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FREE APP 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

ISRO | BHEL | DRDO & OTHER PSUs



GATE

Thermodynamics

{ Closed system Analysis }

MOST EXPECTED QUESTIONS

Live@ 3pm

PART-2

Kanisth sir



The internal energy of certain system is a function of temperature alone and is given by the formula $E = 25 + 0.25t$ kJ. If this system executes a process for which the work done by it per degree temperature increase is 0.75 kNm, the heat interaction per degree temperature increase, in kJ, is

(a) - 1.00

(b) - 0.50

(c) 0.50

(d) 1.00

[ESE : 1995]

① → d

$$E = 25 + 0.25t \quad \text{kJ}$$

$$\frac{\delta W}{\delta t} = 0.75 \text{ kNm} \quad \frac{dE}{dt} = 0.25$$

$$\frac{\delta Q}{\delta t} = ?$$

$$\delta Q = dE + \delta W$$

$$\frac{\delta Q}{\delta t} = \frac{dE}{dt} + \frac{\delta W}{\delta t}$$

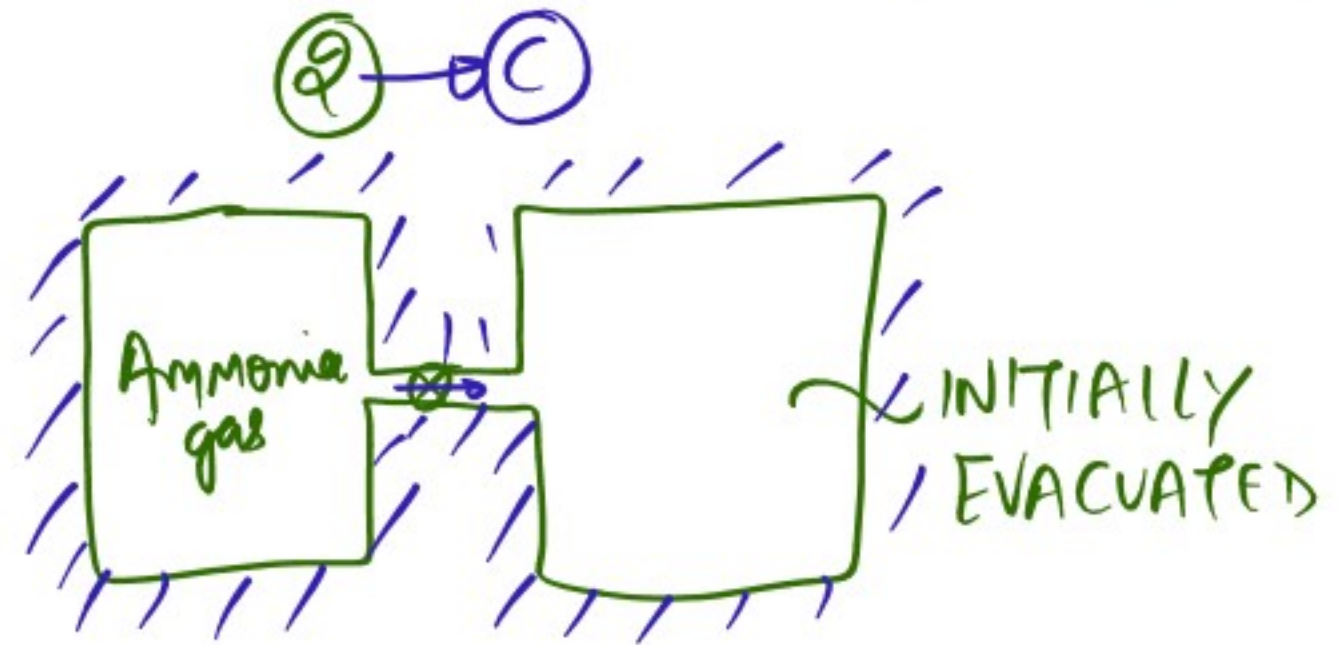
$$= 0.25 + 0.75$$

$$\frac{\delta Q}{\delta t} = 1$$

The heat transfer Q , the work done W and the change in internal energy U are all zero in the case of

- (a) a rigid vessel containing steam at 150°C left in the atmosphere which is at 25°C ~~X~~
- (b) 1 kg of gas contained in an insulated cylinder expanding as the piston moves slowly outwards ~~X~~
- (c) a rigid vessel containing ammonia gas connected through a valve to an evacuated rigid vessel, the vessel, the valve and the connecting pipes being well insulated and the valve being opened and after a time, condition through the two vessel becoming uniform
- (d) 1 kg of air flowing adiabatically from the atmosphere into a previously evacuated bottle

[ESE : 1996]



FREE EXP $\rightarrow W=0$
 INSULATED $Q \rightarrow U$
 $U \rightarrow U$

Q.4 Match the curves in **Diagram-I** (process on p - V plane) with the curves in **Diagram-II** (Process on T - s plane) and select the correct answer:

Diagram-I

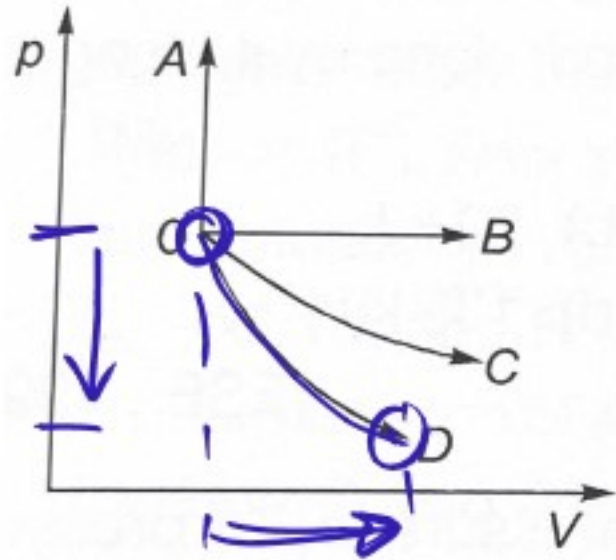
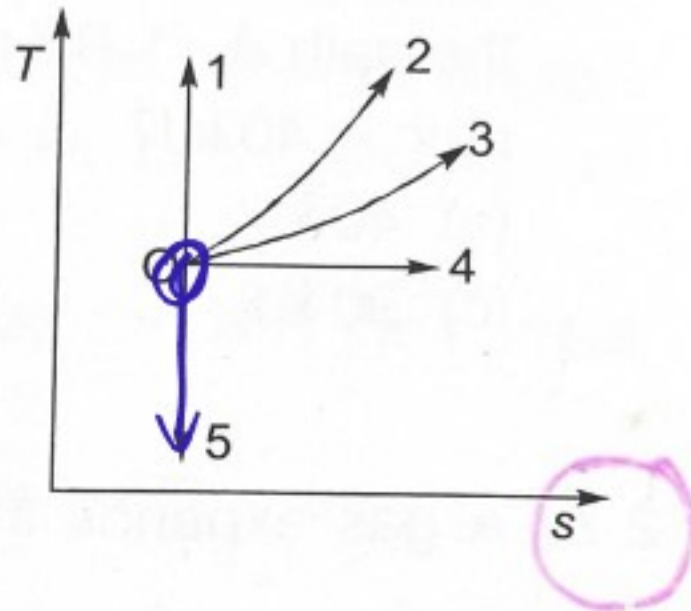


Diagram-II



A \rightarrow VOLUME constant \rightarrow 2
 B \rightarrow PRESSURE const \rightarrow 3
 C \rightarrow ISOTHERMAL \rightarrow 4
 D \rightarrow ISENTROPIC \rightarrow 5

(3) \rightarrow (b)

Codes:

	A	B	C	D
(a)	3	2	4	5
(b)	2	3	4	5
(c)	2	3	4	1
(d)	1	4	2	3

[ESE : 1996]

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$$

$$T_2 < T_1$$

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$T_2 < T_1$$

Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I

- A. Work done in a polytropic process
- B. Work done in steady flow process
- C. Heat transfer in a reversible adiabatic process
- D. Work done in an isentropic process

List-II

- 1. $-\int V dp$
- 2. Zero
- 3. $\frac{p_1 V_1 - p_2 V_2}{\gamma - 1}$
- 4. $\frac{p_1 V_1 - p_2 V_2}{n - 1}$

Codes:

	A	B	C	D
(a)	4	1	3	2
(b)	1	4	2	3
<input checked="" type="checkbox"/> (c)	4	1	2	3
(d)	1	2	3	4

$$\frac{p_1 V_1 - p_2 V_2}{n - 1}$$



$$A \rightarrow 4$$

$$B \rightarrow 1$$

$$C \rightarrow 2$$

$$D \rightarrow 3$$

[ESE : 1996]

Assertion (A): If the enthalpy of a closed system decreased by 25 kJ while the system receives 30 kJ of energy by heat transfer, the work done by the system is 55 kJ. X

Reason (R): The first law energy balance for a closed system is (notations have their usual meaning) $\Delta E = Q - W$. ✓ [ESE : 2001]

Q.5 A → FALSE
R → CORRECT //

$$\Delta h = -25 \text{ kJ}$$

$$Q = +30 \text{ kJ}$$

$$W = +55$$

$$\delta Q = \underline{\underline{dE}} + \delta W$$

$$\delta Q = \underline{\underline{dU}} + \cancel{dKE} + \cancel{dPE} + \delta W$$

$$\delta Q = \underline{\underline{dU}} + \delta W$$

~~$$\delta Q = dh$$~~

Assertion (A): Specific heat at constant pressure for an ideal gas is always greater than the specific heat at constant volume.

