Thermodynamics and Kinetic Theory

Question1

Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R .

Assertion A: Houses made of concrete roofs overlaid with foam keep the room hotter during summer.

Reason R: The layer of foam insulation prohibits heat transfer, as it contains air pockets.

In the light of the above statements, choose the correct answer from the options given below.

[NEET 2024 Re]

Options:

A.

A is true but R is false.

B.

A is false but R is true.

C.

Both A and R are true and R is the correct explanation of A.

D.

Both A and R true but R is NOT the correct explanation of A.

Answer: B

Solution:

Layer of foam create an insulation which prohibits heat transfer, and hence roofs of houses containing foam keep room cooler during summer.

Question2

The equilibrium state of a thermodynamic system is described by
A. Pressure
B. Total heat
C. Temperature

D. Volume
E. Work done
Choose the most appropriate answer from the options given below.

[NEET 2024 Re]

Options:

A.

A, B and E only

B.

B, C and D only

C.

A, B and C only

D.

A, C and D only

Answer: D

Solution:

Equilibrium state of a thermodynamic system is defined by state variables P, V and T. Work done and total heat are path variables.

Question3

According to the law of equipartition of energy, the number of vibrational modes of a polyatomic gas of constant $\gamma = \frac{C_p}{C_v}$ is (C_p where C_V are the specific heat capacities of the gas at constant pressure and constant volume, respectively):

[NEET 2024 Re]

Options:

A.

$$\frac{4+3\gamma}{\gamma-1}$$

B.

$$\frac{3+4\gamma}{\gamma-1}$$

C.

$$\frac{4-3\gamma}{\gamma-1}$$

D.

$$\frac{3-4\gamma}{\gamma-1}$$

Answer: C

Solution:

A polygamic gas has 3 translational, 3 rotational and f vibration modes

$$U = \frac{3}{2}k_BT + \frac{3}{2}k_BT + fk_BT$$

$$U = (3+f)k_BT$$

$$C_V = (3+f)R$$

$$C_p = (4+f)R$$

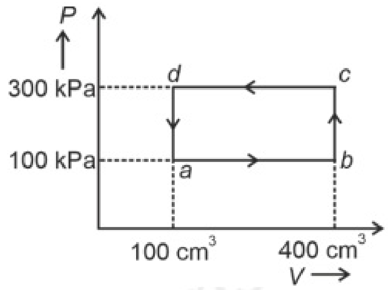
$$\frac{C_p}{C_v} = \frac{4+f}{3+f} = \gamma$$

$$4+f = 3\gamma + f\gamma$$

$$4-3\gamma = f(\gamma-1) \Rightarrow f = \frac{4-3\gamma}{\gamma-1}$$

Question4

A thermodynamic system is taken through the cycle abcda. The work done by the gas along the path bc is:



[NEET 2024]

Options:

A.

Zero

B.

30 J

C.

–90 J

D.

–60 J

Answer: A

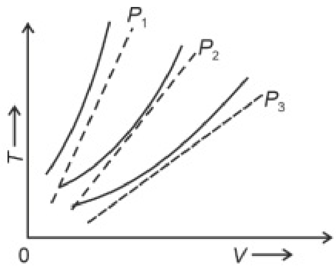
Solution:

Path bc is an isochoric process.

∴ Work done by gas along path bc is zero.

Question5

The following graph represents the T-V curves of an ideal gas (where T is the temperature and V the volume)at three pressures P_1, P_2 and P_3 compared with those of Charles's law represented as dotted lines.



Then the correct relation is:

[NEET 2024]

Options:

A.

$P_3 > P_2 > P_1$

B.

$P_1 > P_3 > P_2$

C.

$P_2 > P_1 > P_3$

D.

$P_1 > P_2 > P_3$

Answer: D

Solution:

At same temperature, curve with higher volume corresponds to lower pressure.

$V_3 > V_2 > V_1$

$\Rightarrow P_1 > P_2 > P_3$

(We draw a straight line parallel to volume axis to get this)

Question6

A Carnot engine has an efficiency of 50% when its source is at a temperature 327∘C. The temperature of the sink is

[NEET 2023]

Options:

A.

15°C

B.

100°C

C.

200°C

D.

27°C

Answer: D

Solution:

Solution:

Efficiency $\eta = \frac{50}{100} = \frac{1}{2}$

Efficiency of Carnot engine

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

$$\eta = 1 - \frac{T_2}{600}$$

$$\frac{1}{2} = 1 - \frac{T_2}{600}$$

$$\frac{T_2}{600} = \frac{1}{2} \Rightarrow T_2 = 300\text{K}$$

$$T_2 = 300 - 273 = 27^{\circ}\text{C}$$

Question7

The temperature of a gas is −50°C. To what temperature the gas should be heated so that the rms speed is increased by 3 times?

[NEET 2023]

Options:

A.

3295°C

B.

3097K

C.

223K

D.

669°C

Answer: A

Solution:

$v_{rms} = \sqrt{\frac{3RT}{m}}$

$T_1 = 273 - 50$

$v_{rms} \propto \sqrt{T} \quad = 223K$

v_{rms} is increased by 3 times $\quad T_2 = ?$

So, final rms speed $= v + 3v = 4v$

$\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}}$

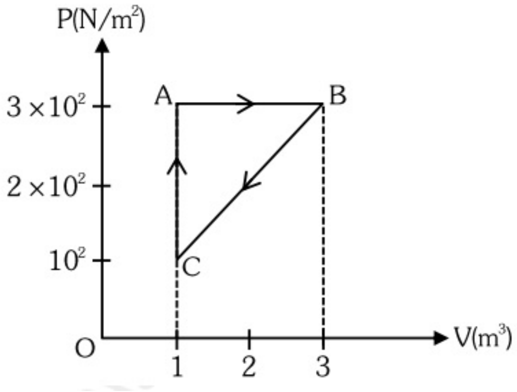
$\frac{v}{4v} = \sqrt{\frac{223}{T_2}} \Rightarrow \frac{1}{16} = \frac{223}{T_2}$

$T_2 = 3568K$

$T_2 = 3568 - 273 = 3295^{\circ}C$

Question8

For the given cycle, the work done during isobaric process is :



[NEET 2023 mpr]

Options:

A.

200J

B.

Zero

C.

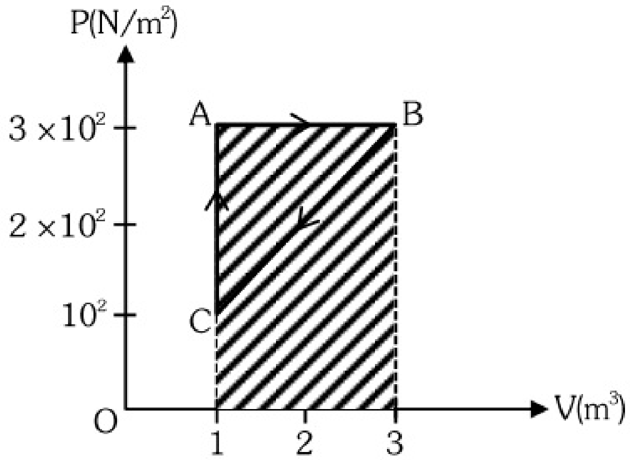
400J

D.

