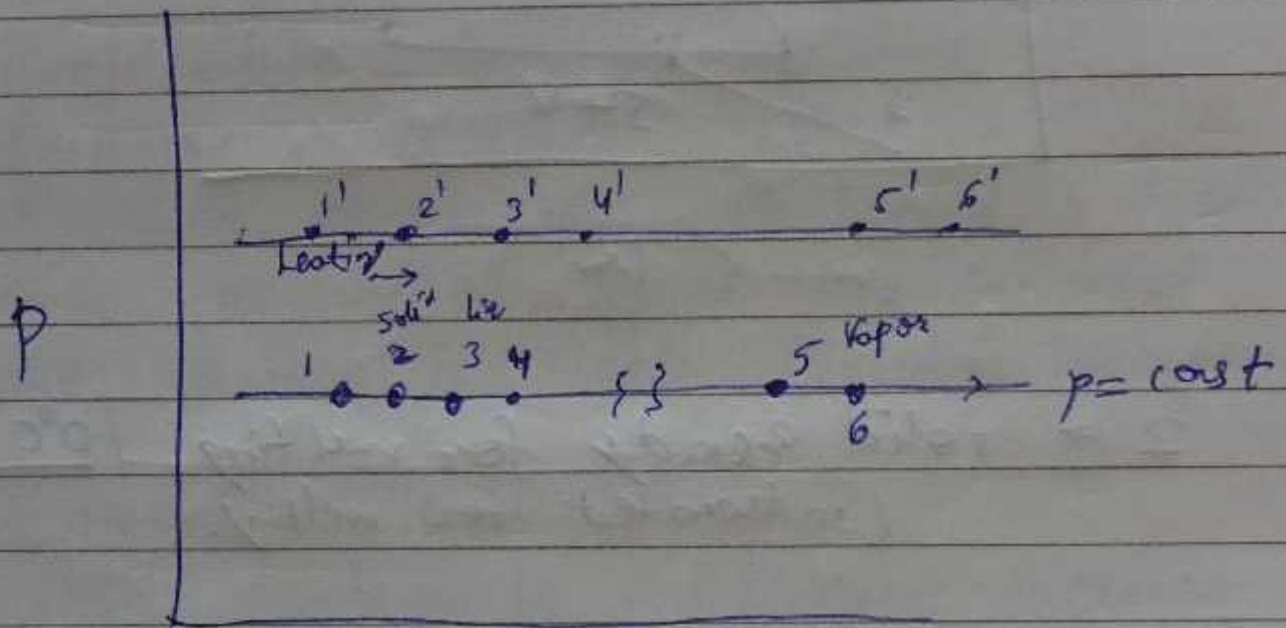


Date \_\_\_\_\_

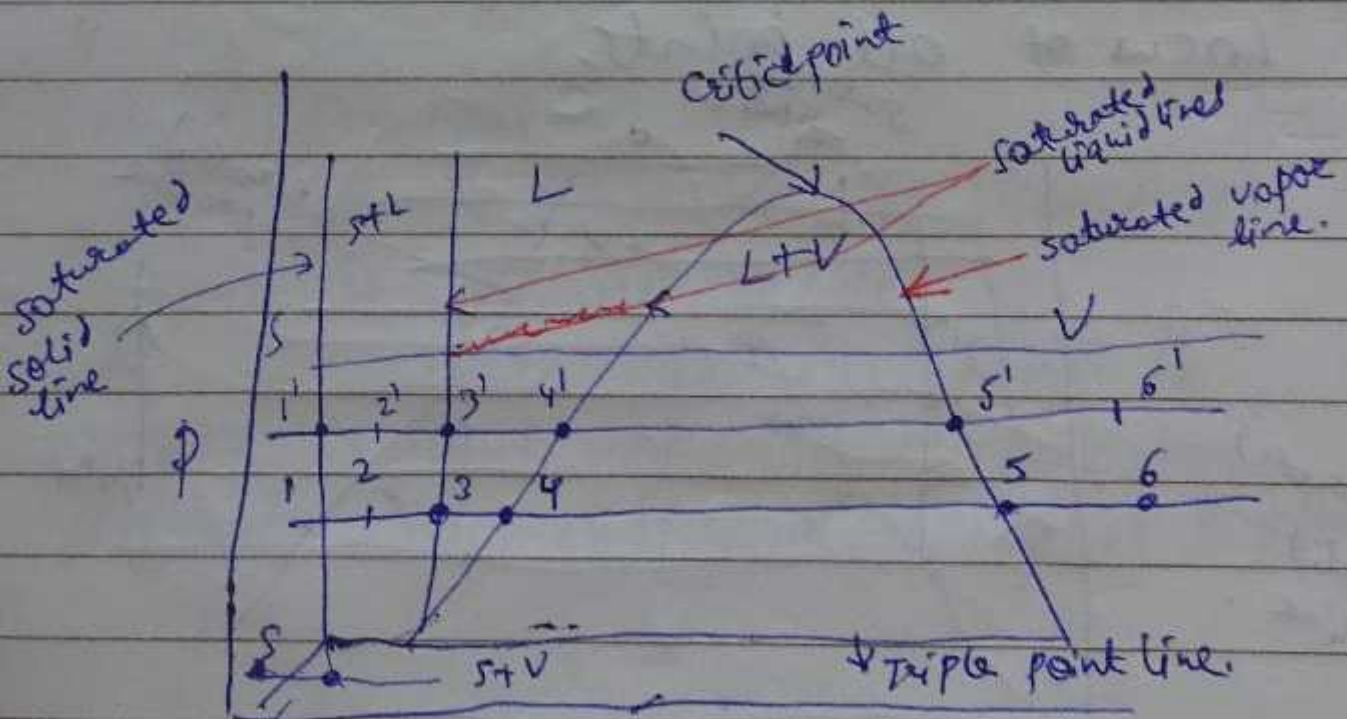
# Properties of Pure substances &

Solid  $\rightarrow$  liquid  $\rightarrow$  (latent heat)  
 liquid  $\rightarrow$  vapour (latent heat)

## Phase diagrams.



U.



Solid converted to Vapour directly (sublimation).

