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CLASS SCHEDULE

MECHANICAL ENGINEERING

HMT	MONDAY Live @11AM	YOGESH SIR
PRODUCTION	TUESDAY Live @11AM	GAURAV SIR
SOM	WEDNESDAY Live @8PM	MUKESH SIR
THERMODYNAMICS	THURSDAY Live @11AM	KANISTH SIR
ENGINEERING MATHEMATICS	FRIDAY Live @11AM	ANANT SIR

HEAT & MARK

3 HRS

ISRO | BHEL | DRDO & OTHER PSUs

GATE

Thermodynamics

Thermodynamic Relations

MOST EXPECTED QUESTIONS

Live@ 3pm

PART-1

Kanisth sir

The throttling of certain gases may be used for getting the refrigeration effect. The value of Joule-Thomson coefficient (μ) for such a throttling process is

(a) $\mu = 0$
(b) $\mu = 1$
(c) $\mu < 1$
(d) $\mu > 1$

[ESE : 2007]

1 → d

T ↓

$\mu > 1$

Which one of the following statements is correct?

(a) Compressibility factor is unity for ideal gases

(b) Compressibility factor is zero for ideal gases

(c) Compressibility factor is lesser than unity for ideal gases

(d) Compressibility factor is more than unity for ideal gases. [ESE : 2007]

(a)

$Z = 1$

$PV = ZRT$

$\Downarrow$

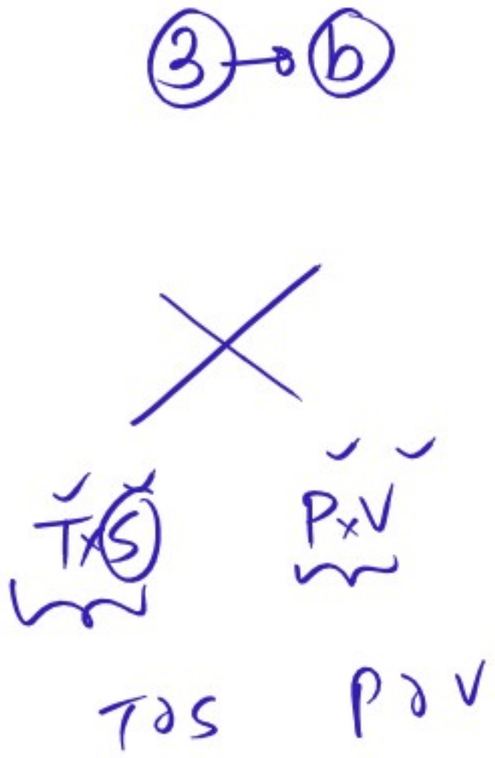
1

Which thermodynamic property is evaluated with the help of Maxwell equations from the data of other measurable properties of a system?

(a) Enthalpy (b) Entropy

(c) Latent heat (d) Specific heat

[ESE : 2007]



Which one of the following relationships defines the Helmholtz function F?

(a) $F = H + TS$ (b) $F = H - TS$

(c) $F = U - TS$ (d) $F = U + TV$

[ESE : 2007]

④ → ©

$F = U - TS$

At critical point the enthalpy of vaporization is

(a) dependent on temperature only

(b) maximum

(c) minimum

(d) zero

[ESE : 2008]

5 → (d)

$h_f = h_g$

$h_{fg} = 0$

When a system reaches the state of equilibrium, the following property assumes its maximum value

(a) Availability

(b) Entropy

(c) Gibbs function

(d) Helmholtz function

[ESE : 2012]

6 → b

MON - SAT ⇒ 3PM (1 to 1.30)

THURSDAY ⇒ 11 AM (3 HRS)

