Exercise 2 (Going Step – by – Step)

Basic Concepts

1. Out of p, V and T

   (a) p and V are independent variables and T is dependent variable

   (b)p and V and T are independent variables and V is dependent

   (c) V and T are independent variables and p is dependent variable

   (d) All are dependent as well as independent variables

2. Out of boiling point (I), entropy (II), pH(III) and emf of a cell (IV), extensive properties are

   (a) I, II (b) I, II, III

   (c) I, III, IV (d) All of these

3. Out of internal energy (A), temperature (B), pressure (C), volume (D), work (E) and enthalpy (F), state functions are

   (a) A, B, C, D (b) A, B, C, E, F

   (c) A, E, F (d) A, C, E

4. Which is not a state function?

   (a) q (b) H

   (c) E (d) G

5. Out of following statements : I, II, and III

   I : A system may be a complex as a human body or as simple as a mixture consisting of a drop of water.

   II : A system is said to be macroscopic when it consists of large number of molecules, atoms or ions.

   III : Pressure, volume temperature and surface area are some macroscopic properties.

   Select the correct statements.

   (a) I, II, III (b) I, II

   (c) I, III (d) II, III

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6. System can be closed if it can

   (a) exchange heat and matter with surroundings

   (b) exchange heat but not the matter with surroundings

   (c) neither exchange heat nor matter with surroundings

   (d) None of the above

7. Out of the following which is not the set of intensive properties?

   (a) Boiling point, pH, molarity

   (b) Volume, area, length

   (c) Freezing point, elevation in boiling point, volume

   (d) Refractive index, molality, density

8. Select the correct statements.

   (a) The Kelvin scale of temperature is based on the absolute zero of temperature and triple point of water, scale being called as thermodynamic temperature scale.

   (b) The basic Si unit of temperature is Kelvin

   (c) One Kelvin is $\frac{1}{273.16}$ of the triple point temperature of water (273.16 K)

   (d) All of the above are correct statements

9. Triple point of water corresponds to

   (a) 1 atm, 0°C (b) 1 atm, 0 K

   (c) 4.58 Torr, 0.01°C (d) 1 atm, 0.01°C

10. Which of the following is a state function?

    (a) The temperature of an ice cube

    (b) The amount of work in expansion

    (c) Both (a) and (b)

    (d) None of the above

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Work and Internal Energy

11. 1g of H_2 gas at STP is expanded so that volume is doubled. Hence, work done is

(a) -22.4 L atm **(b) -11.2 L atm**

(c) -44.8 L atm (d) +11.2 L atm

12. 1 mole of Al_4C_3 (S) reacts with H_2O in a closed vessel at 27°C against atmospheric pressure. Work done is

(a) – 1800 cal (b) – 600 cal

(c) + 1800 cal **(d) zero**

13. If the above system is in an open vessel then work done is

(a) – 1800 cal (b) – 600 cal

(c) + 1800 call (d) + 600 cal

14. Consider the following chemical changes

I : CaC_2 (S) + $2H_2O$ (I) $\longrightarrow$ $Ca(OH)_2$ (S) + C_2H_2 (g)

II : $2SO_2$ (g) + O_2 (g) $\rightarrow$ $2SO_2$ (g)

III : 2Fe (S) + $3H_2O$ (g) $\rightarrow$ Fe_2O_3 (S) + $3H_2$ (g)

Work is done by the system in the cases of

(a) I, II (b) II, III

(c) I only (d) None of these

15. In question (14) above, work is done on the system in the case of

(a) I, II, III (b) I, III

(c) I only **(d) II only**

16. Consider the following statements.

I : When a system returns to its original condition, the overall change in a state function is zero.

II : When a gas expands, work energy is released, hence work done is negative and is done by the system.

III : C(S) + CO_2 (g) $\longrightarrow$ 2CO (g)

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In this Δn_g = zero, hence work is done.

Select the correct statements(S).