## Quality Calculation.

$$x = \frac{m_v}{m_v + m_f}$$

$$u_x = (1-x) u_f + x u_g$$

$$h_x = (1-x) h_f + x h_g$$

$$s_x = (1-x) s_f + x s_g$$

Table = Steam tables

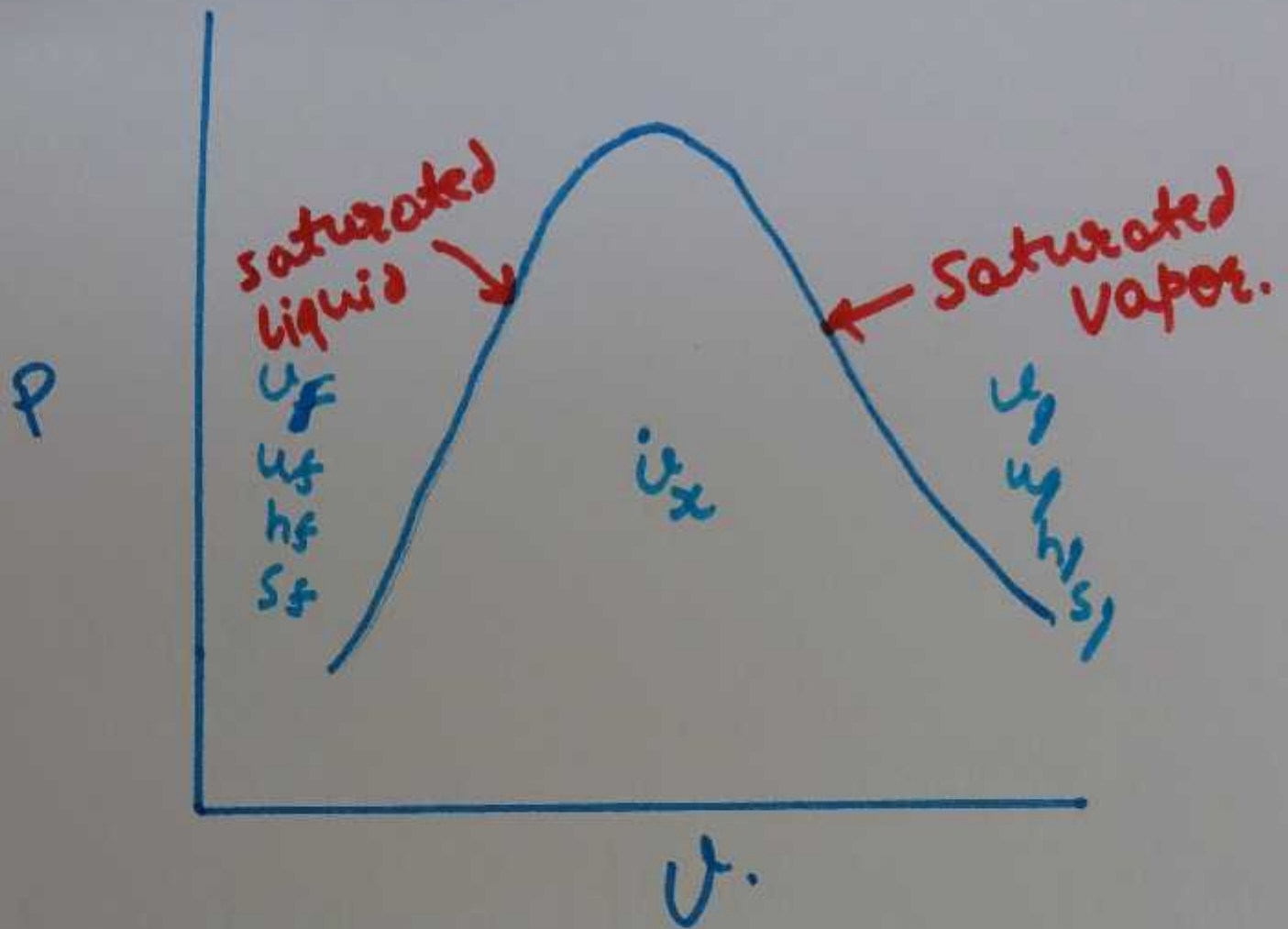
saturated steam.

P	t	$v_f$	$v_g$	$u_f$	$u_g$	$h_f$	$h_g$	$s_f$	$s_g$
MPa	$^{\circ}\text{C}$	$\text{m}^3/\text{kg}$				$\text{kJ/kg}$		$\text{kJ/kg K}$	

$$v_{fg} = v_g - v_f$$



# Phase diagram



$v_x$  is a mixture of liquid & vapor.

$u_f, u_g, h_f, s_f$  and  $u_g, u_f, h_g, s_g$  values are read from steam tables and calculations are done.

$$v_x = (1-x)u_f + x u_g.$$

$T = 44^\circ\text{C}$  ,  $x = 0.5$  find  $P_{\text{sat}}$ ,  $u$ ,  $h$ ,  $v_g$

