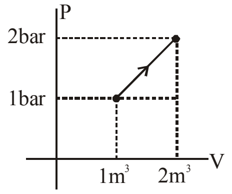
THERMODYNAMICS & THERMOCHEMISTRY EXERCISE-I

1. What is ΔU for the process described by figure. Heat supplied during the process q = 200 kJ.



(1) +50 kJ
(2) –50 kJ
(3) –150 kJ
(4) + 150 kJ

2. What is the change in internal energy when a gas is compressed from 377 ml of 177 ml under a constant pressure of 1520 torr, while at the same time being cooled by removing 124 J heat ?
[Take : (1L atm) = 100 J]

(1) –24 J
(2) – 84 J
(3) – 164 J
(4) – 248 J

3. For a reaction, $2X(s) + 2Y(s) \rightarrow 2C(\ell) + D(g)$
The q_p at 27°C is – 28 KCal. mol^{-1}. The q_V is ----------- K. Cal. mol^{-1} :–

(1) – 27.4
(2) + 27.4
(3) – 28.6
(4) 28.6

4. Ethyl chloride (C_2H_5Cl), is prepared by reaction of ethylene with hydrogen chloride :

$$C_2H_4(g) + HCl(g) \longrightarrow C_2H_5Cl(g)$$
$$\Delta H = -\ 72.3\ kJ/mol$$

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

(1) –69.8
(2) –180.75
(3) –174.5
(4) –139.6

5. One mole of an ideal monoatomic gas expanded irreversibly in two stage expansion.
State-1 (8.0 bar, 4.0 litre, 300 K)
State-2 (2.0 bar, 16litre, 300 K)
State-3 (1.0 bar, 32 litre, 300 K)
Total heat absorbed by the gas in the process is

(1) 116J
(2) 40 J
(3) 4000 J
(4) None of these

6. When a gas is compressed adiabatically and reversibly, the final temperature is-

(1) Higher than the initial temperature
(2) Lower than the initial temperature
(3) The same as initial temperature
(4) Dependent upon the rate of compression

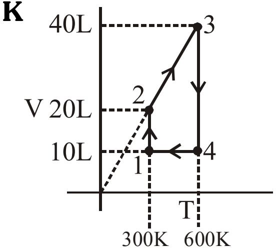
7. A gas $\left(C_{v,m} = \frac{5}{2}R\right)$ behaving ideally was allowed to expand reversibly and adiabatically from 1 litre to 32 litre. It's initial temperature was 327°C. The molar enthalpy change (in J/mole) for the process is :-

(1) –1125 R
(2) – 575 R
(3) –1575 R
(4) None of these

8. Two moles of an ideal gas ($C_V = \frac{5}{2}R$) 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 ?

(1) 250 R
(2) 300 R
(3) 400 R
(4) 500 R

9. What is the net work done when 1 mole of monoatomic ideal gas
undergoes in a process described by 1, 2, 3, 4 in given V–T graph
Use : R = 2cal/mole K
ln 2= 0.7



(1) –600 cal
(2) – 660 cal
(3) + 660 cal
(4) + 600 cal

10. The heat capacity of liquid water is 75.6 J/mol.K, while the enthalpy of fusion of ice is 6.0 kJ/mol. What is the smallest number of ice cubes at 0°C, each containing 9.0 g of water, needed to cool 500 g of liquid water from 20°C to 0°C ?

(1) 1 (2) 7 (3) 14 (4) None of these

11. Change in entropy is negative for :-

(1) Bromine $(\ell) \longrightarrow$ Bromine (g)
(2) $C(s) + H_2O(g) \longrightarrow CO(g) + H_2(g)$
(3) (3) N_2(g, 10 atm, 298 K) $\longrightarrow$ N_2 (g, 1 atm, 298K)
(4) Fe(at 400 K) $\longrightarrow$ Fe(at 300 K)

12. 5 mole of an ideal gas expand reversibly from a volume of 8 dm^3 to 80dm^3 at a temperature of 27°C. The change in entropy is :–

(1) 41.57 JK^{-1}
(2) – 95.73 JK^{-1}
(3) 95.73 JK^{-1}
(4) – 41.57 JK^{-1}

13. If $\Delta H_{vaporisation}$ of substance $X(\ell)$ (molar mass : 30 g/mol) is 300 J/g at it's boiling point 300 K, then molar entropy change for reversible condensation process is :-

