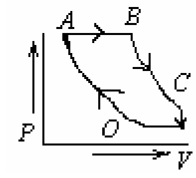
THERMODYNAMICS

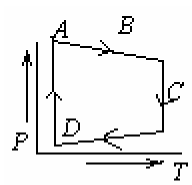
PREVIOUS EAMCET QUESTIONS

ENGINEERING

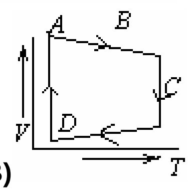
1. An ideal gas is subjected to a cyclic process ABCD as depicted in the P-V diagram given below :

Which of the following curves represents the equivalent cyclic process :

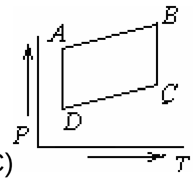




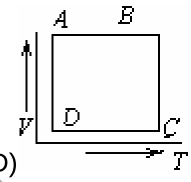
A)



B)



C)



D)

1) A 2) B 3) C 4) D

(2009 E)

Ans : 1

Sol: In P,V diagram process AB is isobaric process in which pressure remains constant.

Process BC is isothermal process in which, temperature remains constant.

Process CD is isochoric process in which, volume remains constant.

Process AD is adiabatic process in which no exchange of heat takes place.

2. An ideal gas is subjected to a cyclic process involving four thermodynamic states; the amount of heat (Q) and work (W) involved in each these states are **(2009 E)**

Q_1 =6000J, Q_2 =-5500J, Q_3 =-3000J, Q_4 =+3500J

W_1 =2500J, W_2 =-1000J, W_3 =-1200J, W_4 =X.J

The ratio of network done by gas to the total heat absorbed by the gas is η. The value of x and η are nearly

1)500:7.5% 2)700:10.5 % 3)1000:21% 4)1500:15%

Ans :2

Sol: Total heat in the process = Q = $Q_1+Q_2+Q_3+Q_4$

$$\Rightarrow Q = 6000 + (-5500) + (-3000) + 3500$$

$$\Rightarrow Q = 1000J$$

Total work done in the process = W = $W_1+W_2+W_3+W_4$

$$\Rightarrow W = 2500 + (-1000) + (-1200) + x$$

$$\Rightarrow W = 300 + x$$

$\therefore$ Total heat = Total work

1000 = 300 + x

$$\Rightarrow x = 700J$$

$$\eta = \frac{net\ work\ done}{total\ heat\ absrobed}$$

$$\eta = \left[\frac{1000}{6000+3500}\right] \times 100$$

= 10.5%

3. Two cylinders A and B fitted with pistons contain equal number of moles of an ideal monoatomic gas at 400 K. The piston of A is free to move while that of B is held fixed, same amount of heat energy is given to the gas in each cylinder. If the rise in temperature of the gas in A is 42K., The rise in temperature of the gas in B is $(\gamma = 5/3)$ **(2009 E)**

1)21K 2)35 K 3)42 K 4)70 K

Ans :4

Sol: Process A is at constant pressure

$$\therefore (dQ)_p = nc_p (dT)_A$$

Process B is at constant volume

$$\therefore (dQ)_V = nc_V (dT)_B$$

As same amount of heat energy is given to both the cylinders A and B

$$\therefore nc_P (dT)_A = nc_V (dT)_B$$

$$\Rightarrow \frac{5R}{2} \times 42 = \frac{3R}{2} \times (dT)_B$$

[For monoatomic gas CP = 5R/2, CV = 3R/2]

$$\Rightarrow (dT)_B = 70K$$

4. In the adiabatic compression the decrease in volume is associated with **(2008 E)**
1) increase in temperature and decrease in pressure
2) decrease in temperature and increase in pressure
3) decrease in temperature and decrease in pressure
4) increase in temperature and increase in pressure

Ans : 4

Sol: In any compression, the decrease in volume is associated with increase in temperature. As volume decreases pressure increases.

5. Which of the following is true in the case of an adiabatic process where $\gamma = \frac{C_p}{C_v}$? **(2008 E)**

1) $p^{1-\gamma}T^{\gamma} = constant$ 2) $pT^{\gamma} = constant$

3) $p^{\gamma}T^{\gamma} = constant$ 4) $pT = constant$

Ans:1

Sol: In Adiabatic process, the relation between P & T is $P^{1-\gamma}T^{\gamma}$ = constant.

