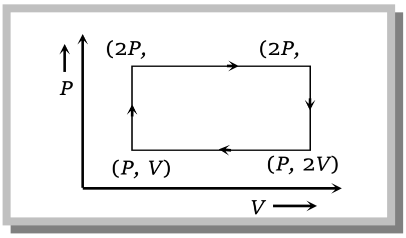
# Practice Problems

## *Problems based on $\Delta Q$, $\Delta U$ and $\Delta W$*

**1.** Work done in the given $P$-$V$ diagram in the cyclic process is




(a) $PV$

(b) $2PV$

(c) $PV/2$

(d) $3PV$

**2.** Which of the following is not a thermodynamics co-ordinate

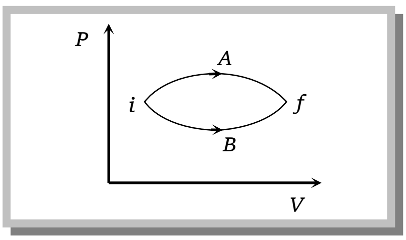
(a) $P$ (b) $T$ (c) $V$ (d) $R$

**3.** Which of the following can not determine the state of a thermodynamic system **[AFMC 2001]**

(a) Pressure and volume (b) Volume and temperature

(c) Temperature and pressure (d) Any one of pressure, volume or temperature

**4.** In the figure given two processes $A$ and $B$ are shown by which a thermo-dynamical system goes from initial to final state $F$. If $\Delta Q_A$ and $\Delta Q_B$ are respectively the heats supplied to the systems then



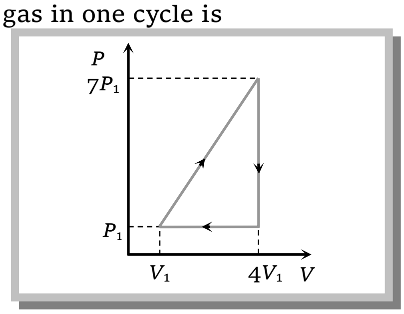

(a) $\Delta Q_A = \Delta Q_B$

(b) $\Delta Q_A \geq \Delta Q_B$

(c) $\Delta Q_A < \Delta Q_B$

(d) $\Delta Q_A > \Delta Q_B$

**5.** In the cyclic process shown in the figure, the work done by the gas in one cycle is




(a) $28\ p_1V_1$

(b) $14\ p_1V_1$

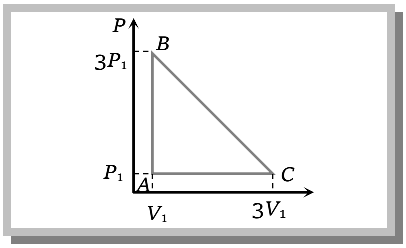
(c) $18\ p_1V_1$

(d) $9\ p_1V_1$

**6.** The internal energy of an ideal gas depends upon **[RPMT 1997; MP PMT 1999]**

(a) Specific volume (b) Pressure (c) Temperature (d) Density

**7.** An ideal gas is taken around the cycle $ABCA$ as shown in the $P$-$V$ diagram. The net work done by the gas during the cycle is equal to **[CPMT 1991]**




(a) $12\ P_1V_1$

(b) $6\ P_1V_1$

(c) $3\ P_1V_1$

(d) $P_1V_1$

**8.** The internal energy $U$ is a unique function of any state , because change in $U$ **[CPMT 1980]**

(a) Does not depend upon path (b) Depend upon the path

(c) Corresponds to an adiabatic process (d) Corresponds to an isothermal process

**9.** Which of the following statements is/are correct

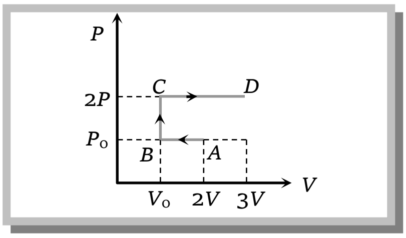
(a) Whenever heat is supplied to a gas, its internal energy increases

(b) Internal energy of a gas must increase when its temperature is increased

(c) Internal energy of a gas may be increased even if heat is not supplied to the gas

(d) Internal energy of a gas is proportional to square of the velocity of the vessel in which gas is contained