(1) 30 J/mol.K (2) –300 J/mol.K

(3) –30 J/mol.K (4) None of these

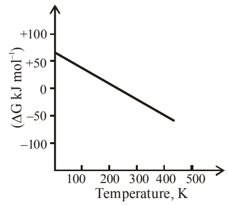
14. If S^0 for H_2, Cl_2 and HCl are 0.13, 0.22 and 0.19 KJ K^{-1} mol^{-1} respectively. The total change in standard entropy for the reaction,

$H_2 + Cl_2 \longrightarrow 2HCl$ is :

(1) 30 JK^{-1} mol^{-1} (2) 40 JK^{-1} mol^{-1}

(3) 60 JK^{-1} mol^{-1} (4) 20 JK^{-1} mol^{-1}

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



(1) $\Delta H > 0, \Delta S > 0$

(2) $\Delta H > 0, \Delta S < 0$

(3) $\Delta H < 0, \Delta S > 0$

(4) $\Delta H < 0, \Delta S < 0$

16. What is the free energy change (ΔG) when 1.0 mole of water at 100°C and 1 atm pressure is converted into steam at 100°C and 1 atm pressure ?

(1) 80 cal (2) 540 cal

(3) 620 cal (4) zero

17. For a reaction at 25°C enthalpy change (ΔH) and entropy change (ΔS) are -11.7×10^3 J mol^{-1} and –105 J mol^{-1} K^{-1} respectively. The reaction is :

(1) Spontaneous (2) Non spontaneous

(3) At equilibrium (4) Can't say anything

18. For hypothetical reversible reaction,

$\frac{1}{2} A_2(g) + \frac{3}{2} B_2(g) \longrightarrow AB_3(g)$; $\Delta H = -20$ KJ

if standard entropies of A_2, B_2 and AB_3 are 60, 40 and 50 JK^{-1} $mole^{-1}$ respectively. The above reaction will be in equilibrium at the temperature :-

(1) 400 K (2) 500 K

(3) 250 K (4) 200 K

19. For the hypothetical reaction ,

$A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$

$\Delta_r G$ and $\Delta_r S$ are 20 kJ/mole and –20 JK^{-1} mol^{-1} respectively at 200 K.

If $\Delta_r C_p$ is 20 JK^{-1} mol^{-1} then $\Delta_r H$ at 400 K is :-

(1) 20 kJ/mole (2) 7.98 kJ/mole

(3) 28 kJ/mole (4) None of these

20. The value of ΔG_f° of gaseous mercury is 31 KJ/mole. At what total external pressure mercury start 1boiling at 25°C. [R = 8.3 J/K mole]

(1) $10^{-5.44}$ (2) $10^{-12.5}$

(3) $10^{-6.52}$ (4) $10^{-3.12}$

21. Which of the following equations represents a reaction that provides the heat of formation of CH_3Cl?

(1) $C(s) + HCl(g) + H_2(g) \rightarrow CH_3Cl(g)$

(2) $C(s) + 3/2\ H_2(g) + 1/2\ Cl_2(g) \rightarrow CH_3Cl(g)$

(3) $C(s) + 3\ H(g) + Cl(g) \rightarrow CH_3Cl(g)$

(4) $CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$

22. Use the given standard enthalpies of formation to determine the heat of reaction of the following reaction:

$TiCl_4(g) + 2\ H_2O(g) \rightarrow TiO_2(g) + 4\ HCl(g)$

ΔH°_f $TiCl_4(g) = -763.2$ kJ/mole

ΔH°_f $TiO_2(g) = -944.7$ kJ/mole

ΔH°_f $H_2O(g) = -241.8$ kJ/mole

ΔH°_f $HCl(g) = -92.3$ kJ/mole

(1) – 278.1 (2) + 369.2

(3) + 67.1 (4) – 67.1

23. $2NO_2(g) \rightarrow N_2O_4(g)$

$\Delta U^\circ_f\ [N_2O_4(g)] = 2$ kcal/ mole

and $\Delta U^\circ_{reaction} = -16$ kcal /mol then calculate $\Delta H^\circ_{formation}$ of NO_2 at 727°C

