THERMODYNAMICS

CALORIMETRY

Calorimetry is the study of the measurement of quantities of heat

- **HEAT:**
  - It is the energy exhange between two systems due to the temperature difference.
  - S.I unit is joule
  - The C.G.S unit is calorie
  - The dimensional formula is $[ML^2T^{-2}]$
  - The amount of heat gained or lost depends upon the nature of material and its state.
  - The heat flows from higher temperature region to lower temperature region.
  - Calorie: It is the quantity of heat required to raise the temperature of 1g. of water from 14.5^0C to 15.5^0C.
  - 1calorie = 4.186J.
  - Heat is measured by using calorimeter
- **SPECIFIC HEAT:**
  - It is the amount of heat required to raise the temperature of 1g of a substance through 1^0C. $s=\frac{1}{m}\frac{\Delta Q}{\Delta T}$
  - The S.I unit is $Jkg^{-1}K^{-1}$
  - The C.G.S unit is $Cal.g^{-1}\,{}^0C^{-1}$
  - Dimensional formula is $L^2T^{-2}K^{-1}$

S.No.	Substance	CGS Value Specific heat	S.I Value Specifi heat
1.	Water	1 cal $g^{-1}\,{}^0C^{-1}$	4186 $JKg^{-1}K^{-1}$
2.	ice	0.5 cal $g^{-1}\,{}^0c^{-1}$	2100 $Jkg^{-1}k^{-1}$

- **HEATCAPACITY(OR) THERMAL CAPACITY:**
  - It is the amount of heat required to raise the temperature of the body by 1^0C

$$c=\frac{\Delta Q}{\Delta T}$$

  - The S.I.unit is JK^{-1}
  - The C.G.S unit is Cal $^oC^{-1}$
  - Dimensional formula : $ML^2T^{-2}K^{-1}$
  - Thermal capacity depends on mass and nature of substance.
- **WATER EQUIVALENT:**
  - Mass of water which has same thermal capacity as that of the substance is called water equivalent
  - It is numerically equal to heat capacity (ms)
  - The S.I unit is kg
  - The C.G.S unit is g
- **DULONG AND PETIT'S LAW :**
  The product of specific heat of an element in the solid state and its atomic weight is a constant and is approximately equal to 6.4 cal/gram atom / ^0C
- **CHANGE OF STATE:**
  - Matter exists in three states or phases such as solid, liquid and gas.
  - Matter can exist in all these three phases simultaneously at a particular pressure and temperature.
  - Melting of ice or vapourisation of water is an example for change of state. During change of state, temperature remains constant.
- **MELTING:**
  - Every solid melts at a definite temperature called melting point.
  - In case of substances which expand on freezing, the melting point is lowered due to increase of pressure.
    Ex: Ice, cast Iron, type metal etc.,
  - In case of substances which contract on freezing, the melting point rises due to increase of pressure.
    Ex: Brass, Cu.
  - Addition of impurities (or) presence of impurities generally reduces the melting point of a substance.
  - The freezing point, melting point and the boiling point of a substance depends onthe external pressure and on the purity of the substance.
  - The melting point of the substance which contracts on liquification decreases with increase of pressure. Ex: cast iron, ice and type metal. the lowering of melting point of ice is 0.0072^0C /atmosphere.
  - The melting point of those substances which expand on liquification increases with the increase of pressure.
    Ex: wax, gold, silver, copper etc
  - The melting of ice when pressure is appiled and resolidification on removal of pressure is called regelation.
  - Snow-ball preparation is due to regelation.
- **BOILING AND EVAPORATION:**
  - It is the change of state from liquid to vapour at a particular temperature.
  - Increase of pressure increases the boiling point of a liquid.
  - On mountains, it is difficult to cook food because with increase in height, pressure decreases and hence the boiling point of water decreases.
  - Boiling point of a liquid depends on nature of the liquid, applied pressure and presence of impurities.
  - the escape of molecules from the free

surface of a liquid is called evaporation

- Refrigerators, air coolers etc., work on the principle of cooling produced by evaporation.
- Body temperature is also controlled by evaporation of sweat
- Evaporation is a slow process where as boiling is a quick process
- Evaporation takes place at all temperatures where as boiling takes place at a particular temperature
- Evaporation takes place only at the surface of a liquid where as boiling occurs through out the liquid.
- The rate of evaporation depends on the nature of the liquid
- The rate of evaporation is more when the difference in temperatures of the liquid and the surrounding air is high

- **SUPER HEATING OF A LIQUID :**

A Liquid can be slowly heated beyond its boilingpoint.
In side a pressure cooker the boiling point of water is greater than 100^0C
water free from dust and air can
be heated up to 137^0C with out changing to the vapour state. Super-heated water is unstable. stirring or even a slight mechanical disturbance causes the water to boil immediately.

- **HOAR-FROST AND SUBLIMATION :-**

It is a process of conversion from gaseous state to solid state directly on cooling a material. The reverse process of the hoar -frost is sublimation.

- **LATENT HEAT :**

It is the amount of heat required to change unit mass of a substance from one state to another state without any change of temperature.

- **LATENT HEAT OF FUSION OF ICE:**
  - It is the amount of heat required to convert 1gram of ice at 0^0c to 1 gram of water at 0^0c.
  - The S.I value is $0.335X10^6$ J/kg
  - The C.G.S value is 80 cal/g

13. LATENT HEAT OF VAPOURISATION:

- It is the amount of heat required to convert 1gram of water at 100^oc to 1gram of steam at 100^0C.
- The S.I value is $2.26x10^6$ J/kg.
- The C.G.S value is 540 Cal/g
- Latent heat of vapourisation decreases with increase in temperature.
- Latent heat of a substance becomes zero at critical temperature..
- Latent heat depends on the nature of a substance and pressure.
- The product of the latent heat of fusion and the atomic weight of a substance is known as atomic latent heat.

- **LAW OF MIXTURES (OR) CALORIMETRY PRINICPLE:**
  - When three substances of different masses m_1, m_2 and m_3 specific heats s_1, s_2, s_3 and at different temperatures t_1, t_2, and t_3 respectively are mixed, then the resultant temperature is

$$t=\frac{m_1s_1t_1+m_2s_2t_2+m_3s_3t_3}{m_1s_1+m_2s_2+m_3s_3}$$

  - When ice at 0^0C and steam at 100^0C are mixed, mass of ice that melts is $m_{ice} = 8\, m_{steam}$
When "x" gram of steam is mixed with "y" gram of ice, the resultant temperature is

$$t=\frac{80(8x-y)}{(x+y)}$$

  - When ice and water are mixed the mass of ice that just melts is

$$m_{ice}=\frac{ms\theta}{80}$$

Where m= mass of water.

  - When ice and steam are mixed, the amount of steam that just condenses into water at 100^0C.

$$m_{steam}=\frac{m_{ice}}{3}$$

  - When ice at 0^0C and steam at 100^0C are mixed then resultant temperature must be between 0^0C and 100^0C. The resultant temperature cannot be less than 0^0C or more than 100^0C.
  - Steam is used in heat engines as working substance because of its high latent heat.
  - Heavy water is used as coolant in nuclear reactors because of its high specific heat.
  - In extinguishing fire hot water is preferred than cold water since hot water becomes vapour quickly and vapours do not allow fire.
  - Inside a deep mine boiling point of water is greater than 100^0C.
  - Steam at 100^0C produces more severe burns than water at 100^0C as steam gives out more heat due to its latent heat.

- **CALORIFIC VAULE :**

Calorific value of a fuel is the quantity of heat liberated when one gram of the fuel is burnt completely.
unit: cal/g or J/kg
It can be determined by using Bomb Calorimeter or Bell Calorimeter
Note : Calorific value of a food stuff is the quantity of heat liberated when a unit mass

of the food stuff is completely utilised by the body.

- **THERMODYNAMICS:** It is the branch of physics that deals with the conversion of heat into other forms of energy.
- **SYSTEM:**
  - A particular portion of matter or a restricted region of space under investigation is called system.
  - If the state of a system is represented by pressure (P), volume (V), temperature (T) and Entropy (S) then it is called a thermodynamic system.
- **TYPES OF SYSTEMS:**
  - Open system: It is the system in which both heat and matter can be exchanged with surroundings.
    Ex: Plants, Animals etc.,
  - Closed system: It is the system in which only heat is exchanged with the surroundings.
    Ex: An electric vapour lamp.
  - Isolated system: It is the system in which neither heat nor matter is exchanged with surroundings.
    Ex: Thermos Flask.
- **THERMAL EQUILIBRIUM:** If two bodies are at the same temperature then they are said to be in thermal equilibrium. When bodies are in equilibrium, no exchange of heat takes place
- **ZEROTH LAW OF THERMODYNAMICS:** If two bodies A and B are in thermal equilibrium with a third body C then the bodies A and B will also be in thermal equilibrium with each other. Zeroth law gives the concept of temperature.
- **INTERNAL WORK:** It is the work done by one part of a system on its another parts. Example: work done by a gaseous system against intermolecular forces.
- **EXTERNAL WORK:** When work is done by the system or on the system by the surroundings then it is called external work.
- **WORKDONE BY A GAS DURING EXPANSION:**
  - When a gas expands at constant pressure then for a small change in volume dv workdone is dw=pdv
  - If the volume changes from v_1 to v_2 at constant pressure p, the work done is $w=p(v_2-v_1)$
- **SIGN CONVENTION:**
  - If the work is done by the system , then work done is (+) ve.
    $(\therefore dv > 0, w > o)$
  - If work is done by the system, heat is released and the temperature of the system decreases.
  - If the work is done on the system, then it is (-) ve.
    $(\therefore dv < o, w < o)$
  - If work is done on the system then heat is absorbed and consequently the temperature of the system increases.
  - When work is done by the system against external pressure then dw=pdv

$$w = \int_{v_1}^{v_2} p \, dv$$

  - Area under p-v graph is equal to the work done
- **INTERNAL ENERGY:** It is the energy possessed by the system due to molecular motion and molecular configuration. Internal energy of a system is a thermodynamic function. It is of two types.
  - Internal Potential Energy: It is the energy present in a system on account of its molecular configuration is called internal potential energy.
  - Internal Kinetic Energy: It is the energy present in a system on account of motion of its molecules is defined as internal kinetic energy.
    - Change in internal engery
      $\Delta U = \Delta U_K + \Delta U_P$
    - The change in internal energy depends upon the initial and final states only.
      $\Delta U = U_{final} - U_{initial}$
    - For an ideal gas since there are no intermolecular forces of attraction there is no potential energy. For such a gas the internal kinetic energy depends only on temperature.
    - Internal energy of real gases depends upon temperature and volume.
    - Change in internal energy is zero in a cyclic process.
    - Real gases consist of both kinetic energy and potential energy due to intermoleculer forces.

  Ex: If a fan is turned on in a closed room then the temperature of the room increases because the molecular speeds increases.
- **FIRST LAW OF THERMODYNAMICS:**
  - All the heat added to a system is partly utilised to do the mechanical work and remaining to increase its internal energy.
  - The differential form of first law of thermodynamics is
    dQ=dU+dW, where
    dQ = heat added,
    dU = Increase in internal energy.
    dW= work done

- It defines the property of system called internal energy.
- It is a consequence of law of conservation of energy.

- **SIGN CONVENTIONS:**
  - When heat is added to the system dQ is + ve(+dQ)
  - When heat is taken from the system dQ is -ve (-dQ)
  - When gas expands work is done by the gas dw is positive (+ dW)
  - When gas contaracts work is done on the gas dw is negative.(-dW)
  - When internal energy of system increases and dU is +ve (+dU)
  - When internal energy of system decreases and dU is -ve(-dU)

- **RELATION BETWEEN WORK AND HEAT (JOULE'SLAW):** The amount of heat poduced is directly proportional to the amount of work done.

  $H \alpha W$ or W=JH.

  J= $\frac{W}{H}$ where J= Mechanical equivalent of heat.

- **MECHANICAL EQUIVALENT OF HEAT (J):**
  - It is the amount of work necessary to produce unit amount of heat engegy.
  - J is not a constant or physical quantity. It is simply a conversion factor which is used to convert joule or erg into calorie or kilocalorie.

- **VALUES OF 'J':**
  - J = 4.186 J/cal =4.186X10 ^{7} erg/cal =4186 J/K.cal
  - When heat and work are in Joule then J = 1
  - The height from which ice is to be dropped to melt it completely is

    h= $\frac{JL}{g}$

    where L= Latent heat of ice.
  - The rise in temperature of water when it falls from a height h to the ground is,

    $$\Delta\theta = \frac{gh}{Js}$$

    where 's' is specific heat of water
  - When a body of mass m moving with a velocity v is stopped and all of its energy is retained by it , then the increase in temperature is.

    $$\Delta\theta = \frac{v^2}{2Js}$$

  - When a block of ice of mass M is dragged with constant velocity on a rough horizontal surface of coefficient of friction μ , through a distance d, then the mass of ice melted is,

    $$m = \frac{\mu Mgd}{JL}$$

    Where m=mass of ice melted.
  - When a block of mass m is dragged on a rough horizontal surface of coefficient of friction μ , then the rise in temparature of block is,

    $$\Delta\theta = \frac{\mu gd}{Js}$$

  - If a bullet just melts when stopped by an obstacle and if all the heat produced is absorbed by the bullet then

    $$ms\Delta\theta + mL = \frac{1}{2}\ \frac{mv^2}{J}$$

    Where L= Latent heat of the material of the bullet
    s= Specific heat
  - A metal ball falls from a height 'h_1' and bounces to height 'h_2'. The rise in temperature of the ball is

    $$\Delta\theta = \frac{g(h_1 - h_2)}{Jc}$$

- **JOULE'S LAW 0R MAYER'S HYPOTHESIS:** It states that there is no change in internal energy during the free expansion of gas.

