 MPa (342.24)					P = 17.5 MPa (354.75)					P = 20.0 MPa (365.81)				
	v	u	h	s	s	v	u	h	s	s	v	u	h	s	s
Sat.	.010 337	2455.5	2610.5	5.3098		.007 920	2390.2	2528.8	5.1419		.005 834	2293.0	2409.7	4.9269	
350	.011 470	2520.4	2692.4	5.4421											
400	.015 649	2740.7	2975.5	5.8811		.012 447	2685.0	2902.9	5.7213		.009 942	2619.3	2818.1	5.5540	
450	.018 445	2879.5	3156.2	6.1404		.015 174	2844.2	3109.7	6.0184		.012 695	2806.2	3060.1	5.9017	
500	.020 80	2996.6	3308.6	6.3443		.017 358	2970.3	3274.1	6.2383		.014 768	2942.9	3238.2	6.1401	
550	.022 93	3104.7	3448.6	6.5199		.019 288	3083.9	3421.4	6.4230		.016 555	3062.4	3393.5	6.3348	
600	.024 91	3208.6	3582.3	6.6776		.021 06	3191.5	3560.1	6.5866		.018 178	3174.0	3537.6	6.5048	
650	.026 80	3310.3	3712.3	6.8224		.022 74	3296.0	3693.9	6.7357		.019 693	3281.4	3675.3	6.6582	
700	.028 61	3410.9	3840.1	6.9572		.024 34	3398.7	3824.6	6.8736		.021 13	3386.4	3809.0	6.7993	
800	.032 10	3610.9	4092.4	7.2040		.027 38	3601.8	4081.1	7.1244		.023 85	3592.7	4069.7	7.0544	
900	.035 46	3811.9	4343.8	7.4279		.030 31	3804.7	4335.1	7.3507		.026 45	3797.5	4326.4	7.2830	
1000	.038 75	4015.4	4596.6	7.6348		.033 16	4009.3	4589.5	7.5589		.028 97	4003.1	4582.5	7.4925	
1100	.042 00	4222.6	4852.6	7.8283		.035 97	4216.9	4846.4	7.7531		.031 45	4211.3	4840.2	7.6874	
1200	.045 23	4433.8	5112.3	8.0108		.038 76	4428.3	5106.6	7.9360		.033 91	4422.8	5101.0	7.8707	
1300	.048 45	4649.1	5376.0	8.1840		.041 54	4643.5	5370.5	8.1093		.036 36	4638.0	5365.1	8.0442	

		P = 25.0 MPa					P = 30.0 MPa					P = 35.0 MPa				
375	.001 973 1	1798.7	1848.0	4.0320		.001 789 2	1737.8	1791.5	3.9305		.001 700 3	1702.9	1762.4	3.8722		
400	.006 004	2430.1	2580.2	5.1418		.002 790	2067.4	2151.1	4.4728		.002 100	1914.1	1987.6	4.2126		
425	.007 881	2609.2	2806.3	5.4723		.005 303	2455.1	2614.2	5.1504		.003 428	2253.4	2373.4	4.7747		
450	.009 162	2720.7	2949.7	5.6744		.006 735	2619.3	2821.4	5.4424		.004 961	2498.7	2672.4	5.1962		
500	.011 123	2884.3	3162.4	5.9592		.008 678	2820.7	3081.1	5.7905		.006 927	2751.9	2994.4	5.6282		
550	.012 724	3017.5	3335.6	6.1765		.010 168	2970.3	3275.4	6.0342		.008 345	2921.0	3213.0	5.9026		
600	.014 137	3137.9	3491.4	6.3602		.011 446	3100.5	3443.9	6.2331		.009 527	3062.0	3395.5	6.1179		
650	.015 433	3251.6	3637.4	6.5229		.012 596	3221.0	3598.9	6.4058		.010 575	3189.8	3559.9	6.3010		

TABLE A.3 (SI) (cont'd.)

