Thermodynamics 1 (MEP 261)

Quiz 3 (20 Marks)

Model Answer

Class ZA, Date: March 17, 2012

Name: **University ID:**

Complete the following table for refrigerant–134a (16 Marks).

Specify each state on *T*-*s* diagram (4 Marks).

Point	*T,* °C	*p,* kPa	*u*, kJ/kg	*v*, m^3/kg	***x***	Phase description
1	**-10**	**300**				
2	**20**			**0.012**		
3		**120**				**Saturated vapor**
4	**75**	**700**				

Solution:

For refrigerant–134a:

State 1: T = –10 °C, p = 300 kPa , From Table A–12 (Saturated **refrigerant–134a** –Pressure table),

For p = 280 kPa, T_{sat} = –1.25 °C,

For p = 320 kPa, T_{sat} = 2.46 °C,

Hence, for p = 300 kPa, T_{sat} = –1.25 + 2.46 °C= 1.21°C = 0.605°C

As T (= –10 °C)< T_{sat} (= 0.605 °C), Hence, State 1 is compressed (subcooled) liquid,

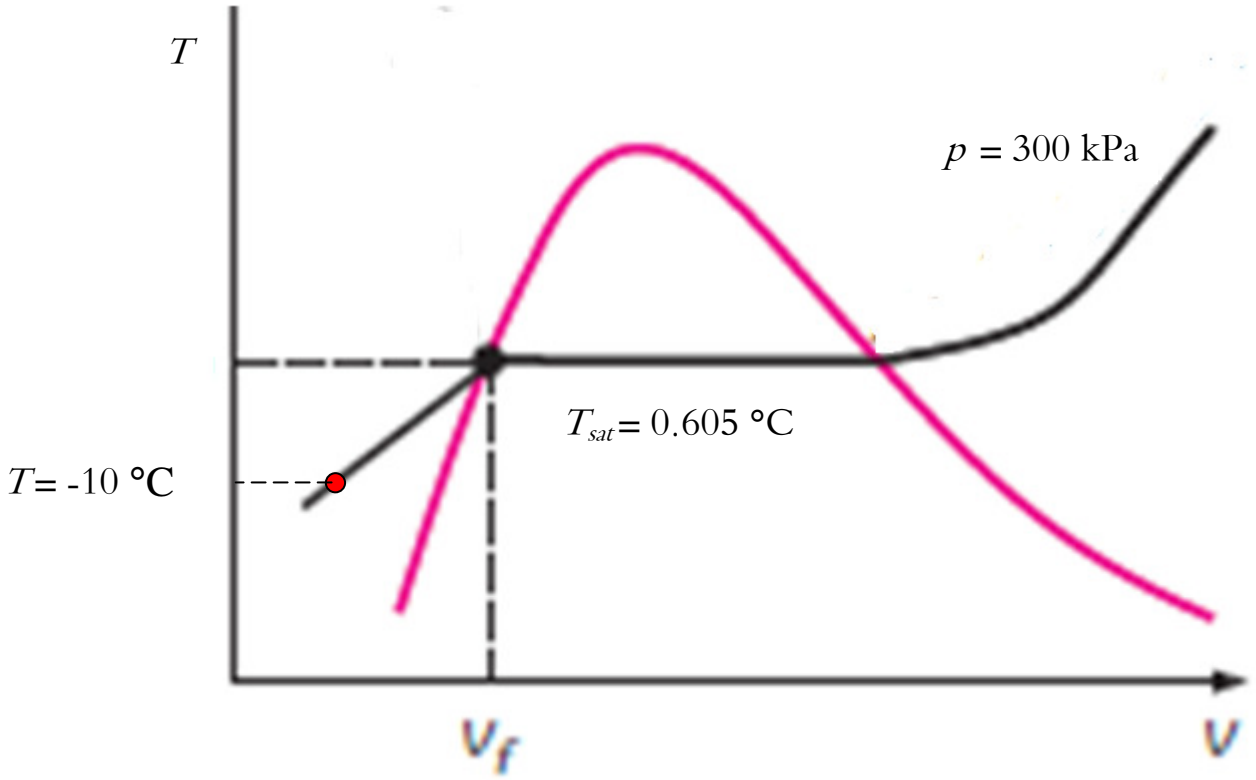
Hence, conditions are nearly the same as those at Saturated liquid corresponding to T = –10.0 °C.