When a real gas undergoes Joule-Thomson expansion the temperature

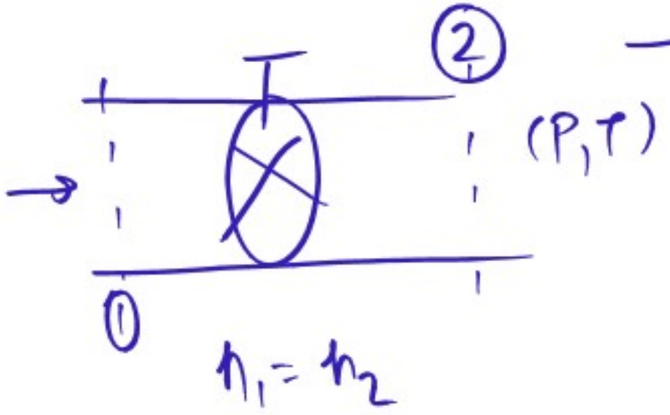
(a) may remain constant

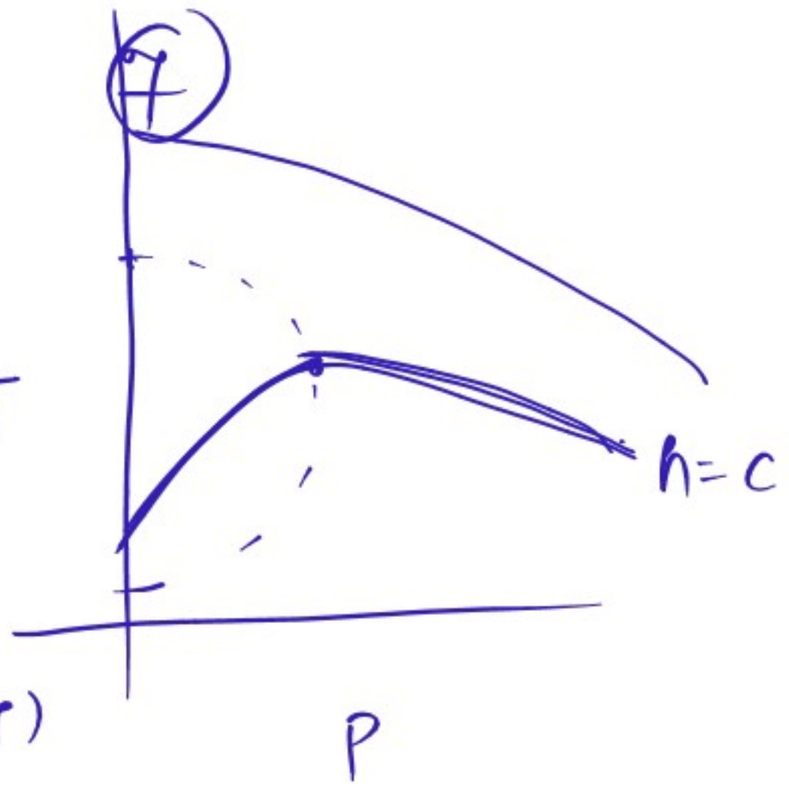
(b) always increases

(c) may increases or decreases

(d) always decreases

[ESE : 2007]





In a real gas equation $pv = zRT$, depending on the values of pressure and temperature of the real gas, the value of z

(a) Should always be less than 1

(b) May be less than 1, may be greater than 1 or equal to 1

(c) Should always be greater than 1

(d) Should always be equal to 1 **[ESE : 2014]**

(a) (b)

$Z = 1$ (IDEAL GAS)

CSE-PRE

Match List I with List II and select the correct answer :

List-I

A. Joule Thomson coefficient → $\left(\frac{\partial T}{\partial P}\right)_h$ → 4

B. C_p for monoatomic gas → 1

C. $C_p - C_v$ for diatomic gas → 3

D. $(\partial U/\partial T)_V$ → 2

List-II

1. $5/2\ R$
2. C_v
3. R
4. $(\partial T/\partial p)_h$

Codes:

	A	B	C	D
(a)	3	2	4	1
(b)	4	1	3	2
(c)	3	1	4	2
(d)	4	2	3	1

(a) → (b)

(a) 4, 2, 3, 1 ✓

$C_p = \frac{\gamma R}{\gamma - 1} \Rightarrow \frac{5R}{\frac{2}{3}\left(\frac{5-3}{3}\right)}$

$\Rightarrow \frac{5}{2}R$

$\gamma \to \frac{5}{3}$

$\gamma \to 1 + \frac{2}{F}$

$1 + \frac{2}{3}$

If h, p, T and v refer to enthalpy, pressure, temperature and specific volume respectively; and subscripts g and f refer to saturation conditions of vapour and liquid respectively, then Clausius-Clapeyron equation applied to change of phase from liquid to vapour states is

(10) (b)

(a) $\frac{dp}{dt} = \frac{(h_g - h_f)}{(v_g - v_f)}$ (b) $\frac{dp}{dt} = \frac{(h_g - h_f)}{T(v_g - v_f)}$ ✓