(1) 9 kcal /mol (2) 4.5 kcal /mol

(3) 8 kcal /mol (4) 10 kcal /mol

24. The reaction $CH_4(g) + Cl_2(g) \longrightarrow CH_3Cl(g) + HCl(g)$ has $\Delta H = -25$ kCal.

Bond	**Bond Enthalpy kCal**
ε_{C-Cl}	84
ε_{H-Cl}	103
ε_{C-H}	x
ε_{Cl-Cl}	y
x : y = 9 : 5	

From the given data, what is the bond enthalpy of Cl—Cl bond

(1) 70 kCal (2) 80 kCal

(3) 67.75 kCal (4) 57.75 kCal

25. The enthalpy changes of the following reactions at 27°C are

$Na(s) + \frac{1}{2}Cl_2(g) \longrightarrow NaCl(s)$:

$\Delta_rH = -411$ kJ/mol

$H_2(g) + S(s) + 2O_2(g) \longrightarrow H_2SO_4(\ell)$:

$\Delta_rH = -811$ kJ/mol

$2Na(s) + S(s) + 2O_2(g) \longrightarrow Na_2SO_4(s)$:

$\Delta_rH = -1382$ kJ/mol

$\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) \longrightarrow HCl(g)$:

$\Delta_rH = -92$ kJ/mol;

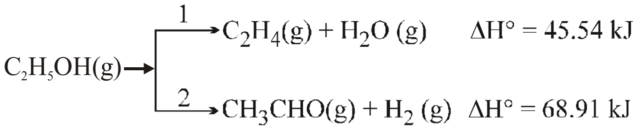
from these data, the heat change of reaction at constant volume (in kJ/mol) at 27°C for the process (R = 8.3 J/K-mol)

$2NaCl(s) + H_2SO_4(\ell) \longrightarrow Na_2SO_4(s) + 2HCl(g)$ is

(1) 67 (2) 62.02

(3) 71.98 (4) None

26. Ethanol can undergoes decomposition to form two sets of products



if the molar ratio of C_2H_4 to CH_3CHO is 8 : 1 in a set of product gases, then the enthalpy involved in the decomposition of 1 mole of ethano/is :

(1) 65.98 kJ (2) 48.137 kJ

(3) 48.46 kJ (4) 57.22 kJ

27. ΔH_f^0 of water is – 285.8 kJ mol^{-1}. If enthalpy of neutralisation of monoacid strong base is –57.3 kJ mol^{-1}, ΔH_f^0 of OH^- ion will be

(1) – 228.5 kJ mol^{-1} (2) 228.5 kJ mol^{-1}

(3) 114.25 kJ mol^{-1} (4) –114.25 kJ mol^{-1}

28. The molar heat capacities at constant pressure (assume constant with respect to temperature) of A, B and C are in ratio of **1.5 : 3.0 : 2.0** . If enthalpy change for the exothermic reaction $A + 2B \longrightarrow 3C$ at 300 K is – 10 kJ/mol & $C_{p,m}$ (2) is 300 J/mol then enthalpy change at 310 K is

(1) – 8.5 kJ/mol (2) 8.5 kJ/mol

(3) – 11.5 kJ/mol (4) none of these

29. Reactions involving gold have been of particular interest to a chemist . Consider the following reactions,

$Au(OH)_3 + 4\,HCl \longrightarrow HAuCl_4 + 3\,H_2O$,

$\Delta H = -28$ kCal

$Au(OH)_3 + 4\,HBr \longrightarrow HAuBr_4 + 3\,H_2O$,

$\Delta H = -36.8$ kCal

In an experiment there was an absorption of 0.44 kCal when one mole of $HAuBr_4$ was mixed with 4 moles of HCl . What is the percentage conversion of $HAuBr_4$ into $HAuCl_4$?

