# CHEMICAL THERMO DYNAMICS

# ADDITIONAL POINTS FOR SYNOPSIS: System:

A specific portion of matter under study which is isolated from the rest of the universe with a bounding surface is called a system's surroundings. The rest of the universes which might be in a position to exchange energy and matter with the system is called the surroundings.

#### **Types of Systems**

- a) A system which can exchange mass as well as energy with the surroundings is called "open system". e.g. lime kiln, ice in an open beaker.
- **b**) A system that can exchange energy with the surrounding and not mass is called a 'closed system i.e., ice in a closed beaker.
- c) A system which can exchange neither mass nor energy with the surroundings is called isolated system e.g., ice in a thermous flask.

#### **Extensive Property**

A property which depends upon the amount of the substance(s) present in the system, e.g., mass, volume, energy, work, internal energy, enthalpy, entropy, etc.

#### **Intesnsive Property**

A property which is independent upon the amount of the substance(s) present in the system is called 'intensive property' e.g., temperature, pressure, density, concentration, viscosity, refractive index, surface tension, specific heat, etc.,

#### **State Function**

The thermodynamic parameters which depend only upon initial and final states of the system and are independent of how the change is accomplished are called state functions.

#### Example:

Internal energy, enthalpy, entropy, free energy, pressure, temperature, volume, etc. Work and heat energy are not state functions.

#### Internal Energy (E):

The total energy stored in a substance by virtue of its chemical nature is called its internal energy, i.e., it is the sum of its translational, vibrational, rotational, chemical bond energy, electronic energy, nuclear energy of constituent atoms as potential energy due to interaction with neighbouring molecules is called Internal or Intrinsic Energy:

 $E = E_t + E_r + E_v + E_e + E_n + E_{PE}$ 

It is a state function and its absolute value can't be determined.

Change in intenal energy can be determined with help of Bomb Calorimeter.

It depends upon quantity of a substance, its chemical nature, temperature, pressure and volume of the substance.

For a given system, E is directly proportional to its absolute temperature.

At constant volume, the quantity of heat supplied to a system (isochoric process) is equal to the increase in this internal energy, i.e.,

In the adiabatic expansion of a gas, it gets cooled because of decrease in internal energy In a reversible process, the change in internal energy is zero, since E is a state function. For exothermic reactions, the sign is positive

Ji.e.,

In endothermic process while for exothermic processes.

#### The modynamic Process:

The operation by which a thermodynamic system change from one state to another is called a thermodynamic process which is always accompained by change in energy although in case of open system, change of matter may also occur.

### (i) Isothermal process:

A process in which although heat enters or leaves the system yet temperature of system remains constant throughout the process. In this change of state (e.g. freezing, melting,

evaporation, condensation) is an isothermal process, Isothermal processes are often carried out by placing the system in a thermo state (a constant temperature bath)

#### (ii) Adiabatic process:

A process during which no heat enters or leaves the system during any step of the process, so that temperature will decrease or increase when the reaction is endothermic and exothermic respectively.

Such process are often carried out in closed insulated containers such as thermous bottle. for this change in heat

CHEMICAL THERMODYNAMICS & ENERGETICS

#### Γ. 7

<u>DISHA SCIEN</u>	<u>CE ACADENIY</u>
<ul> <li>(iii) Isobaric process: A process during which pressure of the system remains constant throughout the reaction e.g., heating of water to its boiling point and its vaporisation take place at the same atmospheric pressure. Expansion of gas in a system is an example of it.</li> <li>(vi) Isochoric process: Volume of the system remains constant through-</li> </ul>	Laws of Thermodynamics: First law of Thermodunamics: It is simply the law of conservation of energy which states that "Energy can neither be created nor destroyed although it can be converted from one form to another". When work is done by the system When work is done on the system
a substance in non-expanded chamber or change taking place in a closed system are ex- amples of these process. In such cases	In case of small changes (In case work is done by the
<ul> <li>(v) Cyclic process: A process during which system comes to its initial state through a number of different processes, is called a cyclic process, , In such cases, . Nature of Work and Heat: Work (W) = where</li> </ul>	<ul> <li>system i.e., expansion) or (in case work is done on the system compression) =</li> <li>(i) When , i.e., cyclic process,</li> <li>(ii) When volume remains constant where v indicates constant volume</li> </ul>
intensity factor is a measure of force respon- sible for work and capacity factor is a measure of extent for which work is done Thus, a) Mechanical Work =	(iii) For adiabatic process, , where q indicates constant heat. (iv) When a gas expands against an external pres- sure P, the work done by it will be: , i.e., $W = -P\Delta V$
<ul> <li>b)Electrical Work = Prrential difference Charge flown =</li> <li>c)Expansion work = Pressure Change in volume =</li> <li>d) Gravitational work = Gravitational force Height = Units of work = dyne cm or erg (CGS system) Netwon m (Nm) or Joule (MKS system)</li> <li>i)Work, Heat and Energy have same units</li> <li>ii)Work is not a state function because amount of work performed depends upon the path followed</li> <li>iii)Positive value of work signifies that the work has been done on the system by the surround- ings and it leads to an increase in the internal energy of the system. Negative value of work indicates that work has been done by the system and it leads to decrease in the inter- nal energy of the system.</li> <li>iv) The general expression for all type of PV- work can be written as . Thus for expansion, i.e., when , is positive. Hence . For compression, , is negative hence</li> </ul>	<ul> <li>(v) When a gas is compressed, work is done on the system and is given by</li> <li>(vi) When a gas expands into vaccum, work done by it is zero, since P = 0, there fore W = 0.</li> <li>(vii) In case of expansion of a gas, maximum work is done, if the process is isothermal and reversible.</li> <li>Limitations of First Law of the Thermodynamics:</li> <li>(i) It does not predict whether the process can occur spontaneously or not i.e., whether it is feassiable or not and if so, in which direction. The first law does not indicate whether heat can flow from a colder end to a hotter end or not. All that the first law tells that, if the process occurs, the heat energy gained by one end would be exactly equal to that lost by the other end. Similarly, the first law does not tell whether a gas can diffuse from low pressure to high pressure or not, whether water can run up hill or not, etc.,</li> <li>(ii) The first law states that energy of one form can be converted into an equivalent amount of energy of another form. However, by experience, it has been observed that although various forms of enrgy can be completely transformed into another, heat energy cannot be completely converted into equivalent amount of work without producing some change elsewhere.</li> </ul>

CHEMICAL THERMODYNAMICS & ENERGETICS

#### Second Law of Thermodynamics:

This states that "heat cannot itself pass from a colder to a warmer body. "Thus, if heat is to be transferred from the cold to the hot body, work must be provided by an external agency.. An alternative and useful expression of the second law is " any system of its own accord will always undergo change in such a way as to increase the entropy". "Every perfect machine working reversibly between the same temperature of source and sink have the same efficiency whatever be nature of substance used" (Carnot-theorm)

#### Lord Kelvin Statement:

" It is impossible to take heat from a hotter revervoir and convert it completely into work by a cyclic process without transferring a part of it to a cooler reservoir". This statement recognizes the fact that the heat engine can never be 100% efficient

#### **Clausius Statement:**

"It is impossible for a cyclic proces to transfer heat from a system at a lower temperature to one at higher temperature without applying some work". i.e., without converting some work to heat.