Reason (R): Heat added at constant volume is not utilized for doing any external work.

[ESE : 2002]

⑥ Ⓐ

In highly rarefied gases the concept of this loses validity

→ VERY LOW PRESSURE

- (a) Thermodynamic equilibrium
- (b) Continuum
- (c) Stability
- (d) Macroscopic viewpoint

[ESE : 2012]

(7) → (b)

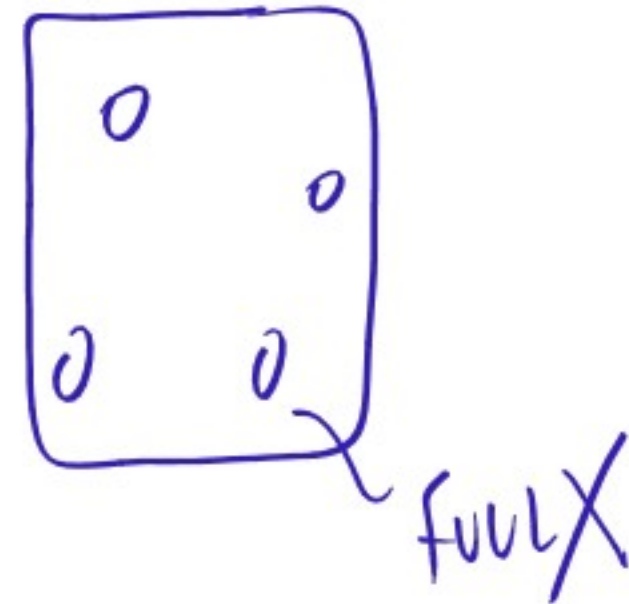
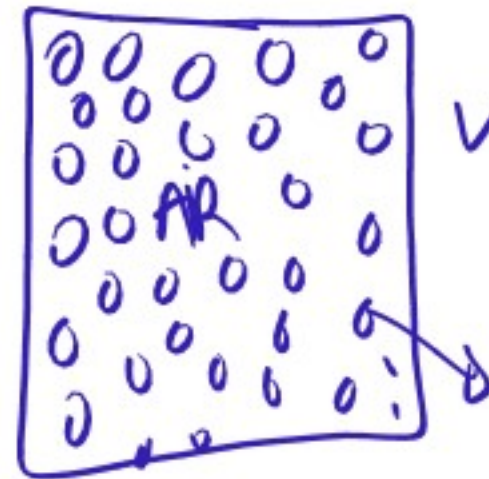
concept of Continuum



MATTER



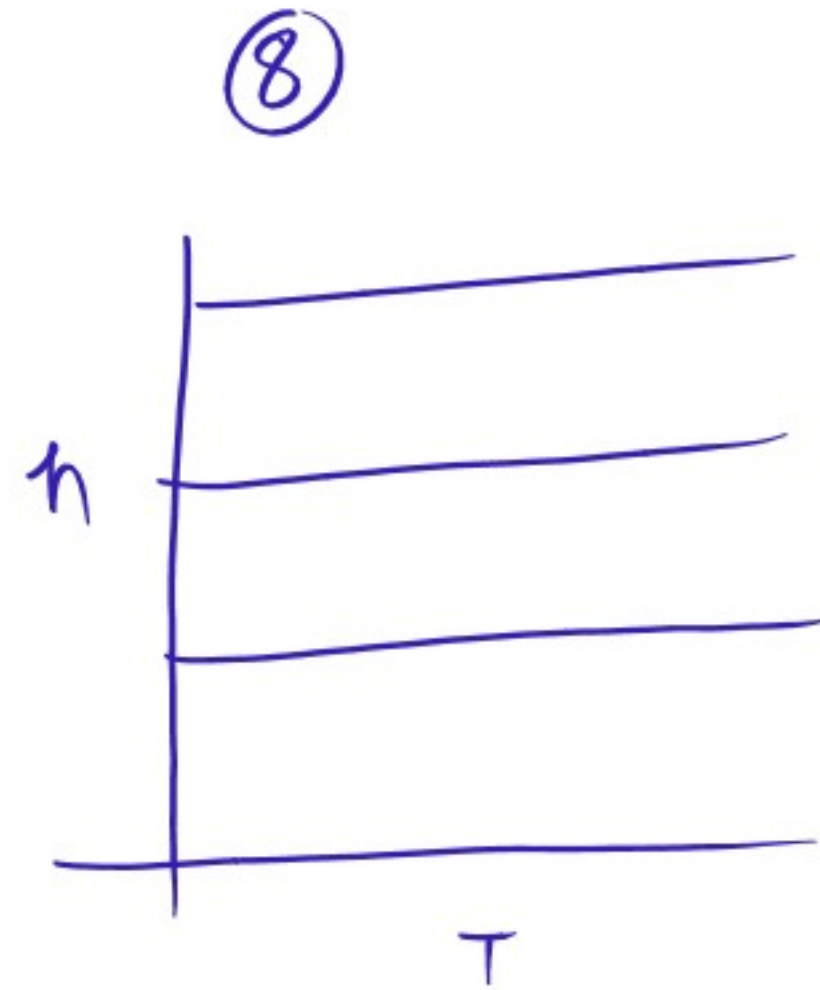
CONTINUOUS



Assertion (A): An air filled balloon released from the ground goes up and up till it reaches a certain elevation and floats in the air.

