EXERCISE-I

First Law of Thermodynamics ($\Delta Q = \Delta U + \Delta W$)

1. If R = universal gas constant, the amount of heat needed to raise the temperature of 2 mole of an ideal monatomic gas from 273K to 373K when no work is done
(A) 100 R (B) 150 R
(C) 300 R (D) 500 R

2. Find the change in internal energy of the system when a system absorbs 2 *kilocalorie* of heat and at the same time does 500 *joule* of work
(A) 7900 J (B) 8200 J
(C) 5600 J (D) 6400 J

3. A system performs work ΔW when an amount of heat is ΔQ added to the system, the corresponding change in the internal energy is ΔU. A unique function of the initial and final states (irrespective of the mode of change) is
(A) ΔQ (B) ΔW
(C) ΔU and ΔQ (D) ΔU

4. A container of volume $1 m^3$ is divided into two equal compartments by a partition. One of these compartments contains an ideal gas at 300 K. The other compartment is vacuum. The whole system is thermally isolated from its surroundings. The partition is removed and the gas expands to occupy the whole volume of the container. Its temperature now would be
(A) 300 K (B) 239 K
(C) 200 K (D) 100 K

5. 110 J of heat is added to a gaseous system, whose internal energy change is 40 J, then the amount of external work done is
(A) 150 J (B) 70 J
(C) 110 J (D) 40 J

6. Which of the following is not thermodynamically function
(A) Enthalpy (B) Work done
(C) Gibb's energy (D) Internal energy

7. When the amount of work done is 333 *cal* and change in internal energy is 167 *cal*, then the heat supplied is
(A) 166 *cal* (B) 333 *cal*
(C) 500 *cal* (D) 400 *cal*

8. First law thermodynamics states that
(A) System can do work
(B) System has temperature
(C) System has pressure
(D) Heat is a form of energy

9. A thermo-dynamical system is changed from state (P_1, V_1) to (P_2, V_2) by two different processes. The quantity which will remain same will be
(A) ΔQ (B) ΔW
(C) $\Delta Q + \Delta W$ (D) $\Delta Q - \Delta W$

10. In thermodynamic process, 200 *Joules* of heat is given to a gas and 100 *Joules* of work is also done on it. The change in internal energy of the gas is
(A) 100 J (B) 300 J
(C) 419 J (D) 24 J

11. Which of the following statements is correct for any thermodynamic system
(A) The internal energy changes in all processes
(B) Internal energy and entropy are state functions
(C) The change in entropy can never be zero
(D) The work done in an adiabatic process is always zero

12. A system is provided with 200 cal of heat and the work done by the system on the surrounding is 40 *J*. Then its internal energy

(A) Increases by 600 *J*
(B) Decreases by 800 *J*
(C) Increases by 800 *J*
(D) Decreases by 50 *J*

13. In a thermodynamic process, pressure of a fixed mass of a gas is changed in such a manner that the gas molecules gives out 20 *J* of heat and 10 *J* of work is done on the gas. If the initial internal energy of the gas was 40 *J*, then the final internal energy will be

(A) 30 *J* (B) 20 *J*
(C) 60 *J* (D) 40 *J*

14. Heat is not being exchanged in a body. If its internal energy is increased, then

(A) Its temperature will increase
(B) Its temperature will decrease
(C) Its temperature will remain constant
(D) None of these

15. Out of the following which quantity does not depend on path

(A) Temperature (B) Energy
(C) Work (D) None of these

16. First law of thermodynamics is a special case of

(A) Newton's law
(B) Law of conservation of energy
(C) Charle's law
(D) Law of heat exchange

17. One mole of an ideal monatomic gas is heated at a constant pressure of one atmosphere from $0^{o}C$ to $100^{o}C$. Then the change in the internal energy is

(A) 6.56 *joules*
(B) 8.32×10^{2} *joules*
(C) 12.48×10^{2} *joules*
(D) 20.80 *joules*

18. If the ratio of specific heat of a gas at constant pressure to that at constant volume is γ, the change in internal energy of a mass of gas, when the volume changes from *V* to 2V constant pressure *p*, is

(A) $R/(\gamma-1)$ (B) pV
(C) $pV/(\gamma-1)$ (D) $\gamma pV/(\gamma-1)$

19. If $C_V = 4.96 cal/mole\ K$, then increase in internal energy when temperature of 2 moles of this gas is increased from 340 *K* to 342 *K*

