{ QUESTIONS { 5 DAYS/WEEK
(3pm to 4.30PM)(MON, TUE, WED, FRI, SAT)

{ CONCEPTS →

11 AM
(THURSDAY)
FREE CLASS
⇓
ON APP

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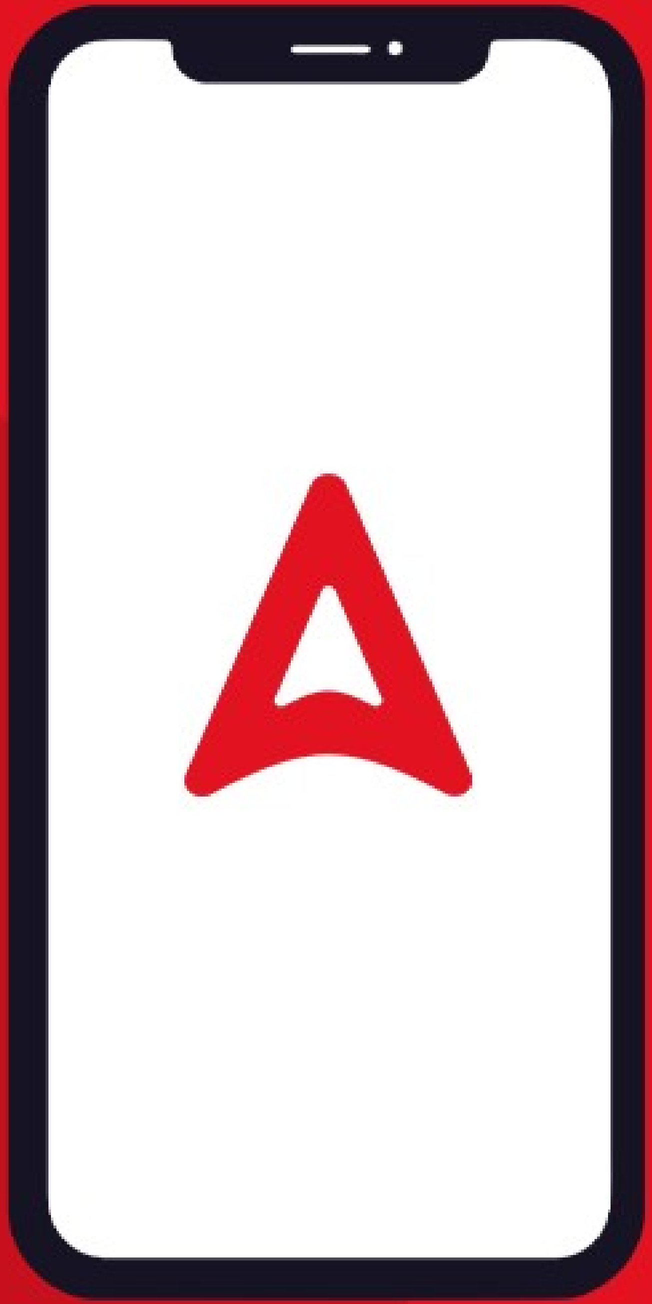


ESE → (PYQs)
PSUs → (PYQs)
CSE → (PYQs)

ISRO | BHEL | DRDO & OTHER PSUS

QUESTION SERIES ME

Heat and Work

Time- 3pm Date- 11 april 2023

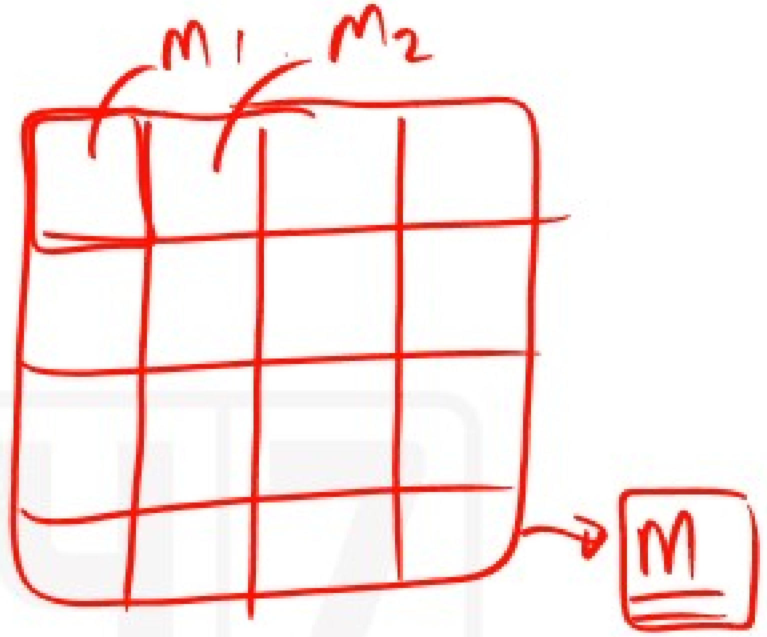
Kanisth sir

What are the properties of a thermodynamic system, whose value for the entire system is equal to the sum of their values for individual parts of the system ?

(a) Thermodynamic properties
(b) Extensive properties ✓
(c) Intensive properties
(d) None of the above

[CSE-Pre : 2006]

① → ⓑ



Which one of the following is an intensive thermodynamic property?

INDEPENDENT OF MASS

(a) Density

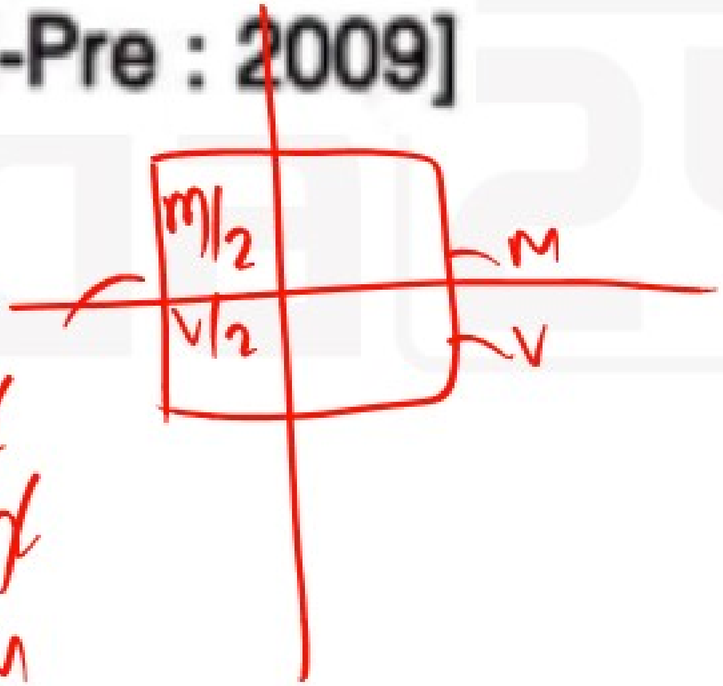
(b) Energy

(c) Entropy ✓

(d) Volume

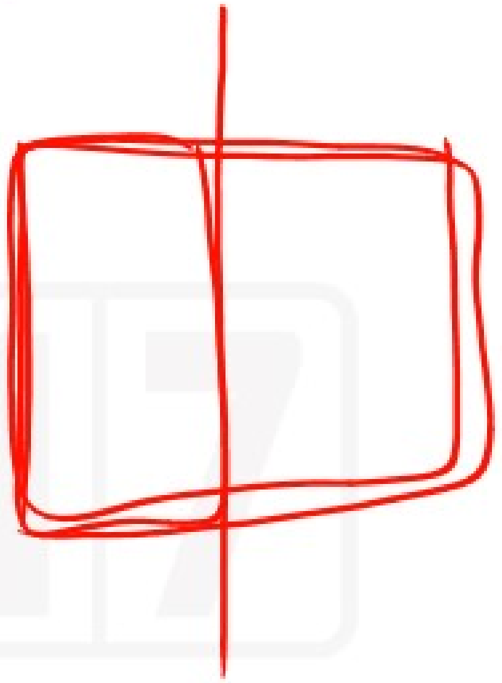
[CSE-Pre : 2009]