#### Third Law of Thermodynamics"

This states that for a perfect crystal at about zero on the Kelvin scale, the entropy is zero. " This follows, the predictions of Einstein that the specific heats of all substances would approach zero at **0** Kelvin and the conclusion of Planck that the entropy of all pure solids and liquids approach zero at this tempeature.

#### Spontaneous, Natural (OR) Irreversible Process: "A process which proceeds of its own accord without the help of any external agency, is called a spontaneous process.

"All natural processes are spontaneous, hence the term, natural is also used for the spontaneous process, also spontaneous processes cannot be reversed without the help of an external energy, these are also said to be irreversible.

The term 'non-spontaneous' is applied to processes which has not natural tendency or urge to occur, e.g. electrolysis of water. The term spontaneous does not give any idea of the rate of the process.

#### **Examples:**

- (i) Water flows down-hills spontaneously and the direction cannot be reversed unless some external work is done on it.
- (ii) Heat flows spontaneously from the hot end of a metallic bar to its cold end but never from cold end to hot end.

- (iii) Heat flows spontaneously from a hot reservior to a cold reservoir. However, transference of heat from a cold reservoir to hot reservoir as in a refrigerator need energy from outside the system
- (iv) Diffusion of a solute from a concentrated solution to a less concentrated solution, when these are in contact with each other, occur spontaneously till the equilibrium is achieved.
- (v) electricity flows spontaneously from a point. The direction of flow can be reversed only when an external field is applied in the opposite direction.
- (vi) A gas expands spontaneosly from a region of high pressure to a region of low pressure. The reverse process cannot occur unless work is done on it.
- (vii) A piece of zinc dissolution occurs spontaneously in copper sulphate solution, precipitating copper and evolving some heat.

#### Entropy (S)

It is a thermodynamic quantity which is a measure of the degree of disorder within any system. The greater the degree disorder, the higher the entropy.

Thus, for a given substance,

Any change taking place which results in an increase in entropy has a positive entropy change  $(\Delta S)$ . Most spontaneous thermodynamic pro- *Last Saccompained by an increase in entropy.* Entropy has units of joules per degree per mole. The entropy of the universe always increase in the course of every natural change i.e.,

> and energy of universe is conserved while entropy of universe always increases in any natural or spontaneous process

#### Gibb's Free Energy (

It is a thermodynamic state function represented by G (after Willard Gibbs). the free energy change in any system is related to the enthalpy and entropy changes by the equation: is a measure of the maxi-

num amount of useful work which may be obtained from the change under consideration. In any system, the value of the free energy change determines the position of equilibrium in that equilibirum the free energy . For substances in their standard state, i.e., 1 mole

at 1 atmopsheric pressure and a specified temperature, the change in free energy is called the standard free energy change

This latter quantity is of considerable importance, in that, it determines the thermodynamic feasibility of a reaction.

### <u>HA SCIENCE ACADEM</u>

	For a reaction to be thermodynamically feasible and this for more products than reactants to be formed at equailibrium, the value of must	] C	The specific heat capacity is denoted by c and can be calculated with the help of formula
(i) (ii) (iii)	be negative, i.e., there must be a decrease on standard free energy from reactants to prod- ucts. and are usually expressed in kilojoule per mole for chemical reactions. For spontaneous process, is negative For process in equilibirum, is zero For process occuring in backward direction and not in forward direction is positive Stan- dard free energy change () and equilibirum constant are related as below: Where $\Delta G^0 =$	v t c s s s s s	where, $q =$ heat required to raise the tempera- ture by one degree c = specific heat capacity m =mass = temperature chagne For gases two molar heats viz, molar heat at constant pressure and molar heat at con- stant volume are defined, is always greater than and both of them are related as where $R = 2$ cal
	(Free energy of formation of products - Free energy of formation of reactants) Standard	H a	From the ratio of and we get the idea of atomicity of a gas.
	enthalpies of formation , standard free	(a) I	For monoatomic gas ; $C_v = 3  cal$
•	energies of formation $(\Delta G_f^0)$ and absolute en- tropies of selected substances at 298 K are given below: The quantity of heat required to raise the tem- perature of a system of one degree is called heat	ł (b) I	hence, $\gamma = \frac{C_p}{C_v} = \frac{5}{3} = 1.67$ For diatomic gas $C_p = 7 \ cal$ ; $C_v = 5 \ cal$
	canacity of that system. This is denoted by	ł	hence $\gamma = \frac{C_p}{r} = \frac{7}{r} = 1.40$
	(Heat capacity when volume is constant) and	$\mathbf{O}$	$C_v$ 5
	(Heat canacity when pressure is constant)		$C_p = 8 cal; C_y = 6 cal$
	Thus, in general we can say	aP weitin	$\frac{1}{4\pi} \frac{1}{m} \frac{1}{m} \frac{1}{m} \frac{1}{m} \frac{1}{\gamma} \frac{1}{m} \frac{1}{\mu} 1$
	Heat capacity = For solids and lquids there is not much differ- ence between the values of and . How- ever for gases these quntities differ which can be calculated as as at constant volume Similarly as at constant pressure	• I r l c F c C F C C F C C F C C F	If an ideal gas expands in vacuum adiabatically, no cooling is produced in the process i.e., . However if a real gas is allowed to expand through a porous plug into the region of lower pressure, the gas is cooled and the extent of cooling is proportional to the difference in pressures of two sides. This phenomenon of cooling of gas is called Joule-Thomson effect. This effect is observed when i.e., at constant enthalpy. The effect is also called Joule- Kelvin effect.
z	The heat capacity of a substance is directly pro- portional to the amount of substance i.e., de- pends upon amount of substance In chemical calculations we often use specific heat capacity and molar heat capacities of which specific heat is defined as "The heat required to raise the temperature of one unit mass by one degree (either celcius or kelvin)". When the above definition is given in terms of mole it is considered as molar heat capacities i.e., the heat capacity of 1 mole of a substance	V Is	Where, $T_m$ = melting point of substance Where, $T_b$ = boiling point of substance simi- arly
	capacity of 1 mole of a substance.		
	/IICAL THERMODYNAMICS & ENERGETICS   [D]	SHA]	