- **SPECIFIC HEAT OF GASES:**
  - A gas will have two specific heats.
    a) Specific heat at constant volume (c_v)
    b) Specific heat at constant pressure(c_p)
  - Specific heat depends only on the nature of material and temperature
  - Water has largest specific heat among solids and liquids.
  - Among solids, liquids, and gases specific heat is maximum for Hydrogen.
  - Specific heat slightly increases with increase of temprature.
  - In liquids specific heat is minimum for Mercury.
  - The value of specific heat may lie between 0 and ∞.
  - In isothermal process, the value of specific heat is ∞ but in adiabatic process its value is zero.
  - Specific heat of water is maxium at 15^0c and minimum at 37^0c.
  - Specific heat of all substances is zero at 0K.
  - Substances with highest specific heat are bad conductors of heat and with low specific heat are good thermal and electrical conductors.
  - The substance with large specific heat

warms up slowly and cools down slowly.

- C_p is greater than C_V and,

$\frac{C_p}{C_v} = \gamma$ (C_p, C_V are molar specific heats)

- $C_p - C_V = R$ (for 1 mole of gas) where R is universal gas constant
R= 8.3 J/ mol-K
- $C_p - C_v = r$ (for 1 gm of gas)
Where r is specific gas constant

$C_p - C_v = \frac{R}{J}$ (In heat units).

- **Cv, Cp AND VALUES OF DIFFERENT GASES:**

S.No.	Nature of gas	C_p	C_v	$\gamma = \frac{c_p}{c_v}$
1.	Monoatomic	$\frac{5}{2}R$	$\frac{3}{2}R$	$\frac{5}{3} = 1.67$
2.	Diatomic	$\frac{7}{2}R$	$\frac{5}{2}R$	$\frac{7}{5} = 1.4$
3.	Tri (or) Polyatomic	4R	3R	$\frac{4}{3} = 1.33$

γ value is always greater than one.It depends upon the atomicity of a gas. It decreases with increase in atomicity.

$$C_p = \gamma \frac{R}{\gamma - 1} \text{ and } \quad C_v = \frac{R}{\gamma - 1}$$

- **γ OF MIXTURE OF GASES:** When n_1 moles of a gas with specific heat at constant volume C_{V1} is mixed with n_2 moles of another gas of specific heat at constant volume C_{v2} then

$$(C_v)_{\text{mixture}} = \frac{n_1 c_{v1} + n_2 c_{v2}}{n_1 + n_2}$$

$$(C_p)_{\text{mixture}} = (C_v)_{\text{mixture}} + R$$

$$\gamma_{\text{mixture}} = \frac{C_{p(\text{mixture})}}{C_{v(\text{mixture})}}$$

Fraction of heat absorbed that is converted into internal energy is $\frac{dU}{dQ} = \frac{C_v}{C_p} = \frac{1}{\gamma}$

Fraction of heat absorbed that is converted into workdone= $\frac{dW}{dQ} = \frac{R}{C_p} = 1 - \frac{1}{\gamma}$

- **ISOTHERMAL PROCESS:**
  - In this process, the pressure and volume of gas changes but temperature remains constant.
  - The system is in thermal equilibrium with the surroundings.
  - It is a slow process.
  - The internal energy of the system remains constant i.e., du=0
  - It obeys the Boyle's law i.e. PV=k
  - The workdone during the isothermal expansion at constant temperature is

$$W = 2.303 RT \log_{10}\left(\frac{V_2}{V_1}\right)$$

$$= 2.303\, RT\log_{10}\left(\frac{p_1}{p_2}\right)$$

  - The isothermal elasticity

$$= -\frac{dp}{dv/v} = p\,.$$

The -ve sign represents, as pressure increases volume decreases.

  - It takes place in a conducting vessel.

- **ADIABATIC PROCESS:**
  - The pressure, volume and temperature of a gas change but total heat remains constant i.e., dQ=0 (Q=constant).
  - It is a quick process.
  - The internal energy changes as temperature changes.
  - The adiabatic process is represented by the equations.

PV^{γ} = constant

$TV^{\gamma-1}$ constant

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

- The workdone by the system during the adiabatic expansion is

$$w = \frac{R}{\gamma - 1}(T_1 - T_2) = nC_v(T_1 - T_2)$$

$$= n\frac{c_p}{\gamma}(T_1 - T_2) \qquad = \frac{p_2 v_2 - p_1 v_1}{\gamma - 1}$$

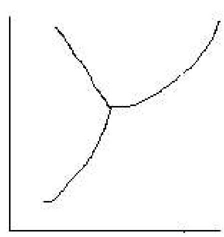
  - The adiabatic elasticity of gas is γ p.
  - The slope of adiabatic curve is γ times greater than the isothermal curve.
  - It takes place in a non conducting vessel.
  - Adiabatic expansion causes cooling and contraction causes heating.
  - If two samples of gases are compressed so that their pressures have the same increase, one sample isothermally and the other adia-batically, final volume is more in adiabatic change. If their pressures decrease by the same factor the final volume is more in Isothermal change.

- **ISOCHORIC PROCESS:**
  - It is a process in which the volume of the system remains constant.
    i.e., ΔV =0 for such process ΔW =0
  - In this process, the increase in internal energy is maximum where as the work done is zero.
- **ISOBARIC PROCESS:** It is a process in which the pressure of the system remains constant. i.e., Δ p=o
- **THE EQUATION OF STATE FOR DIFFERENT TYPES OF PROCESSES:**

Sl. No.	Name of the process	Quantity remains constant	Quantity which becomes Zero	Result in I law
1.	Isother-mal	Tempera-ture	dU	dQ=dW
2.	Isobaric	Pressue	None	dQ=du+dW
3.	Isochoric	volume	dW	dQ=dU
4.	Adiabatic	heat energy	dQ	dU=-dW

Work done is maximum during isobaric process and minimum in adiabatic process.

- **TRIPLE POINT:**
  - The tempertature and pressure where solid, liquid and vapour states are co-exist is called triple point.
  - The triple point of water is 273.16K (0.00750^0c) and pressure 613.10 Pa. (0.0459 cm of Hg)



  - A graph drawn between the pressure and temperature representing the different states of matter is called the phase diagram.
  - OA is the steam line and along this line water and steam are in equilibrium state.
  - Above the line water exists and below steam exists.
  - The curve has positive slope showing the boiling point increases with pressure.
  - OB is called Hoar-frost line. Along this line ice and vapour coexist.
  - OB has positive slope.
  - OC is called ice line, along this line water and ice are in equilibrium.
  - Above the ice line water exists.The curve has negative slope showing the melting point decreases with increase of the pressure.
- **SECOND LAW OF THERMODYNAMICS:**
  - Claussius statement: It is impossible for a self acting machine unaided by any external agency to transfer heat from a cold reservior to a hot reservior. In other words heat can't by itself flow from a colder to a hotter body.
  - Kelvin-Planck Statement: It is impossible for an engine working during a cyclic process to extract heat from a reservoir and convert completely into work. In other words 100% conversion of heat into work is impossible.

CONCEPTUAL QUESTIONS

1. System A is in thermal equilibrium with B and B is separately in thermal equilibrium with C. Then A and C are in thermal equilibrium, from which law of thermo dynamics it follows?
   1. Zeroth 2. First 3. Second 4. Third
2. Zeroth law of thermodynamics gives the concept of
   1. Pressure 2. Volume
   3. Temperature 4. Heat
3. Thermodynamic system returns to its original state, which of the following is NOT possible?
   1. The work done is Zero
   2. The work done is positive
   3. The work done is negative
   4. The work done is independent of the path followed
4. When we switch on the fan in a closed room. The temperature of the air molecules
   1. Increase 2. Decrease
   3. Remains Unchanged
   4. May increase or decrease depending on the speed of rotation of the fan.
5. The work done by a thermodynamic system depends upon
   1. The initial and final states of the system
   2. Path along which work is done
   3. Only on the initial state of the system
   4. Only on the final state
6. Which type of molecular motion does not contribute towards internal energy ?
   1. Translational 2. Rotational
   3. Vibrational 4. All the above
7. In which of the process the internal energy of the system remains constant ?
   1. Adiabatic 2. Isochoric
   3. Isobaric 4. Isothermal
8. The internal energy of a perfect gas is independent of
   1. Pressure 2. Temperature
   3. Volume 4. Specific heat

9. The internal energy of a perfect gas is
1. Complete kinetic
2. Complete potential
3. Sum of potential and kinetic energy of the molecules
4. Difference of kinetic and potential energies of the molecules

10. The internal energy of a real gas is independent of
1. pressure 2. temperature
3. volume 4. latent heat

11. How does the internal energy change when the ice and wax melt at their normal melting points?
1. Increases for ice, decreases for wax
2. Decreases for ice and increases for wax
3. Decreases both for ice and wax
4. Increases both for ice and wax

12. Internal energy per mole of gas depends on
1. viscosity 2. density
3. temperature 4. thermal conductivity

13. In the free expansion of a gas, its internal energy
1. remains constant 2. increases
3. decreases
4. sometimes increases , sometimes decreases

14. The internal energy of an ideal gas depends upon
1. only its pressure 2. only its volume
3. only its temperature
4. its pressure and volume

15. Heat is
1. kinetic energy of molecules
2. potential and kinetic energy of molecules
3. Energy in transit
4. work done on the system

16. The temperature determines the direction of net change of
1. gross kinetic energy
2. intermolecular kinetic energy
3. gross potential energy
4. intermolecular potential energy

17. The thermal motion means
1. motion due to heat engine
2. disorderly motion of the body as a whole
3. motion of the body that generates heat
4. random motion of molecules

18. Heat required to raise the temperature of one gram of water through 1^0c is
1. 0.001 Kcal 2. 0.01 Kcal
3. 0.1 Kcal 4. 1.0 Kcal

19. The direction of flow of heat between two bodies is determined by
1. Average kinetic energy 2. total energy
3. internal energy 4. potential energy

20. Heat is absorbed by a body . But its temperature does not raised which of the following statement explains the phenomena ?
1. only K.E. of vibration increases
2. only P.E. of inter molecular force changes
3. no increase in internal energy takes place
4. increase in K.E. is balanced by decrease in P.E.

21. When heat is added to a system at constant temperature, which of the following is possible.
1. internal energy of system increases
2. work is done by system
3. neither internal energy increases nor work done by system
4. internal energy increases and also work done by system

22. Heat capacity of a substance is infinite. It means
1. heat is given out
2. heat is taken in
3. no change in temperature whether heat is taken in (or) given out
4. all of the above

23. The temperature range in the definition of calorie is
1. 14.5^0c to 15.5^0c 2. 15.5^0c to 16.5^0c
3. 1^0c to 2^0c 4. 13.5^0c to 14.5^0c

24. The heat capacity of material depends upon
1. the structure of a matter
2. temperature of matter
3. density of matter
4. specific heat of matter

25. We need mechanical equivalent of heat because
1. it converts work into heat
2. in C.G.S system, heat is not measured in the units of work
3. in S.I., heat is measure in the units of work
4. of some reason other than those mentioned above

26. The mechanical equivalent of heat J is
1. A constant 2. A physical quantity
3. A conversion factor
4. A dimensional quantity

27. The bullet fired from a gun gets heated on striking a target because
1. it loses energy
2. mechanical work is converted in to heat
3. of latent heat
4. specific heat

28. The first law of thermodynamics is based on the law of conservation of
1. energy 2. mass
3. momentum 4. pressure

29. First law of thermodynamics is a special case of
1. law of conservation of energy
2. Charle's law
3. law of conservation of mass
4. Boyle's law

30. Which of the following states of matter have two specific heats ?
1. solid 2. gas 3. liquid 4. vapour

31. The specific heat of a gas in an isothermal process is
1. infinity 2. zero 3.negative 4.remains constant

32. In defining the specific heat, temperature is represented in ^0F instead of ^0C. Then the value of specific heat will
1. decreases 2. increases
3. remain constant
4. be converted to heat capacity

33. The ratio of the relative rise in pressure for adiabatic compression to that for isothermal compression is
1. γ 2. $\frac{1}{\gamma}$ 3. $1-\gamma$ 4. $\frac{1}{1-\gamma}$

34. Ratio of isothermal elasticity of gas to the adiabatic elasticity is
1. γ 2. $\frac{1}{\gamma}$ 3. $1-\gamma$ 4. $\frac{1}{1-\gamma}$

35. Why the specific heat at a constant pressure is more than that at constant volume
1. there is greater inter molecular attraction at constant pressure
2. at constant pressure molecular oscillation are more violent
3. rational work need to be done for allowing expansion of gas at constant pressure
4. due to more reasons other than those mentioned in the above

36. The ratio [C_p / C_v] of the specific heats at a constant pressure and at a constant volume of any perfect gas
1. can't be greater than 5/4
2. can't be greater than 3/2
3. can't be greater than 5/3
4. can have any value

37. Which of the following formulae is wrong ?
1. $C_v = \frac{R}{\gamma - 1}$ 2. $\frac{C_p}{C_v} = \gamma$
3. $C_p = \frac{\gamma . R}{\gamma - 1}$ 4. $C_p - C_v = 2R$

38. Which of the following laws of thermodynamics leads to the interference that it is difficult to convert whole of heat into work
1. zeroth 2. second 3. first 4. third

