

LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 4

LEFEL 4

EXAMINATION PERIOD

MAY 2020

CYFNOD ARHOLIADAU

MAI 2020

MODULE CODE: M4X00386
ENGINEERING SCIENCE 2

TIME: 2 HOURS

ANSWER ALL QUESTIONS

Equipment or materials required – Calculator.

FORMULAE BOOKLET FOR ELECTRICAL ENGINEERING
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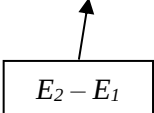
$Q = CV$	$Q = It$	$V = IR$	$V = V_0 e^{-\frac{t}{RC}}$	$I = I_0 e^{-\frac{t}{RC}}$
$Q = Q_0 e^{-\frac{t}{RC}}$	$P = IV$	$P = I^2 R$	$P = \frac{V^2}{R}$	$E = \frac{1}{2} CV^2$
$E = \frac{1}{2} QV$	$\rho = \frac{RA}{l}$	$R_T = R_1 + R_2 + R_3$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$	$V = \varepsilon - Ir$
$V_{rms} = \frac{V_0}{\sqrt{2}}$	$I_{rms} = \frac{I_0}{\sqrt{2}}$	$V_{rms} = I_{rms} R$		

FORMULAE BOOKLET FOR THERMODYNAMICS

- **BASIC CONCEPT:**

The change in the energy content of a body or any other system is equal to the difference between the energy input and the energy output, and the energy balance is expressed as:

$$\Delta E = E_{in} - E_{out}$$



WORK:

Work done **by** the system is considered: **POSITIVE**

Work done **on** the system is considered: **NEGATIVE**

HEAT:

Heat transfer **into** the system is considered: **POSITIVE**.

Heat transfer **out** of the system is considered: **NEGATIVE**.

- **CLOSED SYSTEMS:**

Non-flow energy equation:

$$\Delta U = Q - W$$

- **ENTHALPY:**

$$H = U + P.V \quad (\text{J})$$

Where:

- U = internal energy
- P = pressure
- V = volume

- **FLOW WORK:**

The **flow work**, or **flow energy**, or again **displacement energy**:

$$W_{flow} = P \times V$$

- **OPEN SYSTEMS / Steady-flow systems**

✓ Mass Balance:

$$\sum_{in} \dot{m} = \sum_{out} \dot{m} \quad (\text{kg/s})$$

✓ Energy Balance:

$$\dot{Q} - \dot{W} = \sum_{out} \dot{m} \cdot \left(h + \frac{1}{2} \cdot c^2 + g \cdot z \right) - \sum_{in} \dot{m} \cdot \left(h + \frac{1}{2} \cdot c^2 + g \cdot z \right)$$

- **CONTINITY OF MASS FLOW:**

$\dot{m}$ = mass flow in kg/s

A = cross sectional area in m^2

v = specific volume in m^3/kg

c = velocity in m/s

Consider the volume of substance passing the section per second = $\dot{V}$ in m^3/s

$$\dot{V} = \dot{m} \cdot v \quad \text{also} \quad \dot{V} = A \cdot c \quad (\text{Continuity equation})$$

Therefore:

$$\dot{m} \cdot v = A \cdot c$$

From which

$$\dot{m} = \frac{A \cdot c}{v}$$

- **OPEN SYSTEMS / Unsteady-flow systems**

✓ Mass Balance:

$$m_i - m_e = m_2 - m_1$$

Where:

- i = inlet, and e = exit.
- 1 = initial state, and 2 = final state of the control volume.
- Often one or more terms in this equation are zero.