Reason (R): With increase in elevation the temperature of the atmospheric air increases and so the density decreases. ✗

[ESE : 2010]

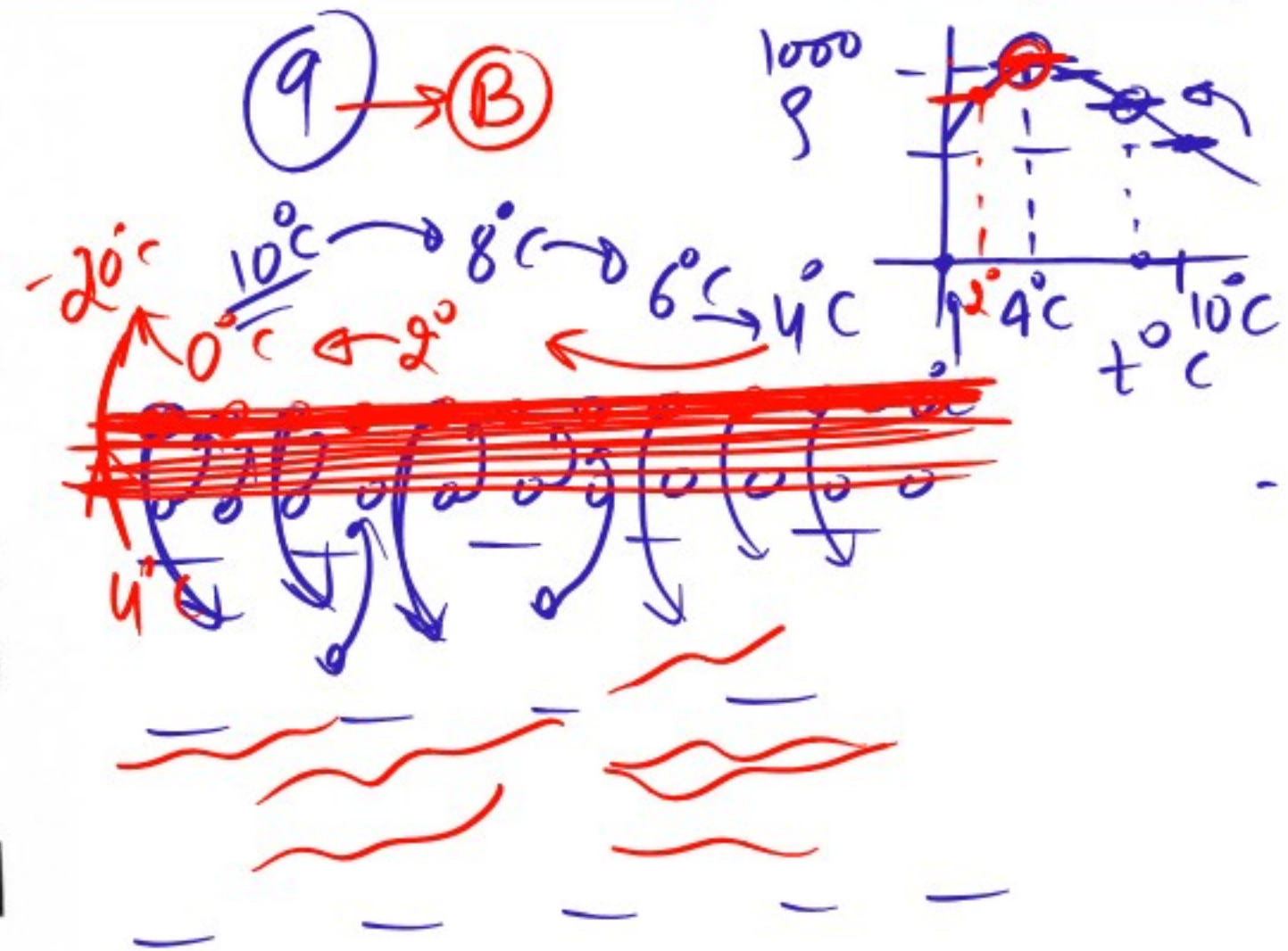


Assertion (A): When the surface of a lake is cooled during winter, the cooled surface water descends to the bottom as long as its temperature exceeds 4°C , but when cooled below 4°C it floats at the top. (✓)

