CHEMISTRY

FOR IIT JEE ASPIRANTS OF CLASS 12 FOR CHEMISTRY

THERMODYNAMICS

Illustration

1. Show that pressure of a fixed amount of a ideal gas is a state function

$$V = \frac{nRT}{p}$$

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2. Find the work done when 18 ml of water is getting vapourised at 373 K is open vessel

(Assume the ideal behaviour of water vapour).

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3. Calculate work for the expansion of a subsatnce from $3m^3$ to $5m^3$ against.

Constant pressure $= 10^5 Pa$

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4. Calculate charge in interanl energy of 10 gm of H_2,when it's state id charge from $(300k, 1Atm)$ to

$(500K, 2Atm)$

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5. Calculate charge in interanl energy for a gas under going from state-I $(300K, \times 2 \times 10^{-2}m^3)$ to state -II $(400K, 4 \times 10^{-2}m^3)$ for one mol .of vanderwaal gas.

$[C_V = 121J/K/\text{mole}]$

$\left\{Given: \left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P\right.$

$C_V = 12J/K/mol$

$\left. a = 2J.m./mol^2\right\}$

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6. The pressue of a fluid is a linear function of volume (P=a+bV)and the internal energy of the fluide is $U = 34 + 3PV$(S.I.units). Find a,b,w, ΔE and q for change is state from $(100Pa, 3m^3)$ to

$(400Pa, 6m^3)$

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7. 1 mole of real gas is subjected to a process from$(2\text{bar}, 40lit., 300K)$ to $(4,^{-} 30lit., 400K)$. If

Change in interal energy is 20 kJ then calculate enthalpy charge for the process.

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8. One mole of an ideal gas is expanded isothermally at 300 K from 10 atm to 1 atm. Calculate q,w, DeltaU

& DeltaH under the following conditions.

(i) Expansion is carried out reversibly .

(ii) Expansion is carried out irreversibly.

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9. One mol an ideal gas is expanded from$(10atm, 10lit)$. $(2atm, 50lit)$ isothermally . First against 5 atm

then against 2 atm . Calculate work done in each step and compare it with single step work done.

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10. For 1 mole of monoatomic gas . Calculate $w, \Delta U, \Delta H, q$

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11. One mole of an non liner triatomic ideal gas is expanded adiabaticlly at 300 K from 16 atm to 1 atm

Calculate Work done under the following conditions

(i) Expansion is carried out reversibly (ii) Expansion is carreid out irrevesibly

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12. Calculate work done is process BC for 1 mol of an ideal gas if total 600 cal heat is released by the gas

is whole process

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13.

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14. Calculate maximum η for an heat engine operating between 27° C to 127° C.

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15. Calcuate entrophy change in each step for an ideal gas (monoatomic)

$$\underset{(\ 1\text{ atm, }22.4\text{ l, }273\text{ K})}{State(A)} \rightarrow \underset{(1\text{ atm, }33.6\text{ l, }409.5\text{ K})}{State(B)} \rightarrow \underset{(2\text{ atm, }33.6\text{ l, }819\text{K})}{State(C)}$$

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16. One mole of an ideal gas is expanded isothermally jat $300K$ from 10 atm to 1 atm . Find the values of

$\Delta S_{sys}, \Delta S_{surr}, \& \Delta S_{\text{total}}$ under the following conditions .

(i) Expansion is carried out reversibly

(ii) Expansion is carried out irreversibly

(iii) Expansion is free.

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17. For the reaction

$N_2 + 2O_2 \rightarrow 2NO_2$

Given: at 1 atm , 300 K

$$\begin{array}{ll} S_{N_2} = 180 J / mol / K & C_P(N_2) = 30 J / mol / K \\ S_{O_2} = 220 J / mol / K & C_P(O_2) = 30 J / mol / K \\ S_{NO_2} = 240 J / mol / K & C_P(NO_2) = 40 J / mol / K \end{array}$$

Calculate (i) $\Delta S_{300} K, 5atm$

$(i) \Delta S_{400} K, 5atm$

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18. Calculate entropy charge

$H_2O(l, 1atm, 100^\circ C)$ rarr $H_2O(g, 1 \quad atm, 110^\circ)$

$H_2O(l, 2 \quad atm, 100^\circ)$rarr $H_2O(g, 2 \quad atm, 100^\circ)$

$\Delta H_{vap} = 40kJ / \text{mole" "}C_p(l) = 75J / \text{mole} / K\text{" "}C_p(g) = 35J / \text{mole} / K$

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Solved Example

1. Value of γ for CH_4 molecule is (Consider vibarational degree of freedom to be active).

A. $4/3$

B. $\frac{13}{12}$

C. $\frac{15}{14}$

D. $\frac{17}{15}$

Answer: B

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2. $gama$ for NH_3 including contribution from vibrataional degree's freedom is

A. $4/3$

B. $\frac{10}{9}$

C. $\frac{7}{6}$

D. $\frac{13}{12}$

Answer: B

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3. 1 mole of an ideal gas is expanded isokthermally and reversibly from 1 litre to litre. Which of the

following is false for the process ?

A. $\Delta T = 0$

B. $\Delta E = 0$

C. $\Delta H = 0$

D. heat supplied (q)=0

Answer: D

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4. Pressure over 1 liter of s liquid is gradually increase from 1 vbar to 100 1 bar under adiabatic condition.

If the final volume of the liquid is 990 ml , calculate ΔE and `Delta H of the process assurimg linear variation

of volume with pressure.

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5. One mole of a real gas is subjected to a process from (2 bar , 30 lit ., 300k) to (2 bar , 40 , lit ., 500K)

Given :$C_v = 25J / \frac{\text{mole}}{K}$

$C_p = 40J / \frac{\text{mole}}{K}$

Calculate ΔU.

A. 5000 J

B. 6000 J

C. 8000 J

D. 10000 J

Answer: B

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6. One mole of ideal gas undergoes following cyclic process

(i) Isochoric heating from $(P_1 V_1 T_1)$ to double temperature.

(II) Isobaric expansion from to double voulme .

(III) Linear expansion (on PV curve) to $(P_1, 8V_1)$.

Isobaric copmression to initial state.

Calculate the magnitude of work done in calories if initial trempérature of the gas in is $300K$?

Given : $R = 2\frac{Cal}{mol - K}$

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7. Determine the total work done by gas (in Joule) if system

follows an expansion process as shown in figure

[Given : 1 bar liter =100J]

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8. A student is calculating the work during a reversible isothermal process

, show by 2 mole of an ideal

gas . He by mistake calculate the area as show in the PV graph (Shaded

area) equal to 49.26 liter atm .

Calculate the correct value of work (in litre atm) during the process.

(Given : R =0.0821 liter atm // "mole"/K)

A. 49.26

B. -34.14

C. -78.63

D. -98.52

Answer:

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9. Calculate the magnitude of work done (in atm lit.) for the given cyclic process involing 1 mole of an

ideal gas .[Given : R =0.08 atm lit./mole /k]

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10. Log P vs log V curve is plotted for an ideal gas, which is true for the gas ?

A. Monoatomic & undergoing adiabitc chagre

B. Monatomic & undergoing an isothermal change

C. Diamtomic & undergoing an adiabitc charge

D. Triatomic & undergoing an isothermal change

Answer: C

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11. A certain mass of a gas is expanded from (1L, 10 atm) to (4L, 5 atm) against a constant external pressure of 1 atm . If initial temperature of gas is 300 K and the heat capacity of process is $50J/^{\circ}C.Calc\underline{a}te$ DeltaH`(in kJ) of the process .(Given 1 L atm = 100 J).

