EXERCISE-I

Basic concepts

- 1. Identify the intensive quantity from the following
 - (A) Enthalpy and temperature
 - (B) Volume and temperature
 - (C) Enthalpy and volume
 - (D) Temperature and refractive index
- 2. Which of the following units represents the largest amount of energy
 - (A) Electron volt (B) Erg
 - (C) Joule (D) Calorie
- **3.** Energy equivalent to one erg, one joule and one calorie is in the order
 - (A) 1erg >1 joule >1 calorie
 - (B) 1erg>1calorie>1 joule
 - (C) 1*calorie*>1*joule*>1*erg*
 - (D) 1 *joule*>1*calorie*>1*erg*
- 4. Heat produced in calories by the combustion of one gram of carbon is called
 - (A) Heat of combustion of carbon
 - (B) Heat of formation of carbon
 - (C) Calorific value of carbon
 - (D) Heat of production of carbon
- **5.** Conditions of standard state used in thermochemistry is
 - (A) $0^{\circ}C$ and 1 atm (B) $20^{\circ}C$ and 1 atm
 - (C) $25^{\circ}C$ and 1 atm (D) 0K and 1 atm
- 6. The temperature of the system decreases in an (A) Adiabatic compression
- (B) Isothermal compression
 - (C) Isothermal expansion
 - (D) Adiabatic expansion
- 7. For the isothermal expansion of an ideal gas
 - (A) E and H increases
 - (B) E increases but H decreases
 - (C) H increases but E decreases
 - (D) E and H are unaltered

- 8. If a refrigerator's door is opened, then we get (A) Room heated
 - (B) Room cooled
 - (C) More amount of heat is passed out
 - (D) No effect on room
- 9. The cooling in refrigerator is due to
 - (A) Reaction of the refrigerator gas
 - (B) Expansion of ice
 - (C) The expansion of the gas in the refrigerator
 - (D) The work of the compressor
- **10.** Point out the wrong statement in relation to enthalpy
 - (A) It is a state function
 - (B) It is an intensive property
 - (C) It is independent of the path followed for the change
 - (D) Its value depends upon the amount of substance in the system
- **11.** The process, in which no heat enters or leaves the system, is termed as
 - (A) Isochoric (B) Isobaric
 - (C) Isothermal (D) Adiabatic
- 12. The intensive property among these quantities is
 - (A) Enthalpy (B) Mass/volume
 - (C) Mass (D) Volume
- **13.** In thermodynamics which one of the following is not an intensive property
 - (A) Pressure (B) Density
 - (C) Volume (D) Temperature
- **14.** If in a container neither mass and nor heat exchange occurs then it constitutes a
 - (A) Closed system (B) Open system
 - (C) Isolated system (D) Imaginary system
- **15.** Which of the following is not a state function (A) ΔS (B) ΔG
 - (C) ΔH (D) ΔQ

First law of thermodynamics and Hess law

- **16.** Enthalpy for the reaction $C + O_2 \rightarrow CO_2$ is
 - (A) Positive (B) Negative
 - (C) Zero (D) None
- **17.** During an isothermal expansion of an ideal gas its
 - (A) Internal energy increases
 - (B) Enthalpy decreases
 - (C) Enthalpy remains unaffected
 - (D) Enthalpy reduces to zero
- **18.** The work done in ergs for the reversible expansion of one mole of an ideal gas from a volume of 10 litres to 20 litres at $25^{\circ}C$ is
- (A) $2.303 \times 298 \times 0.082 \log 2$
 - (B) $298 \times 10^7 \times 8.31 \times 2.303 \log 2$
 - (C) $2.303 \times 298 \times 0.082 \log 0.5$
 - (D) $8.31 \times 10^7 \times 298 2.303 \log 0.5$
- **19.** The law of conservation of energy states that (A) The internal energy of a system is constant
 - (B) The heat content of a system is constant
 - (C) Energy is neither created nor destroyed
 - (D) There is an equivalence between energy and mass
- **20.** The enthalpies of the elements in their standard states are assumed to be
 - (A) Zero at 298 K
 - (B) Unit at 298 K
 - (C) Zero at all temperatures
 - (D) Zero at 273 K
- **21.** The heat Q for a reaction at constant volume is equal to

(A)
$$H_P - H_R$$
 (B) $H_R - H_P$

(C)
$$E_P - E_R$$
 (D) None of these

22. Which of the following expressions represents the first law of thermodynamics

(A) $\Delta E = -q + W$	(B) $\Delta E = q - W$
(C) $\Lambda E = a + W$	(D) $\Delta E = -a - W$

23. In a reversible isothermal process, the change in internal energy is

(A) Zero	(B) Positive
(C) Negative	(D) None of these

- 24. A schematic plot of $\ln K_{eq}$ versus inverse of
 - temperature for a reaction is shown below