Reason (R): Ice forms at the top of a pond in winter while bottom fluid stays warmer at more than 4°C . (✓)

(B) ✓

[ESE : 2010]



Molar specific heats of an ideal gas depend on

- (a) its pressure
- (b) its temperature
- (c) both its pressure and temperature
- (d) the number of atoms in a molecule,

[ESE : 2010]

(10) → (d) R, γ

$$C_p = \frac{R\gamma}{\gamma-1}$$

$$C_v = \frac{R}{\gamma-1}$$

$\frac{R}{M}$

$$R = \frac{\bar{R}}{M}$$

$$\left. \begin{aligned} \bar{C}_p &= \frac{\bar{R}\gamma}{\gamma-1} \\ \bar{C}_v &= \frac{\bar{R}}{\gamma-1} \end{aligned} \right\}$$

$\bar{R} \Rightarrow$ UNIVERSAL GAS CONSTANT

$\gamma \rightarrow 1 + \frac{2}{F}$ \hookrightarrow DOF

O, $F=3$

O-O, $F=5$

Pressure reaches a value of absolute zero

- (a) at a temperature of -273 K \times
 - (b) under vacuum condition \times
 - (c) at the earth's centre \times
 - (d) when molecular momentum of system becomes zero \checkmark
- [ESE : 2002]

(11) \rightarrow (d)

$$T = 0\text{ K}$$

Number of components (C), phases (P) and degrees of freedom (F) are related by Gibbs phase rule as

(a) $C - P - F = 2$

(b) $F - C - P = 2$

(c) $C + F - P = 2$

(d) $P + F - C = 2$

[ESE : 2001]

(12) → (d)

$$F = C - P + 2$$

$$F + P - C = 2$$

The correct sequence of the decreasing order of the value of characteristic gas constants of the given gases is

- (a) hydrogen, nitrogen, air, carbon dioxide
- (b) carbon dioxide, hydrogen, nitrogen, air
- (c) air, nitrogen, carbon dioxide, hydrogen
- (d) nitrogen, air, hydrogen, carbon dioxide

[ESE : 1995]

$$\downarrow R = \frac{\bar{R}}{\underbrace{M}_{\uparrow}}$$

$M \rightarrow$

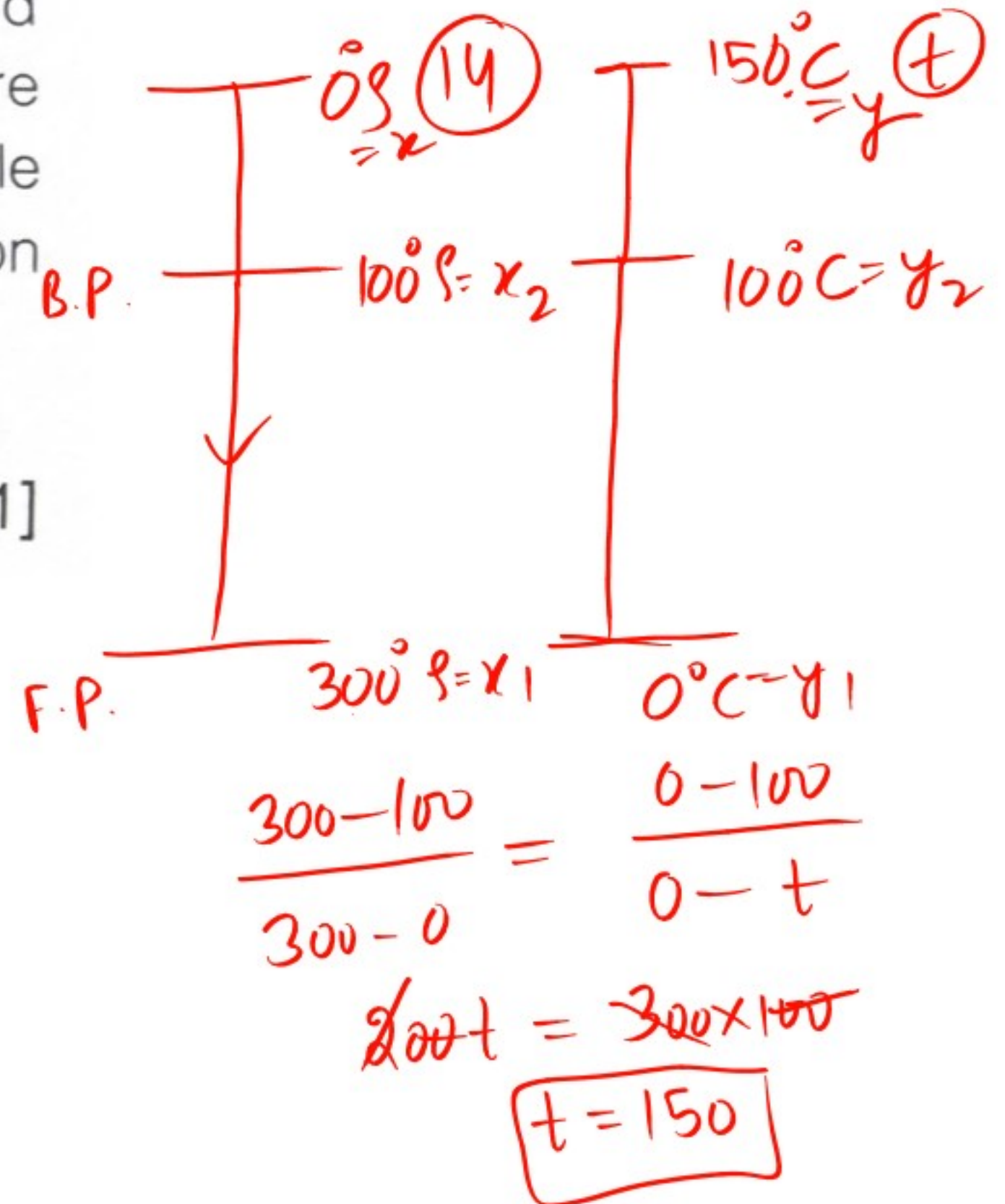
(13) \rightarrow (a)



