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Assessment :  
THERMODYNAMICS  
Subject : PHYSICS  
Class : XI

Time : 0000  
Marks: 59

- 1 The door of a running refrigerator inside a room is left open. The correct statement out of the following ones is: 1
- (a) The room will be cooled slightly  
(b) The room will be warmed up gradually  
(c) The room will be cooled to the temperature inside the refrigerator (d) The temperature of the room will remain unaffected.

**Ans :**

(b)

Coefficient of performance of refrigerator is

$$\frac{Q_2}{W} = \frac{T_2}{T_1 - T_2}$$

When the door of a running refrigerator inside a room is left open,  $T_2 \rightarrow T_1$ .

Coefficient of performance increases.  $Q_2$  increases. Therefore, heat energy given to the room increases. Hence the room will be warmed up gradually.

- 2 In an adiabatic change, the pressure  $P$  and temperature  $T$  of a diatomic gas are related by the relation  $P \propto T^c$  where  $c$  equals 1
- (a) 5/3  
(b) 2/5  
(c) 3/5  
(d) 7/2

**Ans :(d)**

Equation of adiabatic change is

$$\therefore P \propto T^{\frac{\gamma}{\gamma-1}}$$

For diatomic gas,  $\gamma = \frac{7}{5}$

$$P \propto T^{7/2}$$

- 3 110 J of heat are added to a gaseous system and its internal energy increases by 40 J, then the amount of work done is: 1

- (a) 150 J
- (b) 70 J
- (c) 110 J
- (d) 40 J

**Ans :**(b)

$$\text{Form } dU + dW = dQ \quad dW = dQ - dU = 110 - 40 = 70 \text{ J}$$

4 The internal energy of an ideal gas depends on: 1

- (a) Pressure
- (b) Volume
- (c) Temperature
- (d) Size of the molecule

**Ans :**(c)

5 A gas performs minimum work when it expands 1

- (a) adiabatically
- (b) isothermally
- (c) isobarically
- (d) isochorically

**Ans :**(d)

In isochoric process,  $V = \text{constant}$ ,  $dV = 0$

$dW = P(dV) = 0$  and hence minimum.

6 **For a gas,  $\gamma = 1.4$ . Then atomicity,  $C_p$  and  $C_v$  of the gas are** 1

(a) **Monoatomic,  $\frac{5}{2}R, \frac{3}{2}R$**

(b) **Monoatomic,  $\frac{7}{2}R, \frac{5}{2}R$**

(c) **Diatomic,  $\frac{7}{2}R, \frac{5}{2}R$**

(d) **Triatomic,  $\frac{7}{2}R, \frac{5}{2}R$**

**Ans :**

(c)

From  $\gamma = \left(1 + \frac{2}{n}\right) = 1.4$ , we get  $n = 5$ , which is the number of degrees of freedom of a diatomic gas.

$$C_v = \frac{n}{2}R = \frac{5}{2}R$$

$$C_p = \left(\frac{n}{2} + 1\right)R = \frac{7}{2}R$$

- 7 The SI unit of mechanical equivalent of heat (J) is 1
- (a) joule/calorie  
 (b) calorie  
 (c) calorie  $\times$  erg  
 (d) erg/calorie

**Ans :**(a)

SI unit of J is joule/calorie.

- 8 A given quantity of an ideal gas is at pressure P and absolute temperature T. 1  
 The isothermal bulk modulus of the gas is
- (a)  $\frac{2}{3}P$                       (b)  $P$   
 (c)  $\frac{2}{3}P$                       (d)  $2P$

**Ans :**(b) $K_i = P =$  the pressure exerted by the gas.

- 9 According to first law of thermodynamics, 1
- (a) heat neither enters nor leaves the system  
 (b) heat is constant in isothermal system  
 (c) energy is conserved  
 (d) none of these

**Ans :**(c)

First law of thermodynamics is the principle of conservation of energy.

- 10 If m is the mass,  $\theta$  is temperature and 'a' is specific heat, then thermal capacity K is given by 1
- (a)  $K = ms\theta$   
 (b)  $K = m\theta$

(c)  $K = \frac{ms}{\theta}$

(d)  $K = ms$

Ans : (d)

Thermal capacity = Mass  $\times$  Specific heat =  $m \times s$

- 11 Efficiency of engine is  $\eta_1$  at  $T_1 = 200^\circ\text{C}$  and  $T_2 = 0^\circ\text{C}$  and  $\eta_2$  at  $T_1 = 0^\circ\text{C}$  and  $T_2 = 200\text{ K}$ . Find the ratio of  $\frac{\eta_1}{\eta_2}$ .

