Self Practice Paper (SPP)

1. A given mass of gas expands from the state A to the state B by three paths 1, 2 and 3 as shown in the figure. If w_1 , w_2 and w_3 respectively be the magnitudes work done by the gas along three paths then :



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10.	For the following reaction, $C_{Diamond} + O_2(g) \longrightarrow CO_2(g)$; $\Delta H = -94.0$ kcal								
	$C_{Graphite} + O_2 (g) \longrightarrow CO_2(g) ; \Delta H = -97.6 \text{ kcal}$								
	The heat required to ch	ange 1 g of C_{diam}	nond	→ C _{graphite} is					
	(1) 3.6 kcal	(2) 43.2 kcal		(3) 191.6 kcal	(4) 0.3 kcal				
11.	$C(s) + O_2(g) \longrightarrow C$;O ₂ , (g);	$\Delta H = -$	94.3 kcal/mol					
	CO (g) + $\frac{1}{2}O_2(g)$	$\rightarrow CO_{2}(g);$	∆H = –	H = - 67.4 kcal/mo!					
	$O_2(g) \longrightarrow 2O(g);$		∆H = 1	117.4 kcal/mol					
	$CO(g) \longrightarrow C(g) + c$	O(g) ;	∆H = 2	30.6 kcal/mol					
	Calculate ΔH for C (s)	\longrightarrow C (g) in kc	cal/mol.	(2)447	(4)445				
10		(2)154							
12.	is : (gas constant = 2)	insion of one mo	le of an	Ideal gas from 10 atm to	o 1 atm at 273 K, the work done				
	(1) – 895.8 cal	(2) – 1171.6 ca	I	(3) – 1381.8 cal	(4) – 1499.6 cal				
13.	One mole of an ideal g	as for which C_v =	= 3/2 R i	s heated reversibly at a	constant pressure of 1 atm from				
	25°C to 100°C. The ∆H	is : (2) 27 256 ccl		(2) 272 56 col	(4) 2725 6 ccl				
	(1) 3.775 cai	(2) <i>31</i> .250 Cal		(3) 372.50 Cal	(4) 3725.0 Cal				
14.	The heat of reaction for : C = H(c) + 12O(c) + 10CO(c) + 4HO(c)								
	at constant volume is	_ 1228.2 kcal a	2(9) · ¬	The heat of reaction a	at constant pressure and same				
	temperature is :								
	(1) – 1228.2 kcal	(2) – 1229.3 kc	al	(3) – 1232.9 kcal	(4) – 1242.6 kcal				
15.	Two moles of an ideal	gas are compre	ssed isc	othermally (100°C) and r	eversibly from a pressure of 10				
	(1) + 15.482 kJ	(2) + 10.464 kJ	inge is .	(3) + 5.684 kJ	(4) + 3.364 kJ				
16.	One gram sample of N	H₄NO₃ is decom	psed in a	a bomb calorimeter. The	e temperature of the calorimeter				
	increases by 6.12K. T decomposition for NH	he heat capacit	y of the	e system is 1.23 kJ/g/d	leg. What is the molar heat of				
	(1) – 7.53 kJ/mol	(2) – 398.1 kJ/r	nol	(3) – 16.1 kJ/mol	(4) – 602 kJ/mol				
17.	How much energy is re	eleased when 6	moles of	f octane is burnt in air ?	Given $\Delta {\rm H_{f^\circ}}$ for CO $_2$ (g), ${\rm H_2O}$ (g)				
	and C_8H_{18} (I) respective (1) – 6.2 kJ	ly are – 490, – 2 (2) – 37,4 kJ	40 and -	+ 160 J/moi : (3) – 35.5 kJ	(4) – 20.0 kJ				
18	One mole of an ideal of	uas is allowed to	evnand	reversibly and adiabatic	cally from a temprature of 27°C				
10.	The work done is 3 kJ.	The final tempra	ture of t	he gas is equal to $[Cv = (3) 225 K$	20 kJ ⁻¹]: (4) 300 K				
19	Internal energy does po	tinclude ·		(0) 220 1					
13.	(1) Nuclear energy			(2) Vibrational energy	oull				
	(3) Rotational energy (4) Energy due to gravitational pull								

20. 4.6 kJ heat is librated on burning 0.5 g of sulphur. The enthalpy of formation of SO_2 is :