39. The process, in which the internal energy of the system remains constant ?
1. adiabatic 2. isobaric
3. isochoric 4. isothermal

40. The temperature at which adiabatic change is equivalent to the isothermal change ?
1. zero degree celsius 2. zero kelvin
3 critical temperature
4. above critical temperature

41. Two identical sample of gases are allowed to expand (i) isothermally (ii) adiabatically work done is
1. more in the isothermal process
2. more in the adiabatic process
3. equivalent in both process
4. equal in all process

42. In the isothermal expansion of a gas
1. the work done by gas is zero
2. heat is taken from the gas
3. heat is neither given nor thaken from gas
4. internal energy stored in the gas is constant

43. The conversion of water into ice is an
1. isothermal process 2. isochoric process
3. isobaric process 4. entropy process

44. The internal energy of an isolated system
1. remains constant 2. keeps on changing
3. zero 4. depending on gas

45. When an ideal gas is expands isothermally, its internal energy will
1. increases 2 decreases
3. remains constant 4. becomes zero

46. For an isothermal process
1. dQ = dw 2. dQ = du
3. dw = du 4. dQ = du + dw

47. For the Boyle's law to hold good, the necessary condition is
1. Isobaric 2. Isothermal
3. Isochoric 4. Adiabatic

48. Two samples of gas A and B, initially at same temperature and pressure, are compressed to half their initial volume, A isothermally and B adiabatically. The final pressure in
1. A and B will be same
2. A will be more than in B
3. A will be less than in B
4.A will be double that in B

49. In which of the following processes all three thermodynamic variables, that is pressure volume and temperature can change
1. Isobaric 2. Isothermal
3. Isochoric 4. Adiabatic

50. During adiabatic expansion the increase in volume associated with
1. increase in pressure and temperature
2. decrease in pressure and temperature
3. increase in pressure and decrease in temperature
4.Decrese in pressure and increase in temperature

51. A gas is being compressed adiabatically. The specific heat of the gas during compression is
1. zero 2. infinite
3. finite but non zero 4. undefined

52. The process in which no heat enters or leaves the system is termed as
1. Isochoric 2. Isobaric
3. Isothermal 4. adiabatic

53. The gas law $\left[\frac{pv}{T}\right]$ = constant is true for
1. isothermal change only
2. adiabatic change only
3. Both isothermal & adiabatic
4. neither isothermal nor adiabatic

54. During adiabatic compression of a gas, its temperature
1. falls 2. rises
3. remains constant 4. becomes zero

55. On compressing a gas suddenly, its temperature
1. increases 2. decreases
3. remains constant 4. all the above

56. The work done on the system in an adiabatic compression depends on
1. the increase in internal energy of the system
2. the decrease in internal energy
3. the change in volume of the system
4. all the above

57. The internal energy of compressed real gas, as compared to that of the normal gas at the same temperature is
1. less 2. more
3. sometimes less, sometimes more
4. maximum

58. The ratio of slopes of adiabatic and isothermal curves is
1. γ 2. $\frac{1}{\gamma}$ 3. γ^2 4. γ^3

59. An isothermal process is
1.slow process 2.quick process
3. very quick process 4. both 1 & 2

60. The energy taken by system is dQ and work done by system is dw increase in internal energy is du, the quantity which does not depend on path is
1. du 2. dQ 3. dQ & dw 4. dw

61. du + dw = 0 is valid for
1. adiabatic process 2. isothermal process
3. isobaric process 4. isochoric process

62. Which of the following at 100^0C produces most severe burns ?
1. hot air 2. water 3. steam 4. oil

63. The latent heat of vapouristion of water is more than latent heat of fusion of ice ?
1. on vapourisation much larger increase in volume takes place
2. increase in kinetic energy is much larger on boiling
3. kinetic energy decreases on boiling
4. volume decreases when the ice melts

64. Which of the following will extinguish the fire quickly
1. water at 100^0C 2. steam at 100^0C
3. water at 0^0C 4. ice at 0^0C

65. The type of energy is gained (or) lost by the molecules when ice melts is
1. K.E is gained 2. K.E. is lost
3. P.E is gained 4. P.E. is lost

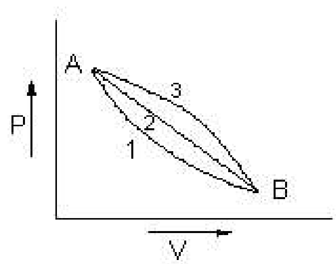
66. The latent heat of vapourisation of a substance is always
1. greater than its latent of fusion
2. greater than its latent heat of sublimation
3. equal to its latent latent heat of sublimation
4. less than its latent heat of fusion

67. A piece of ice at 0^0C is dropped into water at 0^0C. Then ice will
1. melt 2. be converted to water
3. not melt 4. partially melt

68. When two blocks of ice are pressed against each other then they stick together (coalesce) because
1. cooling is produced 2. heat is produced
3. increase in pressure increase melting point
4. increase in pressure, decrease in melting point

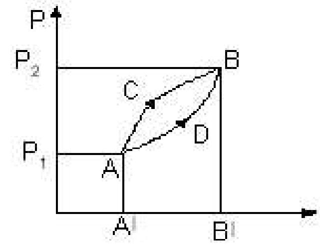
69. Ice is found to be slippery when a man walks on it this is so because
1. increase in pressure causes ice to melt faster
2. increase in pressure causes ice to melt slower
3. its surface is smooth and cold
4. ice is colder

70. A given mass of a gas expands from the state A to the state B by three paths 1,2 and 3 as shown in the figure. If W_1, W_2 and W_3 respectively be the work done by the gas along the three paths then



1. $W_1 > W_2 > W_3$ 2. $W_1 < W_2 < W_3$
3. $W_1 = W_2 = W_3$ 4. $W_1 < W_2, W_1 < W_3$

71. 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 is given by the area



1. $P_1ACBP_2P_1$ 2. ACBB'A'A
3. ACBDA 4. ADBB'A'A

72. In isothermal expansion the pressure is determined by
1. temperature only 2. compressibility only
3. both temperature and compressibility
4. latent heat

73. A given system undergoes a change in which the work done by the system equals the decrease in its internal energy. The system must have undergone an
1. Isothermal change 2. Adiabatic change
3. Isobaric change 4. Isochoric change

74) A closed vessel contains some gas at a given temperature and pressure. If the vessel is given a very high velocity, the temperature of the gas is 1 . increases 2. decreases
3. may increase or decrease depending upon the nature of the gas
4. does not change

75) Cooking is difficult on mountains because
1) water boils at low temperature
2) water boils at high temperature
3) water does not boil
4) it is cool there

76) Paraffin wax contracts on solidification. So its melting point with pressure
1) increases 2) decreases
3) remains same 4)we can't say

77) In a pressure cooker cooking is done quickly because
1) the cooker doesnot absorb any heat
2) it has a safety valve
3) boiling point of water rises due to increased pressure
4) it is a prestige to cook in a cooker

78) A large block of ice is placed on a table when the surroundings are at 0^0C
1) ice melts at the sides
2) ice melts at the top
3) ice melts at the bottom
4) ice does not melt at all

79) What energy transformation takes place when ice is converted into water
1) heat energy to kinetic energy
2) kinetic energy to heat energy
3) heat energy to latent heat
4) heat energy to potential energy

80) Heat is supplied to a diatomic gas at constant pressure. The ratio of $\Delta Q : \Delta U : \Delta W$ is
1) 5 : 3 : 2 2) 5 : 2 :3 3) 7 : 5 : 2 4) 7 : 2 : 5

81) Unit mass of liquid of volume V_1 completely turns into a gas of volume V_2 at constant atmospheric pressure P and temperature T. The latent heat of vaporization is "L". Then the change in internal energy of the gas is
1) L 2) L+P(V_2 - V_1) 3) L - P(V_2-V_1) 4) Zero

82) In a isobaric (constant pressure) process. the correct ratio is
1) $\Delta Q : \Delta U = 1 : 1$ 2) $\Delta Q : \Delta U = 1 : \gamma-1$
3) $\Delta Q : \Delta U = \gamma-1 : 1$ 4) $\Delta Q : \Delta U = \gamma : 1$

83) In an isobaric process, the correct ratio is
1) $\Delta Q : \Delta W = 1 : 1$ 2) $\Delta Q : \Delta W = \gamma : \gamma-1$
3) $\Delta Q : \Delta W = \gamma-1 : \gamma$ 4) $\Delta Q : \Delta W = \gamma : 1$

KEY

01) 1	02) 3	03) 4	04) 1	05) 2
06) 2	07) 4	08) 3	09) 1	10) 2,3
11) 1	12) 3	13) 1	14) 3	15) 3
16) 2	17) 4	18) 1	19) 1	20) 2
21) 2	22) 3	23) 1	24) 4	25) 2
26) 3	27) 2	28) 1	29) 1	30) 2
31) 1	32) 1	33) 1	34) 2	35) 3
36) 3	37) 4	38) 3	39) 4	40) 2
41) 1	42) 4	43) 3	44) 1	45) 3
46) 1	47) 2	48) 3	49) 4	50) 2
51) 1	52) 4	53) 3	54) 2	55) 1
56) 1	57) 1	58) 1	59) 1	60) 1
61) 1	62) 3	63) 1	64) 1	65) 3
66) 1	67) 3	68) 4	69) 1	70) 3
71) 3	72) 2	73) 2	74) 4	75) 1
76) 1	77) 3	78) 3	79) 4	80) 3
81) 3	82) 4	83) 2		

LEVEL-1

CALORIMETRY

1. The ratio of densities of two substances is 2 : 3 and that of specific heats is 1 : 2. The ratio of thermal capacities per unit volume is
1. 1 : 2 2. 2 : 1 3. 1 : 3 4. 3 : 1

2. The density of a substance is 400 kgm^{-3} and that of another substance is 600 kgm^{-3}. The heat capacity of 40 c.c of first substance is equal to that of 30 c.c of second substance. The ratio of their specific heats is
1. 1 : 6 2. 6 : 1 3. 9 : 8 4. 8 : 9

3. A body absorbs 1000 calories of heat when it is heated from 20^0C to 70^0C. The water equivalent of the body is
1. 10 g 2. 15 g 3. 20 g 4. 25 g

4. Two spheres of copper of diameters 10cm and 20 cm will have thermal capacities in the ratio
1. $\frac{1}{8}$ 2. $\frac{1}{2}$ 3. $\frac{1}{4}$ 4. $\frac{1}{6}$

5. When 5 moles of gas is heated from 100^0C to 120^0C at constant volume, the change in internal energy is 200 J. The specific heat capacity of the gas is
1. 5 J $mol^{-1}K^{-1}$ 2. 4 J $mol^{-1}K^{-1}$
3. 2 J $mol^{-1}K^{-1}$ 4. 1 J $mol^{-1}K^{-1}$

6. The amount of heat required to convert 5g of ice at 0^0C into water at 40^0C is
1. 400 cal 2. 200 cal 3. 600 cal 4.1000 cal

7. The thermal capacity of 100g lead shot is (specific heat of lead is 0.03 cal/g/^0C)
1. 3 cal/^0C 2. 30 cal/^0C
3. 300 cal/^0C 4. 0.3 cal/^0C

8. Specific heat of aluminium is 0.25 cal/g/^0c. The water equivalent of an aluminium vessel of mass one kilogram is
1. 40 cal/^0C 2. 250 cal/^0C
3. 25 cal/^0C 4. 2.5 cal/^0C

9. Two liquids A and B of equal volumes have their specific heats in the ratio 2 : 3. If they have same thermal capacity, then the ratio of their densities is
1. 1 : 1 2. 2 : 3 3. 3 : 2 4. 5 : 6

10. Two spheres have their radii in the ratio 1 : 2, the densities of their materials are in the ratio 2 : 3 and their specific heats are in the ratio 3:4, then the ratio of their thermal capacities is
1. 3 : 4 2. 1 : 16 3. 2 : 3 4. 1 : 1

11. The densities of two substances are in the ratio 3 : 4 and their specific heats are in the ratio 2 : 3. The ratio of thermal capacities per unit volume of these substances is
1. 2 : 3 2. 3 : 4 3. 1 : 1 4. 1 : 2

12. 1kg of water and 1kg of steel are heated through 1K. The change in their internal energies are (Specific heat of steel = 460 J/kg/K ; Specific heat of water = 4200J/kg./K)
1. 460 J, 4200 J 2. 4200 J, 460 J
3. 1000 J, 4200 J 4. 460 J, 1000 J

13. Two liquids A and B are at 30^0C and 20^0C respectively. When they are mixed in equal masses the temperture of the mixture is found to be 26^0C. The ratio of specific heat is
1. 4 : 3 2. 3 : 4 3. 2 : 3 4. 3 : 2

14. M kg of ice at 0^0C is mixed with M kg of water at 10^0c. The final temperature is
1. 8^0C 2. 6^0C 3. 4^0C 4. 0^0C

15. 5 g of steam at 100^0C is mixed with 5g of the ice at 0^0C. The final temperature of the mixture is
1. 100^0C 2. 95^0C 3. 90^0C 4. 80^0C

16. A beaker contains 200g of water. The heat capacity of the beaker is equal to that of 20g water. The initial temperature of water in the beaker is 20^0C. If 440g of hot water at 92^0C is poured in, the final temperature (neglecting radiation loss) will be nearly
1. 58^0C 2. 68^0C 3. 73^0C 4. 78^0C

17. If 10g of the ice at 0^0C is mixed with 10g of water at 10^0C, then the final temperature of the mixture will be
1. 5^0C 2. 0^0C 3. 100 K 4. 40^0C

