ARE 346P/CE 389H
HVAC Design Midterm Exam II November 15, 2018

Answer the questions in the spaces provided on the question sheets. Additional empty pages as well as Tables and charts that you may need are provided at the end.

Note: From the two questions the best one will count, i.e., both questions will be corrected and the best result will count towards your total.

SHOW ALL YOUR WORK

Open book
Open notes
no tablet/laptops/communication

Name: _____

UT EID: _____

Question	Points	Score
Heat Exchangers	30	
Duct Design	30	
Total:	60	

Question 1: Heat Exchangers . . . . . 30 points

Moist air at 2 m^3/s, 21 °C dry-bulb temperature, 13 °C wet-bulb temperature, a pressure of 101.325 kPa is heated to 40 °C by condensing refrigerant-22 at a pressure of 1.942 MPa. The refrigerant enters as saturated vapor and leaves as saturated liquid. The refrigerant is mixed, the air is unmixed. Sketch the heat exchanger schematically (as in the HW assignments) and label (1) air entry, (2) air exit, (A) R-22 entry, and (B) R-22 exit. Use the labels as subscripts in your calculations. Determine:

5 (a) the mass flow rate of refrigerant required (kg/s)

5 (b) the value of NTU

5 (c) the overall conductance of the heat exchanger (UA)

5 (d) the correction factor F

5 (e) the logarithmic mean temperature difference (LMTD), and

5 (f) the heating capacity of the heat exchanger (kW)

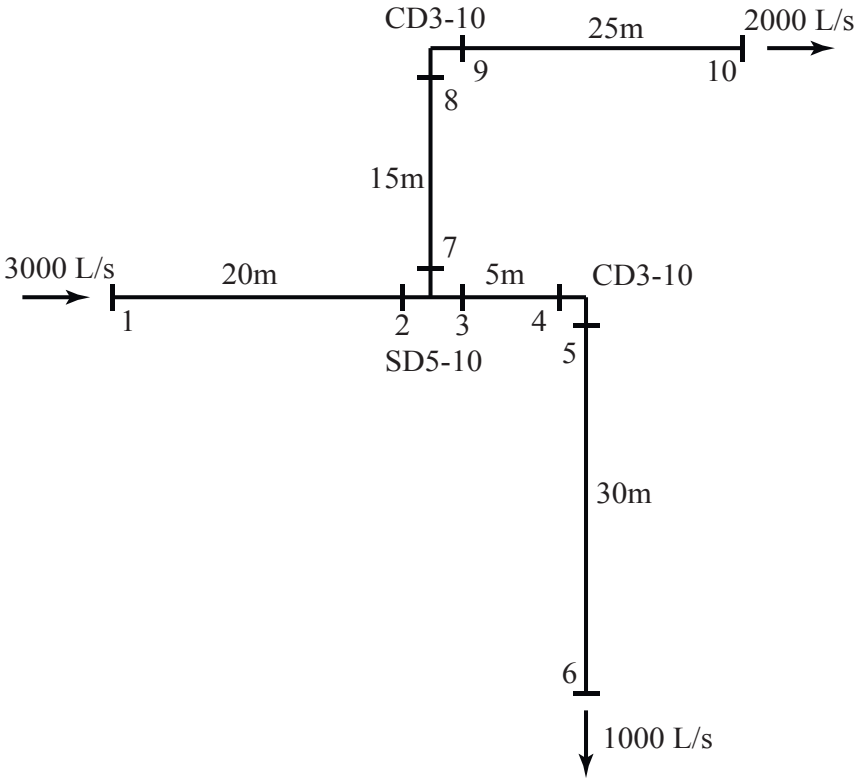
Use the psychrometric chart from Question 3 to determine necessary quantities.