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	[molecular weight of S (1) + 294.4 kJ	= 32, O = 16] (2) – 294.4 kJ	(3) + 462.4 kJ	(4) – 462.4 kJ				
21.	The change in entropy fusion for ice = 6.0 kJ m	for the fusion of 1 mole nol -1] :	of ice is [melting point of	ice = 273 K, molar enthalpy of				
	(1) 11.73 JK⁻¹ mol⁻¹	(2) 18.84 JK ⁻¹ mol ⁻¹	(3) 21.97 JK ⁻¹ mol ⁻¹	(4) 24.47 JK ⁻¹ mol ⁻¹				
22.	An ideal gas is allowed to expand under adiabatic conditions. The zero value is of :							
	(1) $\Delta T = 0$	$(2) \Delta S = 0$	(3) $\Delta G = 0$ (4) None of these					
23.	In the fusion of one mole of a solid melting at 27°C the entropy change can be represented by which the following (latent heat of fusion = 2930 J mol ⁻¹)? (1) 2930 $ \mathbf{k} ^{-1}$ mol ⁻¹ (2) 16.64 $ \mathbf{k} ^{-1}$ mol ⁻¹ (2) 104.67 $ \mathbf{k} ^{-1}$ mol ⁻¹ (4) 0.77 $ \mathbf{k} ^{-1}$ mol ⁻¹							
24		() i i i i i i i i i i i i i i i i i i i						
24.	$\Delta G = \Delta H - 1\Delta S$ was giv (1) Farady	(2) Kirchoff	(3) Einstein	(4) Gibbs-Helmholtz				
25.	Internal energy is : (1) partly potential and ((3) totally potential	partly kinetic	(2) totally kinetic (4) none of the above					
26.	Which of the follwoing to $(1) E > O$	(4) None of these						
27.	If 0.75 mole of an ideal	gas expands isotherma	ly at 27°C from 15 lit. to	25 lit. then the maximum work				
	done is (1) 9.14 J	(2) 9.23 J	(3) 9.43 J	(4) 9.75 J				
28.	For the reaction, $N_2 + 3$	$H_2 \longrightarrow 2NH_3$ which or	ne of the following is corr	ect regarding ΔH ?				
	(1) $\Delta H = \Delta E - RT$	(2) $\Delta H = \Delta E - 2RT$	(3) $\Delta H = \Delta E + 2RT$	(4) $\Delta H = \Delta E + RT$				
29.	If a process is both end	othermic and spontaneo	us, then :					
	(1) ∆S > 0	(2) ∆S < 0	(3) ∆G > 0	(4) ∆E = 0				
30.	Ice – Water mass ratio at constant pressure. If	is mantained as 1 : 1 in C_{P} (ice) = C_{P} (water) = 4	a given system containi .18 J mol ^{_1} K ^{_1} molar he	ng water in equilibrium with ice at capacity of such a system is				
	(1) Zero	(2) Infinity	(3) 4.182 JK ⁻¹ mol ⁻¹	(4) 75.48 JK ⁻¹ mol ⁻¹				
31.	A piece of zinc at a temperature of 40.0°C weighing 84 g is dropped into 40 g of boiling water (T = 100°C). The specific heat of zinc is 0.400 J g ⁻¹ C ⁻¹ and that of water is 4.20 J g ⁻¹ °C ⁻¹ . What is the final common temperature reached by both the zinc and water.							
	(1) 90 °C	(2) 80 °C	(3) 95 °C	(4) 85 °C				
32.	1 mole of NH ₃ gas at 2	7° C is expanded in rev	ersible adiabatic condition	on to make volume 8 times (γ =				
	1.33). Final temperature (1) 150 K, 900 cal	e and work done respect (2) 150 K, 400 cal	ively are - (3) 250 K, 1000 cal	(4) 200 K, 800 cal				
33.	A gas expands adiabati	cally at constant pressur	e such that T \propto V ^{-1/2} . The	e value of $\gamma \left(C_{_{p,m}}\!/C_{_{v,m}} \right)$ of the gas				
	(1) 1.30	(2) 1.50	(3) 1.70	(4) 2				