(Fill your answer by multiplying it with 100)

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12. A liquid confined inside an adiabatic container is suddenly taken from state 1 to state 2 by a single stages

process as shown, then ΔH is

A. $\Delta H = \dfrac{2\gamma P_0 V_0}{\gamma - 1}$

B. $\Delta H = -P_0 V_0$

C. $\Delta H = -3P_0 V_0$

D. $\Delta H = -\dfrac{3\gamma P_0 V_0}{\gamma - 1}$

Answer: B

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13. One mole of Argon is heated using $PV^{5/2}$ = constant . By what amount heat is absorbed during the

'process , when temperture changes by $\Delta T = 26K$.

A. $100J$

B. $200J$

C. $180J$

D. $208J$

Answer: C

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14. One mole monoatomic ideal gas was taken through process ABCD as show in . Calculate

(i) $W_{AB}, W_{BC}, W_{CD}, W_{DA}$

(ii) $q_{AB}, q_{BC}, q_{CD}, q_{DA}$

(iii) $\Delta H_{AB}, \Delta H_{BC}, \Delta H_{CD}, \Delta H_{DA}$

$[Use : \ln(3/2) = 0.40 : In(4/3) = 0.29]$

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15. Work done (in kJ) by the gas in the following cyclic process is

A. -11

B. -11000

C. 11

D. 11000

Answer: A

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16. Consider an isothernmal cylinder and massless kpiston assembly in which ideal gas is filled . Cross sectional

area of the cylinder = $1m^2$. Three masses m_1, m_2 and m_3 are kept on the piston . When m_1 id removed ,

piston moves upon point A. When $m_1 \& m_2$ both are removed piston moves upto jkpint B & when m_1

$m_2 \& m_3$ all three are removed , piston moves upto ,lpoint C. Calculate work done by the gas

(in joule) when piston moves from point B to point C.

$\left[Given : m_1 = 2 \times 10^4 kg, m_2 = 3 \times 10^4 kg, g = 10 m / s^2\right]$

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17. Calculate difference in work done in process -I to process -II.

$(Given : \pi = 3)$

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18. The external pressure 2 atm is applied frictionless movable piston, fitted in vessel containing 100 g of

X(l) at 450 K. Now heat is supplied keeping pressure constant till 40 g of

X is evaporated to from X(g)

at 500 K (boiling pont) . Calculate charge in internal (ΔU) energy in kJ for overall processe.

Assume vapour of X(l) behaves like an ideal gas.

Given : Molar heat capacity of $X(l) = 60J/mol. K$:

DeltaH_(vaporisationm) = 30 kJ// mol : R = 8.3 J// mol- K $At. weitghof$X= 20 G//MOL`.

[Fill your answer by mutiplying it with 100.]

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19. An ideal gas with adiabatic exponent γ undergoes a process in which internal energy depends on volume

as $U = aV^{\alpha}$ then select the correct statement .

A. Change in internal energy is $\frac{\gamma - 1}{\alpha}\Delta T$

B. Molar heat capacity of process is $\frac{R}{1-\gamma} + \frac{R}{\alpha}$

C. Heat exchange in the process is given by $\Delta U\left[1 + \frac{1-\gamma}{\alpha}\right]$

D. Equation of process is given is PV^x=constant , where $x > 0 \text{ if } \alpha < 1.$

Answer: D

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20. An adiabatic cyclinder fitted with an adiabatic piston at the right end of cylinder, is dicided into equal

halves with a monoatomic gas of the left side and diatomic gas on right side, using animpermeable movales

adiabatic wall , . If the piston is pushed slowely to compress the diatomic gas to $\frac{3}{4}th$ of its origanl volume.

The new volume of the monoatomic gas would be.

A. $V_{\text{new}} = V_{\text{initial}} \times \left[\frac{4}{3}\right]^{\frac{25}{21}}$

B. $V_{\text{new}} = V_{\text{initial}} \times \left[\frac{7}{5}\right]^{\frac{3}{4}}$

C. $V_{\text{new}} = V_{\text{initial}} \times \left[\frac{3}{4}\right]^{\frac{21}{25}}$

D. $V_{\text{new}} = V_{\text{initial}} \times \frac{3}{4}$

Answer: C

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21. Calculate the work done by system in an irrevesible (single step) adiabatic expansion of 1 mole of a polyatomic gas from 300K and pressure 10 atm to 1 atm.$(\gamma = 1.33)$.

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22. A cylinder container of volume 4.48 liters is containing equal no . Of moles of a monoatomic gas in two section A and B separated by an adiabatic frictionless piston as show in figure . The initial temperature and pressue of gases was 273 K and 1 atm. Now gas section 'A' is slowly heated till the volume of section B becomes $1/2\sqrt{2}$ of initinal volume. Find total change in ΔH for section A and B . (in cal/mole)

$$[C_v \text{of monoatomic gas} = 3/2R, \gamma = 5/3]$$

$[UseR = 2cal/mol\&\sqrt{2} = 1.4]$

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23. A gas $\left(C_{v.m} = \frac{5}{2}R\right)$ behaving ideally is allowed to expand reversibly and adiabatically from 1 litre to 32 litre. Its initial temperature is $327^\circ C$. The molar enthalpy change (in J/mol) for the process is :

A. $-1125R$

B. $-575R$

C. $-1575R$

D. None of these

Answer: C

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24. 1000 gm water is heated from 27° C to $47^{\circ}C$ at a constant pressure of 1 bar . The coefficient of volume expansion of water is $0.002/^{\circ}$ C and the molar volume of water at 0° is $18.00cm^{3}/\text{mol}$. The magnitude of work done (in J) by water is

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25. The temperture of a definite amount of an ideal monoatomic gas becomes four times in a reversible process for which heat exchange is zero. Which of the following is correct relation between the final and initial parameters of gas ?

A. $V_f = 8V_i$

B. $P_f = 32P_i$

C. $V_f = 16V_i$

D. $P_f = \frac{1}{16}P_i$

Answer: B

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26. Inversion temperature $\left(T_i = \frac{2a}{Rb}\right)$ is defined as the temperature above which if gas is expanded

adiabatically it gets warm up but if temperature of gas is lower than T_i then it will cool down. What will

happen to gas if it is adiabatically expanded at $50^\circ C$ if its Boyle's temperature is $20^\circ C$

A. heating

B. cooling

C. constant

D. None of these

Answer: B

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27. Which of the following statement(s) is /are correct:

Statement (a): The entropy of isolated system with P-V work only is always maximized at equilibrium

Statement (b) : It is possible for the entropy of closed system to decrease substanilly in a irreverrsible process.

Statement (c): Entrophy can be created but not destrpoyed .

Statment (d) : ΔS_{system} is always zero for reversible processe in an isolated system

A. Statement a, b, c

B. Statement b,d

C. Staement a,b,c

D. All

Answer: D

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28. 1 Kg stone at 27°C falls 100 m into a lake whose temperature is 27° C. Find the entropy charge of (a) the stone (b) the lake (c) the univers when

(i) stone is lowered reversibly

(ii) stone is dropped freely

Compare the loss of available energy in two cases

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29. A mole of steam is condensed at 100° C, the water is cooled to 0°C and frozen to i.e . What is the difference in entropies of the stem and ice? The heat of vaporization and fusion are $540cal \quad gm^{-1}$ and $80cal \quad gm^{-1}$ respectively . Use the average heat capacity of liquild water as $1cal \quad gm^{-1} degree^{-1}$.