Hence, From Table A–11, corresponding to T = –10 °C

T, °C	v_f, m^3/kg	u_f, kJ/kg	h_f, kJ/kg	s_f, kJ/kg.K
-10	*0.0007535*	*38.40*	*38.55*	*0.15504*

$v = v_f = 0.0007535 m^3/kg$ & $u = u_f = 38.40$ kJ/kg

$h = h_f = 38.5$ kJ/kg & $s = s_f = 0.15504$ kJ/kg.K



State 2: T = 20 °C, v = 0.012 m^3/kg, *From Table A-11* (Saturated **refrigerant–134a** -Temperature table)

For T = 20 °C, p_{sat} = 572.07 kPa, v_f = 0.0008161 m^3/kg, v_g = 0.035969 m^3/kg , u_f = 78.86 kJ/kg, u_{fg} = 162.16 kJ/kg, u_g = 241.02 kJ/kg.

As v_f (= 0.0008161 m^3/kg) < v (= 0.012 m^3/kg) < v_g (= 0.035969 m^3/kg)

Hence, state 2 is saturated liquid-vapor mixture

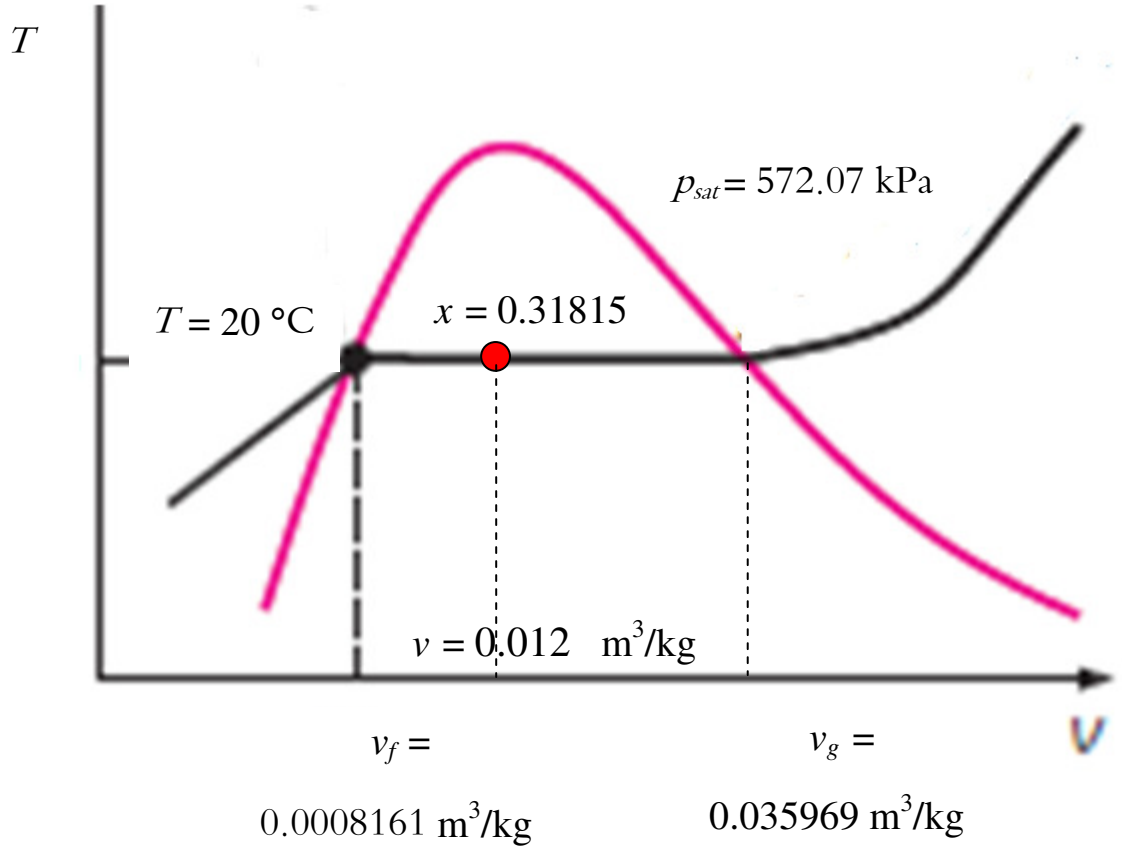
$$\boldsymbol{x = \frac{v - v_f}{v_g - v_f}}$$