600J

Answer: D

Solution:



AB is isobaric process

$W_{AB} = P(V_2 - V_1)$

$W_{AB} = 3 \times 10^2(3-1)$

$W_{AB} = 3 \times 100 \times 2$

$W_{AB} = 600J$

Question9

A container of volume 200cm3 contains 0.2 mole of hydrogen gas and 0.3 mole of argon gas. The pressure of the system at temperature 200K (R = 8.3JK^{-1}mol^{1}) will be :-

[NEET 2023 mpr]

Options:

A.

6.15×10^5Pa

B.

6.15×10^4Pa

C.

4.15×10^5Pa

D.

4.15×10^6Pa

Answer: D

Solution:

$$P_{mix} = \frac{(\mu_1 + \mu_2)RT_{mix}}{V_{mix}}$$

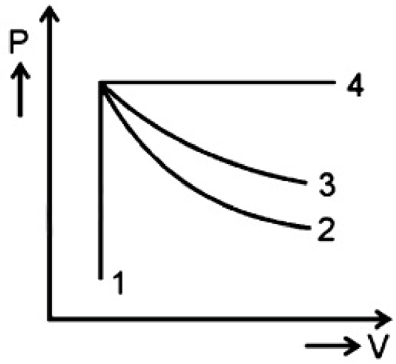
$$= \frac{(0.2 + 0.3) \times 8.3 \times 200}{200 \times 10^{-6}}$$

$$= \frac{0.5 \times 8.3 \times 200}{200 \times 10^{-6}}$$

$$P_{mix} = 4.15 \times 10^6 P_a$$

Question10

An ideal gas undergoes four different processes from the same initial state as shown in the figure below.
Those processes are adiabatic, isothermal, isobaric and isochoric. The curve which represents the adiabatic process among 1, 2, 3 and 4 is



[NEET-2022]

Options:

A. 1

B. 2

C. 3

D. 4

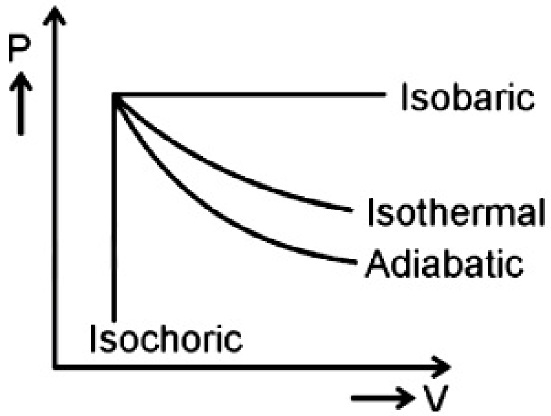
Answer: B

Solution:

Sol. $\left(\frac{dP}{dV}\right)_{\text{adiabatic}} = -\gamma P$

$\left(\frac{dP}{dV}\right)_{\text{isothermal}} = -P$

$\left(\frac{dP}{dV}\right)_{\text{adiabatic}} > \left(\frac{dP}{dV}\right)_{\text{isothermal}}$



Question11

The volume occupied by the molecules contained in 4.5kg water at STP, if the intermolecular forces vanish away is
[NEET-2022]

Options:

A. $5.6 \times 10^{6} \mathrm{m}^{3}$

B. $5.6 \times 10^{3} \mathrm{m}^{3}$

C. $5.6 \times 10^{-3} m^3$

D. $5.6 m^3$

Answer: D

Solution:

Solution:

From ideal gas equation

$PV = nRT$

$\left[n = \frac{\text{mass of water}}{\text{mol. wt.}} = \frac{4.5 \times 10^3}{18}\right]$

$V = \frac{nRT}{P}$

At. STP $\Rightarrow T = 273K$

$P = 10^5 N/m^2$

$V = \frac{4.5 \times 10^3}{18} \times \frac{8.3 \times 273}{10^5} = 5.66 m^3$

Question12

An ideal gas follows a process described by the equation $PV^2 = C$ from the initial (P_1, V_1, T_1) to final (P_2, V_2, T_2) thermodynamic states, where C is a constant. Then :
[NEET Re-2022]

Options:

A. If $P_1 > P_2$ then $V_1 > V_2$

B. If $P_1 > P_2$ then $T_1 < T_2$

C. If $V_2 > V_1$ then $T_2 > T_1$

D. If $V_2 > V_1$ then $T_2 < T_1$

Answer: D

Solution:

Solution:

$PV^2 = C \Rightarrow TV =$ const and $\frac{T^2}{P} =$ const

$P\uparrow \Rightarrow V\downarrow \quad T\uparrow \Rightarrow V\downarrow \quad T\uparrow = P\uparrow$

$P_1 > P_2 \Rightarrow V_2 > V_1 \quad V_2 > V_1 \Rightarrow T_1 > T_2 \quad P_1 > P_2 = T_1 > T_2$

Question13

Three vessels of equal capacity have gases at the same temperature and pressure. The first vessel contains helium (monoatomic), the second contains fluorine (diatomic) and the third contains sulfur hexafluoride (polyatomic). The correct statement, among the following is [NEET Re-2022]

Options:

A. The root mean square speed of sulfur hexafluoride is the largest

B. All vessels contain unequal number of respective molecules

C. The root mean square speed of molecules is same in all three cases

D. The root mean square speed of helium is the largest

Answer: D

Solution:

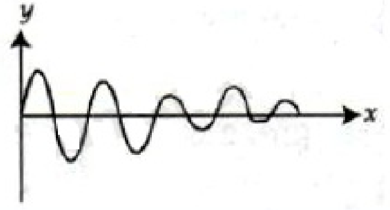
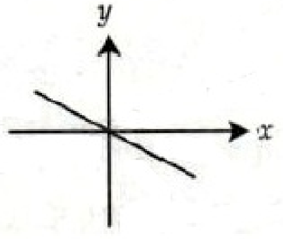
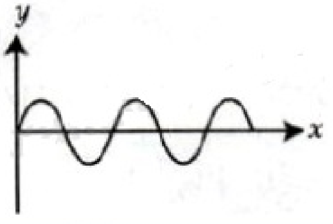
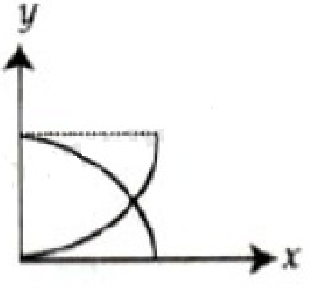
$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

Concept : v_{rms} is independent of degree of freedom.

M_{Helium} is smallest among all given so, v_{rms} for Helium is maximum.

Question14

Match List - I with List - II:

List - I (x-y graphs)	List-II (Situations)
(a) 	(i) Total mechanical energy is conserved
(b) 	(ii) Bob of a pendulum is oscillating under negligible air friction
(c) 	(iii) Restoring force of a spring
(d) 	(iv) Bob of a pendulumis oscillating along with air friction

Choose the correct answer from the options given below: [NEET Re-2022]

Options:

A. (a) - (iii), (b) - (ii), (c) - (i), (d) - (iv)

B. (a) - (iv), (b) - (ii), (c) - (iii), (d) - (i)

C. (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i)

D. (a) - (i), (b) - (iv), (c) - (iii), (d) - (ii)

Answer: C

Solution:

Graph (a) represents damped oscillation

$a \longrightarrow$ (iv)

Graph (b) represents restoring force of spring

$F = -kx$

$b \longrightarrow$ (iii)

Graph (c) represents undamped oscillations

$c \longrightarrow$ (ii)

Graph (d) represents total mechanical energy conservation

$d \longrightarrow$ (i)

Question15

A cup of coffee cools from 90°C to 80°C in t minutes, when the room temperature is 20°C. The time taken by a similar cup of coffee to cool from 80°C to 60°C at a room temperature same at 20°C is [NEET 2021]

Options:

A. $\frac{13}{10}t$

B. $\frac{13}{5}t$

C. $\frac{10}{13}t$

D. $\frac{5}{13}t$

Answer: B

Solution:

Solution:

From Average form of Newton's law of cooling $-\left(\frac{T_1+T_2}{2}-T_s\right)K = \frac{T_1-T_2}{\Delta t}$

T_1 and T_2 are initial and final temperature and T_s is surrounding temperature.