18. One gram of water at 80^0C is mixed with one gram of ice at 0^0C. The resultant temperature is
1. 100^0C 2. 0^0C 3. 80^0C 4. 40^0C

19. If 20g of water at 60^0C is mixed with 60g of water at 20^0C. The resultant temperature is
1. 60^0C 2. 20^0C 3. 30^0C 4. 0^0C

20. The heat energy required to vapourise 5kg of water at 373 K is
1. 2700 K.cal 2. 1000 K.cal
3. 27 K.cal 4. 270 K.cal

21. The amount of heat required to convert 1g of ice at -10^{0}C into steam at 100^{0}C is (specific heat of ice = 0.5 cal/g/^{0}C, latent heat of ice = 80 cal/g , latent heat of steam = 540 cal/g)
1. 3045 J 2. 735 J 3. 1000 J 4. 4200 J

22. A liquid of specific heat 0.3 cal/g/^{0}C at 90^{0}C is mixed with another liquid of specific heat 0.5 cal/g^{0}C at 15^{0}C. If the resultant temperature of mixture is 60^{0}C then the ratio of their mases is
1. 5 : 2 2. 2 : 5 3. 1 : 1 4. 3 : 4

23. Two liquids A and B are at temperatures of 75^{0}C and 150^{0}C respectively. Their masses are in the ratio of 2 : 3 and specific heats are in the ratio 3 : 4. The resultant temperature of the mixture, when the above liquids, are mixed (Neglect the water equivalent of container) is
1. 125^{0}C 2. 100^{0}C 3. 50^{0}C 4. 150^{0}C

24. It takes 15 minutes for an electrical kettle to heat a certain quantity of water in grams from 0^{0}c to boiling point 100^{0}C. If takes 81 minutes to boil water into steam, the latent heat of steam is
1. 80 cal/g 2.540 cal/g 3. 100 cal/g 4.336 cal/g

25. A copper weight and iron weight of the same mass were dropped from the same height on the ground. Which of the weights had the higher temperature after the impact ? (specific heat of Cu = 0.1 Kcal/kg/^{0}C ;specific heat of iron = 0.11 Kcal/kg/^{0}C)
1. Iron weight 2. Copper weight
3. Both iron and copper 4. Cannot be answered

FIRST LAW OF THERMODYNAMICS
(dQ = dU + dW)

26. A gas absorbs 80 cal of heat. If the work done by the gas is 150J the change in internal engery is
1. 150 J 2. 80 J 3. 186 J 4. 156 J

27. Heat energy of 2100 J is given to a gas at a constant pressure of 10^5 Pa. The increase in internal energy if the change in volume is $5 \times 10^{-3} m^3$
1. 1500 J 2. 1400 J 3. 1600 J 4. 800 J

28. When 20 cal of heat is supplied to a system, the increase in internal energy is 50 J . If the external work done is 35 J, the mechanical equivalent of heat is
1. 4.25 J/cal 2. 1.26 J/cal
3. 4.92 J/cal 4. 2.1 J/cal

29. 100 J work is done on a gas to reduce its volume under adiabatic conditions. The change in internal energy of the gas is
1. +100 J 2. -100 J 3. -200 J 4. +200 J

30. In a thermodynamic process the pressure of fixed mass of gas is changed. In this process gas releases 20 J heat and 8 J work is done on the gas. If initial internal enrgy of the gas is 30 J, then final internal energy is
1. 2 J 2. 42 J 3. 18 J 4. 58 J

31. 70 cal heat is required to raise the temperature of 2 moles of an ideal gas at constant pressure from 25^{0}C to 30^{0}C , then the amount of heat required to raise the temperature of same gas through same raise of temp. at constant volume is
1. 50 cal 2. 70 cal 3. 90 cal 4. 60 cal

32. In a thermodynamic process with 2 moles of gas 30 J of heat is released and 22 J of work is done on the gas. Given that initial internal energy of the sample was 20 J . The final internal energy is
1.72 J 2.32 J 3.28 J 4.12 J

33. A gas for which γ is $\frac{4}{3}$ is heated at constant pressure. The percentage of heat supplied used for external work is
1. 25% 2. 75 % 3. 60 % 4. 40 %

34. The molar specific heat of hydrogen at constant volume is 5 cal. Heat required to raise the temp. of 1 gm H_2 gas by 1^{0}C at constant volume is
1. 2 cal 2. 2.2 cal 3. 2.5 cal 4. 4 cal

35. The molar specific heat of helium at constant volume is 3 cal. Heat energy required to raise the temperature of 1gm helium gas by 1^{0}C at constant pressure is
1. 1.2 Cal 2. 1.25 Cal 3. 3 Cal 4. 4 Cal

36. A quantity of heat 'Q' is supplied to a monoa tanic ideal gas which expands at constant pressure. The fraction of heat that goes into work done by the gas is
1. $\frac{2}{5}$ 2. $\frac{5}{2}$ 3. $\frac{4}{5}$ 4. 1

37. 3 moles of gas requires 60 cal of heat for 5^{0}C rise of temperature at constant volume. Then heat required for 5 moles of same gas under constant pressure for 10^{0}C raise of temperature is
1. 200 Cal 2. 400 Cal 3. 100 Cal 4. 300 Cal

38. For a gas the ratio of the two specific heats is $\frac{5}{3}$. If R = 2 cal / mol/K then the values of C_p and Cv are
1. 5 ,3 cal / mol / ^{0}K 2. 3 ,4 cal / mol / ^{0}K
3. 4 ,3 cal / mol / ^{0}K 4. 3.5 , 7 cal / mol /^{0}K

39. If for a gas $\frac{R}{C_v}$ = 0.67, this gas is made up of molecules which are
1. Diatomic 2. Monoatomic
3. Poly atomic
4. Mixture of diatoamic & Polyatomic

40. One mole of an ideal gas requires 207 J heat to raise the temperature by 10K when heated at constant pressure. If the same gas is heated at constant volume to raise the temperature by the same 10K, the heat required is (R=8.3 J/mol/K)
1. 187J 2. 29J 3. 215.3J 4. 124 J

41. If the ratio of sp.heat of a gas at constant pressure to that at constant volume is γ , the change in internal energy of gas, when the volume changes from V to 2V at constant pressure P is
1. $\frac{R}{\gamma-1}$ 2. PV 3. PV / ($\gamma-1$) 4. $\gamma PV/(\gamma-1)$

42. For a certain gas, the ratio of specific heats is $\frac{3}{2}$. The value of C_p for the gas is
1. R 2. 2R 3. 3R 4. 5R

43. For hydrogen gas C_p-C_v= a and for Oxygen gas C_p-C_v = b, Then the relation between 'a' and 'b'. is
1. a = 16b 2. b = 16a 3. a = 4b 4. a = b

44. One gram of water on evaporation at atmospheric pressure forms 1671 cm^3 of steam. Heat of vaporisation at this pressure is 540 cal gm^{-1}. The increase in internal energy is
1. 250cal 2. 500cal 3. 1000cal 4. 1500cal

45. A cylinder of fixed capacity 67.2 litres contains helium gas at S.T.P. The amount of heat required to raise the temperature of the gas by 15^0C is (R =8.31 J/mol/K)
1. 520 J 2. 560.9 J 3. 620 J 4. 621.2 J

ADIABATIC AND ISOTHERMAL

46. For a gas $\gamma = \frac{5}{3}$. 800c.c. of this gas is suddenly compressed to 100c.c. If the initial pressure is P, then the final pressure will be
1. $\frac{P}{32}$ 2. $\frac{24}{5}$ 3. 8P 4. 32P

47. In an adiabatic change, the pressure P and temperature T of a mnoatomic gas are related as P α T^c where C equals.
1. $\frac{5}{3}$ 2. $\frac{2}{3}$ 3. $\frac{3}{5}$ 4. $\frac{5}{2}$

48. A polyatomic gas ($\gamma = \frac{4}{3}$) is compressed to $\frac{1}{8}$ of its volume adiabatically. If it's initial pressure is P, the new pressure will be
1. 8P 2. 16P 3. 6P 4. 2P

49. During an adiabatic change the density becomes $\frac{1}{16}$ th of initial value, then $\frac{P_1}{P_2}$ = (γ =1.5)
1. 16 2. 4 3. 32 4. 64

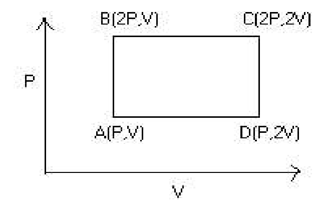
50. A fixed amount of dry air at temperature of 27^0C is compressed to $\frac{1}{9}$ of original volume. Its final temperature is (γ_1=1.5)
1. 627^0C 2. 600^0C 3. 158^0C 4. 527^0C

51. The pressure and density of a diatomic gas $\left(\gamma = \frac{7}{5}\right)$ where $\frac{\rho_1}{\rho_2}$ = 32 then $\frac{p_2}{p_1}$ should be
1. 126 2. 128 3. 146 4. 124

52. In an adiabatic expansion, the temperature of 5 moles of gas γ = 1.5 falls from 87^0C to 27^0C, then the work done is
1. 2400 Cal 2. 4980 Cal
3. 1200 Cal 4. 3000 Cal

53. If a monoatomic gas is suddenly compressed to $\frac{1}{8}$ of its volume adiabatically, then the pressure of the gas is
1. 8 times the initial 2. 16 times the initial
3. 32 times the initial 4. 128 times the initial

54. An ideal monoatomic gas is taken round the cycle ABCDA as shown in the diagram. The work done during the cycle is



1. PV 2. 2PV 3. 3PV 4. 4PV

55. A gas is compressed isothermally and adiabatically. The corresponding change in volume are found to be 51 c.c and 34 c.c. The value of γ for the gas is
1. 1.67 2. 1.4 3. 1.33 4.1.5

56. Waterfall is falling from 160m height. Assuming that half the K.E. of falling water gets converted into heat, the rise in temperature of water is appoximately.
1. 0.1^0C 2. 0.2^0C 3. 0.3^0C 4. 0.4^0C

57. How much will the temperature of 100g of water be raised by doing 4200 J of work is stirring the water?
1. 0.01^0C 2. 0.1^0C 3. 1^0C 4. 10^0C

58. From what minimum height a block of ice has to be dropped in order that it may melt completely on hitting the ground
1. mgh 2. $\frac{mgh}{J}$ 3. $\frac{JL}{g}$ 4. $\frac{J}{Lg}$

59. A bullet travelling at 100 ms^{-1} suddenly hits a concrete wall. If its K.E. is converted completely into heat , the raise in temperature is $\left(s = 100 Jkg^{-1}K^{-1}\right)$
1. 20K 2. 40K 3. 50K 4. 60K

60. To metal balls of same material having masses 50gm and 100gm collides with a target with same velocity. Then the ratio of their rise in temperature is
1. 1:2 2. 4:1 3. 2:1 4. 1:1

61. The difference between the two specific heat of a gas C_p- C_v =2 cal. If R = 8.31 $\times$ 10^7 erg/k/gm,the value of mechanical equivalent of heat is
1. 4.15J/cal 2. 42J/cal
3. 420J/cal 4. 4200J/cal

62. The height of water fall is 210 m assuming that the surface on which the water is falling is perfectly insulated and all the kinetic energy of water is dissipated as heat. Find the rise in temparature of the water. (g = 10 m/s^2, Specific heat of water = 1000 cal.Kg^{-1}C^{-1} , J = 4200 J/K. cal)
1. 0.1^{0}C 2. 0.5^{0}C 3. 1^{0}C 4. 0.25^{0}C

63. From which height a block of ice must be dropped in order that it melts completely. Assume that all the energy is retained by the ice. (g = 10ms^{-2}, L = 80 cal gm^{-1} and J = 4.2 joules/cal.)
1. 1000 Km 2.100 Km 3.33.6 Km 4.1 Km

64. A diatomic gas is heated at constant pressure. The fraction of the heat energy is used to increase the internal energy is
1. 3/5 2. 3/7 3. 5/7 4. 5/9

65. The triatomic gas is heated isothermally. What percentage of the heat energy is used to increase the internal energy
1. 0 % 2. 14 % 3. 60 % 4. 100 %

66. For a certain gas the ratio of specific heats is 3/2. What is the value of C_p for it
1. R 2. 2R 3. 3R 4. 5R

67. Four students found set of C_p and C_v [in cal/deg mole] as given below, which of the following set is correct
1. $C_v = 4$, $C_p = 2$ 2. $C_v = 4$, $C_p = 3$
3. $C_v = 3$, $C_p = 4$ 4. $C_p = 5$, $C_v = 3$

KEY

01)3	02)3	03)3	04)1	05)3
06)3	07)1	08)2	09)3	10)2
11)4	12)2	13)4	14)4	15)1
16)2	17)2	18)2	19)3	20)1
21)1	22)1	23)1	24)2	25)2
26)3	27)3	28)1	29)1	30)3
31)1	32)4	33)1	34)3	35)4
36)1	37)4	38)1	39)2	40)4
41)3	42)3	43)4	44)2	45)2
46)4	47)4	48)2	49)4	50)1
51)2	52)3	53)3	54)1	55)4
56)2	57)4	58)3	59)3	60)4
61)1	62)2	63)3	64)3	65)1
66)3	67) 4			