(a) I, II, III **(b) I, III**

(c) II, III (d) I, III

17. Numerical value of work done is maximum in case of

(a) C_3H_8 (g) + 50_2 (g) → $3CO_2$ (g) + $4H_2$ (g)

(b) C(S) + CO_2 (g) → 2CO (g)

(c)3Fe (S) +$4H_2O$ (g) → Fe_3O_4 (S) + $4H_2$ (g)

(d)NH_4Cl (S) → NH_3 (g) +HCl (g)

18. If W = − 20 kJ the negative sign indicates that the

(a) expanding system gains work energy and does work on the surroundings

(b) expanding system loses work energy and does work on the surroungs

(c) expanding system gains work energy and does work on the system

(d) expanding system loses work energy and does work by the surroundings

19. I mole each of CaC_2, Al_4C_3, Mg_2C_3 reacts with H_2O in separate open flask Numerical value of work done by the system is in order

(a) $CaC_2 < Al_4C_3 = Mg_2C_3$

(b) $CaC_2 < Al_4C_3 < Mg_2C_3$

(c) $CaC_2 = Mg_2C_3 < = Al_4C_3$

(d) $CaC_2 = Mg_2C_3 = Al_4C_3$

20. Select the correct statements(S)

(a) When energy is transferred to the system from the surroundings as work, the surroundings do work on the system and the value of work (W) positive

(b) When energy is transferred from the system to the surroundings as work, work is done on the surroundings and the value of W negative

(c) Both (a) and (b)

(d) None of the above

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21. If bond energy of N — H bond is x cal mol^{-1} change in internal energy in the following chemical process is

$$NH_3 (g) \rightarrow N (g) + 3H (g)$$

(a) x cal (b) 4x cal

(c) 3x cal (d) 2x cal

22. Select the correct statements(S).

(a) When work is done on the system, internal energy of the system increase.

(b) When work is done by the system, internal energy of the system decrease.

(c) Both (a) and (b)

(d) None of the above

23. Temperature of one mole of helium gas is increased by 1°C, hence increase in internal energy is

(a) 7 cal (b) 5 cal

(c) 3.5 cal **(d) 3 cal**

24. Which has maximum internal energy?

(a) Helium gas (b) Oxygen gas

(c) Ozone gas (d) Equal

25. A process or reaction which takes heat from the surroundings is said to be … and which releases heat to the surroundings is said to be …

(a) endothermic, exothermic

(b) exothermic endothermic

(c) both endothermic

(d) both exothermic

26. Consider the reaction shown

$2CO(g) + O_2 (g) \rightarrow CO_2 (g) + 135.2$ kcal (ΔE)

This reaction is … because the sign ΔE is …

(a) endothermic, positive (b) exothermic, positive

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(c) endothermic, negative **(d) exothermic, negative**

27. The value of ΔE is positive when energy is transferred from the

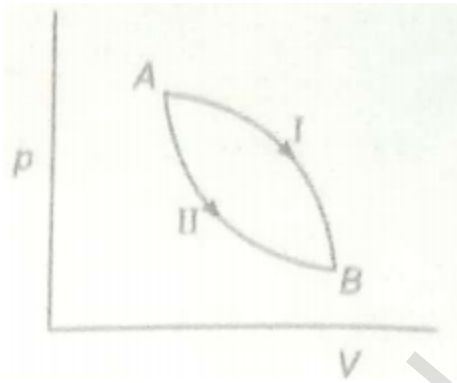
(a) surroundings to the system

(b) system to the surroundings

(c) system to system

(d) surroundings to surroundings

28. In the following changes A to B, ΔE_1 (change in internal energy of path I) and ΔE_2 (change in internal energy of path II) are related to one each other by



(a)$\Delta E_1 > \Delta E_2$

(b)$\Delta E_2 > \Delta E_1$

(c))$\Delta E_1 = \Delta E_2$

(d)Temperature is also required to correlate them

29. Internal energy E

(a) is a state function

(b) is an intensive property

(c) Both (a) and (b) are correct

(d) None of the above is correct

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30. Na(S) is converted into Na^+ (g)

$$Na\,(S) \overset{q_1}{\rightarrow} Na\,(g)$$

$$Na\,(g) \overset{q_1}{\rightarrow} + Na\,(g)$$

then internal energy change ΔE is

(a)q_1 (b) q_2

(c) $q_1 + q_2$ (d) $q_1 - q_2$

First Law of Thermodynamics

31. Which of the following has the highest enthalpy content and which the lowest at a given temperature?

I : H_2O (S) II : H_2O (I)

III : H_2O (g)

	Highest	Lowest
(a)	I	II
(b)	I	III
(c)	**III**	**I**
(d)	II	III

32. $\Delta H = \Delta E$ for the case

(a) C_2H_4 (g) + H_2 (g) $\rightarrow$ C_2H_6 (g)