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34.	0.5 mole each of two	ideal gases A $\left(C_{v, m} = \right)$	$\left(\frac{5}{2}R\right)$ and B (C _{v, m} = 3R) are taken in a container and					
	expanded reversibly a from 350 K and 250 K. (1) = 100 R	nd adiabatically, during t Find ΔH (in cal/mol) for t	this process temperature the process :	e of gaseous mixture decreased					
	(1) = 100 K	(2) - 137.3 K	(3) = 375 K						
35.	When one mole of an ideal gas is comressed to half of its initial volume and simultaneously heated to								
	(1) C_{1} ln 2	(2) C In 2	(3) R ln 2	(4) (C., – R) ln 2					
36.	The enthalpy change for a given reaction at 298 K is $- x J \text{ mol}^{-1}$ (x being positive). If the reaction occurs spontaneously at 298 K, the entropy change at that temperature (1) can be negative but numerically larger than x/298 (2) can be negative but numerically smaller than x/298 (3) cannot be negative (4) cannot be positive								
37.	Given, $H_2(g) + Br_2(g)$	——→ 2HBr(g), ∆H ⁰ 1 and	d standard enthalpy of co	ondensation of bromine is ΔH_2^0 ,					
	standard enthalpy of fo	rmation of HBr at 25°C is	S						
	(1) ∆H ⁰ ₁ / 2	(2) $\Delta H_{1}^{0} / 2 + \Delta H_{2}^{0}$	(3) $\Delta H_{1}^{0} / 2 - \Delta H_{2}^{0}$	(4) (∆H ⁰ ₁ –∆H ⁰ ₂) / 2					
38.	One mole of anhydrous MgCl ₂ dissolves in water and librates 25 cal/mol of heat. $\Delta H_{hydration}$ of MgCl ₂ = – 30 cal/mol. Heat of dissolution of MgCl ₂ .H ₂ O is								
	(1) +5 cal/mol	(2) –5 cal/mol	(3) 55 cal/mol	(4) –55 cal/mol					
39.	The average O–H bond	d energy in H ₂ O with the	help of following data						
	(1) $H_2O_{(\ell)} \longrightarrow H_2O_{(g)}$; $\Delta H = + 40.6 \text{ KJ mol}^{-1}$								
	(2) $2H_{(g)} \longrightarrow H_{2(g)}$; $\Delta H = -435.0 \text{ KJ mol}^{-1}$								
	(3) = (3)								
	(3) $O_{2(g)} \longrightarrow 2O_{(g)}; \Delta$	LH = + 489.6 KJ mol⁻¹							
	(3) $O_{2(g)} \longrightarrow 2O_{(g)}; \Delta$ (4) $2H_{2(g)} + O_{2(g)} \longrightarrow$.H = + 489.6 KJ mol⁻¹ 2H ₂ O(ℓ) ; ΔH = − 571.6	KJ mol⁻¹						
	(3) $O_{2(g)} \longrightarrow 2O_{(g)}$; Δ (4) $2H_{2(g)} + O_{2(g)} \longrightarrow$ (1) 584.9 KJ mol ⁻¹	LH = + 489.6 KJ mol ⁻¹ 2H ₂ O(ℓ) ; ΔH = − 571.6 (2) 279.8 KJ mol ⁻¹	KJ mol ⁻¹ (3) 462.5 KJ mol ⁻¹	(4) 925 KJ mol⁻¹					
40.	(3) $O_{2(g)} \longrightarrow 2O_{(g)}$; Δ (4) $2H_{2(g)} + O_{2(g)} \longrightarrow$ (1) 584.9 KJ mol ⁻¹ S ₁ : Ice in contact with S ₂ : The process is known i.e., dP = 0. S ₃ : A spontaneous pro-	$\Delta H = + 489.6 \text{ KJ mol}^{-1}$ $2H_2O(\ell); \Delta H = -571.6$ (2) 279.8 KJ mol}^{-1} water constitutes a home own as isochoric in which process is reversible in national body of the second	KJ mol ⁻¹ (3) 462.5 KJ mol ⁻¹ ogeneous system. h the pressure remains o ure.	(4) 925 KJ mol ⁻¹ constant throughout the change,					
40.	(3) $O_{2(g)} \longrightarrow 2O_{(g)}$; Δ (4) $2H_{2(g)} + O_{2(g)} \longrightarrow$ (1) 584.9 KJ mol ⁻¹ S ₁ : Ice in contact with S ₂ : The process is known i.e., dP = 0. S ₃ : A spontaneous pro- S ₄ : Integral heat of solution	$\Delta H = + 489.6 \text{ KJ mol}^{-1}$ $2H_2O(\ell)$; $\Delta H = -571.6$ (2) 279.8 KJ mol}^{-1} water constitutes a home own as isochoric in which process is reversible in national button is same as heat of (2) F F T T	KJ mol ⁻¹ (3) 462.5 KJ mol ⁻¹ ogeneous system. h the pressure remains o ure. hydration of substance.	(4) 925 KJ mol ⁻¹ constant throughout the change,					
40.	(3) $O_{2(g)} \longrightarrow 2O_{(g)}$; Δ (4) $2H_{2(g)} + O_{2(g)} \longrightarrow$ (1) 584.9 KJ mol ⁻¹ S ₁ : Ice in contact with S ₂ : The process is known i.e., dP = 0. S ₃ : A spontaneous properties S ₄ : Integral heat of sole (1) F F F F S : Molar heat at const	$AH = + 489.6 \text{ KJ mol}^{-1}$ $2H_2O(\ell) ; \Delta H = -571.6$ (2) 279.8 KJ mol}^{-1} water constitutes a home own as isochoric in which because is reversible in nate lution is same as heat of (2) F F T T tant pressure - Molar be	KJ mol ⁻¹ (3) 462.5 KJ mol ⁻¹ ogeneous system. h the pressure remains o ure. hydration of substance. (3) T T T T	 (4) 925 KJ mol⁻¹ constant throughout the change, (4) T T F F 					
40.	(3) $O_{2(g)} \longrightarrow 2O_{(g)}$; Δ (4) $2H_{2(g)} + O_{2(g)} \longrightarrow$ (1) 584.9 KJ mol ⁻¹ S ₁ : Ice in contact with S ₂ : The process is known i.e., dP = 0. S ₃ : A spontaneous pro- S ₄ : Integral heat of sol (1) F F F F S ₁ : Molar heat at consecutive S ₂ : $\Delta H_{sub} = \Delta H_{fusion} + \Delta$ S ₃ : Pressure is an integral	$AH = + 489.6 \text{ KJ mol}^{-1}$ $2H_2O(\ell)$; $\Delta H = -571.6$ (2) 279.8 KJ mol}^{-1} water constitutes a home own as isochoric in which because is reversible in nature fution is same as heat of (2) F F T T tant pressure = Molar heat ΔH_{vap} .	KJ mol ⁻¹ (3) 462.5 KJ mol ⁻¹ ogeneous system. h the pressure remains o ure. hydration of substance. (3) T T T T eat at constant volume +	 (4) 925 KJ mol⁻¹ constant throughout the change, (4) T T F F P∆V. 					
40.	(3) $O_{2(g)} \longrightarrow 2O_{(g)}$; Δ (4) $2H_{2(g)} + O_{2(g)} \longrightarrow$ (1) 584.9 KJ mol ⁻¹ S ₁ : Ice in contact with S ₂ : The process is known i.e., dP = 0. S ₃ : A spontaneous proposed S ₄ : Integral heat of sole (1) F F F F S ₁ : Molar heat at consets S ₂ : $\Delta H_{sub} = \Delta H_{fusion} + \Delta$ S ₃ : Pressure is an integral S ₄ : For reaction	$AH = + 489.6 \text{ KJ mol}^{-1}$ $2H_2O(\ell)$; $\Delta H = -571.6$ (2) 279.8 KJ mol}^{-1} water constitutes a home pown as isochoric in which be as isochoric in which DCESS is reversible in nate button is same as heat of (2) F F T T tant pressure = Molar head ΔH_{vap} . ensive property. 2A(g) + B(g)	KJ mol ⁻¹ (3) 462.5 KJ mol ⁻¹ ogeneous system. h the pressure remains of ure. hydration of substance. (3) T T T T eat at constant volume + \longrightarrow 3C(g) $\Delta H =$	 (4) 925 KJ mol⁻¹ constant throughout the change, (4) T T F F P∆V. -x kJ then for reaction 					
40.	(3) $O_{2(g)} \longrightarrow 2O_{(g)}$; Δ (4) $2H_{2(g)} + O_{2(g)} \longrightarrow$ (1) 584.9 KJ mol ⁻¹ S ₁ : Ice in contact with S ₂ : The process is known i.e., dP = 0. S ₃ : A spontaneous pro- S ₄ : Integral heat of sol (1) F F F F S ₁ : Molar heat at consecutive S ₂ : $\Delta H_{sub} = \Delta H_{fusion} + \Delta$ S ₃ : Pressure is an integral S ₄ : For reaction $\frac{3}{2}C(g) \longrightarrow A(g) + \frac{B}{2}(g)$	$AH = + 489.6 \text{ KJ mol}^{-1}$ $2H_2O(\ell) ; \Delta H = -571.6$ (2) 279.8 KJ mol}^{-1} water constitutes a home own as isochoric in which because is reversible in nature button is same as heat of (2) F F T T tant pressure = Molar head ΔH_{vap} . ensive property. $2A(g) + B(g)$ $\Delta H = \frac{x}{2} \text{ kJ}.$	KJ mol ⁻¹ (3) 462.5 KJ mol ⁻¹ ogeneous system. h the pressure remains of ure. hydration of substance. (3) T T T T eat at constant volume + \longrightarrow 3C(g) $\Delta H =$	 (4) 925 KJ mol⁻¹ constant throughout the change, (4) TTFF PΔV. -x kJ then for reaction 					