HINTS

1. $\frac{H_1}{H_2} = \frac{d_1 c_1}{d_2 c_2}$

2. $\frac{c_1}{c_2} = \frac{v_2 d_2}{v_1 d_1}$

3. 1000 = mc (70-20) = w x 50

w = $\frac{1000}{50}$ = 20 gm

4. $\frac{m_1}{m_2} = \frac{r_1^3}{r_2^3} = \frac{1}{8}$

$\frac{H_1}{H_2} = \frac{m_1}{m_2} = \frac{1}{8}$

5. dQ = du = mc Δ t since dQ = 200J

Δ t = 20K and M = 5mole, hence

c = 2J mol^{-1}K^{-1}

6. Q = ms $\Delta\theta$

7. Q = ms

8. water equivalent = ms

9. $m_1 s_1 = m_2 s_2$, $v_1 p_1 s_1 = v_2 p_2 s_2$

$\frac{\rho_1}{\rho_2} = \frac{v_2 s_2}{v_1 s_1} = \frac{s_2}{s_1}$

10. $\frac{C_1}{C_2} = \frac{r_1^3}{r_2^3} \text{ x } \frac{d_1}{d_2} x \frac{s_1}{s_2}$

11. $\frac{T_1}{T_2} = \frac{\rho_1 s_1}{\rho_2 s_2}$

12. Q = ms Δ t

16. Applying principle of calorimtry

(200 + 20) x 1 x $\theta = 68^0 c$

19. 20(60-t) = 60 (t-20)

22. $ms\Delta t_1 = ms\Delta t_2$

26. du = dQ - dw

27. du = dQ - pdv

28. dQ = du + dw

29. du = -dw

30. $U_2 - U_1 = dQ - dW$

32. dQ = du + dw = $u_2 - u_1$ + dw

33. $\frac{dw}{dQ} x100 = \left(1 - \frac{1}{\gamma}\right) x100$

34. dQ = $nc_v dt$

35. $c_p = c_v + R$
dQ = $nc_p dt$

36. $\frac{dw}{dQ} = 1 - \frac{1}{\gamma}$

37. du = $nc_v dt$
$c_{v =}$ u , $c_p = c_v + R$ = 6 cal/mol/K
Qp = $nc_p dt$ = 5 x6x10 = 300 cal

38. $c_v = \frac{R}{\gamma - 1}$ $c_p - c_v = R$

39. $\frac{R}{w} = \frac{c_p - c_v}{c_v} = \gamma - 1 = 0.67$

γ = 01.67

40. $c_p = \frac{5}{2}R$ $c_v = \frac{3}{2}R$

$\frac{Q_v}{Q_p} = \frac{3}{5}$ here Q_p = 270 J , Q_v = 124 J

41. dv = nc_vdt also $\frac{c_p}{c_v} = \gamma$

$\frac{c_p - c_v}{c_v} = \gamma - 1$ i.e. $c_v = \frac{R}{\gamma - 1}$

42. $\frac{c_p}{c_v} = \frac{3}{2} = \frac{c_v + R}{c_v} = \frac{3}{2}$

hence c_v = 2R and c_p = 3R

43. Both are diatomic gases also

$c_p - c_v$ = R for all gases

44. dQ = du + dw

mL = du+pdv

du = mL -pdv

45. Q = nc_vdT

= 3 x $\frac{3}{2}$ x 8 .31x 15 = 560. 9 J

46. $p_1 v_1^{\gamma} = p_2 v_2^{\gamma}$

47. $T^{\gamma} p^{1-\gamma} = const$

48. $p_1 v_1^{\gamma} = p_2 v_2^{\gamma}$

49. $\frac{p_1}{p_2} = \left(\frac{d_1}{d_2}\right)^{\gamma}$

50. $TV^{\gamma-1}$=constant

51. $pv^{\gamma} = k$ $\frac{p}{\rho^{\gamma}}$ = k

$\frac{p_2}{p_1} = \frac{p_2^{\gamma}}{p_1^{\gamma}}$

52. w = $\frac{nR}{\gamma - 1}(T_1 - T_2)$

where R = 2 cal mol^{-1} k^{-1}

53. $pv^{\gamma} = k$ where $\gamma = \frac{5}{3}$

54. work done = Area under rect angle

55. $\left(\frac{dv}{v}\right)$ Isothermal = $\gamma\left(\frac{dv}{v}\right)$ Adiabatic

56. $\frac{1}{2}$ mgh = msdt

57. w = JH w = Jmc $\Delta\theta$

4200 = 4.2 x 100 x 1 x $\Delta\theta$

$\Delta\theta$ = 10^0C

58. w = JH mgh = Jml

59. $\frac{1}{2}$ mv^2 = ms $\Delta\theta$

60. $\frac{1}{2}$ mv^2 = ms Δt

Δt is independent of mass of ball

61. $c_p - c_v = \frac{R}{J}$ J = $\frac{R}{c_p - c_v}$

62. mgh = Jms θ

63. mgh = JmL

LEVEL - II

CALORIMETRY

1. Three liquids A,B and C of masses 400gm, 600 gm and 800 gm are at 30^0c, 40^0c and 50^0c respectively. When A and B are mixed resultant temperature is 36^0C when B and C are mixed resultant temperature is 44^0C Then ratio of their specific heats are

1. 2:1:1 2. 3:2:1 3. 2:2:1 4. 1:4:9

2. 10gm of Ice at -20^0C is added to 10g of water at 50^0C. The amount of ice and water that are present at equillibrium respectively

1. 0,20g 2. 5g, 15 g
3. 5g, 10g 4. 10g, 10g

3. A boy eats an ice cube of mass 100gm at 0^0C. If the body temperature of the boy is 37^0C the number of joules of energy lost by the boy is $(L_{ice} = 33000 J/kg$ for water Sp. heat =4200 J-$kg^{-1}K^{-1}$)

1. 49140 J 2. 39140 J
3. 49000 J 4. 29140 J

4. 1gm of ice at 0^0C is converted to steam at 100^0C the amount of heat required will be

1. 756 cal 2. 12000 cal
3. 716 cal 4. 450 cal

5. The temperature of 100 gm of water is to be raised from 24^0C to 90^0C by adding steam to it. The mass of the steam required for this purpose is

1. 10gm 2. 12 gm 3. 14gm 4. 16gm

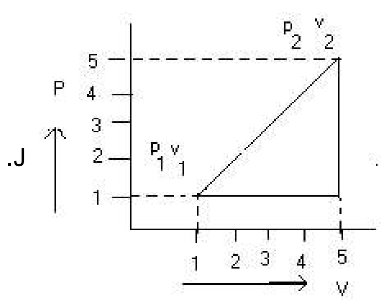
FIRST LAW OF THERMODYNAMICS

6. When a monoatomic gas expands at constant pressure the precentage of heat supplied that increases the internal energy of the gas and that which is invovled in expansion is
1. 75%, 25% 2. 25%, 75%
3. 60%,40% 4. 40%, 60%

7. Two moles of monoatomic gas $\left(\gamma_1 = \frac{5}{3}\right)$ is mixed with three moles of diatomic gas $\left(\gamma_2 = \frac{7}{5}\right)$, then the value of γ of the mixture is
1. 3 2. 2 3. 1.5 4. 1

8. One mole of monoatomic gas is mixed with three moles of a diatomic gas. Then molar specific heat of the mixture at constant volume is
1. 2R 2. 9R 3. 2.25R 4. 3R

9. A system changes from the state (p_1,v_1) to (p_2,v_2) as shown in the diagram. The workdone by the system is



1. 12×10^4J 2. 12×10^8J
3. 12×10^5J 4. 6×10^4 J

10. A diatomic gas is heated at constant pressure. The fracrtion of heat energy used to increase the internal energy is
1. $\frac{3}{5}$ 2. $\frac{3}{7}$ 3. $\frac{5}{7}$ 4. $\frac{5}{9}$

ADIABATIC AND ISOTHERMAL

11. One mole of an ideal gas $(\gamma = 1.4)$ is adiabatically compressed so that its temperature rises from 27^{0}C to 35^{0}C. The work done by the gas is
(R= 8.47J/mol/K)
1. -160 J 2. -168 J
3. 150 J 4. 120 J

12. A monoatomic ideal gas initially at 17^{0}C is suddenly compressed to $\frac{1}{8}$ of its original volume. The tempeturature after compression is
1. 17^0 C 2. 136^{0}C 3. 887^{0}C 4. 240^{0}C

13. If a triatomic gas is heated isothermally, percentage of the heat energy which is used to increase the internal energy is
1. Zero 2. 14% 3. 60% 4. 100%

JOULE'S LAW (W = JH)

14. A lead bullet strikes a steel plate with a velocity of 300 ms^{-1} and completely stopped. If the heat produced is shared equally between the bullet and the target the rise in temperature of the bullet is
(Sp. heat of lead 0.03cal/gm/^{0}C)
1. 89.3^{0}C 2. 49.3^{0}C 3.178.6^{0}C 4. 357.2^{0}C

15. A 0.1kg steel ball falls from a height of 10m and bounces to a height of 7m. The rise in temperature of the ball is
(C = 0.1 kcal/kg/c^0)
1. 0.05^{0}C 2. 0.064^{0}C
3. 0.06^{0}C 4. 0.07^{0}C

16. A steel drill is making 180 revolutions per minute. Under constant couple of 5 Nm. If it drills a hole in 7 sec. in a steel block of mass 600 gm rise in temperature of the block (S= 0.1 cal/gm/K)
1. 2.6^{0}C 2. 1.3^{0}C 3. 5.2^{0}C 4. 3^{0}C

17. A block of ice falls from certain height and completely melts. If only $\frac{3}{4}$ of the energy is absorbed by the block, the height of the fall should be (L= 363 S.I units)
1. 48.4m 2. 84.4 m 3. 88.4 m 4. 44.8 m

18. 2kg of Ice block should be dropped from 'x km' height to melt completely. The 8 kg of ice block should be dropped from height
1. 4x km 2. x km 3. 2x km 4. x/2 km

KEY

1.3	2.2	3.1	4. 3	5. 2
6. 3	7. 3	8. 3	9. 3	10. 3
11. 2	12. 3	13.1	14. 3	15. 4
16. 1	17. 1	18. 2		

HINTS

1. Heat gained = Heat lost from two equations. Solve for $s_1 : s_2 : s_3$
2. Heat given by water $= mc\Delta\theta$ = 5000 cal
Heat required by ice at -20^{0}C to 0^{0}c=100 cal
Heat remained =500-100=400cal
mass of ice melted =m=5gm
Remaining ice= 10-5=5gm
3. $Q = mL + ms\Delta\theta$
4. Q = mL+mc(100-0)+mL_s
= 80+100+536
= 716 cal
5. Let mass of steam =m gm
Heat lost by steam
=mx540+m(100-90)=550m
Heat gained by water=100(90-24)=6600 cal
$\therefore$ 550m=6600

$$m = \frac{6600}{550} = 12g$$

6. Heat supplied = dQ = $nc_p dT$
Increase in internal energy, dU= $nc_v dT$

$$\frac{du}{dQ} = \frac{C_v}{C_p} = \frac{1}{\gamma} = \frac{3}{5} = 60\%$$

Heat involved = 40%

7. $$\gamma = \frac{n_1 c_{p1} + n_2 c_{p2}}{n_1 c_{v1} + n_2 c_{v2}}$$

$$\gamma = \frac{n_1\gamma_1 + n_1\gamma_2}{n_1 + n_2}$$

8. $$C_v = \frac{n_1 C_{v1} + nC_{v2}}{n_1 + n_2}$$

$$C_{v1} = \frac{3R}{2}, \; C_{v2} = \frac{5R}{2}$$,n_1=1&n_2=3

9. W=Area of triangle + Area of rectangle
10. dQ=dU+dW
for diatomic gas dQ= C_P dT
and du = C_V dT

11. dw= $\frac{nR(T_1 - T_2)}{\gamma - 1}$ = $\frac{1 \times 8.4(-8)}{1.4 - 1}$ = -168J

12. $TV^{\gamma-1} = K$ when $\gamma = 5/3$

13. In isothermal process no change in internal energy takes place

14. $\frac{1}{4} mV^2 = Jmc_s \Delta T$

15. W=JH mg(h_1-h_2)= $Jmc_s \Delta\theta$

16. $c\theta = J(ms\Delta t)$; $\theta = 2\pi nt$

17. $\frac{3}{4} mgh$ = JmL

18. n= $\frac{JL}{g}$ (h) is independent of mass of ice block

LEVEL - III

1. 1g of H_2 gas is heated by 1^0C at constant pressure. The amount of heat spent in expansion of gas is

1. $\frac{4.155}{4.18} cal$ 2. $\frac{4.7}{2.1} cal$

3. $\frac{6.8}{2.2} cal$ 4. $\frac{1.26}{1.7} cal$

2. Equal volumes of monoatomic and diatomic gases of same initial temperature and pressure and mixed. The ratio of their specific heats of the mixture $\left(\frac{c_p}{c_v}\right)$ will be

1. 1 2. 1.5 3. 1.52 4. 1.53

3. The temperature of equal masses of three different liquids A,B and C are 12^0C, 19^0C and 28^0C respectively. When A and B are mixed the temperature is16^0C and when B and C are mixed it is 23^0C. The temperature when A and C are mixed is

1. 10.1^0C 2. 20.2^0C 3.30.3^0C 4.40.4^0C

4. 30g of ice 0^0C and 20 g of steam at 100^0C are mixed. The composition of the resultant mixture is

1. 40g of water and 10g steam at 100^0C
2. 10g of ice and 40g of water at 0^0C
3. 50g of water at 100^0C
4. 35g of water and 15g of steam at 100^0C

5. 100g of steam at 100^0C condenses into water at 20^0C. The amount of heat liberated in the process is

1. 54 K.Cal 2. 80 K.Cal
3. 62 K.Cal 4. 100 K.Cal

6. 0.3 kg of steam at 100^0c is mixed with 6 kg of water. After the steam condenses the temperature of the mixture rises to 40^0c. The initial temperature of the water is

1.30^0C 2. 40^0C 3.70^0C 4.10^0C

7. Steam is passed into water taken in a vessel (total thermal capacity 110 cal/^0C) at 30^0C till the resultant temperature is 90^0C . If latent heat of steam is 540 cal/g, the increase in mass of the water.