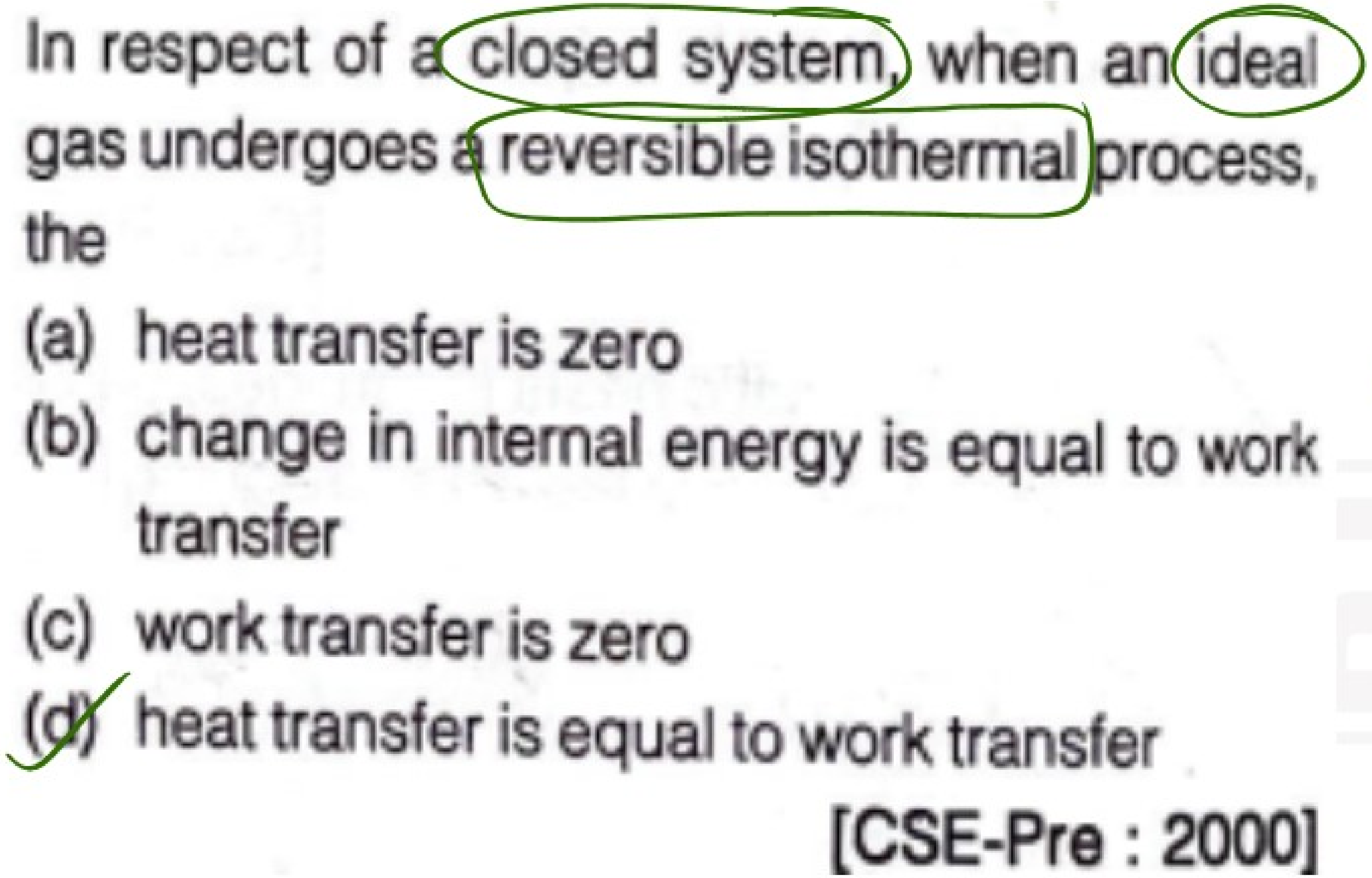
$\rho = \frac{M}{V}$



$\rho = \frac{M/\cancel{2}}{V/\cancel{2}}$

$= \frac{M}{V}$





In respect of a closed system, when an ideal gas undergoes a reversible isothermal process, the

(a) heat transfer is zero

(b) change in internal energy is equal to work transfer

(c) work transfer is zero

[✓ (d) heat transfer is equal to work transfer]

[CSE-Pre : 2000]

③

$$\delta Q = dU + \delta W$$

$$\downarrow$$

$$\delta Q = \overset{0}{\cancel{mc_v\,dT}} + \delta W$$

$$\boxed{\delta Q = \delta W}$$

④Q. → ⓒ An insulated chamber is separated in two parts by a membrane. One part has vacuum and other is filled with gases. After some time membrane ruptures and gas fills the whole chamber. Which of these statement is incorrect-

a. Pressure of gas decreases ✓

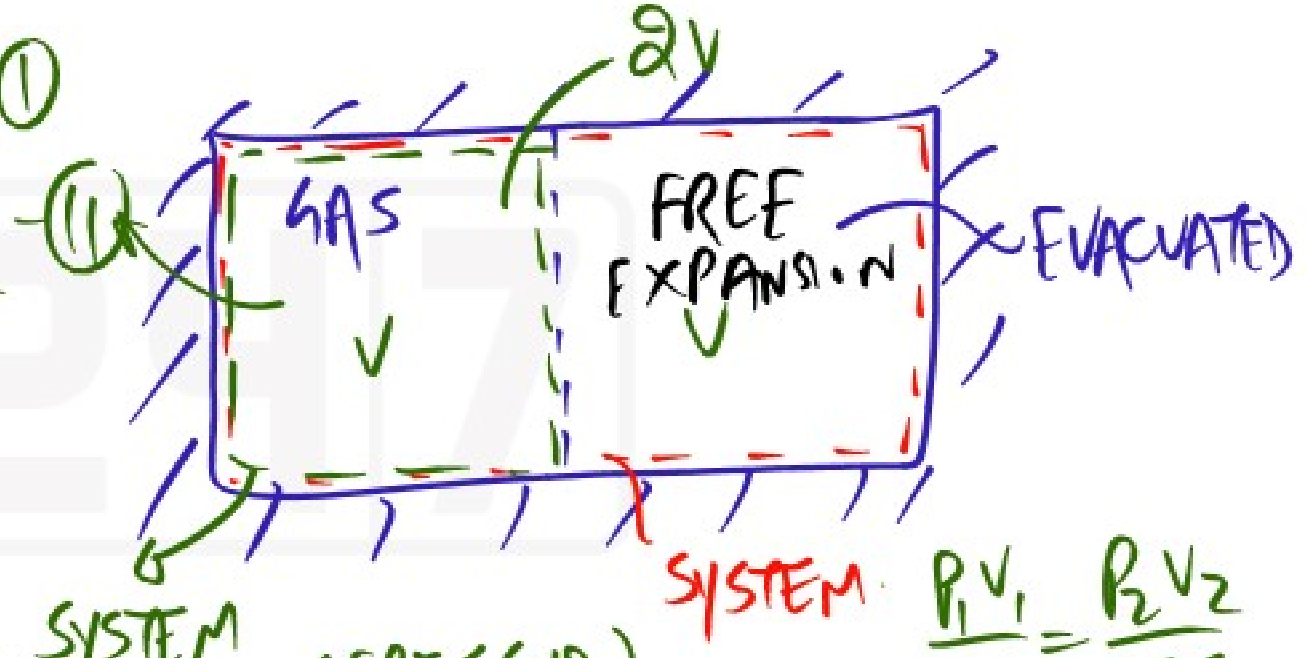
b. Temperature of gas remains constant ✓

c. Entropy of gas remains constant ✗

d. No work is done by the gas ✓

$$\frac{P_1V_1}{T_1} = mR \quad \text{- ①}$$

$$\frac{P_2V_2}{T_2} = mR \quad \text{- (II)}$$



$$\delta Q \xrightarrow{} 0 \text{ SYSTEM}$$

$$\delta Q = dU + \delta W \xrightarrow{} 0 \text{ (FREE EXP.)}$$

$$dU = 0$$

$$\Downarrow$$

$$mC_v dT = 0$$

$$dT = 0$$

$$\boxed{T = C}$$

$$\frac{P_1V_1}{\cancel{T_1}} = \frac{P_2V_2}{\cancel{T_2}}$$

$$P_1 \times \cancel{V} = P_2 \times 2\cancel{V}$$

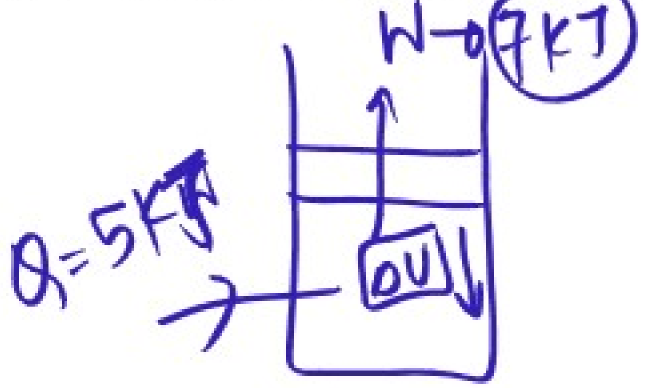
$$\boxed{P_2 = \frac{P_1}{2}}$$

$$\boxed{\Delta S_{uni} \geq 0} \to \begin{cases} \Delta S_{uni} = 0 \text{ (REV.)} \\ \Delta S_{uni} > 0 \text{ (IRRE)} \end{cases}$$