(A) 27.80 *cal* (B) 19.84 *cal*
(C) 13.90 *cal* (D) 9.92 *cal*

20. Temperature is a measurement of coldness or hotness of an object. This definition is based on

(A) Zeroth law of thermodynamics
(B) First law of thermodynamics
(C) Second law of thermodynamics
(D) Newton's law of cooling

Isothermal Process

21. For an isothermal expansion of a perfect gas, the value of $\frac{\Delta P}{P}$ is equal

(A) $-\gamma^{1/2}\frac{\Delta V}{V}$ (B) $-\frac{\Delta V}{V}$
(C) $-\gamma\frac{\Delta V}{V}$ (D) $-\gamma^{2}\frac{\Delta V}{V}$

22. The gas law $\frac{PV}{T}=$ constant is true for

(A) Isothermal changes only
(B) Adiabatic changes only
(C) Both isothermal and adiabatic changes
(D) Neither isothermal nor adiabatic changes

23. One mole of O_2 gas having a volume equal to 22.4 *litres* at $0^{o}C$ and 1 atmospheric pressure in compressed isothermally so that its volume reduces to 11.2 *litres*. The work done in this process is

(A) 1672.5 J (B) 1728 *J*

(C) −1728J (D) −1572.5 J

24. If a gas is heated at constant pressure, its isothermal compressibility

(A) Remains constant

(B) Increases linearly with temperature

(C) Decreases linearly with temperature

(D) Decreases inversely with temperature

25. Work done per mol in an isothermal change is

(A) $RT\log_{10}\frac{V_2}{V_1}$ (B) $RT\log_{10}\frac{V_1}{V_2}$

(C) $RT\log_e\frac{V_2}{V_1}$ (D) $RT\log_e\frac{V_1}{V_2}$

26. The isothermal Bulk modulus of an ideal gas at pressure *P* is

(A) P (B) γP

(C) $P/2$ (D) P/γ

27. In isothermal expansion, the pressure is determined by

(A) Temperature only

(B) Compressibility only

(C) Both temperature and compressibility

(D) None of these

28. The isothermal bulk modulus of a perfect gas at normal pressure is

(A) $1.013\times10^{5}\,N/m^{2}$

(B) $1.013\times10^{6}\,N/m^{2}$

(C) $1.,013\times10^{-11}\,N/m^{2}$

(D) $1.013\times10^{11}\,N/m^{2}$

29. In an isothermal change, an ideal gas obeys

(A) Boyle's law

(B) Charle's law

(C) Gaylussac law

(D) None of the above

30. In isothermic process, which statement is wrong

(A) Temperature is constant

(B) Internal energy is constant

(C) No exchange of energy

(D) (A) and (B) are correct

31. A thermodynamic process in which temperature *T* of the system remains constant though other variable *P* and *V* may change, is called

(A) Isochoric process

(B) Isothermal process

(C) Isobaric process

(D) None of these

32. If an ideal gas is compressed isothermally then

(A) No work is done against gas

(B) Heat is released by the gas

(C) The internal energy of gas will increase

(D) Pressure does not change

33. When an ideal gas in a cylinder was compressed isothermally by a piston, the work done on the gas was found to be 1.5×10^{4} joules. During this process about

(A) 3.6×10^{3} *cal* of heat flowed out from the gas

(B) 3.6×10^{3} *cal* of heat flowed into the gas

(C) 1.5×10^{4} *cal* of heat flowed into the gas

(D) 1.5×10^{4} *cal* of heat flowed out from the gas

34. When heat is given to a gas in an isothermal change, the result will be

(A) External work done

(B) Rise in temperature

(C) Increase in internal energy

(D) External work done and also rise in temp.