(b) C (S) + CO_2 (g) $\rightarrow$ 2CO (g)

(c) NH_4HS (S) $\rightarrow$ NH_3 (g) + H_2S (g)

(d) CH_4 (g) + $2O_2$ (g) $\rightarrow$ $CO_2 2H_2O$ (g)

33. A gas is cooled and loses 50 J of heat. The gas contracts as it cools and work done on the system equal to 20 J is exchanged with the surroundings. Hence, ΔE is

(a) 70 J **(b) -30J**

(c) 30 J (d) -70 J

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34. For all gases , $C_p - C_V = R$. This R is the

(a) change kinetic energy when temperature of 1 mole of a gas is increased by 1°C

(b) mechanical work when the temperature of 1 mole of a gas is increased by 1°C

(c) change in potential energy when gas is allowed to fall

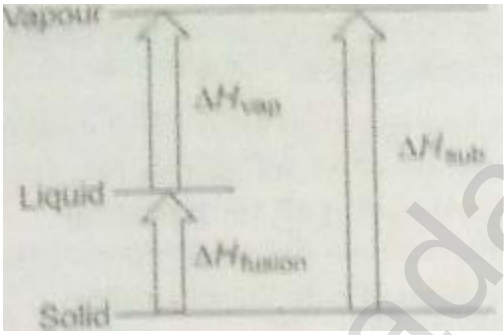
(d) None of the above

35. When an ideal gas expands in vacuum work done is

(a) R (b) $\frac{3}{2} R$

(c) 4 R **(d) 0**

36. From the figure representing enthalpy change of various transition as indicated, a substance has maximum enthalpy when present in



(a) solid state (b) liquid state

(c) gaseous state (d) equal in all states

37. For an ideal gas

(a) pV = constant under isothermal condition

(b) $\left(\frac{\partial E}{\partial R}\right)_T = 0$

(c) Both (a) and(b)

(d) None of the above

38. When 1 g H_2 at STP expands under atmospheric pressure such that volume is doubled, then work done is

(a) – 11.2 L atm (b) + 11.2 L atm

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(c) - 22.4 L atm (d) + 22.4 L atm

39. When 1 mole of CO_2 (g) occupying volume 10 L at 27 °C is expanded under adiabatic condition, temperature falls to 150 K. Hence, final volume is

(a) 20 L (b) 5 L

(c) 80 L (d) 40 L

40. For the reaction. H_2 (g) ⟶ 2H (g), ΔH = x kJ hence, enthalpy of H_2 (g) are respectively

(a) 0, x kJ **(b) 0, $\frac{X}{2}$**

(c) X, $\frac{X}{2}$ (d) $\frac{X}{2}$, X

Isothermal and Adiabatic Expansion

41. The value of ΔE when the system absorbs 1000 kJ of heat and does 650 kJ of work on the surroundings is

(a) 350 kJ (b) -350 kJ

(c) 1650 kJ (d) -1650 kJ

42. The value of ΔE when 1500 cal of heat is added to the system while the system does work equivalent to 2500 cal by expanding against the surrounding atmosphere is

(a) 4000 cal (b) 1000 cal

(c) – 1000 cal (d) – 4000 cal

43. Select the correct statements(S).

(a) Joule- Thomson effect is zero in an ideal gas

(b) Joule- Thomson coefficient

$$\mu\pi = \frac{1}{C_p}\left[\frac{2a}{RT} - b\right] \text{ for a real gas}$$

(c) Both (a) and (b)

(d) None of the above

44. 8 g of O_2 gas at 27°C is compressed to half of the volume under isothermal and reversible condition. Work done (in cal) on the system is

(a) W = 0

(b) W = 2.303 x 150 log 2

(c) W = - 2.303 x 150 log 2

(d) W = - 2.303 x 300 x 8 x 2 log 2

Second Law of Thermodynamics

45. Efficiency of a Carnot's engine is 100% when

(a) sink is placed at 0°C

(b) sink is placed at 0 K

(c) source is placed at 100°C

(d) source is placed at 400°C

46. Which can account for maximum work under isothermal and reversible condition?

(a) First law of thermodynamics

(b) Second law of thermodynamics

(c) Both (a) and (b)

(d) None of the above

47. A Carnot engine absorbs 6000 kJ of heat from a source at 600 K. If only 50% of useful work is obtained, sink has been placed at