✓ Energy Balance: (when kinetic and potential energy changes associated with the control volume and fluid streams are negligible)

$$Q - W = \sum_{out} mh - \sum_{in} mh + (m_2 u_2 - m_1 u_1)$$

- **IDEAL GAS:**

We defined an **ideal gas** as a gas whose temperature, pressure, and specific volume are related by:

$$P \cdot v = R \cdot T$$

where:

- R is the gas constant (kJ/kg.K) or (kPa.m³/kg.K)
- P the absolute pressure (kPa)
- T the absolute temperature (K)
- v is the specific volume (m³/kg)

The change in internal energy or enthalpy for an **ideal gas** during a process from state 1 to state 2 are defined as:

$$u_2 - u_1 = c_v(T_2 - T_1) \quad (\text{kJ/kg})$$

$$h_2 - h_1 = c_p(T_2 - T_1) \quad (\text{kJ/kg})$$

where:

- c_v is the specific heat at constant volume
- c_p is the specific heat at constant pressure

Reminder:

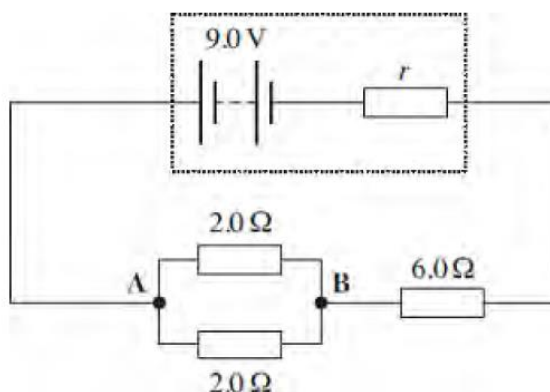
$$^{\circ}\text{C} = K - 273$$

$$K = ^{\circ}\text{C} + 273$$

ELECTRICAL ENGINEERING

1. QUESTION ONE (10 marks)

A battery of emf 9.0 V and internal resistance, r , is connected in the circuit shown in the figure below.



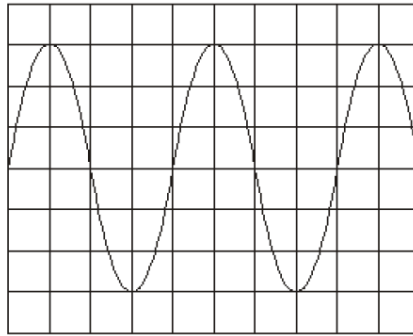
Given that the battery current is 1 A calculate:

- The potential difference between points A and B. [2]
- The internal resistance r . [3]
- The energy transformed by the circuit in 5 minutes. [2]
- State and explain why it is an advantage for a battery to have a low internal resistance. [3]

2. QUESTION TWO (20 marks)

- Domestic users in the United Kingdom are supplied with mains electricity at a root mean square voltage of 230 V. State what is meant by root mean square voltage. [2]
- Calculate the peak value of the supply voltage. [2]
- Calculate the average power dissipated in a lamp connected to the mains supply when the rms current is 0.26 A. [2]
- In the UK, mains devices operate at a frequency of 50 Hz. What is the period of each cycle. [2]
- Figure 2 shows an ac waveform that is displayed on an oscilloscope screen. The trace obtained on the screen has a time base setting at 10 ms per division and the voltage sensitivity at 15 V per division. For the AC source shown calculate:

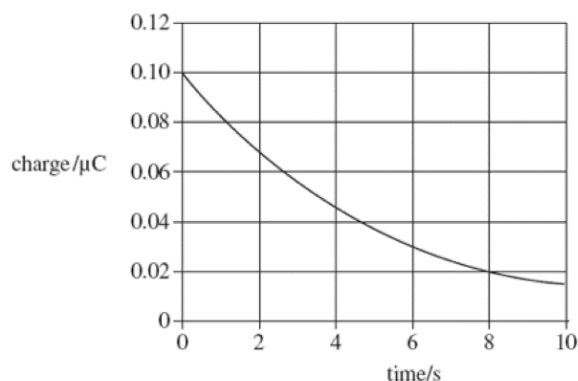
Figure 2



- i. The frequency. [2]
- ii. The rms voltage. [2]
- iii. The peak voltage. [2]
- iv. The peak to peak voltage. [2]
- v. What would happen if the time base was switched off? [2]
- vi. How many complete cycles would you expect to see if the time base was set to 40ms per division? [2]