(1) 0.5 % (2) 0.6 %

(3) 5 % (4) 50 %

30. Hydrazine, a component of rocket fuel, undergoes combustion to yield N_2 and H_2O.

$$N_2H_4(\ell) + O_2(g) \longrightarrow N_2(g) + 2H_2O(\ell)$$

What is the enthalpy change of combustion of N_2H_4 (kJ/mole)

Given Reaction	**ΔH/kJ**
$2NH_3(g)+3N_2O(g) \rightarrow 4N_2(g)+3H_2O(\ell)$	– 1011 kJ
$N_2O(g) + 3H_2(g) \rightarrow N_2H_4(\ell) + H_2O(\ell)$	– 317 kJ
$4NH_3(g) + O_2(g) \rightarrow 2N_2H_4(\ell) + 2H_2O(\ell)$	– 286 kJ
$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(\ell)$	– 285 kJ

(1) – 620.5 (2) – 622.75

(3) 1167.5 (4) + 622.75

ANSWER KEY

Exercise-I

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	**1**	**2**	**3**	**4**	**3**	**1**	**3**	**4**	**3**	**3**
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	**4**	**3**	**3**	**1**	**1**	**4**	**2**	**2**	**1**	**1**
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	**2**	**4**	**3**	**4**	**2**	**2**	**1**	**3**	**3**	**1**

PREVIOUS YEARS' QUESTIONS EXERCISE-II

THERMODYNAMICS

1. A process A $\longrightarrow$ B is difficult to occur directly instead it takes place in three successive steps. **[JEE 2006]**

$$\begin{tikzcd} C \arrow[r] & D \arrow[d] \\ A \arrow[u] & B \end{tikzcd}$$

ΔS (A $\longrightarrow$ C) = 50 e.u.
ΔS (C $\longrightarrow$ D) = 30 e.u.
ΔS (B $\longrightarrow$ D) = 20 e.u.

Where e.u. is entropy unit.

Then the entropy change for the process ΔS (A $\longrightarrow$ B) is :-

(1) + 100 e.u. (3) – 60 e.u.
(3) – 100 e.u. (4) + 60 e.u.

2. Assuming that water vapour is an ideal gas, the internal energy change (ΔU) when 1 mol of water is vapourised at 1 bar pressure and 100°C, (Given : Molar enthalpy of vapourisation of water at 1 bar and 373 K = 41 kJ mol^{-1} and R = 8.3 J mol^{-1} K^{-1} will be) :- **[AIEEE-2007]**

(1) 4.100 kJ mol^{-1} (2) 3.7904 kJ mol^{-1}
(3) 37.904 kJ mol^{-1} (4) 41.00 kJ mol^{-1}

3. In conversion of lime-stone to lime,

$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$

the values of $\Delta H°$ and $\Delta S°$ are +179.1 kJ mol^{-1} and 160.2 J/K respectively at 298 K and 1 bar. Assuming that $\Delta H°$ and $\Delta S°$ do not change with temperature, temperature above which conversion of limestone to lime will be spontaneous is :- **[AIEEE-2007]**

(1) 1008 K (2) 1200 K
(3) 845 K (4) 1118 K

4. For the process H_2O (l) (1 bar, 373 K) $\longrightarrow$ H_2O(g) (1 bar, 373 K), the correct set of thermodynamic parameters is :- **[JEE 2007]**

(1) $\Delta G = 0$, $\Delta S = +$ ve
(2) $\Delta G = 0$, $\Delta S = -$ ve
(3) $\Delta G = +$ ve, $\Delta S = 0$
(4) $\Delta G = -$ ve, $\Delta S = +$ve

5. Among the following, the state function(s) is (are) **[JEE 2009]**

(1) Internal energy
(2) Irreversible expansion work
(3) Reversible expansion work
(4) Molar enthalpy

6. For a particular reversible reaction at temperature T, ΔH and ΔS were found to be both +ve. If T_e is the temperature at equilibrium, then reaction would be spontaneous when :- **[AIEEE-2010]**

(1) $T = T_e$
(2) $T_e > T$
(3) $T > T_e$
(4) T_e is 5 times T

7. The value of enthalpy change (ΔH) for the reaction

$C_2H_5OH_{(\ell)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(\ell)}$

at 27°C is –1366.5 kJ mol^{-1}. The value of internal energy change for the above reaction at this temperature will be :- **[AIEEE-2011]**

(1) –1371.5 kJ
(2) –1369.0 kJ
(3) –1364.0 kJ
(4) –1361.5 kJ

8. The entropy change involved in the isothermal reversible expansion of 2 moles of an ideal gas from a volume of 10 dm^3 to a volume of 100 dm^3 at 27°C is :- **[AIEEE-2011]**