In new temperature scale say $^{\circ}\rho$, the boiling and freezing points of water at one atmosphere are $100^{\circ}\rho$ and $300^{\circ}\rho$ respectively. Correlate this scale with the Centigrade scale. The reading of $0^{\circ}\rho$ on the Centigrade scale is

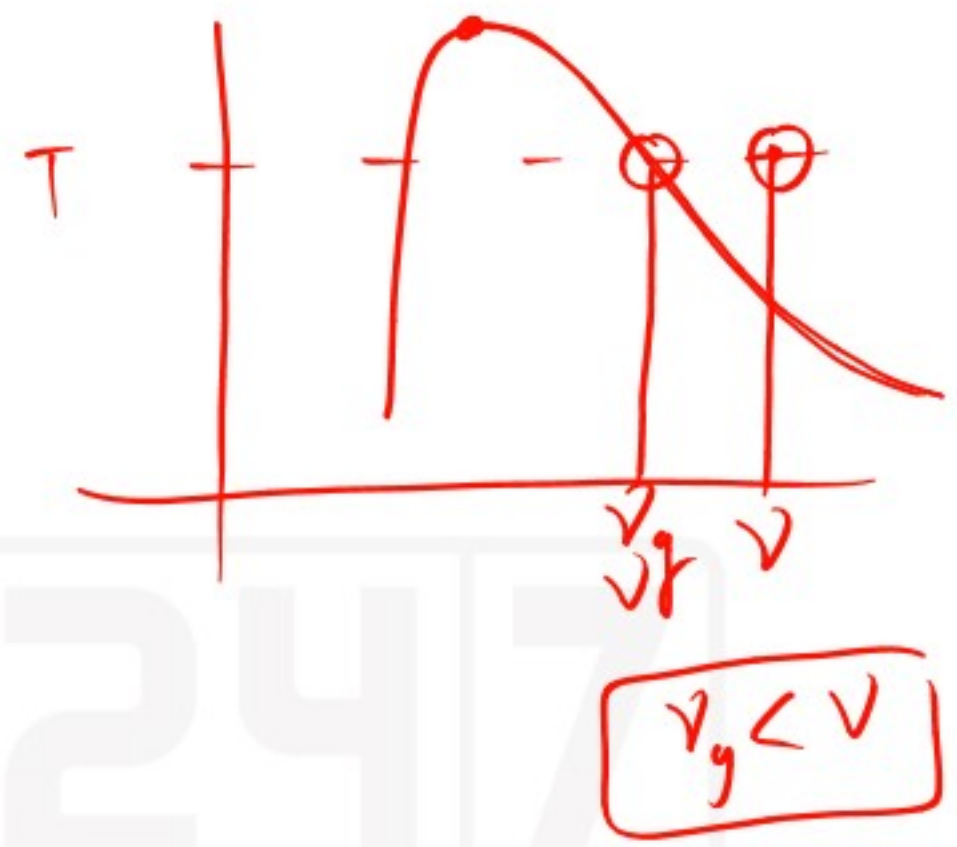
- (a) 0°C
- (b) 50°C
- (c) 100°C
- (d) 150°C [ESE : 2001]
- (e) 175°C

(14) \rightarrow (d)



Which one of the following is the correct statement? Steam is said to be superheated when the

- (a) actual volume is greater than volume of saturated steam
- (b) actual volume is less than volume of saturated steam
- (c) actual volume is equal to volume of saturated steam
- (d) None of the above



15 → a

Which one of the following properties remains unchanged for a real gas during Joule—Thomson process?

