BACHELOR OF CHEMICAL ENGINEERING EXAMINATION, 2024

(2nd Year, 1st Semester)

CHEMICAL PROCESS PRINCIPLES

Time : Three hours | Full Marks : 100

(Attempt all questions)

		Marks
	CO1	
Q1	Do solve the followings: (i) Convert the 67 PSI to Pa (ii) Convert the 14.7 atm to Pa (iii) Convert the 54 PSF to atm (iv) Convert pressure of 1 mm H2O to Pa (v) Convert the poundal to N	5×3=15
	CO3	
Q2	An experiment on the growth rate of certain organisms requires an environment of humid air enriched in oxygen. Three input streams are fed into an evaporation chamber to produce an output stream with the desired composition. A: Liquid water, fed at a rate of 20.0 cm /min B: Air (21 mole% O , the balance N) C: Pure oxygen, with a molar flow rate one-fifth of the molar flow rate of stream B The output gas is analyzed and is found to contain 1.5 mole% water. Draw and label a flowchart of the process, do degrees of freedom analysis and calculate all unknown stream variables.	15
Q3	Elaborate the followings: (i) Wet-bulb temperature and dry-bulb temperature (ii) Degree of freedom	5×2=10
	CO4	
Q4	Assuming ideal gas behavior, calculate the heat that must be transferred in each of the following cases. (i) A stream of nitrogen flowing at a rate of 100 mol/min is heated from 20 °C to 100 °C. (ii) Nitrogen contained in a 5-liter flask at an initial pressure of 3 bar is cooled from 80 °C to 20 °C	15
Q5	One hundred g-moles per hour of liquid -hexane at 30 °C and 7 bar is vaporized and heated to 250 °C at constant pressure. Neglecting the effect of pressure on enthalpy, estimate the rate at which heat must be supplied.	20
	CO5	
Q6	Air at 75 °F and 75% relative humidity is cooled to 56 °F at a constant pressure of 1 atm. Use the psychrometric chart to calculate the fraction of the water that condenses and the rate at which heat must be removed to deliver 1000 ft^3/min of humid air at the final condition.	25

[Turn over

Properties Table

Table B.1: Selected Physical Property Data

Compound	Formula	Mol. Wt.	SG (20° /4°)	$T_m(°C)^b$	$\Delta\hat{H}_m(T_m)^c$ kJ/mol	$T_b(°C)^d$	$\Delta\hat{H}_V(T_b)^{e,j}$ kJ/mol	$T_C(K)^f$	$P_C(atm$	$(\Delta H_f^o)^{h,j}$ kJ/mol	$(\Delta H_c^o)^{i,j}$ kJ/mol
N-Hexane	C_6H_{14}	86.17	0.659	– 95.32	13.03	68.74	28.85	507.9	29.9	– 198.8(l) – 167.2(g)	– 4163.1(l) – 4194.8(g)
Nitrogen	N_2	28.02	-----	– 210.0	0.720	– 195.8	5.577	126.20	33.5	0 (g)	--------

Table B.2: Heat Capacities

Compound	Formula	Mol. Wt.	State	*Form*	*Temp Unit*	a×10³	b×10⁵	c×10⁸	d×10¹²	Range (Units of T)
N-Hexane	C_6H_{14}	86.17	L g	1 1	°C °C	216.3 137.44	--- 40.85	----- – 23.92	---- 57.66	20–100 0–1200
Nitrogen	N_2	28.02	g	1	°C	29.00	0.2199	0.5723	– 2.871	0–1500