(1) 32.3 J mol^{-1} K^{-1}
(2) 42.3 J mol^{-1} K^{-1}
(3) 38.3 J mol^{-1} K^{-1}
(4) 35.8 J mol^{-1} K^{-1}

9. The incorrect expression among the following is :- **[AIEEE-2012]**

(1) $K = e^{-\Delta G°/RT}$

(2) $\dfrac{\Delta G_{system}}{\Delta S_{total}} = -T$

(3) In isothermal process, $W_{reversible} = -nRT \ln \dfrac{V_f}{V_i}$

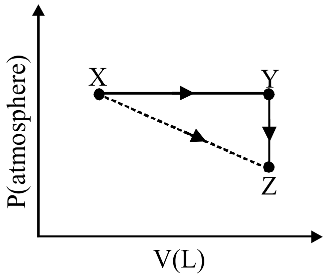
(4) $\ln K = \dfrac{\Delta H° - T\Delta S°}{RT}$

10. The difference between the reaction enthalpy change ($\Delta_r H$) and reaction internal energy change ($\Delta_r U$) for the reaction : **[JEE-MAINS(online)-2012]**

$2C_6H_6(\ell) + 15O_2(g) \rightarrow 12CO_2(g) + 6H_2O(\ell)$ at 300 K is (R = 8.314 J mol^{-1} K^{-1})

(1) 0 J mol^{-1}
(2) 2490 J mol^{-1}
(3) –2490 J mol^{-1}
(4) –7482 J mol^{-1}

11. For an ideal gas, consider only P-V work in going from an initial state X to the final state Z. The final state Z can be reached by either of the two paths shown in the figure. Which of the following choice(s) is (are) correct ? [take ΔS as change in entropy and w as work done] **[JEE 2012]**



(1) $\Delta S_{x\to z} = \Delta S_{x\to y} + \Delta S_{y\to z}$

(2) $W_{x\to z} = W_{x\to y} + W_{y\to z}$

(3) $W_{x\to y\to z} = W_{x\to y}$

(4) $\Delta S_{x\to y\to z} = \Delta S_{x\to y}$

12. Which of the following statements/relationships is not correct in thermodynamic changes ? **[JEE-MAINS(online)-2014]**

(1) $q = -nRT\,\ell n\frac{V_2}{V_1}$ (isothermal reversible expansion of an ideal gas)

(2) For a system at constant volume, heat involved merelv changes to internal energy.

(3) $w = -nRT\ln\frac{V_2}{V_1}$ (isothermal reversible expansion of an ideal gas)

(4) $\Delta U = 0$ (isothermal reversible expansion of a gas)

13. The molar heat capacity (C_p) of CD_2O is 10 cals at 1000 K. The change in entropy associated with cooling of 32 g of CD_2O vapour from 1000 K to 100 K at constant pressure will be **[JEE-MAINS-(online) 2014]**

(D = deuterium, at. mass = 2u)

(1) -23.03 cal deg^{-1}

(2) 2.303 cal deg^{-1}

(3) 23.03 cal deg^{-1}

(4) -2.303 cal deg^{-1}

14. The entropy (S^o) of the following substances are **[JEE-MAINS-(online) 2014]**

CH_4 (g) 186.2 J K^{-1} mol^{-1}
O_2 (g) 205.0 J K^{-1} mol^{-1}
CO_2 (g) 213.6 J K^{-1} mol^{-1}
H_2O (l) 69.9 J K^{-1} mol^{-1}

The entropy change (ΔS^o) for the reaction

$CH_4(g) + 2O_2(g) \to CO_2(g) + 2H_2O\ (\ell)$ is:-

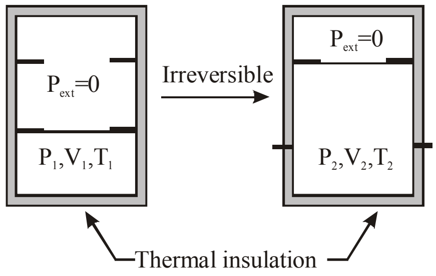
(1) -312.5 JK^{-1} mol^{-1}

(2) $-$ 37.6 JK^{-1} mol^{-1}

(3) $-$ 108.1 JK^{-1} mol^{-1}

(4) $-$ 242.8 JK^{-1} mol^{-1}

15. An ideal gas in thermally insulated vessel at internal pressure = P_1, volume = V_1 and absolute temperature = T_1 expands irrversibly against zero external pressure, as shown in the diagram. The final internal pressure, volume and absolute temperature of the gas are P_2, V_2 and T_2, respectively. For this expansion, **[JEE 2014]**