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30. Heat capcaity of a solid A(s) given by aT^{3} in vicinity at abbsolute zero . Taking heat capacity to be aT^{3} ferom 0 K and 10 K, from 10 K to noramal

M.P at 150 K and c from 150 K to 200 K , find the absolute entropy of A(l) at 200 K .

Given $a = 0.5 \times 10^{-3} J(\ \text{k mole})$

b=15 J (K mole)

c=20 J (K mole)

$\Delta H_{fusion} = \ + 30KJ/\text{mole}$

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31. For a perfectly crystalline solid $C_{\text{p,m}} = T^3 + bT$, where a & b are constant . If $C_{\text{p,m}}$ is $0.04J/k - \text{mole}$ at 10 K and io $0.92J/K - \text{mole}$ at 20 k, Then molar entropy at 20 k is.

A. $0.\ 92J/K - mol$

B. $8.66J/K - mol$

C. $0.813J/K - mol$

D. None

Answer: C

32. Two mole of ideal gas is expanded irrversibly & isothermally at 27° C until its volume is double and $3.3kJ$ heat is absorbed from surrounding . Determine ΔS_{System} & $\Delta S_{\text{surrounding}}$.

33. As ideal gas undergoing cyclie process ABC .A consisting of isothermal expansion AB, isobaric compression BC & adiabatic copmression CA. Find the %(approximate) efficiency of cycle.

$$\left[Given: T_A = T_B = 400K, \gamma = 1.5, In2 = 0.7, 2^{1/3} = 0.8\right]$$

34. 0.5 mole of an ideal monoatomic gas at STP conditions undergoes a process , if the final volume of gas is $(22.5 \times e)$ lit, then the entropy change in thid process in k/J/mol is .

(Given: Process isobaric)

(Fill your answer by multiplying it with $\frac{100}{R}$)

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35. When two equal sized pieces of the same mental at different temperature T_h (hot piece) and T_c(cold piece) are brought into thremal constant and isolated from it's surrounding. The total charge in entropy of system is given by

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36. A reversible heat engine A(based on carnot cycle) absorbs heat from a reservoir at 1000 K and rejects

heat to a reservoir at T_2. A second reversible engine B absorbs, the same amount of heat as rejected by

the engine A, from the reservoir at T_2 and rejects energy to a reservoir at 360 K.

If the efficienices of engines A and B are the same then the temperature T_2 is .

A. 680 K

B. 640 K

C. 600 K

D. none

Answer: D

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37. Whch of the following statement(s) is/are correct :

Statement (a) : In any closed system with P,V work only ,G is always minimized at eqilibrium .

Statement (b): ΔG is always zero for a

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38. Select the correct statement(s).

A. $dG = Vdp - SdT$ is applicale for all process involving both 'PV' and non

B.

C.

D.

Answer: B

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39. Form the given T-S diagram of a reversible carnot engine, find

(i) work delivered by engine in one cycle

(ii) heat taken from the source in each cycle .

(iii) $\Delta S_{\sin k}$ in each cycle .

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40. Fixed amount of an ideal gas contained in a sealed rigid vessl(V=24.6 litre) at 1.0 bar is heated reversibly from 27° to 127° C. Determine charge in G ibb's energy (|ΔG|in Joule) if entropy $s = 10 + 10^{+2}T(J/K)$

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41. A reaction at 300 K with $\Delta G^\circ = -1743J/mol$ consister of 3 mole of A(g), mole of B(g) and 3 mole of C (g). If A, B and C(g) . If A,B and C are equal are in equilibrium in 1 liter container then the reaction may be

$[Given: 2 = e^{0.7}, R = 8.3J/K - mol]$

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Exercise

1. Select the intensive and extensive propertie from the following :

Entropy , specific entropy , triple point of water , volume of gas , pressure.

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2. Show that Volume of a fixed amount of an ideal gas is a state function

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3. Find the work done in each case :

(a) When one mole of ideal gas in 10 liter container aat 1 atm, is allowed to enter a vaccuated bulb of capacity 100 liter.

(b) When 1 mole of gas expands from 1 liter to 5 liter a against constant stamospherice pressue .

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4. Calculate change in internal energy of CO_2 for two mole, if temperatur change I s$100K$ in very high tempertaure range.

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5. One mole of an ideal gas expands from state-I (Atm , 20 litre) to (2 Atm , 10 litre) isothermally .

Caluclate , $w \& \Delta U$.

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6. 1150 kcal heat is relased when following reaction is carried out constant volume 27°

$$C_7H_{16}(l) + 11O_2(g) \rightarrow 7CO_2(g) + 8H_2(l)$$

Find the heat change at const power .

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7. Calculate work done for an ideal gas(In 2=0.7)

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8. Calculate w=?(In 2=0.7)

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9. One mole of an non linear triatomic ideal gas is compressed adiabatically at 300 K from 1 atm to 16 atm.

Calculate Work done under the following conditions.

(i) Expansion is carried out reversibly

(ii) Expansion is carried out irreversibly.

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10. One mole of ideal monatomic gas in taken in cyclice process ABCA as shown in the figure

Calculate :

(a) The work done by the gas

(b) The heat rejected by the gas in the path CA

(c) The net heat absorbed be the by gas in the path BC

(d) Maximum temperature obtained by the gas during the cycle.

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11. One mole of an non linear triatomic ideal gas is expanded abiabatically at 300 K form 16 atm to 1 atm ltbr gt Find the value $\Delta S_{sys}, \Delta S_{surr} \& \Delta S_{\text{total}}$ under the following conditions.

(i) Expansion is carried out reversibly

(ii) Expansion is carried out irreversibly

(iii) Expansion is free.

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12. For the reaction

$N_2 + 2O_2 \rightarrow 2NO_2$

Given : at 1 atm, 300 K

$S_{N_2} = 180J/mol/K \qquad C_P(N_2) = 30J/mol/K$

$S_{O_2} = 220J/mol/K \qquad C_P(O_2) = 30J/mol/K$

$S_{NO_2} = 240J/mol/K \qquad C_P(NO_2) = 40J/mol/K$

Calculate (i) $\Delta S_{300}K, 5atm$

$(i)\Delta S_{400}K, 5atm$

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13. Calculate entropy change

$H_2O(l, 1atm, 100^\circ) \rightarrow H_2O(g, 1atm, 110^\circ)$

$H_2O(l, 1atm, 100^\circ) \rightarrow H_2O(g, 2atm, 100^\circ)$

$\Delta H_{vap} = 40kJ/\text{mole" "}C_p(l) = 75J/\text{mole}/K\text{" "}C_p(g) = 35J/\text{mole}/K$

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14. Calculate ΔG for

(i) $H_2O(l, 2atm, 300K) \rightarrow H_2O(g, 2atm, 300K)$

(ii) $H_2O(l, P \quad atm, 300K) \rightarrow H_2O(g, P \quad atm, 300K)$ Cacluate p for which $\Delta G = 0$

Given: $\Delta H_{373} = 40kJ$

$$C_P(H_2O, l) = 75J/mol/K$$

$$C_P(H_2O, g) = 35J/mol/K$$

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Exercise 1

1. Out of boiling pont (I), entropy (II), pH (III) and density (IV), Intensive properties are :

A. I,II

B. I,II,III

C. I,III,IV

D. All of these

Answer: C

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2. Consider the reaction at 300 K

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g) \qquad \Delta H = -185 kJ/mol$

Calculate ΔU if 3 mole of H_2 completely react with 3 mo,le f of Cl_2 to from HCl.