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42. Stearic acid $[CH_3(CH_2)_{16}CO_2H]$ is a fatty acid. 1.0 g of stearic acid was burned in a bomb calorimeter. The bomb had a heat capacity of 652 J/°C. If the temperature of 500g water (c = 4.18 J/g°C) rose from 25.0 to 39.3°C, how much heat was released when the stearic acid was burned ? [Given C_p (H₂O) = 4.18 J/g°C]

	(1) 39.21 kJ	(2) 29.91 kJ	(3) 108 kJ	(4) 9.32 kJ					
43.	(i) Cis–2–butene –	(i) Cis–2–butene \rightarrow trans–2–butene,							
	(ii) Cis–2–butene -	ΔH_2							
	(iii) Trans–2–butene is more stable than cis–2–butene.								
	(iv) Enthalpy of co	mbustion of 1-butene,	$\Delta H = -649$	$\Delta H = -649.8 \text{ kcal/mol}$					
	(v) $9\Delta H_1 + 5 \Delta H_2 =$								
	(vi) Enthalpy of co	ne, $\Delta H = -647$	$\Delta H = -647.0$ kcal/mol.						
	The value of ΔH_1 8	ΔH_2 in Kcal/mole are							
	(1) – 1.0, 1.8	(2) 1.8, -1.0	(3) –5, 9	(4) – 2, 3.6					