		6.	The	molar h	eat capacity of water in e	equilib-	
			rium	with ic	e at constant pressure is:		
	Where $T_{\rm eq}$ = sublimation temperature		a. Ne		b. Zero		
Noto	where, $T_{sub}$ – sublimation temperature		c. Inf	inity	d. 40.45 <i>kJK</i>	$C^{-1}mol^{-1}$	
(i)	have (+) ve value for spontaneous processes	7.	Thea	additivi	ty property of (forma	tion)	
(I) (ii)	have () ve value for non-monteneous processes		value	e is kno	wn as		
(11)	The zero value of indicates equilibrium state		a. Ki	"s law			
(III) (i==)	The zero value of indicates equilibrium state.		b. Th	ne Lavo	sier and laplace law		
(IV)	For a reversible process at equilibrium can		c.He	ess's lav	w d. The paulir	ng law	
	be calculated by , Where $q_{rev} =$ heat	8.	For a entro	revers py of th	ible process, the total ch he universe is equal to	ange in	
	supplied at temperature T in a reversible process Free Energy and Electromotive Force (E.M.F)		a. Δ	S (syste	m)+ (surroundings)		
	of a Cell Using,		b.	(syste	em) - (surroundings)		
			c. Ze	ero	d. Negative		
	$\Lambda C = m FF$	9.	Whic	chofthe	follwoing statements are co	rrect?	
	$\Delta O = -m^2 E_{\text{Cell}}$		a. Th	e entro	py of an isolated system	increase	
	We have		in an	irrever	sible process		
	$-nFE_{\text{Cell}} = -nFE_{\text{Cell}}^0 + 2.303 \ RT \ \log Q$		b. The entropy of an isolated system remains				
	$E = E^0 = 2.303 RT_{100} Q$		unch	anged i	in a reversible process		
	$E_{cell} = E_{cell} - \frac{1000}{nF}$		c. Th	e entro	py can never decrease		
LEV	EL-I		d. Al	l of the	above	an at 9	
1.	When heat is supplied to an ideal gas in an iso-	10.		elonov	ving table, which are con	ect?	
	thermal process, the						
	a) Gas will do positive work	NG¥_	<b>I</b> Gn <sup>₽</sup> F	E2/\$63	R Tulos Peaction		
	b) Gas will do negative work	$\Delta S_{\text{subl}} = -$	mation				
	d) Gaswill not obey the law of conservation of energy	-ve	+ve	-ve	temparature		
2.	An adiabatic process is a process in which				Non-Spontaneous regardless		
	a. All energy is transferred as heat	+ve.	-ve	+ve	of temparature		
	b. No energy is transferred as heat	+ve	+ve	-Ve	Spontaneous only at high		
	c. The temparature of a gas decrease in a	i ve	1 40	- • C	temparature		
	d B and C	-ve	-ve	-ve	Spontaneous only at low		
3	If the internal energy of an ideal gas decrease				temparature		
	by the same amount as the work done by the		a. 1,2	2 only	b. 1,2 and 4	only	
	system, the process is		c. 1 a	and $4 \text{ or}$	nly d. All of the	above	
	a. cyclic b. Isothermal	11.	Ident	tity the	intensive quantity from th	e follow-	
4	c. Adiabatic d. Isolated		ing:	41a a 1.00 x x	and tamen another		
4.	when the gas is ideal and the process is iso-		a. Ell	lunaipy a	and temperature		
			c Fn	thalny	and volume		
	a. $P_1 V_1 = P_2 V_2$ b. $E_1 = E_2$ c .		d Te	mnarat	ure and refractive index		
	d. A and B	12.	Whe	n a gas	subjected to adiabatic ex	xpansion,	
5.	Which of the following statment is correct?		it get	ts coole	ed due to	<b>I</b>	
	a. The work done by the system on the		a. Fa	ll in ten	nparature		
P	b The work done on the system by the		b. Lo	oss in ki	netic energy		
	surroundings is positive		c. De	ecrease	in velocity		
	c. The heat absorbed by the system from the		d. En	nergy sp	bent in doing work		
	surroundings is positive						
	d. All of the above						
CHEM	IICAL THERMODYNAMICS & ENERGETICS)	ISHA					

13.	The change in internal energy of a system	23.	Work done by the system in a cyclic process is
	depends on		equal to
	a. Intial and final states of a system		a. Zero b. c. d.
	b. Whether the path is reversible	24.	Internal energy of an ideal gas depends on
	c. Whether the path is irreversible		a. Pressure b. Temparature
	d. None of the above		c. Volume d. None
14.	The amount of heat measured for a reaction in	25.	Vibrational energy is
	a bomb calorimeter is		a. Partially potential and partially kinetic
	a. b. c. d.		b. Only potential c. Only kinetic
15.	The enthalpies of elements in their standard		d. None of the above
	states are taken as zero. Hence the enthalpy of	26.	All the naturally occuring processes i.e. spon-
	formation of a compound		taneous processes proceed spontaneously in a
	a. Should always be negative		direction which leads to
	b. Should always be positive		a. Decrease of free energy
	c. Will be equal to twice the energy of combustion		b. Increase of free energy
	d. May be positive or negative	27	c. Decrease of entropy $d. 2 \approx 3$
16.	Evaporation of water is	27.	select the confect minitations of find law of thei-
	a. An exothermic change		a Classy golids at zero Kalvin has antrony
	b. An endothermic change		a. Olassy solids at zero Kervin has entropy
	c. A process where no heat change occurs		b Solids having mixtures of isotopes do not have
	d. A process accompanied by chemical reaction		entrony zero at zero K elvin
17.	Which of the following fuels will have highest		a Crustala of
	calorific value (kJ/kg)?		do not
	a. Charcoal b. Kerosene		have zero entropy at zero Kelvin
10	c. Wood d. Dung		d. All the above
18.	A spontaneous reaction is impossible if	RT RT	Linguage in free energy
	a. Both and are negative	272	a. Increase in antrony
	b. Both and are positive		c. Decrease in entropy
	c. is negative and is positive		d No change in entropy
	d. is positive and is negative	29	When hydrogen and oxygen burn to form water
19.	In which of the following case, entropy decrease	27.	in an oxyhydrogen torch the entropy change is
	a. Solid changing to liquid		ave b. +ve c. 0 d. +ve or -ve
	b. Expansion of a gas c. Crystals dissolve	30.	If a refrigerator door is kept open, then we get
	d. Polymerisation		a. Room cooled b. Room heated
20.	In which case, a spontaneous reaction is im-		c. More heat is pased out
	possible at any temparature		d. No effect on room
	a. b.	31.	In a reversible isothermal process, the change
	c d In all the cases		in internal energy is
21	Warming ammonium chloride with sodium by		a. Zero b. Positive
<u></u> <u> <u> </u> <u> </u></u>	droxide in a test tube is an example of		c. Negative d. None
	a Closed system b Isolated system	32.	When the value of entropy is greater, then the
	c Open system d None of the above		ability for work is
22	When an ideal gas is compressed adiabatically		a. Maximum b. Minimum
	and reversibly, the final temparature is		c. Medium d. None of these
	a. Higher than the initial temprature	33.	The internal energy of one mole of gas is
N	b. Lower than the initial temparature		- 1 1
	c. The same as the intial temparature		a. b. c. d.
	d. Dependent on the system of compression		
CHEM	IICAL THERMODYNAMICS & ENERGETICS	SHA	
		<u> </u>	