A. 0

B. $-185kJ$

C. $555kJ$

D. None of these

Answer: D

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3. Ethyl choride $(C_2H_4(g)Cl)$, is prepared byt reaction of ethylen with hydrogen chloride :

$C_2H_4(g) + HCl \rightarrow C_2H_5Cl(g)$

What is the value of ΔU (in kJ), if 70 g ethlene and 73 g of HCl are allowed to react at 300 K.

A. -69.8

B. -180.75

C. -174.5

D. -139.6

Answer: D

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4. What is ΔU for the process described by figure . Heat supplied during the process $q = 100kJ$

A. $+50kJ$

B. $-50kJ$

C. $-150KJ$

D. $+150kJ$

Answer: B

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5. What is the change in internal energy when a gas constants from 377 ml to 177 ml under a constant

pressure of 1520 torr , while at the same time being cooled by removing 124 J heat ?

[Take :(1 L atm)n= 100 J]

A. $-24J$

B. $-84J$

C. $-164J$

D. $-248J$

Answer: B

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6. The heat capcity of liquild water is $75.6J/mol.K$, while the enthalpy of fusion of ice is $6.0kJ/mol$, What

is the smallest number of ice cubes at 0° C, each containig $9.0g$ of water

,needed to cool 500 g of liquild

water from j 20° to 0° C ?

A. 1

B. 7

C. 14

D. None of these

Answer: C

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7. An ideal gas is taken around the cycle ABCD A as shown in figure . The net work done during the cycle is equal to :

A. zero

B. positive

C. negative

D. we cannot predict

Answer: A

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8. Molar heat capacity of water in equilibrium with ice at canstant pressure is

A. zero

B. ∞

C. $40.\ 45kJK^{-1}\text{mol}^{-1}$

D. $75.48JK^{-1}\text{mol}^{-1}$

Answer: B

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9. A cyclic process ABCD is show in PV diagram for a ideal gas . Which of the

following digram reppresents the same process ?

A.

B.

C.

D.

Answer: C

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10. One mole of an ideal monoatomic gas expanded irreversibly in two stage expansion .

$\text{State}-1 \qquad (8.0 \text{ bar}, 4.0 \text{ liters}, 300\text{K})$

$\text{State}-2 \qquad (2.0 \text{ bar}, 16 \text{ liters}, 300\text{K})$

$\text{State}-3 \qquad (1.0 \text{ bar}, 32 \text{ liters}, 300\text{K})$

Total heat absored by the gas in the process is :

A. 116 J

B. 40 J

C. 4000 J

D. None of these

Answer: C

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11. What is the net work done (in calories) by 1 mole of monatomic ideal gas in a process described by

1, 2,3, 4 in given V-T graph .

Use : $R = 2cal / \text{mole K}$

$\ln 2 = 0.7$

A. $-600cal$

B. $-660cal$

C. $+660cal$

D. $+600cal$

Answer: B

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12. An insulated container of gas has two chambers separated by an insulating partition. One of the chambers has volume V_1 and contains ideal gas at pressure P_1 and temperature T_1.The other chamber has volume V_2 and contains ideal gas at pressure P_2 and temperature T_2. If the partition is removed without doing any work on the gas, the final equilibrium temperature of the gas in the container will be

A. $\dfrac{T_1T_2(P_1V_1+P_2V_2)}{P_1V_1T_2+P_2V_2T_1}$

B. $\dfrac{P_1V_1T_1+P_2V_2T_2}{P_1V_1+P_2V_2}$

C. $\dfrac{P_1V_1T_2+P_2V_2T_1}{P_1V_1+P_2V_2}$

D. $\dfrac{T_1T_2(P_1V_1+P_2V_2)}{P_1V_1T_1+P_2V_2T_2}$

Answer: A

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13. One mole of an ideal gas is allowed to expand reversible and adiabatically from a temperatureof$27^\circ C$)if the work done during the process is3kJ,the final temperature will be equal to$\left(C_v=20JK^{-1}\right)$

A. $100k$

B. $450k$

C. $150k$

D. $400k$

Answer: C

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14. A gas $\left(C_{v.m}=\frac{5}{2}R\right)$ behaving ideally was allowed to expand reversibly and adiabatically from 1 liter to

32 liter . It's initial at temperature was 327° C . The molar enthalpy changes $(\text{in } J/\text{mole})$ for the process is

A. $1125R$

B. $-575R$

C. $-1575R$

D. None of these

Answer: C

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15. Two moles of an ideal gas $\left(C_V = \frac{5}{2}R\right)$ was compressed adiabatically against constant pressure of 2 atm .

Which was initially at 350 K and 1 atm pressure. The work involve in the process is equal to.

A. $250R$

B. $300R$

C. $400R$

D. $500R$

Answer: D

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16. A diatomic ideal gas initially at 273 K is given 100 cal heat due to which system did 209 J work.

Molar heat capacity (C_m)n of gas for the process is :

A. $\frac{3}{2}R$

B. $\frac{5}{2}R$

C. $\frac{5}{4}R$

D. 5 R

Answer: D

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17. For an ideal monoatic gas during any process $T = kV$, find out the molar heat capacity od the gas

during the process. (Assme vibrational degree of freedom to be active)\

A. $\frac{5}{2}R$

B. 3R

C. $\frac{7}{5}R$

D. 4 R

Answer: A

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18. The maximum efficiency of a heat engine operating between 100° and 25° C is

A. 20.11%

B. 22.2%

C. 25.17%

D. None

Answer: A

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19. A heat engine operating n between 227° and $27^{\circ}C$ absorbs 2 K a cal of heat from the 227° reservoir reversibly per cycle . The amount of work done in one cycle is

A. 0. 4 cal

B. 0.8 cal

C. 4 Kcal

D. 87 Kcal

Answer: B

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20. A reversible heat engine A(based on carnot cycle) absorbs heat from a reservoir at 1000 K and rejects heat to a reservoir at T_2 . A second reserviour at T_2 and rejects energy to a reservoir at 360 K . If the efficiencies of engines A and B are the same then the temperature $T_2$is .

A. 680 K

B. 640 K

C. 600 K

D. None

Answer: C

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21. The entropy change when two of ideal monoatomic gas is heated form $200 \rightarrow 300^{\circ} C$ reversiblity and isochorically?

A. $\frac{3}{2} R \ln . \left(\frac{300}{200}\right)$

B. $\frac{5}{2} R \ln . \left(\frac{573}{273}\right)$

C. $3R \ln . \left(\frac{573}{473}\right)$

D. $\frac{3}{2} R \ln . \left(\frac{573}{473}\right)$

Answer: C

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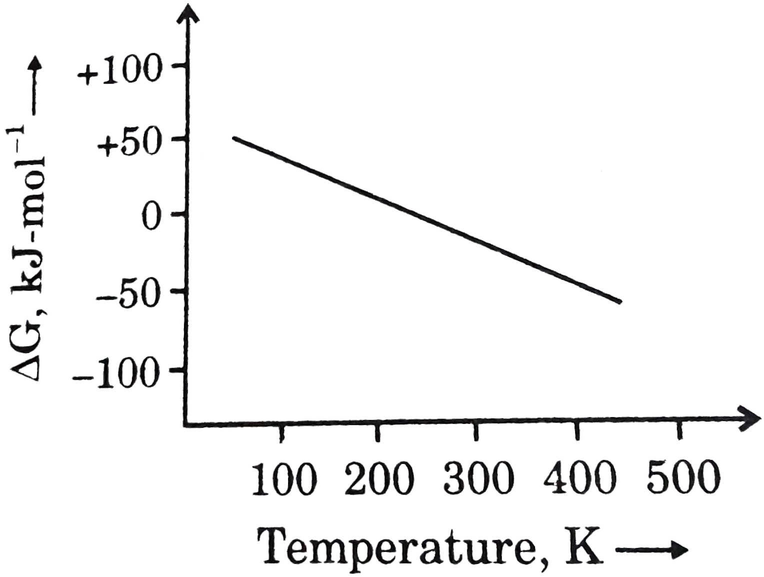
22. What can be concluded about the values of ΔH and ΔS from this graph ?