- (a) Temperature (b) Enthalpy ✓
(c) Entropy (d) Pressure

(16) → (b)

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

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

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

(17) (b)

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

For an ideal gas, the expression

$$\left[T \left(\frac{\partial s}{\partial T} \right)_p - T \left(\frac{\partial s}{\partial T} \right)_v \right] \text{ is equal to}$$

- (a) zero
- (c) R

- (b) C_p / C_v
- (d) RT

$$C_p - C_v = R$$

18 → C

$$Tds = du + p dv \quad \left. \begin{array}{l} v=c \\ dv=0 \end{array} \right\}$$

$$Tds = C_v dT \quad |_{v=c}$$

$$T \left(\frac{\partial s}{\partial T} \right)_v = C_v$$

$$Tds = dh - v dp \quad \left. \begin{array}{l} p=c \\ dp=0 \end{array} \right\}$$

$$Tds = C_p dT \quad |_{p=c}$$

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

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

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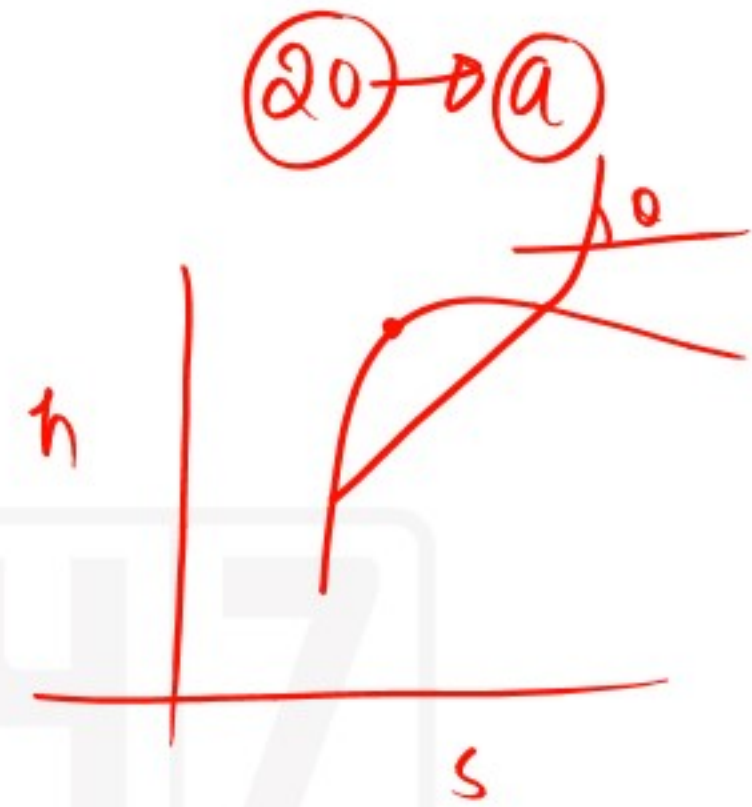
Which one of the following is the correct statement? Clapeyron equation is used for

(19) → (C)

- (a) finding specific volume of vapour
- (b) finding specific volume of liquid
- (c) finding latent heat of vaporization ✓
- (d) finding sensible heat

Constant pressure lines in the super-heated region of the Mollier diagram have what type of slope?

- (a) ✓ A positive slope
- (b) A negative slope
- (c) Zero slope
- (d) May have either positive or negative slopes



In free expansion of a gas between two equilibrium states, the work transfer involved

- (a) can be calculated by joining the two states on p - v coordinates by any path and estimating the area below
- (b) can be calculated by joining the two states by a quasistatic path and then finding the area below
- (c) is zero
- (d) is equal to heat generated by friction during expansion

Variation of pressure and volume at constant temperature are correlated through

- (a) Charle's law
- (b) Boyle's law
- (c) Joule's law
- (d) Gay Lussac's law

For a non-flow constant pressure process the heat exchange is equal to

- (a) zero
- (b) the work done
- (c) the change in internal energy
- (d) the change in enthalpy

The equation of state :

$$pV = RT \left(1 + \frac{B}{V} + \frac{C}{V^2} + \frac{D}{V^3} + \dots \right),$$

is known as

- (a) Van der Waals equation
- (b) Benedict-Webb-Rubin equation
- (c) Gibbs equation
- (d) Virial equation

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Which one of the following is the correct expression for change in the internal energy for a small temperature change ΔT for an ideal gas?

(a) $\Delta U = C_v \times \Delta T$ (b) $\Delta U = C_p \times \Delta T$

(c) $\Delta U = \frac{C_p}{C_v} \times \Delta T$ (d) $\Delta U = (C_p - C_v)\Delta T$



What is the ratio of the slopes of p-v curves for an adiabatic process and an isothermal process ?