$\Rightarrow -K\left[\frac{(90+80)}{2}-20\right] = \frac{90-80}{t}$

$\Rightarrow -K(65) = \frac{10}{t}$

$\Rightarrow K = \frac{-2}{13t}$

In second case,

$-K\left(\frac{80+60}{2}-20\right) = \frac{(80-60)}{t_1}$

$\Rightarrow -K(50) = \frac{20}{t_1}$

$\Rightarrow \frac{2}{13t}(50) = \frac{20}{t_1}$

$\Rightarrow t_1 = \frac{13t}{5}$

Question16

Match Column - I and Column - II and choose the correct match from the given choices.

Column - I	Column - II
(A) Root mean square speed of gas molecules	(P) $\frac{1}{3}nm\bar{v}^2$
(B) Pressure exerted by ideal gas	(Q) $\sqrt{\frac{3RT}{M}}$
(C) Average kinetic energy of a molecule	(R) $\frac{5}{2}RT$
(D) Total internal energy of 1 mole of a diatomic gas	(S) $\frac{3}{2}k_BT$

[NEET 2021]

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Options:

A. (A) - (R), (B) - (P), (C) - (S), (D) - (Q)

B. (A) - (Q), (B) - (R), (C) - (S), (D) - (P)

C. (A) - (Q), (B) - (P), (C) - (S), (D) - (R)

D. (A) - (R), (B) - (Q), (C) - (P), (D) - (S)

Answer: C

Solution:

Root mean square speed of gas molecule = $\sqrt{\frac{3RT}{M}}$

Pressure exerted by ideal gas $= \frac{1}{3}nm\bar{v}^2$

Average kinetic energy of a molecule $= \frac{3}{2}k_BT$

Total internal energy of a gas is (U) = $\frac{1}{2}nf\,RT$

Here, $n = 1$
$f = 5$

$U = \frac{5}{2}RT$
Hence, (A) - (Q), (B) - (P), (C) - (S), (D) - (R)

Question17

A cylinder contains hydrogen gas at pressure of 249 kPa and temperature 27˚C.
Its density is : ($R = 8.3 J\ mol^{-1}K^{-1}$)
[2020]

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Options:

A. $0.2 kg / m^3$

B. $0.1 kg / m^3$

C. $0.02 kg / m^3$

D. $0.5 kg / m^3$

Answer: A

Solution:

Solution:
(a) Given : Pressure $P = 249 kPa = 249 \times 10^3 N / m^2$
Mass of hydrogen, $M = 2g = 2 \times 10^{-3} kg$
Temperature, $T = 27 + 273 = 300K$
Using, ideal gas equation,
$PV = nRT \quad PM = \rho RT \Rightarrow \rho = \frac{PM}{RT} \left(\because \rho = \frac{M}{V}\right) \therefore \rho = \frac{(249 \times 10^3)(2 \times 10^{-3})}{8.3 \times 300}$
$= 0.2 kg / m^3$

Question18

The mean free path for a gas, with molecular diameter d and number density n can be expressed as:
(2020)

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Options:

A. $\frac{1}{\sqrt{2} n \pi d^2}$

B. $\frac{1}{\sqrt{2} n^2 \pi d^2}$

C. $\frac{1}{\sqrt{2} n^2 \pi^2 d^2}$

D. $\frac{1}{\sqrt{2}n\pi d}$

Answer: A

Solution:

Solution:
(a) Mean free path for a gas
$\lambda_m = \frac{1}{\sqrt{2}n\pi d^2}$
Here, d = diameter of a gas molecule and,
n = molecular density.

Question19

Two cylinders A and B of equal capacity are connected to each other via a stop cock. A contains an ideal gas at standard temperature and pressure. B is completely evacuated. The entire system is thermally insulated. The stop cock is suddenly opened. The process is: [2020]

Options:

A. adiabatic

B. isochoric

C. isobaric

D. isothermal

Answer: A

Solution:

Solution:
(a) Entire system is thermally insulated. So,no heat exchange with surrounding will take place. Hence, process will be adiabatic.

Question20

In which of the following processes, heat is neither absorbed nor released by a system? (NEET 2019)

Options:

A. isochoric

B. isothermal

C. adiabatic

D. isobaric

Answer: C

Solution:

Solution:
Adiabatic process is the process in which no exchange of heat energy takes place between the gas and the surroundings, i.e.,$\Delta Q = 0$

Question21

Increase in temperature of a gas filled in a container would lead to (NEET 2019)

Options:

A. decrease in intermolecular distance

B. increase in its mass

C. increase in its kinetic energy

D. decrease in its pressure

Answer: C

Solution:

Solution:
As per kinetic theory of gases, kinetic energy of gas molecules is directly proportional to the temperature of the gas.

Question22

The value of $\gamma\left(=\frac{C_p}{C_v}\right)$, for hydrogen, helium and another ideal diatomic gas X (whose molecules are not rigid but have an additional vibrational mode), are respectively equal to (Odisha NEET 2019)

Options:

A. $\frac{7}{5}, \frac{5}{3}, \frac{9}{7}$

B. $\frac{5}{3}, \frac{7}{5}, \frac{9}{7}$

C. $\frac{5}{3}, \frac{7}{5}, \frac{7}{5}$

D. $\frac{7}{5}, \frac{5}{3}, \frac{7}{5}$

Answer: A

Solution:

$\gamma = 1 + \frac{2}{n}$

For H_2, $\gamma = 1 + \frac{2}{5} = \frac{7}{5}$

For He, $\gamma = 1 + \frac{2}{3} = \frac{5}{3}$

For X, $\gamma = 1 + \frac{2}{7} = \frac{9}{7}$

Question23

A sample of 0.1g of water at 100˚C and normal pressure ($1.013 \times 10^5 Nm^{-2}$) requires 54 cal of heat energy to convert to steam at 100˚C. If the volume of the steam produced is 167.1cc, the change in internal energy of the sample, is
(NEET 2018)

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Options:

A. 104.3J

B. 208.7J

C. 42.2J

D. 84.5J

Answer: B

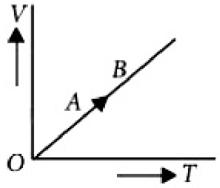
Solution:

Solution:
Using first law of thermodynamics, $\Delta Q = \Delta U + \Delta W$
$\Rightarrow 54 \times 4.18 = \Delta U + 1.013 \times 10^5 (167.1 \times 10^{-6} - 0)$
$\Rightarrow \Delta U = 208.7J$

Question24

The volume (V) of a monatomic gas varies with its temperature (T), as

shown in the graph. The ratio of work done by the gas, to the heat absorbed by it, when it undergoes a change from state A to state B, is