⑤ **Q. ASSERTION (A) :** Though heat is added during a polytropic expansion process for which gamma>n>1, the temperature of the gas decreases during the process

Reason (R) the work done by the system exceeds the heat added to the system

1. [✓ Both A and R are true and R is the correct explanation of A]
2. Both A and R are true but R is not the correct explanation of A
3. A is true but R is false
4. A is false but R is true



Q. An insulated box containing 0.5 kg of gas having Cv=0.98 kJ/kgK falls from a balloon 4 km above the earth surface. The temperature rise of the gas when the box hit the ground is

(A) 0 K

(B) 20 K

(C) 40 K ✓

(D) 60 K

$\boxed{dU} + dPE = 0$

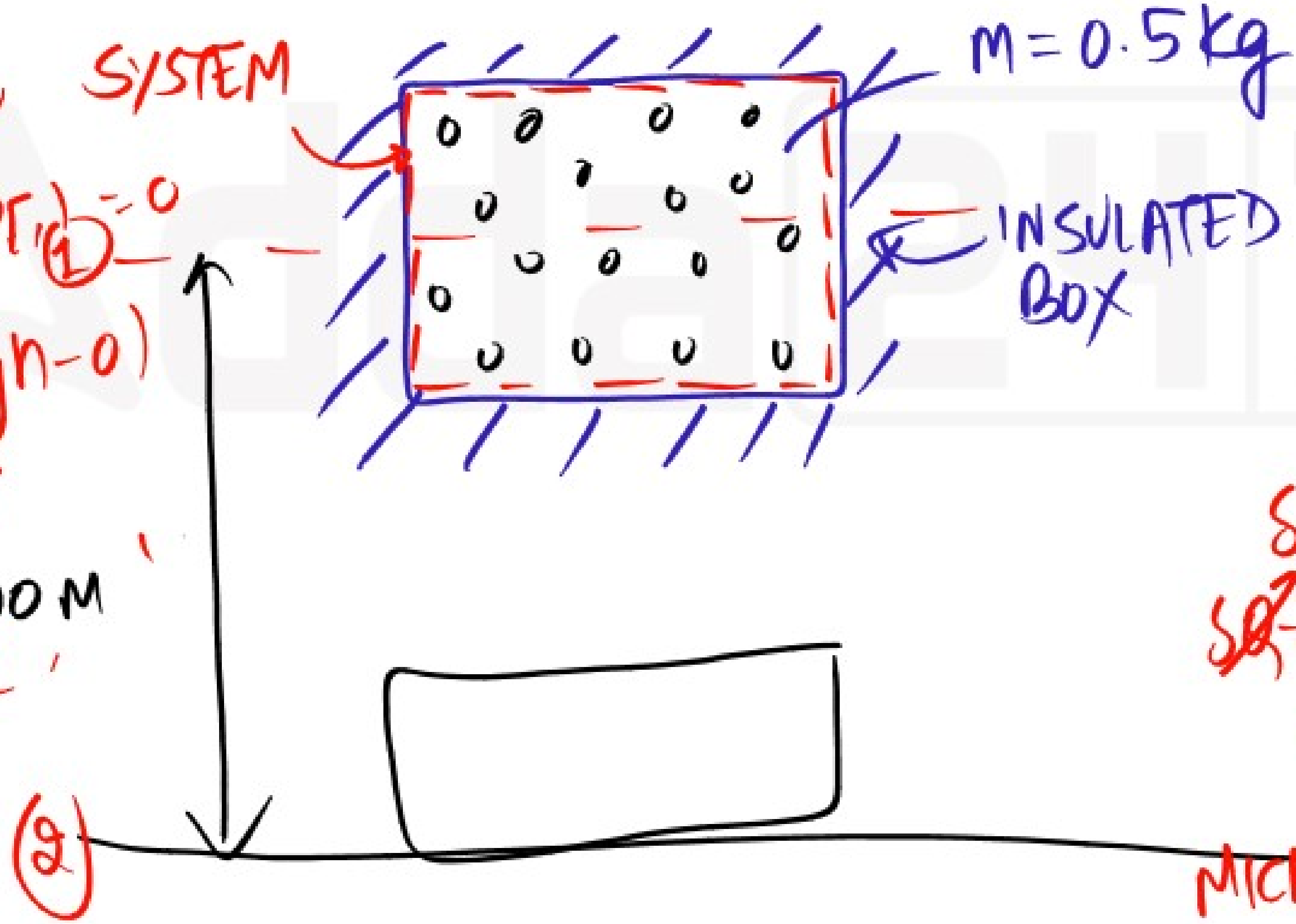
$mC_v\Delta T + (PE_2 - PE_1) = 0$

$mC_v(T_2 - T_1) + (-mgh - 0)$

$\cancel{m}g(4000) = \cancel{m}C_v\Delta T$

$\Delta T = \frac{4000 \times 9.8 \times 10^{-3}}{0.98}$

$= 40K$



$\{Q = 0, W_b = 0\}$

FIRST LAW

⇓

CLOSED LAW

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

$\overset{0}{\cancel{\delta Q}} = \underbrace{dU}_{\text{MICROSCOPIC}} + \underbrace{\overset{0}{\cancel{dKE}} + dPE}_{\text{MACROSCOPIC}} + \overset{0}{\cancel{\delta W}}$

Q. For an ideal gas with constant values of specific heats, for calculation of the specific enthalpy, [2 Marks] ⑦

1. It is sufficient to know only the temperature. ✓
2. Both temperature and pressure are required to be known.
3. Both temperature and volume are required to be known.
4. Both temperature and mass are required to be known.

$\Delta H = mC_p \boxed{\underline{\Delta T}}$

During a non-flow thermodynamic process (1-2), executed by a perfect gas, the heat interaction is equal to the work interaction $(Q_{1\text{-}2} = W_{1\text{-}2})$. When the process is **[1 Mark]**

(A) Adiabatic

[✓ (B) Isothermal]

(C) Isentropic

(D) Polytropic

⑧

$$\delta Q = dU + \delta W$$

$$\Downarrow$$

$$mC_v \Delta T$$

$$\Downarrow$$

$$0$$

$$\Delta T \rightarrow 0$$

The heat transferred in a thermodynamic cycle of system consisting of four processes are successively 0, 8, 6 and –4 units. The net change in the internal energy of the system will be

⑨ ⓑ

(a) –8

[✓ (b) zero]

(c) 10

(d) –10

For the expression $\int pdv$ to represent the work, which of the following conditions should apply?

(a) ✓ The system is closed one and process takes place in non-flow system

(b) The process is non-quasistatic

(c) The boundary of the system should not move in order that work may be transferred

(d) If the system is open one, it should be non-reversible

⑩ → ⓐ

The expression $\int PdV$ can be used for obtaining work of

(a) Throttling process ✗

(b) Steady flow reversible process ✗

(c) Non-flow reversible process ✓

(d) Adiabatic irreversible process ✗

⑪ → Ⓒ

$\boxed{\underline{\int PdV}} = W_b$

→ CLOSED SYSTEM

→ QUASI-STATIC (REVERSIBLE)

Heat and work are

(A) Intensive properties ✗

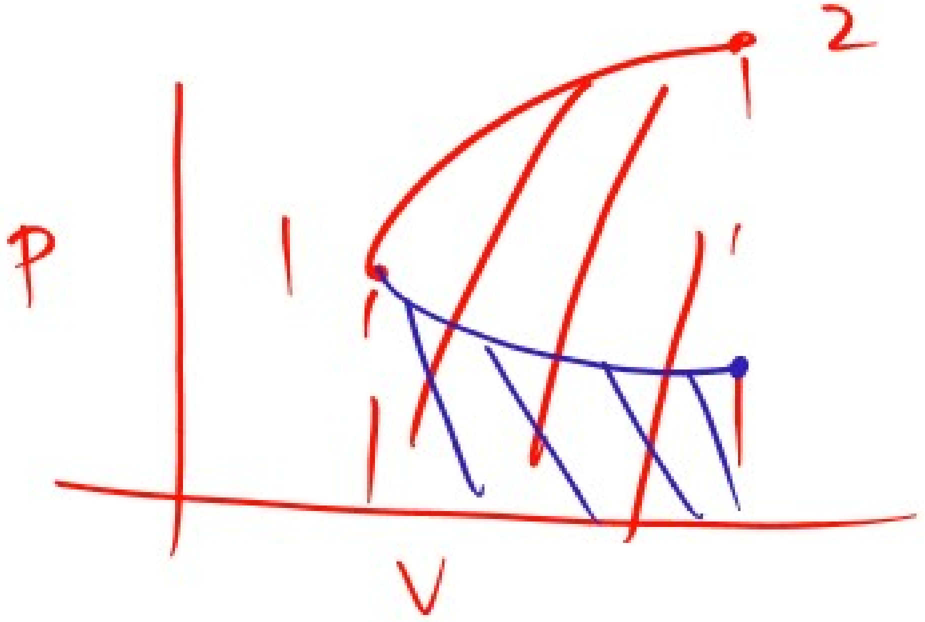
(B) Extensive properties ✗

(C) Point function ✓

(D) Path functions

⑫ Ⓒ

$W_b = \int p\,dv$



Which of the following statements are TRUE with respect to heat and work?