34.	Which of the following statements is incorrect? a. The entropy of an isolated system increase in an irreversible process	42.	Mechanical work is specially important in systems that contain a. solid - liquid b. liquid - liquid				
	b. The entropy of an isolated system remains unchanged in a reversible process	43	c. solid - solid d. gases				
	c. as well as $\Delta S_{surrounding}$ are nega-	13.	a. $\Delta H > \Delta E$ b.				
35.	tive quantities d. Entropy can never decrease Choose the correct relation :	44.	c. d. None of these The value of free energy change at equilibrium is a. Positive b. Negative c. Zero d. Not definite				
	a. $\Delta G = \Delta H + \Delta n R T$ b.	45.	According to third law of thermodynamics, which one of the following quantities for a per- fectly crystalline solid is zero at absolute zero.				
	с.	16	a. Entropy c. Internal energy d. Enthalpy				
36.	d. None of these Which of the following are thermodynamically	46.	a) surface tension b) Density c) Heat capacity d) Specific heat				
	stable? a. C (diamond) b. C (graphite)	47.	Which one of the following is an intensive quantity? a) Temperature b) Volume				
37.	c. (red) d. All are equally stable In which one of the following sets, all the prop-	48.	c) Number of moles d) Work Which change would have a negative value?				
	erties belong to same category? a. mass, volume, Pressure	6	a)				
	b. Temparature, Pressure, Volume c. Heat capacity, density, entropy						
38.	d. Enthalpy, internal energy, volume The difference between and at con-	2000	$ \overset{\text{ad}}{d} Cl(\underline{g}) + \partial \overline{d} \xrightarrow{\mathcal{F}} Cl^{-}(g) $				
	stant volume is equal to :	49.	Unit of entropy is				
	a. b. c. d.		a) $JK^{-1}mole^{-1}$ b)				
39	If the internal energy an ideal was decreases by	50	c) <i>JK mole</i> d) None of these For a spontaneous reaction which one is true?				
57.	the same amount as work done by the system,	50.	a) b)				
	the process is :		c) d) None of these				
	a. cyclic b. isothermal c. adiabatic d. isolated	51.	represents calculation of at				
40.	Select the exothermic compund among the fol-		a) b)				
	lowing with respect to enthalpy of formation :		c) d) None of these				
	a. b.	52.	of a system is not equal to				
A1	c. d. When a gog is allowed to avoid from a region		a) b) c) $n \times Q$ d)				
41.	of extremely high pressure to a region of ex-	53.	sublimation of graphite and diamond				
	tremely low pressure, there occurs a change of		respectively are x and y . What is				
S	temparature. This phenomenon is connected with		for the change; Graphite diamond				
	a. first law of thermodynamics		a) b)				
	b. Joule Thomson effect		c) $(x-y) kI mol^{-1} = 4) (y-x) kI mol^{-1}$				
	c. Globs Heimholf z equation d. None of the above						
	NICAL THERMODYNAMICS & ENERGETICS	SHA					

### NCE ACADEMY

6.

7.

8.

- Which one of the following quantity is indepen-54. dent of path?
  - a) molar internal energy

b) volume d) work

55. Evaporation of water is

c) q + W

- a) an exothermic process
- b) an endothermic process
- c) an exothermic process at  $100^{\circ}C$
- d) an endothermic process at

KEY								
1.a	2.d	3.c	4.d	5.d				
6.c	7.c	8.c	9.d	10.d				
11.d	12.d	13.a	14.c	15.d				
16.b	17.b	18.d	19.d	20.b				
21.c	22.c	23.d	24.b	25.a				
26.a	27.d	28.b	29.a	30.b				
31.a	32.a	33.a	34.c	35.c				
36.b	37.d	38.c	39.c	40.c				
41.b	42.d	43.c	44.c	45.a				
46.c	47.a	48.d	49.a	50.b				
51.b	52.d	53.c	54.c	55.b				

#### **LEVEL-II**

- The heat of combustion of solid benzoicacid and 1. at constant volume is The at heat of combustion at constant pressure is a) b)
- c) d) The heats of combustion of yellow P and red P 2. respectively. The are and heat of transition of yellow to red phosporus is
  - a)

3.

- c)
- of a reaction
  - a) Depends only on the nature of the reactants

**b**)

d)

- b) Depends only on the nature of the products
- c) Depends on the nature of reactants, products and path used to bring about the change
- d) Depends on the nature of reactants and the products but not on path used to bring about the change.
- Which of the following statements is true about the entropy of the universe?
  - a) Increases and tends towards maximum value
  - b) Decreases and tends to be zero c) Different intermediate reaction
  - d) Decreases and Increases with a periodic rate.

- 5. Given
- $X^+(g) \rightarrow X^{+2}(g) + e^-; \Delta H = 420 \ kJ \ mol^{-1}$  $X^{+2}(g) \to X^{+3}(g) + e^{-}; \Delta H = 3547 \, kJ \, mol^{-1}$ Which ion is most likely to be present in the crystalline compound formed between X and fluorine? a)  $\chi^{+3}$ b) c) d) For precipitation reaction of with which of the following statements is correct? for the reaction is zero a) b) for the reaction is negative for the reaction is part-time c) d) Entropy decreases during a) crystallization of sucrose from solution b) vaporisation of water c) Melting of ice d) Vaporization of Camphor The enthalpy for the following reactions at  $25^{\circ}C$  are given below : ii)  $\hat{H}_{2}(g) \rightarrow 2H(g); 104.18 kcal$ iii)  $O_2(g) \rightarrow 2O(g)$ ; 118.32 kcal Calculate the Q - H bond energy in the hydroxyl radical. a. - 101.19 kcal b. + 206.13 kcal c. - 206.13 kcal d. + 101.19 kcal 9. If 50 calorie are added to a system does work of 30 calorie on surroundings, the change in internal energy of system is a. 20 cal b. 50 cal c. 40 cal d. 30 cal 10. Latent heat of vaporisation of a liquid at 500 K and 1 atm. pressure is 10.0 kcal/mol. What will be the change in internal energy of 3 mole of liquid at same temparature a. 13.0 kcal b. -13.0 kcal c. 27.0 kcal d. -27.0 kcal 11. Boiling point of a liquid is 50 K at 1 atm. and . What will be its b.p. at 10 atm. a. 150 K b. 75 K d. 200 K c. 100 K