1. 60g 2. 110g 3. 12g 4.550g

8 A piece of iron weighing 16g at temperature of 112.5^0C is dropped over a block of ice 2.5 g of ice melts. If the latent heat of ice is 80 cal/g. The specific heat of iron is

1. 1 Cal g^{-1} C^{-1} 2.1/9 cal g^{-1} C^{-1}
3. 0.01cal $g^{-1}C^{-1}$ 4.1/16 cal g^{-1} C^{-1}

9. Metal nails weighing 100gm heated to 100^0C and dropped into a copper calorimeter of mass 100 g containing 40 gm of water at 1^0C. If the resulting temperature is 10^0C. The specific heat of metal is (Sp. Heat of copper is 0.1 calg^{-1} c^{-1})

1. 0.01 Cal g^{-1} c^{-1} 2. 0.05 Cal g^{-1} c^{-1}
3. 0.03 Cal g^{-1} c^{-1} 4. 0.5 Cal g^{-1} c^{-1}

10. A man of 60kg get 1000 cal of heat by eating 5 mangoes. His efficiency is 28%. To what height he can jump by using this energy

1. 2m 2. 20m 3. 28m 4. 0.2m

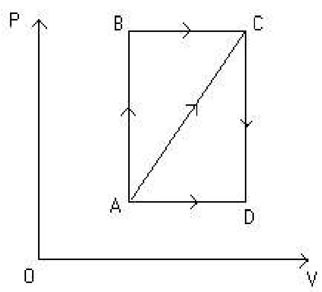
11. A nail at 0^0C falls from a height of 1km on an ice surface and its whole kinetic energy is converted into heat. What fraction of it will melt?

1. $\frac{1}{33}$ 2. $\frac{1}{8}$

3. $\frac{1}{33} x10^{-4}$ 4. whole of it will melt

12. A lead bullet travelling at 210m/s enters a block of wood and is brought to rest. Assuming 75% of heat absorbed by the bullet, calculate the increase in temperature (Specific heat of lead 0.03X 10^3 cal/kg/c^0 and J= 4.2 X 10^3 J/K.Cal) nearly
1. 131^0C 2. 100^0C 3. 31^0C 4. 69^0C

13. A thermodynamic process is shown in the figure. The pressure and volumes corresponding to some points in the figure are



P_A= 3X10^4 Pa V_A= 2X10^{-3} m^{-3}
P_B= 8X10^4 Pa V_B= 5X$10^{-3}$$m^{-3}$
In the process AB, 600J of heat is added to the system and in process BC, 200J of heat is added to the system. The change in internal energy of the system in process AC would be
1. 560J 2. 800J 3. 600J 4. 640J

14. Find the change in the internal energy when 15 gms of air is heated from 0^0C to 5^0C. The specific heat of air at constant volume is 0.2 cal/gm/C^0.
1. 75 Cal 2. 30 Cal 3. 15 Cal 4. 105 Cal

15. For adiabatic expansion of a monoatomic perfect gas the volume increases by 24%. The percentage of decrease in pressure is
1. 24% 2. 40% 3. 48% 4. 71%

KEY

1. 1	2. 2	3. 2	4. 1	5. 3
6. 4	7. 3	8. 2	9. 2	10.1
11.1	12.1	13. 1	14.3	15.2

HINTS

1. dw=pdv

for 1gm H_2 gas, pv=nRT = $\frac{1}{2}$RT

dw=pdv= $\frac{1}{2}$RdT

here dT= 1^0K= 1^0C(nearly)

dw=R.$\frac{dT}{2}$ =8.31X10^7X $\frac{1}{2}$ erg

= 4.155X10^7erg

dw = $\frac{4.155}{4.18}$cal

2. $\gamma = \frac{n_1\gamma_1 + n_2\gamma_2}{n_1 + n_2}$

3. C_A(16-12)=C_B(19-16) $\Rightarrow \frac{C_A}{C_B} = \frac{3}{4}$

C_B(23-19)=C_C(28-23) $\Rightarrow \frac{C_B}{C_C} = \frac{5}{4}$

$\Rightarrow \frac{C_A}{C_C} = \frac{15}{16}$

When A andC are mixed

$C_A(\theta - 12)$=$C_C(28-\theta)$

Where θ is common temperature

θ=20.2^{0}C

4. $m_sL_s = (m_{ice}L_{ice} + m_{ice}s\Delta t)$
Where m_s=mass of steam condensed to rise temperature of ice to 100^0c water.

6. Heat lost = Heat gained
7. Heat lost = Heat gained
8. Heat lost = Heat gained
9. Heat lost = Heat gained

10. $J \times \frac{2.8 \times Q}{100}$ =mgh

11. mgh= Jm^1L

$\frac{m^1}{m} = \frac{gh}{JL} = \frac{980 \times 10^5}{4.2 \times 10^7 \times 80} = \frac{1}{33}$

13. State AB is a isochoric process, so no work is done BC is Isobaric process there work done=P_B (V_D-V_A))=240J
dQ= 600+200=800J
Now dQ= dU+dW
dU= 800-240=560J

15. p V^γ =K

Hence $\frac{\Delta p}{p} \times 100$ = - $\gamma \frac{\Delta v}{v} \times 100$

for monoatomic gas $\gamma = 5/3$

$\frac{\Delta p}{p} \times 100 = \frac{5}{4} \times 24 = 40$

NEW MODEL QUESTION & ANSWERS

1. Match the following :

List - I	List - II
a) Isothermal process	e) const volume
b) Isochoric process	f) no heat exchange
c) Isobaric process	g) const temp
d) adiabtic process	h) const pressure

1) a - g, b - e, c - h, d - f
2) a - e, b - g, c - h, d - f
3) a - g, b - c, c - g, d - h
4) a - g, b - f, c - e, d - h

2. Match the following :

List - I	List - II
a) Latent heat capacity	e) $ML^2T^{-2}K^{-1}$
b) Specific heat capacity	f) $M^0L^2T^{-2}K^{-1}$
c) Stefans constant	g) L^2T^{-2}
d) Boltzmaum constant	h) $MT^{-3}K^{-4}$

1) a - g, b - f, c - h, d - e
2) a - f, b - g, c - e, d - h
3) a - g, b - h, c - f, d - e
4) a - h, b - e, c - f, d - g

3. Match the following :

Process	Workdone
a) Adiabatic process	e) zero
b) Isothermal process	f) $P(V_1 - V_2)$
c) Isochoric process	g) $RT\ \log\left(P_1/P_2\right)$
d) Isobaric process	h) $\frac{R}{\gamma - 1}(T_1 - T_2)$

1) a - h, b - g, c - e, d - f
2) a - h, b - g, c - f, d - e
3) a - g, b - e, c - f, d - h
4) a - h, b - f, c - e, d - g

4. Match the following :

List - I	List - II
a) Isothermal process	e) dQ = dU+dW
b) Adiabatic process	f) dQ = dW
c) Isobaric process	g) dQ = dU
d) Isochoric process	h) dU = -dW

1) a - h, b - e,c - g, d - f
2) a - f, b - e, c - h, d - g
3) a - f, b - h, c - e, d - g
4) a - h, b - f, c - g, d - e

5. Match the following :

List - I	List - II
a) SI units of thermal capacity	e) Jkg^{-1}
b) SI units of specific heat	f) Jk^{-1}
c) SI units of latent heat	g) $Jkg^{-1}k^{-1}$
d) SI unit of Internal energy	h) J

1) a - f, b - g, c - e, d - h
2) a - g, b - e, c - f, d - h
3) a - f, b - e, c - g, d - h
4) a - e, b - f, c - h, d - g

6. Match the following :

List - I	List - II
a) workdone on the system	e) Positive
b) heat energy given to the system	f) negative
c) change in internal energy	g) may be +ve or -ve
d) during cyclic process change in internal energy	h) zero

1) a - g, b - e, c - h, d - f
2) a - f, b - g, c - e, d - h
3) a - f, b - e, c - g, d - h
4) a - g, b - e, c - h, d - g

7. Match the following :

List - I	List - II
a) Among solids and liquids	e) Mercury specific heat is maximum for
b) In liquids specific heat is	f) Water minimum for
c) With increase of pressure	g) Increases the boiling point of a liquid
d) With increase of pressure	h) Decreases the melting point of a solid substance

1) a - f, b - e, c - h, d - g
2) a - e, b - f, c - g, d - h
3) a - e, b - g, c - f, d - h
4) a - f, b - e, c - g, d - h

8. Match the following :

Nature of Gas	Specific Heat at Constant volume(C_v)
a) Monoatomic	e) $\frac{6R}{2}$
b) Diatomic	f) $\frac{4R}{2}$
c) Triatomic	g) $\frac{3}{2}R$
d) Mixture of equal moles of di and mono atomic gases	h) $\frac{5}{2}R$

1) a - e, b - f, c - g, d - h
2) a - g, b - h, c - f, d - e
3) a - f, b - g, c - h, d - e
4) a - g, b - h, c - e, d - f

9. Match the following :

Nature of the Gas	Fraction of interanl enregy
a) Triatomic gas	d) 3 / 5
b) diatomic gas	e) 3 / 4
c) Monoatomic gas	f) 5 / 7

1) a - e, b - f, c - d,
2) a - e, b - d, c - f,
3) a - d, b - e, c - f,
4) a - d, b - f, c - e,

10. Match the following :

List - I	List - II
a) Isobaric	e) Work done in the process $W = nRT \log_e \frac{V_2}{V_1}$
b) Isochoric	f) PV graph is a straight line par allel to volume axis
c) Adiabtic	g) first law of thermo dynamics is $dQ = du$
d) Isothermal	h) It is a sudden and quick process

1) a - f, b - g, c - h, d - e
2) a - g, b - f, c - h, d - e
3) a - h, b - e, c - f, d - g
4) a - e, b - g, c - e,d - h

!1. Match the following :

Process — Ex: for the process

a) Isothermal — e) Any process in an open place
b) Adiabatic — f) Melting of gold
c) Isobaric — g) Process inside a pressure cooker
d) Isochoric — h) Explosion of a bomb

1) a - g, b - f,c - e, d - h
2) a - f, b - h, c - g, d - e
3) a - h, b - g, c - f, d - e
4) a - f, b - h, c - e, d - g

12. Match the following :

List-I	**List - II**
a) Heat cannot flow from a body at low temperature to a body at a higher temperature by itself	d) Zeroth law of thermodynamics
b) Introduces concept of temperature	e) Clausius statement
c) Based on the law of conservation of energy	f) First law of thermo dynamics

List II

1) a - e, b - d, c - f,
2) a - e, b - f, c - d,
3) a - f, b - e, c - d,
4) a - e, b - d, c - d,

13. Match the following :

List - I	**List - II**
a) food is cooked faster in a pressure cooker.	e) melting point is lowered with rise in pressure.
b) two blocks of ice when pressed together forms a single block	f) melting of ice into water
c) specific heat infinity	g) boiling point is el evated with rise in pressure
d)specific heat zero	h) $dQ = 0$ (adiabatic process)

1) a - e, b - f, c - h, d - g
2) a - g, b - e, c - f, d - h
3) a - g, b - e, c - h, d - f
4) a - f, b - e, c - h, d - g

14. Match the following :

List - I	List - II
a) Thermos flask containing coffee is vigorously shaken	e) temp increases
b) door of a refrigerator is opened while it is working	f) temp decreases
c) cycle tube gets punctured	g) $dQ = du, dw = 0$
d)gas heated in a vessel fitted with a tight piston	h) $dQ = 0$

1) a - h, b - f, c - e, d - g
2) a - h, b - e, c - f, d - g
3) a - h, b - g, c - e, d - f
4) a - g, b - h, c - e, d - f

15. **A:** Zeroth law of thermodynamics gives us the concept of energy
B: Internal energy is dependent on temperature
1) Both Assertion and Reason are true and reason is correct explanation of Assertion.
2) Both Assertion and Reason are true but reason is not correct explanation of Assertion.
3) Assertion is true but reason is false
4) Assertion is false but reason is true

16. **Assertion (A) :** Two systems which are in thermal equilibrium with a third system are in thermal equilibrium with each other.
Reason (R) : The heat flows always from a system at higher temperature to a system at a lower temperature
1) Both Assertion and Reason are true and reason is correct explanation of Assertion.
2) Both Assertion and Reason are true bur reason is not correct explanation of Assertion.
3) Assertion is true but reason is false
4) Both assertion and reason are false

17. **Assertion (A) :** Specific heat at constant volume is greater than the specific heat at constant pressure.
Reason (R) : At constant volume, work will be done by the gas. So specific heat at constant volume is more
1) Both Assertion and Reason are true and reason is correct explanation of Assertion.
2) Both Assertion and Reason are true bur reason is not correct explanation of Assertion.
3) Assertion is true but reason is false
4) Both assertion and reason are false