Ⓑ → ⓑ

[1 Mark]

(i) They are boundary phenomena ←

(ii) They are exact differentials ✗

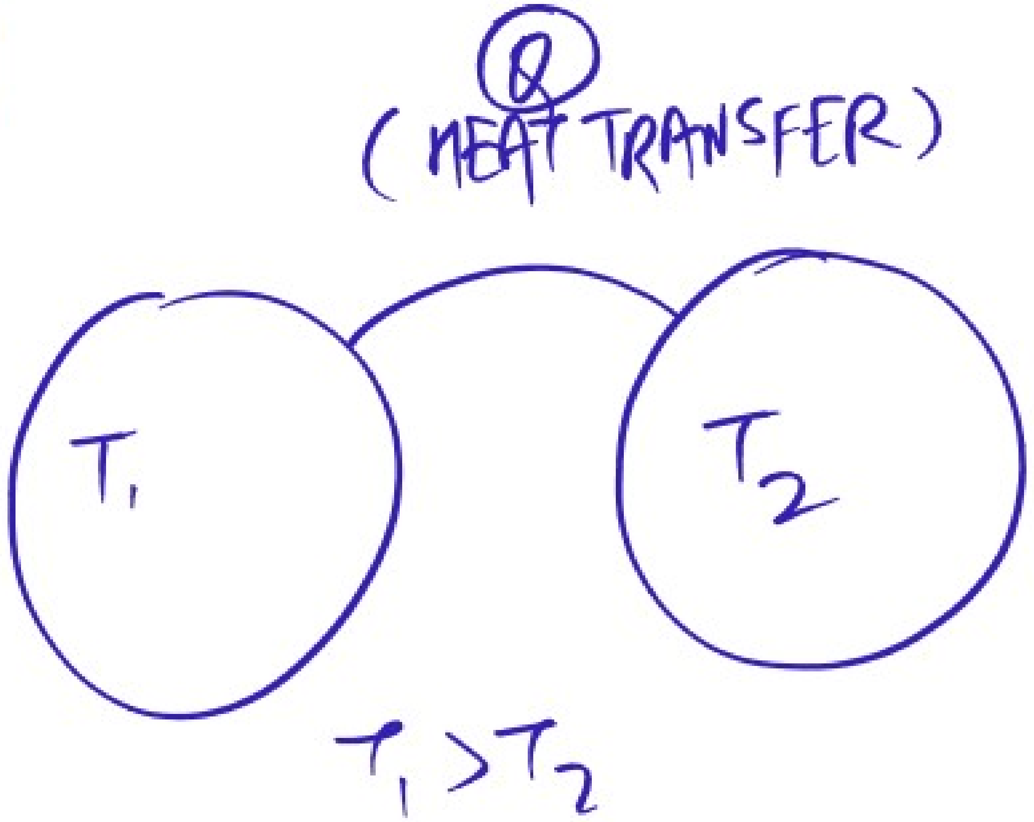
(iii) They are path functions ✓

(A) Both (i) and (ii)

(B) Both (i) and (iii) ✓

(C) Both (ii) and (iii)

(D) Only (iii)



A frictionless piston cylinder device contains a gas initially at 0.8 MPa and 0.015 m^3. It expands quasi-statically at constant temperature to a final volume of 0.030 m^3. The work output (in kJ) during this process will be **[1 Mark]**

(A) 8.32 (B) 12.00

(C) 554.67 (D) 8320.00

14

$$W_b = P_1 V_1 \ln \frac{V_2}{V_1}$$

$$= 0.8\times10^3 \times .015 \ln\left(\frac{.03}{0.015}\right)$$

$$W_b = \underbrace{12 \times \ln 2} \Rightarrow \boxed{8.32}$$

LEARN

$$\left\{\begin{matrix} \ln 2 \\ \ln 3 \\ \ln 5 \end{matrix}\right\} *** \left\{\begin{matrix} \sqrt{2} \\ \sqrt{3} \\ \sqrt{5} \end{matrix}\right\} ***$$

A mass m of a perfect gas at pressure p_1 and volume V_1 undergoes an isothermal process. The final pressure is p_2 and volume is V_2. The work done on the system is considered positive. If R is the gas constant and T is the temperature, then the work done in the process is

15

[1 Mark]

(A) $p_1V_1 \ln\frac{V_2}{V_1}$ ✗

(B) $-p_1V_1 \ln\frac{p_1}{p_2}$ ✓

(C) $RT \ln\frac{V_2}{V_1}$ ✗

(D) $-mRT \ln\frac{p_2}{p_1}$ ✗

$$W_b = -P_1V_1 \ln\frac{V_2}{V_1}$$

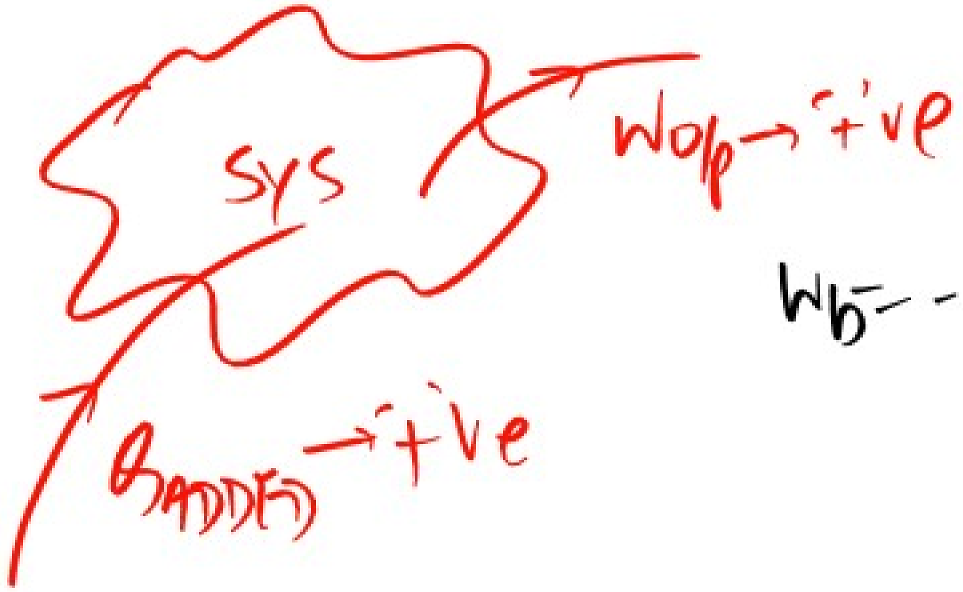
$$\boxed{P_1V_1 = P_2V_2 = mRT_1 = mRT_2}$$

$$\Downarrow$$

$$\frac{V_2}{V_1} = \frac{P_1}{P_2}$$

$$\Downarrow$$

$$W_b = -P_1V_1 \ln\frac{P_1}{P_2}$$



⑯

During a process with heat and work interactions, the internal energy of a system increases by 30 kJ. The amounts of heat and work interactions are respectively

(a) –50 kJ and –80 kJ ✓
(b) –50 kJ and 80 kJ
(c) 50 kJ and 80 kJ
(d) 50 kJ and –80 kJ

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

$\Downarrow$

$\delta Q - \delta W = +30$

$-50-(-80)$

$-50+80 \Rightarrow 30$

$-50-(80)$

-130 X

$50-80$

$=-30$ X

$50-(-80)$

130 X

A system undergoes a change of state during which 100 kJ of heat is transferred to it and it does 50 kJ of work. The system is brought back to its original state through a process during which 120 kJ of heat is transferred to it. What is the work done by the system?