6. The temperature of the system decreases in the process of **(2007 E)**
1) Free expansion
2) Adiabatic expansion
3) Isothermal expansion
4) Isothermal compression

Ans : 2

Sol: In adiabatic expansion, work done is at the expense of internal energy.

Therefore temperature decreases

7. Two cylinders A and B fitted with pistons contain equal number of moles of an ideal monoatomic gas at 400 K. The piston of A is free to move while that of B is held fixed, same amount of heat energy is given to the gas in each cylinder. If the rise in temperature of the gas in A is 42K., The rise in temperature of the gas in B is $\left(\gamma = 5/3\right)$ **(2009 E)**

1)21K 2)35 K 3)42 K 4)70 K

Ans :4

Sol: Process A is at constant pressure

$$\therefore \left(dQ\right)_p = nc_p\left(dT\right)_A$$

Process B is at constant volume

$$\therefore \left(dQ\right)_V = nc_V\left(dT\right)_B$$

As same amount of heat energy is given to both the cylinders A and B

$$\therefore nc_P\left(dT\right)_A = nc_V\left(dT\right)_B$$

$$\Rightarrow \frac{5R}{2}\times 42 = \frac{3R}{2}\times\left(dT\right)_B$$

[For monoatomic gas CP = 5R/2, CV = 3R/2]

8. A given mass of a gas is compressed isothermaly until its pressure is doubled. It is then allowed to expand adiabatically until its original volume is restored and its pressure is then found to be 0.75 of its initial pressure. The ratio of the specific heats of the gas is approximately : **(E 2006)**

1) 1.20 2) 1.41 3) 1.67 4) 1.83

Ans :2

Sol: In Isothermal process temperature remains constant

$$\therefore P_1V_1 = P_2V_2$$

Given $\therefore P_2 = 2P_1 \Rightarrow V_2 = \frac{V_1}{2}$

In Adibatic process PV^γ = constant

$$\Rightarrow P_1V_1^\gamma = P_2V_2^\gamma$$

Given P_1 = 2P, $P_2 = \frac{3P}{4}$

$$\Rightarrow \frac{P_1}{p_2} = \left(\frac{V_2}{V_1}\right)^2$$

$$\Rightarrow \left(\frac{2P}{3P/4}\right) = \left(\frac{2}{1}\right)^2$$

[As volume is restored]

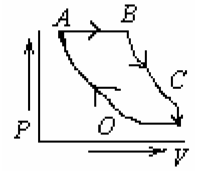
$$\Rightarrow \frac{8}{3} = 2^\gamma$$

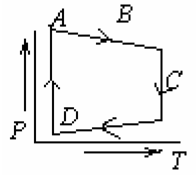
Taking log on both sides

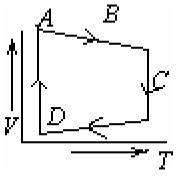
$$\Rightarrow \log\frac{8}{3} = \gamma\log 2$$

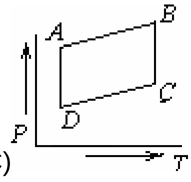
On solving γ = 1.41

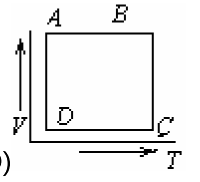
9. An ideal gas is subjected to a cyclic process ABCD as depicted in the P-V diagram given below : Which of the following curves represents the equivalent cyclic process :



A) 

B) 

C) 

D) 

1) A 2) B 3) C 4) D

(2006 E)

Ans : 1

Sol: In P,V diagram process AB is isobaric process in which pressure remains constant.

Process BC is isothermal process in which, temperature remains constant.

Process CD is isochoric process in which, volume remains constant.

Process AD is adiabatic process in which no exchange of heat takes place.