(NEET 2018)

Options:

A. $\frac{2}{5}$

B. $\frac{2}{3}$

C. $\frac{1}{3}$

D. $\frac{2}{7}$

Answer: A

Solution:

Solution:
Given process is isobaric.
$\therefore \mathrm{d\,Q} = \mathrm{nC_p d\,T}$; where C_p is specific heat at constant pressure.
or $\mathrm{d\,Q} = \mathrm{n}\left(\frac{5}{2}\mathrm{R}\right)\mathrm{d\,T}$
Also, $\mathrm{d\,W} = \mathrm{Pd\,V} = \mathrm{nRd\,T}$ $(\because \mathrm{PV} = \mathrm{nRT})$
Required ratio $= \frac{\mathrm{d\,W}}{\mathrm{d\,Q}} = \frac{\mathrm{nRd\,T}}{\mathrm{n}\left(\frac{5}{2}\mathrm{R}\right)\mathrm{d\,T}} = \frac{2}{5}$

Question25

The efficiency of an ideal heat engine working between the freezing point and boiling point of water, is (NEET 2018)

Options:

A. 26.8%

B. 20%

C. 6.25%

D. 12.5%

Answer: A

Solution:

Efficiency of an ideal heat engine, $\eta = \left(1 - \frac{T_2}{T_1}\right)$

Freezing point of water $= 0°C = 273K$
Boiling point of water $= 100°C = (100 + 273)K = 373K$
T_2: sink temperature $= 273K$
T_1: Source temperature $= 373K$

$\%\eta = \left(1 - \frac{T_2}{T_1}\right) \times 100 = \left(1 - \frac{273}{373}\right) \times 100$

$= \left(\frac{100}{373}\right) \times 100 = 26.8\%$

Question26

At what temperature will the rms speed of oxygen molecules become just sufficient for escaping from the Earth's atmosphere? (Given : Mass of oxygen molecule (m) = 2.76×10^{-26} kg, Boltzmann's constant $k_B = 1.38 \times 10^{-23} J\,K^{-1}$) (NEET 2018)

Options:

A. $2.508 \times 10^4 K$

B. $8.360 \times 10^4 K$

C. $5.016 \times 10^4 K$

D. $1.254 \times 10^4 K$

Answer: B

Solution:

Solution:
Escape velocity from the Earth's surface is
$v_{escape} = 11200 ms^{-1}$
Say at temperature T, oxygen molecule attains escape velocity.

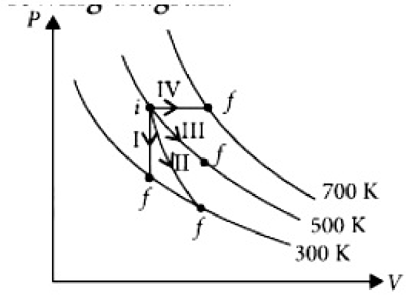
So, $v_{escape} = \sqrt{\frac{3k_B T}{m_{O_2}}}$

$\Rightarrow 11200 = \sqrt{\frac{3 \times 1.38 \times 10^{-23} \times T}{2.76 \times 10^{-26}}}$

On solving, $T = 8.360 \times 10^4 K$.

Question27

Thermodynamic processes are indicated in the following diagram.



Match the following

Column - 1	Column - 2
P. Process I	A. Adiabatic
Q. Process II	B. Isobaric
R. Process III	C. Isochoric
S. Process IV	D. Isothermal

(2017 NEET)

Options:

A. P→C, Q→A, R→D, S→B

B. P→C, Q→D , R→B, S→A

C. P→D,Q→B,R→A,S→C

D. P→A,Q→C,R→D,S→B

Answer: A

Solution:

In process I, volume is constant
∴ Process I → Isochoric; P → C
As slope of curve II is more than the slope of curve III
Process II → Adiabatic and Process III → Isothermal
∴ Q → A, R → D
In process IV, pressure is constant
Process IV → Isobaric; S → B

Question28

A carnot engine having an efficiency of $\frac{1}{10}$ a heat engine, is used as a refrigerator. If the work done on the system is 10 J, the amount of energy absorbed from the reservoir at lower temperature is (2015, 2017 NEET)

Options:

A. 90 J

B. 99 J

C. 100 J

D. 1 J

Answer: A

Solution:

Solution:

The relation between coefficient of performance and efficiency of carnot engine is given as $\beta = \frac{1-\eta}{\eta}$

Given

$\eta = \frac{1}{10}, W = 10J$

$\beta = \frac{1-\frac{1}{10}}{\frac{1}{10}} = \frac{9}{10} \cdot 10 = 9$

Since, $\beta = \frac{Q_2}{W}$,Where Q_2 is the amount of energy absorbed from the reservoir

$\therefore Q_2 = \beta W = 9 \times 10 = 90J$

Question29

A gas mixture consists of 2 moles of O_2 and 4 moles of Ar at temperature T. Neglecting all vibrational modes, the total internal energy of the system is
(NEET 2017)

Options:

A. 15 RT

B. 9 RT

C. 11 RT

D. 4 RT

Answer: C

Solution:

The internal energy of 2 moles of O_2 atom is

$U_{O_2} = \frac{n_1 f_1}{2} RT = 2 \times \frac{5}{2} \times RT$

$U_{O_2} = 5RT$

The internal energy of 4 moles of Ar atom is

$U_{Ar} = \frac{n_2 f_2 RT}{RT} = 4 \times \frac{3}{2} \times RT = 6RT$

∴ The total internal energy of the system is
$U = U_{O_2} + U_{Ar} = 5RT + 6RT = 11RT$

Question30

A gas is compressed isothermally to half its initial volume. The same gas is compressed separately through an adiabatic process until its volume is again reduced to half. Then
(2016 NEET Phase-I)

Options:

A. Compressing the gas isothermally or adiabatically will require the same amount of work.

B. Which of the case (whether compression through isothermal or through adiabatic process) requires more work will depend upon the atomicity of the gas.

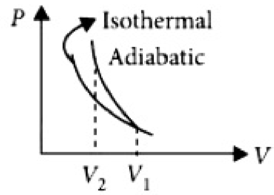
C. Compressing the gas isothermally will require more work to be done.

D. Compressing the gas through adiabatic process will require more work to be done.

Answer: D

Solution:

Solution:



$V_1 = V$

$V_2 = \frac{V}{2}$

On P-V diagram,
Area under adiabatic curve > Area under isothermal curve.
So compressing the gas through adiabatic process will require more work to be done.