A. $\Delta H > 0, \Delta S > 0$

B. $\Delta H > 0, \Delta S < 0$

C. $\Delta H < 0, \Delta S > 0$

D. $\Delta H < 0, \Delta S < 0$

Answer: A

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23. If $\Delta H_{\text{vaporisation}}$ of substance X (l) (molar mass :30 g/mol) is 300 J/g at it's boiling piont 300K, then

molar entropy change for reversible conddensation process is

A. $30J/mol.\ K$

B. $-300J/mol.\ K$

C. $-30J/mol.\ K$

D. None of these

Answer: C

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24. The change in entrophy of 2 moles of ideal gas upon isothermal expansion at $243.6K$ from 20 liter until

the pressure becomes 1 atm, is :

A. 1.385 cal/K

B. $-1.2cal/K$

C. $-30J/mol.K$

D. None of these

Answer: C

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25. Pressure of 10 moles of an ideal gas is changed from 2 atm to 1 at against constant external pressure without change in temperature. If surrounding temperature (300K) and pressure (1 atm) always remains constant then calculate total entropy change $\left(\Delta S_{\text{system}} + \Delta S_{\text{surrounding}}\right)$ for given process.

[Given : ? n2 = 0.70 and R = 8.0 J/mol/K]

A. $56J/K$

B. $14J/K$

C. $16J/K$

D. None of these

Answer: C

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26. The enthalpy of tetramerization of X in gas phase $(4X(g) \rightarrow X_4(g))$ is -100 kJ/mol at 300K.

The enthalpy of vaporisation for liquid X and X_4 are respectively $30kJ/mol$ and $72kJ/mol$ respectively .

ΔS for tetramerization of X in liquid phase is - 125J/K mol at 300K.

What is the ΔG at 300n K for tetramerization of X liquid phase ?

A. $-52kJ/mol$

B. $-89.5kJ/mol$

C. $-14.5kJ/mol$

D. None the these

Answer: C

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27. Standard enthorpy of X_2, Y_2 and XY_3 are 60,40 and $50JK^{-1}mol^{-1}$, respectively . For the reaction , $\frac{1}{2}X_2 + \frac{3}{2}Y_2 \rightarrow XY_3, \Delta H = -30kJ$ to be at equilibrium, the temperature of will be

A. 1250 K

B. 500 K

C. 750K

D. 1000K

Answer: C

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28. For the f reaction at $300K$

$A(g) + B(g) \rightarrow C(g)$

$\Delta U = -3.0kcal$, $\Delta S = -10.0cal/K$

Value of the ΔG is

A. $-600cal$

B. $-6600cal$

C. $-6000cal$

D. None

Answer: A

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29. The correct relationship between free energy change in a reaction and the corresponding equilibrium constant K is

A. $-\Delta G^\circ = RT \ln K$

B. $\Delta G = RT \ln K$

C. $-\Delta G = RT \ln K$

D. $\Delta G^{\circ} = RT \ln K$

Answer: A

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30. The value of ΔG_f° of gaseous mercury is $31 KJ / \text{mole}$. At what total external pressure mercury start boiling at $25^{\circ} C$. $[R = 8.3 J / \text{K mole}]$

A. $10^{-5.44}$

B. $10^{-12.5}$

C. $10^{-6.52}$

D. $10^{-3.12}$

Answer: A

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31. What is $\Delta_r G$(KJ/mol) for sysnthesis of ammonia at 298K at following sets of partial pressure:

$N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3, \Delta_r G^\circ = -33KJ/mol.$

$[Take R = 8.3J/K\text{mole}, \log 2 = 0.3, \log 3 = 0.48]$

Gas	N_2	H_2	NH_3
Pressure(atm)	1	3	0.02

A. $+6.5$

B. -6.5

C. $+60.5$

D. -60.5

Answer: D

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32. For the reaction takes places at certain tempreature

$NH_4HS(s) \Leftrightarrow NH_3(g) + H_2S(g),$

if eqilibrium pressure is X bar, then $\Delta_r G^\circ$ would be

A. $-2RT\ln X$

B. $-RT\ln(X-\ln 2)$

C. $-2RT(\ln X-\ln 2)$

D. None of these

Answer: C

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33. Calculate $\log_{10}\left\{[C]_{eq}/[A]_{eq}\right\}$ where [C] and [A] are equilirium molar concetration of respective

species, when 2 2 mole each of A and B were allowed to come to equilibrium at 900 K.

$$A+B\overset{900K}{\Longleftrightarrow}C+D \quad , \quad \Delta G^{\circ}=460.6\text{Calorie}$$

Take: $\ln X=2.303\log X$
$\underset{R=2Cal/K\text{mole}}{}$

A. 5.56×10^{-02}

B. 5.57×10^{-03}

C. 1.1×10^{-2}

D. 1.1×10^{-3}

Answer: A

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34. What is the free energy charge (ΔG) when 1.0 mole of water at $100^{\circ} C$ and 1 atm pressure is converted into steam at $100^{\circ} C$ and 1 atm pressure ?

A. 80 cal

B. 540 cal

C. 620 cal

D. zero

Answer: D

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35. What is the free energy charge (ΔG) when 1.0n mole of water at $100^{\circ} C$ and 1 atm pressue is converted

into steam at $100^{\circ} C$ and 2 atm pressure ?

A. zero cal

B. 540 cal

C. 517.13 cal

D. 510 cal

Answer: C

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Paragraph Type

1. A cyclindrical container of volume $44.8 litres$ is containing equal no.of moles (in integer no.) of an ideal monoatomic gas in two sections A and B separeted by an adiabatic frictionless piston as show in figure

The initinal temperature and pressure of gas in both section B becomes $(1/8)^{th}$ of initial volume .

Given : $R = 2cal/\text{mole} - K, C_{v,m}$ of monoatmic gas $= \frac{3}{2}R$,

At 1 atm & 0° ideal gas occupy $22.4liter$.

What will be the final pressure in contianer B:

A. 2 atm

B. 8 atm

C. 16 atm

D. 32 atm

Answer: D

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2. A cyclindrical container of volume $44.8litres$ is containing equal no.of moles (in integer no.) of an ideal

monoatomic gas in two sections A and B separeted by an adiabatic frictionless piston as show in figure

The initinal temperature and pressure of gas in both section B becomes $(1/8)^{th}$ of initial volume .

Given : $R = 2cal/\text{mole -K}, C_{v,m}$ of monoatmic gas $= \frac{3}{2}R$,

At 1 atm & 0° ideal gas occupy $22.4liter$.

Find temperature in container A will be

A. 1638 K

B. 6988 k

C. 3274 K

D. 51 K

Answer: A

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3. A cyclindrical container of volume $44.8 litres$ is containing equal no.of moles (in integer no.) of an ideal

monoatomic gas in two sections A and B separeted by an adiabatic frictionless piston as show in figure

The initinal temperature and pressure of gas in both section B becomes $(1/8)^{th}$ of initial volume .