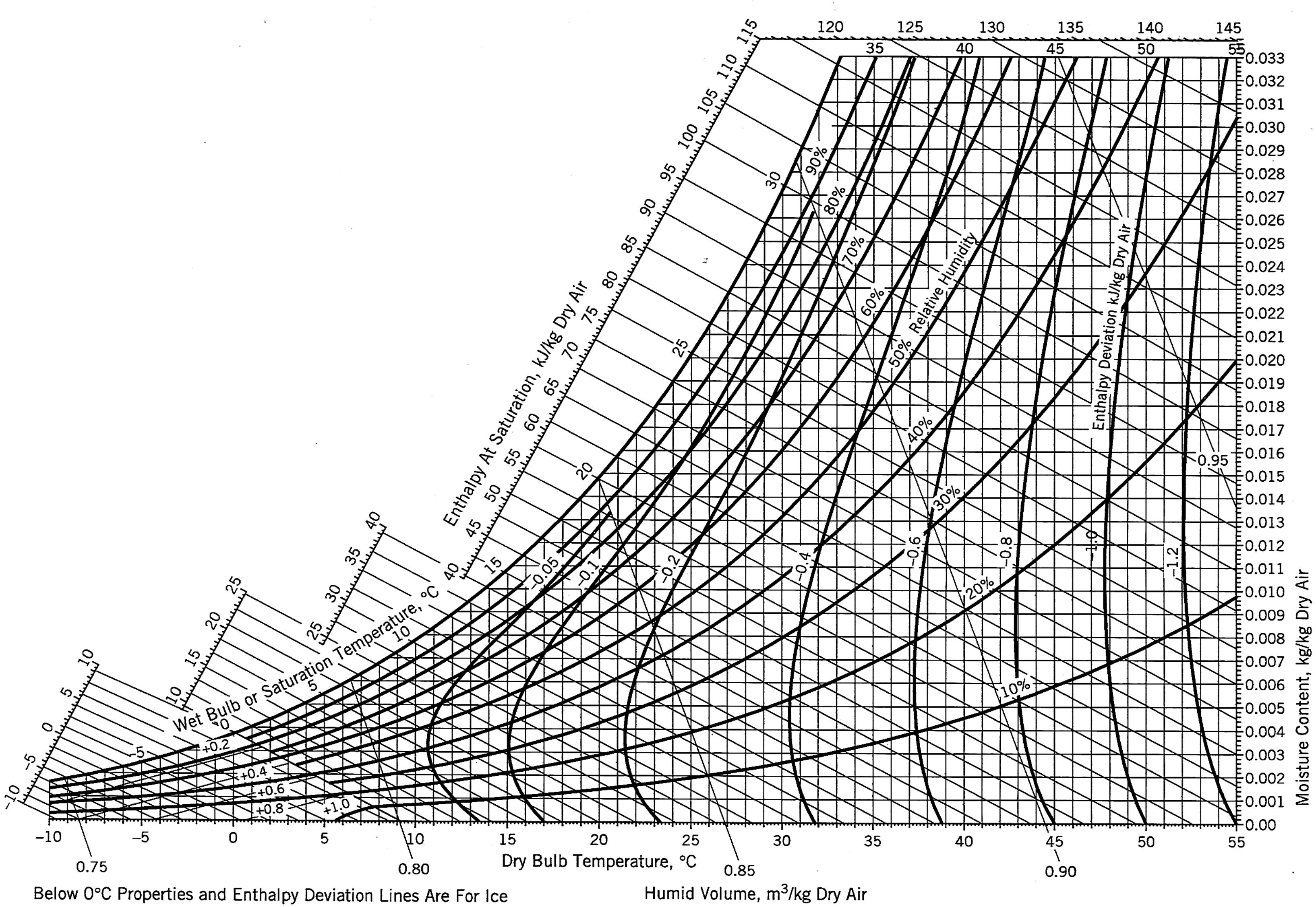

Figure 8.4-1 Psychrometric chart—SI units. Reference states: H_2O (L, 0°C, 1 atm), dry air (0°C, 1 atm). (Reprinted with permission of Carrier Corporation.)