**10.** $P$-$V$ diagram of an ideal gas is as shown in figure. Work done by the gas in process $ABCD$ is




(a) $4\ P_0V_0$

(b) $2\ P_0V_0$

(c) $3\ P_0V_0$

(d) $P_0V_0$

## *Problems based on Joule's law*

**11.** In a water-fall the water falls from a height of 100 $m$. If the entire kinetic energy of water is converted into heat, the rise in temperature of water will be

(a) 0.23°$C$ (b) 0.46°$C$ (c) 2.3°$C$ (d) 0.023°$C$

**12.** A lead bullet of 10 $g$ travelling at 300 $m/s$ strikes against a block of wood and comes to rest. Assuming 50% of heat is absorbed by the bullet, the increase in its temperature is (specific heat of lead = 150$J/kg$, $K$)

(a) 100°$C$ (b) 125°$C$ (c) 150°$C$ (d) 200°$C$

**13.** The mechanical equivalent of heat $J$ is **[MP PET 2000]**

(a) A constant (b) A physical quantity (c) A conversion factor (d) None of these

**14.** The S.I. unit of mechanical equivalent of heat is **[MP PMT/PET 1998]**

(a) $Joule \times Calorie$ (b) $Joule\ /\ Calorie$ (c) $Calorie \times Erg$ (d) $Erg\ /\ Calorie$

**15.** A lead ball moving with a velocity $V$ strikes a wall and stops. If 50% of its energy is converted into heat, then what will be the increase in temperature (Specific heat of lead is $S$)

(a) $\frac{2V^2}{JS}$ (b) $\frac{V^2}{4JS}$ (c) $\frac{V^2S}{J}$ (d) $\frac{V^2S}{2J}$

**16.** A 10*kg* mass falls through 25 *m* on to the ground and bounces to a height of 0.50 *m*. Assume that all potential energy lost is used in heating up the mass. The temperature rise will be (Given specific heat of the material is 252 *Joule/kg K*) **[ISM Dhanbad 1994]**

(a) 0.95 *K* (b) 0.095 *K* (c) 0.0095 *K* (d) None of these

**17.** 4200 *J* of work is required for

(a) Increasing the temperature of 10 *gm* of water through 10°*C* (b) Increasing the temperature of 100 *gm* of water through 10°*C*

(c) Increasing the temperature of 1 *kg* of water through 10°*C* (d) Increasing the temperature of 10 *kg* of water through 10°*C*

## *Problems based on First law of thermodynamics*

### ▶ *Basic level*

**18.** First law of thermodynamics is a special case of **[CPMT 1985; RPET 2000; DCE 2000; CBSE PMT 2000; AIEEE 2002; AFM**

(a) Newton's law (b) Law of conservation of energy

(c) Charle's law (d) Law of heat exchange

**19.** If $\Delta Q > 0$ when heat flows into a system, $\Delta W > 0$ when work is done on the system, then the increase in the internal energy $\Delta U$ is

**[AMU (Med.) 2001]**

(a) $\Delta W + \Delta Q$ (b) $\Delta W - \Delta Q$ (c) $\Delta Q - \Delta W$ (d) $-(\Delta Q + \Delta W)$

**20.** In a given process on an ideal gas, $dW = 0$ and $dQ < 0$. Then for the gas **[IIT-JEE (Screening) 2001]**

(a) The temperature will decrease (b) The volume will increase

(c) The pressure will remain constant (d) The temperature will increase

**21.** If $\Delta Q$ and $\Delta W$ represent the heat supplied to the system and the work done on the system respectively, then the first law of thermodynamics can be written as (where $\Delta U$ is the internal energy)

(a) $\Delta Q = \Delta U + \Delta W$ (b) $\Delta Q = \Delta U - \Delta W$ (c) $\Delta Q = \Delta W - \Delta U$ (d) $\Delta Q = -\Delta W - \Delta U$

**22.** 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*

**23.** In a thermodynamic process pressure of a fixed mass of a gas is changed in such a manner that the gas releases 20 *joules* of heat and 8 *joules* of work was done on the gas. If the initial internal energy of the gas was 30 *joules*, then the final internal energy will be

**[CPMT 1986]**

(a) 2 *J* (b) 42 *J* (c) 18 *J* (d) 58 *J*

**24.** In a reversible isobaric heating of an ideal gas from state 1 to state 2, the equations for heat transfer and work are

