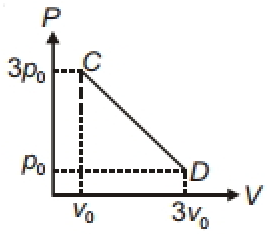
Jupiter Academy

Subjects : Physics — PRACTICE PAPER 08

Total Marks : 180 — (Solutions)

Physics - Section A (MCQ)

1. The process CD is shown in the diagram. As system is taken from C to D, what happens to the temperature of the system?



A) Temperature first decreases and then increases

B) Temperature first increases and then decreases

C) Temperature decreases continuously

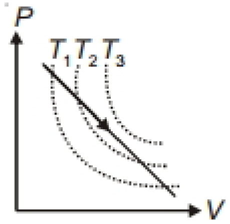
D) Temperature increases continuously

Solution : (Correct Answer: B)

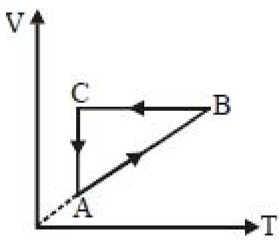
$T_3 > T_2 > T_1$

So from $C \rightarrow D$

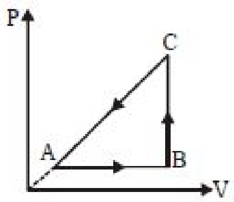
Temperature first increases then decreases.



2. A cyclic process $ABCA$ is shown in the $V-T$ diagram. Process on the $P-V$ diagram is



A)



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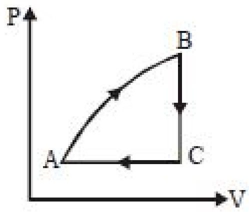
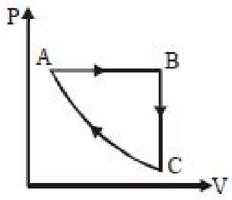
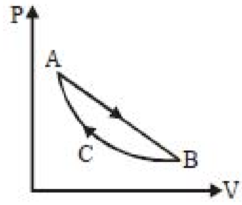


C)



D)



Solution : (Correct Answer: C)

The process AB is isobaric since it is an inclined straight line in the $V-T$ diagram.

The process BC is an isochoric process since the volume is constant

The process CA is isothermal since, temperature remains constant.

The only $P-v$ graph that matches the above criteria is option C

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

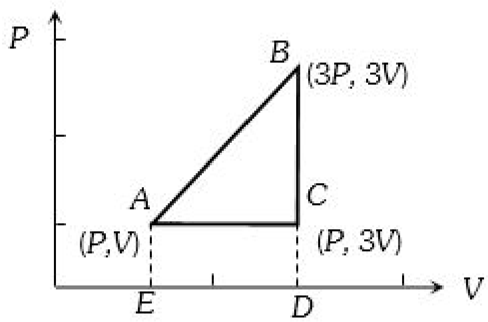
A) Isochoric B) Isobaric

C) Isothermal D) Adiabatic

Solution : (Correct Answer: D)

(d)In adiabatic process, no transfer of heat takes place between system and surrounding.

4. An ideal gas is taken around $ABCA$ as shown in the above $P-V$ diagram. The work done during a cycle is



A) $2PV$ B) PV C) $1/2PV$ D) Zero

Solution : (Correct Answer: A)

Work done = Area enclosed by triangle ABC

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

5. Neon gas of a given mass expands isothermally to double volume. What should be the further fractional decrease in pressure, so that the gas when adiabatically compressed from that state, reaches the original state?

A) $1-2^{-2/3}$
B) $1-3^{1/3}$
C) $2^{1/3}$
D) $3^{2/3}$

Solution : (Correct Answer: A)

(a)

$P_1V_1 = P_2V_2$ [for isothermal]

$PV = P \times 2V$

$\frac{P}{2} = P'$

$P_1V_1^{\gamma} = P_2V_2^{\gamma}$ [for adiabatic]

$\frac{P}{2} \times (2V)^{5/3} = P_2(V)^{5/3}$ [γ for neon $= 5/3$]

$P = P_2 \cdot (2)^{-2/3}$

Fractional decrease $= \frac{P_2-P}{P_2} = \frac{P_2-P_2\cdot(2)^{-2/3}}{P_2} = 1-2^{-2/3}$

6. A diatomic gas undergoes a process represented by $PV^{1.3}$ = constant. Choose the incorrect statement

A) The gas expands by absorbing heat from the surroundings
B) The gas cools down during expansion
C) The work done by surroundings during expansion of the gas is negative
D) None of these

Solution : (Correct Answer: D)

(d)

$PV^{1.3} = K$

$W = \frac{P_2V_2-P_1V_1}{1-N}$

$\because N > 1$, so W is negative.