- The reaction must be
- (A) Exothermic
- (B) Endothermic
- (C) One with negligible enthalpy change
- (D) Highly spontaneous at ordinary temperature
- **25.** Hess law of heat summation includes
 - (A) Initial reactants only
 - (B) Initial reactants and final products
 - (C) Final products only
 - (D) Intermediates only
- **26.** An ideal gas at constant temperature and pressure expands, then its
 - (A) Internal energy remains same
 - (B) Internal energy decreases
 - (C) Internal energy increases
 - (D) Entropy first increases and then decreases
- **27.** The internal energy of a substance
 - (A) Increases with increase in temperature
 - (B) Decreases with increase in temperature
 - (C) Can be calculated by the relation $E = mc^2$
 - (D) Remains unaffected with change in temperature
- **28.** The relation between change in internal energy (ΔE) , change in enthalpy (ΔH) and work done (*W*) is represented as

(A)
$$\Delta H = \Delta E + W$$
 (B) $W = \Delta E - \Delta H$

- (C) $\Delta E = W \Delta H$ (D) $\Delta E = \Delta H + W$
- 29. Work done during isothermal expansion of one mole of an ideal gas from 10 *atm* to 1 *atm* at 300 *K* is (Gas constant = 2)
 - (A) 938.8 *cal.* (B) 1138.8 *cal.*
 - (C) 1381.8 *cal*. (D) 1581.8 *cal*.

30. Joule-Thomson expansion is

(A) Isobaric	(B) Isoenthalpic
(C) Isothermal	(D) None of these

31. One mole of an ideal gas is allowed to expand freely and adiabatically into vacuum until its volume has doubled. A statement which is not true concerning this expression is

(A)
$$\Delta H = 0$$
 (B) $\Delta S = 0$

- (C) $\Delta E = 0$ (D) W = 0
- **32.** At $27^{\circ}C$, one mole of an ideal gas is compressed isothermally and reversibly from a pressure of 2 *atm* to 10 *atm*. The values of ΔE and *q* are (*R* = 2)
 - (A) 0, -965.84 cal
 - (B) 965.84 cal, + 965.84 cal
 - (C) + 865.58 cal, 865.58 cal
 - (D) 865.58 cal, 865.58 cal
- **33.** The work done by a system is 8 *joule*, when 40 *joule* heat is supplied to it. What is the increase in internal energy of system

(A) 25 <i>J</i>	(B) 30 <i>J</i>
(C) 32 J	(D) 28 <i>J</i>

34. A system absorb 600J of heat and work equivalent to 300J on its surroundings. The change in internal energy is

(A) 300 J	(B) 400 J
(C) 500 J	(D) 600 J

35. Work done during isothermal expansion of one mole of an ideal gas from 10 atom. to 1 atm at 300K is

(A) 4938.8 <i>J</i>	(B) 4138.8 J
(C) 5744.1 <i>J</i>	(D) 6257.2 J

- **36.** If gas, at constant temperature and pressure expands then its
 - (A) Entropy increases and then decreases
 - (B) Internal energy increases
 - (C) Internal energy remains the same
 - (D) Internal energy decreases
- **37.** For the reaction
 - $PCl_{5}(g) \rightarrow PCl_{3}(g) + Cl_{2}(g)$

(A)
$$\Delta H = \Delta E$$
 (B) $\Delta H > \Delta E$
(C) $\Delta H < \Delta E$ (D) None of these

- **38.** Enthalpy (H) is equal to
 - (A) Internal energy (E)
 - (B) Product of pressure (P) and volume (V) of gas
 - (C) Internal energy (E)+PV
 - (D) Work (W) done by a system
- **39.** ΔE° of combustion of isobutylene is $-X kJ mol^{-1}$. The value of ΔH° is
 - $(\mathbf{A}) = \Delta E^{o} \qquad \qquad (\mathbf{B}) > \Delta E^{o}$
 - $(C) = 0 \qquad (D) < \Delta E^{\circ}$
- **40.** One mole of an ideal gas is allowed to expand reversibly and adibatically from a temperature of $27^{\circ}C$. If the work done during the process is 3kJ, then final temperature of the gas is $(C_v = 20J / K)$

IInd & IIIrd Law of thermodynamics and Entropy

- 41. In which state, the matter have highest entropy(A) Solid(B) Liquid(C) Gas(D) Equal in all
- **42.** Which of the following pairs of a chemical reaction is certain to result in spontaneous reaction ?
- (A) Exothermic and decreasing disorder
 - (B) Endothermic and increasing disorder
 - (C) Exothermic and increasing disorder
 - (D) Endothermic and decreasing disorder
- **43.** When one mole of monoatomic ideal gas at T *K* undergoes adiabatic change under a constant external pressure of 1 atm changes volume from 1 litre to 2 litre. The final temperature in Kelvin would be

(A)
$$\frac{T}{2^{(2/3)}}$$
 (B) $T + \frac{2}{3 \times 0.0821}$
(C) T (D) $T - \frac{2}{3 \times 0.0821}$

44. 9.0 gm of H_2O is vaporised at $100^{\circ}C$ and 1 atm pressure. If the latent heat of vaporisation of water is xJ / gm, then ΔS is given by

(A) $\frac{x}{373}$	(B) $\frac{18x}{100}$
(C) $\frac{18x}{373}$	(D) $\frac{1}{2} \times \frac{18x}{373}$