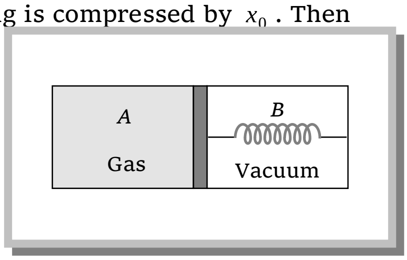
(a) $Q = C_P(T_2 - T_1), W = p(V_2 - V_1)$ (b) $Q = C_P(T_2 - T_1), W = 0$

(c) $Q = \int_1^2 C_P dT, W = 0$ (d) None of these

### ▶▶ *Advance level*

**25.** A thermally insulated chamber of volume $2V_0$ is divided by a frictionless piston of area *S* into two equal parts *A* and *B*. Part *A* has an ideal gas at pressure $P_0$ and temperature $T_0$ and in part *B* is vacuum. A massless spring of force constant *k* is connected with piston and the wall of the container as shown. Initially spring is unstretched. Gas in chamber *A* is allowed to expand. Let in equilibrium spring is compressed by $x_0$. Then

(a) Final pressure of the gas is $\frac{kx_0}{S}$



(b) Work done by the gas is $\frac{1}{2}kx_0^2$

(c) Change in internal energy of the gas is $\frac{1}{2}kx_0^2$

(d) Temperature of the gas is decreased

## *Problems based on* Isothermal process

**26.** Which is incorrect **[DCE 2001]**

(a) In an isobaric process, $\Delta P = 0$ (b) In an isochoric process, $\Delta W = 0$

(c) In an isothermal process, $\Delta T = 0$ (d) In an isothermal process, $\Delta Q = 0$

**27.** Consider the following statements

**Assertion** (*A*): The isothermal curves intersect each other at a certain point

**Reason (*R*)** : The isothermal changes take place slowly, so the isothermal curves have very little slope

Of these statements **[AIIMS 2001]**

(a) Both *A* and *R* are true and *R* is a correct explanation of *A*

(b) Both *A* and *R* are true but *R* is not a correct explanation of *A*

(c) *A* is true but *R* is false

(d) Both *A* and *R* are false

(e) *A* is false but *R* is true

**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.** When an ideal gas in a cylinder was compressed isothermally by a piston, the work done on the gas was found to be $1.5\times10^4 J$. During this process about

(a) $3.6\times10^3$ *calorie* of heat flowed out from the gas (b) $3.6\times10^3$ *calorie* of heat flowed into the gas

(c) $1.5\times10^4$ *calorie* of heat flowed into the gas (d) $1.5\times10^4$ *calorie* of heat flowed out from the gas

**30.** 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

**31.** *N moles* of an ideal diatomic gas are in a cylinder at temperature *T*. Suppose on supplying heat to the gas, its temperature remain constant but *n* moles get dissociated into atoms. Heat supplied to the gas is

(a) Zero (b) $\frac{1}{2}nRT$ (c) $\frac{3}{2}nRT$ (d) $\frac{3}{2}(N-n)RT$

## *Problems based on* Adiabatic process

**32.** The slopes of isothermal and adiabatic curves are related as

(a) Isothermal curve slope = Adiabatic curve slope (b) Isothermal curve slope = $\gamma$ × Adiabatic curve slope

(c) Adiabatic curve slope = $\gamma$ × Isothermal curve slope (d) Adiabatic curve slope = $\frac{1}{2}\times$ Isothermal curve slope

**33.** The work done in which of the following processes is equal to the change in internal energy of the system **[UPSEAT 20**

(a) Adiabatic process (b) Isothermal process (c) Isochoric process (d) None of these

**34.** In an adiabatic process, the state of a gas is changed from $P_1, V_1, T_1$ to $P_2, V_2, T_2$. Which of the following relation is correct

**[Orissa JEE 2003]**

(a) $T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$ (b) $P_1V_1^{\gamma-1} = P_2V_2^{\gamma-1}$ (c) $T_1P_1^{\gamma} = T_2P_2^{\gamma}$ (d) $T_1V_1^{\gamma} = T_2V_2^{\gamma}$

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

**[CPMT 1992; MP PMT 1986, 87, 94, 97; DCE 2001; UPSEAT 1999; 2001; AFMC 2002]**

(a) $PT^{\gamma}$ = constant (b) $PT^{-1+\gamma}$ = constant (c) $P^{\gamma-1}T^{\gamma}$ = constant (d) $P^{1-\gamma}T^{\gamma}$ = constant