(a) 50 kJ
(b) 70 kJ
(c) 120 kJ
[✓ (d) 170 kJ]

⑰

$Q_{12} = 100$ kJ

$W_{12} = 50$ kJ

$Q_{21} = 120$

W_{21}

$$Q_{12} + Q_{21} = W_{12} + W_{21}$$

$$100 + 120 = 50 + W_{21}$$

$$\boxed{170 = W_{21}}$$

⑱

Match **List-I** with **List-II** and select the correct answer using the code given below:

$\delta Q = \boxed{dU} + \overline{PdV}$

$= dU + d(PV)$

$= d(U + PV) = dH$

List-I (Process)	List-II (Heat transfer equal to)
A. Constant volume	1. Zero
B. Constant pressure	2. Change in internal energy
C. Constant temperature	3. Change in enthalpy
D. Constant entropy	4. Work done

REV + ADIA } ISENTROPIC

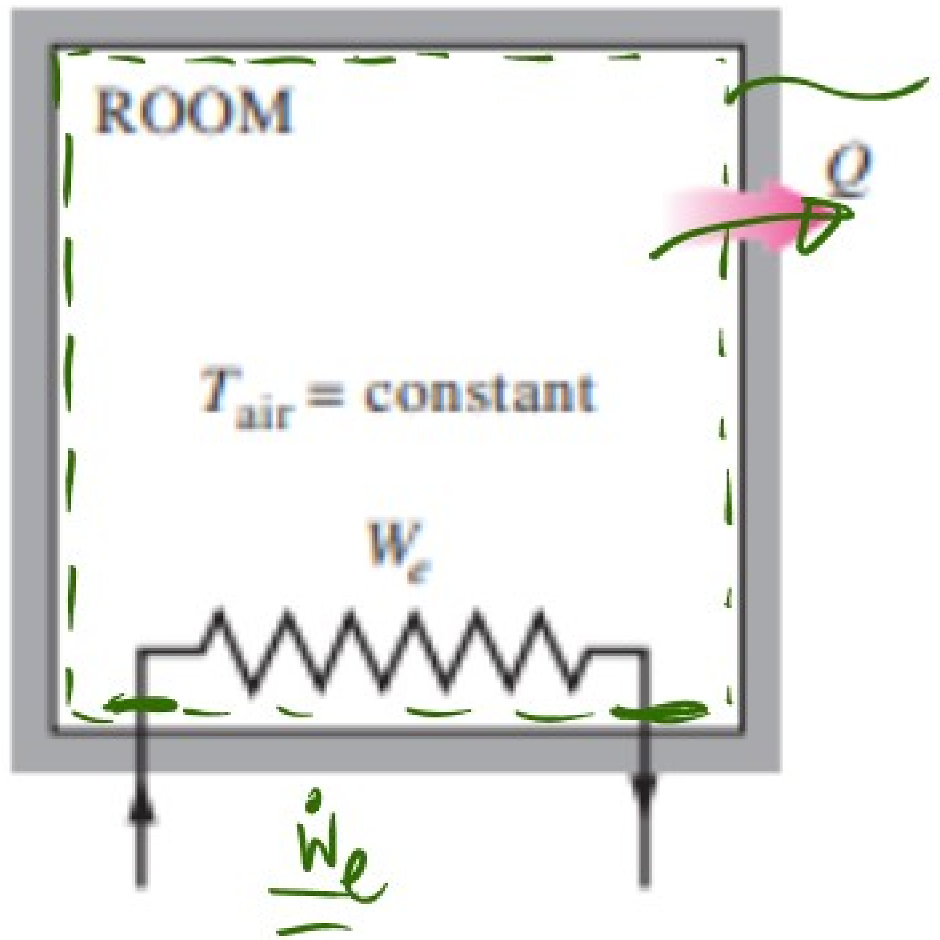
Code :

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

***

Q. A room is heated by a baseboard resistance heater. When the heat losses from the room on a winter day amount to 6500 kJ/h, the air temperature in the room remains constant even though the heater operates continuously. Determine the power rating of the heater, in kW.

(19)



SYSTEM ⇒ $\delta Q = dU + \boxed{\delta W}$

$dU \Downarrow m c_v \Delta T \downarrow 0$

$$-\frac{6500}{3600}\left(\frac{kJ}{s}\right) = \underline{\underline{W}}$$

$$W = \boxed{-}\ \underline{\underline{1.81}}\ kW$$

Triple point temperature of water is

(a) 273 K

(b) 273.14 K

(c) 273.15 K

(d) [✓ 273.16 K]

⑳

$\boxed{0.01^\circ c}$

$$T = 273.15 + 0.01$$

$$= 273.16\ \underline{\underline{K}}$$

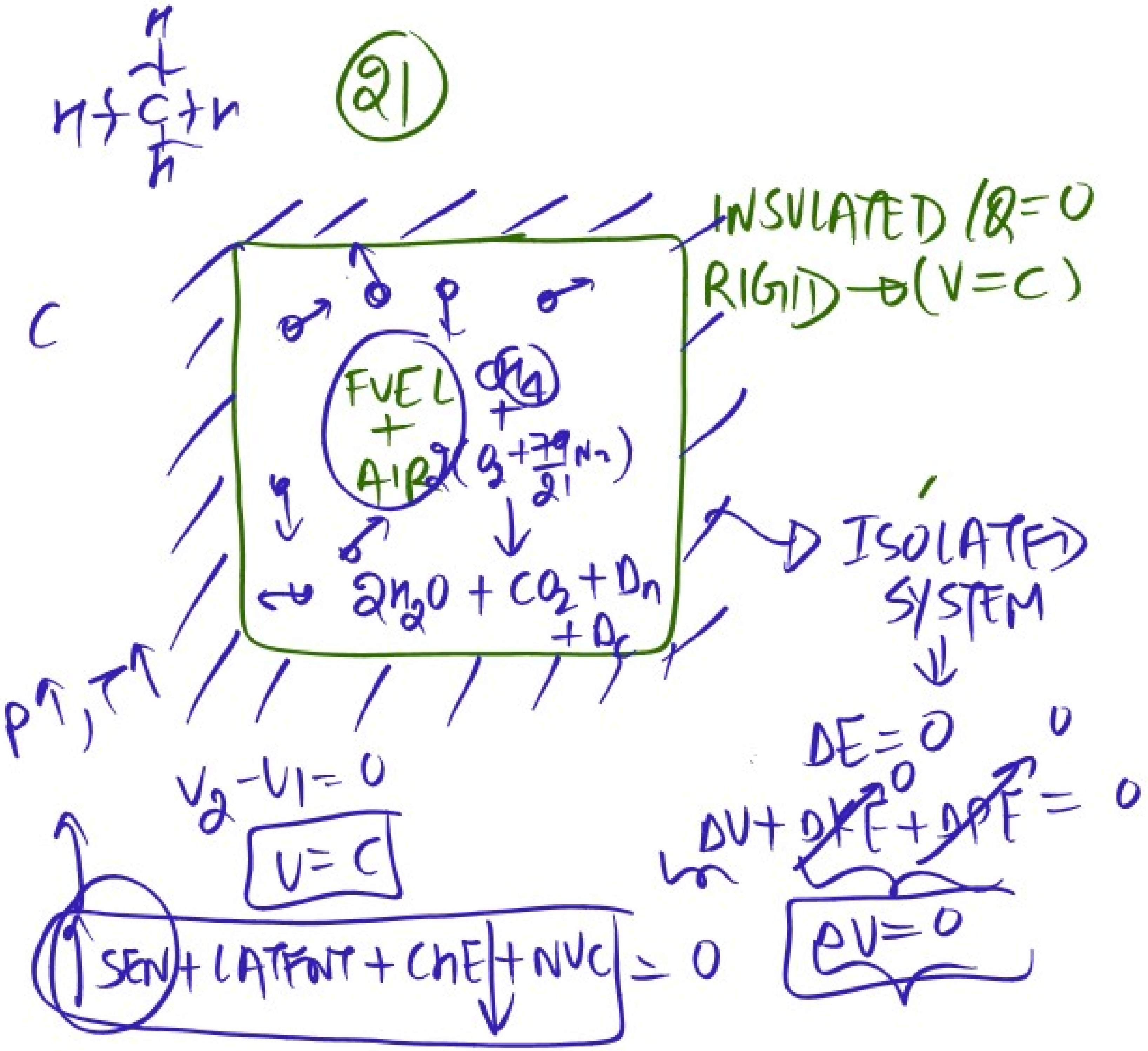
An insulated rigid vessel contains a mixture of fuel and air. The mixture is ignited by a minute spark. The contents of the vessel experience. **[1 Mark]**