35. When 1 *gm* of water at $0^{o}C$ and $1\times10^{5}\ N/m^{2}$ pressure is converted into ice of volume $1.091\,cm^{2}$, the external work done will be

(A) 0.0091 *joule* (B) 0.0182 *joule*

(C) – 0.0091 *joule* (D) – 0.0182 *joule*

36. The latent heat of vaporisation of water is 2240 *J/gm*. If the work done in the process of expansion of 1 *g* is 168 *J*, then increase in internal energy is

(A) 2408 *J* (B) 2240 *J*

(C) 2072 *J* (D) 1904 *J*

37. 540 *calories* of heat convert 1 cubic centimeter of water at $100^{o}C$ into 1671 cubic centimeter of steam at $100^{o}C$ at a pressure of one atmosphere. Then the work done against the atmospheric pressure is nearly

(A) 540 *cal* (B) 40 *cal*

(C) Zero *cal* (D) 500 *cal*

38. One mole of an ideal gas expands at a constant temperature of 300 *K* from an initial volume of 10 *litres* to a final volume of 20 *litres*. The work done in expanding the gas is

(R = 8.31 *J/mole-K*)

(A) 750 *joules* (B) 1728 *joules*

(C) 1500 *joules* (D) 3456 *joules*

39. A cylinder fitted with a piston contains 0.2 *moles* of air at temperature 27°*C*. The piston is pushed so slowly that the air within the cylinder remains in thermal equilibrium with the surroundings. Find the approximate work done by the system if the final volume is twice the initial volume

(A) 543 *J* (B) 345 *J*

(C) 453 *J* (D) 600 *J*

40. The volume of an ideal gas is 1 litre and its pressure is equal to 72*cm* of mercury column. The volume of gas is made 900 cm^3 by compressing it isothermally. The stress of the gas will be

(A) 8 *cm* (mercury) (B) 7 *cm* (mercury)

(C) 6 *cm* (mercury) (D) 4 *cm* (mercury)

Adiabatic Process

41. The slopes of isothermal and adiabatic curves are related as

(A) Isothermal curve slope = adiabatic curve slope

(B) Isothermal curve slope = $\gamma\times$ adiabatic curve slope

(C) Adiabatic curve slope = $\gamma\times$ isothermal curve slope

(D) Adiabatic curve slope = $\frac{1}{2}\times$ isothermal curve slope

42. Pressure-temperature relationship for an ideal gas undergoing adiabatic change is $(\gamma = C_p / C_v)$

(A) PT^{γ} = constant

(B) $PT^{-1+\gamma}$ = constant

(C) $P^{\gamma-1}T^{\gamma}$ = constant

(D) $P^{1-\gamma}T^{\gamma}$ = constant

43. The amount of work done in an adiabatic expansion from temperature T to T_1 is

(A) $R(T-T_1)$

(B) $\frac{R}{\gamma-1}(T-T_1)$

(C) RT

(D) $R(T-T_1)(\gamma-1)$

44. During the adiabatic expansion of 2 moles of a gas, the internal energy of the gas is found to decrease by 2 *joules*, the work done during the process on the gas will be equal to

(A) 1 *J* (B) -1 J

(C) 2 *J* (D) -2 *J*

45. The adiabatic elasticity of hydrogen gas $(\gamma = 1.4)$ at NTP is

(A) $1\times10^5\ N/m^2$

(B) $1\times10^{-8}\ N/m2$

(C) $1.4\ N/m^2$

(D) $1.4\times10^5\ N/m^2$

46. If γ denotes the ratio of two specific heats of a gas, the ratio of slopes of adiabatic and isothermal *PV* curves at their point of intersection is

(A) $1/\gamma$ (B) γ

(C) $\gamma - 1$ (D) $\gamma + 1$

47. Air in a cylinder is suddenly compressed by a piston, which is then maintained at the same position. With the passage of

(A) The pressure decreases

(B) The pressure increases

(C) The pressure remains the same

(D) The pressure may increase or decrease depending upon the nature of the gas

48. When a gas expands adiabatically

(A) No energy is required for expansion

(B) Energy is required and it comes from the wall of the container of the gas

(C) Internal energy of the gas is used in doing work

(D) Law of conservation of energy does not hold

49. One *gm* mol of a diatomic gas $(\gamma = 1.4)$ is compressed adiabatically so that its temperature rises from $27^{\circ}C$ to $127^{\circ}C$. The work done will be

(A) 2077.5 *joules*

(B) 207.5 *joules*

(C) 207.5 *ergs*

(D) None of the above

50. Compressed air in the tube of a wheel of a cycle at normal temperature suddenly starts coming out from a puncture. The air inside

(A) Starts becoming hotter

(B) Remains at the same temperature

(C) Starts becoming cooler

(D) May become hotter or cooler depending upon the amount of water vapour present