(1) q = 0 (2) $T_2 = T_1$

(3) $P_2V_2 = P_1V_1$ (4) $P_2V_2^{\gamma} = P_1V_1^{\gamma}$

16. ΔU is equal to **[JEE-MAINS(offline)-2017]**

(1) Isochoric work (2) Isobaric work

(3) Adiabatic work (4) Isothermal work

17. The enthalpy change on freezing of 1 mol of water at 5°C to ice at –5°C is : **[JEE-MAINS(online)-2017]**

(Given $\Delta_{fus}H$ = 6 kJ mol^{-1} at 0°C,
$C_P(H_2O, l)$ = 75.3 J mol^{-1} K^{-1},
$C_P(H_2O, s)$ = 36.8 J mol^{-1} K^{-1})

(1) 6.56 kJ mol^{-1} (2) 5.81 kJ mol^{-1}

(3) 6.00 kJ mol^{-1} (4) 5.44 kJ mol^{-1}

18. An ideal gas undergoes isothermal expansion at constant pressure. During the process:- **[JEE-MAINS-(online) 2017]**

(1) enthalpy remains constant but entropy increases.

(2) enthalpy increases but entropy decreases.

(3) Both enthalpy and entropy remain constant.

(4) enthalpy decreases but entropy increases.

THERMOCHEMISTRY

19. Which of the following is not an endothermic reaction? **[JEE 1999]**

(1) Combustion of methane

(2) Decomposition of water

(3) Dehydrogenation of ethene to acetylene

(4) Conversion of graphite to diamond

20. ΔH_f° for $CO_2(g)$, $CO(g)$ and $H_2O(g)$ are – 393.5, –110.5 and –241.8 kJ mol^{-1} respectively. The standard enthalpy change (in kJ) for the reaction $CO_2(g) + H_2(g) \longrightarrow CO(g) + H_2O(g)$ is **[JEE 2000]**

(1) 524.1 (2) 41.2

(3) –262.5 (4) – 41.2

21. The enthalpy changes for the following processes are listed below : **[AIEEE-2006]**

$Cl_2(g) = 2Cl(g)$, 242.3 kJ mol^{-1}

$I_2(g) = 2I(g)$ 151.0 kJ mol^{-1}

$ICl(g) = I(g) + Cl(g)$, 211.3 kJ mol^{-1}

$I_2(s) = I_2(g)$, 62.76 kJ mol^{-1}

Given that the standard states for iodine and chlorine are $I_2(s)$ and $Cl_2(g)$, the standard enthalpy of formation for $ICl(g)$ is :-

(1) –16.8 kJ mol^{-1}

(2) +16.8 kJ mol^{-1}

(3) +244.8 kJ mol^{-1}

(4) –14.6 kJ mol^{-1}

22. Oxidising power of chlorine in aqueous solution can be determined by the parameters indicated below:

$$\frac{1}{2}Cl_2(g) \xrightarrow{\frac{1}{2}\Delta_{diss}H^{\ominus}} Cl(g) \xrightarrow{\Delta_{eg}H^{\ominus}} Cl^-(g) \xrightarrow{\Delta_{hyd}H^{\ominus}} Cl^-(aq)$$

[AIEEE-2008]