3. QUESTION THREE (20 marks)

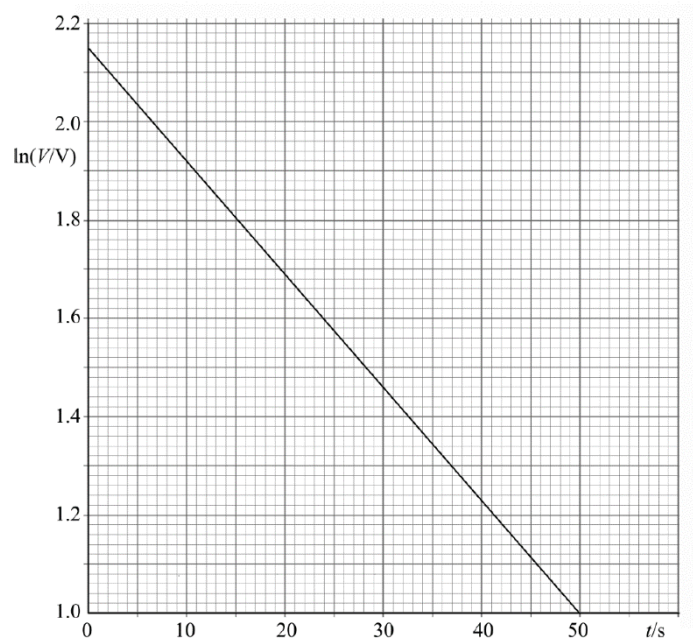
- a. Define the capacitance of a capacitor. [2]
- b. A capacitor of capacitance $330\ \mu\text{F}$ is charged to a potential difference of $9.0\ \text{V}$. It is then discharged through a resistor of resistance $470\ \text{k}\Omega$. Calculate:
 - i. The energy stored when the capacitor is fully charged. [2]
 - ii. The time constant of the discharging circuit. [2]
 - iii. The potential difference across the capacitor $60\ \text{s}$ after discharging has begun. [3]
- c. The graph below shows how the charge on a capacitor decreases over time when placed across a $100\ \text{k}\Omega$.



From the graph calculate:

- i. The time constant of the circuit. [2]
- ii. The capacitance of the capacitor. [2]

- d. On an experiment to analyse how the voltage of a capacitor changes with time the following graph was obtained.



- i. Use this graph to calculate the pd across the capacitor when $t = 0$. [3]
- ii. The time constant. [2]
- iii. The capacitance of the capacitor given that the resistance used was $91 \text{ k}\Omega$. [2]

THERMODYNAMICS

4. QUESTION FOUR / Closed System (16 marks)

A well-insulated rigid tank contains 5 kg of a saturated liquid-vapour mixture of water as shown in Figure 1. The initial mixture has a quality of 0.35721 and a pressure of 100 kPa. An electric heater placed in the tank is turned on, until the entire liquid is vaporised (that is, until the quality reaches 1). During the duration of the process, the electric heater resistor is connected to a 110 Volts source, and a current of 8 A flows through the resistor.

- i. Knowing that the volume remains constant, determine the final pressure. [8]
- ii. Determine the length of time in hour the heater must be kept on. [8]

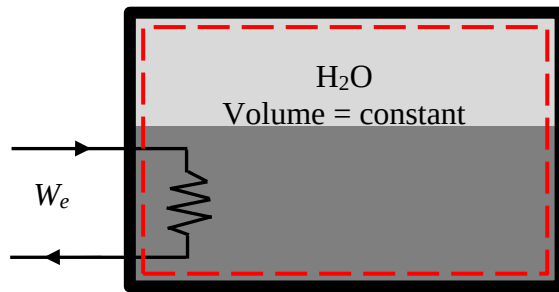


Figure 1: Well-insulated rigid tank.

Assumptions:

- Kinetic and potential energy changes are negligible.
- The electrical work can be determined from: $W_e = V \cdot I \cdot \Delta t$ where V and I are the voltage and current respectively and Δt the time duration.
- The properties of the fluid can be found in Table A-5.
- In a saturated liquid-vapour mixture, the mass fraction of vapour is called the *quality* and is expressed as:

$$x = \frac{m_{vapour}}{m_{total}}$$

Quality may have values between 0 (saturated liquid) and 1 (saturated vapour). It has no meaning in the compressed liquid or superheated vapour regions. In the saturated mixture region, the average value of any intensive property y is determined from:

$$y = y_f + x \cdot y_{fg}$$

where f stands for saturated liquid, g for saturated vapour and y stands for v , u or h .