51. One mole of helium is adiabatically expanded from its initial state (P_i, V_i, T_i) to its final state (P_f, V_f, T_f). The decrease in the internal energy associated with this expansion is equal to

(A) $C_V(T_i - T_f)$

(B) $C_P(T_i - T_f)$

(C) $\frac{1}{2}(C_P + C_V)(Ti - T_f)$

(D) $(C_P - C_V)(T_i - T_f)$

52. At N.T.P. one mole of diatomic gas is compressed adiabatically to half of its volume $\gamma = 1.41$. The work done on gas will be

(A) 1280 *J* (B) 1610 *J*

(C) 1815 *J* (D) 2025 *J*

53. For adiabatic process, wrong statement is

(A) $dQ = 0$

(B) $dU = -dW$

(C) *Q* = constant

(D) Entropy is not constant

54. A diatomic gas initially at $18°C$ is compressed adiabatically to one-eighth of its original volume. The temperature after compression will be

(A) $10^{o}C$ (B) $887^{o}C$

(C) 668K (D) $144^{o}C$

55. A gas is being compressed adiabatically. The specific heat of the gas during compression is

(A) Zero (B) Infinite

(C) Finite but non-zero (D) Undefined

56. The process in which no heat enters or leaves the system is termed as

(A) Isochoric (B) Isobaric

(C) Isothermal (D) Adiabatic

57. Two moles of an ideal monatomic gas at $27^{o}C$ occupies a volume of V. If the gas is expanded adiabatically to the volume $2V$, then the work done by the gas will be $[\gamma = 5/3, R = 8.31 J/mol K]$

(A) $-2767.23J$ (B) $2767.23J$

(C) $2500J$ (D) $-2500J$

58. At $27^{o}C$ a gas is suddenly compressed such that its pressure becomes $\frac{1}{8}$th of original pressure. Temperature of the gas will be $(\gamma = 5/3)$

(A) $420K$ (B) $327^{o}C$

(C) $300K$ (D) $-142^{o}C$

59. $\Delta U + \Delta W = 0$ is valid for

(A) Adiabatic process

(B) Isothermal process

(C) Isobaric process

(D) Isochoric process

60. An ideal gas at a pressures of 1 atmosphere and temperature of $27^{o}C$ is compressed adiabatically until its pressure becomes 8 times the initial pressure, then the final temperature is $(\gamma = 3/2)$

(A) $627^{o}C$ (B) $527^{o}C$

(C) $427^{o}C$ (D) $327^{o}C$

61. One mole of an ideal gas at an initial temperature of T K does 6 R joules of work adiabatically. If the ratio of specific heats of this gas at constant pressure and at constant volume is 5/3, the final temperature of gas will be

(A) $(T + 2.4)K$ (B) $(T - 2.4)K$

(C) $(T + 4)K$ (D) $(T - 4)K$

62. A gas is suddenly compressed to 1/4 th of its original volume at normal temperature. The increase in its temperature is $(\gamma = 1.5)$

(A) 273 K (B) 573 K

(C) 373 K (D) 473 K

63. A gas $(\gamma = 1.3)$ is enclosed in an insulated vessel fitted with insulating piston at a pressure of $10^{5} N/m^{2}$. On suddenly pressing the piston the volume is reduced to half the initial volume. The final pressure of the gas is

(A) $2^{0.7} \times 10^{5}$ (B) $2^{1.3} \times 10^{5}$

(C) $2^{1.4} \times 10^{5}$ (D) None of these

64. The internal energy of the gas increases In

(A) Adiabatic expansion

(B) Adiabatic compression

(C) Isothermal expansion

(D) Isothermal compression

65. We consider a thermodynamic system. If ΔU represents the increase in its internal energy and W the work done by the system, which of the following statements is true

(A) $\Delta U = -W$ in an adiabatic process

(B) $\Delta U = W$ in an isothermal process

(C) $\Delta U = -W$ in an isothermal process

(D) $\Delta U = W$ in an adiabatic process

Isobaric and Isochoric Processes

66. Work done by 0.1 mole of a gas at $27°C$ to double its volume at constant pressure is $(R = 2\ cal\ mol^{-1}\ {}^{o}C^{-1})$