T	P = 25.0 MPa					P = 30.0 MPa					P = 35.0 MPa				
	v	u	h	s	s	v	u	h	s	s	v	u	h	s	s
700	.016 646	3361.3	3777.5	6.6707	6.5606	.013 661	3335.8	3745.6	6.5606	6.4631	.011 533	3309.8	3713.5	6.4631	
800	.018 912	3574.3	4047.1	6.9345	6.8332	.015 623	3555.5	4024.2	6.8332	6.7450	.013 278	3536.7	4001.5	6.7450	
900	.021 045	3783.0	4309.1	7.1680	7.0718	.017 448	3768.5	4291.9	7.0718	6.9886	.014 883	3754.0	4274.9	6.9886	
1000	.023 10	3990.9	4568.5	7.3802	7.2867	.019 196	3978.8	4554.7	7.2867	7.2064	.016 410	3966.7	4541.1	7.2064	
1100	.025 12	4200.2	4828.2	7.5765	7.4845	.020 903	4189.2	4816.3	7.4845	7.4057	.017 895	4178.3	4804.6	7.4057	
1200	.027 11	4412.0	5089.9	7.7605	7.6692	.022 589	4401.3	5079.0	7.6692	7.5910	.019 360	4390.7	5068.3	7.5910	
1300	.029 10	4626.9	5354.4	7.9342	7.8432	.024 266	4616.0	5344.0	7.8432	7.7653	.020 815	4605.1	5333.6	7.7653	
P = 40.0 MPa															
375	.001 640 7	1677.1	1742.8	3.8290	3.7639	.001 559 4	1638.6	1716.6	3.7639	3.7141	.001 502 8	1609.4	1699.5	3.7141	
400	.001 907 7	1854.6	1930.9	4.1135	4.0031	.001 730 9	1788.1	1874.6	4.0031	3.9318	.001 633 5	1745.4	1843.4	3.9318	
425	.002 532	2096.9	2198.1	4.5029	4.2734	.002 007	1959.7	2060.0	4.2734	4.1626	.001 816 5	1892.7	2001.7	4.1626	
450	.003 693	2365.1	2512.8	4.9459	4.5884	.002 486	2159.6	2284.0	4.5884	4.4121	.002 085	2053.9	2179.0	4.4121	
500	.005 622	2678.4	2903.3	5.4700	5.1726	.003 892	2525.5	2720.1	5.1726	4.9321	.002 956	2390.6	2567.9	4.9321	
550	.006 984	2869.7	3149.1	5.7785	5.5485	.005 118	2763.6	3019.5	5.5485	5.3441	.003 956	2658.8	2896.2	5.3441	
600	.008 094	3022.6	3346.4	6.0114	5.8178	.006 112	2942.0	3247.6	5.8178	5.6452	.004 834	2861.1	3151.2	5.6452	
650	.009 063	3158.0	3520.6	6.2054	6.0342	.006 966	3093.5	3441.8	6.0342	5.8829	.005 595	3028.8	3364.5	5.8829	
700	.009 941	3283.6	3681.2	6.3750	6.2189	.007 727	3230.5	3616.8	6.2189	6.0824	.006 272	3177.2	3553.5	6.0824	
800	.011 523	3517.8	3978.7	6.6662	6.5290	.009 076	3479.8	3933.6	6.5290	6.4109	.007 459	3441.5	3889.1	6.4109	
900	.012 962	3739.4	4257.9	6.9150	6.7882	.010 283	3710.3	4224.4	6.7882	6.6805	.008 508	3681.0	4191.5	6.6805	
1000	.014 324	3954.6	4527.6	7.1356	7.0146	.011 411	3930.5	4501.1	7.0146	6.9127	.009 480	3906.4	4475.2	6.9127	
1100	.015 642	4167.4	4793.1	7.3364	7.2184	.012 496	4145.7	4770.5	7.2184	7.1195	.010 409	4124.1	4748.6	7.1195	
1200	.016 940	4380.1	5057.7	7.5224	7.4058	.013 561	4359.1	5037.2	7.4058	7.3083	.011 317	4338.2	5017.2	7.3083	
1300	.018 229	4594.3	5323.5	7.6969	7.5808	.014 616	4572.8	5303.6	7.5808	7.4837	.012 215	4551.4	5284.3	7.4837	