Heat supplied by surrounding heat goes to do work.

$\therefore$ Down when expands.

7. A gas undergoes a change at constant temperature. Which of the following quantities remain fixed?

A) Pressure
B) Entropy
C) Heat exchanged with the system
D) All the above may change

Solution : (Correct Answer: D)

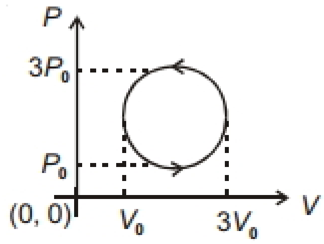
(d)

When temperature change $= 0$ then,

$P_1V_1 = P_2V_2 =$ constant

Rest may change.

8. Work done in the cyclic process shown in figure is ....



A) $4P_0V_0$
B) $-4P_0V_0$
C) $-\frac{22}{7}P_0V_0$
D) $-13P_0V_0$

Solution : (Correct Answer: C)

Cyclic process is anticlockwise then

Work done $= -$ (Area of $P-V$ graph)

$W = -\pi R_1R_2$

$= -\pi\left(\frac{3P_0-P_0}{2}\right) \times \left(\frac{3V_0-V_0}{2}\right)$

$= \frac{-22}{7}P_0V_0$

9. A Camot cycle consists of

A) Two stages
B) Four stages
C) Six stages
D) Eight stages

Solution : (Correct Answer: B)

(b)

This cycle is one of the foundations of the second law of thermodynamics, and Carnot is often considered the father of thermodynamics. He was one of the pioneers who first determined an idealistic way of converting heat energy into work done. Carnot cycle is one of the most efficient heat engines.

Carnot cycle consists of the following four processes:

I. The gas goes through an isothermal expansion at a high temperature. In this process the gas takes q_{in} amount of heat from the surrounding and does w_1 amount of work on the surrounding.

II. The gas then undergoes a reversible adiabatic expansion. Hence, the temperature of the gas comes down to a lower temperature T_{low} .

III. Then the gas is compressed isothermally at T_{low} temperature. In this process, the gas loses q_{out} amount of heat, and surroundings do work on the gas.

IV. Now the gas goes through a reversible adiabatic compression which makes the temperature rise up to T_{high} .

The following diagram shows the $P-V$ diagram of the Carnot's cycle.

Hence, Carnot's cycle consists of two isothermal and two adiabatic processes.

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

A) 8 B) 7 C) 6 D) 4

Solution : (Correct Answer: A)

(a)For isothermal process $P_1V_1 = P_2V_2$

==> $P_2 = \frac{P_1V_1}{V_2} = \frac{72\times1000}{900} = 80\,cm$

Stress $\Delta P = P_2 - P_1 = 80 - 72 = 8cm$

11. When heat energy of $1500\ Joules$, is supplied to a gas at constant pressure $2.1\ \times 10^5\ N/m^2$, there was an increase in its volume equal to 2.5×10^{-3} m^3. The increase in internal energy of the gas in Joules is ...... J

A) 450 B) 525 C) 975 D) 2025

Solution : (Correct Answer: C)

(c) According to FLOT

$\Delta Q = \Delta U + P(\Delta V)$==> $\Delta U = \Delta Q - P(\Delta V)$

$= 1500 - (2.1 \times 10^5)(2.5 \times 10^{-3})$$= 975\,Joule$

12. An air bubble of volume v_0 is released by a fish at a depth h in a lake. The bubble rises to the surface. Assume constant temperature and standard atmospheric pressure above the lake. The volume of the bubble just before touching the surface will be (density) of water is ρ

A) v_0

B) $v_0(\rho gh/p)$

C) $\frac{v_0}{\left(1+\frac{\rho gh}{p}\right)}$

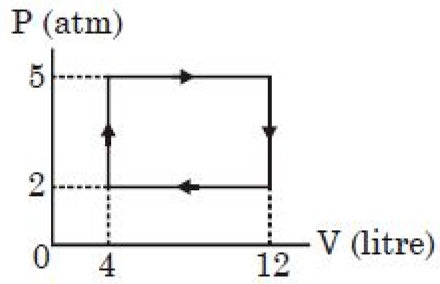
D) $v_0\left(1+\frac{\rho gh}{p}\right)$

Solution : (Correct Answer: D)

(d)

As the bubble rises the pressure gets reduced for constant temperature, if P is the standard atmospheric pressure, then $(P+\rho gh)V_0 = PV$ or V $= V_0\left(1+\frac{\rho gh}{P}\right)$