(a) $\frac{1}{\gamma}$

(b) $\gamma + 1$

(c) γ

(d) $\frac{1}{\gamma} + 1$

For a gas that is allowed to expand reversibly and adiabatically, there is no change in

- (a) internal energy (b) temperature
(c) entropy (d) enthalpy

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Q. A series of operations, which takes place in a certain order and restore the initial conditions at the end, is known as

- (a) Reversible cycle
- (b) Irreversible cycle
- (c) Thermodynamic cycle
- (d) None of these

Q. A 120 - V electric resistance heater draws 10 A. It operates for 10 min in a rigid volume. Calculate the work done on the air in the volume.

- (a) 720000 kJ
- (b) 720 kJ
- (c) 12000 J
- (d) 12 kJ

Q. Which of the following processes is irreversible process

- (a) Isothermal
- (b) Adiabatic
- (c) Throttling
- (d) All of the above

Q. In a reversible adiabatic process the ratio (T_1/T_2) is equal to -

(a) $\left(\frac{p_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}}$

(b) $\left(\frac{v_1}{v_2}\right)^{\frac{\gamma-1}{\gamma}}$

(c) $(v_1 v_2)^{\frac{\gamma-1}{2\gamma}}$

(d) $\left(\frac{v_2}{v_1}\right)^{\gamma}$

Q. In the polytropic process equation $PV^n = \text{constant}$ if n is infinitely large, the process is termed as -

- (a) Constant volume
- (b) Constant pressure
- (c) Constant temperature
- (d) Adiabatic

- Q. Internal energy of system containing perfect gas depends on
- (a) Pressure only
 - (b) Temperature only
 - (c) Pressure and temperature
 - (d) Pressure temperature and specific heat

Q. Which of the following equations is incorrect? (where V, P, T and Q are volume, pressure, temperature and heat transfer respectively)

(a) $\oint dV = 0$

(b) $\oint dP = 0$

(c) $\oint dT = 0$

(d) $\oint dQ = 0$

Q. A polytropic process with $n = -1$, initiates with $P = V = 0$ and ends with $P = 600$ kPa and $V = 0.01$ m³. The work done is

- (a) 2 kJ
- (b) 3 kJ
- (c) 4 kJ
- (d) 6 kJ

Q. For an ideal gas, enthalpy is represented by

(a) $H = U - RT$

(b) $H = U + RT$

(c) $H = RT - U$

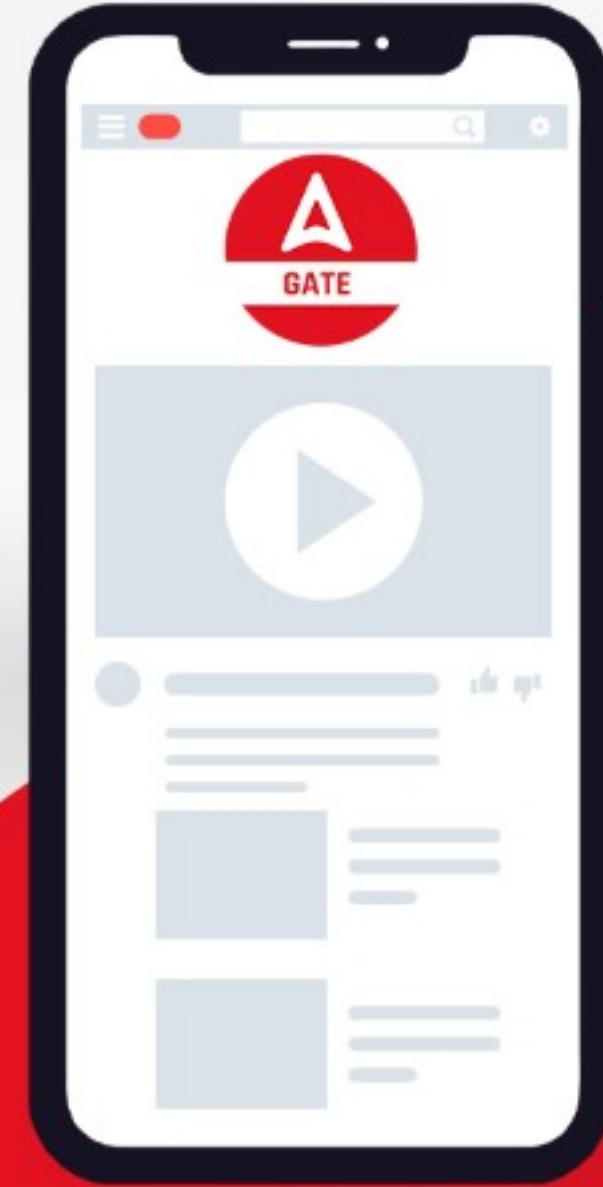
(d) $H = -(U + RT)$

Q. Certain quantities cannot be located on the graph by a point but are given by the area under the curve corresponding to the process. These quantities in concepts of thermodynamics are called as

- (a) cyclic functions
- (b) point functions
- (c) path functions
- (d) real functions



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