- For specific volume, $v_{fg} = v_g - v_f$

5. QUESTION FIVE / Opens System, Steady-Flow Process (16 marks)

A compressor requires a power input of 4 kW to compress air at 120 kPa and 20°C to 100 kPa and 300°C as shown in Figure 2. The compressor is not well insulated and it is estimated that the equivalent of 10% of the power input is lost to the surroundings in the form of heat. Calculate,

- i. The mass flow rate of air in kg/s, [10]
- ii. The volumetric flow rate of air in litre/s at both the inlet and outlet. [6]

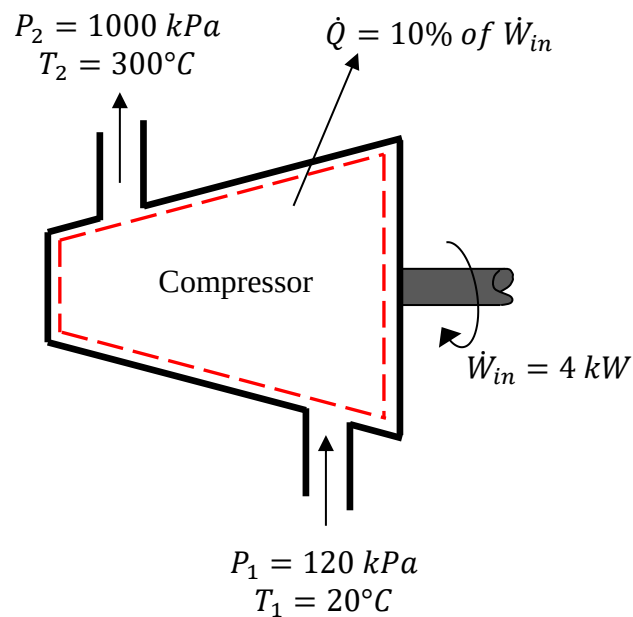


Figure 2: Compressor.

Assumptions:

- The compressor operates under steady-flow conditions.
- Kinetic and potential energy are negligible.
- Air is considered as an ideal gas.
- Air properties can be found in Table A-2.

6. QUESTION SIX / Open System, Unsteady-Flow Process (18 marks)

A vertical piston-cylinder device initially contains 0.8 m^3 of refrigerant R-134a at 1.2 MPa and 120°C . A linear spring at this point applies full force to the piston as shown in Figure 3. A valve connected to the cylinder is now opened, and refrigerant is allowed to escape. The spring unwinds as the piston moves down, and the pressure, volume and temperature drop to 600 kPa , 0.5 m^3 and 90°C at the end of the process. The piston-cylinder is not well insulated and heat is lost to the surroundings during the process. Knowing that the enthalpy of exiting fluid is assumed to be the average of initial and final enthalpies of the refrigerant in the cylinder, and noting that for a linear spring, the boundary work can be determined from,

$$W_b = \frac{P_1 + P_2}{2} (V_1 - V_2)$$

Calculate,

- The mass of refrigerant that has escaped the cylinder during the process. [8]
- The amount of heat transfer between the piston-cylinder and the surroundings during the process. [10]