- **45.** The ΔS for the vaporisation of 1 mol of water is 88.3 *J/mole K*. The value of ΔS for the condensation of 1 *mol* of vapour will be
 - (A) 88.3 J/mol K (B) $(88.3)^2 J/mol K$

(C)
$$- 88.3 \ J/mol \ K$$
 (D) $\frac{1}{88.3} \ J/mol \ K$

- **46.** The total entropy change for a system and its surroundings increases, if the process is
 - (A) Reversible (B) Irreversible
 - (C) Exothermic (D) Endothermic
- **47.** For chemical reactions, the calculation of change in entropy is normally done
 - (A) At constant pressure
 - (B) At constant temperature
 - (C) At constant temperature and pressure both
 - (D) At constant volume
- **48.** When the value of entropy is greater, then the ability of work
 - (A) Is maximum (B) Is minimum
 - (C) Is medium (D) None of these
- **49.** Which of the following is true for the reaction $H_2O(l) = H_2O(g)$ at $100^\circ C$ and 1 atmosphere
 - (A) $\Delta E = 0$ (B) $\Delta H = 0$
 - (C) $\Delta H = \Delta E$ (D) $\Delta H = T \Delta S$
- **50.** The enthalpy change for the transition of liquid water to steam, $\Delta H_{vap} = 37.3 kJ mol^{-1}$ at 373 K. The entropy change for the process is
 - (A) $111.9 J mol^{-1}K^{-1}$ (B) $37.3 J mol^{-1}K^{-1}$ (C) $100 J mol^{-1}K^{-1}$ (D) $74.6 J mol^{-1}K^{-1}$
- **51.** Following data is known about melting of a compound AB. $\Delta H = 9.2 kJ mol^{-1}$, $\Delta S = 0.008 kJ K^{-1} mol^{-1}$. Its melting point is (A) 736 K (B) 1050 K (C) 1150 K (D) 1150°C

- **52.** The volume of a gas decreases from 500cc to 300cc when a sample of gas is compressed by an average pressure of 0.6 *atm*. During this process 10 J of heat is liberated. The change in internal energy is (A) -2.16 J (B) 12.156 J
 - (C) 2.16 J (D) 101.3 J
- **53.** The standard entropies of $CO_2(g), C(s)$ and $O_2(g)$ are 213.5, 5.690 and $205 JK^{-1}$ respectively. The standard entropy of formation of $CO_2(g)$ is
 - (A) $1.86 JK^{-1}$ (B) $1.96 JK^{-1}$ (C) $2.81 JK^{-1}$ (D) $2.86 JK^{-1}$
- **54.** Which of the following endothermic processes are spontaneous
 - (A) Melting of ice
 - (B) Evaporation of water
 - (C) Heat of combustion
 - (D) Both (A) and (B)
- **55.** For the reaction $H_2O(s) = H_2O(l)$ at $0^{\circ}C$ and normal pressure
 - (A) $\Delta H > T \Delta S$ (B) $\Delta H = T \Delta S$
 - (C) $\Delta H = \Delta G$ (D) $\Delta H < T \Delta S$
- **56.** The unit of entropy is (A) $J mol^{-1}$ (B) $JK mol^{-1}$
 - (C) $J mol^{-1}K^{-1}$ (D) $J^{-1}K^{-1}mol^{1}$
- **57.** The entropy changed involved in the conversion of 1 *mole* of liquid water at 373 *K* to vapour at the same temperature will be

 $[\Delta H_{\rm vap} = 2.257 kJ / gm]$

- (A) 0.119 kJ (B) 0.109 kJ
- (C) $0.129 \ kJ$ (D) $0.120 \ kJ$
- **58.** When a liquid boils, there is
 - (A) An increase in entropy
 - (B) A decrease in entropy
 - (C) An increase in heat of vaporization
 - (D) An increase in free energy

- **59.** Which one of the following has ΔS° greater than zero
 - (A) $CaO + CO_2(g) = CaCO_3(s)$
 - (B) NaCl(aq) = NaCl(s)
 - (C) $NaNO_3(s) = Na^+(aq) + NO_3^-(aq)$
 - (D) $N_2(g) + 3H_2(g) = 2NH_3(g)$
- **60.** The molar heat capacity of water at constant pressure is $75 \ JK^{-1}mol^{-1}$. When 1.0 kJ of heat is supplied to 100 g of water which is free to expand the increase in temperature of water is (A) 6.6 K (B) 1.2 K (C) 2.4 K (D) 4.8 K