10. 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 **(2005 E)**

1) $\frac{\gamma - 1}{PV}$ 2) PV 3) $\frac{PV}{\gamma - 1}$ 4) V

Ans : 3

Sol: From Ist law of thermodynamics

$$dQ = du + dw$$

$$\Rightarrow dw = dQ - du$$

dw = work done = P.dv, dQ = nc_P dT, du = nc_v dT

$$\Rightarrow du = n\left(c_p - c_v\right)dT \text{ ....(1)}$$

But $\Rightarrow du = nc_v dT$ ....(2)

Dividing (1) & (2)

$$\Rightarrow \frac{P\left[V_2 - V_1\right]}{du} = \frac{n\left(c_p - c_v\right)dT}{nc_v dT}$$

$$\Rightarrow \frac{P\left[2V - V\right]}{du} = \frac{C_P}{C_V} - \frac{C_V}{C_V}$$

$$\Rightarrow \frac{PV}{du} = r - 1$$

$$\Rightarrow du = \frac{PV}{r-1}$$

11. Two identical containers A and B with frictionless pistons contain the same ideal gas at the same temperature and same volume V. The mass of the gas in A is m_A and that in B is m_B. The gas in each cylinder is now allowed to expand isothermally to the final volume2V. The changes in the pressure in A and B are found to be ΔP and $1.5\Delta P$ respectively. Then **[2005 E]**

1) $4m_A = 9m_B$ 2) $2m_A = 3m_B$ 3) $3m_A = 2m_B$ 4) $9m_A = 4m_B$

Ans : 3

Sol: According to the ideal gas equation $\frac{P_1}{m_1} = \frac{P_2}{m_2}$

12. 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) **(2004 E)**

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

Ans :3

Sol: From the adiabatic relation between P, V

$$P_1V_1^2 = P_2V_2^2$$

$$\Rightarrow P_1\left(\frac{m}{d_1}\right)^r = P_1\left(\frac{m}{d_2}\right)^r$$

$$\frac{P_2}{P_1} = \left(\frac{d_2}{d_2}\right)^r = (32)^{7/5} = 2^7 = 128$$

13. 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 **(2004 E)**

1) 550^0C 2) 500^0C 3) 550K 4) 500 K

Ans :

Sol: Resultant temperature of mixture = $\frac{n_1T_1 + n_2T_2}{n_1 + n_2}$

$$= \frac{4\times 400 + 2\times 700}{4+2}$$

= 500 K

14. The temperature of 5 moles of a gas at constant volume is changed from 100^0C to 120^0C. The change in internal energy is 80J. The heat capacity of the gas at constant volume will be (in J/K) **(2003 E)**

1) 8 2) 4 3) 0.8 4) 0.4

Ans:2

Sol: Thermal capacity = $\frac{dQ}{dT}$

At constant volume dV = 0

$$\therefore dQ = du$$

$$\therefore \frac{dQ}{dT} = \frac{du}{dT} = \frac{80}{120-100} = 4$$

15. 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. $\frac{5}{14}\frac{\pi^2 r^2 n^2}{s}$

Ans:1

Sol : According to Joule's law $\Rightarrow W = J(ms\theta)$

$$\frac{1}{2}\left[\frac{1}{2}I\omega^2\right] = ms(d\theta)$$

For a sphere $I = \frac{2}{3}mr^2$

$$\Rightarrow \frac{1}{4}\left[\frac{2}{5}mr^2\right]\omega^2 = ms(d\theta)$$

$$\Rightarrow \frac{1}{4}\left[\frac{2}{5}mr^2\right](4\pi^2 n^2) = ms(d\theta)$$

$$\therefore (d\theta) = \frac{2}{5}\frac{\pi^2 n^2 r^2}{S}$$

16. 5 moles of hydrogen $\left(\gamma_1 = \frac{7}{5}\right)$ initially 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) **(2002 E)**

1.21.55 2.41.5 3.65.55 4.80.55

Ans :2

Sol : Increase in internal energy = nC_v dT

$$du = n\left[\frac{R}{\gamma-1}\right]dT = 5\left[\frac{8.3}{7/5-1}\right](400)$$

= 41500 J=41.5 KJ

17. A lead bullet of 10 g travelling with 300 m/s strikes against a block of wood and comes to rest. Assuming 50% of heat is absorbed by the bullet, the increase in its temperature is (Sp. heat of lead is 150 $Jkg^{-1} k^{-1}$) **(2001 E)**