(A) 54 *cal* (B) 600 *cal*

(C) 60 *cal* (D) 546 *cal*

67. Unit mass of a liquid with volume V_1 is completely changed into a gas of volume V_2 at a constant external pressure *P* and temperature *T*. If the latent heat of evaporation for the given mass is *L*, then the increase in the internal energy of the system is

(A) Zero (B) $P(V_2 - V_1)$

(C) $L - P(V_2 - V_1)$ (D) *L*

68. A gas expands $0.25 m^3$ at constant pressure $10^3 N/m^2$, the work done is

(A) 2.5 *ergs* (B) 250 *J*

(C) 250 *W* (D) 250 *N*

69. Two kg of water is converted into steam by boiling at atmospheric pressure. The volume changes from $2 \times 10^{-3} m^3$ to $3.34 m^3$. The work done by the system is about

(A) – 340 *kJ* (B) – 170 *kJ*

(C) 170 *kJ* (D) 340 *kJ*

70. An ideal gas has volume V_0 at $27^o C$. It is heated at constant pressure so that its volume becomes $2V_0$. The final temperature is

(A) $54^o C$ (B) $32.6^o C$

(C) 327 °C (D) 150 *K*

71. If 300 *ml* of a gas at $27^o C$ is cooled to $7^o C$ at constant pressure, then its final volume will be

(A) 540 *ml* (B) 350 *ml*

(C) 280 *ml* (D) 135 *ml*

72. Which of the following is correct in terms of increasing work done for the same initial and final state

(A) Adiabatic < Isothermal < Isobaric

(B) Isobaric < Adiabatic < Isothermal

(C) Adiabatic < Isobaric < Isothermal

(D) None of these

73. A sample of gas expands from volume V_1 to V_2. The amount of work done by the gas is greatest when the expansion is

(A) Isothermal

(B) Isobaric

(C) Adiabatic

(D) Equal in all cases

74. Which of the following is a slow process

(A) Isothermal (B) Adiabatic

(C) Isobaric (D) None of these

75. How much work to be done in decreasing the volume of and ideal gas by an amount of $2.4 \times 10^{-4} m^3$ at normal temperature and constant normal pressure of $1 \times 10^5 N/m^2$

(A) 28 *joule* (B) 27 *joule*

(C) 25 *joule* (D) 24 *joule*

76. A Container having 1 mole of a gas at a temperature 27°*C* has a movable piston which maintains at constant pressure in container of 1 *atm*. The gas is compressed until temperature becomes 127°*C*. The work done is (C_p for gas is 7.03 *cal/mol⁻K*)

(A) 703 *J* (B) 814 *J*

(C) 121 *J* (D) 2035 *J*

77. In a reversible isochoric change

(A) $\Delta W = 0$ (B) $\Delta Q = 0$

(C) $\Delta T = 0$ (D) $\Delta U = 0$

78. Entropy of a thermodynamic system does not change when this system is used for

(A) Conduction of heat from a hot reservoir to a cold reservoir

(B) Conversion of heat into work isobarically

(C) Conversion of heat into internal energy isochorically

(D) Conversion of work into heat isochorically

79. The work done in which of the following processes is zero

(A) Isothermal process
(B) Adiabatic process
(C) Isochoric process
(D) None of these

80. In which thermodynamic process, volume remains same

(A) Isobaric (B) Isothermal
(C) Adiabatic (D) Isochoric

Heat Engine, Refrigerator and Second Law of Thermodynamics

81. For a reversible process, necessary condition is

(A) In the whole cycle of the system, the loss of any type of heat energy should be zero
(B) That the process should be too fast
(C) That the process should be slow so that the working substance should remain in thermal and mechanical equilibrium with the surroundings
(D) The loss of energy should be zero and it should be *quasistatic*

82. In a cyclic process, work done by the system is

(A) Zero
(B) Equal to heat given to the system
(C) More than the heat given to system
(D) Independent of heat given to the system

83. An ideal gas heat engine operates in a Carnot's cycle between $227^{o}C$ and $127^{o}C$. It absorbs 6×10^4 J at high temperature. The amount of heat converted into work is....