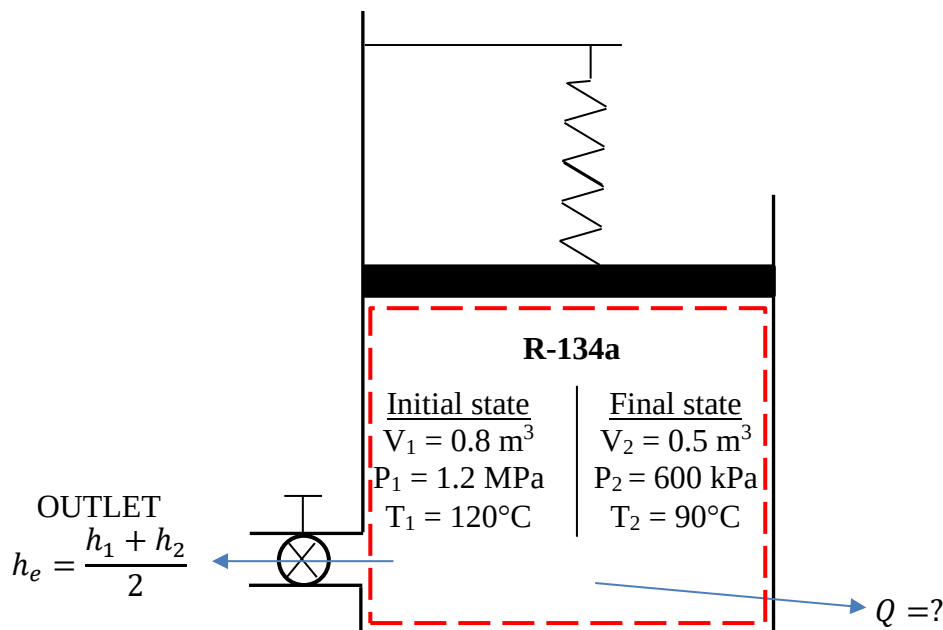


Figure 3: Vertical piston-cylinder.

Assumptions:

- This is an unsteady-flow process.
- Kinetic and potential energy changes are negligible.
- At both the initial and final states, the refrigerant R-134a is in a superheated state.
- The properties of refrigerant R-134a can be found in Table A-13.

TABLE A-2

Ideal-gas specific heats of various common gases

(a) At 300 K

Gas	Formula	Gas constant, R kJ/kg · K	c_p kJ/kg · K	c_v kJ/kg · K	k
Air	—	0.2870	1.005	0.718	1.400
Argon	Ar	0.2081	0.5203	0.3122	1.667
Butane	C ₄ H ₁₀	0.1433	1.7164	1.5734	1.091
Carbon dioxide	CO ₂	0.1889	0.846	0.657	1.289
Carbon monoxide	CO	0.2968	1.040	0.744	1.400
Ethane	C ₂ H ₆	0.2765	1.7662	1.4897	1.186
Ethylene	C ₂ H ₄	0.2964	1.5482	1.2518	1.237
Helium	He	2.0769	5.1926	3.1156	1.667
Hydrogen	H ₂	4.1240	14.307	10.183	1.405
Methane	CH ₄	0.5182	2.2537	1.7354	1.299
Neon	Ne	0.4119	1.0299	0.6179	1.667
Nitrogen	N ₂	0.2968	1.039	0.743	1.400
Octane	C ₈ H ₁₈	0.0729	1.7113	1.6385	1.044
Oxygen	O ₂	0.2598	0.918	0.658	1.395
Propane	C ₃ H ₈	0.1885	1.6794	1.4909	1.126
Steam	H ₂ O	0.4615	1.8723	1.4108	1.327