$$P_{\text{sat}} = 9.0987 \text{ kPa}$$

$$v_x = 8.02 \text{ m}^3/\text{kg}$$

$$u_x = 1309.977 \text{ kJ/kg}$$

$$h_x = 1382.9 \text{ kJ/kg}$$

$$s_x = 4.40 \text{ kJ/kgK}$$

$$v_g = (1-x)v_f + xv_g$$

05  
11  
20

T C	P <sub>sat</sub> kPa	v <sub>f</sub> m <sup>3</sup> /kg	v <sub>g</sub> m <sup>3</sup> /kg	v <sub>fg</sub> m <sup>3</sup> /kg	h <sub>f</sub> kJ/kg	h <sub>g</sub> kJ/kg	h <sub>fg</sub> kJ/kg	u <sub>f</sub> kJ/kg	u <sub>g</sub> kJ/kg	u <sub>fg</sub> kJ/kg	s <sub>f</sub> kJ/kg K	s <sub>g</sub> kJ/kg K
0	0.6119	0.000995	205.94	205.93	0.9007	2500.02	2499.12	0.9001	2374.02	2373.12	-0.0013	9.1582
2	0.7066	0.000995	179.63	179.63	9.2488	2504.40	2495.15	9.2481	2377.48	2368.24	0.0297	9.1052
4	0.8140	0.000996	157.04	157.04	17.5909	2508.60	2491.01	17.5901	2380.76	2363.17	0.0604	9.0531
6	0.9357	0.000996	137.59	137.59	25.9279	2512.64	2486.72	25.9269	2383.90	2357.97	0.0908	9.0020
8	1.0732	0.000997	120.82	120.82	34.2606	2516.58	2482.31	34.2595	2386.91	2352.66	0.1209	8.9519
10	1.2282	0.000997	106.31	106.31	42.5897	2520.42	2477.83	42.5885	2389.84	2347.25	0.1508	8.9026
12	1.4026	0.000998	93.74	93.74	50.9160	2524.19	2473.27	50.9146	2392.70	2341.79	0.1804	8.8542
14	1.5985	0.000999	82.83	82.83	59.2401	2527.90	2468.66	59.2385	2395.51	2336.27	0.2098	8.8066
16	1.8180	0.000999	73.33	73.33	67.5625	2531.58	2464.02	67.5607	2398.27	2330.71	0.2389	8.7599
18	2.0635	0.001000	65.04	65.04	75.8837	2535.23	2459.34	75.8817	2401.01	2325.13	0.2678	8.7141
20	2.3376	0.001000	57.80	57.80	84.2043	2538.85	2454.65	84.2020	2403.73	2319.53	0.2964	8.6690
22	2.6431	0.001001	51.47	51.46	92.5247	2542.46	2449.94	92.5220	2406.43	2313.91	0.3249	8.6247
24	2.9830	0.001002	45.90	45.90	100.845	2546.06	2445.21	100.842	2409.12	2308.28	0.3531	8.5811
26	3.3604	0.001002	41.02	41.02	109.166	2549.65	2440.48	109.163	2411.81	2302.65	0.3811	8.5384
28	3.7789	0.001003	36.72	36.71	117.488	2553.23	2435.74	117.484	2414.49	2297.01	0.4090	8.4963
30	4.2420	0.001004	32.92	32.92	125.811	2556.81	2431.00	125.807	2417.17	2291.36	0.4366	8.4550
32	4.7536	0.001005	29.57	29.56	134.136	2560.39	2426.25	134.131	2419.84	2285.71	0.4640	8.4143
34	5.3181	0.001005	26.60	26.60	142.462	2563.96	2421.50	142.456	2422.52	2280.06	0.4913	8.3744
36	5.9398	0.001006	23.96	23.96	150.790	2567.53	2416.74	150.784	2425.19	2274.40	0.5183	8.3351
38	6.6235	0.001007	21.62	21.62	159.120	2571.09	2411.97	159.113	2427.86	2268.74	0.5452	8.2964
40	7.3743	0.001008	19.54	19.54	167.452	2574.65	2407.20	167.444	2430.52	2263.08	0.5719	8.2584
42	8.1975	0.001009	17.69	17.69	175.786	2578.20	2402.41	175.778	2433.18	2257.41	0.5985	8.2210
44	9.0987	0.001009	16.04	16.03	184.123	2581.75	2397.63	184.114	2435.84	2251.73	0.6248	8.1843