13. An ideal gas undergoes a cyclic process as shown in diagram. The net work done by the gas in the cycle is



A) $12\,litre-atm$ B) $24\,J$

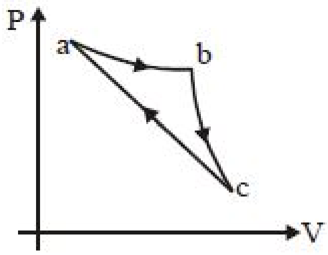
C) $24\,litre-atm$ D) $-24\,J$

Solution : (Correct Answer: C)

$\mathrm{W} =$ Area inside cycle $= (12-4) \times (5-2)$

$= 24$ litre—atm

14. In the $P-V$ diagram shown, the gas does $5\ J$ of work in isothermal process ab and $4\ J$ in adiabatic process bc. .... J will be the change in internal energy of the gas in straight path c to a ?



A) 9 B) 1 C) 4 D) 5

Solution : (Correct Answer: C)

For isothermal : $\Delta U = 0$

For adiabatic : $\Delta U = -\Delta W$

15. An iron rod of heat capacity C is heated to temperature $8T_0$. It is then put in a cylindrical vessel of adiabatic walls having two moles of air which can be treated as diatomic ideal gas at temperature T_0 and closed by a movable piston which is also adiabatic. The atmospheric pressure is P_0 . The cylinder with the piston combined have heat capacity $2C$. Find the equilibrium temperature . (Assume temperature of air to be uniform and equal to vessel at all times) .

A) $\left(\frac{8C+7R}{3C+7R}\right)T_0$ B) $\left(\frac{10C+7R}{C+7R}\right)T_0$

C) $\left(\frac{8C+7R}{C+7R}\right)T_0$ D) $\left(\frac{10C+7R}{3C+7R}\right)T_0$

Solution : (Correct Answer: D)

$\mathrm{C}\,(8\mathrm{T}_0 - \mathrm{T}) = 2\mathrm{C}\,(\mathrm{T}-\mathrm{T}_0) + 2 \times \frac{7\mathrm{R}}{2}\,(\mathrm{T}-\mathrm{T}_0)$

16. Consider two containers A and B containing identical gases at the same pressure, volume and temperature. The gas in container A is compressed to half of its original volume isothermally while the gas in container B is compressed to half of its original value adiabatically. The ratio of final pressure of gas in B to that of gas in A is

A) $2^{\gamma-1}$ B) $\left(\frac{1}{2}\right)^{\gamma-1}$
C) $\left(\frac{1}{1-\gamma}\right)^2$ D) $\left(\frac{1}{\gamma-1}\right)^2$

Solution : (Correct Answer: A)

When the compression is isothermal for gas in A

$P_2V_2 = P_1V_1$

$P_2 = P_1\frac{V_1}{V_2} = P_1\frac{V_1}{V_1/2} = 2P_1$

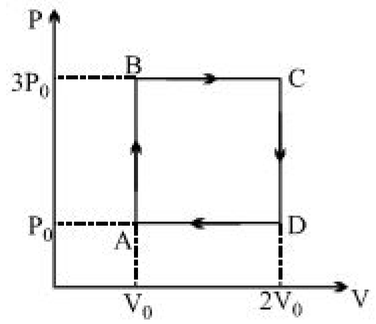
For gas in B, when compression is adiabatic,

$P_2'V_2' = P_1V_1^{\gamma}$

$P_2' = P_1\left(\frac{V_1}{V_2'}\right)^{\gamma} = P_1\left(\frac{V_1}{V_1/2}\right)^{\gamma} = 2^{\gamma}P_1$

$\therefore \frac{P_2'}{P_2} = \frac{2^{\gamma}P_1}{2P_1} = 2^{\gamma-1}$

17. A ideal monoatomic gas is carried around the cycle $ABCDA$ as shown in the fig. The efficiency of the gas cycle is



A) $\frac{4}{21}$ B) $\frac{2}{21}$
C) $\frac{4}{31}$ D) $\frac{2}{31}$

Solution : (Correct Answer: A)

Heat is absorbed only during processes AB and BC

Gas is monoatomic.Hence $C_v = \frac{3}{2}R, C_p = \frac{5}{2}R$

Heat absorbed during AB, $\Delta Q_{AB} = nC_v\Delta T$ $= \frac{3}{2}nR\Delta T = \frac{3}{2}V\Delta P = 3P_oV_o$

Heat absorbed during BC, $\Delta Q_{BC} = nC_p\Delta T$ $= \frac{5}{2}nR\Delta T = \frac{5}{2}P\Delta V = \frac{15}{2}P_oV_o$

Hence, net heat absorbed $= \Delta Q = \Delta Q_{AB} + \Delta Q_{BC}$ $= \frac{21}{2}P_oV_o$