Heat of reaction

- **61.** Which of the following is an example of endothermic reaction
 - (A) $C_2H_2 + 2H_2 \rightarrow C_2H_6$; $\Delta E = -314.0 \, kJ$
 - (B) $C + O_2 \rightarrow CO_2$; $\Delta E = -393.5 kJ$
 - (C) $N_2 + O_2 \rightarrow 2NO; \Delta E 180.5 kJ$
 - (D) $2H_2 + O_2 \rightarrow 2H_2O$; $\Delta E + 571.8 kJ$
- **62.** If the enthalpy of B is greater than of A, the reaction $A \rightarrow B$ is
- (A) Endothermic(B) Exothermic(C) Instantaneous(D) Spontaneous
- **63.** Given that
 - $2C(s) + 2O_2(g) \rightarrow 2CO_2(g); \Delta H = -787 \, kJ$ $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l); \Delta H = -286 \, kJ$ $C_2H_2(g) + 2\frac{1}{2}O_2(g) \rightarrow 2CO_2(g) + H_2O(l); \Delta H = -1301 kJ$ Heat of formation of acetylene is
 - (A) -1802 kJ (B) +1802 kJ
 - (C) $-800 \, kJ$ (D) $+228 \, kJ$
- 64. Enthalpy change for reaction,
 - $\frac{1}{2}H_2 + \frac{1}{2}Cl_2 \rightarrow HCl$, is called
 - (A) Enthalpy of combination
 - (B) Enthalpy of reaction
 - (C) Enthalpy of formation
 - (D) Enthalpy of fusion

- 65. The enthalpy of neutralization is about 57.3 kJ for the pair(A) HCl and NH₄OH
 - (B) NH_4OH and HNO_3
 - (C) HCl and NaOH
 - (D) CH₃COOH and NaOH
- 66. Heat of combustion ΔH of CH_4, C_2H_6, C_2H_4 and C_2H_2 gases are -212.8, -373.0, -337.0and -310.5 kcal respectively at the same temperature. The best fuel among these gases is (A) CH_4 (B) C_2H_6 (C) C_2H_4 (D) C_2H_2
- 67. Heat of formation of $CO_2(g)$, $H_2O(l)$ and $CH_4(g)$ are -94.0, -68.4 and -17.9 kcal respectively. The heat of combustion of methane is
 - (A) $-212.9 \ kcal$ (B) $-136.8 \ kcal$ (C) $-304.3 \ kcal$ (D) $-105.2 \ kcal$
- 68. The heat of reaction does not depend upon
 - (A) Temperature of the reaction
 - (B) Physical state of reactants and products
 - (C) Whether the reaction is carried out at constant pressure or at constant volume
 - (D) The method by which the final products are obtained from the reactants
- **69.** Heat of neutralisation of a strong acid by a strong base is a constant value because
- (A) Salt formed does not hydrolyse
 - (B) Only H^+ and OH^- ions react in every case
 - (C) The strong base and strong acid react completely
 - (D) The strong base and strong acid react in aqueous solution
- **70.** Heat of neutralisation of an acid by a base is highest when
 - (A) Both the acid and base are weak
 - (B) Both the acid and base are strong
 - (C) The acid is strong and the base is weak
 - (D) The acid is weak and the base is strong

- **71.** The heat change ΔH for the reaction $2CO + O_2 \rightarrow 2CO_2; \Delta H = -135 \, kcal$ is called (A) Heat of formation (B) Heat of reaction (C) Heat of combustion (D) Heat of solution 72. The heats of combustion of rhombic and monoclinic sulphur are respectively 70960 and 71030 calories. What will be the heat of conversion of rhombic sulphur to monoclinic (A) 70960 calories (B) 71030 calories (C) - 70 calories (D) + 70 calories **73.** The heat of formation of $H_2O(l)$ is - 68.0 *kcal*, the heat of formation of $H_2O(g)$ is likely to be $(A) - 68.0 \ kcal$ $(B) - 67.4 \ kcal$ (C) 80.0 kcal (D) - 58.3 kcal74. Which of the following fuels will have the highest calorific value (kJ/kg) (A) Charcoal (B) Kerosene (C) Wood (D) Dung 75. The heat of combustion of carbon is -94 kcal at 1 *atm* pressure. The intrinsic energy of CO_2 is (A) + 94 kcal(B) -94 kcal (C) +47 kcal (D) -47 kcal 76. If $H^+ + OH^- \rightarrow H_2O + 13.7 \, kcal$, then the neutralization for of complete heat neutralization of one mole of H_2SO_4 by base will be (A) 13.7 kcal (B) 27.4 kcal (C) 6.85 kcal (D) 3.425 kcal
- **77.** The lowest value of heat of neutralization is obtained for
 - (A) HCl + NaOH
 - (B) $CH_3COOH + NH_4OH$
 - (C) $NH_4OH + HCl$
 - (D) $NaOH + CH_3COOH$

- 78. Heat of neutralisation for the given reaction $NaOH + HCl \rightarrow NaCl + H_2O$ is $57.1 kJ mol^{-1}$. What will be the heat released when 0.25 mole of NaOH is titrated against 0.25 mole of HCl (A) $22.5 kJ mol^{-1}$ (B) $57.1 kJ mol^{-1}$ (C) $14.3 kJ mol^{-1}$ (D) $28.6 kJ mol^{-1}$ 79. Reaction, $H_2(g) + I_2(g) \rightarrow 2HI(g)$ $\Delta H = -12.40$ kcal. According to this, the heat of formation of HI will be (A) 12.4 kcal (B) - 12.4 kcal(D) 6.20 kcal $(C) - 6.20 \ kcal$ 80. All reactions with chemical dissociation are (A) Reversible
 - (B) Reversible and endothermic
 - (C) Exothermic
 - (D) Reversible or irriversible and endothermic or exothermic
- **81.** One of the phenomena which cannot be described as combustion is
 - (A) Oxidation of coal in air
 - (B) Burning of magnesium in nitrogen
 - (C) Reaction of antimony in chlorine
 - (D) Lighting of an electric lamp
- **82.** Which of the following statements is correct about heat of combustion
 - (A) It may be exothermic in some cases and endothermic in other cases
 - (B) It is applicable to gaseous substances only
 - (C) It is always an exothermic reaction
 - (D) Its value does not change with temperature