(a) 27°C (b) 300°C

(c) 127°C (d) 327°C

48. Select the correct statements(S).

(a) At absolute zero of the sink work obtained is maximum

(b) Kinetic energy of a molecule is zero at 0°C

(c) Volume of one mole of gas is 22.4 L at 0 K

(d) All of the above

49. Heat obtained due to expansion of 1 mol of H_2 gas at 1000 K from 10 L to 100 L under isothermal reversible condition is absorbed by an engine having a sink at 300 K. Useful work obtained is

(a) – 1382 cal (b) – 3224 cal

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(c) 1382 cal **(d) 3224 cal**

50. ($\Delta H - \Delta E$) is maximum at a given temperature in case of

(a) PCl_5 (g) → PCl_3 (g) + Cl_2 (g)

(b) $CaCO_3$ (g) → CaO (S) + CO_2 (g)

(c) NH_4HS (S) → NH_3 (g) + H_2S (g)

(d) N_2 (g) + O_2 (g) → 2NO (g)

Entropy

51. Which has the maximum entropy of vaporization?

(a) Ethanol (I) (b) Benzene (I)

(c) Toluene (I) (d) CO_2 (g)

52. Select the correct statements (S) about entropy S.

(a) $S_{(vapour)} > S_{(vapour)} > S_{(vapour)}$ **(b) $S_{(vapour)} > S_{(vapour)} > S_{(vapour)}$**

(c) $S_{(vapour)} < S_{(vapour)} < S_{(vapour)}$ (d) $S_{(vapour)} = S_{(vapour)} > S_{(vapour)}$

53. Water and alcohols have unusually large entropies of

(a) larger molecular weight

(b) larger density

(c) extensive hydrogen bonding

(d) lower free energy

54. Select the correct alternate for the endothermic change.

(a) $\Delta H < 0$, $\Delta S_{system} < 0$

(b) $\Delta H > 0$, $\Delta S_{system} < 0$

(c) $\Delta H < 0$, $\Delta S_{surroundings} < 0$

(d) $\Delta H > 0$, $\Delta S_{surroundings} < 0$

55. Select the correct alternate for the exothermic process.

(a) $\Delta H < 0$, $\Delta S_{surroundings} > 0$

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(b) $\Delta H < 0, \Delta S_{system} < 0$

(c) Both (a) and (b)

(d) None of the above

56. Select the correct alternate about entropy

(a) $\lim_{T\to\infty} S = 0$ (b) $\lim_{T\to 0} S = \infty$

(c) $\lim_{T\to 0} S = 0$ (d) $S_{vapour}\ S_{liquid}$

57. Which of the following processes is spontaneous?

(a) Diffusion of perfume molecules from one side of the room to the other

(b) Decomposition of solid $CaCO_3$

(c) Heat flow from a cold object to a hot object

(d) Climbing up a mountain

58. Select the correct statements (S)

(a) By Trouton's rule entropy of vaporization of most liquids is 88 ± 5 J mol^{-1} K^{-1} at normal b.p.

(b) Due to extensive H-bonding H_2O (l) is most ordered, hence, its entropy of vaporization is usually high

(c) Entropy of $CaCO_3$ (S) is zero at -273°C

(d) All of the above

59. For the following reaction

$$CaCO_3\ (S) \rightarrow CaO\ (S) + CO_2\ (g)$$

If at 0 K, ΔS of the this reaction is x cal mol^{-1}, then entropy of CO_2 (g) at 0 K is

(a)-x cal (b) -2x cal **(c) +x cal** (d) 0 cal

60. Which has the highest entropy per mole of the substance?

(a) H_2 at 25°C at 1 atm (b) H_2 at STP

(c) H_2 at 100 K at 1 atm (d) H_2 at 0 K at 1 atm

Free Energies

61. Which is not true about G?

(a) G is a state function

(b) Decrease in G, (-ΔG) is equal to net work done

(c) If ΔG is positive, reaction is spontaneous

(d) ΔG = $\Delta G°$ if K = 1

62. An endothermic reaction is spontaneous if

(a) $\Delta H > T\Delta S$

(b) $\Delta H < T\Delta S$

(c) $\Delta H = T\Delta S$

(d) $T\Delta S$ = 0

63. $H_2O_{ice}(S) \rightleftharpoons H_2O,\ \Delta H° = +6.01\ kJ\ mol^{-1}$

$$\Delta S° = 22.0\ JK^{-1}\ mol^{-1}$$

Formation of ice is favoured at a temperature

(a)above 0°C

(b) below 0°C

(c) at 0°C

(d) above 10°C

64. For the reaction, at 298 K

$CaCO_3$ (S) → CaO (S) + CO_2 (g),

$$\Delta H^{\circ} = 178.3\ kJ,\ \ \Delta S° = 160\ J\ K^{-1}$$

Select the correct statements(S).