Question31

The molecules of a given mass of a gas have r.m.s. velocity of $200 ms^{-1}$ at 27°C and $1.0 \times 10^5 N\,m^{-2}$ pressure. W hen the temperature and pressure of the gas are respectively, 127°C and $0.05 \times 10^5 N\,m^{-2}$, the r.m.s. velocity of its molecules in m s-1 is
(2016 NEET Phase-I)

Options:

A. $\frac{100\sqrt{2}}{3}$

B. $\frac{100}{3}$

C. $100\sqrt{2}$

D. $\frac{400}{\sqrt{3}}$

Answer: D

Solution:

As, $v_{rms} = \sqrt{\frac{3k)BT}{m}}$

$\therefore \frac{v_{27}}{v_{127}} = \sqrt{\frac{27+273}{127+273}} = \sqrt{\frac{300}{400}} = \frac{\sqrt{3}}{2}$

or $v_{127} = \frac{2}{\sqrt{3}} \times v_{27} = \frac{2}{\sqrt{3}} \times 200ms^{-1}$

$= \frac{400}{\sqrt{3}}ms^{-1}$

Question32

A refrigerator works between 4°C and 30°C. It is required to remove 600 calories of heat every second in order to keep the temperature of the refrigerated space constant. The power required is (Take 1 cal = 4.2 Joules)
(2016 NEET Phase-I)

Options:

A. 236.5 W

B. 2365 W

C. 2.365 W

D. 23.65 W

Answer: A

Solution:

Given, $T_2 = 4°C = 277K$
$T_1 = 30°C = 303K$
$Q_2 = 600$ cal per second
Coefficient of performance
$\alpha = \frac{T_2}{T_1 - T_2} = \frac{277}{303-277} = \frac{277}{26}$
Also, $\alpha = \frac{Q_2}{W}$
$\therefore$Work to be done per second = power required

$= W = \frac{Q_2}{\alpha} = \frac{26}{277} \times 600$ cal per secnd

$= \frac{26}{277} \times 600 \times 4.2J$ per second $= 236.5$ W

Question33

One mole of an ideal monatomic gas undergoes a process described by the equation $PV^3 =$ constant.The heat capacity of the gas during this process is (2016 NEET Phase-II)

Options:

A. $\frac{3}{2}R$

B. $\frac{5}{2}R$

C. 2R

D. R

Answer: D

Solution:

Process described by the equation,

$PV^3 =$ constant

For a polytropic process,$PV^\alpha =$ constant

$C = C_v + \frac{R}{1-\alpha} = \frac{3}{2}R + \frac{R}{1-3} = R \quad (\because \alpha=3)$

Question34

The temperature inside a refrigerator is t_2˚C and the room temperature is t_1˚C. The amount of heat delivered to the room fbr each joule of electrical energy consumed ideally will be (2016 NEET Phase-II)

Options:

A. $\frac{t_1}{t_1 - t_2}$

B. $\frac{t_1 + 273}{t_1 - t_2}$

C. $\frac{t_{21} + 273}{t_1 - t_2}$

D. $\frac{t_1 + t_2}{t_1 + 273}$

Answer: B

Solution:

Solution:
Temperature inside refrigerator $= t_2 °C$
Room temperature $= t_1 °C$
For refrigerator,

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

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

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

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

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

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

Question35

A given sample of an ideal gas occupies a volume V at a pressure P and absolute temperature T. The mass of each molecule of the gas is m. Which of the following gives the density of the gas ? (2016 NEET Phase-II)

Options:

A. $\frac{P}{(kT)}$

B. $\frac{Pm}{(kT)}$

C. $\frac{P}{(kTV)}$

D. mkT

Answer: B

Solution:

Solution:
As $PV = nRT$
p=or $n = \frac{PV}{RT} = \frac{\text{mass}}{\text{molar mass}}$..........(i)

Density(ρ) = $\frac{\text{mass}}{\text{volume}} = \frac{(\text{molar mass})P}{RT} = \frac{(mN_A)P}{RT}$
[From eqn. (i)]
$\rho = \frac{mP}{kT} (\because R = N_A k)$

Question36

An ideal gas is compressed to half of its initial volume by means of several processes. Which of the process results in the maximum work done on the gas?
(2015)

©

Options:

A. Isochroic

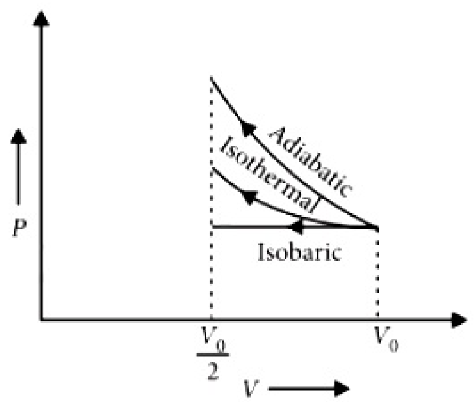
B. Isothermal

C. Adiabatic

D. Isobaric

Answer: C

Solution:



The $P - V$ diagram of an ideal gas compressed from its initial volume V_0 to $\frac{V_0}{2}$ by several processes is shown in the figure.
Work done on the gas = Area under $P - V$ curve. As area under the $P - V$ curve is maximum for adiabatic process, so work done on the gas is maximum for adiabatic process.

Question37

Two vessels separately contain two ideal gases A and B at the same temperature, the pressure of A being twice that of B. Under such conditions, the density of A is found to be 1.5 times the density of B. The ratio of molecular weight of A and B is
(2015)

Options:

A. 2

B. $\frac{1}{2}$

C. $\frac{2}{3}$

D. $\frac{3}{4}$

Answer: D

Solution:

Solution:
According to an ideal gas equation, the molecular weight of an ideal gas is
$M = \frac{\rho RT}{P}$ as $\left(P = \frac{\rho RT}{M}\right)$
where P, T and ρ are the pressure, temperature and density of the gas respectively and R is the universal gas constant.
∴ The molecular weight of A is
$M_A = \frac{\rho_A RT_A}{P_A}$ and that of B is $M_B = \frac{\rho_B RT_B}{P_B}$
Hence, their corresponding ratio is
$\frac{M_A}{M_B} = \left(\frac{\rho_A}{\rho_B}\right)\left(\frac{T_A}{T_B}\right)\left(\frac{P_B}{P_A}\right)$
Here, $\frac{\rho_A}{\rho_B} = 1.5 = \frac{3}{2}, \frac{T_A}{T_B} = 1$ and $\frac{P_A}{P_B} = 2$
$\therefore \frac{M_A}{M_B} = \left(\frac{3}{2}\right)(1)\left(\frac{1}{2}\right) = \frac{3}{4}$

Question38

The coefficient of performance of a refrigerator is 5. If the temperature inside freezer is -20°C, the temperature of the surroundings to which it rejects heat is (2015)

Options:

A. 11°C

B. 21°C

C. 31°C

D. 41°C

Answer: C

Solution:

The coefficient of performance of a refrigerator is

$\alpha = \frac{T_2}{T_1 - T_2}$

Where T_1 and T_2 are the temperatures of hot and cold reservoirs (in kelvin) respectively.

Here,

$\alpha = 5,\ T_2 = -20°C = -20 + 273K = 253K$

$T_1 = ?$

$\therefore 5 = \frac{253K}{T_1 - 253K}$

$5T_1 - 5(253K) = 253K$

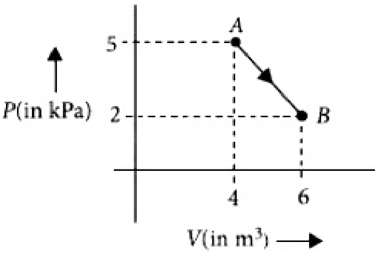
$5T_1 = 253K + 5(253K) = 6(253)$

$T_1 = \frac{6}{5}(253K) = 303.6K = 303.6 - 273$

$= 30.6° \approx 31°C$

Question39

One mole of an ideal diatomic gas undergoes a transition from A to 5 along a path AB as shown in the figure. The change in internal energy of the gas during the transition is



(2015)

Options:

A. 20 J

B. -12 kJ

C. 20 kJ

D. -20kJ

Answer: D

Solution:

Solution:

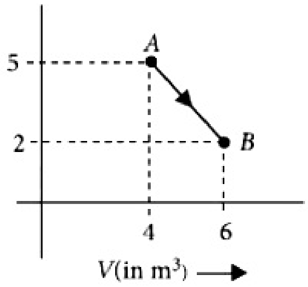
We know $\Delta U = nC_V\Delta T$

$= n\left(\frac{5R}{2}\right)(T_B - T_A)$ [for diatomic gas, $C_V = \frac{5R}{2}$]

$= \frac{5nR}{2}\left(\frac{P_BV_B}{nR} - \frac{P_AV_A}{nR}\right)$ [$\because PV + nRT$]

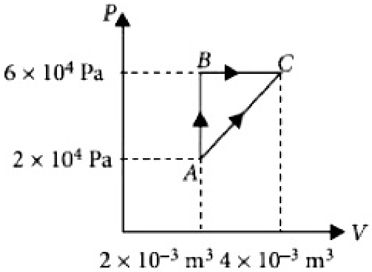
$= \frac{5}{2}(P_BV_B - P_AV_A) = \frac{5}{2}(2 \times 10^3 \times 6 - 5 \times 10^3 \times 4)$

$= \frac{5}{2}(-8 \times 10^3) = -20kJ$



Question40

Figure below shows two paths that may be taken by a gas to go from a state A to a state C In process .45, 400 J of heat is added to the system and in process BC, 100 J of heat is added to the system. The heat absorbed by the system in the process AC will be



(2015)

Options:

A. 460 J

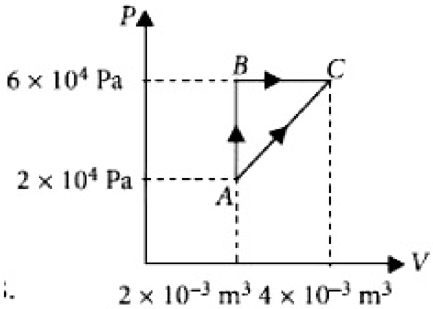
B. 300 J

C. 380 J

D. 500 J

Answer: A

Solution:



As initial and final points are same so
$\Delta U_{ABC} = \Delta U_{AC}$
AB is isochoric process
$\Delta W_{AB} = 0$
$\Delta Q_{AB} = \Delta U_{AB} = 400J$
BC is isobaric proces
$\Delta Q_{BC} = \Delta U_{BC} + \Delta W_{BC}$

$100 = \Delta U_{BC} + 6 \times 10^4 (4 \times 10^{-3} - 2 \times 10^{-3})$
$100 = \Delta U_{BC} + 12 \times 10$
$\Delta U_{BC} = 100 - 120 = -20J$
As, $\Delta U_{ABC} = \Delta U_{AC}$
$\Delta U_{AB} + \Delta U_{BC} = \Delta Q_{AC} - \Delta W_{AC}$
$400 - 20 = \Delta Q_{AC} - (2 \times 10^4 \times 2 \times 10^{-3}) + \frac{1}{2} \times 2 \times 10^{-3} \times 4 \times 10^4$
$380 = \Delta Q_{AC} - (40 + 40)$, $\Delta Q_{AC} = 380 + 80 = 460J$

Question41

A monoatomic gas at a pressure P, having a volume V expands isothermally to a volume 2 V and then adiabatically to a volume 16 V. The final pressure of the gas is (Take $\gamma = \frac{5}{3}$)
(2014)

Options:

A. 64P

B. 32P

C. $\frac{P}{64}$

D. 16P

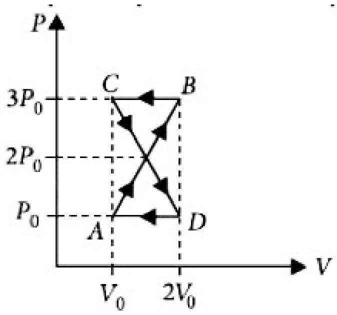
Answer: C

Solution:

First, isothermal expansion
$PV = P'(2V)$; $P' = \frac{P}{2}$
Then, adiabatic expansion
$P'(2V)^{\gamma} = P'(16V)^{\gamma}$
(For adiabatic process, $PV^{\gamma} =$ constant)
$\frac{P}{2}(2V)^{\frac{5}{3}} = P_f(16V)^{\frac{5}{3}}$
$P_f = \frac{P}{2}\left(\frac{2V}{16V}\right)^{\frac{5}{3}} = \frac{P}{2}\left(\frac{1}{8}\right)^{\frac{5}{3}} = \frac{P}{2}\left(\frac{1}{2^3}\right)^{\frac{5}{3}}$
$= \frac{P}{2}\left(\frac{1}{2^5}\right) = \frac{P}{64}$

Question42

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



(2014)

Options:

A. P_0V_0

B. $2P_0V_0$

C. $\frac{P_0V_0}{2}$

D. zero

Answer: D

Solution:

Solution:
In a cyclic process work done is equal to the area under the cycle and is positive if the cycle is clockwise and negative if anticlockwise.
As is clear from figure,

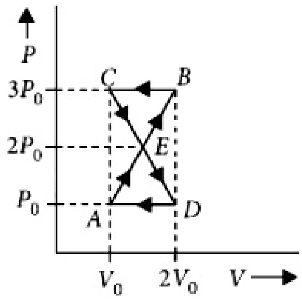
$W_{AEDA} = +\text{Area of } \Delta AED = +\frac{1}{2}P_0V_0$

$W_{BCEB} = -\text{Area of } \Delta BCE = -\frac{1}{2}P_0V_0$

The net work done by the system is

$W_{net} = W_{AEDA} + W_{BCEB}$

$= +\frac{1}{2}P_0V_0 - \frac{1}{2}P_0V_0 = \text{zero}$



Question43

The mean free path of molecules of a gas, (radius r) is inversely proportional to
(2014)

Options:

A. r^3

B. r^2

C. r

D. $\sqrt{r}$

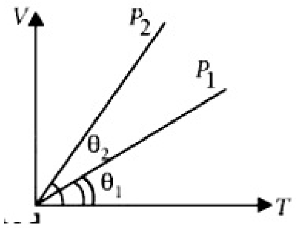
Answer: B

Solution:

Solution:
Mean free path, $\lambda = \frac{1}{\sqrt{2} n \pi d^2}$
where n is the number density and d is the diameter of the molecule.
As $d = 2r$ $\quad \therefore \lambda = \frac{1}{4\sqrt{2} n \pi r^2}$ or $\lambda \propto \frac{1}{r^2}$

Question44

In the given (V -T) diagram, what is the relation between pressure P_1 and P_2



(2013 NEET)

Options:

A. $P_2 < P_1$

B. Cannot be predicted

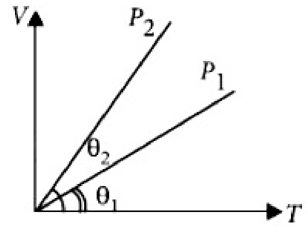
C. $P_2 = P_1$

D. $P_2 > P_1$

Answer: A

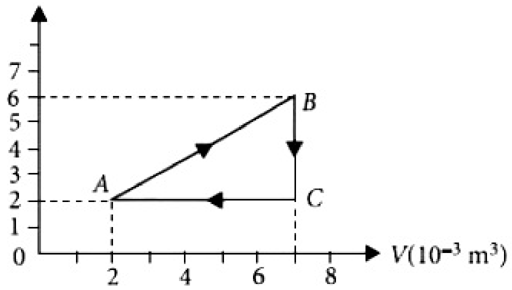
Solution:

Solution:
According to ideal gas equation
$PV = nRT$ or $V = \frac{nRT}{P}$
For an isobaric process, P = constant and $V \propto T$
Therefore, $V - T$ graph is a straight line passing through origin.
Slope of this line is inversely proportional to P.
In the given figure
$(slope)_2 > (Slope)_1$
$\therefore P_2 < P_1$



Question45

A gas is taken through the cycle A → B → C shown. What is the net work done by the gas?