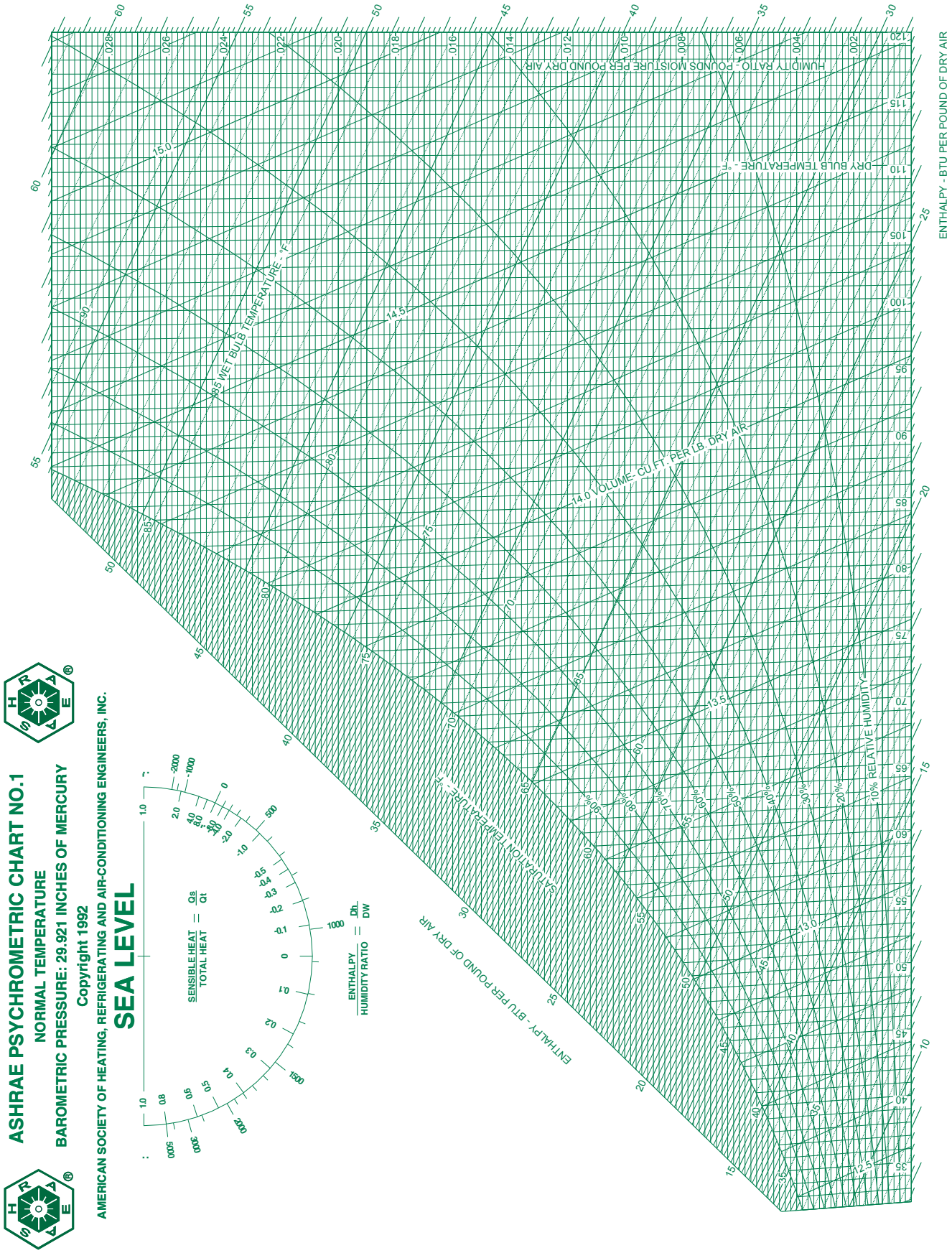
Use the following constants where necessary:

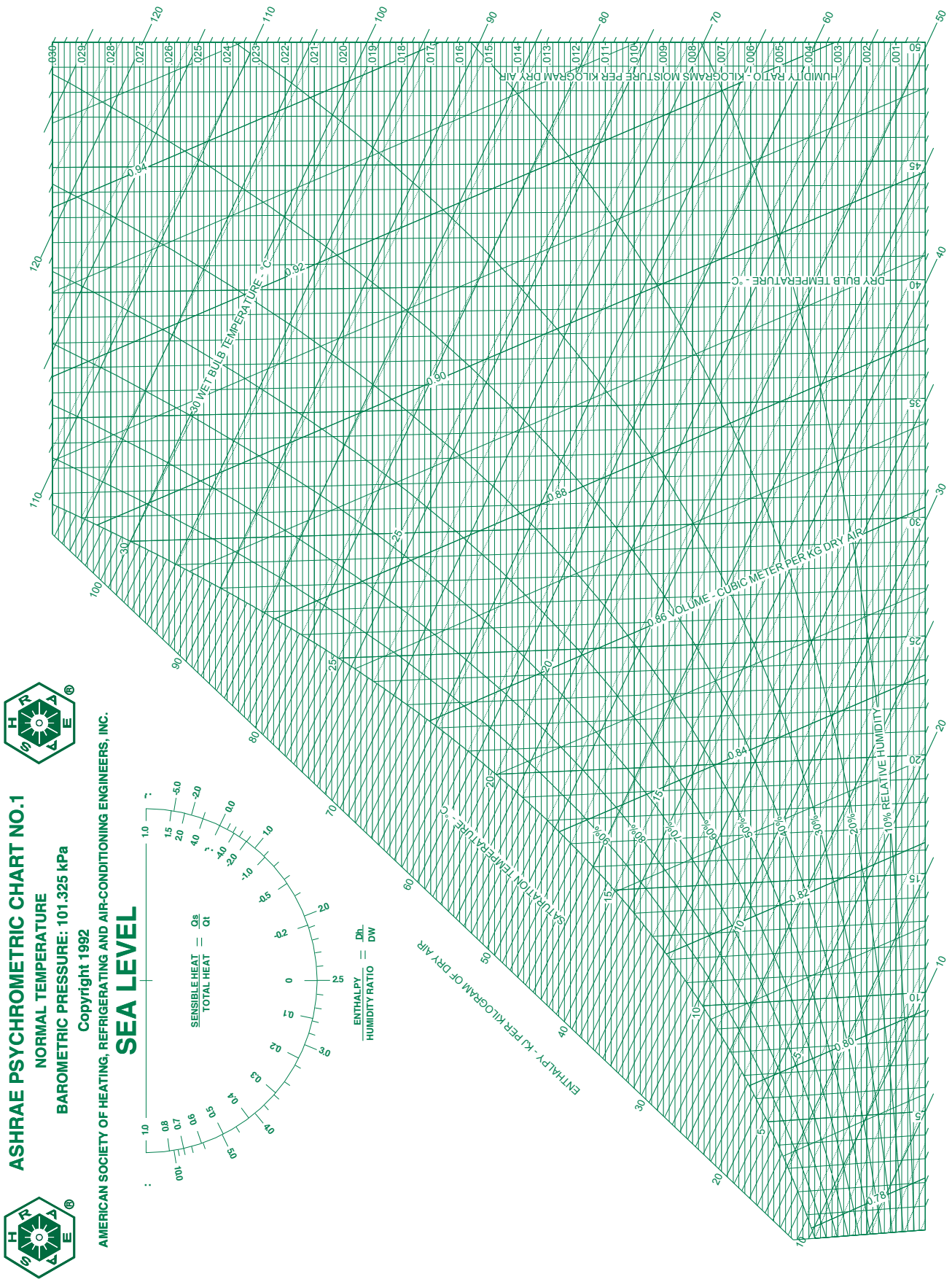
$c_a = 1.0$ kJ/kg$_a$°C

$c_{pw} = 1.86$ kJ/kg$_w$°C

Question 2: Duct Design . . . . . 30 points
Size the supply-duct system shown in the following Figure using round ducts. Specify the total pressure needed at location 1 for this system if the diffusers both have a total pressure loss of 12 Pa. If necessary, balance the system using the equal friction method.




ASHRAE PSYCHROMETRIC CHART NO.1
NORMAL TEMPERATURE
BAROMETRIC PRESSURE: 29.921 INCHES OF MERCURY
Copyright 1992
AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.
SEA LEVEL
SENSIBLE HEAT / TOTAL HEAT = Qs/Qt
ENTHALPY / HUMIDITY RATIO = Dh/DW
DRY BULB TEMPERATURE - °F
WET BULB TEMPERATURE - °F
HUMIDITY RATIO - POUNDS MOISTURE PER POUND DRY AIR
ENTHALPY - BTU PER POUND OF DRY AIR
ENTHALPY - BTU PER POUND OF DRY AIR
10% RELATIVE HUMIDITY
14.0 VOLUME- CU.FT. PER LB. DRY AIR