TABLE A-5

Saturated water—Pressure table

Press., <i>P</i> kPa	Sat. temp., <i>T</i> _{sat} °C	Specific volume, m ³ /kg		Internal energy, kJ/kg			Enthalpy, kJ/kg			Entropy, kJ/kg · K		
		Sat. liquid, <i>v</i> _f	Sat. vapor, <i>v</i> _g	Sat. liquid, <i>u</i> _f	Evap., <i>u</i> _{fg}	Sat. vapor, <i>u</i> _g	Sat. liquid, <i>h</i> _f	Evap., <i>h</i> _{fg}	Sat. vapor, <i>h</i> _g	Sat. liquid, <i>s</i> _f	Evap., <i>s</i> _{fg}	Sat. vapor, <i>s</i> _g
1.0	6.97	0.001000	129.19	29.302	2355.2	2384.5	29.303	2484.4	2513.7	0.1059	8.8690	8.9749
1.5	13.02	0.001001	87.964	54.686	2338.1	2392.8	54.688	2470.1	2524.7	0.1956	8.6314	8.8270
2.0	17.50	0.001001	66.990	73.431	2325.5	2398.9	73.433	2459.5	2532.9	0.2606	8.4621	8.7227
2.5	21.08	0.001002	54.242	88.422	2315.4	2403.8	88.424	2451.0	2539.4	0.3118	8.3302	8.6421
3.0	24.08	0.001003	45.654	100.98	2306.9	2407.9	100.98	2443.9	2544.8	0.3543	8.2222	8.5765
4.0	28.96	0.001004	34.791	121.39	2293.1	2414.5	121.39	2432.3	2553.7	0.4224	8.0510	8.4734
5.0	32.87	0.001005	28.185	137.75	2282.1	2419.8	137.75	2423.0	2560.7	0.4762	7.9176	8.3938
7.5	40.29	0.001008	19.233	168.74	2261.1	2429.8	168.75	2405.3	2574.0	0.5763	7.6738	8.2501
10	45.81	0.001010	14.670	191.79	2245.4	2437.2	191.81	2392.1	2583.9	0.6492	7.4996	8.1488
15	53.97	0.001014	10.020	225.93	2222.1	2448.0	225.94	2372.3	2598.3	0.7549	7.2522	8.0071
20	60.06	0.001017	7.6481	251.40	2204.6	2456.0	251.42	2357.5	2608.9	0.8320	7.0752	7.9073
25	64.96	0.001020	6.2034	271.93	2190.4	2462.4	271.96	2345.5	2617.5	0.8932	6.9370	7.8302
30	69.09	0.001022	5.2287	289.24	2178.5	2467.7	289.27	2335.3	2624.6	0.9441	6.8234	7.7675
40	75.86	0.001026	3.9933	317.58	2158.8	2476.3	317.62	2318.4	2636.1	1.0261	6.6430	7.6691
50	81.32	0.001030	3.2403	340.49	2142.7	2483.2	340.54	2304.7	2645.2	1.0912	6.5019	7.5931
75	91.76	0.001037	2.2172	384.36	2111.8	2496.1	384.44	2278.0	2662.4	1.2132	6.2426	7.4558
100	99.61	0.001043	1.6941	417.40	2088.2	2505.6	417.51	2257.5	2675.0	1.3028	6.0562	7.3589
101.325	99.97	0.001043	1.6734	418.95	2087.0	2506.0	419.06	2256.5	2675.6	1.3069	6.0476	7.3545
125	105.97	0.001048	1.3750	444.23	2068.8	2513.0	444.36	2240.6	2684.9	1.3741	5.9100	7.2841
150	111.35	0.001053	1.1594	466.97	2052.3	2519.2	467.13	2226.0	2693.1	1.4337	5.7894	7.2231
175	116.04	0.001057	1.0037	486.82	2037.7	2524.5	487.01	2213.1	2700.2	1.4850	5.6865	7.1716
200	120.21	0.001061	0.88578	504.50	2024.6	2529.1	504.71	2201.6	2706.3	1.5302	5.5968	7.1270
225	123.97	0.001064	0.79329	520.47	2012.7	2533.2	520.71	2191.0	2711.7	1.5706	5.5171	7.0877
250	127.41	0.001067	0.71873	535.08	2001.8	2536.8	535.35	2181.2	2716.5	1.6072	5.4453	7.0525
275	130.58	0.001070	0.65732	548.57	1991.6	2540.1	548.86	2172.0	2720.9	1.6408	5.3800	7.0207
300	133.52	0.001073	0.60582	561.11	1982.1	2543.2	561.43	2163.5	2724.9	1.6717	5.3200	6.9917
325	136.27	0.001076	0.56199	572.84	1973.1	2545.9	573.19	2155.4	2728.6	1.7005	5.2645	6.9650
350	138.86	0.001079	0.52422	583.89	1964.6	2548.5	584.26	2147.7	2732.0	1.7274	5.2128	6.9402
375	141.30	0.001081	0.49133	594.32	1956.6	2550.9	594.73	2140.4	2735.1	1.7526	5.1645	6.9171
400	143.61	0.001084	0.46242	604.22	1948.9	2553.1	604.66	2133.4	2738.1	1.7765	5.1191	6.8955
450	147.90	0.001088	0.41392	622.65	1934.5	2557.1	623.14	2120.3	2743.4	1.8205	5.0356	6.8561
500	151.83	0.001093	0.37483	639.54	1921.2	2560.7	640.09	2108.0	2748.1	1.8604	4.9603	6.8207
550	155.46	0.001097	0.34261	655.16	1908.8	2563.9	655.77	2096.6	2752.4	1.8970	4.8916	6.7886
600	158.83	0.001101	0.31560	669.72	1897.1	2566.8	670.38	2085.8	2756.2	1.9308	4.8285	6.7593
650	161.98	0.001104	0.29260	683.37	1886.1	2569.4	684.08	2075.5	2759.6	1.9623	4.7699	6.7322
700	164.95	0.001108	0.27278	696.23	1875.6	2571.8	697.00	2065.8	2762.8	1.9918	4.7153	6.7071
750	167.75	0.001111	0.25552	708.40	1865.6	2574.0	709.24	2056.4	2765.7	2.0195	4.6642	6.6837