44. Use the following data to calculate the enthalpy of formation of As_2O_3

(i) $As_2O_3(s) + [(3H_2O + aq)]$	$\longrightarrow 2H_{3}AsO_{3}(aq)$,	$\Delta H = +7$	7550 cal	
(ii) As(s) + $\frac{3}{2}$ Cl ₂ (g) \longrightarrow As	${ m sCl}_{ m _3}\left(\ell ight)$;	$\Delta H = -7$	71390 cal	
(iii) $AsCl_3(\ell)$ + (3 H ₂ O + aq)	\longrightarrow H ₃ AsO ₃ (aq) + 3H	ICI(aq);	$\Delta H = -1$	17580 cal	
(iv) $HCI(g) + aq \longrightarrow HCI$ (a	aq)	;	$\Delta H = -1$	17315 cal	
(v) $\frac{1}{2}H_2(g) + \frac{1}{2}CI_2(g) \longrightarrow$	HCl(g)	- 2	$\Delta H = -2$	22000 cal	
(vi) $H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H$	2 ² O(ℓ)	;	∆H = –6	68360 cal	
(1) – 154.68 kcal (2)) + 154.68 kcal	(3) – 255.48 kc	al	(4) + 255.48 kc	al

45. From the following data calculate the enthalpy change for the sublimation of ice at 223 K [mean heat capacity of ice = 2 JK⁻¹ gm⁻¹, mean heat capacity of H₂O (ℓ) = 4.2 JK⁻¹gm⁻¹, mean heat capacity of H₂O (ν) = 1.85 JK⁻¹gm⁻¹, enthalpy of fusion of ice at 0°C = 334 J gm⁻¹, enthalpy of evaporation of water at 100° = 2255 J gm⁻¹] (1) 3386.5 J.g⁻¹ (2) 2546.5 J.g⁻¹ (3) 2831.5 J.g⁻¹ (4) 2631.5 J.g⁻¹

	SP	P A	nsv	/ers									
1.	(2)	2.	(4)	3.	(1)	4.	(4)	5.	(3)	6.	(2)	7.	(3)
8.	(1)	9.	(2)	10.	(4)	11.	(4)	12.	(3)	13.	(3)	14.	(2)
15.	(3)	16.	(4)	17.	(2)	18.	(2)	19.	(4)	20.	(2)	21.	(3)
22.	(2)	23.	(4)	24.	(4)	25.	(1)	26.	(4)	27.	(3)	28.	(2)
29.	(1)	30.	(2)	31.	(1)	32.	(1)	33.	(2)	4.	(3)	35.	(4)
36.	(2)	37.	(4)	38.	(1)	39.	(3)	40.	(1)	41.	(4)	42.	(1)
43.	(1)	44.	(1)	45.	(3)								

SPP Solutions

2. Av.
$$C_{V,m} = \frac{n_1 C_{V,m_1} + n_2 C_{V,m_2}}{n_1 + n_2} = 2 R$$

for adiabatic process $dU = dW$
 $\frac{dT}{T} = \frac{R}{C_{V,m}} \left(\frac{dV}{V}\right) \qquad \Rightarrow \qquad n_1 C_{V,m_1} dT + n_2 C_{V,m_2} dT = -(n_1 RT + n_2 RT) \times \frac{dV}{V}$
 $\ln \frac{T_2}{T_1} = -\frac{1}{2} \ln \left(\frac{V_2}{V_1}\right) \qquad \Rightarrow \qquad T_2 = 320 \times \left(\frac{1}{4}\right)^{1/2} = 160 K$
 $\Delta U = (n_1 C_{V,m_1} + n_2 C_{V,m_2}) \Delta T = -960 R$

3.
$$W = -Pext (V_2 - V_1) = -1 atm (1 L)$$

- 4. $\Delta n_g = 0 \Rightarrow \Delta H^0 = \Delta U^0$ For 2 mole $\Delta U^0 = -370$ kJ.
- **5.** ΔS will be same because entropy is a state function.

6.
$$\Delta S_{system} = nR \ln \frac{V_2}{V_1} = 2 \times R \times \ln 2 J/K$$
$$\Delta S_{surrounding} = -q/T$$
$$\Delta S_{total} = 2Rln2 - q/T$$

7.
$$\Delta S = nC_{p,m} \ln \frac{T_2}{T_1} = 2.5 \times 18 \times 4.2 \ln \left(\frac{360}{300}\right) = 34.02 \text{ J/K}$$

8.
$$A(g) \stackrel{\sim}{=} B(g) \qquad P_{B} = \frac{1}{4}P_{A} \qquad P_{A} = 4P_{B}$$
$$K_{p} = \frac{P_{B}}{P_{A}} = \frac{P_{A}/4}{P_{A}} = \frac{1}{4}$$
$$At \text{ equilibrium } \Delta G = 0.$$
$$\Delta G^{o} = -RT \ln K_{p} = -RT \ln K_{p}$$

9.
$$\Delta S = nC_v \ln \left(\frac{T_f}{T_i}\right) + nR \ln \left(\frac{V_f}{V_i}\right)$$

10.
$$C_{Diamond} + O_2 \longrightarrow CO_2(g)$$
; $\Delta H = -94.0$ kcal
 $C_{Graphite} + O_2 \longrightarrow CO_2(g)$; $\Delta H = -97.6$ kcal
 $C_{Diamond} \longrightarrow C_{Graphite} \Delta H = 3.6$ kcal
Heat required to convert 12 gram diamond to graphite = 3.6
2.6