The energy involved in the conversion of $\frac{1}{2}Cl_2(g)$ to $Cl^-(aq)$

(using the data $\Delta_{diss}H^{\ominus}_{Cl_2}$ = 240 kJ mol^{-1},

$\Delta_{eg}H^{\ominus}_{Cl}$ = –349 kJ mol^{-1},

$\Delta_{hyd}H^{\ominus}_{Cl^-}$ = –381 kJ mol^{-1})

will be:-

(1) –610 kJ mol^{-1}

(2) –850 kJ mol^{-1}

(3) +120 kJ mol^{-1}

(4) +152 kJ mol^{-1}

23. On the basis of the following thermochemical data $\left(\Delta G_f^0 H^+_{(aq)} = 0\right)$

$H_2O(\ell) \rightarrow H^+(aq) + OH^-(aq)$; ΔH = 57.32 kJ

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(\ell)$; ΔH = –286.20 kJ

The value of enthalpy of formation of OH^- ion at 25°C is :- **[AIEEE-2009]**

(1) +228.88 kJ (2) –343.52 kJ

(3) –22.88 kJ (4) –228.88 kJ

24. In a fuel cell methanol is used as fuel and oxygen gas is used as an oxidizer. The reaction is

$$CH_3OH(\ell) + \frac{3}{2}O_2(g) \longrightarrow CO_2(g) + 2H_2O(\ell)$$

At 298 K standard Gibb's energies of formation for $CH_3OH(\ell)$, $H_2O(\ell)$ and $CO_2(g)$ are –166.2, –237.2 and –394.4 kJ mol^{-1} respectively. If standard enthalpy of combustion of methanol is –726 kJ mol^{-1}, efficiency of the fuel cell will be **[AIEEE-2009]**

(1) 90% (2) 97%

(3) 80% (4) 87%

25. The standard enthalphy of formation of NH_3 is –46.0 kJ mol^{-1}. If the enthalpy of formation of H_2 from its atoms is –436 kJ mol^{-1} and that of N_2 is –712kJ mol^{-1}, the average bond enthalpy of N–H bond in NH_3 is :- **[AIEEE-2010]**

(1) –1102 kJ mol^{-1} (2) –964 kJ mol^{-1}

(3) + 352 kJ mol^{-1} (4) +1056 kJ mol^{-1}

26. Consider the reaction : **[AIEEE-2011]**

$4NO_2(g) + O_2(g) \rightarrow 2N_2O_5(g)$, Δ_rH = –111kJ.

If $N_2O_5(s)$ is formed instead of $N_2O_5(g)$ in the above reaction, the Δ_rH value will be :-

(Given, ΔHof sublimation for N_2O_5 is 54 kJ mol^{-1})

(1) –165 kJ (2) +54 kJ

(3) +219 kJ (4) –219 kJ

27. The enthalpy of neutralisation of NH_4OH with HCl is –51.46 kJ mol^{-1} and the enthalpy of neutralisation of NaOH with HCl is –55.90 kJ mol^{-1}. The enthalpy of ionisation of NH_4OH is: **[JEE-MAINS (online) 2012]**

(1) +107.36 kJ mol^{-1}

(2) –4.44 kJ mol^{-1}

(3) –107.36 kJ mol^{-1}

(4) +4.44 kJ mol^{-1}

28. Using the data provided, calculate the multiple bond energy (kJ mol^{-1}) of a $C \equiv C$ bond in C_2H_2. That energy is (take the bond energy of a C–H bond as 350 kJ mol^{-1}.) **[JEE 2012]**

$2\,C(s) + H_2(g) \rightarrow C_2H_2(g)$ ΔH = 225 kJ mol^{-1}

$2\,C(s) \longrightarrow 2C(g)$ ΔH = 1410 kJ mol^{-1}

$H_2(g) \longrightarrow 2H(g)$ ΔH = 330 kJ mol^{-1}

(1) 1165 (2) 837

(3) 865 (4) 815

29. Given : **[JEE-MAINS (online) 2013]**

(1) $H_2 (g) + \frac{1}{2} O_2 (g) \rightarrow H_2O (l)$;

$\Delta H^o_{298K} = -285.9$ kJ mol^{-1}

(2) $H_2(g) + \frac{1}{2} O_2 (g) \rightarrow H_2O (g)$;

$\Delta H^o_{298K} = -241.8$ kJ mol^{-1}

The molar enthalpy of vapourisation of water will be :-

(1) 241. 8 kJ mol^{-1} (2) 527.7 kJ mol^{-1}
(3) 44.1 kJ mol^{-1} (4) 22.0 kJ mol^{-1}