TABLE A-13

Superheated refrigerant-134a (Continued)

T °C	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K
$P = 0.50 \text{ MPa } (T_{\text{sat}} = 15.71^\circ\text{C})$					$P = 0.60 \text{ MPa } (T_{\text{sat}} = 21.55^\circ\text{C})$				$P = 0.70 \text{ MPa } (T_{\text{sat}} = 26.69^\circ\text{C})$			
Sat.	0.041118	238.75	259.30	0.9240	0.034295	241.83	262.40	0.9218	0.029361	244.48	265.03	0.9199
20	0.042115	242.40	263.46	0.9383								
30	0.044338	250.84	273.01	0.9703	0.035984	249.22	270.81	0.9499	0.029966	247.48	268.45	0.9313
40	0.046456	259.26	282.48	1.0011	0.037865	257.86	280.58	0.9816	0.031696	256.39	278.57	0.9641
50	0.048499	267.72	291.96	1.0309	0.039659	266.48	290.28	1.0121	0.033322	265.20	288.53	0.9954
60	0.050485	276.25	301.50	1.0599	0.041389	275.15	299.98	1.0417	0.034875	274.01	298.42	1.0256
70	0.052427	284.89	311.10	1.0883	0.043069	283.89	309.73	1.0705	0.036373	282.87	308.33	1.0549
80	0.054331	293.64	320.80	1.1162	0.044710	292.73	319.55	1.0987	0.037829	291.80	318.28	1.0835
90	0.056205	302.51	330.61	1.1436	0.046318	301.67	329.46	1.1264	0.039250	300.82	328.29	1.1114
100	0.058053	311.50	340.53	1.1705	0.047900	310.73	339.47	1.1536	0.040642	309.95	338.40	1.1389
110	0.059880	320.63	350.57	1.1971	0.049458	319.91	349.59	1.1803	0.042010	319.19	348.60	1.1658
120	0.061687	329.89	360.73	1.2233	0.050997	329.23	359.82	1.2067	0.043358	328.55	358.90	1.1924
130	0.063479	339.29	371.03	1.2491	0.052519	338.67	370.18	1.2327	0.044688	338.04	369.32	1.2186
140	0.065256	348.83	381.46	1.2747	0.054027	348.25	380.66	1.2584	0.046004	347.66	379.86	1.2444
150	0.067021	358.51	392.02	1.2999	0.055522	357.96	391.27	1.2838	0.047306	357.41	390.52	1.2699
160	0.068775	368.33	402.72	1.3249	0.057006	367.81	402.01	1.3088	0.048597	367.29	401.31	1.2951
$P = 0.80 \text{ MPa } (T_{\text{sat}} = 31.31^\circ\text{C})$					$P = 0.90 \text{ MPa } (T_{\text{sat}} = 35.51^\circ\text{C})$				$P = 1.00 \text{ MPa } (T_{\text{sat}} = 39.37^\circ\text{C})$			
Sat.	0.025621	246.79	267.29	0.9183	0.022683	248.85	269.26	0.9169	0.020313	250.68	270.99	0.9156
40	0.027035	254.82	276.45	0.9480	0.023375	253.13	274.17	0.9327	0.020406	251.30	271.71	0.9179
50	0.028547	263.86	286.69	0.9802	0.024809	262.44	284.77	0.9660	0.021796	260.94	282.74	0.9525
60	0.029973	272.83	296.81	1.0110	0.026146	271.60	295.13	0.9976	0.023068	270.32	293.38	0.9850
70	0.031340	281.81	306.88	1.0408	0.027413	280.72	305.39	1.0280	0.024261	279.59	303.85	1.0160
80	0.032659	290.84	316.97	1.0698	0.028630	289.86	315.63	1.0574	0.025398	288.86	314.25	1.0458