**36.** A monoatomic gas ($\gamma$ = 5/3) is suddenly compressed to $\frac{1}{8}$ of its original volume adiabatically, then the pressure of the gas will change to **[CPMT 1976, 83; MP PMT 1994; Roorkee 2000; KCET (Engg./Med.) 2000; Pb. PMT 1999, 2001]**

(a) $\frac{24}{5}$ (b) $\frac{40}{3}$ (c) 8 (d) 32 times it's initial pressure

**37.** Consider the following statements

**Assertion** (*A*): In adiabatic compression, the internal energy and temperature of the system get decreased

**Reason (*R*)** : The adiabatic compression is a slow process

Of these statements **[AIIMS 2001]**

(a) Both *A* and *R* are true and *R* is a correct explanation of *A*

(b) Both *A* and *R* are true but *R* is not a correct explanation of *A*

(c) *A* is true but *R* is false

(d) Both *A* and *R* are false

(e) *A* is false but *R* is true

**38.** If $\gamma$ denotes the ratio of two specific heats of a gas, the ratio of slopes of adiabatic and isothermal *P-V* curves at their point of intersection is

(a) $1/\gamma$ (b) $\gamma$ (c) $\gamma - 1$ (d) $\gamma + 1$

**39.** During the adiabatic expansion of 2 *moles* of a gas, the internal energy was found to have decreased by 100 *J*. The work done by the gas in this process is

(a) Zero (b) – 100 *J* (c) 200 *J* (d) 100 *J*

**40.** For an adiabatic expansion of a perfect gas, the value of $\frac{\Delta P}{P}$ is equal to **[CPMT 1983; MP PMT 1990]**

(a) $-\sqrt{\gamma}\frac{\Delta V}{V}$ (b) $-\frac{\Delta V}{V}$ (c) $-\gamma\frac{\Delta V}{V}$ (d) $-\gamma^2\frac{\Delta V}{V}$

**41.** The pressure in the tyre of a car is four times the atmospheric pressure at 300 *K*. If this tyre suddenly bursts, its new temperature will be ($\gamma$ = 1.4)

(a) $300\,(4)^{1.4/0.4}$ (b) $300\left(\frac{1}{4}\right)^{-0.4/1.4}$ (c) $300\,(2)^{-0.4/1.4}$ (d) $300\,(4)^{-0.4/1.4}$

**42.** 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

**43.** The adiabatic elasticity of hydrogen gas ($\gamma$ = 1.4) at N.T.P. is

(a) $1\times10^5\ N/m^2$ (b) $1\times10^{-8}\ N/m^2$ (c) $1.4\ N/m^2$ (d) $1.4\times10^5\ N/m^2$

**44.** Two identical adiabatic vessels are filled with oxygen at pressure $P_1$ and $P_2$ $(P_1 > P_2)$. The vessels are interconnected with each other by a non-conducting pipe. If $U_{01}$ and $U_{02}$ denote initial internal energy of oxygen in first and second vessel respectively and $U_{f_1}$ and $U_{f_2}$ denote final internal energy values, then

(a) $\frac{U_{01}}{U_{02}} = \frac{P_1}{P_2}, U_{f_1} > U_{f_2}$ (b) $\frac{U_{01}}{U_{02}} = \frac{P_2}{P_1}, U_{f_1} > U_{f_2}$ (c) $\frac{U_{01}}{U_{02}} = \frac{P_2}{P_1}, U_{f_1} = U_{f_2}$ (d) $\frac{U_{01}}{U_{02}} = \frac{P_1}{P_2}, U_{f_1} = U_{f_2}$

**45.** The volume of a gas at two atmospheric pressure is 1 *litre*. Its volume is increased to 4.5 *litre* by adiabatic process, then the heat taken by the gas in calories in this process will be

(a) 840 (b) 84 (c) 8.4 (d) Zero

## *Problems based on* Isobaric process

**46.** In which process the *P-V* indicator diagram is a straight line parallel to volume axis **[KCET (Engg./Med.) 2000; CPMT 20**

(a) Irreversible (b) Adiabatic (c) Isothermal (d) Isobaric

**47.** When heat is given to a gas in an isobaric process, then

(a) The work is done by the gas (b) Internal energy of the gas increases

(c) Both (a) and (b) (d) None from (a) and (b)

**48.** The specific heat of hydrogen gas at constant pressure is $C_p = 3.4 \times 10^3\ cal/kg°C$ and at constant volume is $C_v = 2.4 \times 10^3\ cal/kg°C$. If one *kilogram* hydrogen gas is heated from 10°*C* to 20°*C* at constant pressure, the external work done on the gas to maintain it at constant pressure is