ASHRAE PSYCHROMETRIC CHART NO.1
NORMAL TEMPERATURE
BAROMETRIC PRESSURE: 101.325 kPa
Copyright 1992
AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.
SEA LEVEL
DRY BULB TEMPERATURE - °C
HUMIDITY RATIO - KILOGRAMS MOISTURE PER KILOGRAM DRY AIR
ENTHALPY - KJ PER KILOGRAM OF DRY AIR
ENTHALPY - KJ PER KILOGRAM DRY AIR
WET BULB TEMPERATURE - °C
VOLUME - CUBIC METER PER KG DRY AIR
10% RELATIVE HUMIDITY
SENSIBLE HEAT / TOTAL HEAT = Qs/Qt
ENTHALPY / HUMIDITY RATIO = Dh/DW

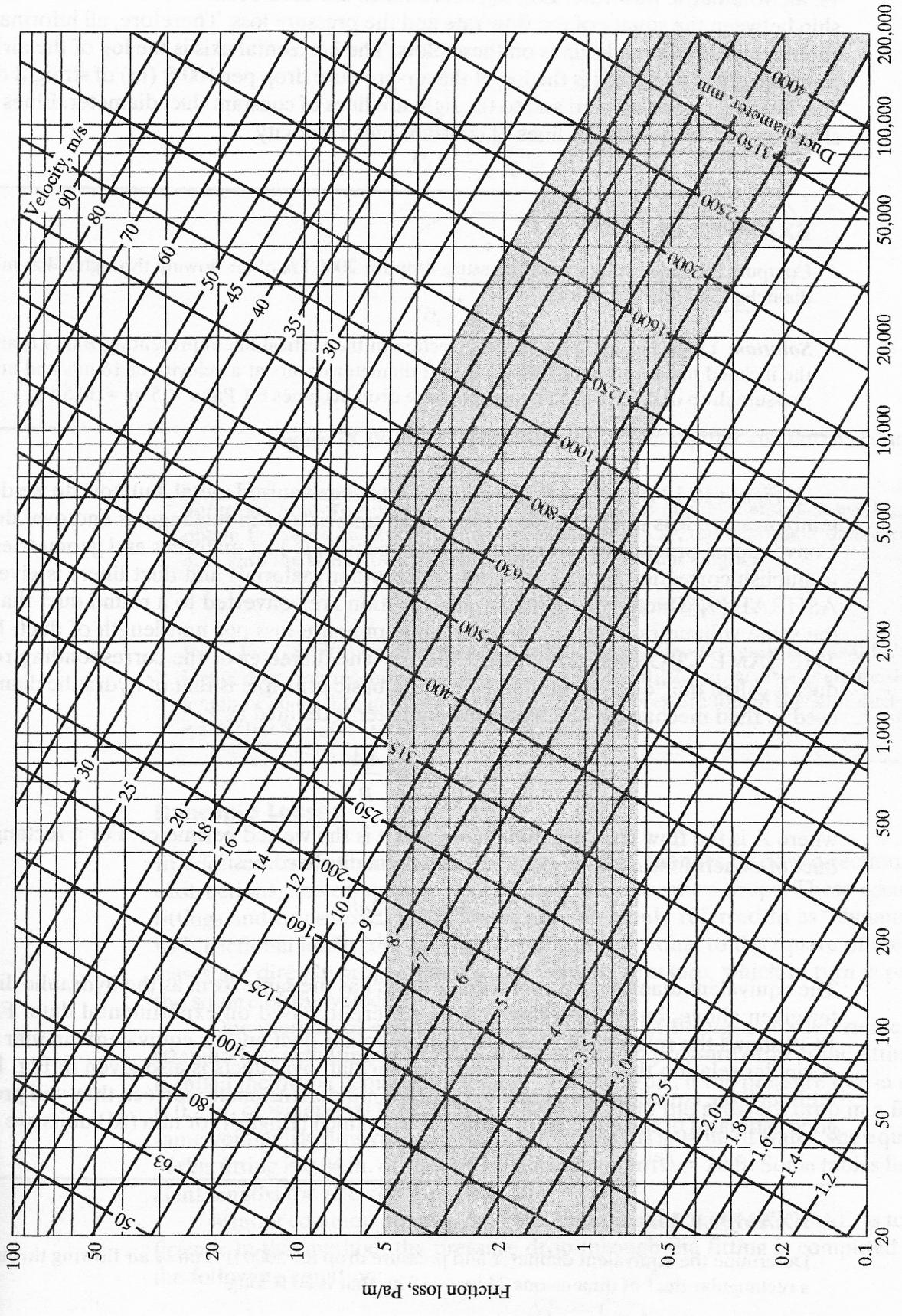
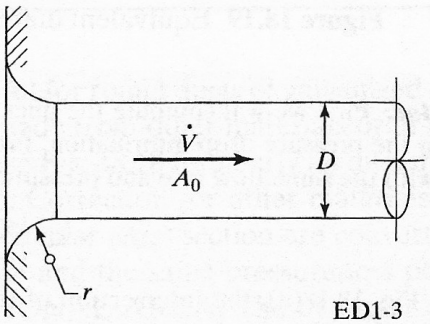