83.
$$H_2 + \frac{1}{2}O_2 \rightarrow H_2O; \Delta H = -68.39 \, kcal$$

 $K + H_2O + Water$
 $\rightarrow KOH(aq) + \frac{1}{2}H_2; \Delta H = -48 \, kcal$
 $KOH + Water \rightarrow KOH(aq); \Delta H = -14 \, kcal$
The heat of formation of KOH is (in kcal)
(A) -68.39 + 48 - 14 (B) -68.39 - 48 + 14
(C) 68 39 - 48 + 14 (D) 68 39 + 48 + 14

- 84. Which of the following reaction can be used to define the heat of formation of $CO_2(g)$
 - (A) $C(\text{graphite}) + O_2(g) = CO_2(g)$
 - (B) $CH_4(g) + 2O_2(g) = CO_2(g) + 2H_2O(l)$

(C)
$$CO(g) + \frac{1}{2}O_2(g) = CO_2(g)$$

(D) $C_6H_6(l) + 7\frac{1}{2}O_2(g) = 6CO_2 + 3H_2O(l)$

- 85. The enthalpy of formation of ammonia is $-46.0 kJ mol^{-1}$. The enthalpy change for the reaction $2NH_3(g) \rightarrow 2N_2(g) + 3H_2(g)$ is (A) $46.0 kJ mol^{-1}$ (B) $92.0 kJ mol^{-1}$
 - (C) $23.0 \ kJ \ mol^{-1}$ (D) $92.0 \ kJ \ mol^{-1}$
- 86. Heat of formation in the reaction
 - $H_2 + Cl_2 \rightarrow 2HCl + 44\,kcal$ is

(A) 44 <i>kcal</i>	(B) 44000 kcal
(C) 22 <i>kcal</i>	(D) 11 kcal

87. When water is added to quick lime, the reaction is

(A) Exothermic	(B) Endothermic
(C) Explosive	(D) None of these

- **88.** In an exothermic reaction ΔH is
 - (A) Positive
 - (B) Negative
 - (C) Zero
 - (D) Both positive or negative
- 89. The heat change for the following reaction $C(s) + 2S(s) \rightarrow CS_2(l)$ is known as
- (A) Heat of vaporization(B) Heat of solution(C) Heat of fusion(D) Heat of formation
- **90.** The enthalpy of combustion of benzene from the following data will be

(i)
$$6C(s) + 3H_2(g) \rightarrow C_6H_6(l); \Delta H = +45.9 \, kJ$$

(ii) $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l); \Delta H = -285.9 \, kJ$
(iii) $C(s) + O_2(g) \rightarrow CO_2(g); \Delta H = -393.5 \, kJ$
(A) + 3172.8 kJ (B) - 1549.2 kJ

C)
$$- 3172.8 \ kJ$$
 (D) $- 3264.6 \ kJ$

- **91.** Standard molar enthalpy of formation of CO_2 is equal to
 - (A) Zero
 - (B) The standard molar enthalpy of combustion of gaseous carbon
 - (C) The sum of standard molar enthalpies of formation of CO and O_2
 - (D) The standard molar enthalpy of combustion of carbon (graphite)

92. In the complete combustion of butanol $C_4H_9OH(l)$, if ΔH is enthalpy of combustion and ΔE is the heat of combustion at constant volume, then

- (A) $\Delta H < \Delta E$
- (B) $\Delta H = \Delta E$ (C) $\Delta H > \Delta E$
- D ALL AE relation connect 1
- (D) $\Delta H, \Delta E$ relation cannot be predicted

93.
$$C + O_2 \rightarrow CO_2; \Delta H = X$$

$$CO + \frac{1}{2}O_2 \rightarrow CO_2; \Delta H = Y$$

Then the heat of formation of *CO* is

(A) $X - Y$	(B) $Y - 2X$
(C) $X + Y$	(D) $2X - Y$

94. The values of heat of formation of SO_2 and SO_3 are -298.2 kJ and -98.2 kJ. The heat of reaction of the following reaction will be

$$SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$$

(A) $-200 kJ$ (B) $-356.2 kJ$
(C) $+200 kJ$ (D) $-396.2 kJ$

- **95.** Calculate the standard heat of formation of carbon disulphide (l), given that the standard heat of combustion of carbon (s), sulphur (s) and carbon disulphide (l) are -393.3, -293.72 and $-1108.76 kJ mol^{-1}$ respectively
 - (A) $-128.02 kJ mol^{-1}$ (B) $+12.802 kJ mol^{-1}$
 - (C) $+128.02 kJ mol^{-1}$ (D) $-12.802 kJ mol^{-1}$