$\frac{dp}{dT} = \frac{h_{fg}}{T v_{fg}}$

(c) $\frac{dp}{dt} = \frac{(h_g - h_f)}{T}$ (d) $\frac{dp}{dt} = \frac{(h_g - h_f)T}{(h_g - h_f)}$

Which combination of the following statements is correct? **[2 Marks]**

P. A gas cools upon expansion only when its Joule-Thomson coefficient is positive in the temperature range of expansion

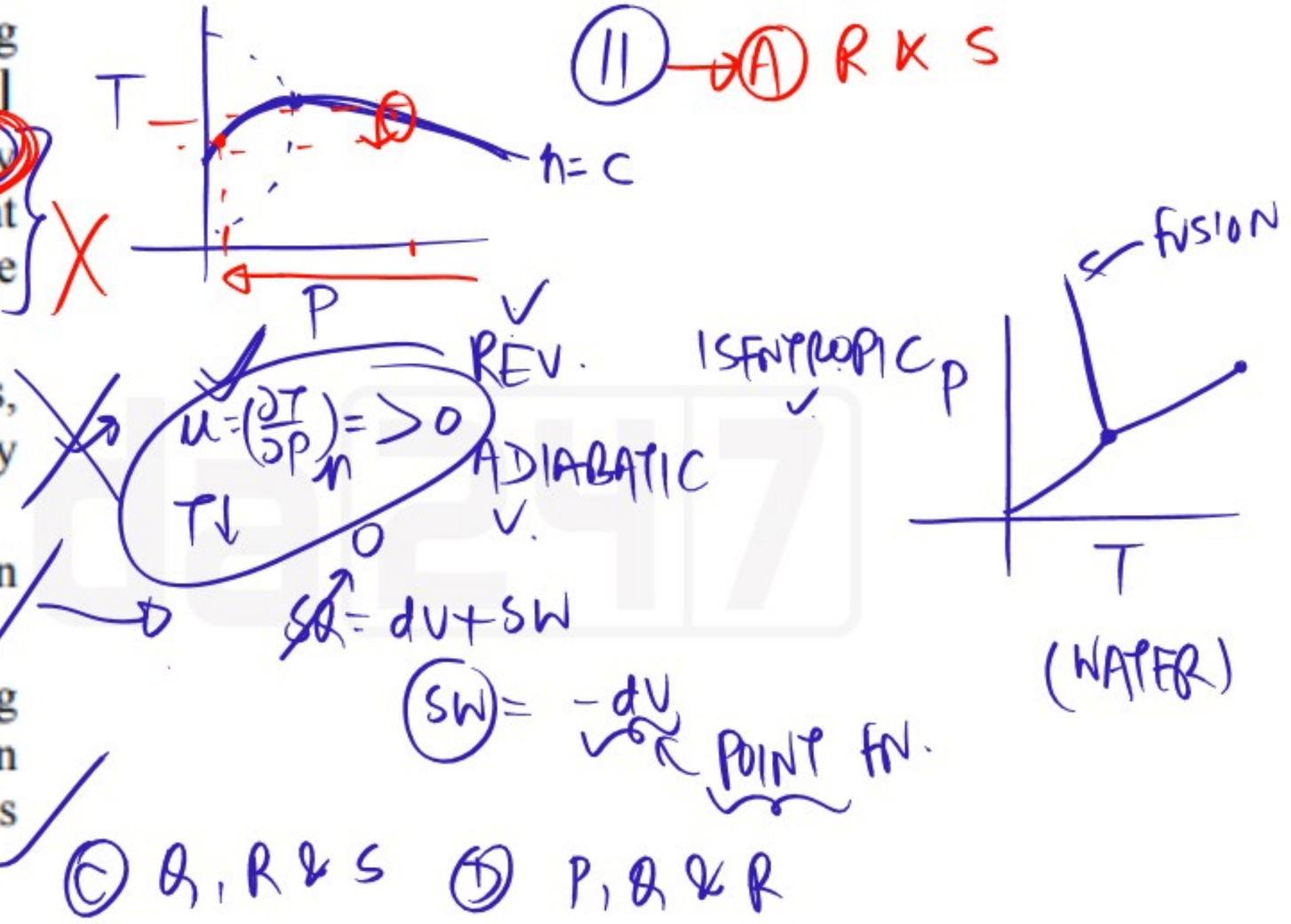
Q. For a system undergoing a process, its entropy remains constant only when the process is reversible