(a)The reaction is spontaneous at this temperature (298 K)

(b) If temperature is decreased forward reaction is favoured

(c) The reaction is spontaneous in forward direction only at temperature above 1000 K

(d) The reaction is spontaneous in forward direction only at temperature above 1114 K

65. An exothermic reaction with ΔS = -ve, is

(a) spontaneous at all temperature

(b) spontaneous at high temperature

(c) non-spontaneous at low temperature

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(d) spontaneous at low temperature

66. For the reaction, A → B, ΔH = + ve, ΔS = - ve

This reaction is

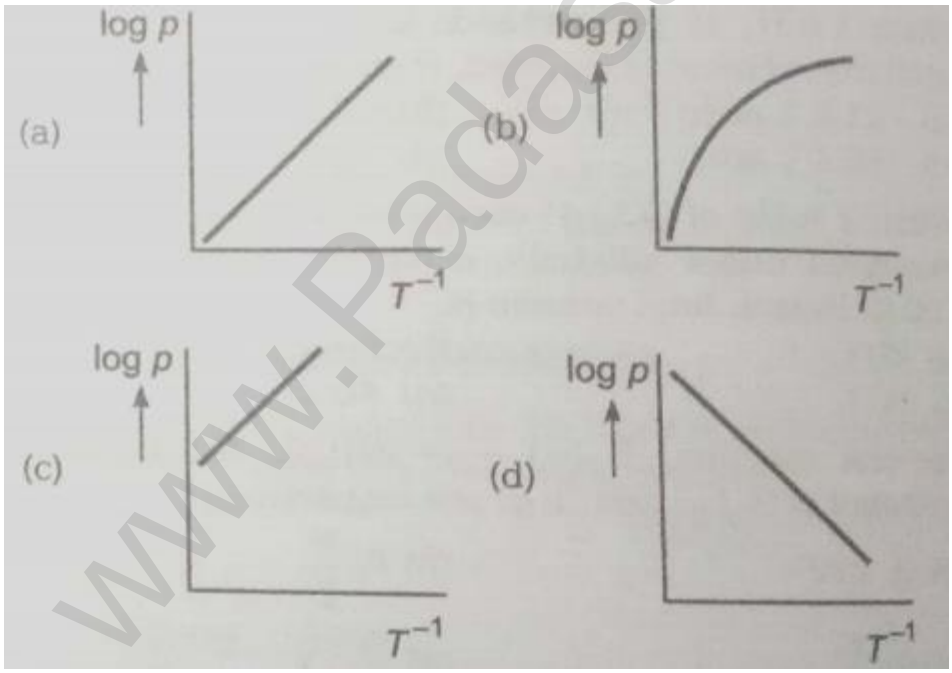
(a)non-spontaneous at all temperature

(b) non- spontaneous at low temperature

(c) non-spontaneous at high temperature

(d) spontaneous at high temperature

67. $H_2O\ (g) \rightleftharpoons H_2O\ (I)$, $\Delta H = -10\ kcal\ mol^{-1}$. For this transition, vapour pressure change with temperature as given



ans: (d)

68. For the equilibrium , liquid ⇌ gas, Clapeyron – Clausius equation(S) is

(a) $P = A_e{}^{-\Delta H/RT}$

(b) $\log_{10}P = -\frac{\Delta H}{2.303\ RT} + constant$

(c) $\frac{d\log_{10}P}{dT} = \frac{\Delta H}{2.303\ RT^2}$

(d) All of the above

69. Which is equal to the total work done?

(a) $-\Delta A$ (b) $-\Delta G$ (c) $-\Delta H$ (d) $-\Delta E$

70. For the equilibrium at 298 K

$$2H_2O \rightleftharpoons H_3O^+ + OH^- K = 1 \times 10^{-14}$$

$\Delta G°$ is approximately

(a)100 kJ (b) -80 kJ **(c) 80 kJ** (d) -100 kJ

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