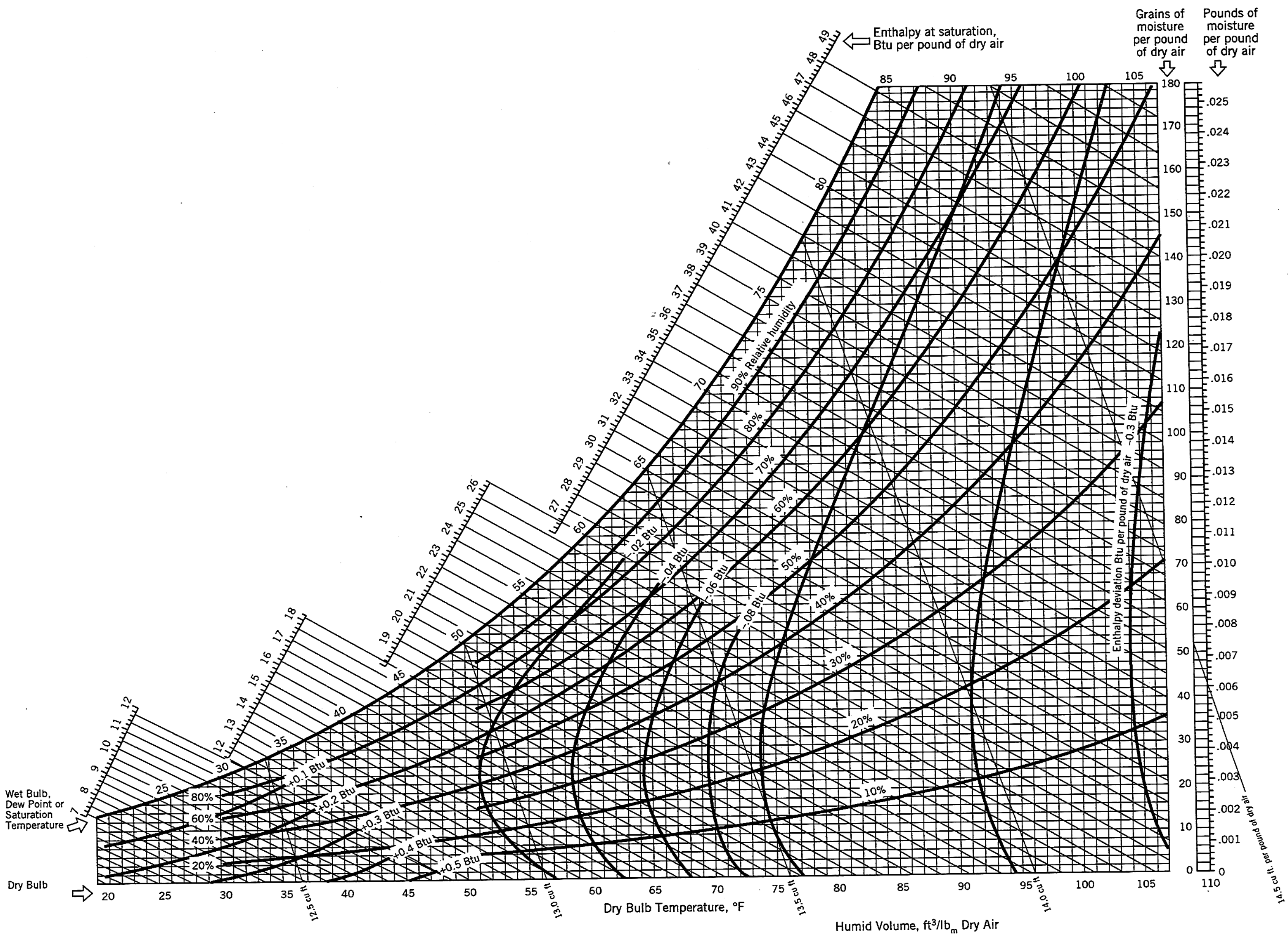

Figure 8.4-2 Psychrometric chart—American Engineering units. Reference states: H_2O (L, 32°F, 1 atm), dry air (0°F, 1 atm). (Reprinted with permission of Carrier Corporation.)