1. 100^0C 2. 125^0C 3. 150^0 C 4. 200^0C

Ans :3

Sol: According to Joule's law $\Rightarrow W = J(ms\theta)$

50% of heat is absorbed by the bullet

$$= \frac{1}{2}\left[\frac{1}{2}mv^2\right] = J[ms\theta]$$

$$\Rightarrow \theta = \frac{v^2}{J(4s)} = \frac{(300)(300)}{4(150)} = 150^0 C$$

18. 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 **(2001 E)**

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

Ans :3

Sol: We know $P_1 v_1^r = P_2 v_2^r$

$$\frac{P_1}{d_1^r} = \frac{P_2}{d_2^r} \Rightarrow \frac{P}{d^r} = \frac{P^1}{d_1^\gamma}$$

$$\Rightarrow \frac{P^1}{P} = \left(\frac{d_1}{d}\right)^\gamma = (32)^{7/5}$$

$= 2^7 = 128$

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) **(2000 E)**

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

Ans :4

Sol: For an adiabatic medium, $P^{\gamma-1} \alpha T^r$

According to the given problem, $P \alpha T^3$

$$\therefore T^{3(\gamma-1)} \alpha T^\gamma$$

$$\Rightarrow 3(\gamma - 1) = \gamma \Rightarrow \gamma = \frac{3}{2}$$

20. An ideal gas of a pressure of 1 atmosphere and temperature of 27°C is compressed adiabatically unit its pressure becomes 8 times the initial pressure, then the final temperature is **(2000 E)**

1. 627 ^{0}C 2. 527 ^{0}C 3. 427 ^{0}C 4. 327 ^{0}C

Ans : 4

Sol: We know $\frac{P_1^{\gamma-1}}{P_1^\gamma} = \frac{P_2^{\gamma-1}}{P_2^\gamma}$

P_1 = 1 atm; T_1 = 300 K; $\gamma = \frac{3}{2}$

P_2 = 8 atm; T_2 = ?

$$\therefore \frac{(1)^{3/2}}{(300)^{3/2}} = \frac{(8)^{1/2}}{(T_2)^{3/2}}$$

Squaring on both sides

$$\frac{(1)}{(300)^3} = \frac{8}{T_2^3}$$

$$\therefore T_2 = 600K = 327^0 C$$

21. Two liquids at temperatures 60^{0}C and 20^{0}C 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 **(2000 E)**

1. 70^{0}C 2. 40^{0}C 3. 50^{0}C 4. 35^{0}C

Ans:4

Sol: Heat lost by Hot liquid = Heat gained by cold liquid

$$\Rightarrow (mst)_{Hot\,liquid} = (mst)_{cold\,liquid}$$

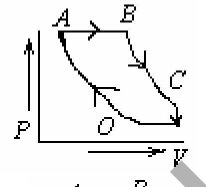
$$\Rightarrow (3)(4)(60-t) = (4)(5)(t-20)$$

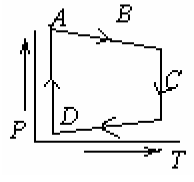
Where 't' is resultant temperature

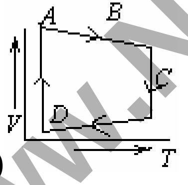
$$\Rightarrow 8t = 280^0 \Rightarrow t = 35^0 C$$

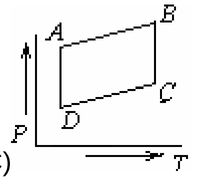
MEDICAL

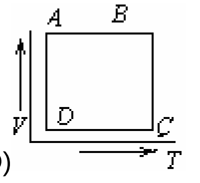
22. An ideal gas is subjected to a cyclic process ABCD as depicted in the P-V diagram given below : Which of the following curves represents the equivalent cyclic process :



A) 

B) 

C) 

D) 

1) A 2) B 3) C 4) D

(2009 M)

Ans : 1

Sol: In P,V diagram process AB is isobaric process in which pressure remains constant.

Process BC is isothermal process in which, temperature remains constant.

Process CD is isochoric process in which, volume remains constant.

Process AD is adiabatic process in which no exchange of heat takes place.