96. $S + \frac{3}{2}O_2 \rightarrow SO_3 + 2x \, kcal$ $SO_2 + \frac{1}{2}O_2 \rightarrow SO_3 + y \, kcal$

2 2 3 5

Find out the heat of formation of SO_2

(A) 2x - y (B) 2x + y

(C) x + y (D) 2x / y

97. The combustion enthalpies of carbon, hydrogen and methane are $-395.5 kJ mol^{-1}$, $-285.8 kJ mol^{-1}$ and $-890.4 kJ mol^{-1}$ respectively at $25^{\circ}C$. The value of standard formation enthalpies of methane at that temperature is

(A) $890.4 kJ mol^{-1}$ (B) $-298.8 kJ mol^{-1}$

(C)
$$-74.7 kJ mol^{-1}$$
 (D) $-107.7 kJ mol^{-1}$

- **98.** Equal volumes of methanoic acid and sodium hydroxide are mixed. If x is the heat of formation of water, then heat evolved on neutralisation is
- (A) More than x (B) Equal to x(C) Twice of x (D) Less than x
- 99. The neutralisation of a strong acid by a strong base liberates an amount of energy per mole of H⁺ that
 - (A) Depends upon which acid and base are involved
 - (B) Depends upon the temperature at which the reaction takes place
 - (C) Depends upon which catalyst is used
 - (D) Is always the same

100. When 0.5g of sulphur is burnt to $SO_2, 4.6 kJ$

of heat is liberated. What is the enthalpy of formation of sulphur dioxide

 $(A) + 147.2 \ kJ$ $(B) - 147.2 \ kJ$ $(C) - 294.4 \ kJ$ $(D) + 294.4 \ kJ$

101. $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l);$ $\Delta H \text{ at } 298 \ K = -285.8 \ kJ$

The molar enthalpy of vaporisation of water at 1 *atm* and $25^{\circ}C$ is 44 *kJ*. The standard enthalpy of formation of 1 *mole* of water vapour at $25^{\circ}C$ is

 $(A) - 241.8 \ kJ$ $(B) 241.8 \ kJ$ $(C) 329.8 \ kJ$ $(D) -329.8 \ kJ$

102. When 4 g of iron is burnt to ferric oxide at constant pressure, 29.28 kJ of heat is evolved. What is the enthalpy of formation of ferric oxide (At. Wt. of Fe = 56)

(A)
$$- 81.98 \ kJ$$
 (B) $- 819.8 \ kJ$
(C) $- 40.99 \ kJ$ (D) $+ 819.8 \ kJ$

103. When a strong acid, strong base or their salt are dissolved in water, they are completely ionised. If a strong acid is added to a strong base, H^+ ions from the former combine with OH^- ions of the latter forming water. The formation of each water molecule liberates a certain quantity of energy and the reaction is exothermic. The heat liberated when one mole of water is formed by combining hydrochloric acid and sodium hydroxide is 13.7 *kcal*. The heat liberated when one mole of water is formed by combining sulphuric acid and sodium hydroxide is

(11) 25.5 kcu (1) 0.5	ксиі
() () =	

- **104.**2.1 *g* of *Fe* combines with *S* evolving 3.77 *kJ*. The heat of formation of *FeS* in *kJ/mol* is
 - (A) 1.79
 (B) 100.5
 (C) 3.77
 (D) None of these

105. In the reaction: $H_2 + Cl_2 \rightarrow 2HCl_2 = 194kJ$.

Heat of formation of *HCl* is

(A) + 97 kJ(B) + 194 kJ(C) - 194 kJ(D) - 97 kJ

106. The ΔH_f^o for $CO_2(g), CO(g)$ and $H_2O(g)$ are -393.5, -110.5 and $-241.8 k Jmol^{-1}$ respectively. The standard enthalpy change (in kJ) for the reaction $CO_2(g) + H_2(g) \rightarrow$ $CO(g) + H_2O(g)$ is

(A) 524.1 (B) 41.2

(C) - 262.5 (D) - 41.2

- **107.** Which of the following compounds will absorb the maximum quantity of heat when dissolved in the same amount of water ? The heats of solution of these compounds at $25^{\circ}C$ in *kJ/mole* of each solute is given in brackets
 - (A) $HNO_3(\Delta H = -33)$
 - (B) $KCl(\Delta H = +17.64)$
 - (C) $NH_4NO_3(\Delta H = +25.5)$
 - (D) $HCl(\Delta H = -74.1)$

108. In the reaction $C + 2S \rightarrow CS_2 + \Delta H, \Delta H$ is the

- (A) Heat of combustion
- (B) Heat of neutralisation
- (C) Heat of solution
- (D) None of these
- **109.** The heat of formation of methane $C(s) + 2H_2(g) \rightarrow CH_4(g)$ at constant pressure is 18500 *cal* at 25° C. The heat of reaction at constant volume would be

(A) 17904 cal
(B) 18202 cal
(C) 18798 cal
(D) 19096 cal

110. The enthalpy of combustion of $C_6H_{6(l)}$ is

- 3250 kJ. When 0.39 g of benzene is burnt excess of oxygen in an open vessel, the amount of heat evolved is