R. The work done by a closed system in an adiabatic is a point function

S. A liquid expands upon freezing when the slope of its fusion curve on pressure temperature diagram is negative

(A) R and S (B) P and Q

(C) Q, R and S (D) P, Q and R



For a simple compressible system v, s, p and T are specific volume, specific entropy, pressure and temperature respectively. As per Max-wells relations $\left(\frac{\partial v}{\partial s}\right)_P$ is equal to **[1 Mark]**

(A) $\left(\frac{\partial p}{\partial v}\right)_T$

(B) $\left(\frac{\partial T}{\partial p}\right)_s$

(C) $\left(\frac{\partial s}{\partial T}\right)_p$

(D) $-\left(\frac{\partial T}{\partial v}\right)_p$

12 → b

$\left(\frac{\partial v}{\partial s}\right)_P = \left(\frac{\partial T}{\partial P}\right)_S$

Pv

Ts

For a gas, pressure p, volume v and temperature T are dependent on each other. Then which one of the following p -v -T relationship will be obeyed?

(a) $\left(\frac{\partial p}{\partial T}\right)_v\left(\frac{\partial v}{\partial T}\right)_p\left(\frac{\partial v}{\partial p}\right)_T = -1$

(b) $\left(\frac{\partial p}{\partial T}\right)_v\left(\frac{\partial T}{\partial v}\right)_p\left(\frac{\partial v}{\partial p}\right)_T = -1$ ✓

(c) $\left(\frac{\partial p}{\partial T}\right)_v\left(\frac{\partial v}{\partial T}\right)_p\left(\frac{\partial p}{\partial v}\right)_T = -1$

(d) $\left(\frac{\partial p}{\partial T}\right)_v = \left(\frac{\partial T}{\partial v}\right)_p\left(\frac{\partial p}{\partial v}\right)_T$

13 → b

$\left(\frac{\partial x}{\partial y}\right)_z\left(\frac{\partial y}{\partial z}\right)_x\left(\frac{\partial z}{\partial x}\right)_y = -1$

$x \to P$
$y \to V$
$z \to T$

$\left(\frac{\partial P}{\partial V}\right)_T\left(\frac{\partial V}{\partial T}\right)_P\left(\frac{\partial T}{\partial P}\right)_V = -1$

$\left(\frac{\partial V}{\partial P}\right)_T\left(\frac{\partial T}{\partial V}\right)_P\left(\frac{\partial P}{\partial T}\right)_V = -1$

Which of the following thermodynamic properties relate to the Clausius-Clapeyron equation?

1. Pressure ✓
2. Temperature ✓
3. Entropy
4. Specific volume ✓
5. Enthalpy ✓
6. Internal energy

Select the correct answer using the code given below :

(a) 1, 2, 6, 5 (b) 4, 2, 3, 5
(c) 6, 4, 1 (d) 4, 5, 2, 1

14 → d

$$\frac{dP}{dT} = \frac{h_{fg}}{T v_{fg}}$$

P, T, h, v

For water at 25^{0}C,

$$\frac{dp_s}{dT_s} = 0.189 \text{ kPa / K}$$

(p_s is the saturation pressure in kPa and T_s is the saturation temperature in K) and the specific volume of dry saturated vapour is 43.38 m^3/kg. Assume that the specific volume of liquid is negligible in comparison with that of vapour. Using the Clausius-Clapeyron equation, an estimate of the enthalpy of evaporation of water at 25^{0}C (in kJ/kg) is _____. **[1 Mark]**

(15)

$$\frac{dP}{dT} = \frac{h_{fg}}{T(v_g - v_f)}$$

$v_f \to 0$

$$h_{fg} = \left(\frac{dP}{dT}\right) \times T \times v_g$$

$$\Rightarrow 0.189 \times (298)(43.38)$$

$$\Rightarrow$$

The INCORRECT statement about the characteristics of critical point of a pure substance is that **[1 Mark]**

(A) There is no constant temperature vaporization process

(B) It has point of inflection with zero slope

(C) The ice directly converts from solid phase to vapor phase

(D) Saturated liquid and saturated vapor states are identical

16 → C

Which one of the following statements is correct for a superheated vapour?