23. How much heat energy in joules must be supplied to 14 gms of nitrogen at room temperature to raise its temperature by 40^{0}C at constant pressure (Mol. wt. of N_2= 28 gm, R= constant) **[2009 M]**

1) 50 R 2) 60 R 3) 70 R 4) 80 R

Ans :3

Sol: Amount of Heat supplied = $Q = nc_p(dT)$

But n = no of moles = $\frac{mass}{mol.wt} = \frac{m}{M}$

$$\therefore Q = \frac{m}{M} C_p \left(dT \right)$$
$$= \frac{14}{28} \times \frac{7R}{2} \times 40 = 70R$$

24. A lead bullet, of initial temperature 27^0C and speed 'v' kmph penetrates into a solid object and melts. If 50% of the kinetic energy is used to heat it, the value of v in kmph is (for lead melting point = 600K, latent heat of fusion = $2.5 \times 10^4 \, Jkg^{-1}$ specific heat $125 Jkg^{-1} K^{-1}$).

1) 3600 2) 1800 3) 1200 4) 1000

Ans :2

Sol: According to Joules law

$$\omega = JQ$$
$$\therefore \frac{1}{2} mv^2 = J\left[ms\Delta t + mL \right]$$

But 50% of K.E. is used to heat it

$$\therefore V = \sqrt{4\left[S\Delta t + L \right]}$$
$$= \sqrt{4\left[125 \times 300 + 2.5 \times 10^4 \right]}$$
$$= 2 \times 250 = 500 ms^{-1}$$

V in kmph = $500 \times \frac{18}{5} = 1800$

25. One mole of an ideal gas undergoes an isothermal change at temperature T so that its volume v is doubled .R is the molar gas constant. The work done by the gas during this change is **(2008 M)**

1) $RT \log 4$ 2) $RT \log 2$ 3) $RT \log 1$ 4) $RT \log 3$

Ans : 2

Sol: W = Amount of work done is Isothermal process

$$= nRT \log_e \left(\frac{V_2}{V_1} \right)$$
$$= 1\left(RT \right) \log_e \left(\frac{2V}{V} \right)$$

= RT log 2

26. 10 gm of ice at 10^0C is mixed with 100 gm of water at 50^0C contained in a calorimeter weighting 50gm. (specific heat of water = 1 calgm^{-10}C and specific heat of copper = 0.09 cal gm^{-10}C). The final temperature reached by the mixture is **[2007 M]**

1) 25.5^0C 2) 30.0^0C 3) 38.2^0C 4) 40.0^0C

Ans: 3

Sol: According to the principle of method of mixtures

Heat lost by Hot bodies = Heat gained by cold bodies

$$\Rightarrow m_\omega s_\omega \Delta t + m_c s_c \Delta t = m_1 s_1 \Delta t + m_i s_w Dt$$

$$\Rightarrow 100 \times 1 \times \left(50 - t_R \right) + 50 \times 0.09 \times \left(50 - t_R \right) = 10 \times \frac{1}{2} \times \left(0 - 10 \right) + 10 \times 80 + 10 \times 1 \times \left(t_R - 0 \right)$$

On solving $t_R = 38.2^0$C

27. For an adiabatic process the relation between V and T is given by **(2007 M)**

1) $TV^{\gamma} =$ constant 2) $T^{\gamma}V =$ constant 3) $TV^{1-\gamma} =$ constant 4) $TV^{\gamma-1} =$ constant

Ans : 4

Sol: The adiabatic relation between V & T is

$$TV^{\gamma-1} = \text{constant}$$

28. Consider the following two statements and choose the correct answer :
A) If heat is added to a system its temperature must always increase
B) If positive work is done by a system in thermodynamic process its volume must increase **(2007 M)**

1) Both (A) and (B) are correct 2) (A) is correct but (B) is wrong
3) (B) is correct but (A) is wrong 4) Both (A)and (B)are wrong

Ans :3

Sol: A) It is not necessary in all cases because in Isothermal process temperature remains constant

B) If work is done by the system then the work is called positive and the volume increases.

29. An ideal gas after going through a series of four thermodynamic states in order reaches the initial state again (cyclic process) the amounts of heat (Q) and work (W) involved in the states are

Q_1=6000J, Q_2=-5500J, Q_3=-3000J, Q_4=+3500J

W_1=2500J, W_2=-1000J, W_3=-1200J, W_4=X.J

The ratio of net work done by gas to the total heat absorbed by the gas is η the value of x and η are nearly **(M 2006)**