90	0.033941	299.95	327.10	1.0981	0.029806	299.06	325.89	1.0860	0.026492	298.15	324.64	1.0748
100	0.035193	309.15	337.30	1.1258	0.030951	308.34	336.19	1.1140	0.027552	307.51	335.06	1.1031
110	0.036420	318.45	347.59	1.1530	0.032068	317.70	346.56	1.1414	0.028584	316.94	345.53	1.1308
120	0.037625	327.87	357.97	1.1798	0.033164	327.18	357.02	1.1684	0.029592	326.47	356.06	1.1580
130	0.038813	337.40	368.45	1.2061	0.034241	336.76	367.58	1.1949	0.030581	336.11	366.69	1.1846
140	0.039985	347.06	379.05	1.2321	0.035302	346.46	378.23	1.2210	0.031554	345.85	377.40	1.2109
150	0.041143	356.85	389.76	1.2577	0.036349	356.28	389.00	1.2467	0.032512	355.71	388.22	1.2368
160	0.042290	366.76	400.59	1.2830	0.037384	366.23	399.88	1.2721	0.033457	365.70	399.15	1.2623
170	0.043427	376.81	411.55	1.3080	0.038408	376.31	410.88	1.2972	0.034392	375.81	410.20	1.2875
180	0.044554	386.99	422.64	1.3327	0.039423	386.52	422.00	1.3221	0.035317	386.04	421.36	1.3124
$P = 1.20 \text{ MPa } (T_{\text{sat}} = 46.29^\circ\text{C})$					$P = 1.40 \text{ MPa } (T_{\text{sat}} = 52.40^\circ\text{C})$				$P = 1.60 \text{ MPa } (T_{\text{sat}} = 57.88^\circ\text{C})$			
Sat.	0.016715	253.81	273.87	0.9130	0.014107	256.37	276.12	0.9105	0.012123	258.47	277.86	0.9078
50	0.017201	257.63	278.27	0.9267								
60	0.018404	267.56	289.64	0.9614	0.015005	264.46	285.47	0.9389	0.012372	260.89	280.69	0.9163
70	0.019502	277.21	300.61	0.9938	0.016060	274.62	297.10	0.9733	0.013430	271.76	293.25	0.9535
80	0.020529	286.75	311.39	1.0248	0.017023	284.51	308.34	1.0056	0.014362	282.09	305.07	0.9875
90	0.021506	296.26	322.07	1.0546	0.017923	294.28	319.37	1.0364	0.015215	292.17	316.52	1.0194
100	0.022442	305.80	332.73	1.0836	0.018778	304.01	330.30	1.0661	0.016014	302.14	327.76	1.0500
110	0.023348	315.38	343.40	1.1118	0.019597	313.76	341.19	1.0949	0.016773	312.07	338.91	1.0795
120	0.024228	325.03	354.11	1.1394	0.020388	323.55	352.09	1.1230	0.017500	322.02	350.02	1.1081
130	0.025086	334.77	364.88	1.1664	0.021155	333.41	363.02	1.1504	0.018201	332.00	361.12	1.1360
140	0.025927	344.61	375.72	1.1930	0.021904	343.34	374.01	1.1773	0.018882	342.05	372.26	1.1632
150	0.026753	354.56	386.66	1.2192	0.022636	353.37	385.07	1.2038	0.019545	352.17	383.44	1.1900
160	0.027566	364.61	397.69	1.2449	0.023355	363.51	396.20	1.2298	0.020194	362.38	394.69	1.2163
170	0.028367	374.78	408.82	1.2703	0.024061	373.75	407.43	1.2554	0.020830	372.69	406.02	1.2421
180	0.029158	385.08	420.07	1.2954	0.024757	384.10	418.76	1.2807	0.021456	383.11	417.44	1.2676

Diwedd/End