1

(a) 1.00

(b) 0.721

(c) 0.577

(d) 0.34

Ans : (c)

$$\eta_1 = 1 - \frac{273 + 0}{200 + 273} = \frac{200}{473}$$

$$\eta_2 = 1 - \frac{-2000 + 273}{0 + 273} = \frac{200}{273}$$

$$\frac{\eta_1}{\eta_2} = \frac{200}{473} \times \frac{273}{200} = \frac{273}{473} = 0.577$$

- 12 During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature. The ratio CP/CV for gas is

1

(a) 4/3

(b) 2

(c) 5/3

(d) 3/2

Ans : (d)

For an adiabatic change,

$$PT^{\gamma/(1-\gamma)} = \text{constant}$$

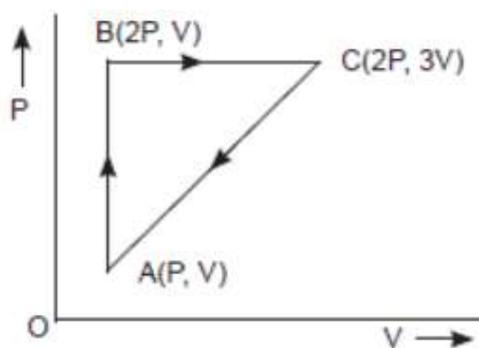
$$\therefore \frac{\gamma}{1-\gamma} = -3 \text{ or } -3 + 3\gamma = \gamma$$

$$2\gamma = 3$$

$$\gamma = \frac{3}{2}$$

- 13 An ideal gas is taken through a cycle ABCA as shown in Fig. The work done during the cycle is:

1



- (a)  $\frac{1}{2}PV$                       (b)  $2PV$   
 (c)  $4PV$                             (d)  $PV$

Ans : (d)

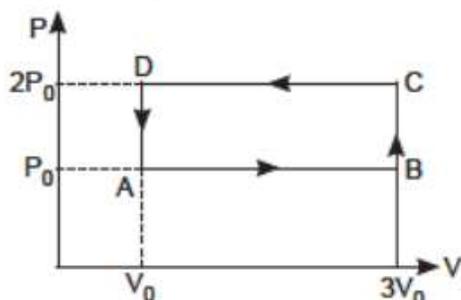
Work done = Area of  $\Delta ABC$

$$= \frac{1}{2}BC \times AB = \frac{1}{2}(3V - V)(2P - P)$$

$$W = PV$$

- 14 An ideal gas undergoes cyclic process ABCDA as shown in given P-V diagram (Fig.).

1



The amount of work done by the gas is:

- (a)  $6P_0V_0$   
 (b)  $-2P_0V_0$   
 (c)  $+2P_0V_0$   
 (d)  $+4P_0V_0$

Ans :

(b)

Work done = Change in pressure  $\times$  Change in volume =  $(2P_0 - P_0)(3V_0 - V_0) = 2P_0V_0$

Since the cyclic process is anticlockwise, work done by the gas is negative, i.e.,  $-2P_0V_0$ .

- 15 Three copper blocks of masses  $M_1$ ,  $M_2$  and  $M_3$  kg respectively are brought into thermal contact till they reach equilibrium. Before contact, they were

1

at  $T_1, T_2, T_3$  ( $T_1 > T_2 > T_3$ ). Assuming there is no heat loss to the surroundings, the equilibrium temperature  $T$  is: (s is specific heat of copper)

$$(a) \quad T = \frac{T_1 + T_2 + T_3}{3}$$

$$(b) \quad T = \frac{M_1 T_1 + M_2 T_2 + M_3 T_3}{M_1 + M_2 + M_3}$$

$$(c) \quad T = \frac{M_1 T_1 + M_2 T_2 + M_3 T_3}{3(M_1 + M_2 + M_3)}$$

$$(d) \quad T = \frac{M_1 T_1 s + M_2 T_2 s + M_3 T_3 s}{M_1 + M_2 + M_3}$$

**Ans :**

(b)