(a) $10^5$ *calories* (b) $10^4$ *calories* (c) $10^3$ *calories* (d) $5 \times 10^3$ *calories*

**49.** 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*

**50.** A vessel contains an ideal monoatomic gas which expands at constant pressure, when heat *Q* is supplied to it. Then work done by the gas in the expansion is

(a) *Q* (b) 3*Q*/5 (c) 2*Q*/5 (d) 2*Q*/3

**51.** 540 *calories* of heat convert 1 cubic centimeter of water at 100°*C* into 1671 cubic centimeter of steam at 100°*C* at a pressure of one atmosphere. Then the work done against the atmospheric pressure is nearly

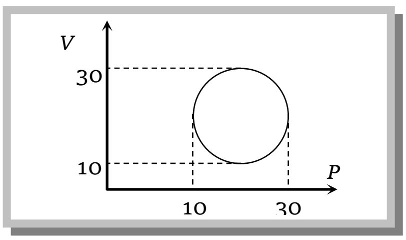
(a) 540 *cal* (b) 40 *cal* (c) Zero *cal* (d) 500 *cal*

**52.** When 1 *g* of water changes from liquid to vapour phase at constant pressure of 1 atmosphere, the volume increases from $1\ cm^3$ to 1671 *cc*. The heat of vaporisation at this pressure is 540 *cal*/*g*. The increase in internal energy of water

(a) 2099 *J* (b) 3000 *J* (c) 992 *J* (d) 2122 *J*

## *Problems based on* Cyclic and non-cyclic process

**53.** Heat energy absorbed by a system in going through a cyclic process shown in figure is




(a) $10^7\ \pi J$

(b) $10^4\ \pi J$

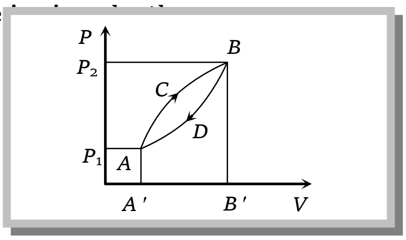
(c) $10^2 \pi J$

(d) $10^{-3}\ \pi J$

**54.** A system, after passing through different states returns back to its original state is

(a) Adiabatic process (b) Isobaric process (c) Isothermal process (d) Cyclic process

**55.** A thermodynamic system is taken from state *A* to *B* along *ACB* and is brought back to *A* along *BDA* as shown in the *PV* diagram. The net work done during the complete cycle



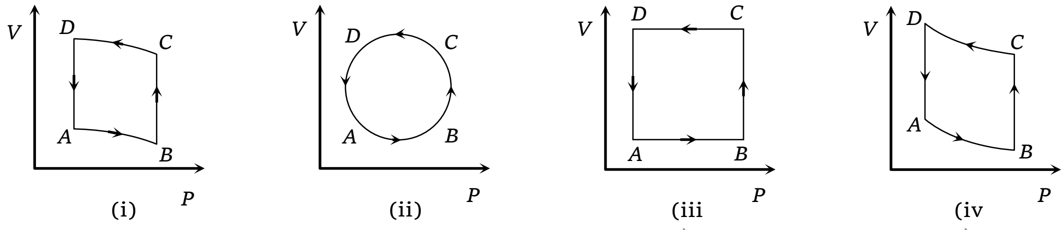

(a) $P_1ACBP_2P_1$

(b) *ACBB'A'A*

(c) *ACBDA*

(d) *ADBB'A'A*

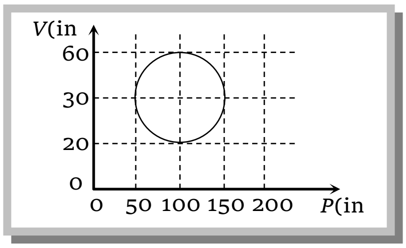
**56.** In the diagrams (i) to (iv) of variation of volume with changing pressure is shown. A gas is taken along the path *ABCD*. The change in internal energy of the gas will be




(a) Positive in all cases (i) to (iv) (b) Positive in cases (i), (ii) and (iii) but zero in (iv) case

(c) Negative in cases (i), (ii) and (iii) but zero in (iv) case (d) Zero in all four cases