1)500:7.5 2)700:10.5 3)1000:21 4)1500:15

Ans :2

Sol: Total heat in the process = Q = $Q_1+Q_2+Q_3+Q_4$

$$\Rightarrow Q = 6000+(-5500)+(-3000)+3500$$

$$\Rightarrow Q = 1000J$$

Total work done in the process = W = $W_1+W_2+W_3+W_4$

$$\Rightarrow W = 2500+(-1000)+(-1200)+x$$

$$\Rightarrow W = 300+x$$

$\therefore$ Total heat = Total work

1000 = 300 + x

$$\Rightarrow x = 700J$$

$$\eta = \frac{net\ work\ done}{total\ heat\ absrobed}$$

$$\eta = \left[\frac{1000}{6000+3500}\right]\times 100$$

= 10.5%

30. 'm' grams of a gas of molecular weight M is flowing in an isolated tube with velocity V. If the gas flow is suddenly stopped the rise in its temperature is : (γ = ratio of specific heats; R = universal gas constant;

J = mechanical equivalent of heat) **[2006 M]**

1) $\frac{MV^2(\gamma-1)}{2RJ}$ 2) $\frac{m}{M}\frac{V^2(\gamma-1)}{2RJ}$ 3) $\frac{mV^2\gamma}{2RJ}$ 4) $\frac{MV^2\gamma}{2RJ}$

Ans : 1

Sol: According to Joules law $W = JQ$

$$\Rightarrow \frac{1}{2}mv^2 = JQ \Rightarrow \frac{1}{2}mv^2 = J\left[ms\Delta t\right]$$

31. A bullet of mass 10×10^{-3} kg moving with a speed of 20 ms^{-1} hits an ice $\left(0^0 c\right)$ block of 990 g kept at rest on a frictionless floor and gets embedded in it, If ice takes 50% of K.E. (in grams) approximately is :(J=4.2 J/Cal) (Latent heat of ice =80 cal/g) **(2006 M)**

1) 6 2)3 3) 6×10^{-3} 4) 3×10^{-3}

Ans : 2

Sol: According to the law of conservation of momentum

$$m_1v_1 = \left(m_1 + m_2\right)v_2$$

$$10\times10^{-3}\times20 = 1000\times10^{-3}\times V_2$$

$$V_2 = 0.2ms^{-1} = 2\times10^{-1}$$

Amount of energy lost by system

$$= \frac{1}{2}m_1v_1^2 - \frac{1}{2}\left(m_1+m_2\right)v_2^2$$

$$= \frac{1}{2}\times10\times10^{-3}\times400 - \frac{1}{2}\times10^3\times10^{-3}\times4\times10^{-2}$$

= 2 – 0.02

= 1.98 J

$\therefore$ As 50% of K.E. is lost by the system

$\therefore$ from joules law

W = JQ

$$\frac{1}{2}\left[1.98\right] = m\times80\times4200$$

$$\therefore m = 3\times10^{-3}kg$$

= 3 g

32. 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 $3.36\times10^5\,Jkg^{-1}$) **(2005 E)**

1) 10^{-3} 2) 1.5×10^{-3} 3) 2×10^{-3} 4) 2.5×10^{-3}

Ans : 1

Sol: According Joules law

$$W = JQ \Rightarrow \frac{1}{2}mv^2 = J\left[mL\right]$$

$\frac{1}{2}M_{ice}v^2 =$ mass of ice melt $\times$ Latent heat of ice

$$\therefore \frac{1}{2}\times42\times4^2 = m\times80\times4200$$

$$\Rightarrow m = \frac{21\times 16}{80\times 4200} = 10^{-3} kg$$

33. The sample of the same gas, x, y and z, for which the ratio of specific heats $\gamma = 3/2$ 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 **(2004 M)**

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

Ans :2

Sol: Sample x : Adiabatic process

$$P_x V_1^{\gamma} = P_x^1 V_2^{\gamma}$$

$$P_x^1 = \left(\frac{V_1}{V_2}\right)^{\gamma} P_x$$

$$= \left(\frac{V}{2V}\right)^{1.5} P_x = \frac{P_x}{2\sqrt{2}} \text{ ....(1)}$$

Sample Y = Isobaric process

$$P_y^1 = P_y \text{ ....(2)}$$

Sample Z = Isothermal process

$$P_1 V_1 = P_Z V_Z \Rightarrow P_Z^1 V_Z^1 = P_Z V_Z$$

$$P_Z{}^1 = \frac{P_Z V_Z}{V_Z^1} = \frac{P_Z V_Z}{2V_Z} = \frac{P_Z}{2} \text{ ....(3)}$$