Since there is no heat loss to the surroundings, total heat content at equilibrium after contact = total heat content before contact

$$\text{i.e., } (M_1 + M_2 + M_3)sT = M_1 s T_1 + M_2 s T_2 + M_3 s T_3$$

$$\text{or } T = \frac{M_1 T_1 + M_2 T_2 + M_3 T_3}{M_1 + M_2 + M_3}$$

16 An ideal heat engine exhausting heat at  $27^\circ \text{C}$  is to have 25% efficiency. It must take heat at

1

- (a)  $127^\circ \text{C}$
- (b)  $227^\circ \text{C}$
- (c)  $327^\circ \text{C}$
- (d)  $673^\circ \text{C}$

**Ans :(a)**

17A carnot engine working between 300 K and 600 K has work output of 800 J per cycle. The amount of heat energy supplied to the engine from source in each cycle is

1

- (a) 800 J
- (b) 1600 J
- (c) 3500 J
- (d) 6400 J

**Ans :(b)**

18A given system undergoes a change in which work done by the system equals the decrease in its internal energy. The system must have undergone

1

- (a) isothermal change

- (b) adiabatic change
- (c) isobaric change
- (d) isochoric change

**Ans :**

(b)

When a gas expands suddenly, (adiabatic change) work is done by the gas. Therefore, internal energy of the system decreases.

- 19 During melting of a slab of ice at  $273^{\circ}\text{K}$  at atmospheric pressure, 1
- (a) positive work is done by ice water system on the atmosphere
  - (b) positive work is done on ice water system by the atmosphere
  - (c) internal energy of ice water system increases
  - (d) internal energy of ice water system decreases.

**Ans :**

(b)

During melting of ice, volume decreases. Therefore, positive work is done on the system by the atmosphere. Also heat spent in melting increases the internal energy of ice-water system.

- 20 One mole of an ideal gas at an initial temperature of  $T\text{K}$  does  $6R$  joule of work adiabatically. If the ratio of specific heats of this gas at constant pressure and at constant volume is  $5/3$ , the final temperature of the gas will be: 1
- (a)  $(T + 4)K$
  - (b)  $(T - 4)K$
  - (c)  $(T + 2.4)K$
  - (d)  $(T - 2.4)K$

**Ans :** (b)

Here,  $T_1 = T$ ,  $W = 6R$

$$\gamma = \frac{C_p}{C_v} = \frac{5}{3}, T_2 = ?$$

In an adiabatic process,

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

$$6R = \frac{R(T_2 - T_1)}{1 - 5/3}$$

$$T_2 - T = 6 \left( -\frac{2}{3} \right) = -4$$

$$T_2 = (T - 4)K$$

21A carnot engine whose sink is at 300 K has an efficiency of 40%. By how much should the temperature of source be increased so as to increase its efficiency by 50% of original efficiency.

1

- (a) 380 K
- (b) 275 K
- (c) 325 K
- (d) 250 K

Ans : (d)

Here,  $T_2 = 300$  K,  $\eta_1 = 40\%$

$$\eta_1 = 1 - \frac{T_2}{T_1}$$

$$\frac{40}{100} = 1 - \frac{300}{T_1}$$

$$\therefore T_1 = 500 \text{ K}$$

$$\eta_2 = 40\% + \frac{50}{100} \times 40\% = 60\%$$

$$T_2 = 300 \text{ K}, T_1 = ?$$

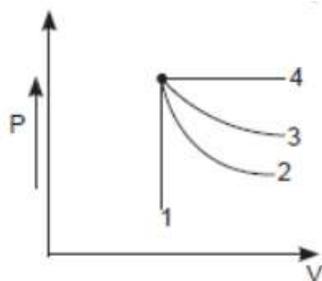
As  $\eta_2 = 1 - \frac{T_2'}{T_1'}$

$$\therefore \frac{60}{100} = 1 - \frac{300}{T_1'} \text{ or } T_1' = 750 \text{ K}$$

$$T_1' - T_1 = 250 \text{ K}$$

22An ideal gas undergoes four different processes from the same initial state (figure). Four processes are adiabatic, isothermal, isobaric and isochoric. Out of 1, 2, 3 and 4 which one is adiabatic?