(A) Increase in temperature, pressure and energy

(B) Decrease in temperature, pressure and energy

[✓ (C)] Increase in temperature and pressure but no change in energy

(D) Increase in temperature and pressure but decreases in energy



Dryness fraction of steam means the mass ratio of

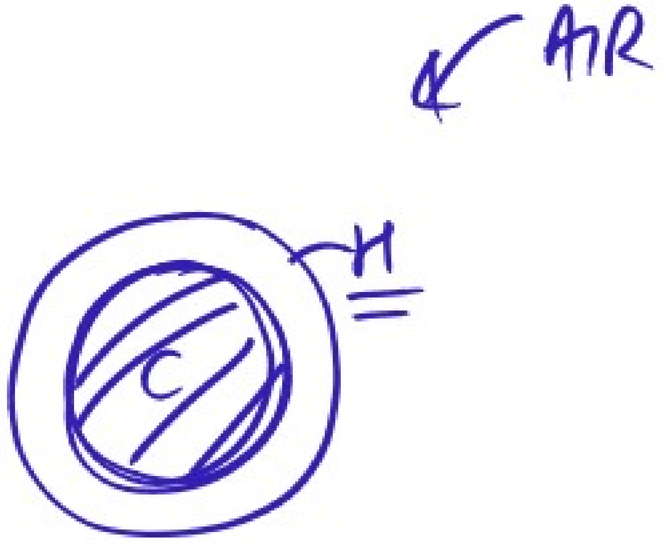
(a) wet steam to dry steam ✗

(b) dry steam to water particles in steam ✗

(c) water particles to total steam ✗

[✓ (d) dry steam to total steam]

22 ⇓



$x = \frac{m_v}{m_{total}}$

$$\boxed{CH_4} + 2\underbrace{\left(O_2 + \frac{79}{21}N_2\right)}_{AIR} \longrightarrow 2H_2O + CO_2$$

$+ D_H + D_C$

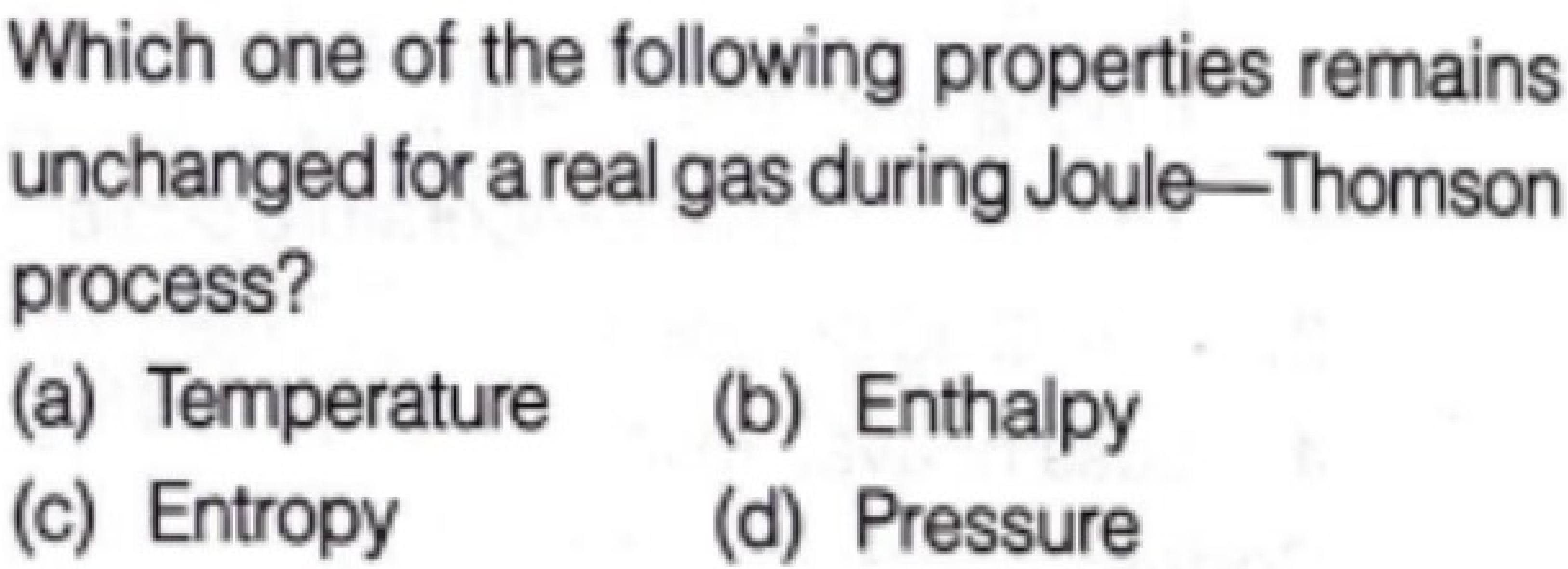
Which one of the following is the correct statement? Steam is said to be superheated when the