(A) 4.8×10^4 J (B) 3.5×10^4 J
(C) 1.6×10^4 J (D) 1.2×10^4 J

84. An ideal heat engine exhausting heat at $77\,^{o}C$ is to have a 30% efficiency. It must take heat at

(A) $127^{o}C$ (B) $227^{o}C$
(C) $327^{o}C$ (D) $673^{o}C$

85. Efficiency of Carnot engine is 100% if

(A) $T_2 = 273$ K (B) $T_2 = 0$ K
(C) $T_1 = 273$ K (D) $T_1 = 0$ K

86. A Carnot's engine used first an ideal monatomic gas then an ideal diatomic gas. If the source and sink temperature are $411^{o}C$ and $69^{o}C$ respectively and the engine extracts 1000 J of heat in each cycle, then area enclosed by the PV diagram is

(A) 100 J (B) 300 J
(C) 500 J (D) 700 J

87. A Carnot engine absorbs an amount Q of heat from a reservoir at an absolute temperature T and rejects heat to a sink at a temperature of $T/3$. The amount of heat rejected is

(A) $Q/4$ (B) $Q/3$
(C) $Q/2$ (D) $2Q/3$

88. The temperature of sink of Carnot engine is $27^{o}C$. Efficiency of engine is 25%. Then temperature of source is

(A) $227^{o}C$ (B) $327^{o}C$
(C) $127^{o}C$ (D) $27^{o}C$

89. The temperature of reservoir of Carnot's engine operating with an efficiency of 70% is 1000K. The temperature of its sink is

(A) 300 K (B) 400 K
(C) 500 K (D) 700 K

90. In a Carnot engine, when $T_2 = 0^\circ C$ and $T_1 = 200^\circ C$, its efficiency is η_1 and when $T_1 = 0^\circ C$ and $T_2 = -200^\circ C$, Its efficiency is η_2, then what is η_1 / η_2

(A) 0.577

(B) 0.733

(C) 0.638

(D) Can not be calculated

91. A Carnot's engine is made to work between 200°*C* and 0°*C* first and then between 0°*C* and –200°*C*. The ratio of efficiencies of the engine in the two cases is

(A) 1.73 : 1 (B) 1 : 1.73

(C) 1 : 1 (D) 1 : 2

92. Efficiency of a Carnot engine is 50% when temperature of outlet is 500 *K*. In order to increase efficiency up to 60% keeping temperature of intake the same what is temperature of outlet

(A) 200 *K* (B) 400 *K*

(C) 600 *K* (D) 800 *K*

93. Even Carnot engine cannot give 100% efficiency because we cannot

(A) Prevent radiation

(B) Find ideal sources

(C) Reach absolute zero temperature

(D) Eliminate friction

94. "Heat cannot by itself flow from a body at lower temperature to a body at higher temperature" is a statement or consequence of

(A) Second law of thermodynamics

(B) Conservation of momentum

(C) Conservation of mass

(D) First law of thermodynamics

95. A Carnot engine takes 3×10^6 cal. of heat from a reservoir at 627°*C*, and gives it to a sink at 27°*C*. The work done by the engine is

(A) 4.2×10^6 J (B) 8.4×10^6 J

(C) 16.8×10^6 J (D) Zero

96. The first operation involved in a Carnot cycle is

(A) Isothermal expansion

(B) Adiabatic expansion

(C) Isothermal compression

(D) Adiabatic compression

97. For which combination of working temperatures the efficiency of Carnot's engine is highest

(A) 80 *K*, 60 *K* (B) 100 *K*, 80 *K*

(C) 60 *K*, 40 *K* (D) 40 *K*, 20 *K*

98. The efficiency of Carnot engine when source temperature is T_1 and sink temperature is T_2 will be

(A) $\frac{T_1 - T_2}{T_1}$ (B) $\frac{T_2 - T_1}{T_2}$

(C) $\frac{T_1 - T_2}{T_2}$ (D) $\frac{T_1}{T_2}$

99. An ideal heat engine working between temperature T_1 and T_2 has an efficiency η, the new efficiency if both the source and sink temperature are doubled, will be

(A) $\frac{\eta}{2}$ (B) η

(C) 2η (D) 3η

100. An ideal refrigerator has a freezer at a temperature of $-13°C$. the coefficient of performance of the engine is 5. The temperature of the air (to which heat is rejected) will be

(A) 325°*C* (B) 325*K*

(C) 39°*C* (D) 320°*C*