Hence,

$$\boldsymbol{x = \frac{0.012 - 0.0008161}{0.035969 - 0.0008161}}$$

Hence, $x = 0.31815$,

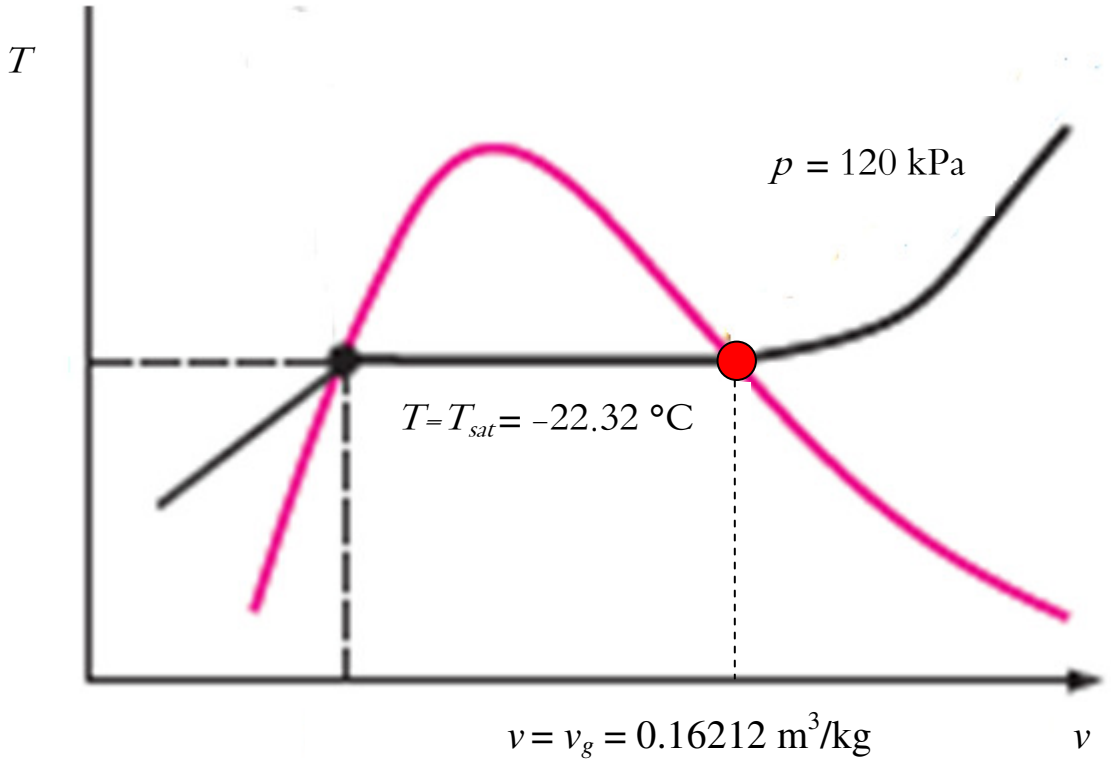
$u = u_f + x\, u_{fg} = 78.86$ kJ/kg + 0.31815× 162.16 kJ/kg= 130.4512 kJ/kg



State 3: $p =$ 120 kPa , *Satureated vapor, x = 1;*

From Table A-12 (Saturated **refrigerant–134a** –Pressure table)**,**

For $p =$ 120 kPa, $T = T_{sat} =$ –22.32 °C, $v = v_g =$ 0.16212 m³/kg , $u = u_g =$ 217.51 kJ/kg.



State 4: T = 75 °C, p = 700 kPa ,

From Table A-12 (Saturated **refrigerant–134a** –Pressure table)**,**

$T_{sat\ at\ p\ =\ 700\ kPa}$ (=26.69 °C),

As T (=**75** °C) > $T_{sat\ at\ p\ =\ 700\ kPa}$ (=26.69 °C), hence state 4 is superheated vapor.