TABLE 4

<i>p</i> (<i>t</i> Sat.) MPa		Liquid											
		0			2.5 (223.99)			5.0 (263.99)					
<i>t</i>	$10^3 v$	<i>u</i>	<i>h</i>	<i>s</i>	$10^3 v$	<i>u</i>	<i>h</i>	<i>s</i>	$10^3 v$	<i>u</i>	<i>h</i>	<i>s</i>	
Sat.													
0	1.0002	-0.03	-0.03	-0.0001	0.9990	-0.00	2.50	-0.0000	0.9977	0.04	5.04	0.0001	
20	1.0018	83.95	83.95	0.2966	1.0006	83.80	86.30	0.2961	0.9995	83.65	88.65	0.2956	
40	1.0078	167.56	167.56	0.5725	1.0067	167.25	169.77	0.5715	1.0056	166.95	171.97	0.5705	
60	1.0172	251.12	251.12	0.8312	1.0160	250.67	253.21	0.8298	1.0149	250.23	255.30	0.8285	
80	1.1291	334.87	334.87	1.0753	1.0280	334.29	336.86	1.0737	1.0268	333.72	338.85	1.0720	
100	1.0436	418.96	418.96	1.3069	1.0423	418.24	420.85	1.3050	1.0410	417.52	422.72	1.3030	
120	1.0604	503.57	503.57	1.5278	1.0590	502.68	505.33	1.5255	1.0576	501.80	507.09	1.5233	
140	1.0800	588.89	588.89	1.7395	1.0784	587.82	590.52	1.7369	1.0768	586.76	592.15	1.7343	
160	1.1024	675.19	675.19	1.9434	1.1006	673.90	676.65	1.9404	1.0988	672.62	678.12	1.9375	
180	1.1283	762.72	762.72	2.1410	1.1261	761.16	763.97	2.1375	1.1240	759.63	765.25	2.1341	
200	1.1581	851.8	851.8	2.3334	1.1555	849.9	852.8	2.3294	1.1530	848.1	853.9	2.3255	
210	1.1749	897.1	897.1	2.4281	1.1720	895.0	898.0	2.4238	1.1691	893.0	898.8	2.4195	
220	1.1930	943.0	943.0	2.5221	1.1898	940.7	943.7	2.5174	1.1866	938.4	944.4	2.5128	
230	1.2129	989.6	989.6	2.6157	1.2092	987.0	990.1	2.6105	1.2056	984.5	990.6	2.6055	
240	1.2347	1037.1	1037.1	2.7091	1.2305	1034.2	1037.2	2.7034	1.2264	1031.4	1037.5	2.6979	
250	1.2590	1085.6	1085.6	2.8027	1.2540	1082.3	1085.4	2.7964	1.2493	1079.1	1085.3	2.7902	
260	1.2862	1135.4	1135.4	2.8970	1.2804	1131.6	1134.8	2.8898	1.2749	1127.9	1134.3	2.8830	
270	1.3173	1186.8	1186.8	2.9926	1.3102	1182.4	1185.7	2.9844	1.3036	1178.2	1184.3	2.9766	
280	1.3535	1240.4	1240.4	3.0904	1.3447	1235.1	1238.5	3.0808	1.3365	1230.2	1236.8	3.0717	
290	1.3971	1297.0	1297.0	3.1918	1.3855	1290.5	1294.0	3.1801	1.3750	1284.4	1291.3	3.1693	
300	1.4520	1358.1	1358.1	3.2992	1.4357	1349.6	1353.2	3.2843	1.4214	1341.9	1349.0	3.2708	
310					1.4803	1404.1	1411.5	3.3789					

FIGURE 5.11a Extract from subcooled table (SI units).

TABLE A.4 (SI)
Properties of Compressed Liquid (Steam)

T	P = 5 MPa (263.99)					P = 10 MPa (311.06)					P = 15 MPa (342.24)				
	v	u	h	s		v	u	h	s		v	u	h	s	
Sat.	.001 285 9	1147.8	1154.2	2.9202		.001 452 4	1393.0	1407.6	3.3596		.001 658 1	1585.6	1610.5	3.6848	
0	.000 997 7	.04	5.04	.0001		.000 995 2	.09	10.04	.0002		.000 992 8	.15	15.05	.0004	
20	.000 999 5	83.65	88.65	.2956		.000 997 2	83.36	93.33	.2945		.000 995 0	83.06	97.99	.2934	
40	.001 005 6	166.95	171.97	.5705		.001 003 4	166.35	176.38	.5686		.001 001 3	165.76	180.78	.5666	
60	.001 014 9	250.23	255.30	.8285		.001 012 7	249.36	259.49	.8258		.001 010 5	248.51	263.67	.8232	
80	.001 026 8	333.72	338.85	1.0720		.001 024 5	332.59	342.83	1.0688		.001 022 2	331.48	346.81	1.0656	
100	.001 041 0	417.52	422.72	1.3030		.001 038 5	416.12	426.50	1.2992		.001 036 1	414.74	430.28	1.2955	
120	.001 057 6	501.80	507.09	1.5233		.001 054 9	500.08	510.64	1.5189		.001 052 2	498.40	514.19	1.5145	
140	.001 076 8	586.76	592.15	1.7343		.001 073 7	584.68	595.42	1.7292		.001 070 7	582.66	598.72	1.7242	
160	.001 098 8	672.62	678.12	1.9375		.001 095 3	670.13	681.08	1.9317		.001 091 8	667.71	684.09	1.9260	
180	.001 124 0	759.63	765.25	2.1341		.001 119 9	756.65	767.84	2.1275		.001 115 9	753.76	770.50	2.1210	
200	.001 153 0	848.1	853.9	2.3255		.001 148 0	844.5	856.0	2.3178		.001 143 3	841.0	858.2	2.3104	
220	.001 186 6	938.4	944.4	2.5128		.001 180 5	934.1	945.9	2.5039		.001 174 8	929.9	947.5	2.4953	
240	.001 226 4	1031.4	1037.5	2.6979		.001 218 7	1026.0	1038.1	2.6872		.001 211 4	1020.8	1039.0	2.6771	
260	.001 274 9	1127.9	1134.3	2.8830		.001 264 5	1121.1	1133.7	2.8699		.001 255 0	1114.6	1133.4	2.8576	
280						.001 321 6	1220.9	1234.1	3.0548		.001 308 4	1212.5	1232.1	3.0393	
300						.001 397 2	1328.4	1342.3	3.2469		.001 377 0	1316.6	1337.3	3.2260	
320											.001 472 4	1431.1	1453.2	3.4247	
340											.001 631 1	1567.5	1591.9	3.6546	