Also, net work done $= \Delta W$ =area under $P-V$ graph $= 2P_oV_o$

Hence efficiency $= \frac{\Delta W}{\Delta Q} = \frac{4}{21}$

18. If heat is added at constant volume, $6300\ J$ of heat are required to raise the temperature of an ideal gas by $150\ K$. If instead, heat is added at constant pressure, 8800 joules are required for the same temperature change. When the temperature of the gas changes by $300\ K$, the internal energy of the gas changes by ..... J

A) 5000 B) 12600
C) 17600 D) 22600

Solution : (Correct Answer: B)

Heat added at constant volume is equal to the change in internal energy of the system. Change in internal energy $\Delta U = nC_v\Delta T$

For $\Delta T = 150K, \quad \Delta U = Q_v = 6300\mathrm{J}$

$\therefore \quad 6300 = nC_v(150) \qquad \ldots(1)$

Let the change in internal energy be ΔU for $\Delta T = 300K$

$\therefore \Delta U = nC_v(300) \qquad \ldots(2)$

Dividing (2) and (1) we get $\frac{\Delta U}{6300} = \frac{300}{150}$

$\Longrightarrow \Delta U = 12600\mathrm{J}$

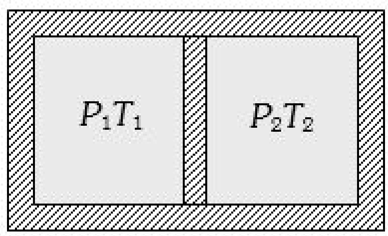
19. Work done by air when it expands from $50\ litres$ to $150\ litres$ at a constant pressure of 2 atmosphere is

A) 2×10^4 joules
B) 2×100 joules
C) $2\times10^5\times100$ joules
D) $2\times10^{-5}\times100$ joules

Solution : (Correct Answer: A)

(a) $W = P\times\Delta V = 2\times10^5(150-50)\times10^{-3} = 2\times10^4J$

20. Following figure shows on adiabatic cylindrical container of volume V_0 divided by an adiabatic smooth piston (area of cross-section = A) in two equal parts. An ideal gas $(C_P/C_V = \gamma)$ is at pressure P_1 and temperature T_1 in left part and gas at pressure P_2 and temperature T_2 in right part. The piston is slowly displaced and released at a position where it can stay in equilibrium. The final pressure of the two parts will be (Suppose x = displacement of the piston)



A) P_2 B) P_1

C) $\frac{P_1\left(\frac{V_0}{2}\right)^{\gamma}}{\left(\frac{V_0}{2}+Ax\right)^{\gamma}}$ D) $\frac{P_2\left(\frac{V_0}{2}\right)^{\gamma}}{\left(\frac{V_0}{2}+Ax\right)^{\gamma}}$

Solution : (Correct Answer: C)

As finally the piston is in equilibrium, both the gases must be at same pressure P_f.

It is given that displacement of piston be in final state x and if A is the area of cross-section of the piston.

Hence the final volumes of the left and right part finally can be given by figure as

$V_L = \frac{V_0}{2} + Ax$ and $V_R = \frac{V_0}{2} - Ax$

As it is given that the container walls and the piston are adiabatic in left side and the gas undergoes adiabatic expansion and on the right side the gas undergoes adiabatic compressive.

Thus we have for initial and final state of gas on left side

$P_1\left(\frac{V_0}{2}\right)^{\gamma} = P_f\left(\frac{V_0}{2} + Ax\right)^{\gamma}$ ..... (i)

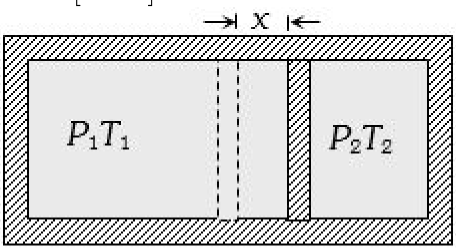
Similarly for gas in right side, we have $P_2\left(\frac{V_0}{2}\right)^{\gamma}$ $= P_f\left(\frac{V_0}{2} - Ax\right)^{\gamma}$ ..... (ii)

From eq. (i) and (ii)

$\frac{P_1}{P_2} = \frac{\left(\frac{V_0}{2}+Ax\right)^{\gamma}}{\left(\frac{V_0}{2}-Ax\right)^{\gamma}}$ ==> $Ax = \frac{V_0}{2}\frac{\left[P_1^{1/\gamma}-P_2^{1/\gamma}\right]}{\left[P_1^{1/\gamma}+P_2^{1/\gamma}\right]}$

Now from equation (i)

$P_f = \frac{P_1\left(\frac{V_0}{2}\right)^{\gamma}}{\left[\frac{V_0}{2}+Ax\right]^{\gamma}}$