Figure 18.18b Pressure loss in typical round galvanized sheet-metal ducts.
[Reprinted by permission from *ASHRAE Fundamentals 1993* (SI), p. 32.6.]

TABLE 18.6 Total Pressure-Loss Coefficients for Bell-Mouth Inlet to a Round Duct

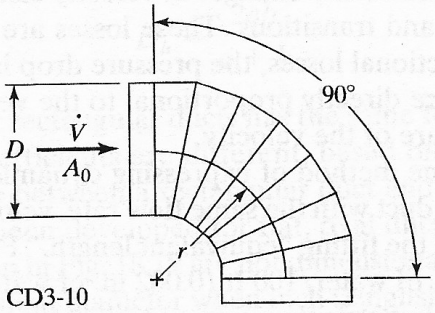


ED1-3

r/D	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.08	0.10	0.12	0.16	0.20	10.00
C_o	0.50	0.44	0.37	0.31	0.26	0.22	0.20	0.15	0.12	0.09	0.06	0.03	0.03

SOURCE: Reprinted by permission from *ASHRAE Duct Fitting Database, 1994.*

TABLE 18.7 Total Pressure-Loss Coefficients for a 90-deg Pleated Elbow in a Round Duct, 7 Sections, $r/D = 2.5$

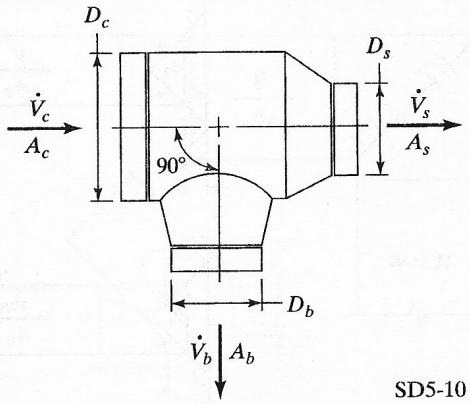


CD3-10

D, in. (mm)	3(75)	6(150)	9(230)	12(300)	15(380)	18(450)	27(690)	60(1500)
C_o	0.16	0.12	0.10	0.08	0.07	0.06	0.05	0.03

SOURCE: Reprinted by permission from *ASHRAE Duct Fitting Database, 1994.*

TABLE 18.8 Total Pressure-Loss Coefficients for Diverging Tee in a Round Duct with a Conical Branch Tapered into the Body