From (1), (2) and (3)

$$P_x{}^1 : P_y{}^1 : P_z{}^1 = \frac{P_x}{2\sqrt{2}} : P_y : \frac{P_Z}{2}$$

$$= \frac{2\sqrt{2}}{2\sqrt{2}} : 1 : \frac{2}{2}$$

= 1 : 1 : 1

34. When a heat of Q is supplied 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) $3R/2$

Ans :1

Sol: The relation between C_P and C_V is

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

$$\therefore C_v = \frac{R}{\gamma - 1} = \frac{R}{\frac{5}{3} - 1} = \frac{3R}{2}$$

35. 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 **(2003 M)**

1) $3/5$ 2) $4/3$ 3) $5/3$ 4) $3/2$

Ans: 4

Sol: In adiabatic process the relation between P & T is $P^{\gamma-1}T^{-\gamma}$ = constant

$$\Rightarrow P^{\gamma-1} \propto T^{\gamma}$$

$$\Rightarrow P \propto T^{\frac{\gamma}{\gamma-1}} \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Comparing (1) with $\Rightarrow P \propto T^3$ ……………...(2)

$$\frac{\gamma}{\gamma-1} = 3 \Rightarrow \gamma = 3\gamma - 3$$

$$\Rightarrow 2\gamma = 3$$

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

36. A gas under constant pressure of 4.5 x 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 x 10^5 J 2.5.25 x 10^5J 3. 3.25 x 10^5J 4.1.25 x 10^5J

Ans: 4

Sol : According to first law of thermodynamics dQ = dU +P(dV) $\Rightarrow dU = dQ = P(dV)$

$$= 800\times10^3 - (4.5\times10^5)(2-0.5)$$

$$= 1.25\times10^5 \text{ J}$$

37. 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

Ans :3

Sol : $C_p - C_v$ = R but R = r M

For Hydrogen $C_p - C_v$ =m(2) ………………..(1)

For Nitrogen C_P - C_v = n(14) …………………(2)

From (1) & (2) m = 7n

38. 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

Ans :4

Sol:

$$P_1V_1^{\gamma} = P_2V_2^{\gamma}$$

$$V_2 = \frac{V_1}{4}$$

$$\therefore \frac{P_1}{P_2} = \left[\frac{V_2}{V_1}\right]^{\gamma} = \left[\frac{1}{4}\right]^{3/2} = \left[\frac{1}{2}\right]^3 = \frac{1}{8}$$

$$\therefore P_2 : P_1 = 8:1$$

39. 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) **(2001 M)**

1. -166J 2. + 166J 3. -168 J 4. + 168

Ans : 2

Sol: Change in internal energy of the gas

$$\frac{R}{\gamma-1}\left[T_2 - T_1\right]$$

$$= \frac{8.3}{(1.4-1)}\left[308-300\right]$$

= 166 J

40. 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 = $460J/kg/^0C$, g= $10ms^{-2}$) **(2000 M)**

1. 0.01^0C 2. 0.1^0C 3. 1^0C 4. 1.1^0C

Ans :2

Sol: Energy of falling body E_1=mgh

= (0.1)(10)(10) = 10J

Energy of the body after rebounding

E_2= (0.1)(5.4)(10) = 5.4J

$\therefore$ Loss of Energy = 4.6 J

W = JH = $J\left(ms\theta\right)$

$$\therefore \theta = \frac{W}{J(ms)} = \frac{4.6}{(0.1)(460)} = 0.1^0 C$$

41. 50g of copper is heated to increase its temperature by 10^0C. If the same quantity of heat is given to 10 g of water, the rise in its temperature is **(2000 M)**
(Specific heat of copper = $420J/kg/^0C$ Specific heat of water = $4200J/kg/^0C$

1. 5^0C 2. 6^0C 3. 7^0C 4. 8^0C

Ans : 1

Sol: Heat lost by hot body = Heat gained by cold body
Heat lost by copper = Heat gained by water $\left(mst\right)_{copper} = \left(mst\right)_{water}$

$$(50)(420)(10) = 10(4200)t$$

$$\therefore t = 5^0 C$$

✵ ✵ ✵