18. Assertion (A): In adiabatic compression, the internal energy and temperature of the system get decreased.
Reason (R) : The adiabatic compression is a slow process
1) Both Assertion and Reason are true and reason is correct explanation of Assertion.
2) Both Assertion and Reason are true bur reason is not correct explanation of Assertion.
3) Assertion is true but reason is false
4) Both assertion and reason are false

19. 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
1) Both Assertion and Reason are true and reason is correct explanation of Assertion.
2) Both Assertion and Reason are true bur reason is not correct explanation of Assertion.
3) Assertion is true but reason is false
4) Both assertion and reason are false

20. **Assertion (A) :** The ratio of C_P/C_v for a diatomic gas is more than that for a monoatomic gas
Reason (R) : The molecules of monoatomic gas have more degrees of freedom than those of a diatomic gas
1) Both Assertion and Reason are true and reason is correct explanation of Assertion.
2) Both Assertion and Reason are true bur reason is not correct explanation of Assertion.
3) Assertion is true but reason is false
4) Both assertion and reason are false

21. Assertion (A) : According to the principle of conservation of energy all heat can be converted into mechanical work
Reason (R) : Due to various losses, it is impossible to convert all heat into mechanical work
1) Both Assertion and Reason are true and reason is correct explanation of Assertion.
2) Both Assertion and Reason are true bur reason is not correct explanation of Assertion.
3) Assertion is true but reason is false
4) Both assertion and reason are false

22. Assertion (A) : Cooking in a pressure cooker is faster
Reason (R) : Boiling point is elevated with rise in pressure
1) Both Assertion and Reason are true and reason is correct explanation of Assertion.
2) Both Assertion and Reason are true bur reason is not correct explanation of Assertion.
3) Assertion is true but reason is false
4) Both assertion and reason are false

23. Assertion (A) : According to Joule, heat and work are related
Reason (R) : For every 1 cal. of heat we can get 4.186 J of mechanical work.
1) Both Assertion and Reason are true and reason is correct explanation of Assertion.
2) Both Assertion and Reason are true bur reason is not correct explanation of Assertion.
3) Assertion is true but reason is false
4) Both assertion and reason are false

24. Assertion (A) : During an adiabatic process, an ideal gas expands by decrease in its internal energy only
Reason (R) : During an adibatic process, heat cannot be exchanged between a system and its surroundings
1) A is true and R is false
2) Both A and R are true and R is the correct explanation of A
3) Both A and R are true and R is not correct explanation of A
4) A is false and R is true

KEY

01.1	02.1	03.1	04.3	05.1	06.3
07.4	08.4	09.1	10.1	11.4	12.1
13.2	14.2	15.4	16.1	17.4	18.4
19.4	20.4	21.2	22.1	23.1	24.2

LEVEL IV

COMPREHENSIVE

1. Read the following passage to answer questions .

The internal energy of gases at room temperature is due to the interaction of molecules and atoms of the gas, the translational, vibrational and rotational kinetic enegies of molecules. The temperature of a substance is a measure of average translational kinetic energy only. At absolute zero the translational kinetic energy of molecules become zero and it is known as zero point energy. At a given temperature gas melecules have random velocity and their average velocity is zero. The rms value of gas molecules is givenby $\sqrt{\frac{3RT}{M}}$. You are given a sample of 2 moles of o_2 gas at 27^{0}C, where the rotational kinetic energy of each molecule is $18\times10^{-23}J$.

1. At zero point energy, a gas may posses
a) vibrational kinetic energy
b) elastic potential energy
c) rotational kinetic energy
d) translational kinetic energy
1) a,c,d are correct 2) a,b,c are correct
3) b,c,d are correct 4) a,b,d are correct

2. The total internal energy of the gas is
1) 7469 J 2) 216.8 J
3) 7685.8 J 4) 6432.2 J

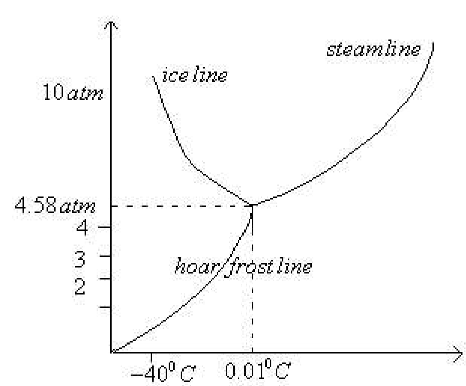
3. The average internal energy of each molecule is
1) $638\times10^{-23}J$ 2) $576\times10^{-23}J$
3) $576\times10^{-23}J$ 4) $216\times10^{-23}J$

4. The total energy of gas at absolute zero is
1) 0 2) 218.2 J
3) 816 J 4) 216.8 J

KEY

1) 2 2) 3 3) 2 4) 4

II. **For 20 g of H_2O the phase diagram is given. Using the diagram answer the following questions.**



1. The maximum temperature at which ice is possible
1) 0^{0}C 2) 0.01^{0}C 3) 100^{0}C 4) 58.6^{0}C

2. When the system is moved from -40^{0}C to 40^{0}C at 5 atm pressure, its phase changes from
1) ice to vapour 2) ice to water to vapour
3) water to vapour 4) vapour to ice

3. When the system is moved from -10^{0}C to 10^{0}C at 2.4 atm pressure, its phae changes from
1) ice to vapour through water
2) water to vapour
3) ice to vapour without entering into water
4) water to ice to vapour

4. At -10^{0}C, the pressure is gradually decreased from 8 atm to 3 atm. Then the phase changes from
1) water to ice to vapour
2) ice to water to vapour
3) water to ice
4) water to vapour without entering into ice

5. For water at 6 atm pressure and at a temperature 18^{0}C, the pressure is reduced to 4.58 atm. The matter that exist at new coordinates is in the form of
1) Ice 2) water 3) vapour
4)co-existance of all three

KEY

1) 2 2) 2 3) 1 4) 3
5) 2

PREVIOUS EAMCET QUESTIONS

1. The tyre of a motor car contains air at 15^{0}C if the temperature increases to 35^{0}C, the approximate percentage increase in pressure is (ignore the expansion of tyre) (2005E)
1) 7 2) 9 3) 11 4)13

2. The ratio of specific heats of a gas is γ. The change in internal energy of one mole of the gas when the volume changes from V to 2V at constant pressure "P" is (2005E)
1) $\frac{\gamma-1}{PV}$ 2) PV 3) $\frac{PV}{\gamma-1}$ 4) V

3. A 42 kg block of ice moving on rough horizontal surface stops due to friction, after some time. If the initial velocity of the decelerating block is 4 ms^{-1}, the mass of ice (in kg) that has melted due to the heat generated by the friction is (latent heat of ice is $3.36\times10^5 Jkg^{-1}$ (2005E)
1) 10^{-3} 2) 1.5×10^{-3}
3) 2×10^{-3} 4) 2.5×10^{-3}

4. A) First law of thermodynamics specifies the conditions under which a body can use its heat energy to produce the work.
B) Second law of thermodynamics states that heat always flows from hot body to cold body by itself
1) Both A and B are true
2) Both A and B are false
3) A is truee but B is false
4) A is false B is true

5. If 4 moles of an ideal monoatomic gas at temperature 400K is mixed with 2 moles of another ideal monoatomic gas at temperature 700K, the temperature of the mixture is (Volume constant (2004E)
1) 550^{0}C 2) 500^{0}C 3) 550K 4) 536 K

6. The pressure and density of a given mass of a diatomic gas $(\gamma = 7/5)$ change adiabatically from (P, d) to (P$^{|}$, d$^{|}$). If $\frac{d^{|}}{d} = 32$ then $\frac{P^{|}}{P}$ is (γ =ratio of specific heats)(2004E)
1) $1/128$ 2) $1/64$ 3) 64 4) 128

7. When a heat of Q is suppiled to one mole of a monoatomic gas $(\gamma = 5/3)$,Then the molar heat capacity of the gas at constant volume is (2004M)
1) $3R/4$ 2) $5R/4$ 3) $7R/4$ 4) $3R/2$

8. The sample of the same gas, x, y and z, for which the ratio of specific heats is $\gamma = 3/2$ have initially the same volume. The volume of the each sample is doubled by adiabatic process in the case of x, by isobaric process in the case of y and by isothermal process in the case of z. If the initial pressure of the sample of x, y and z are in the ratio $2\sqrt{2}:1:2$ then the ratio of the their final pressures is
(2004M)
1) 2 : 1 : 1 2) 1 : 1 : 1
3) 1 : 2 : 1 4) 1 : 1 : 2

9. The temperature of 5 moles of a gas at constant volume is changed from 100^{0}C to 120^{0}C. The change in internal energy is 80J. The heat capacity of the gas at constant volume will be in Joule/Kelvin is (2003E)
1) 8 2) 4 3) 0.8 4) 0.4

10. During an adiabatic process, the pressure of a gas is proportional to the cube of its adiabatic temperature. The value of C_P/C_v for that gas is (2003M)
1) $3/5$ 2) $4/3$ 3) $5/3$ 4) $3/2$

11. 5 moles of hydreogen $\left(\gamma_1 = \frac{7}{5}\right)$ intially at S.T.P is compressed adiabatically so that its temperature becomes 400^0 c . The increase in internal energy in kilojoules is (R = 8.30 J/mole/k) (2002E)
1.21.55 2.41.5 3.65.55 4.80.55

12. A metal sphere of radius 'r ' and specific heat 's' is rotating about an axis passing through its centre at a speed of n rotations per sec is suddenly stopped and 50% of its energy is used in increasing its temperature. The rise in temperature of the sphere is (2002 E)

1. $\frac{2}{5}\frac{\pi^2 r^2 n^2}{s}$ 2. $\frac{1}{10}\frac{\pi^2 n^2}{r^2 s}$

3. $\frac{7}{8}\frac{\pi r^2 n^2 s}{1}$ 4. $\frac{5}{14}\frac{\pi^2 r^2 n^2}{s}$

13. A gas under constant pressure of 4.5×10^5 pa when subjected to 800KJ of heat, changes the volume from 0.5 m^3 to 2.0m^3. The change in the internal energy of the gas. (2002 M)
1. 6.75×10^5 J 2. 5.25×10^5J
3. 3.25×10^5J 4. 1.25×10^5J

14. If for hydrogen $c_p - c_v = m$ and for nitrogen $c_p - c_v = n$, where c_p and c_v refer to specific heats per unit mass respectively at constant pressure and constant volume. The relation between m and n is (2002 M)
1. n = 14m 2. n = 7m
3. m = 7n 4. m= 14n

15. A lead bullet of 10 g travelling with 300 m/s strikes against a block of wood and comes to rest. Assuming 60% of heat is absorbed by the bullet, the increase in its temperature is (Sp. heat of lead is 150 $Jkg^{-1}k^{-1}$) (2001E)
1. 10^0C 2. 12.5^0C 3. 18^0 C 4. 20^0C

16. The pressure and density of a diatomic gas $\left(\gamma=\frac{7}{5};\right)$ changes adiabatically from (p,d) to (p^1,d^1). If $\frac{d'}{d}$ = 32 then $\frac{p'}{p}$ is (2001E)

1. $\frac{1}{128}$ 2. 32 3. 128 4. 256

17. A gas for which γ = 1.5 is suddenly compressed to $\frac{1}{4}$ th of its initial value then the ratio of the final to initial pressure is (2001 M)
1. 1:16 2. 1:8 3. 1:4 4. 8:1

18. I mole of an ideal gas with γ = 1.4 is adiabatically compressed so that its temperature rises from 27^0C to 35^0C. The change in internal energy of the gas is (R= 8.3 Joule mole-1 k-1) (2001M)
1. -166J 2. + 166J 3. -168 J 4. + 168

19. During an adiabatic process, if the pressure of the ideal gas is proportional to the cube of its temperature, the ratio $\gamma=\frac{c_p}{c_v}$ is (C_p- Specific heat at constant pressure C_v-Specific heat at constant volume) (2000E)

1. $\frac{7}{5}$ 2. $\frac{4}{3}$ 3. $\frac{5}{3}$ 4. $\frac{3}{2}$

20. A flask is filled with 13 g of an ideal gas at 27^0 C and its temperature is raised to 52^0C. The mass of the gas that has to be released to maintain the temperature of the gas in the flask at 52^0C and the pressure remaining the same is (2000E)
1. 2.5g 2. 2.0 g 3. 1.5 g 4. 1.0 g

21. An ideal gas at a pressure of 1 atmosphere and temperature of 27^0C is compressed adiabatically until its pressure becomes 8 times the initial pressure, then the final temperature is---------$\left(\gamma=\frac{3}{2}\right)$ (2000 E)

1. 627^0C 2. 527^0C 3. 427^0C 5. 327^0C

22. Two liquids at temperatures 60^0C and 20^0C respectively have masses in the ratio 3:4 and their specific heats in the ratio 4:5. If the two liquids are mixed, the resultant temperature is (2000E)
1. 70^0C 2. 40^0C 3. 50^0C 4. 35^0C

23. A steel ball of mass 0.1 kg falls freely from a height of 10m and bounces to a height of 5.4 m from the ground. If the dissipated energy in this process is absorbed by the ball, the rise in its temperature is (Specific heat of steel = 460J/kg/^{0}C, g= $10ms^{-2}$) (2000 M)
1. 0.01^0C 2. 0.1^0C 3. 1^0C 4. 1.1^0C

24. 50g of copper is heated to increase its temperature by 10^0C. If the same quantity jof heat is given to 10 g of water, the rise in its temperature is (2000M)
(Specific heat of copper = 420J/kg/^{0}C
Specific heat of water = 4200J/kg/^{0}C
1. 5^0C 2. 6^0C 3. 7^0C 4. 8^0C