21. If a Carnot's engine functions at source temperature 127^oC and at sink temperature 87^oC, what is its efficiency .... %

A) 50 B) 25 C) 40 D) 10

Solution : (Correct Answer: D)

(d) $\eta = \frac{T_1-T_2}{T_1} = \frac{(127+273)-(87+273)}{(127+273)}$

$= \frac{400-360}{400} = 0.1 \to 10\%$

22. A gas undergoes a change of state during which $100J$ of heat is supplied to it and it does $20J$ of work. The system is brought back to its original state through a process during which $20J$ of heat is released by the gas. The work done by the gas in the second process is .... J

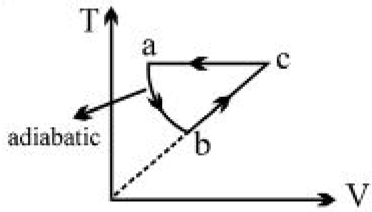
A) 60 B) 40 C) 80 D) 20

Solution : (Correct Answer: A)

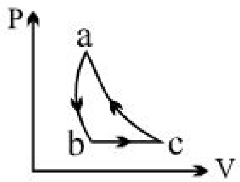
(a) In a cyclic process $\Delta U = 0$==> $\Delta Q = \Delta W$

==> $(100-20) = 20 + W_2$ ==> $W_2 = 60\ J$

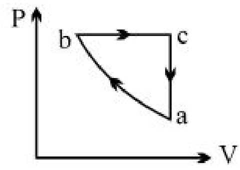
23. PV curve for the process whose VT curve is



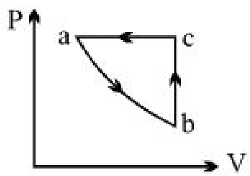
A)



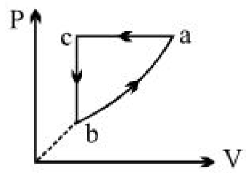
B)



C)

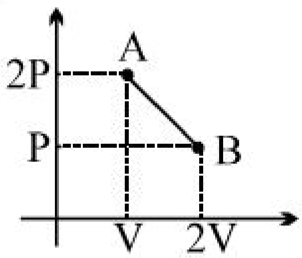


D)



Solution : (Correct Answer: A)

24. One mole of a gas expands obeying the relation as shown in the P/V diagram. The maximum temperature in this process is equal to



A) $\frac{P_0V_0}{R}$ B) $\frac{3P_0V_0}{R}$
C) $\frac{9P_0V_0}{8R}$ D) None of these

Solution : (Correct Answer: C)

This question can be solved by maxima

and minima.

since the graph shown here is a straight line, we can write it's equation in the form of :

$y = mx + c$

here $y = P, x = V, m = \frac{P_2-P_1}{V_2-V_1} = \frac{\frac{P_0}{2}-P_0}{2V_0-V_0}$

$\Rightarrow m = \frac{-P_0}{2V_0}$

c is the intercept and $c = \frac{3P_0}{2}$

We can find c by extra polating the graph Now

$P=\frac{-P_0}{2V_0}V+\frac{3P_0}{2} \qquad ...(1)$

Also, from equation of state, we know the $PV = nRT$

for 1 mole $PV=RT$

or $P=\frac{RT}{V}$

substituting this in equation (1)

$\frac{RT}{V}=\frac{-P_0}{2V_0}V+\frac{3P_0}{2}$

$T=\frac{-\bar{P}_0}{2RV_0}\cdot V^2+\frac{3P_0}{2R}V$

To find the minimum temperature, we will differentiate the above equation

i.e., $\frac{dT}{dV}=-\frac{2P_0}{2RV_0}\cdot V+\frac{3P_0}{2R}$

for $\frac{dT}{dV}=0 \Rightarrow \frac{P_0}{RV_0}\cdot V=\frac{3P_0}{2R}$

$\Rightarrow V=\frac{3V_0}{2}$

This is the critical point.

$\frac{d^2T}{dV^2}=-\frac{P_0}{RV_0}$

which is negative since pressure and volume can't be negative.