CHEMICAL THERMODYNAMICS & ENERGETICS

12. The expression representing Gibbs-Helmholtz equation is :

a. 
$$\Delta G^0 = \Delta H^0 + T \left[ \frac{\partial \left( \Delta G^0 \right)}{\partial T^2} \right]$$

b.

c. 
$$\left[\frac{\partial \left(\Delta G^{0} / T\right)}{\partial \left(1 / T\right)}\right]_{p} = \Delta H^{0}$$
  
d. 
$$\left[\frac{\partial \left(\Delta G^{0} / T\right)}{\partial T}\right]_{p} = -\Delta H^{0}$$

13. The enthalpy of dissolution of  $BaCl_2(s)$  and are and per mole respectively. The enthalpy of hydration for, is

14. The enthalpy of vapourisation of a substance is 840 J per mol and its boiling point is  $-173^{\circ}C$ . Calculate its entropy of vaporisation : a) 8.4 Joule/K/mole b) 21 Joule/K/mole c) 40 Joule/K/mole

- 15. Which has the highest entropy per mol of the substance?
  - a)  $H_2$  at at 1 atm
  - b) at STP
  - c) at 100K at 1 atm

Give  $\Delta H = 145.6 \, kJ$  per mol

18. A hypothetical reaction proceeds through following sequence of steps :

d.

 $\rightarrow E$ 

c.

19. If E,R and D represent the tendency of minimum energy(E), tendency for maximum randomness (R) and overall driving force (D) respectively and arrows represent the direction and magnitude of these tendencies, choose the correct option applies to following reaction :

 $\rightarrow E$ 

$$\frac{2 \alpha r \Theta(g)}{\partial T} = \frac{\pi r \Theta(g)}{T^2} \frac{2 \beta r \Theta(g)}{C^2} \frac{2 \beta r \Theta(g$$

$$-20$$
. For the two equations given below :

(i) 
$$H_2(g) + \frac{1}{2}O_2(g) \to H_2O(l) + a_1 kJ$$
  
(ii)  $H_2(g) + \frac{1}{2}O_2(g) \to H_2O(g) + a_2 kJ$ 

The correct relation between  $a_1$  and is:

b.

d.

C.

21. The mathematical expression for the standard enthalpy of sublimation is given by :

b. 
$$\Delta H_{sub}^{0} = \Delta H_{fus}^{0} - \Delta H_{vap}^{0}$$
  
c.  $\Delta H_{sub}^{0} = \Delta H_{fus}^{0} + \Delta H_{vap}^{0}$   
d.  $\Delta H_{sub}^{0} = \Delta H_{comb}^{0} - \Delta 2 H_{diss}^{0}$   
Here,  $\Delta H_{sub}^{0} = \Delta H_{sublimation}^{0}$ ;  
 $\Delta H_{fus}^{0} = \Delta H_{fusion}^{0}$ ;  $\Delta H_{vap}^{0} = \Delta H_{vaporization}^{0}$ ;  
 $\Delta H_{diss}^{0} = \Delta H_{dissociation}^{0}$ 

CHEMICAL THERMODYNAMICS & ENERGETICS

(JISHA)

22. The enthalpy change when 1 g of water is 30. In thermodynamics, a process is called reversible when frozen at  $0^{\circ}C$ . is : a. surroundings and system change into each other a. -1.435 cal/g b. -80.0 calg b. there is no boundary between system and c. 80 cal/g d. -55.6 cal/g surroundings Mark the incorrect relationship : 23. c. The surroundings are always in equilibrium a.  $\xrightarrow{\Delta H_{vapour}}_{Tb} \approx 88 J / K / mole$ with the system d. the system changes into the surroundings b.  $\Delta H = \Delta E = \Delta \eta_{(g)} RT$ spontaneously c. specific heat X atomic mass = 6 cal/mol  ${}^{\circ}C$ 31. Bond enthalpies of and HX are in the d. ratio 2:1:2. If enthalpy of formation of HX is -One mole of a non-ideal gas undergoes a change 24. 50 , the bond enthalpy of is of state (2.0 atm, 3.0L 95K) (4.0 atm, 5.0L, 245K) with a change in internal energy, b. a. The change in enthalpy d. c. of the process in L atm is. KEY b. 42.3 a. 40.0 c. 44.0 2.d **3.d 4.a 5.b 1.c** d. Not defined because pressure is not constant 7.a 10.c **6.b 8.d 9.a** One mole of an ideal gas at 300 K is expanded 25. 12.c 15.a 11.c 13.b 14.a Isothermally from an intial volume of 1 litre to 18.c 16.b 17.a 19.c 20.d 10 litres. The  $\Delta E$  for this process is 21.c **22.b** 23.d 25.b 24.c 26.a **27.b 28.**a **29.d 30.c** a. 163.7 cal b. zero c. 1381.1 cal d. 9 lit atm **31.**a (1)If 900J/g of heat is exchanged at boiling point 26. of water, then what is increase in entropy? LEVEL-III a. 43.4 J/mole b. 87.2 J/mole The specific heat of a gas is found to be 0.075 1. c. 900 J/mole d. Zero calories at constant volume and its formula wt 27. Entropy change involved in the conversion of 1 is 40. The atomicity of the gas would be: mole of liquid water at 373 K to vapour at the c) Three a) One b) Two d) four same temparature will be 2. When 12.0 g of carbon reacted with a limited  $\left(\Delta H_{vap} = 2.257 k J / g\right)$ quantity of oxygen, 57.5 kcal of heat was produced. Calculated the no. of moles of CO and a. 0.119kJ b. 0.109kJ c. 0.129kJ d.0.12kJ the no. of moles produced. The bond energy of an O-H bond is 28. 109 K.cal.mole<sup>1</sup> When a mole of water is  $\Delta H(CO) =$ [ formed a. 218 K.cal. is released a) 0.54 mol of CO b) 0.46 mol of CO b. 109 K.cal. is released c) 0.64 mol of CO d) 0.74 mol of CO c. 218 K.cal. is absorbed For the reaction at 298 K 3. d. 109 K.cal. is released and . As-29. For the process suming and to be constant, at what and minimum temperature will the reaction become  $\Delta S = 1.20 X 10^2 Jk mol^{-1}$ . spontanous? At what a) 2, 000 K b) 200 K temparature the above process is at equilibrium? c) 4,000 K d) 400 K a. 273K b. d. C.