(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

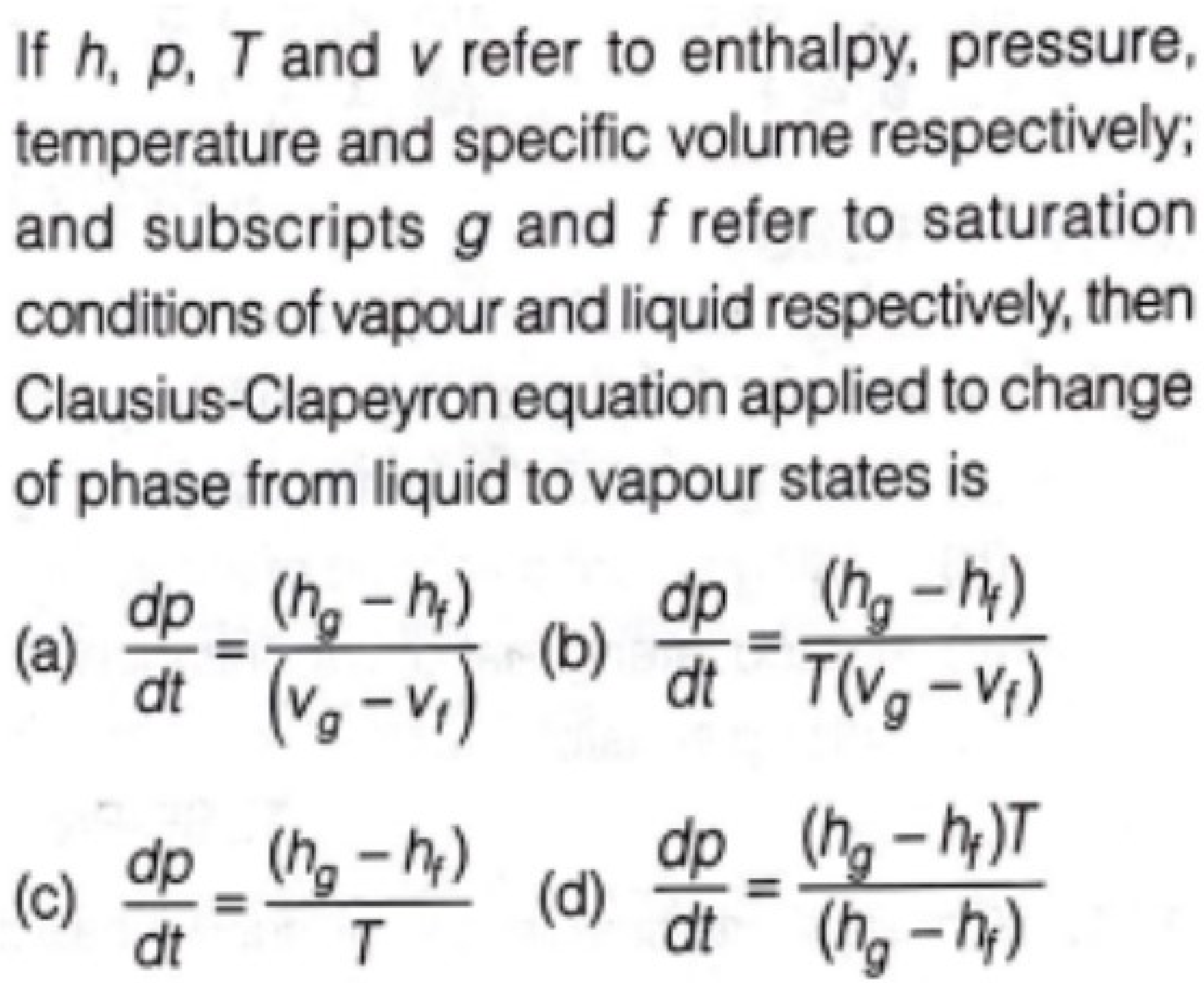
(d) None of the above



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

(a) Temperature (b) Enthalpy

(c) Entropy (d) Pressure



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

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

For an ideal gas, the expression

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

(a) zero

(b) C_p / C_v

(c) R

(d) RT

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

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

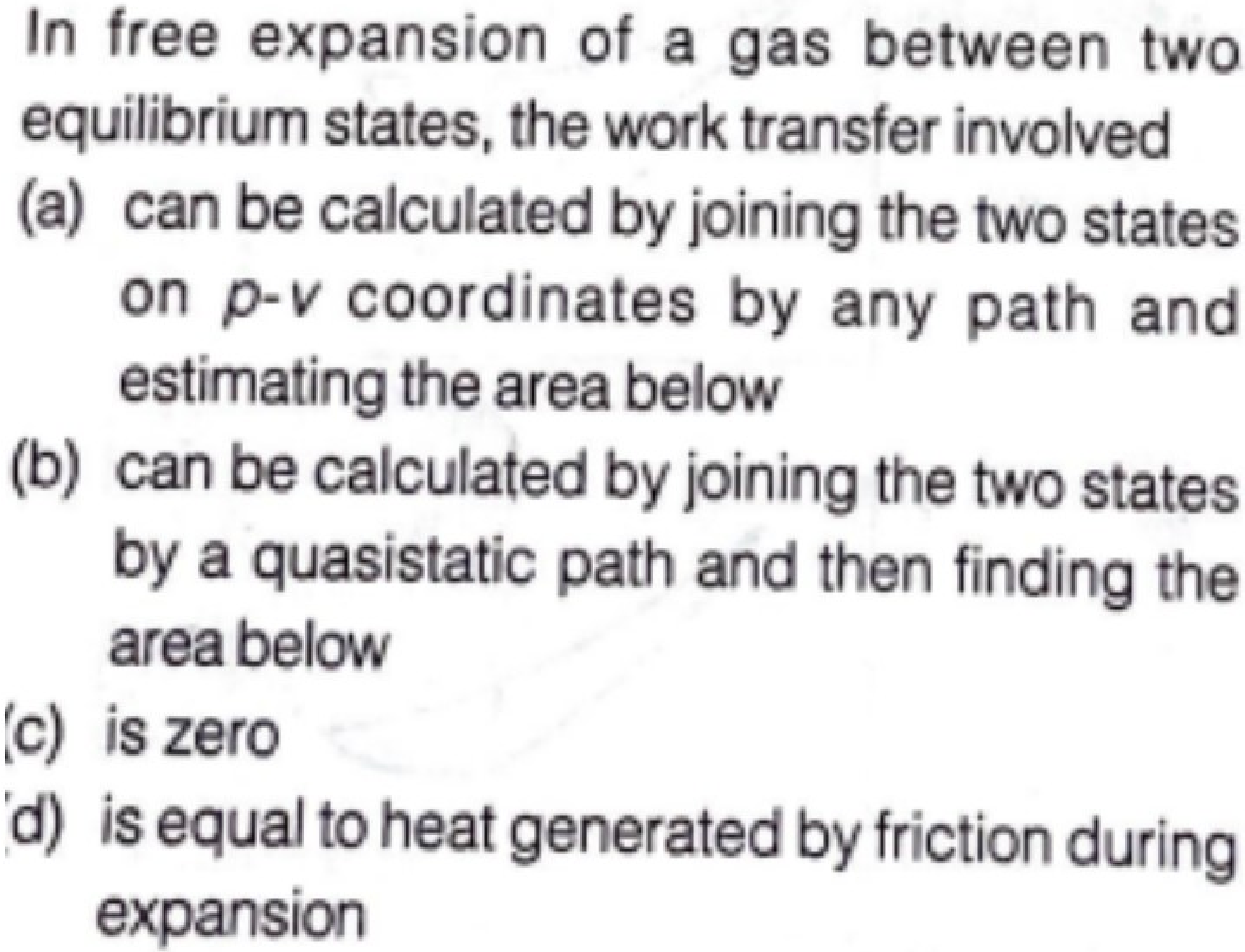
Constant pressure lines in the super-heated region of the Mollier diagram have what type of slope?

(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

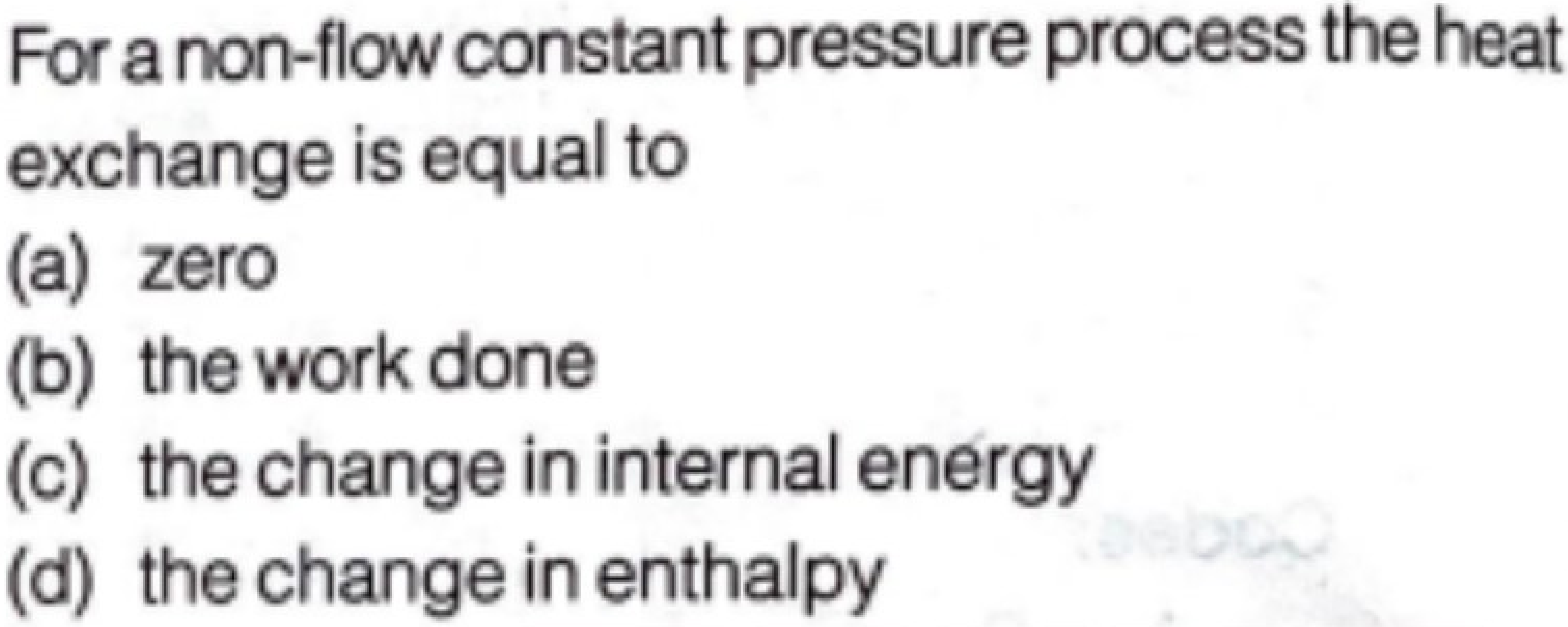
(c) is zero

(d) is equal to heat generated by friction during expansion

Variation of pressure and volume at constant temperature are correlated through

(a) Charle'slaw (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 :