$\Rightarrow$ pt of maximum

Now at $V=\frac{3V_0}{2}$

maximum temperature $=T_{\max}=\frac{-P_0}{2RV_0}\frac{9V_0^2}{4}+\frac{3P_0}{2R}\cdot\frac{3V_0}{2}$

$\Rightarrow T_{\max}=\frac{9P_0V_0}{8R}$

25. Avessel with open mouth contains air at 60^oC. When the vessel is heated upto temperature T, one fourth of the air goes out. The value of T is ..... ^oC

A) 80 **B)** 171 **C)** 333 **D)** 444

Solution : (Correct Answer: B)

$M_1=M, T_1=60+273$

$=333K, M_2$

$=M-\frac{M}{4}=\frac{3M}{4}$

[As $1/4$ th part of air escapes]

If pressure and volume of gas remains constant then $\mathrm{MT}=$ constant

$\therefore \frac{T_2}{T_1}=\frac{M_1}{M_2}=\left(\frac{M}{3M/4}\right)=\frac{4}{3}\Rightarrow T_2$

$=\frac{4}{3}\times T_1=\frac{4}{3}\times 333=444\mathrm{K}$

$=171^{\circ}\mathrm{C}$

26. Monoatomic, diatomic and triatomic gases whose initial volume and pressure are same, are compressed till their volume becomes half the initial volume.

A) If the compression is adiabatic then monoatomic gas will have maximum final pressure.
B) If the compression is adiabatic then triatomic gas will have maximum final pressure.
C) If the compression is adiabatic then their final pressure will be same.
D) If the compression is isothermal then their final pressure will be different.

Solution : (Correct Answer: A)

For an adiabatic process,

$PV^\gamma=$ constant

or

$\frac{P_1}{P_2}=\left(\frac{V_2}{V_1}\right)^\gamma$

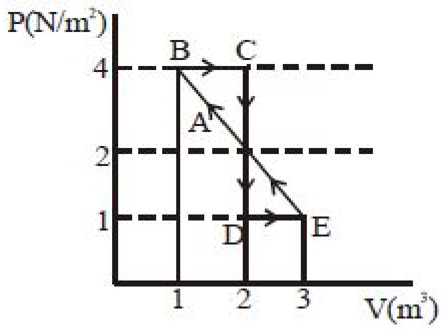
or

$P_2=2^\gamma P_1$

Now, for a monoatomic gas, the value of γ is the highest

Thus, for the same change in volume, the monoatomic gas will have the maximum pressure.

27. One mole of a monoatomic gas is carried along process $ABCDEA$ as shown in diagram. Find the net work done by gas .... J



A) 1.5 **B)** 1 **C)** 0.5 **D)** 0

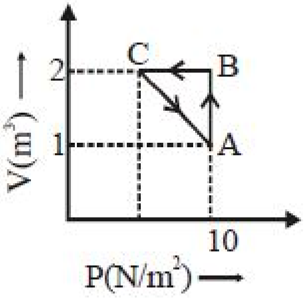
Solution : (Correct Answer: C)

Work $=$ Area enclosed by curve

$\mathrm{W}=\mathrm{W}_{\mathrm{ABCD}}+\mathrm{W}_{\mathrm{DEAD}}$

$\mathrm{W}=1-\frac{1}{2}=\frac{1}{2}\mathrm{J}$

28. An ideal gas is taken through the cycle $A \rightarrow B \rightarrow C \rightarrow A$, as shown in the figure. What is the change in internal energy ...... J.



A) 0 B) -10 C) -15 D) -20

Solution : (Correct Answer: A)

29. An ideal heat engine exhausting heat at $77\,^oC$. To have a 30% efficiency. It must take heat at...... ^oC

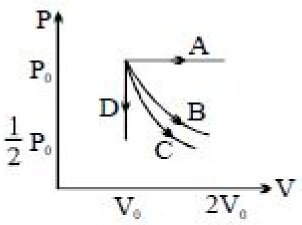
A) 127 B) 227 C) 327 D) 673

Solution : (Correct Answer: B)

$\eta = 1 - \frac{\mathrm{T_L}}{\mathrm{T_H}} \Rightarrow \frac{30}{100} = 1 - \frac{350}{\mathrm{T_H}}$

$\Rightarrow \mathrm{T_H} = 500\mathrm{K}$

30. The PV diagram shows four different possible reversible processes performed on a monatomic ideal gas. Process A is isobaric (constant pressure). Process B is isothermal (constant temperature). Process C is adiabatic. Process D is isochoric (constant volume). For which process (es) does the temperature of the gas decrease?



A) Process A only
B) Process C only
C) Only Processes C and D
D) Only Processes B, C and D

Solution : (Correct Answer: C)

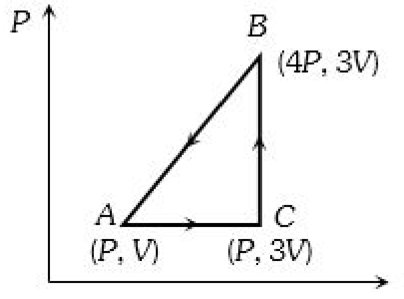
In A temperature will increase

in B temperature remains constant

in $C \& D$ temperature decrease.

Hence, option C is the correct answer.