25. A liquid of mass 'm' and specific heat 'S' is at a temperature '2t'. If another liquid of thermal cpacity 1.5 times, at a temperature of t/3 is added to it, the resultant temperature will be (1999E)

1. $\frac{4}{3}t$ 2. t 3. $\frac{t}{2}$ 4. $\frac{2}{3}t$

26. When heat energy of 1500 J is supplied to a gas at constant pressure is 2.1×10^5 N/m^2 there was a increase in its volume equal to 2.5×10^{-3} m^3. The increase in interanal energy of the gas, in joules is (1999E)
1. 450 2. 525 3. 975 4. 2025

27. The relation between melting point of ice and pressure is shown by ice line, which will be (1999E)
1. with a positive slope
2. with a negative slope
3. parallel to pressure axis
4. parallel to temperature axis

28. For an adiabatic change in a gas, if P, V,T denotes pressure, volume and absolute temperature of gas at any time and γ is the ratio of specific heats of gas, which jof the following equation is ture? (1999 M)

1. $T^{\gamma}P^{1-\gamma}=\text{const.}$ 2. $T^{1-\gamma}P^{\gamma}=\text{const.}$

3. $T^{\gamma-1}V^{\gamma}=\text{const.}$ 4. $T^{\gamma}V^{\gamma}=\text{const.}$

29. Boiling water at 100^0C and cold water at t^0C are mixed in the ratio 1:3 and the resultant maximum temperature was 37^0C. Assuming no heat losses, the value of 't' is (1999M)
1. 4^0C 2. 9^0C 3. 12^0C 4. 16^0C

30. 20g of ice and 20 g of hot water are mixed, when the ice is melted the temperature of the mixture was found to be 0^0C. The temperature of hot water taken should be (L_{ice}=80 cal/g) (1999 M)
1. 40^0C 2. 72^0C 3. 80^0C 4. 96^0C

31. A lead bullet of mass 21 g travelling at a speed of 100 ms^{-1} comes to rest in a wooden block. If no heat is taken away by the wood, the rise in temperature of the bullet in the wood nearly is (Sp. heat of lead 80 cal/kg/^{0}c) (1998E)
1. 25^0c 2. 28^0C 3. 33^0C 4. 15^0C

32. The material that has largest specific heat is (1998 E)
1. mercury 2. water
3. iron 4. diamond

33. First law of thermodynamics states that (1998M)
1. system can do work
2. system has temperature
3. system has pressure
4. heat is form of energy

34. An amount of water of mass 20g, at 0^0C is mixed with 40 g of water at 100^0C, Final temperature of mixture is (1996E)
1. -20^0C 2. 6.66^0C 3. 5^0C 4. 0^0C

35. A piece of lead falls from a height of 100m on a fixed non-conducting slab which brings it to rest. The temperature of the lead piece immediately after collision increases by (Sp.heat of lead is 30.6cal/kg/^{0}C and g= 9.8 m/sec^2.) (1996E)
1. 0K 2. 27^0C 3. 7.62K 4. 4.2K

36. A diatomic gas molecule has translational, rotational and vibrational degrees of freedom. Then $\frac{c_p}{c_v}$ is (1995 E)
1. 1.67 2. 1.4 3. 1.29 4. 1.33

37. An iron ball of mass 0.2 kg is heated to 100^0C when it is put in ice block at 0^0C, 25 g of ice is melted. The specific heat of iron is _________ C.G.S Units (1995 E)
1. 1 2. 0.1 3. 0.8 4. 0.08

38. The amount of heat required to convert 10g of ice at -10^0C into steam at 100^0C is (in cal.) (1995 M)
1. 5400 2. 6400 3. 7200 4. 7250

39. 1g of steam is sent into 1g of ice. The resultant temperature of the mixture is (1995 M)
1. 270^0C 2. 230^0C 3. 100^0C 4. 50^0C

40. 0.1 moles of a diatomic gas at 27^0 c is heated at constant pressure, so that the volume is doubled. If R=2 cal/mol, the work done is (1994 E)
1. 150cal 2. 60 cal 3. 40 cal 4. 30 cal

41. The law obeyed by isothermal process (1994E)
1. Gay-Lussac's law 2. Charles law
3. Boyle's law 4. Dalton's law

42. In P-V graphs, the ratio of slope of adiabatic to isothermal is (1994M)
1. $\gamma - 1$ 2. $\frac{1}{\gamma}$ 3. 1 4. γ

43. Latent heat of vaporization of water is 538 cal/g. During the conversion of 1g of water to steam, if the external work done is 168J, the increase in internal energy is (1994 M)
1) 638cal 2) 538cal 3) 498cal 4) 80cal

44. A quantity of heat 'Q' is supplied to a monoatomic ideal gas which expands at constant pressure. The fraction of heat that goes into workdone by the gas is (1993 E)
1. $\frac{2}{5}$ 2. $\frac{3}{5}$ 3. $\frac{2}{3}$ 4. 1

KEY

01)1	02)3	03)1	04)4	05)4
06)4	07)4	08)2	09)3	10)4
11)2	12)1	13)4	14)3	15)3
16)3	17)2	18)2	19)4	20)4
21)4	22)4	23)2	24)1	25)2
26)3	27)2	28)1	29)4	30)3
31)4	32)2	33)1	34)2	35)3
36)2	37)2	38)4	39)3	40)1
41)3	42)4	43)3	44)1	

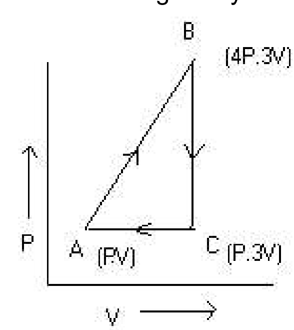
NUMERICALS FROM OTHER COMPETETIVE EXAMINATIONS

1. 110 Joules of heat are added to a gaseous system, whose internal energy is 40 J ; then the amount of external work done is
1. 150 J 2. 70 J 3. 110 J 4. 40 J

2. At 27^0C a gas compressed suddenly such that its pressure becomes 1/32 of original pressure. Final temperature will be (γ = 5/3)
1. 420^0K 2. 300^0K 3. 927^0C 4. 327^0C

3. One mole of an ideal gas requires 207 J heat to raise the temperature by 10k when heated at constant pressure. If the same gas is heated at constant volume to raise the temperature by the same 10k, the heat required is
1. 198.7 J 2. 29 J 3. 215.3 J 4. 124J

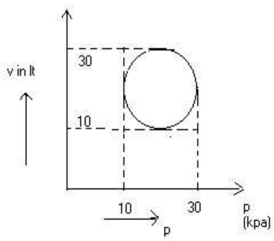
4. A Sample of ideal monoatomic gas is taken round the cycle ABCA as shown in the figure. The work done during the cycle is



1. Zero 2. 3PV 3. 6PV 4. 9PV

5. A gas is compressed at a constant pressure of $50N/m^2$ from a volume of $10m^3$ to a volume of $4m^3$. Energy of 100 J is then added to the gas by heating. Its internal energy is.
1. increased by 400 J 2. increased by 200 J
3. increased by 100 J 4. decreased by 200 J

6. Heat energy absorbed by a system going through a cyclic process shown in figure.



1. $10^7 \pi$ J 2. $10^4 \pi$ J 3.$10^2 \pi$ J 4.$10^{-3} \pi$ J

7. A lead ball moving with a velocity V strikes a wall and stops. If 50% of its energy is converted into heat, The increase in temperature is (Specific heat of lead is S)
1. $2V^2$ / JS 2. V^2 / 4JS
3. V^2 S/ J 4. V^2 S/ 2J

8. Water falls from a height 500m, what is the rise in temperature of water at bottom if whole energy remains in the water ? (J = 4.2)
1. 0.96^0C 2. 1.02^0C 3. 1.16^0C 4. 0.23^0C

9. The isothermal bulk modulus of a gas at atmospheric pressure is
1. $1.293 \times 10^6 Nm^{-2}$ 2. $1.013 X 10^5 Nm^{-2}$
3. accelerator neutrons4. All the these

10. 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
1. isothermal 2. isobaric
3. adiabatic 4. equal in all cases

11. 540 g of ice at 0^0C is mixed with 540 g of water at 80^0C, the final temperature of the mixture in ^0C will be
1. 40 2. 79.9 3. 0 4. 80

12. 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 the mass of gas, when the volume changes from V to 2V at constant pressure P, is
1. $R/(\gamma - 1)$ 2. PV
3. PV / $(\gamma - 1)$ 4. γ PV $(\gamma - 1)$

13. For a gas the difference between the two specific heats is 4150 J/kg K. The specific heats at constant volume of gas if the ratio of specific heat is 1.4 is
1. 8475 J/kg K 2. 5186 J/kg K
3. 1660 J/kg K 4. 10375 J/kg K

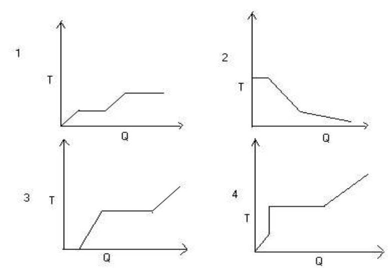
14. When the amount of work done is 333 cal and change in internal energy is 167 cal, then the heat supplied is
1. 166 cal 2. 333 cal
3. 500 cal 4. 400 cal

15. An ideal gas at 27^0C is compressed adiabatically to 8/27 of its original volume. The rise in temperature is (Take γ =5/3)
1. 475^0C 2. 150^0C 3. 275^0C 4. 375^0C

16. Adiabatic modulus of elasticity of a gas is $2.1 \times 10^5 Nm^{-2}$. Its isothermal modulus of elasticity is (C_p / C_v = 1.4)
1. $1.2 \times 10^5 Nm^{-2}$ 2. $1.4 \times 10^5 Nm^{-2}$
3. $1.5 \times 10^5 Nm^{-2}$ 4. $1.8 \times 10^5 Nm^{-2}$

17. Starting with the same initial conditions, an ideal gas expands from volume V_1 to V_2 The amount of work done by the gas is greatest when the expansion is
1. isothermal 2. isobaric
3. adiabatic 4. equal in all cases

18. A block of ice at - 10^0C is slowly heated and converted to steam at 100^0C. Which of the following curves represents the phenomenon qualitatively ?



19. 1g of ice at 0^0C is mixed with 1g of water at 100^0C. The resulting temperature will be
1. ∞ 2. 100^0C 3. 0^0C 4. 5^0C

20. In a thermodynamic process, pressure of a fixed mass of gas is changed in such a manner that the gas releases 20 joule of heat and 8 joule of work was done on the gas. If the initial internal energy of the gas was 30 joule, then the final internal energy will be
1. 2 joule 2. 18 joule 3. 42 joule 4. 58 joule

21. One gram of ice at 0^0C is added to 5 grams of water at 10^0C. If the latent heat of ice be 80 cal/g, then the final temperature of the mixture is :
1. 5^0C 2. 0^0C 3. -5^0C 4. 20^0C

22. Heat required to convert 1 g of ice at 0^0C into steam at 100^0C is
1. 100 cal 2. 0.01 kilo calorie
3. 716 cal 4. 1 kilo calorie

23. Find the change in internal energy of the system when a system absorbs 2 kilocalorie of heat and at the same time does 500 joules of work :
1. 7900 J 2. 8200 J
3. 5600 J 4. 6400 J

KEY

1) 2	2) 3	3) 4	4) 2	5) 1
6) 3	7) 2	8) 3	9) 2	10) 2
11) 3	12) 3	13) 4	14) 3	15) 3
16) 3	17) 2	18) 1	19) 2	20) 2
21) 2	22) 3	23) 1		

HINTS

1. dq=du+dw
2. $T_1^{\gamma} P_1^{1-\gamma} = T_2^{\gamma} P_2^{1-\gamma}$
3. C_P=5/2R,Cv=3/2R

   $\frac{Qv}{QP} = \frac{3}{5}$ here

   Qp = 270J,Qv=124J(nearly)
4. W=area enclosed by the indicator diagram

   $= \frac{1}{2}$ (3V-V) (4P-P)=3PV
5. Acc to 1st low of thermodynamics

   dQ=du+Pdv

   since dv is negative, we get du=400J
6. W=area of loop = $\pi r^2 = \pi (10)2$ J
7. $\frac{1}{2} mv^2 \frac{1}{2}$ = JH = Jmcθ

   $\theta = \frac{v^2}{4Jc}$
8. mgh=mcdθ
9. we know Pv=k

   Pdv+Vdp=0

   P=-$\frac{dp}{dv/v} = Bi$

10. work done is max for Isobaric process

12. du = nc_v dT also $\frac{c_p}{c_v} = \gamma$

    $\frac{c_p - c_v}{c_v} = \gamma - 1$

    ie $c_v = \frac{R}{\gamma - 1}$

    du= $\frac{nr}{\gamma-1} dT = \frac{PdT}{\gamma-1} = \frac{P(2v-v)}{\gamma-1} = \frac{Pv}{\gamma-1}$

13) $C_p - C_v = R$

    $\frac{C_P}{C_V} - 1 = \frac{R}{C_V}$

14) dQ=du+dw=500 cal

15) $pv^{\gamma} = K (or) Tv^{\gamma-1} = const$

16) Bi = $\frac{Ba}{\gamma} = \frac{2.1\times10^5}{1.4} = 1.5\times10^5 N/M^2$

20) du=dQ-dw

23) du=dQ-dw=8400-500=7900 J

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