(A) 16.25 <i>J</i>	(B) 16.25 <i>kJ</i>
(C) 32.5 <i>J</i>	(D) 32.5 <i>kJ</i>

- **111.** The values of ΔH for the combustion of ethene and ethyne are -341.1 and -310.0 kcal respectively. Which of the following is a better fuel
 - (A) $C_2 H_2$ (B) $C_2 H_4$
 - (C) Both of these (D) None of these

- 112.For exothermic reaction, the equilibrium constant (A) Increases with increase of P(B) Decreases with increase of P(C) Increases with increase of temperature (D) Decreases with increase of temperature **113.** In order to decompose 9 g water 142.5 kJ heat is required. Hence the enthalpy of formation of water is (A) - 142.5 kJ(B) + 142.5 kJ(C) - 285 kJ(D) + 285 kJ**114.** What is Δn for combustion of 1 mole of benzene, when both the reactants and the products are gas at 298 K (B) 3/2 (A) 0(C) - 3/2(D) 1/2 **115.**If $C + O_2 \rightarrow CO_2 + 94.2$ kcal $H_2 + \frac{1}{2}O_2 \rightarrow H_2O + 68.3 kcal$ $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 210.8 kcal$ Then the possible heat of methane will be (A) 47.3 kcal (B) 20.0 kcal (C) 45.9 kcal $(D) - 47.3 \ kcal$ **116.**Heat of neutralization of strong acid and weak
- **116.**Heat of neutralization of strong acid and weak base is
 - (A) $57.1 kJ mol^{-1}$
 - (B) $13.7 kJ mol^{-1}$
 - (C) Less than $13.7 k cal mol^{-1}$
 - (D) More than $13.7 k cal mol^{-1}$
- **117.** A system is changed from state *A* to state *B* by one path and from *B* to *A* another path. If E_1 and E_2 are the corresponding changes in internal energy, then
 - (A) $E_1 + E_2 = -ve$ (B) $E_1 + E_2 = +ve$
 - (C) $E_1 + E_2 = 0$ (D) None of these
- **118.** The heat evolved during the combination of 24 g C and 128 g S following the change is $C + S_2 \rightarrow CS_2$; $\Delta H = 22.0 kcal$
 - (A) 11 kcal
 (B) 32 kcal
 (C) 44 kcal
 (D) 22 kcal

119. When the aqueous solution of 0.5 mole HNO_3

is mixed with the 0.3 mole of OH^- solution, then what will be the liberated heat (Enthalpy of neutralization is = 57.1 kJ)

(A) 28.5 kJ (B) 17.1 kJ

(C) 45.7 kJ (D) 1.7 kJ

120. A cylinder of gas is assumed to contain 11.2 kg of butane (C_4H_{10}) . If a normal family needs 20000 kJ of energy per day. The cylinder will last: (Given that ΔH for combustion of butane is – 2658 kJ (A) 20 days (B) 25 days

(C) 26 days (D) 24 days

Bond energy

121. The first ionization energy for *Li* is 5.4 *eV* and electron affinity of *Cl* is 3.61*eV*. The ΔH (in *kJ/mol*) for the reaction $Li(g) + Cl(g) \rightarrow Li^+ + Cl^-$ is (if resulting ions do not combine with each other) $(1eV = 1.6 \times 10^{-19} J)$

(A) 70 (B) 100

- 122. Given that $C(g) + 4H(g) \rightarrow CH_4(g);$ $\Delta H = -166 kJ$
 - The bond energy C H will be
 - (A) $208 \ kJ/mole$ (B) $41.6 \ kJ/mole$ (C) $832 \ kJ/mole$ (D) None of these
- **123.** The H H bond energy is 430 kJ mol and Cl Cl bond energy is 240 kJ mol⁻¹. ΔH for HCl is -90 kJ. The H Cl bond energy is about

(A) $180 kJ mol^{-1}$	(B) $360 kJ mol^{-1}$

- (C) $213 kJ mol^{-1}$ (D) $425 kJ mol^{-1}$
- **124.** If enthalpies of methane and ethane are respectively 320 and 360 calories then the bond energy of C C bond is

(A) 80 calories	(B) 40 calories
(C) 60 calories	(D) 120 calories

125	.If the	bond	energi	es of	H - E	I, Br	– Br	and
	HBr	are	433,	192	and	364	kJ m	ol^{-1}
	respec	tively	, the	ΔH^{a}	for	the	react	tion,
	$H_2(g)$	$) + Br_{2}$	$g(g) \rightarrow$	2 <i>HBr</i>	<i>(g)</i> is	5		
	(A) +	261 k.	J		(B) –	103 k.	J	
	(C) - C	261 kJ	I		(D) +	103 k	J	