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



A) Zero B) $3PV$ C) $6PV$ D) $9PV$

Solution : (Correct Answer: B)

Work done = Area enclosed by indicator diagram

$= \frac{1}{2} \times (3V - V)(4P - P) = 3PV$

32. A mono atomic gas is supplied the heat Q very slowly keeping the pressure constant. The work done by the gas will be

A) $\frac{2}{3}Q$ B) $\frac{3}{5}Q$ C) $\frac{2}{5}Q$ D) $\frac{1}{5}Q$

Solution : (Correct Answer: C)

(c) $\Delta Q = \Delta U + \Delta W$==> $\Delta W = (\Delta Q)_P - \Delta U$

$= (\Delta Q)_P \left[1 - \frac{(\Delta Q)_V}{(\Delta Q)_P}\right]$

$= (\Delta Q)_P \left[1 - \frac{C_V}{C_P}\right] = Q = \left[1 - \frac{3}{5}\right] = \frac{2}{5}Q$

$(\Delta Q)_P = Q$and $\gamma = \frac{5}{3}$ for monatomic gas

33. A polyatomic gas $(\gamma = \frac{4}{3})$ is compressed to $\frac{1}{8}$ of its volume adiabatically. If its initial pressure is P_o, its new pressure will be

A) $8P_o$ B) $16P_0$
C) $6P_o$ D) $2P_o$

Solution : (Correct Answer: B)

(b)$\frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^\gamma$==> $P_2 = P_1\left(\frac{V_1}{V_2}\right)^\gamma = P_0(8)^{4/3} = 16P_0$.

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

A) Starts becoming hotter
B) Remains at the same temperature
C) Starts becoming cooler
D) May become hotter or cooler depending upon the amount of water vapour present

Solution : (Correct Answer: C)

(c)Pressure is reduced, so the temperature falls.

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

A) $1 \times 10^5\ N/m^2$ B) $1 \times 10^{-8}\ N/m^2$
C) $1.4\ N/m^2$ D) $1.4 \times 10^5 N/m^2$

Solution : (Correct Answer: D)

(d) $E_\varphi = \gamma P = 1.4 \times (1 \times 10^5) = 1.4 \times 10^5 N/m^2$

36. A thermo-dynamical system is changed from state (P_1, V_1) to (P_2, V_2) by two different process. The quantity which will remain same will be

A) ΔQ
B) ΔW
C) $\Delta Q + \Delta W$
D) $\Delta Q - \Delta W$

Solution : (Correct Answer: D)

Change in internal energy does not depend upon path so $\Delta U = \Delta Q - \Delta W$ remain constant.

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

A) 2408 B) 2240
C) 2072 D) 1904

Solution : (Correct Answer: C)

(c) $\Delta Q = \Delta U + \Delta W \Rightarrow \Delta U = \Delta Q - \Delta W = 2240 - 168$ $= 2072\ J$.

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

A) ΔQ
B) ΔW
C) ΔU and ΔQ
D) ΔU

Solution : (Correct Answer: D)

(d) Change in internal energy (ΔU) depends upon initial an find state of the function while ΔQ and Δ W are path dependent also.

39. If $R =$ universal gas constant, the amount of heat needed to raise the temperature of 2 mole of an ideal monoatomic gas from $273K$ to $373K$ when no work is done ...... R

A) 100 B) 150 C) 300 D) 500

Solution : (Correct Answer: C)

(c) $\Delta Q = \Delta U + \Delta W \quad \Delta W = 0 ==> \Delta Q = \Delta U$
$= \frac{f}{2}\mu R \Delta T$
$= \frac{3}{2} \times 2R(373 - 273) = 300R.$

40. First law of thermnodynamics is given by

A) $dQ = dU + PdV$
B) $dQ = dU \times PdV$
C) $dQ = (dU + dV)\,P$
D) $dQ = PdU + dV$

Solution : (Correct Answer: A)

(a)$\Delta Q = \Delta U + \Delta W$ and $\Delta W = P\Delta V$

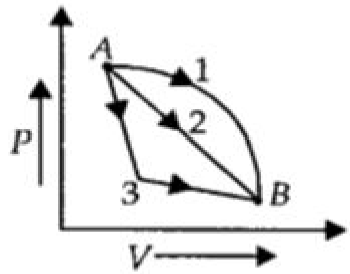
41. *Assertion* : Reversible systems are difficult to find in real world.
Reason : Most processes are dissipative in nature.

A) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
B) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
C) If the Assertion is correct but Reason is incorrect.
D) If both the Assertion and Reason are incorrect.

Solution : (Correct Answer: A)

In any process some energy is found to be converted into heat (dissipative in nature) due to which process becomes irreversible.