 \therefore Heat required to convert 1 gm diamond to graphite = $\frac{3.6}{12}$ = 0.3

11. C(s)
$$\longrightarrow$$
 C(g) can be obtained as $\Delta H = \Delta H_1 - \Delta H_2 - \frac{1}{2}\Delta H_3 + \Delta H_4$

12. Work done in isothermal reversible expansion of an ideal gas = -2.303 nRT log $\frac{p_1}{p_2}$

n = 1, R = 2, T = 273 + 27 = 300 K
p₁ = 10 atm, p₂ = 1 atm
W =
$$-2.303 \times 1 \times 2 \times 300 \log \frac{10}{1} = -1381.8 \text{ cal}$$
 [:: log 10 = 1]

13. We know that

$$C_{p} - C_{v} = R \quad \text{or} \qquad C_{p} = C_{v} + R$$
$$C_{p} = \frac{3}{2}R + R = \frac{5}{2}R \qquad \left[\because C_{v} = \frac{3}{2}R \right]$$

At constant pressure heat given by one mole gas = $mS\Delta T$

$$\Delta H = q_p = 1 \times \frac{5}{2} R (373 - 298)$$
$$= 1 \times \frac{5}{2} \times 1.987 \times 75 = 372.56 \text{ cal}$$

- 14. $C_{10}H_8(s) + 12O_2(g) \longrightarrow 10CO_2(g) + 4H_2O(\ell)$ We know that $\Delta H = \Delta E + \Delta nRT$ $\Delta H =$ Heat at constant pressure $\Delta E =$ Heat of constant volume = -1228.2×10^3 cal $\Delta n =$ Change in gaseous moles = 10 - 12 = -2 T = 298 K, R = 2 cal $\therefore \qquad \Delta H = -1228.2 \times 10^3 + (-2)$ (2) (298) = -1229392 cal = 1229.392 cal
- **15.** We know that for isothermal reversible process :

$$\Delta G = -2.303 \text{ nRT} \log \frac{p_1}{p_2}$$

= -2.303 × 2 × 8.314 × 373 log $\frac{10}{25}$ = + 5684.1 J = + 5.684 kJ

16. We know that heat of decomposition (ΔE)

 $\Delta E = mS\Delta T$ m = 1 g: S = 1.23 kJ/g/deg Molar heat of decomposition of $NH_4NO_3 = 7.5276 \times 80 = 602.2 \text{ kJ/mol}$ \therefore Heat released when one mole is decompsed = - 602.2 kJ/mol 17. $C + O_2 \longrightarrow CO_2, \Delta H = -490 J \dots$ (i) $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O, \Delta H = -240 \text{ J} \dots \text{(ii)}$ $8C + 9H_2 \longrightarrow C_{\circ} H_{1\circ}, \Delta H = + 160 J \dots$ (iii) $8 \times \text{Eq.}(i) = 9 \times \text{Eq.}(ii) - \text{Eq.}(iii)$ we have $C_8H_{18} + \frac{25}{2}O_2 \longrightarrow 8 CO_2 + 9H_2O_2$ $\Delta H = 8 x - 490 + 9 X - 240 + 160$ = - 3920 - 2160 + 160 = - 5920 J/mol Hence, energy exchanged when 6 moles of octane is burnt in air = -5920×6 = - 35520 = - 35.5 kJ Work done during $\frac{\text{reversible}}{\text{adiabatic}}$ expansion of ideal gas under conditions is 18. $W = nC_{v}(T_{2} - T_{1})$ Work done by the gas = -3 K = -3000 J $C_v = 20 \text{ J} / \text{mol K}$ n = 1 $T_1 = 273 + 27 = 300 \text{ K}, T_2 = ?$ Putting the values

 $-3000 = 1 \times 20 (T_2 - 300)$ - 150 = T_2 - 300 300 - 150 = T_2

W

Note : Work done during isothermal irreversable expansion of ideal gas

$$= - P_{ext} (V_2 - V_1)$$

Work done during revesible isothermal expansion of an ideal gas

$$W = -2.303 \text{ nRT log } \frac{V_2}{V_1}$$

19. A fixed quantity of any substance is associated with definite amount of energy which depends upon chemical nature of the substance and its state of existance. Thus energy is called intrinsic or internal energy (μ). It includes, translational energy, rotational energy, vibrational energy, electronic energy, nuclear energy and interaction energy of the molecule. It does not include energy due to gravitational pull.