Given : $R = 2cal/\text{mole -K}, C_{v,m}$ of monoatmic gas $= \frac{3}{2}R,$

At 1 atm & 0° ideal gas occupy $22.4 liter.$

Change in enthalpy for section A in K cal.

A. 48.3

B. 80.53

C. 4.83

D. 8.05

Answer: B

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4. An ideal gas $(C_P/C_V = \gamma)$ is expanded so that the amount of heat transferred to the gas the is equal to the

decrease in its internal energy .

What is the molar heat capacity of gas in this process ?

A. C_V

B. $-C_V$

C. C_P

D. $2C_V$

Answer: B

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5. An ideal gas $(C_P/C_V = \gamma)$ is expanded so that the amount of heat transferred to the gas the is equal to the decrease in its internal energy .

What is the relationship between temperature and volume of gas in this process ?

A. $T.V^{2(\gamma-1)} = \text{constant}$

B. $T.V^{\gamma-1} = \text{constant}$

C. $T.V^{(\gamma-1/2)} = \text{constant}$

D. $T.V^{\gamma} = \text{constant}$

Answer: C

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6. An ideal gas $(C_P/C_V = \gamma)$ is expanded so that the amount of heat transferred to the gas the is equal to the

decrease in its internal energy .

What is the magnitude of work performed by one mole of the gas when its volume increase eight times if the initinal temperature of the gas is $300K$? C_V for the gas is $1.5R$.(

$R = 2cal/mol/K$)

A. 900 cal

B. 450 cal

C. 1247.7 cal

D. 623.8 cal

Answer: A

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7. Two moles of helium gas are taken over the cycle ABCDA , as shown in the P-Tdigram

Assuming the gas to be ideal the work done on the gas in taking if from A to B is -

A. 200 R

B. 300 R

C. $-400R$

D. 500 R

Answer: C

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8. Two moles of helium gas are taken over the cycle ABCDA , as shown in the P-Tdigram

The work done the gas in taking it from D to A is -

A. $-414R$

B. $+414R$

C. $-690R$

D. $+690R$

Answer: B

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9. Two moles of helium gas are taken over the cycle ABCDA , as shown in the P-Tdigram

The net work done on the gas in the cycle ABCD A is -.

A. Zero

B. $-276R$

C. $1076R$

D. $1904R$

Answer: B

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Reasoning Type

1. These question consists of two statements each, printed as Statement-I and Statement-II . While answering

these Question you are required to choose any one of the following four responses.

Statement-I : There is no change in enthalpy of an ideal gas during compression at constant temperature .

Statement -II : Enthalpy of an ideal gas is a function of temperature and pressure.

A. If both Statement -I & Statement are True & the Statement-II is a correct explanation of the Statement -I

B. If both Statement -I & Statement are True & the Statement-II is not a correct explanation of the Statement -I

C. If Statement-I is True but the Statement-II is False.

D. If Statement-I is True but the Statement-II is True .

Answer: C

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2. These question consists of two statements each, printed as Statement-I and Statement-II . While answering

these Question you are required to choose any one of the following four responses.

Statement -I : Due to adiabatic expansion , temperature of an ideal gas always decreases.

Statment -II : For an adiabatic expansion $\Delta U = W$.

A. If both Statement -I & Statement are True & the Statement-II is a correct explanation of the Statement -I

B. If both Statement -I & Statement are True & the Statement-II is not a correct explanation of the Statement -I

C. If Statement-I is True but the Statement-II is False.

D. If Statement-I is false but the Statement-II is True .

Answer: D

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Multiple Correct Choice Type

1. Which of the following is true for reversible adiabatic process involving an ideal gas ?

A. Gas with higherγ has high magnitude of slope in a $P(\text{y-axis})v/sT(\text{x - axis})$ curve

B. Gas with higherγ has high magnitude of slope in a $V(\text{y-axis})v/sT(\text{x - axis})$ curve

C. Gas with higherγ has high magnitude of slope in a $P(\text{y-axis})v/sV(\text{x - axis})$ curve

D. Gas with higherγ has low magnitude of slope in a $P(\text{y-axis})v/sT(\text{x - axis})$ curve

Answer: C::D

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2. An ideal gass is taken from state A (Pressuer P, VolumeV) to the state B (Pressure P/2, Volume 2V) along a stright line path in PV diagram as shown in the adjacent figure .

Select the correct statement (s) among the following .

A. The work done by gas in the process A to B exceeds the work that would be done by gas in if the system were taken from A to B along the isotherm.

B. In The T- V diagram, the path AB become part of parabola.

C. In the P-T diagram, the path AB becomes a part of hyperbola.

D. In going from A toB, the temperature T of the gas first increase to a maximum value then decreases.

Answer: A::B::C

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3. If one mole monoatmic ideal gas was taken through process AB as shown is figure , then select correcgt option(s).

$Given : In 1.5 = 0.4$

A. $W_{AB} = -1496.52J$

B. $q_{AB} = 5237.82J$

C. $\Delta H_{AB} = 3741.3J$

D. $\Delta S_{AB} \text{is} + \text{ve}$

Answer: A::B::D

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4. The normal boiling point of a liquild 'A' is 350 K. ΔH_{vap} to be normal point is $35kJ / mo \le$. Pick out the correct statement(s) .(Assume ΔH_{vap} to be independent of pressure).

A. $\Delta S_{\text{vaporisation}} > 10J/K\text{moleat}350\text{ K and }0.5\text{ atm}$

B. $\Delta S_{\text{vaporisation}} < 10J/K\text{moleat}350\text{ K and }0.5\text{ atm}$

C. $\Delta S_{\text{vaporisation}} < 10J/K\text{moleat}350\text{ K and }2\text{ atm}$

D. $\Delta S_{\text{vaporisation}} = 10J/K\text{moleat}350\text{ K and }2\text{ atm}$

Answer: A::C

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5. Which is the correct is /are correcct :

A. Final temperature in reversible adiabatic expansion is lesser than in irreversible adiabatic expansion .

B. When heat is supplied to an ideal gas in isothermal process, kinetic energy of gas will increasase.

C. When an ideal gas is subjected to adiabatic expansion it gets cooled

D. Entropy increases in atomisation of dihydrgen

Answer: A::C::D

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6. which is / are correct statement .

A. $W_{\text{adiabatic}} > W_{\text{isothermal}}$ in an ideal gas compression from same initial state to same final volume .

B. The value of $\gamma\left(\gamma = \frac{C_p}{C_v}\right)$ remains constant for diatomic gas at all temperature .

C. Entropy increases when an ideal gas expanded isothermally.

D. $\Delta_r H \& \Delta_r S$ both are + ve for the decomposition of $MgCO_3$.

Answer: A::C::D

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7. In isothermal ideal gas compression :

A. $W \text{is } +\text{ve}$

B. ΔH is zero

C. $\Delta S_{gas} \text{is } +\text{ve}$

D. $\Delta G \text{is } + \text{ ve}$

Answer: A::B::D

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8. Which of the following statement (s)is / are false:

A. $\Delta_r S$ for $\frac{1}{2}N_2(g) \rightarrow N(g)$ is positive

B. ΔG_{system} is always zero for a reversible process in a clossed system.

C. ΔG° for an ideal is a function of temperature and pressure.

D. enthropy of a closed system maximized at equilibrium

Answer: B::C::D

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9. Assume ideal gas behaviour for all the gas considered & vibrational degrees of freedom to be active.