**57.** A system is taken through a cyclic process represented by a circle as shown. The heat absorbed by the system is



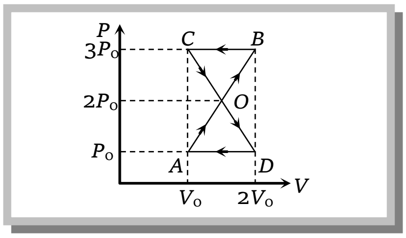

(a) $\pi \times 10^3 J$

(b) $\frac{\pi}{2} J$

(c) $4\pi \times 10^2 J$

(d) $\pi J$

**58.** A thermodynamic system undergoes cyclic process *ABCDA* as shown in figure. The work done by the system is




(a) $P_0V_0$

(b) $2P_0V_0$

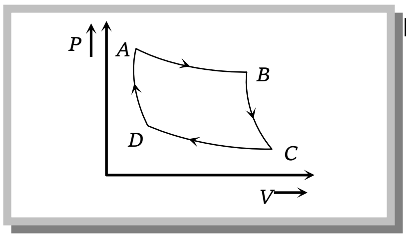
(c) $\frac{P_0V_0}{2}$

(d) Zero

## *Problems based on* Second law of thermodynamics

**59.** The *P-V* graph of an ideal gas cycle is shown here as below. The adiabatic process is described by

**[CPMT 1985; UPSEAT 2003]**




(a) *AB* and *BC*

(b) *AB* and *CD*

(c) *BC* and *DA*

(d) *BC* and *CD*

**60.** A measure of the degree of disorder of a system is known as

(a) Isobaric (b) Isotropy (c) Enthalpy (d) Entropy

**61.** The efficiency of Carnot engine operating with reservior temperature at 100 $K$ and –23 $K$ will be

(a) $\frac{100+23}{100}$ (b) $\frac{100-23}{100}$ (c) $\frac{100+23}{373}$ (d) $\frac{100-23}{373}$

**62.** Coefficient of performance of an ideal refrigerator working between temperature $T_1$ and $T_2$ ($T_1 > T_2$) is **[AFMC 1996]**

(a) $\beta = \frac{T_2}{T_1 - T_2}$ (b) $\beta = \frac{T_2}{T_1 + T_2}$ (c) $\beta = \frac{T_1}{T_1 - T_2}$ (d) $\beta = \frac{T_1}{T_1 + T_2}$

**63.** 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

**64.** The second law of thermodynamics states that

(a) Heat is neither created nor destroyed

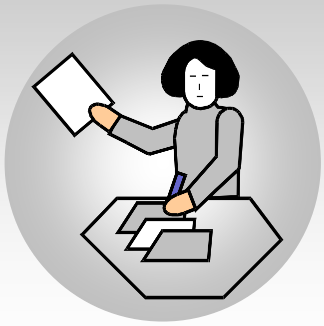
(b) Heat can be converted into other forms of energy

(c) Heat flows from a hot object to a cold one

(d) The mechanical equivalent of heat is the amount of energy that must be expended in order to produce heat

**65.** A Carnot engine works between ice point and steam point. Its efficiency will be

(a) 26.81% (b) 53.36% (c) 71.23% (d) 85.42%



# Answer Sheet (Practice problems)

| 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. |
|---|---|---|---|---|---|---|---|---|---|
| a | d | d | d | d | c | c | a | b, c | c |
| **11.** | **12.** | **13.** | **14.** | **15.** | **16.** | **17.** | **18.** | **19.** | **20.** |
| a | c | c | b | b | a | b | b | a | a |
| **21.** | **22.** | **23.** | **24.** | **25.** | **26.** | **27.** | **28.** | **29.** | **30.** |
| b | b | c | a | a, b, c, d | d | e | a | b | a |
| **31.** | **32.** | **33.** | **34.** | **35.** | **36.** | **37.** | **38.** | **39.** | **40.** |
| b | c | a | a | d | d | d | b | d | c |
| **41.** | **42.** | **43.** | **44.** | **45.** | **46.** | **47.** | **48.** | **49.** | **50.** |
| d | c | d | d | d | d | c | b | d | c |
| **51.** | **52.** | **53.** | **54.** | **55.** | **56.** | **57.** | **58.** | **59.** | **60.** |
| b | a | c | d | c | d | d | d | c | d |
| **61.** | **62.** | **63.** | **64.** | **65.** | | | | | |
| a | a | d | c | a | | | | | |