20. Sulphur burns in oxygen according to the following equation

$${\stackrel{\mathrm{S}}{_{32\mathrm{g}}}}$$
 + $\mathrm{O_2} \rightarrow \mathrm{SO_2} + \Delta \mathrm{H}$

0.5 g S librate = 4.6 kJ heat

1 g S librate =
$$\frac{4.6}{0.5}$$
 kJ
32 g S librate = $\frac{4.6}{0.5}$ x 32 = 294.4 kJ

Heat of formation is the amount of heat librated or absorbed when one mole of compound is formed from its constituent elements hence,

Heat of formation of $SO_2 = -294.4 \text{ kJ}.$

21. Entropy changes of fusion ΔS_{f}

$$\begin{split} \Delta S_{\rm f} &= \frac{\Delta H_{\rm f}}{T} \\ \Delta H_{\rm f} &= 6.0 \text{ x } 103 \text{ J}, \text{T} = 273 \text{ K} \\ \Delta S_{\rm f} &= \frac{6000}{273} = 21.97 \text{ J/K mol.} \end{split}$$

22. Adiabatic is the process in which no heat exchange occurs between the system and surrounding. i.e., dq = 0

as
$$\Delta S = \frac{\Delta q}{T}$$

 $\Rightarrow \Delta S = 0.$

23. Entropy (S) is state function, the disorder or degree of randomness in a system is known as its entropy

$$\Delta S = \frac{q_{(rev)}}{T_f} \text{ or } \Delta H_f$$

 $\mathbf{q}_{_{\text{rev}}}$ = heat absorbed by the system in a reversible manner at given temperature

$$\Delta S_{f} = \frac{2930}{273 + 27} = \frac{2930}{300} = 9.77 \text{ J/K mol}$$

 $\Delta S_{vap} = \frac{\Delta H_{vap}}{T_{vap}}$

Similarly

entropy is an extensive property.

- 24. Gibbs–Helmholtz equation
 - $\Delta G = \Delta H T \Delta S$
 - ΔS = Gibb's free energy
 - ΔH = enthalpy change
 - ΔS = entropy change

This equation is very helpful in producting the spontaneity of a process.

- \rightarrow If Δ G is negative i.e., Δ G < 0, indicate that the process is spontaneous
- \rightarrow If $\Delta G = 0$ i.e., T $\Delta S = 0$, $\Delta S = 0$, process is in eqilibrium.
- \rightarrow If Δ G is positive i.e., Δ G > 0, process is non spontaneous.
- 25. Internal energy (U) (also known as intrinsic energy) is a state function. A fixed quantity of any substance is associated with a definite amount of energy which depends upon chemical nature of substance is known as internal energy. The various energy which contribute towards internal energy are :

- (a) Translational energy of molecule (E,)
- (b) Roatational energy of molecules (E_r)
- (c) Vibrational energy of molecules (E_v)
- (d) Electronic energy (E $_{\rm e})$
- (e) Nuclear energy (E_n)
- (f) Interaction energy of molecules (E_i)

$$\mathbf{u} = \mathbf{E}_{t} + \mathbf{E}_{r} + \mathbf{E}_{v} + \mathbf{E}_{e} + \mathbf{E}_{n} + \mathbf{E}_{i}$$

Change in internal energy (Δu) of a reaction is

$$\Delta U = U_{\text{product}} - U_{\text{reacta}}$$

According to I law of thermodynamics

 $\Delta U \neq q + w$

q = heat energy

W = work done

So internal energy is partly potential and partly kinetic.

27.
$$\therefore \quad \Delta G = 2.303 \text{ nRT} \times \log \frac{V_2}{V_1}$$

Hence ΔG = maximum work obtained = ? n = 0.75 mole, T = 27°C = 27 + 273 = 300 K V₁ = 15 lit, V₂ = 25 lit, R = 0.082 ∴ ΔG = 2.303 × 0.75 × 0.082 × 300 log $\frac{25}{15}$

- 28. For the reaction $N_2 + 3H_2 \longrightarrow 2NH_3$ Number of gaseous molecules (n) = 2 - 4 = -2
 - $\therefore \Delta H = \Delta E + nRT$
 - $\therefore \qquad \Delta \mathsf{H} = \Delta \mathsf{E} + (-2)\mathsf{R}\mathsf{T} \qquad (\because \mathsf{n} = -2)$
 - $\therefore \quad \Delta H = \Delta E 2RT$
- **29.** Process is endothermic i.e., $\Delta H = +$ ve and process is also spontaneous i.e., $\Delta G = -$ ve Hence, from Gibbs-Helmholtz equation
 - $\Delta G = \Delta H T.\Delta S$

 ΔS must be positive so that ΔG may be negative.

32.
$$T_1V_1^{4-1} = T_2V_2^{4-1}$$
 $W = nC_v (T_2 - T_1)$

33. T
$$\propto \frac{1}{\sqrt{V}}$$
; TV^{1/2} = constant

For adiabatic process, $TV^{\gamma-1} = constant$ \therefore $\gamma - 1 = \frac{1}{2}, \gamma = \frac{3}{2}$

34.
$$\Delta H = (n_1 C_{p,m1} + n_2 C_{p,m2}) \Delta T = \left(0.5 \times \frac{7}{2}R + 0.5 \times 4 R\right) (-100) = -375 R$$

35.
$$\Delta S = nC_{v,m} \ln \frac{T_2}{T_1} + nR \ln \frac{V_2}{V_1} = C_{v,m} \ln 2 + R \ln \left(\frac{1}{2}\right) = (C_{v,m} - R) \ln 2$$