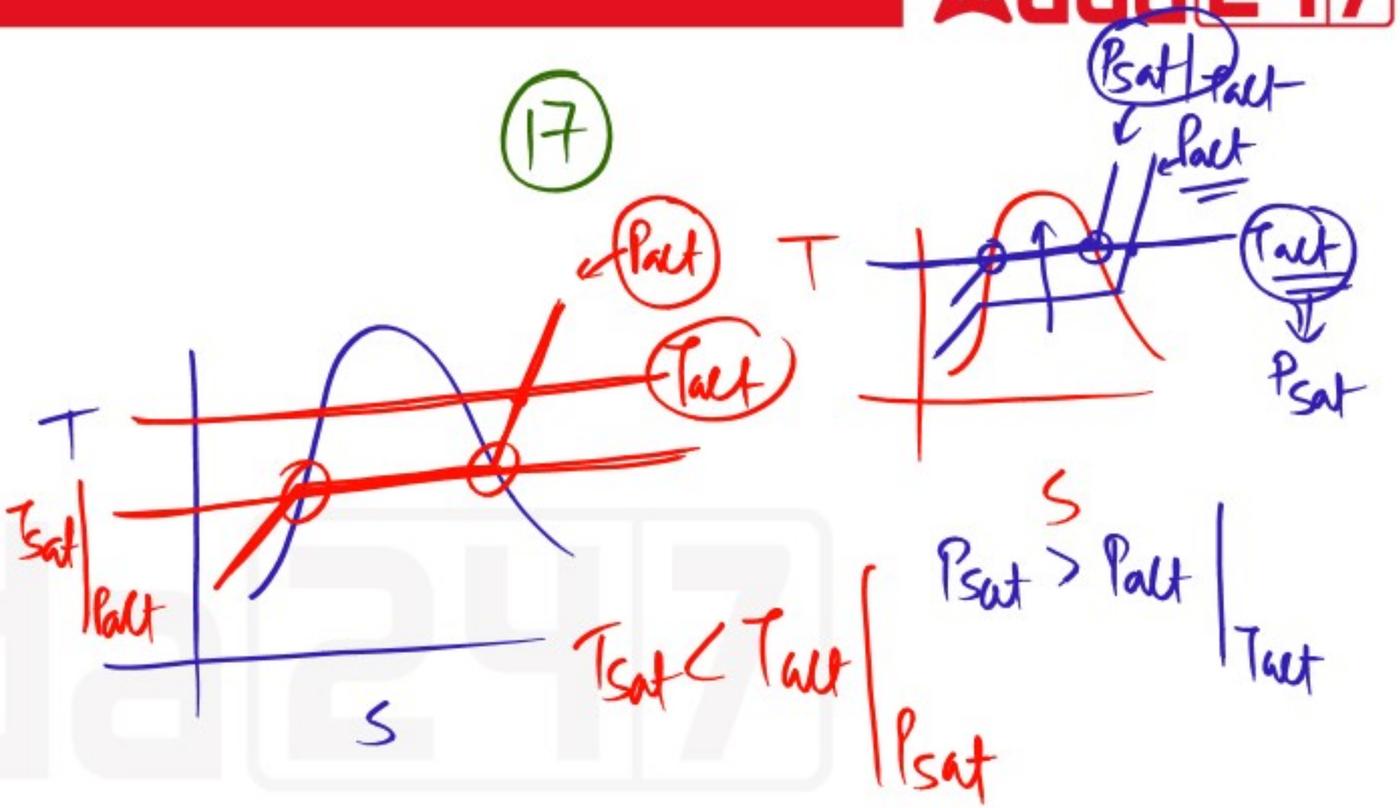
[1 Mark]

(A) Its pressure is less than the saturation pressure at a given temperature.

(B) Its temperature is less than the saturation temperature at a given pressure.

(C) Its volume is less than the volume of the saturated vapour at a given temperature.

(D) Its enthalpy is less than enthalpy of the saturated vapour at a given pressure.



Which one of the following is the correct statement? Clapeyron equation is used for

(a) finding specific volume of vapour

(b) finding specific volume of liquid

(c) finding latent heat of vaporization

(d) finding sensible heat

18 → C

$$\frac{dP}{dT} = \frac{h_{fg}}{T(v_{fg})}$$

P, V, T

$\frac{15}{18}$

11 AM → KEATLWORK

MONDAY → 3 PM

YT

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