(2013 NEET)

Options:

A. Zero

B. -2000 J

C. 2000 J

D. 1000 J

Answer: D

Solution:

Solution:
In a cyclic process, work done is equal to the area under the cycle and is positive if the cycle is clockwise and negative if the cycle is anticlockwise.
∴ The net work done by the gas is
W = Area of the cycle ABCA

$$= \frac{1}{2} \times (7-2) \times 10^{-3} \times (6-2) \times 10^{5}$$

$$= \frac{1}{2} \times 5 \times 10^{-3} \times 4 \times 10^{5}$$

$$= 10 \times 10^{2} \text{J} = 1000 \text{J}$$

Question46

During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its temperature. The ratio of $\frac{C_P}{C_V}$ for the gas is

(2013 NEET)

Options:

A. $\frac{5}{3}$

B. $\frac{3}{2}$

C. $\frac{4}{3}$

D. 2

Answer: B

Solution:

$P \propto T^{3}$............(i)
$PT^{-3} =$ constant
For an adiabatic process,
$PT^{\frac{\gamma}{1-\gamma}} =$ ......(ii)constant
Comparing (i) and (ii), we get
$\frac{\gamma}{1-\gamma} = -3$
$\gamma = -3 + 3\gamma$
$-2\gamma = -3$ or $\gamma = \frac{3}{2}$
As $\gamma = \frac{C_P}{C_V}$ $\therefore \frac{C_P}{C_V} = \frac{3}{2}$

Question47

The amount of heat energy required to raise the temperature of 1 g of Helium at NTP, from T_1 to T_2 K is
(2013 NEET)

Options:

A. $\frac{3}{4}N_a k_B(T_2 - T_1)$

B. $\frac{3}{4}N_a k_B\left(\frac{T_2}{T_1}\right)$

C. $\frac{3}{8}N_a k_B(T_2 - T_1)$

D. $\frac{3}{2}N_a k_B(T_2 - T_1)$

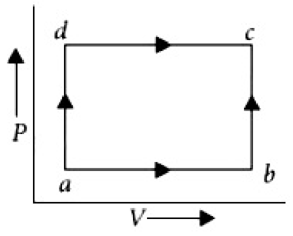
Answer: C

Solution:

As here volume of the gas remains constant, therefore the amount of heat energy required to raise the temperature of the gas is
$\Delta Q = nC_V\Delta T$
Here, number of moles, $n = \frac{1}{4}$
$C_V = \frac{3}{2}R$ ($\because$ He is a monatomic.)
$\Delta T = T_2 - T_1$
$\therefore \Delta Q = \frac{1}{4} \times \frac{3}{2}R(T_2 - T_1)$
$= \frac{3}{8}N_a k_B(T_2 - T_1)$ $\left(\because k_B = \frac{R}{N_a}\right)$

Question48

A system is taken from state a to state c by two paths adc and abc as shown in the figure.



The internal energy at a is $U_a = 10J$. Along the path adc the amount of heat absorbed $dQ_1 = 50J$ and the work obtained $dW_1 = 20J$ whereas along the path abc the heat absorbed $dQ_2 = 36$ J. The amount of work along the path abc is
(KN NEET 2013)

Options:

A. 10J

B. 12J

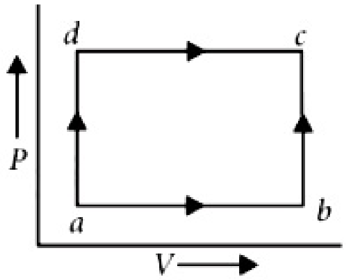
C. 36J

D. 6J

Answer: D

Solution:

According to first law of thermodynamics, $\delta Q = \delta U + \delta W$
Along the path adc
Change in internal energy,
$\delta U_1 = \delta Q_1 - \delta W_1 = 50J - 20J = 30J$
Along the path abc,
Change in internal energy,
$\delta U_2 = \delta Q_2 - \delta W_2$;
$\delta U_2 = 36J - \delta W_2$
As change in internal energy is path independent.
$\therefore \delta U_1 = \delta U_2$
$\Rightarrow 30J = 36J - \delta W_2$
$\delta W_2 = 36J - 30J = 6J$



Question49

Which of the following relations does not give the equation of an adiabatic process, where terms have their usual meaning?
(KN NEET 2013)

Options:

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

B. $PV^{\gamma} =$ constant

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

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

Answer: D

Solution:

For an adiabatic process,
$PV^{\gamma} =$ constant ...(i)
According to ideal gas equation
$PV = nRT$
$\Rightarrow P = \frac{nRT}{V}$
Putting value of P in (i), we get
$\frac{nRT}{V}V^{\gamma} = \text{constant};$
$\therefore TV^{\gamma-1} = \text{constant}$
Again from the ideal gas equation
$V = \frac{nRT}{P}$
Putting value of V in (i), we get
$P\left(\frac{nRT}{P}\right)^{\gamma} =$ constan;t
$P^{1-\gamma}T^{\gamma} =$ constant

Question50

Two Carnot engines A and B are operated in series. The engine A receives heat from the source at temperature T_1 and rejects the heat to the sink at temperature T . The second engine B receives the heat at temperature T and rejects to its sink at temperature T_2. For what value

of T the efficiencies of the two engines are equal (KN NEET 2013)

Options:

A. $\frac{T_1 - T_2}{2}$

B. $T_1 T_2$

C. $\sqrt{T_1 T_2}$

D. $\frac{T_1 + T_2}{2}$

Answer: C

Solution:

Solution:

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

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

For engine A, $\eta_A = 1 - \frac{T}{T_1}$

For engine B, $\eta_B = 1 - \frac{T_2}{T}$

As per question, $\eta_A = \eta_B$

$\therefore 1 - \frac{T}{T_1} = 1 - \frac{T_2}{T}$

$\Rightarrow \frac{T}{T_1} = \frac{T_2}{T}$ or $T = \sqrt{T_1 T_2}$

Question51

In a vessel, the gas is at pressure P. If the mass of all the molecules is halved and their speed is doubled, then the resultant pressure will be (Karnataka NEET 2013)

Options:

A. 2P

B. P

C. $\frac{P}{2}$

D. 4P

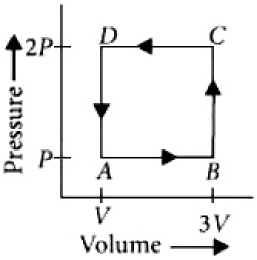
Answer: A

Solution:

As $P = \frac{1}{3}\frac{mN}{V}{v_{rms}}^2$...(i)
where m is the mass of each molecule, N is the total number of molecules, V is the volume of the gas.
When mass of all the molecules is halved and their speed is doubled, then the pressure will be
$P' = \frac{1}{3}\left(\frac{m}{2}\right) \times \frac{N}{V}(2v_{rms})^2$
$= \frac{2}{3}\frac{mN}{V}v^2_{rms} = 2P$