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- **36.** It is because of the fact that for spontaneity, the value of $\Delta G = (\Delta H T\Delta S)$ should be < 0. If ΔH is ve, the value of T ΔS shall have to be less than ΔH or the value of ΔS has to be less than $\frac{\Delta H}{T}$ i.e., $\frac{x}{298}$.
- **37.** $H_2(g) + Br_2(g) \longrightarrow 2HBr(g) \quad \Delta H = \Delta H^\circ_1 \quad ...(i)$ $Br_2(g) \longrightarrow Br_2(\ell) \quad \Delta H = \Delta H^\circ_2 \quad ...(ii)$ $[eq_1 - eq_2]$ $H_2(g) + Br_2(l) \longrightarrow 2HBr(g) \quad \Delta H = \Delta H^\circ_1 - \Delta H^\circ_2$ Required equation, $\frac{1}{2}H_2(g) + \frac{1}{2}Br_2(l) \longrightarrow HBr(g)$

$$\Delta H = \left[\frac{\Delta H_1^{o} - \Delta H_2^{o}}{2}\right]$$

39. (1)
$$H_2O(\ell) \longrightarrow H_2O(g)$$
 $\Delta H = 40.6 \text{ KJ/mole}$
(2) $2H(g) \longrightarrow H(g)$ $\Delta H = -435.0 \text{ KJ/mole}$
(3) $O_2(g) \longrightarrow 2 O_2(g)$ $\Delta H = -49836 \text{ KJ/mole}$
 $2H_2(g) + O_2(g) \longrightarrow H_2O(\ell)$
(4) $\downarrow \qquad \downarrow \qquad \uparrow$ $\Delta H = -571.6 \text{ KJ/mole}$
 $4H(g) + 2O(g)$ $\Delta H = -571.6 \text{ KJ/mole}$
(1) Calculation of ΔH°_{ℓ} ($H_2O_{\ell}\ell$)

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell) \ \Delta H = -571.6 \ \text{KJ/mole}$$
$$\Delta H^\circ_r = 2\Delta H^\circ_F(H_2O, \ell) - 2\Delta H^\circ_F(H_2, (g)) - \Delta H^\circ_F(O_2, g)$$

$$\downarrow \qquad \qquad \downarrow$$
Zero Zero
$$-571.6 = 2\Delta H^{\circ}_{F}(H_{2}O, \ell) \text{ so } \Delta H^{\circ}_{F}(H_{2}O, \ell) = -285.5$$

(2) Calculation of
$$\Delta H^{\circ}_{F}(H_{2}O, g)$$

40.
$$S_1$$
: It is heterogeneous system $H_2O(s) \rightleftharpoons H_2O(l)$.
 S_2 : Inchoric process volume is constant $dV = 0$.

 S_3 : Spontaneous process is irreuesible.

- 42. $-q_{reaction} = q_{bomb} + q_{water}$ $q_{reaction} = (C(bomb) + (m_{water} \times c)) \Delta T$ $= (652 + 500 \times 4.18) \times 14.3$ = 39210 J or 39.21 kJ
- **43.** 1-butene \longrightarrow trans -2-butene $\Delta H = \Delta H_1 - \Delta H_2 = -649.8 + 647.0 = -2.8$ kcal/mole also $9 \Delta H_1 + 5 \Delta H_2 = 0.$ solving $\Delta H_1 = -1.0$ kcal/mole ; $\Delta H_2 = 1.8$ kcal/mole
- 44. $2As(s) + \frac{3}{2}O_2(g) \longrightarrow As_2O_3(s)$; $\Delta H_f(As_2O_3) = ?$ $\Delta H_f = -(i) + 2(ii) + 2(iii) - 6(iv) - 6(v) + 3(vi)$ $\Delta H_f = -7550 - 2 \times 71390 - 2 \times 17580 + 6 \times 17315 + 6 \times 22000 - 3 \times 68360. = -154.68$ Kcal.

45.
$$\begin{array}{c} H_2O(3) \longrightarrow H_2O(9) \\ (223 \text{ K}) & (223 \text{ K}) \\ H_2O(8) & H_2O(9) \\ (273 \text{ K}) & (373 \text{ K}) \\ \downarrow & \downarrow \\ H_2O(\ell) \longrightarrow H_2O(\ell) \\ (273 \text{ K}) & (373 \text{ K}) \\ \Delta H_{\text{sub,}223 \text{ K}} = C_{\text{p,ice}} (273 - 223) + \Delta H_{\text{fusion}} + C_{\text{p,water}} (373 - 273) + \Delta H_{\text{vap}} + C_{\text{p,vapour}} (223 - 373) \\ = 2 \times 50 + 334 + 4.2 \times 100 + 2255 + 1.85 (-150) = 2831.5 \\ [C_{p}\Delta \text{T}] + 334 + [C_{p}\Delta \text{T}] + 2255 = 2 \times 50 + 334 + 4.2 \times 100 + 2255 \\ = [100 + 334 + 420 + 2255] - 277.5 = 2831.5 \text{ J/gram} \end{array}$$