Calculations

Q_{in} = 72,000 Btu/hr ☆ All values found and labelled on the chart Below ☆

Maintain 75°F

outdoor = 90°F

outdoor = 100%

Part A) $Q_{in} = m_a(h_3 - h_2)$

$72000 = m_a(28 - 23.2)$

$\frac{72000}{4.8} = m_a\frac{(4.8)}{4.8}$

15,000 lb/hr = m_a

m_a = 250 lb/min

$m_a = \frac{V}{v_1}$ = 250 = $V/13.8 \cdot 13.8$

250 · 13.8 = V

V = 3450 CFM

Part B) $m_s = \frac{V}{v_s}$ = m_s = 500/13.8

V = 500 CFM

m_s = 36.23 lb/min

$m_4 = m_3 - m_s$ = 250 - 36.23

m_4 = 213.77

$m_o = \frac{V}{v_1}$ = 500/14.5 = 34.48 lb/min = m_o

$m_1 = m_4 + m_o$ = m_1 = 213.77 + 34.48

m_1 = 248.25 lb/min

Now $m_4h_4 + m_oh_o = m_1h_1$

$(213.77)(28) + (34.48)(42.5) = 248.25\, h_1$

$5985.56 + 1465.4 = 248.25\, h_1$

continued

$5985.56 + 1465.4 = 248.25\, h_1$

$$\frac{7450.96}{248.25} = \frac{248.25\, h_1}{248.25}$$

$$\boxed{h_1 = 30.01}$$

State	Dry Bulb Temp	Humidity Ratio
0	90	60 %
1	77	53 %
1',2	55	100 %
3,4,5	75	50 %

Part D) Cooling Capacity for dehumidifying unit

$$Q_{CD} = m_1 (h_1 - h_{1'})$$

$$Q_{CD} = 248.25 (30.01 - 23.8)$$

$$\boxed{Q_{CD} = 1541.63 \text{ Btu/min}}$$

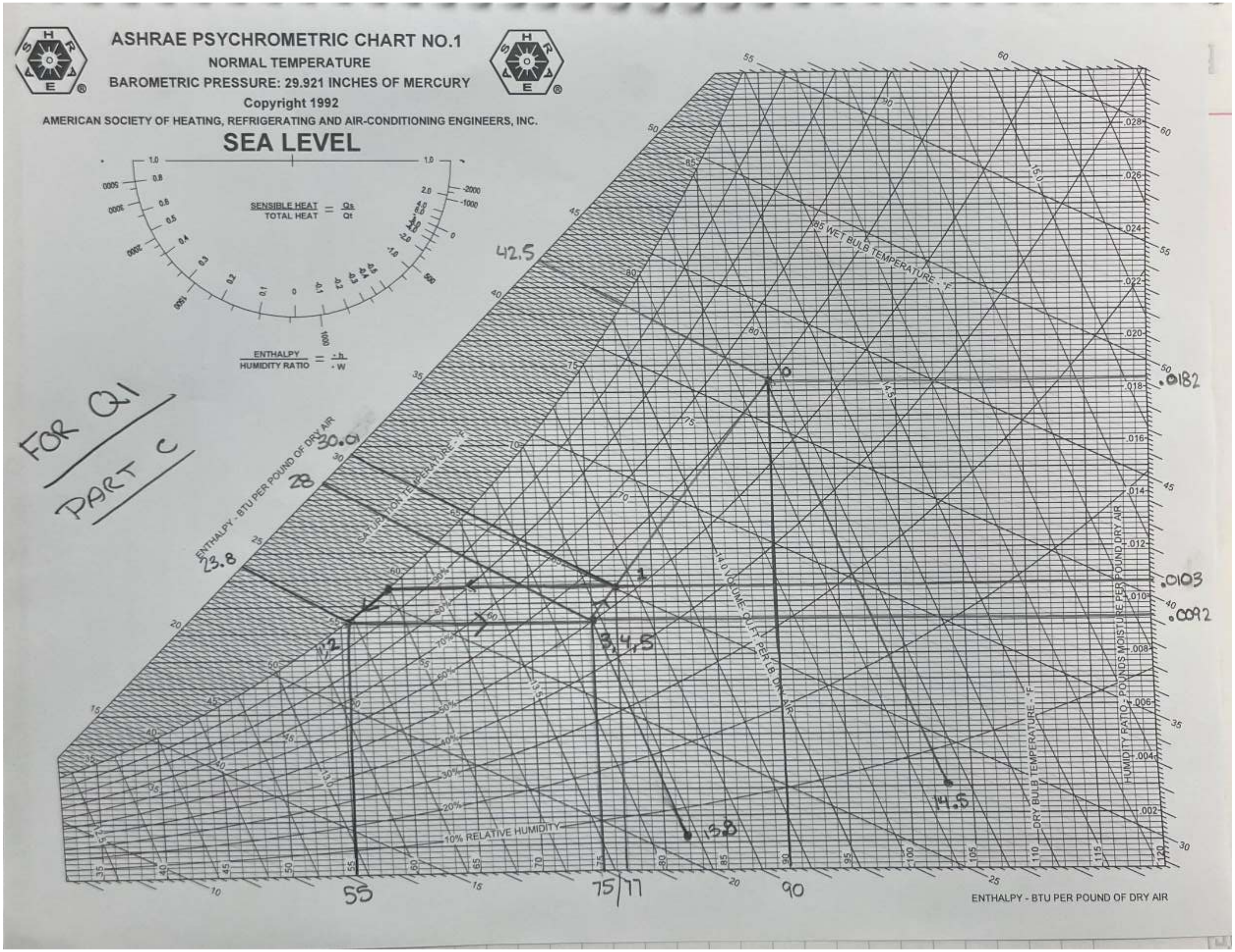
Part E) amount of liquid (from chart)