4	A reaction happens to be in state of equilibrium	11.	Select the correct alternate about entropy
<sup></sup>	at 400 K and occurs spontanously below 400		a) b)
	K in forward direction. The for the pro-		
	cess is . The at 400 K for		c) d)
	this process would be:	12.	Which of the following process is spontaneous?
	a) b)		of the room to the other
	c) d)		b) decomposition of solid <i>CaCO</i> .
5	The volume of a gas expands by at a		c) heat flow from a cold object to a hot object
	constant pressure of The work done		d) climbing up a mountain
	is equal to	13.	,
	a) b) 250 I		
	c) $250$ watt d) $250$ newton		$\Delta S^0 = 22.0 \ I K^{-1} \ mol^{-1}$
6.	A gas expands against a constant external pres-		Formation of ice is favoured at a temperature?
	sure of 2.00 atm from an initial volume of 1.50 L		a) above $0^{\circ}$ b) below
	to a final volume of 3.50 L. The container is well		c) at d) above
	insulated so that no heat enters or leaves the sys-	14	Following reaction occcurs at
	tem. Calculate the change in internal energy $()$		
	a) b) $c) 4 00 d) 25 3$		
7	At a certain temperature and pressure the re-		$\neq 2NOCl(g,1\times10^{-2} \text{ atm})$ 1S:
/.	action is endothermic but		a) b)
	spontaneous Which of the following is true?	$\mathbf{O}$	c) d)
	a) $\Delta G > 0$	15.	The change of entropy, at 298K for the
	$\mathbf{b}$ and		Steachon By which urea is formed from and
		17	
	c) and	2	
	c) and d) and	2	$\rightarrow NH_{*}CONH_{*}(aa) + H_{*}O(l)$ . The standard
8	c) and d) and A gas obsorbs 100 J of heat and is	2	$\rightarrow NH_2CONH_2(aq) + H_2O(l)$ . The standard entropy of NH CONH is
8.	<ul> <li>and</li> <li>and</li></ul>	2	$\rightarrow NH_2CONH_2(aq) + H_2O(l)$ . The standard entropy of $NH_2CONH_2$ is
8.	c) and d) and A gas obsorbs 100 J of heat and is simulataneously compressed by a constant ex- ternal pressure of 1.5 atm from 8 to 2L in vol-	2	$\rightarrow NH_2CONH_2(aq) + H_2O(l)$ . The standard entropy of $NH_2CONH_2$ is
8.	c) and d) and A gas obsorbs 100 J of heat and is simulataneously compressed by a constant ex- ternal pressure of 1.5 atm from 8 to 2L in vol- ume. What is in joules for the gas?	2	$\rightarrow NH_2CONH_2(aq) + H_2O(l)$ . The standard entropy of $NH_2CONH_2$ is a) + 354.4 b)
8.	<ul> <li>and</li> <li>and</li></ul>	2	$\rightarrow NH_2CONH_2(aq) + H_2O(l)$ . The standard entropy of $NH_2CONH_2$ is a) + 354.4 b) c) + 177.2 d)
8. 9.	<ul> <li>and</li> <li>b)</li> <li>b)</li> <li>c)</li> <li>d)</li> <li>c)</li> <li>d)</li> <li>c)</li> <li>d)</li> <li>c)</li> <li>d)</li> <li>c)</li> <li>d)</li> </ul>	16.	$\rightarrow NH_2CONH_2(aq) + H_2O(l)$ . The standard entropy of $NH_2CONH_2$ is a) + 354.4 b) c) + 177.2 d) for conversion of oxygen to ozone
8. 9.	<ul> <li>and</li> <li>b)</li> <li>c)</li> <li>d)</li> <li>and enthalpy of solution is 1</li> <li>If the</li> </ul>	16.	$ → NH_2CONH_2(aq) + H_2O(l). The standardentropy of NH_2CONH_2 isa) + 354.4 b)c) + 177.2 d)for conversion of oxygen to ozoneat 298 K if K for this$
8. 9.	<ul> <li>and</li> <li>b)</li> <li>c)</li> <li>d)</li> <lid)< li=""> <lid)< li=""> <li>d</li></lid)<></lid)<></ul>	16.	$\rightarrow NH_2CONH_2(aq) + H_2O(l)$ . The standard entropy of $NH_2CONH_2$ is a) + 354.4 b) c) + 177.2 d) for conversion of oxygen to ozone at 298 K, if $K_p$ for this
8. 9.	<ul> <li>and</li> <li>b)</li> <li>c)</li> <li>d)</li> <li>and</li> <li>b)</li> <li>c)</li> <li>d)</li> <lid)< li=""> <li< td=""><td>16.</td><td><math display="block"> \rightarrow NH_2CONH_2(aq) + H_2O(l). </math> The standard entropy of <math>NH_2CONH_2</math> is a) + 354.4 b) c) + 177.2 d) for conversion of oxygen to ozone at 298 K, if <math>K_p</math> for this conversion is</td></li<></lid)<></ul>	16.	$ \rightarrow NH_2CONH_2(aq) + H_2O(l). $ The standard entropy of $NH_2CONH_2$ is a) + 354.4 b) c) + 177.2 d) for conversion of oxygen to ozone at 298 K, if $K_p$ for this conversion is
8. 9.	<ul> <li>and</li> <li>b)</li> <li>c)</li> <li>d)</li> <lid)< li=""> <li>d)</li> <lid)< li=""> <lid)< li=""> <li>d)</li> <li>d)</li></lid)<></lid)<></lid)<></ul>	16.	$ \rightarrow NH_2CONH_2(aq) + H_2O(l). $ The standard entropy of $NH_2CONH_2$ is a) + 354.4 b) c) + 177.2 d) for conversion of oxygen to ozone at 298 K, if $K_p$ for this conversion is a) 163 kJ mol <sup>-1</sup> b)
8. 9.	<ul> <li>and</li> <li>b)</li> <li>c)</li> <li>d)</li> <lid)< li=""> <li>d)</li> <lid)< li=""> <lid)< li=""> <lid)< li=""> <lid)< <="" td=""><td>16.</td><td><math display="block">\rightarrow NH_2CONH_2(aq) + H_2O(l)</math>. The standard entropy of <math>NH_2CONH_2</math> is a) + 354.4 b) c) + 177.2 d) for conversion of oxygen to ozone at 298 K, if <math>K_p</math> for this conversion is a) 163 kJ mol<sup>-1</sup> b) c) d)</td></lid)<></lid)<></lid)<></lid)<></lid)<></ul>	16.	$\rightarrow NH_2CONH_2(aq) + H_2O(l)$ . The standard entropy of $NH_2CONH_2$ is a) + 354.4 b) c) + 177.2 d) for conversion of oxygen to ozone at 298 K, if $K_p$ for this conversion is a) 163 kJ mol <sup>-1</sup> b) c) d)
8. 9.	<ul> <li>and</li> <li>b)</li> <li>c)</li> <li>d)</li> <li>c)</li> <li>and enthalpy of solution is 1</li> <li>f)</li> <li>f)</li></ul>	16. 17.	$ \rightarrow NH_2CONH_2(aq) + H_2O(l). The standard entropy of NH_2CONH_2 isa) + 354.4 b)c) + 177.2 d)for conversion of oxygen to ozoneat 298 K, if K_p for thisconversion isa) 163 kJ mol-1 b)c) d)Fo the reaction at$
8. 9.	c) and c) and d) and A gas obsorbs 100 J of heat and is simulataneously compressed by a constant ex- ternal pressure of 1.5 atm from 8 to 2L in vol- ume. What is in joules for the gas? a) b) c) d) The lattice energy of solid NaCl is 180 and enthalpy of solution is 1 . If the hydration energies of and ions are in the ratio 3:2, what is enthalpy of hydration of sodium ion? a. b. 107.4 K Calmol <sup>-1</sup> c. d. 8g of $O_2$ gas at is compressed to half of	16. 17.	$ \rightarrow NH_2CONH_2(aq) + H_2O(l). \text{ The standard} $ entropy of $NH_2CONH_2$ is $ a) + 354.4 \qquad b) $ $ c) + 177.2 \qquad d) $ for conversion of oxygen to ozone $ at 298 \text{ K, if } K_p \text{ for this} $ conversion is $ a) 163 \text{ kJ mol}^{-1}  b) $ $ c) \qquad d) $ Fo the reaction at $ , $
8. 9.	c) and c) and d) and A gas obsorbs 100 J of heat and is simulataneously compressed by a constant ex- ternal pressure of 1.5 atm from 8 to 2L in vol- ume. What is in joules for the gas? a) b) c) d) The lattice energy of solid NaCl is 180 and enthalpy of solution is 1 . If the hydration energies of and ions are in the ratio 3:2, what is enthalpy of hydration of sodium ion? a. b. 107.4 K Calmol <sup>-1</sup> c. d. 8g of $O_2$ gas at is compressed to half of the volume under isothermal and reversible con-	16. 17.	$\rightarrow NH_2CONH_2(aq) + H_2O(l)$ . The standard entropy of $NH_2CONH_2$ is a) + 354.4 b) c) + 177.2 d) for conversion of oxygen to ozone at 298 K, if $K_p$ for this conversion is . a) 163 kJ mol <sup>-1</sup> b) c) d) Fo the reaction at , $\Delta G^0 = -27 kJ$ , $P_{CO}$ 0.0033 atm, hence $\Lambda G$
8. 9.	c) and c) and d) and A gas obsorbs 100 J of heat and is simulataneously compressed by a constant ex- ternal pressure of 1.5 atm from 8 to 2L in vol- ume. What is in joules for the gas? a) b) c) d) The lattice energy of solid NaCl is 180 and enthalpy of solution is 1 . If the hydration energies of and ions are in the ratio 3:2, what is enthalpy of hydration of sodium ion? a. b. 107.4 K Calmol <sup>-1</sup> c. d. 8g of $O_2$ gas at is compressed to half of the volume under isothermal and reversible con- dition. Work done on the system is:	16. 17.	$ \rightarrow NH_2CONH_2(aq) + H_2O(l). \text{ The standard} $ entropy of $NH_2CONH_2$ is $ a) + 354.4 \qquad b) $ $ c) + 177.2 \qquad d) $ for conversion of oxygen to ozone $ at 298 \text{ K, if } K_p \text{ for this} $ conversion is $ a) 163 \text{ kJ mol}^{-1}  b) $ $ c) \qquad d) $ Fo the reaction at $ \Delta G^0 = -27 \text{ kJ}, P_{CO_2} 0.0033 \text{ atm}, \text{hence } \Delta G $ the temperature is
8. 9.	b) and c) and d) and A gas obsorbs 100 J of heat and is simulataneously compressed by a constant ex- ternal pressure of 1.5 atm from 8 to 2L in vol- ume. What is in joules for the gas? a) b) c) d) The lattice energy of solid NaCl is 180 and enthalpy of solution is 1 . If the hydration energies of and ions are in the ratio 3:2, what is enthalpy of hydration of sodium ion? a. b. 107.4 K Calmol <sup>-1</sup> c. d. 8g of $O_2$ gas at is compressed to half of the volume under isothermal and reversible con- dition. Work done on the system is: a) b)	16. 17.	$ \rightarrow NH_2CONH_2(aq) + H_2O(l). \text{ The standard} $ entropy of $NH_2CONH_2$ is $ a) + 354.4 \qquad b) $ $ c) + 177.2 \qquad d) $ for conversion of oxygen to ozone $ at 298 \text{ K, if } K_p \text{ for this} $ conversion is $ a) 163 \text{ kJ mol}^{-1}  b) $ $ c) \qquad d) $ Fo the reaction at $ , \Delta G^0 = -27 \text{ kJ}, P_{CO_2} 0.0033 \text{ atm}, \text{hence } \Delta G $ the temperature is $ a) \qquad b) $
8. 9.	b) and c) and d) and A gas obsorbs 100 J of heat and is simulataneously compressed by a constant ex- ternal pressure of 1.5 atm from 8 to 2L in vol- ume. What is in joules for the gas? a) b) c) d) The lattice energy of solid NaCl is 180 and enthalpy of solution is 1 . If the hydration energies of and ions are in the ratio 3:2, what is enthalpy of hydration of sodium ion? a. b. 107.4 K Calmol <sup>-1</sup> c. d. 8g of $O_2$ gas at is compressed to half of the volume under isothermal and reversible con- dition. Work done on the system is: a) b) c)	16. 17.	$ \rightarrow NH_2CONH_2(aq) + H_2O(l). \text{ The standard} $ entropy of $NH_2CONH_2$ is $ a) + 354.4 \qquad b) $ $ c) + 177.2 \qquad d) $ for conversion of oxygen to ozone $ at 298 \text{ K, if } K_p \text{ for this} $ conversion is $ a) 163 \text{ kJ mol}^{-1}  b) $ $ c) \qquad d) $ Fo the reaction at $ AG^0 = -27 \text{ kJ}, P_{CO_2} 0.0033 \text{ atm}, \text{hence } \Delta G $ the temperature is $ a) \qquad b) $ $ c) \qquad d) $
8. 9.	b) and c) and d) and A gas obsorbs 100 J of heat and is simulataneously compressed by a constant ex- ternal pressure of 1.5 atm from 8 to 2L in vol- ume. What is in joules for the gas? a) b) c) d) The lattice energy of solid NaCl is 180 and enthalpy of solution is 1 . If the hydration energies of and ions are in the ratio 3:2, what is enthalpy of hydration of sodium ion? a. b. 107.4 <i>K</i> Calmol <sup>-1</sup> c. d. 8g of $O_2$ gas at is compressed to half of the volume under isothermal and reversible con- dition. Work done on the system is: a) b) c) d)	16. 17.	$\rightarrow NH_2CONH_2(aq) + H_2O(l)$ . The standard entropy of $NH_2CONH_2$ is a) + 354.4 b) c) + 177.2 d) for conversion of oxygen to ozone at 298 K, if $K_p$ for this conversion is a) 163 kJ mol <sup>-1</sup> b) c) d) Fo the reaction at , $\Delta G^0 = -27 kJ$ , $P_{Co_2} 0.0033$ atm, hence $\Delta G$ the temperature is a) b) c) d)