1



- (a) 4
- (b) 3
- (c) 2
- (d) 1

Ans :(c)

- 23 If an average person jogs, he produces  $14.5 \times 10^3$  cal/min. This is removed by the evaporation of sweat. The amount of sweat evaporated per minute (assuming 1 kg requires  $580 \times 10^3$  cal for evaporation) is: 1
- (a) 0.025 kg  
 (b) 2.25 kg  
 (c) 0.05 kg  
 (d) 0.20 kg

**Ans :**(a)

Amount of sweat evaporated/min

$$\frac{14.5 \times 10^3 \text{ cal/min}}{580 \times 10^3 \text{ cal/kg}} = 0.025 \text{ kg}$$

- 24 What is the value of  $\gamma$  for a gas having ' $n$ ' degrees of freedom ? 1

**Ans :** For  $n$  degrees of freedom,

$$C_v = \frac{n}{2}R, C_p = \left(\frac{n}{2} + 1\right)R$$

$$\therefore \gamma = \frac{C_p}{C_v} = \frac{\frac{n}{2} + 1}{n/2} = \frac{2+n}{n}$$

- 25 What is the thermodynamical work in a reversible process ? 1

**Ans :**Zero.

- 26 Work depends on path in a thermodynamical process. How ? 1

**Ans :**

Depending on the process carried out, the work done varies. So, it is dependent on path.

- 27 Change in internal energy is independent of path followed. Is it true ? Why ? 1

**Ans :**

Yes, change in internal energy depends on the change in temperature alone. So, it is independent of path.

- 28 What are the four steps in a Carnot's engine ? 1

**Ans :**

Isothermal expansion, adiabatic expansion, isothermal compression and adiabatic compression are four steps.

- 29 State Carnot's principle. 1

**Ans :**

No engine working between two temperatures can be more efficient than a Carnot's reversible engine working between the same temperatures.

30 Write the second law of thermodynamics.

1

**Ans :**

According to second law, it is not possible to cool a system cooler than its surroundings without doing work on it.

31 Is first law a conservation law ? How ?

1

**Ans :**

Yes, the total heat energy change is the sum of the internal energy change and work done.  $\Delta Q = \Delta U + \Delta W$ .

32 What is the principle of calorimetry.

1

**Ans :**

Heat lost by a body is equal to heat gained by the other when they are mixed.

33 Is it possible to heat a body without providing heat energy ? How ?

1

**Ans :**Yes. By doing work to change its volume (decrease).

34 Is it possible to liquefy a gas at any condition ?

1

**Ans :**

No. Beyond critical temperature, it is not possible to liquefy however large the pressure may be.

35 Why can a Carnot's engine not get 100% efficiency ?

1

**Ans :**

Due to transmission loss, the energy required to carry the process itself and the inability to build a sink at zero kelvin, one cannot get 100% efficient Carnot's engine.

36 How much will be the internal energy change in (i) Isothermal process (ii) Adiabatic process ?

1

**Ans :**(i) Zero, (ii)  $nC_v dT$ .

37 At what temperature do the Celsius and Fahrenheit scales coincide ?

1

**Ans :-** 40°C.

38 At what temperature do the Kelvin and Celsius scales coincide ? 1

**Ans :** Kelvin and Celsius scales never coincide.

39 What is the temperature at the bottom of a lake when water gets frozen with -ve temperature in the atmosphere ? 1

**Ans :** It can go down only upto 4°C.

40 A body at higher temperature contains more heat. Comment. 1

**Ans :**

The statement may not be true always because heat content of a body depends on mass of body, its specific heat and temperature.

41 Can water be made to boil without heating ? 1

**Ans :**

Yes, by reducing pressure on water, boiling point of water can be brought down to room temperature.

42 Name the principle used in the mercury thermometer. 1

**Ans :**

It is based on the fact that the change in volume of mercury is nearly proportional to the change in temperature.

43 What thermodynamic variable is defined by (a) Zeroth law (b) First law ? 1

**Ans :** Zeroth law defines temperature and first law defines internal energy.

44 Three stars A, B, C appear as green, red and blue respectively. Which star has minimum temperature ? 1

**Ans :**

As  $T \propto \frac{1}{\lambda_m}$  and  $\lambda_m$  for red colour is maximum, therefore temperature T is minimum for star B emitting red colour.