Free energy and Work function

- **126.** The relation $\Delta G = \Delta H T \Delta S$ was given by
 - (A) Boltzmann (B) Faraday
 - (C) Gibbs–Helmholtz (D) Thomson
- **127.** For precipitation reaction of Ag^+ ions with *NaCl*, which of the following statements is correct
 - (A) ΔH for the reaction is zero
 - (B) ΔG for the reaction is zero
 - (C) ΔG for the reaction is negative
 - (D) $[\Delta G] = [\Delta H]$
- **128.**At constant pressure and temperature, the direction to the result of any chemical reaction is where, there is less amount of
 - (A) Entropy (B) Enthalpy
 - (C) Gibb's free energy (D) None of the above
- **129.**The dependence of Gibbs free energy on pressure for an isothermal process of an ideal gas is given by

(A)
$$\Delta G_T = nRT \ln \frac{P_2}{P_1}$$
 (B) $\Delta G_T = nRT \ln \frac{V_2}{V_1}$
(C) $\Delta G_T = nRT \log \frac{P_1}{P_2}$ (D) $\Delta G_T = nRT \log \frac{V_2}{V_1}$

130. For the change $H_2O(l) \rightarrow H_2O(g)$; P = 1 atm, T = 373 K, the free energy change $\Delta G = 0$. This indicates that

- (A) $H_2O(l)$ is in equilibrium with $H_2O(g)$
- (B) Water boils spontaneously at 373 K
- (C) Water does not boil spontaneously at 373 K
- (D) Condensation of water vapour occurs spontaneously at 373 K

131.Born-Haber cycle is used to determine

(A) Crystal energy	(B) Electron affinity

- (C) Lattice energy (D) All of these
- **132.**Gibbs free energy G, enthalpy H and entropy S are interrelated as in
 - (A) G = H + TS(B) G = H - TS
 - (C) G TS = H(D) G = S = H
- 133. The essential condition for the feasibility of a reaction is that
 - (A) The reaction should be exothermic
 - (B) The entropy of products must be larger than that of reactants
 - (C) The reaction is to be accompanied with free energy decrease
 - (D) The reaction has to possess high activation energy
- **134.** The correct relationship between free energy change in a reaction and the corresponding equilibrium constant K_c is

(A)
$$\Delta G = RT \ln K_c$$
 (B) $-\Delta G = RT \ln K_c$

(C)
$$\Delta G^o = RT \ln K_c$$
 (D) $-\Delta G^o = RT \ln K_c$

135.In an irreversible process taking place at constant T and P and in which only pressurevolume work is being done, the change in Gibbs free energy (dG) and change in entropy (dS), satisfy the criteria

(A)
$$(dS)_{V,E} < 0, (dG)_{T,P} < 0$$

- (B) $(dS)_{V_{F}} > 0, (dG)_{T_{P}} < 0$
- (C) $(dS)_{VE} = 0, (dG)_{TP} = 0$
- (D) $(dS)_{V_E} = 0, (dG)_{T_P} > 0$
- 136. The densities of graphite and diamond at 298 K are 2.25 and 3.31 g cm^{-3} , respectively. If the standard free energy difference (ΔG°) is equal to 1895 J mol^{-1} , the pressure at which graphite will be transformed diamond at 298 K is

(A) $9.92 \times 10^5 Pa$	(B) $9.92 \times 10^8 Pa$
(C) $9.92 \times 10^7 Pa$	(D) $9.92 \times 10^6 Pa$

137. The free energy change for the following reactions are given below,

$$C_{2}H_{2}(g) + \frac{5}{2}O_{2}(g) \rightarrow$$

$$2CO_{2}(g) + H_{2}O(l); \Delta G^{\circ} = -1234kJ$$

$$C(s) + O_{2}(g) \rightarrow CO_{2}(g) \ \Delta G^{\circ} = -394kJ$$

$$H_{2}(g) + \frac{1}{2}O_{2}(g) \rightarrow H_{2}O(l) \ \Delta G^{\circ} = -237kJ$$

What is the standard free energy change for the reaction $H_2(g) + 2C(s) \rightarrow C_2H_2(g)$

$$(A) - 209 \ kJ$$
 $(B) - 2259 \ kJ$ $(C) + 2259 \ kJ$ $(D) \ 209 \ kJ$

- **138.** The equilibrium concentration of the species in the reaction $A + B \equiv C + D$ are 3, 5, 10 and 15 mole L^{-1} respectively at 300 K the ΔG for the reaction is
 - (A) 13.81 (B) - 1381.8(C) - 138.18(D) 1391.6
- **139.**Gibb's free enrgy (G) is defined as
 - (B) $\Delta G = \Delta H + \frac{T}{\Lambda S}$ (A) $\Delta G = \Delta H - T \Delta S$ (D) $\Delta G = \Delta H + T.C_n$ (C) $\Delta H = \Delta G - T \Delta S$
- 140.Standard enthalpy and standard entropy changes for the oxidation of ammonia at 298 K are $-382.64 kJ mol^{-1}$ and $-145.6 JK^{-1} mol^{-1}$, respectively. Standard Gibbs energy change for the same reaction at 298K is
 - $(A) 439.3 \text{ kJ } mol^{-1}$ (B) $-523.2 \ kJ \ mol^{-1}$ $(C) - 221.1 \ kJ \ mol^{-1}$ (D) $-339.3 \ kJ \ mol^{-1}$