42. An ideal gas goes from state A to state B via three different processes as indicated in the $P - V$ diagram. If Q_1, Q_2, Q_3 indicate the heat absorbed by the gas along the three processes and $\Delta U_1, \Delta U_2, \Delta U_3$
indicate the change in internal energy along the three processes respectively, then



A) $Q_1 < Q_2 < Q_3$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$
B) $Q_1 < Q_2 = Q_3$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$
C) $Q_1 = Q_2 > Q_3$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$
D) $Q_1 > Q_2 > Q_3$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$

Solution : (Correct Answer: D)

Change in internal energy is path independent and depends only on the initial and final states.

As the initial and final states in the three processes are same. Therefore,

$\Delta u_1 = \Delta u_2 = \Delta u_3$

Workdone, $W = Area\,under\,P - V\,graph$

As area under curve $1 >$ area under curve $2 >$ area under curve 3

$\therefore W_1 > W_2 > W_3$

According to first law of thermodynamics,

$Q = W + \Delta u$

$As W_1 > W_2 > W_3\ and\ \Delta u_1 = \Delta u_2 = \Delta u_3$

$\therefore Q_1 > Q_2 > Q_3$

43. An engine has an efficiency of $1/6$. When the temperature of sink is reduced by 62^oC, its efficiency is doubled. Temperatures of the source is .... ^oC

A) 80 **B)** 95 **C)** 90 **D)** 99

Solution : (Correct Answer: D)

Efficiency of an engine, $\eta = 1 - \frac{T_2}{T_1}$

where T_1 is the temperature of the source and T_2 is the temperature of the sink.

$\therefore \frac{1}{6} = 1 - \frac{T_2}{T_1}\ or,\ \frac{T_2}{T_1} = \frac{5}{6} \qquad ...(i)$

where the temperature of the sink is decreased by $62^{\circ}C\ (or\, 62\, K)$, efficiency becomes double.

Since, the temperature of the source remains unchanged

$\therefore 2 \times \frac{1}{6} = 1 - \frac{(T_2 - 62)}{T_1}\ or,\ \frac{1}{3} = 1 - \frac{(T_2 - 62)}{T_1}$

$or,\ \frac{2}{3} = \frac{T_2 - 62}{T_1}\ or,\ 2T_1 = 3T_2 - 186$

$or,\ 2T_1 = 3\left[\frac{5}{6}\right]T_1 - 186 \qquad [using (i)]$

$\therefore\ \left[\frac{5}{2} - 2\right]T_1 = 186\ or,\ \frac{T_1}{2} = 186$

$or,\ T_1 = 372\, K = 99^{\circ}C.$

44. The temperature inside a refrigerator is $t_2\, ^oC$ and the room temperature is $t_1\, ^oC$. The amount of heat delivered to the room for each joule of electrical energy consumed ideally will be

A) $\frac{t_2+273}{t_1-t_2}$
B) $\frac{t_1+t_2}{t_2+273}$
C) $\frac{t_1}{t_1-t_2}$
D) $\frac{t_1+273}{t_1-t_2}$

Solution : (Correct Answer: D)

Temperature inside refrigerator $= t_2\, ^{\circ}C$

Room temperature $= t_1\, ^{\circ}C$

For refrigerator,

$\frac{Heat\ given\ to\ high\ temperature\ (Q_1)}{Heat\ taken\ from\ lower\ temperature\ (Q_2)} = \frac{T_1}{T_2}$

$\frac{Q_1}{Q_2} = \frac{t_1+273}{t_2+273}$

$\Rightarrow \frac{Q_1}{Q_1 - W} = \frac{t_1+273}{t_2+273}\ or\ 1 - \frac{W}{Q_1} = \frac{t_2+273}{t_1+273}$

$or\ \frac{W}{Q_1} = \frac{t_1-t_2}{t_1+273}$

The amount of heat delivered to the room for each joule pf electrical energy $(W = 1\, J)$

$Q_1 = \frac{t_1+273}{t_1-t_2}$

45. The efficiency of carnot engine is 50% and temperature of sink is $500\ K$. If temperature of source is kept constant and its efficiency raised to 60%, then the required temperature of the sink will be

A) 100 **B)** 400 **C)** 600 **D)** 500

Solution : (Correct Answer: B)

(b) $\eta = 1 - \frac{T_2}{T_1}$==>$\frac{1}{2} = 1 - \frac{500}{T_1}$==> $\frac{500}{T_1} = \frac{1}{2}$.....$(i)$
$\frac{60}{100} = 1 - \frac{T_2{'}}{T_1}$==>$\frac{T_2{'}}{T_1} = \frac{2}{5}$.....$(ii)$
Dividing equation (i) by (ii), $\frac{500}{T_2{'}} = \frac{5}{4}$==>$T_2 = 400K$