Separated equimolar sample of $He, H_2, SO_2 \& CH_4$ were subjected to a two step process as mentioned.

Initially all are at same state of tempreature & prssure.

Step-I $\rightarrow$ All undergo reversible adiabatic expansion to attain same final volume, which is

double the original volume thereby causing the decreases in their temperature .

Step -II $\rightarrow$ After step I all are given appropriate amount of heat isochorically to restore the

Mark the correct option(s).

A. Due to step -I only, the decrease in the tempreature will be maximum for CH_4

B. During step II, heat given will be maximum for CH_4

C. There will be no change in internal energy for any of the gas after both the steps of process are completed.

D. The P-V graph of CH_4 & SO_2 will be same.

Answer: B::C

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10. The normal boiling point of a liquid 'A' is 350 K. ΔH_{vap} to be normal point is $35kJ/mo \leq$. Pick out

the correct statement(s) .(Assume ΔH_{vap} to be independent of pressure).

A. $\Delta S_{\text{vaporisation}} > 10J/K/\text{moleat}350\text{ K and }0.5\text{ atm}$

B. $\Delta S_{\text{vaporisation}} < 0\text{at}350\text{ K and }0.5\text{ atm}$

C. $\Delta S_{\text{vaporisation}} < 100 J/K/\text{mole at } 350 \text{ K and } 2 \text{ atm}$

D. $\Delta G_{\text{vaporisation}} > \quad 0 \text{ at } \ 350 \text{ K and } 2 \text{ atm}$

Answer: A::B::C::D

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11. Select the correct statement(s).

A. For the equuilibrium pressure is constant

B. For equilibrium temperature is constant

C. For equilibrium $\left(\frac{\partial G}{\partial n}\right)_{P,T}$ is constant

D. For equilibrium pressure & temperature is variable .

Answer: A::B::C

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Exercise 3

1. Predict sigh of work done in following reactions at constant pressure.

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2. The gas is cooled such that it loses 65 J of heat . The gas contracts as it cools and work done on the

system equal to 20 J is excharged with the surrounding . What are q, w and ΔU?

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3. The enthalpy of combustion of glucose is- $2808 kJ mol^{-1}$ at 25° C. How many grams of gluc

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4. When a system is taken from state A and B along the path ACB, 80J of heat flows into the system

and the system does 30 J of work .

(a) How much heat flows into the system along path ADB if the work done by the system is 10?

(b) When the system is returned from state B to A along curved path, the work done on the system is 20J. Does the system absorb or liberate heat, and how much ?

(c) If $U_D - U_A = 40J$, find the heat absorbed in the process AD and DB

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5. Five moles of an ideal gas at 300 K, expanded isothermally from an intinal pressue of 4 atm to a final

pressure of 1 atm against a cont. ext pressure of 1 atm . Calculate $q, w, \Delta U$ & ΔH. Calculate the

corresponding of all if the above process is carried out reversibly .

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6. Find the work done when one mole of the gas is expanded reversibly po and isothermally from 5 atm to

1e atm at $25^\circ C$.

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7. Two mole of ideal diatomic gas $(C_{\text{v,m}} = 5/2R)$ at 300 K and 5 atm expanded irreversly & adiabatically to a final pressure of 2 atm against a constant pressure of 1 atm. Calculate q, w, $\Delta H \& \Delta U$.

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8. Calculate the work done the system in a irreversible (single step) adiabatic expansion of 1 mole of a

polyatomic gas $(\gamma = 4/3)$ from 300 K and pressue 10 atm to 1 atm.

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9. 1 mole of CO_2 gas as at 300 K is expanded under reversible adiabatic condition such that its volume becomes

27 times.

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10. One mole of an ideal monoatomic gas is carried through the reversily cycle of the given figure consisiting

of step A, and C and involving state 1,2 and 3. Fill in the blank space in the the table given below assuming

reversible steps.

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11. One mole of an ideal monoatomic gas is put throught reverslible path as show in figure .Fill in the blank

in the table given below :

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12. One mole of a prefect put throught a cycle consiting

of the following three reversible steps :

(CA) Isothermal comoression from 2 atm and 10 litres to 20 atm and litre.

(AB) Isobaric expansion to return the gas to the origanl volume of 10 litre with T going from T_1 to T_2

(BC) Cooling at constant volume to bring the gas to the origanl pressure lt brgt and temperature .

The steps are shown schematically in the figure shown.

Calculate T_1 to T_2.

(b) Calculate `DeltaU, q and will be in calories , for each step and for the cycle .

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13. Water expands when it freezes. Determine amount of work done in joules , when a system consisting of

$1.\ 0L$ of liquid water fressze under a constant pressure of 1.0 atm and froms $1.1L$ of ice .

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14. Lime is made commercially by decomposition of limestonese, $CaCO_3$. What is the change in intremal

energy when 1.00 mole of soild $CaCO_3$ (V= 34. 2 ml) absobs $177.9kJ$ of heat and decomposese at

25° C agnist a pressure of 1.0 atm to give solid CaO. (Volume = 16.9 ml) and CO_2 (g) (V=24.4 L).

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15. The enthy change for the reaction of 50 ml of ethylene with 50. 0 ml of H_2 at 1.5 atm pressure is $\Delta H = -0.31 KJ$. What is the ΔU ?

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16. What is ΔU when 2.0 mole of liquid water vaporise at $100^\circ C$? The heat of vaporistaion , ΔH vap. of water at $100^\circ C$ is $40.66 kJ mol^{-1}$.

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17. If 1.0 kcal of heat is added to 1.2 L of O_2 in a cyclinder of constant pressure of 1 atm , the volume increase to 1.5 L . Calculate ΔU and $\Delta H$of the process.

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18. A heat engine absorbs 760 kJ heat from a source at 380kK . It rejects (1) 650 kJ, (ii) 560 kJ, (iii) 504 kJ of heat to sink at 280 K . State which of these represent a reversible , an irreversible and an impossible cycle .

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19. The efficiency of a carnot cycle is $1/6$. On decreasing the tempertaure of the sink by $65^{\circ}C$, the efficiency increases to $1/3$ .Calculate the tempretaure of source and sink .

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20. A Carnot cycle has an efficiency of 40% . Its low temperature resrvoir is at $7^{\circ}C$. What is the temperature of source ?

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21. One mole of NaCl(s) on melting observed 30.5 kJ of heat and its entropy is increased by $28.8 JK^{-1}$. What is the melting point of sodium chloride ?

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22. Oxygen is heated from 300 to 600 at a constant pressure of 1 bar. What is the increases in molar

entropy ? The molar heat capacity in $JK^{-1}mol^{-1}$ for the O_2 is (Given in 2=0.7)

$$C_P = 10 + 10^{-2}T - 10^6T^2$$

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23. Calculate ΔS_r° at 298 K of ,

(i) $Na(s) + \frac{1}{2}CL_2(g) \rightarrow NaCl(s)$,

(ii) $\frac{1}{2}N_2(s) + 2H_2(g) + \frac{1}{2}Cl_2(g) \rightarrow NH_4Cl(s)$

(iii) C(graphite) to C(diamond).

The values of S° of $Na, Cl_2, NaCl, NH_4Cl, N_2, H_2$,"diamond& graphite are" 51, 223,72,95 ,192,

131, 2.43 & $5.69JK^{-1}mol^{-1}$ respectively .