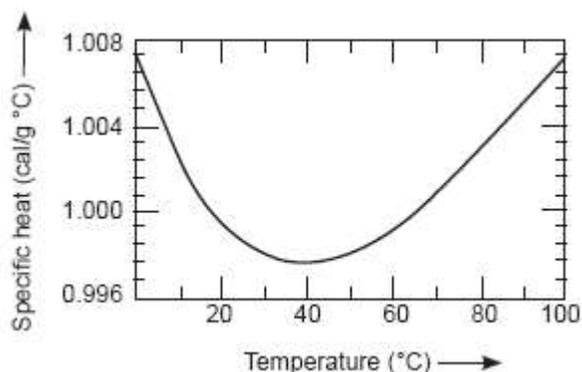
45 Do all solids expand on heating ? Name the solid that contracts on heating. 1

**Ans :** No. Camphor.

46 Plot a graph showing the variation of specific heat of water with temperature. 1

**Ans :**

Variation of specific heat of water with temperature :



47 Name the gas commonly used in refrigerators. 1

**Ans :** Freon ( $\text{CCl}_2\text{F}_2 \rightarrow$  dichloro fluoromethane).

48 What is the value of specific heat of water in S.I. units ? Does it vary with temperature? 1

**Ans :**

Specific heat of water is  $4180 \text{ J kg}^{-1} \text{ K}^{-1}$ . Yes, it does vary little with temperature.

49 If on giving 40 J of heat to a system, work done on the system is 10 J. What will be the change in internal energy of the system ? 1

**Ans :** Internal energy of the system will increase by  $40 + 10 = 50$  joule.

50 In summer, when the valve of a bicycle tube is removed, the escaping air appears cold. Why ? 1

**Ans :**

This happens due to adiabatic expansion of the air of the tube of the bicycle.

51 A cloudy night is hotter than a clear sky night. Why ? 1

**Ans :**

This is because in the cloudy night, heat radiated out from earth is reflected by the clouds back to earth. Hence, temperature of the earth does not fall.

52  $C_p$  is greater than  $C_v$ , why ? 1

**Ans :**

$C_p$  is greater since under constant pressure process, the energy also does work.

53 State First law of thermodynamics. 1

**Ans :**

According to first law of thermodynamics when some quantity of heat ( $dQ$ ) is supplied to a system capable of doing external work, then quantity of heat absorbed by the system ( $dQ$ ) is equal to sum of increase in internal energy of system ( $dU$ ) due to rise in temperature and external work done by system ( $dW$ ) in expansion i.e.

$$dQ = dU + dW$$

54 What is the specific heat of a gas in an isothermal process and in an adiabatic process ? 1

**Ans :** Since  $s = \frac{Q}{m\Delta t}$

For isothermal process,  $s = \infty$  ( $\because \Delta t = 0$ )

For adiabatic process,  $s = 0$ . ( $\because \Delta Q = 0$ )

55 Put a piece of chalk into water. The chalk will emit bubbles in all directions. Explain. 1

**Ans :**

The perforations in it will get filled with water and the air is released as bubble.

56 A piece of lead is hammered. Does its internal energy increase ? Does the heat enter the lead from outside ? 1

**Ans :**

Yes, internal energy of lead increases. No heat energy from outside enters the lead.

57 What is calorimetry ? What is the principle of calorimetry ? 1

**Ans :**

Calorimetry deals with the measurement of heat. The vessel which is largely used in such a measurement is called a calorimeter. The principle of calorimetry is

Heat Gained = Heat Lost

58 What happens to the change in internal energy of a gas during  
(i) isothermal expansion ?  
(ii) adiabatic expansion ? 1

**Ans :** (i) For isothermal process,  $dU = 0$  as  $dT = 0$  and  $dV = nC_v dT$   
 $\therefore$  Internal energy remains same.  
(ii) Internal energy decreases.

59 Write the statements of second law of thermodynamics applicable to  
(i) Heat engine  
(ii) Refrigerator. 1

**Ans :**

(i) **Heat engine** – One cannot devise a process whose only purpose is to convert heat into work.

(ii) **Refrigerator** – One cannot make heat to flow from a cold to a hot body by itself, without using any external agency.