$$m_w = m_1 (\omega_1 - \omega_{1'})$$

$$m_w = 248.25 (.0103 - .0092)$$

$$m_w = 248.25 (.0011)$$

$$\boxed{m_w = .273 \text{ lb/min}}$$


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 = Δh / ΔW
ENTHALPY - BTU PER POUND OF DRY AIR
SATURATION TEMPERATURE - °F
85 WET BULB TEMPERATURE - °F
14.0 VOLUME - CU.FT. PER LB. DRY AIR
10% RELATIVE HUMIDITY
DRY BULB TEMPERATURE - °F
HUMIDITY RATIO - POUNDS MOISTURE PER POUND DRY AIR
ENTHALPY - BTU PER POUND OF DRY AIR
FOR Q1
PART C
42.5
30.01
28
23.8
1,2
3,4,5
0
.0182
.0103
.0092
13.8
14.5
55
75
77
90

Summary → for this problem we showed that we understood cooling and dehumidifying system. We were able to use the charts and equations in order to find the quanity of air supply, the states at each point, the required capacity, of the cooling and dehumidifying unit. With that being said in order to find the correct values you must correctly do the chart.

Analysis → After find the chart states we were able to gather all the data needed in order to find the correct answers. In order to find mass flow we needed to use points on the chart. After that most equations were plug in chug.

2) **Purpose:** The purpose of this question is to determine: The operating pressure of the evaporator & the condenser, the state of the refrigerant after each of the elements of the vapor-compression refrigeration cycle w/ refrigerant R-134a, P-v & T-s diagrams, COP of the cycle, refrigerant mass flow rate, power required by the compressor, and waste heat rate.

Sources: Cengel, Boles, "Thermodynamics - An Engineering Approach", 8th Edition, McGraw Hill 2015

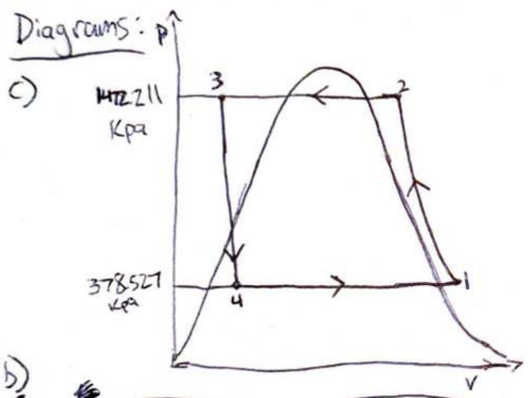
Design Considerations: Refrigerant properties, [redacted] turbine works isenthropically