	.a 2.a	3.a	4.c	5.b	6.	Ifliquio	ds A and B for	m an idea	al solut I	tion [AIEEE 2003]
,	.a 7.c	<b>8.d</b>	9.a	10.c		a) the end	ntropy of mix	ing is zer	0	
	l.c 12.a	13.b	14 <b>.</b> a	15.b		c) the f	free energy of f	s well a	s the e	entropy of
	0.a 17.D					mix	ing are each z	ero		
e	vious Q	uestions			7	d) the e	nthalpy of mix	xing is ze	ero	
	If an ende	othermic reac	tion is non-	spontaneous	/.	stant T	and P and in	which or	nly pre	ssure-vol-
	at freezin	g point of wai	ter and becc n <b>[AIEEE</b> ]	20021		ume we	ork is being d	one, the	chang	e in Gibbs
	a) is	s-ve is t	-ve	2002]		free en	ergy (dG) and	d change	in ent	ropy (dS),
	b) a	nd both	are +ve			satisfy	the criteria	$\mathbf{O}$	[4	AIEEE 2003]
	c) a	nd both	are -ve			a)	2	G		
	d) is	s+ve, is	-ve			b)	,			
	A heat en	gine abosrbs h	neat at te	mperature		c)				
	and heat	at temper	ature . W	Vork done by	,	d)				
	the engin	e is	. This dat	a [AIEEE 2002]	8.	The co	rrect relations	ship betw	veen fr	ree energy
	a) violate	s 1st law of th	ermodynar	nics		change	in a reaction a	nd the co	rrespor	nding equi-
	b) violates	s1stlawofther	modynamic	sisif $Q_1$ is-ve	;	librium	n constant	is	[	[AIEEE 2003]
	c) violates	s 1 st law of the	rmodynamie	cs of is -ve	: <b>(</b>	a)		b) Δ	$G^0 = R$	$RT \ln K_c$
	d) does n	ot violate 1st	law of them	modynamics		c) –ΔC	$\hat{\sigma}^0 = RT \ln K$	d) Δ	G = RT	$T \ln K_c$
	For the r	eactions,		02 1	9.	The ent	tropy change	for a reac	tion do	oes not de-
		,	$\Delta n = -3$	UCE	-2,55-7411		f different real	2.HKsCmb	$M_3(g$	AIEEE 2003
		; Δ	M = -412	J		b) the n	ature of inter	mediate 1	reaction	n steps
	a) carbor	can oxidise '	7n	[AIEEE 2002]		c) the d	ifferences in in	nitial or f	inal ter	nperatures
	b) oxidat	ion of carbon	is not feasi	ble		of invol	lved substance	es fraceta	nto or -	l nno des at-
	c) oxidati	ion of Zn is no	ot feasible		10	a) the p	miscal states (		anc	
	d) Zn car	oxidise carb	on		10.	The for	rmation of the	e oxide i	on $O_{(g)}^{2^2}$	) requires
	The inter	hal energy cha	ange when a	a system goes		as show	exothermic an	a then an	endoth	Nermic step
	goes from	n A to B by a	reversible	path and re-		40 0110 V			I	[1111111 2004]
	turns to s	state A by an	irreversib	le path what	;	0				<b>1</b> _1
	would be	the net chang	ge in interna	al energy?		$O_{(g)} + O_{(g)}$	$e^{T} = O_{(g)}^{2^{-}} \Delta H^{0}$	= 844 1	KJ mo	$l^{-1}$
				[AIEEE 2003]		This is	because	• , .4		
	a)		b )			a) <i>O</i> <sup>-</sup> 1	ion will tend to	o resist th	ne addı	tion of an-
	c) Zero		d) 40 k J			othe	election			