$$pv = RT\left(1+\frac{B}{v}+\frac{C}{v^2}+\frac{D}{v^3}+\ldots\right),$$

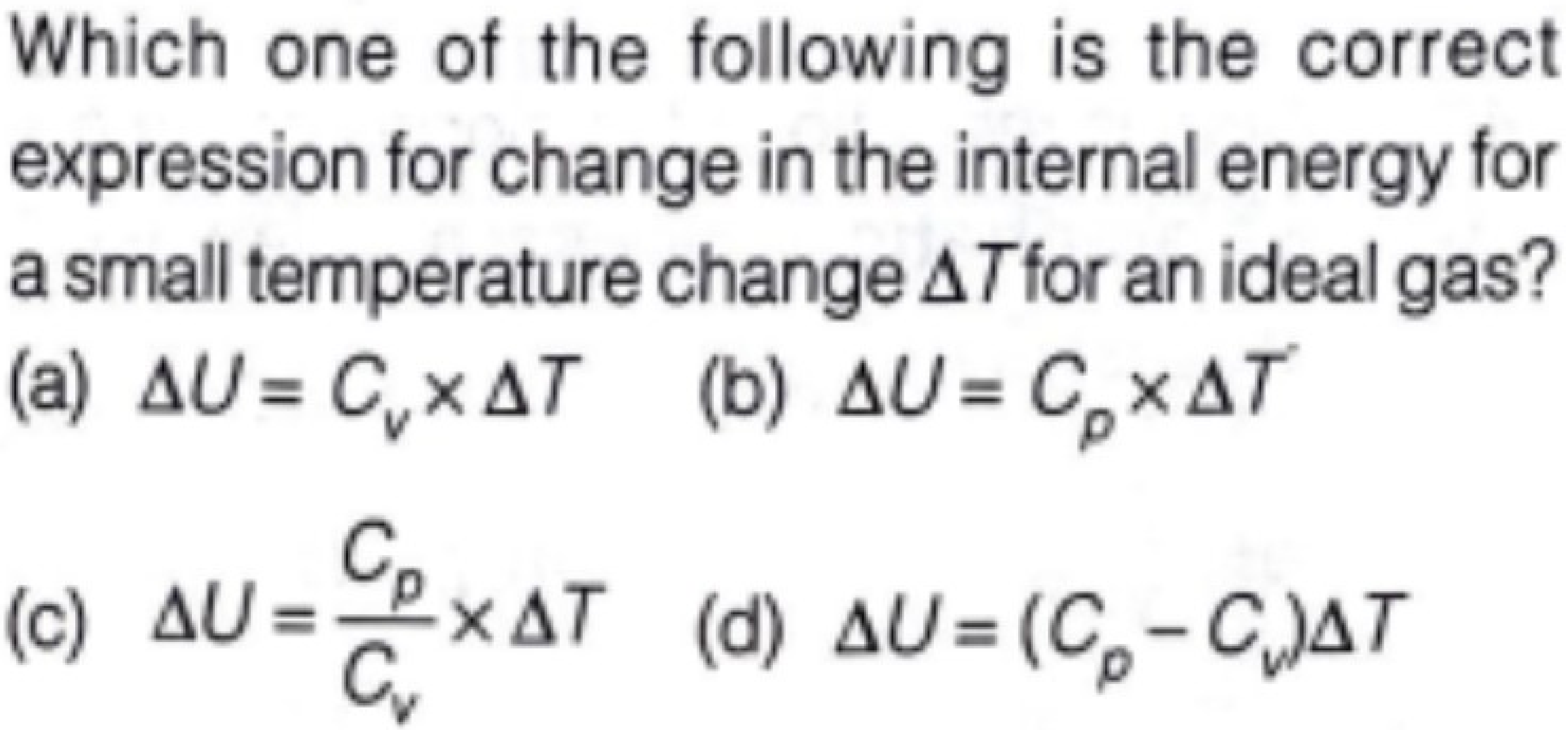
is known as

(a) Van der Waals equation

(b) Benedict-Webb-Rubin equation

(c) Gibbs equation

(d) Virial equation



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) $\Delta U = (C_p - C_v)\Delta T$

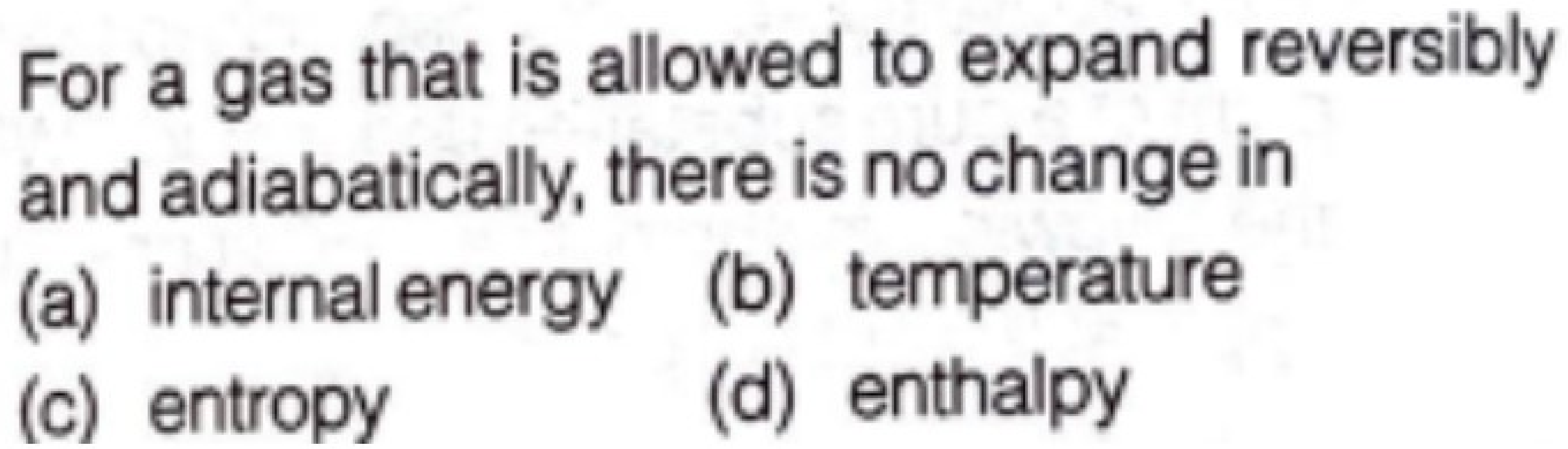
What is the ratio of the slopes of p-v curves for an adiabatic process and an isothermal process ?

(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

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 $\mathrm{PV^n} = \text{constant}$ 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

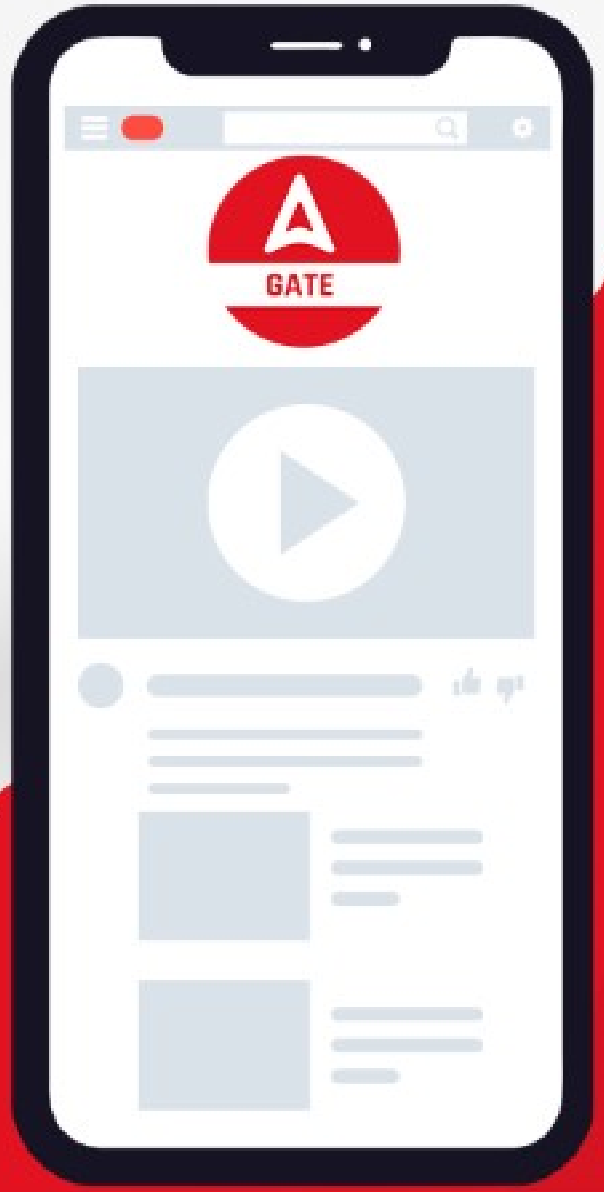
(a) cyclic functions

(b) point functions

(c) path functions

(d) real functions

3PM



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