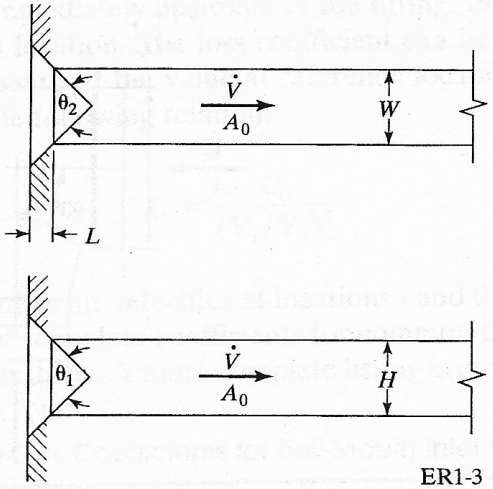
SD5-10

	C_b								
$\dot{V}_b/\dot{V}_c$ =	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
A_b/A_c									
0.1	0.65	0.24							
0.2	2.98	0.65	0.33	0.24	0.18				
0.3	7.36	1.56	0.65	0.39	0.29	0.24	0.20		
0.4	13.78	2.98	1.20	0.65	0.43	0.33	0.27	0.24	0.21
0.5	22.24	4.92	1.98	1.04	0.65	0.47	0.36	0.30	0.26
0.6	32.73	7.36	2.98	1.56	0.96	0.65	0.49	0.39	0.33
0.7	45.26	10.32	4.21	2.21	1.34	0.90	0.65	0.51	0.42
0.8	59.82	13.78	5.67	2.98	1.80	1.20	0.86	0.65	0.52
0.9	76.41	17.75	7.36	3.88	2.35	1.56	1.11	0.83	0.65

	C_s								
$\dot{V}_s/\dot{V}_c$ =	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
A_s/A_c									
0.1	0.13	0.16							
0.2	0.20	0.13	0.15	0.16	0.28				
0.3	0.90	0.13	0.13	0.14	0.15	0.16	0.20		
0.4	2.88	0.20	0.14	0.13	0.14	0.15	0.15	0.16	0.34
0.5	6.25	0.37	0.17	0.14	0.13	0.14	0.14	0.15	0.15
0.6	11.88	0.90	0.20	0.13	0.14	0.13	0.14	0.14	0.15
0.7	18.62	1.71	0.33	0.18	0.16	0.14	0.13	0.15	0.14
0.8	26.88	2.88	0.50	0.20	0.15	0.14	0.13	0.13	0.14
0.9	36.45	4.46	0.90	0.30	0.19	0.16	0.15	0.14	0.13

SOURCE: Reprinted by permission from *ASHRAE Duct Fitting Database, 1994.*

TABLE 18.9 Total Pressure-Loss Coefficients for a Conical Bell-Mouth Inlet to a Rectangular Duct

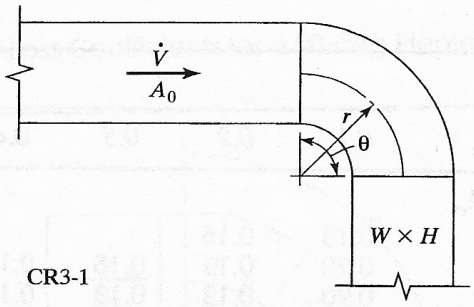


ER1-3

	C_o								
Theta =	*0*	*10*	*20*	*30*	*40*	*60*	*100*	*140*	*180*
L/D_h									
0.025	0.50	0.47	0.45	0.43	0.41	0.40	0.42	0.45	0.50
0.050	0.50	0.45	0.41	0.36	0.33	0.30	0.35	0.42	0.50
0.075	0.50	0.42	0.35	0.30	0.26	0.23	0.30	0.40	0.50
0.100	0.50	0.39	0.32	0.25	0.22	0.18	0.27	0.38	0.50
0.150	0.50	0.37	0.27	0.20	0.16	0.15	0.25	0.37	0.50
0.600	0.50	0.27	0.18	0.13	0.11	0.12	0.23	0.36	0.50

SOURCE: Reprinted by permission from *ASHRAE Duct Fitting Database, 1994.*

TABLE 18.10 Total Pressure-Loss Coefficients for a 90 deg Elbow in a Rectangular Duct



CR3-1

	C_p										
H/W =	*0.25*	*0.50*	*0.75*	*1.00*	*1.50*	*2.00*	*3.00*	*4.00*	*5.00*	*6.00*	*8.00*
r/W											
0.50	1.53	1.38	1.29	1.18	1.06	1.00	1.00	1.06	1.12	1.16	1.18
0.75	0.57	0.52	0.48	0.44	0.40	0.39	0.39	0.40	0.42	0.43	0.44
1.00	0.27	0.25	0.23	0.21	0.19	0.18	0.18	0.19	0.20	0.21	0.21
1.50	0.22	0.20	0.19	0.17	0.15	0.14	0.14	0.15	0.16	0.17	0.17
2.00	0.20	0.18	0.16	0.15	0.14	0.13	0.13	0.14	0.14	0.15	0.15

SOURCE: Reprinted by permission from *ASHRAE Duct Fitting Database, 1994.*