30. Given **[JEE-MAINS (online) 2013]**

Reaction	Energy Change (in kJ)
$Li(s) \longrightarrow Li(g)$	161
$Li(g) \longrightarrow Li^+(g)$	520
$\frac{1}{2} F_2(g) \longrightarrow F(g)$	77
$F(g) + e^- \longrightarrow F^-(g)$	(Electron gain enthalpy)
$Li^+(g) + F^-(g) \longrightarrow LiF(s)$	–1047
$Li(s) + \frac{1}{2} F_2(g) \longrightarrow Li F(s)$	–617

Based on data provided, the value of electron gain enthalpy of fluorine would be :

(1) –300 kJ mol^{-1} (2) –328 kJ mol^{-1}
(3) –350 kJ mol^{-1} (4) –228 kJ mol^{-1}

31. For complete combustion of ethanol,
$C_2H_5OH(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$,
the amount of heat produced as measured in bomb calorimeter, is 1364.47 kJ mol^{-1} at 25°C. Assuming ideality the Enthalpy of combustion, Δ_cH, for the raction will be (R = 8.314 kJ mol^{-1}) :-

[JEE-MAINS(offline)2014]

(1) –1460.50 kj mol^{-1}
(2) – 1350.50 kJ mol^{-1}
(3) – 1366.95 kJ mol^{-1}
(4) – 1361.95 kJ mol^{-1}

32. The standard enthalpy of formation ($\Delta_fH^o_{298}$) for methane, CH_4 is– 74.9 kJ mol^{-1}. In order to calculate the average energy given out in the formation of a C–H bond from this it is necessary to know which one of the following?

[JEE-MAINS(online) 2014]

(1) the dissociation energy of the hydrogen molecule, H_2.
(2) the dissociation energy of H_2 and enthalpy of sublimation of carbon (graphite).
(3) the first four ionisation energies of carbon and electron affinity of hydrogen.
(4) the first four ionisation energies of carbon.

33. The heats of combustion of carbon and carbon monoxide are – 393.5 and – 285.5 kJ mol^{-1}, respectively. The heat of formation (in kJ) of carbon monoxide per mole is :- **[JEE-MAINS(offline)2016]**

(1) – 110.5 (2) 110.5
(3) 676.5 (4) – 676.5

34. Given **[JEE-MAINS(offline)2017]**

$C_{(grahite)} + O_2(g) \rightarrow CO_2(g)$;
$\Delta_rH^\circ = -393.5$ kJ mol^{-1}

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(1)$;
$\Delta_rH^\circ = -285.8$ kJ mol^{-1}

$CO_2(g) + 2H_2O(l) \rightarrow CH_4(g) + 2O_2(g)$;
$\Delta_rH^\circ = +890.3$ kJ mol^{-1}

Based on the above thermochemical equations, the value of Δ_rH° at 298 K for the reaction $C_{(grahite)} + 2H_2(g) \rightarrow CH_4(g)$ will be :-

(1) +74.8 kJ mol^{-1} (2) +144.0 kJ mol^{-1}
(3) –74.8 kJ mol^{-1} (4) –144.0 kJ mol^{-1}

35. The enthalpy change on freezing of 1 mol of water at 5°C to ice at –5°C is :

(Given $\Delta_{fus}H = 6$ kJ mol^{-1} at 0°C,
$C_P(H_2O, l) = 75.3$ J mol^{-1} K^{-1},
$C_P(H_2O, s) = 36.8$ J mol^{-1} K^{-1})

[JEE-MAINS(online)2017]

(1) 6.56 kJ mol^{-1} (2) 5.81 kJ mol^{-1}
(3) 6.00 kJ mol^{-1} (4) 5.44 kJ mol^{-1}

PREVIOUS YEARS QUESTIONS **ANSWER KEY** **Exercise-II**

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	**4**	**3**	**4**	**1**	**1,4**	**3**	**3**	**3**	**4**	**4**
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	**1,3**	**1**	**1**	**4**	**1,2,3**	**3**	**1**	**1**	**1**	**2**
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	**1**	**1**	**4**	**2**	**3**	**4**	**4**	**4**	**3**	**2**
Que.	31	32	33	34	35					
Ans.	**3**	**2**	**1**	**3**	**1**					