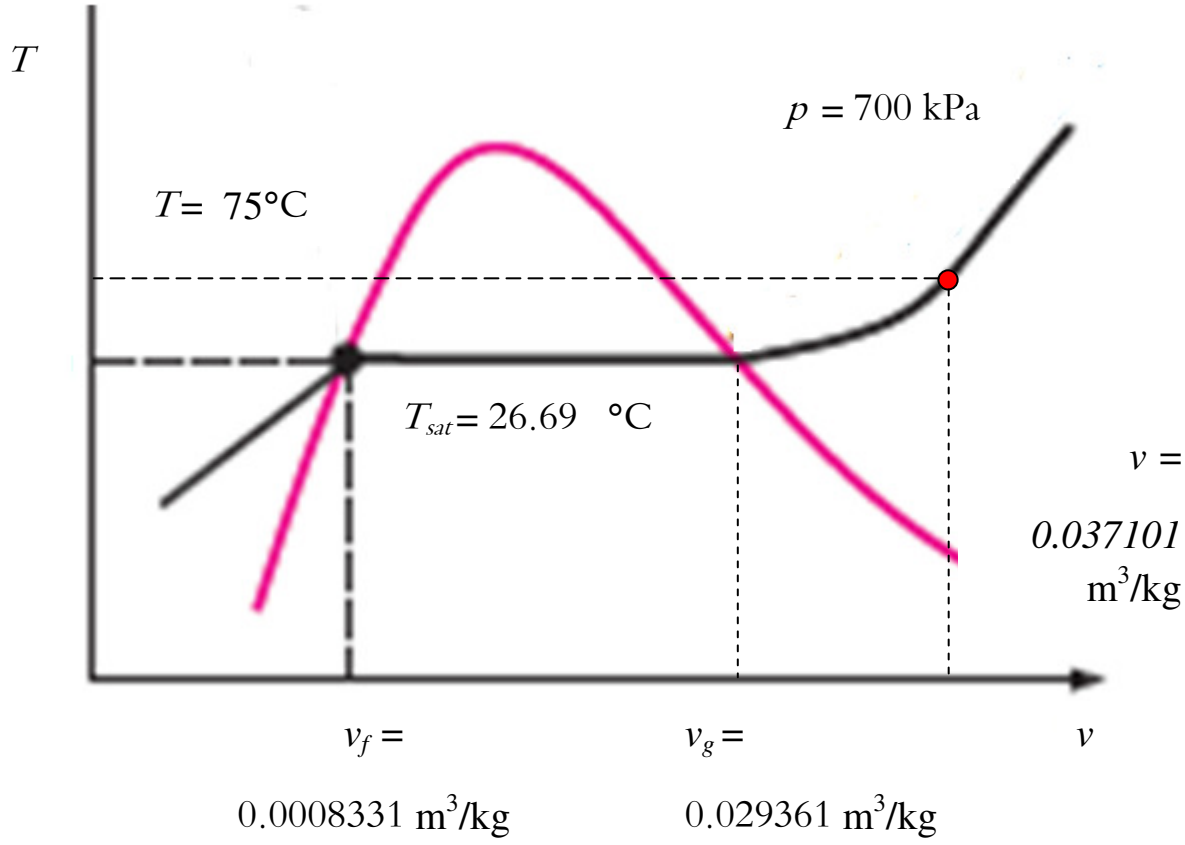
Hence, From Table A–13, Superheated **refrigerant–134a**

For p = 700 kPa (=0.7 MPa), T = 70 °C , *v = 0.036373* m^3/kg & *u = 282.87* kJ/kg

For p = 700 kPa (=0.7 MPa), T = 80 °C , *v = 0.037829* m^3/kg & *u = 291.80* kJ/kg

Hence,

For p = 700 kPa (=0.7 MPa), T = 75 °C , *v = (0.036373 +0.037829)/2 = 0.037101* m^3/kg & *u = (282.87 + 291.80)/2= 287.3* kJ/kg



Solution:

Point	*T,* °C	*p,* kPa	*u*, kJ/kg	*v*, m^3/kg	***x***	Phase description
1	**-10**	**300**	*38.40*	*0.0007535*	-	*Compressed (subcooled) liquid*
2	**20**	*572.07*	*130.4512*	**0.012**	*0.31815*	*Saturated liquid-vapor mixture*
3	*-22.32*	**120**	*217.51*	*0.16212*	*1.0*	**Saturated vapor**
4	**75**	**700**	*287.3*	*0.037101*	-	*Superheated vapor*