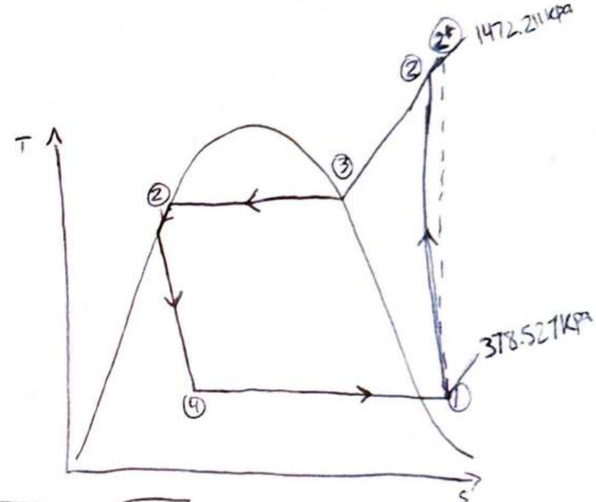
Data & Variables: Conventional air conditioning rating conditions: Evaporating temp = 7.22°C, Condensing temp = 54.4°C
operating presure of evaporator = 378.527 Kpa, operating pressure of condenser = 1472.211 Kpa (a)

Material: Refrigerant-134a

[redacted]

Diagrams: c)





b)

(1)	(2)	(3)	(4)
$h_1 = 405.2123 \frac{kJ}{kg}$	$h_2 = 433.8687 \frac{kJ}{kg}$	$h_3 = 268.59 \frac{kJ}{kg}$	$h_4 = 268.59 \frac{kJ}{kg}$
$S_1 = 1.7326 \frac{kJ}{kg \cdot K}$	$S_2 = 1.7326 \frac{kJ}{kg \cdot K}$	$T_3 = 48.1°C$	$T_4 = 7.2°C$
$P_1 = 378.527$ Kpa	$\frac{h_2 - h_1}{h_2^* - h_1}$ = Isentropic efficiency of compressor	[redacted]	$P_4 = 378.527$ Kpa
$T_1 = 9.92°C$	$\frac{433.8 - 405.2}{h_2' - 405.2} = 80\%$	$P_3 = 1472.211$ kpa	$X = 0.3$
X = Superheated	$h_2' = 441.0328 \frac{kJ}{kg}$	X = Subcooled	
(From [redacted] Saturated & Superheated r134a tables)	$T_2 = 61.67°C$		
	$P_2 = 1472.211$		
	X = Superheated		

d) $COP = \frac{Q_{in}}{W_{compressor}} = \frac{\dot{m}(h_1 - h_4)}{\dot{m}(h_2' - h_1)}$

$COP = \frac{h_1 - h_4}{h_2' - h_1} = \frac{405.2123 - 268.59}{441.0328 - 405.2123}$

$= \frac{136.6223}{35.8205}$

$\boxed{COP = 3.814}$

e) Refrigerant mass flow, $\dot{m}_r$:

$\dot{Q}_{CD} = \dot{m}_r(h_1 - h_4)$

$\dot{Q}_{CD} = 1541.63$ Btu/min

$\dot{Q}_{CD} = 27.11$ kW

$\dot{m}_r = \frac{27.11}{405.2123 - 268.59}$

$\boxed{\dot{m}_r = 0.1984 \text{ kg/s}}$

f) Compressor power:

$W_c = \dot{m}_r(h_2' - h_1)$

$= 0.1984(441.0328 - 405.2123)$

$\boxed{W_c = 7.106 \text{ kW} = 9.52 \text{ HP}}$

g) Waste Heat rate:

$\dot{Q}_{condenser} = \dot{m}_r(h_2' - h_3)$

$= 0.1984(441.0328 - 268.59)$

$\boxed{\dot{Q}_{condenser} = 34.212 \text{ kW}}$

Summary/Analysis:

After calculating the states of the refrigerant at the different points of the cycle using the refrigerant-134a tables, we can then solve for the COP, refrigerant mass flow, compressor power, and the waste heat rate.