TABLE A.4 (SI) (cont'd.)

T	P = 20 MPa (365.81)					P = 30 MPa					P = 50 MPa				
	v	u	h	s		v	u	h	s		v	u	h	s	
Sat.	.002 036	1785.6	1826.3	4.0139		.000 985 6	.25	29.82	.0001		.000 976 6	.20	49.03	.0014	
0	.000 990 4	.19	20.01	.0004		.000 988 6	82.17	111.84	.2899		.000 980 4	81.00	130.02	.2848	
20	.000 992 8	82.77	102.62	.2923		.000 995 1	164.04	193.89	.5607		.000 987 2	161.86	211.21	.5527	
40	.000 999 2	165.17	185.16	.5646		.001 004 2	246.06	276.19	.8154		.000 996 2	242.98	292.79	.8052	
60	.001 008 4	247.68	267.85	.8206		.001 015 6	328.30	358.77	1.0561		.001 007 3	324.34	374.70	1.0440	
80	.001 019 9	330.40	350.80	1.0624		.001 029 0	410.78	441.66	1.2844		.001 020 1	405.88	456.89	1.2703	
100	.001 033 7	413.39	434.06	1.2917		.001 044 5	493.59	524.93	1.5018		.001 034 8	487.65	539.39	1.4857	
120	.001 049 6	496.76	517.76	1.5102		.001 062 1	576.88	608.75	1.7098		.001 051 5	569.77	622.35	1.6915	
140	.001 067 8	580.69	602.04	1.7193		.001 082 1	660.82	693.28	1.9096		.001 070 3	652.41	705.92	1.8891	
160	.001 088 5	665.35	687.12	1.9204		.001 104 7	745.59	778.73	2.1024		.001 091 2	735.69	790.25	2.0794	
180	.001 112 0	750.95	773.20	2.1147		.001 130 2	831.4	865.3	2.2893		.001 114 6	819.7	875.5	2.2634	
200	.001 138 8	837.7	860.5	2.3031		.001 159 0	918.3	953.1	2.4711		.001 140 8	904.7	961.7	2.4419	
220	.001 169 3	925.9	949.3	2.4870		.001 192 0	1006.9	1042.6	2.6490		.001 170 2	990.7	1049.2	2.6158	
240	.001 204 6	1016.0	1040.0	2.6674		.001 230 3	1097.4	1134.3	2.8243		.001 203 4	1078.1	1138.2	2.7860	
260	.001 246 2	1108.6	1133.5	2.8459		.001 275 5	1190.7	1229.0	2.9986		.001 241 5	1167.2	1229.3	2.9537	
280	.001 296 5	1204.7	1230.6	3.0248		.001 330 4	1287.9	1327.8	3.1741		.001 286 0	1258.7	1323.0	3.1200	
300	.001 359 6	1306.1	1333.3	3.2071		.001 399 7	1390.7	1432.7	3.3539		.001 338 8	1353.3	1420.2	3.2868	
320	.001 443 7	1415.7	1444.6	3.3979		.001 492 0	1501.7	1546.5	3.5426		.001 403 2	1452.0	1522.1	3.4557	
340	.001 568 4	1539.7	1571.0	3.6075		.001 626 5	1626.6	1675.4	3.7494		.001 483 8	1556.0	1630.2	3.6291	
360	.001 822 6	1702.8	1739.3	3.8772		.001 869 1	1781.4	1837.5	4.0012		.001 588 4	1667.2	1746.6	3.8101	
380															