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24. The standard enthaply for the reaction $H_2(g) + 1/2O_2(g) \rightarrow H_2O(l)$ is - 285.76 kJ at 298 K.

Calculate the value of ΔH at 373 K .The molar heat capcities at constant pressure (C_P) in the given temperature range of $H_2(g), O_2(g)$ and $H_2O(l)$ are respectively 38.83,16 and $75.312JK^{-1}mol^{-1}$.

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25. Methane (Considered to be an ideal gas) initially at $25^\circ C$ and 1 bar pressure is heated at constant

pressure until the volume has dobbled . The variation of the molar heat capacity with absolute temperature is given by $C_P = 20 + 0.001T$

where C_P is in $JK^{-1}mol^{-1}$. Calculate molar (a) ΔH(b) ΔU.

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26. Calculate the free eneryg change at 298 K for the reaction ,

$Br_2(l) + Cl_2(g) \rightarrow BrCl(g)$. For the reaction $\Delta H^\circ = 29.3kJ\&$

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27. Animals operate under conditons of constant pressure and most of the process tht maintain life are isothermal (in a broad sense) . How much energy is available for sustaining this type of muscular and nervous activity from the combustion of 1mol of glucose molecules under standard conditons at 37° C (blood temperature) ? The entropy change is $+182.4JK^{-1}$ for the reaction stated above

$\Delta H_{\text{combustion}}$[glucose]=-2808 KJ

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28. The entropies of $H_2(g)$ and $H(g)$ are 130.6 and $114.6 J mol^{-1} K^{-1}$ respectively at 298 K. Using the data given below calculate ΔH° (in kJ/ mol) of the reaction given below.

$H_2(g) \rightarrow 2H(g)$, $\Delta G^\circ = 406.62 kJ / mol$

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29. 5 mole $H_2O(l)$ at 373 K and 1 atm is converted into $H_2O(g)$ at 373 K and 5 atm . ΔG for this process is [Given: R = 2 cal/K-mol]

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30. The K_P for reaction $A + B \Leftrightarrow C + D$ is 1.34 at $60^\circ C$ and 6.64 at $100^\circ C$. Determine the standard free energy change of this reaction at each temperature and ΔH° for the reaction over this range of temperature ?

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31. For the reaction at 298 K

$A(g) + B(g) \Leftrightarrow C(g) + D(g)$

$\Delta H^\circ = -29.8 Kcal, \Delta S^\circ = -0.1 Kcal/K$

Calculate ΔG° and K.

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32. The equilibrium constant of the reaction $2C_3H_6(g) \Leftrightarrow C_2H_4(g) + C_4H_8(g)$ is found to fit the expression

$$InK_{eq} = -1.04 - \frac{1088}{T/K}$$

(where T/k is temperature expressed in Kelvin scale)

Calculate the standard reaction enthalpy and entrophy at 400 K.

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33. 3 moles of ideal gas $X\left(C_{p,m}=\frac{5}{2}\right)$ and 2 moles of ideal gas $Y\left(C_{p,m}=\frac{7}{2}R\right)$ are taken in vessa and compressed reversibly and adiabitically, during this process temperature of gaseous mixture increased

from 300 K to 400 K. Calculate change in internal energy (ΔU) in cal of gaseous mixture

(Given $R=2cal/mol.\ K$)

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34. One mole of an ideal monoatomic gas $(C_{V.M}=1.5R)$ is subjected to the following sequence of steps :

(a) The gas is heated reversibly at constant pressure of 1 atm from 298 K to 373 K.

(b) Next, the gas is heated reversibly and isothermally to double its volume.

(c) Finally , the gas is cooled reversibly and adiabatically to 308 K .

Calcuated q, w, ΔH for the overall porcess.

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35. Pressure over 1000 ml of a liquid is gradually increases from 1 bar to 1001 bar under adiabitic conditions. If the final volume of the liquid is 990 ml, calculate ΔU and ΔH of the process, assuming linear variation of volume with pressure .

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36. One mole of a monoatomic gas behving ideally is used as working substance in an engine working in the cycle as shown in the figure . The process AB, BC, CD and DA are respectively reversible isobaric, adiabatic isochoric and isothermal . The ratio of maximum to volume and temperature during the cycle is $8\sqrt{2}$ and 4 respectively. If the maximum T is 800 K and $\gamma = 5/3$. Calculate ΔE (in kJ) for the process BC.

Given $R = 8.3J/K - mol.$

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37. 2 mole of ideal momoatmic gas was subjected to reversible adiabatic compression from initianl state of

P= 1 and T = 300 K till the pressrue is $4\sqrt{2}$ atm and temperature is TK . The gas is then subjected

to reversible isothermal expansion at T K till the internal pressure is one atm . The gas is now isobarically

cooled to attain initial state. Find W_{Net} (in calorie) for whole process . [Use In 2=0.7]

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38. one of an ideal gas is expanded isothermally at 298 K unit its volume is tripled. Find the values of

$DelatS_{\text{gas}}$ and ΔS_{total} under the following conditions.

(i) Expansion is carried out reversiby .

(ii) Expansion is carried out irreversibly where 836.8J of heat is less absorbed than in (i)

(iii) Expansion is free.

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39. 10 g of neon initinally at a pressure of 506.625 kPa and temperature of 473 K expand adiabatically to a pressure of 202.65 kPa . Calculate entropy of the system and of total entropy change for the following ways of carrying out is this expamsion .

(i) Expansion is carried out expansion .

(ii) Expansion occurs aganist a constant external pressure of 202.65 kPa .

(iii) Expansion is a free expansion.

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40. The enthalpy change for vapouriztion of liquid 'A' at 200 K at 1 atm is $22kJ/mol$. Find out $\Delta S_{\text{vapourisation}}$ for liquid 'A' at 200 K? The normal Boiling point of liquid 'A' is 300 K?

$A(l)[200K1atm] \rightarrow A(g)[200K1atm]$

Given: $C_{p,m}(A, l) = 40J/mol - K$

Use, In$(3/2) = 0.405$

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41. At 298 K , $\Delta H^{\circ}_{\text{combustio}}$ (sucrose) $= -5737KJ/mol \& \Delta G^{\circ}_{\text{combustio}}(\text{sucrose}) = -6333KJ/mol.$

Estimate additional non- PV work that is obtained by raising temperature to 310 K,

Assume $\Delta_r C_p = 0$ for this temperature change

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42. Compute $\Delta_r G$ for the reaction $H_2O(l, 1, atm, 323K) \rightarrow H_2O(g, 1atm, 232K)$

Given that :

$\Delta_{vap} H at 373K = 40.639kJmol^{-1}, C_p(H_2O, l) = 75.312JK^{-1}mol^{-1},$

$$C_p(H_2O, g) = 33.305JK^{-1}mol^{-1}.$$

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43. Given are the following standard free energies of formation at 293 K.

$\Delta_f G^\circ / kJmol^{-1}$	$CO(g)$	$CO_2(g)$	$H_2O(g)$	$H_2O(l)$	H_2
	-137.17	-394.36	-228.57	-237.13	zer

(a) Find $D\delta_r G^\circ$ and the standard equilibrium constant K_p^0 at 298 K for the reaction

$$CO(g) + H_2O(g) \Leftrightarrow CO_2(g) + H_2(g)$$

(b) If CO, CO_2 and H_2 are mixed so that the partical pressure of each is 101.325 kPa and the mixture is

brought into contact with excess of liquid water, what will be the partial pressure of gas when

equilibrium is attained at 298 K. The volume available to the gases is contant .

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