a) b) c) d) The correct relationship between free energy change in a reaction and the corresponding equilibrium constant is [AIEEE 2003] b)  $\Delta G^0 = RT \ln K_c$ a) c)  $-\Delta G^0 = RT \ln K_c$  d)  $\Delta G = RT \ln K_c$ The entropy change for a reaction does not de- $H_2(g) = 142 H_3 C m \delta H_3(g) = 2003$ a) use of different reactants for the same product b) the nature of intermediate reaction steps c) the differences in initial or final temperatures of involved substances d) the phiscal states of reactants and products The formation of the oxide ion  $O_{(g)}^{2-}$  requires first an exothermic and then an endothermic step as shown below [AIEEE 2004]  $O_{(g)} + e^{-} = O_{(g)}^{2-} \Delta H^{0} = 844 \text{ KJ mol}^{-1}$ This is because a)  $O^{-}$  ion will tend to resist the addition of another electron b) Oxygen has high electron affinity c) Oxygen is more electronegative bonds are respectively ion has comparatively larger size than d) , the value of oxygen atom enthalpy change for the reaction 11. An ideal gas expands in volume from to  $1 \times 10^{-2} m^3$  at 300 K against a constant pressure of  $1 \times 10^5 Nm^{-2}$ . The work done is [AIEEE 2004] a) 270 kJ b) -900 kJ c) d)

CHEMICAL THERMODYNAMICS & ENERGETICS

b)

d)

If at 298K the bond energies of

414, 347, 615 and 435 kJ

at 298 K will be [AIEEE 2003]

and

a) -250 kJ

c)

5.