Question52

A thermodynamic system is taken through the cycle ABCD as shown in figure. Heat rejected by the gas during the cycle is



(2012)

Options:

A. 2PV

B. 4PV

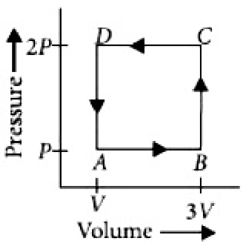
C. $\frac{1}{2}$PV

D. PV

Answer: A

Solution:

Solution:



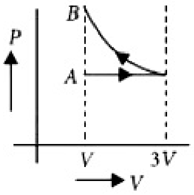
In a cyclic process,$\Delta U = 0$ In a cyclic process work done is equal to the area under the cycle and is positive if the cycle is clockwise and negative if anticlock wise
$\therefore \Delta W = -$ Area of rectangle $ABCD = -P(2V) = -2PV$
According to first law of thermodynamics
$\Delta Q = \Delta U + \Delta W$ or $\Delta Q = \Delta W$
(As $\Delta U = 0$)
i.e., heat supplied to the system is equal to the work done
So heat absorbed, $\Delta Q = \Delta W = -2PV$
$\therefore$ Heat rejected by the gas = 2PV

Question53

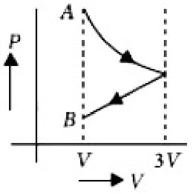
One mole of an ideal gas goes from an initial state A to final state B via two processes : It first undergoes isothermal expansion from volume V to 3V and then its volume is reduced from 3V to V at constant pressure. The correct P-V diagram representing the two processes is (2012)

Options:

A.



B.



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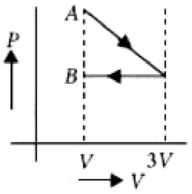

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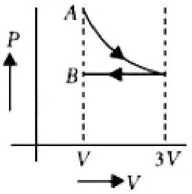
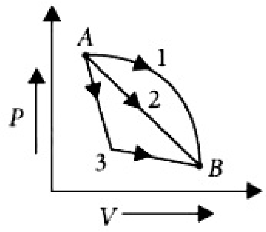


Answer: D

Question54

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 process and ΔU_1, ΔU_2, ΔU_3 indicate the change in internal energy along the three processes respectively, then



(2012 Mains)

Options:

A. $Q_1 > Q_2 > Q_3$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$

B. $Q_3 > Q_2 > Q_1$ 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. $Q_3 > Q_2 > Q_1$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$

Answer: A

Solution:

Solution:
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 $\Delta U_1 = \Delta U_2 = \Delta U_3$
$\therefore Q_1 > Q_2 > Q_3$

Question55

During an isothermal expansion, a confined ideal gas does -150 J of work against its surroundings. This implies that
(2011)

Options:

A. 150 J of heat has been removed from the gas

B. 300 J of heat has been added to the gas

C. no heat is transferred because the process is isothermal

D. 150 J of heat has been added to the gas

Answer: D

Question56

When 1 kg of ice at 0°C melts to water at 0°C, the resulting change in its entropy, taking latent heat of ice to be 80 cal/°C, is (2011)

Options:

A. 273 cal/K

B. 8×10^4 cal/K

C. 80 cal/K

D. 293 cal/K

Answer: D

Solution:

Heat required to melt 1 kg ice at 0°C to water at 0°C is
$Q = m_{ice}L_{ice} = (1kg)(80cal/g)$
$= (1000g)(80cal/g) = 8 \times 10^4$ cal
Change in entropy, $\Delta S = \frac{Q}{T} = \frac{8 \times 10^4 cal}{(273K)} = 293$ cal/K
Note : In the question paper unit of latent heat of ice is given to be cal/°C. It is wrong. The unit of latent heat of ice is cal/g.

Question57

A mass of diatomic gas ($\gamma = 1.4$) at a pressure of 2 atmospheres is compressed adiabatically so that its temperature rises from 27°C to 927°C. The pressure of the gas in the final state is (2011 Mains)

Options:

A. 8 atm

B. 28 atm

C. 68.7 atm

D. 256 atm

Answer: D

Solution:

For an adiabatic process

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

$\therefore \left(\frac{T_i}{T_f}\right)^{\gamma} = \left(\frac{P_i}{P_f}\right)^{\gamma-1}$

$\Rightarrow P_f = P_i \left(\frac{T_f}{T_i}\right)^{\frac{\gamma}{\gamma-1}}$ ...(i)

Here, $T_i = 27°C = 300K$, $T_f = 927°C = 1200K$

$P_i = 2\,atm$, $\gamma = 1.4$

Substituting these values in eqn (i), we get

$P_f = (2)\left(\frac{1200}{300}\right)^{\frac{1.4}{1.4-1}}$

$= (2)(4)^{\frac{1.4}{0.4}} = 2(2^2)^{\frac{7}{2}} = (2)(2)^7 = 2^8 = 256$ atm

----

Question58

If ΔU and ΔW represent the increase in internal energy and work done by the system respectively in a thermodynamical process, which of the following is true? (2010)

Options:

A. $\Delta U - \Delta W$,in a adiabatic process

B. $\Delta U = \Delta W$, in a isothermal process

C. $\Delta U = \Delta W$, in a adiabatic process

D. $\Delta U = -\Delta W$, in a isothermal process

Answer: A

Solution:

Solution:
According to first law of thermodynamics
$\Delta Q = \Delta U + \Delta W$
For an adiabatic process, $\Delta Q = 0$
$\therefore \Delta U = -\Delta W$
For an isothermal process $\Delta U = 0$
$\therefore \Delta Q = \Delta W$
Hence, option (a) is true.

Question59

If C_p and C_v denote the specific heats (per unit mass of an ideal gas of molecular weight M) then (where R is the molar gas constant).
(2010 Mains)

Options:

A. $C_P - C_v = \frac{R}{M^2}$

B. $C_P - C_v = R$

C. $C_P - C_v = \frac{R}{M}$

D. $C_P - C_v = MR$

Answer: C

Question60

A monatomic gas at pressure P_1 and V_1 is compressed adiabatically to $\frac{1}{8}$ th of its original volume. What is the final pressure of the gas?
(2010 Mains)

Options:

A. $64P_1$

B. P_1

C. $16P_1$

D. $32P_1$

Answer: D

Solution:

For an adiabatic process
$PV^{\gamma} =$ constant or $P_1V_1^{\gamma} = P_2V_2^{\gamma}$
For monatomic gas $\gamma = \frac{5}{3}$

$\therefore P_1 V_1^{\frac{5}{3}} = P_2 \left(\frac{V_1}{8}\right)^{\frac{5}{3}} \Rightarrow P_2 = P_1 \times (2)^5 = 32P_1$

Question61

The internal energy change in a system that has absorbed 2 kcal of heat and done 500 J of work is
(2009)

Options:

A. 6400 J

B. 5400 J

C. 7900 J

D. 8900 J

Answer: C

Solution:

Solution:
Heat energy given $dQ = dU + dW$ where dU is the change in internal energy and dW is the work done.
Given $dQ = 2\text{kcal} = 2000 \times 4.2\text{J}$ and $dW = 500\text{J}$
$\therefore dQ = 2000 \times 4.2 = dU + 500 \Rightarrow dU = 7900\text{J}$

Question62

In thermodynamic processes which of the following statements is not true?
(2009)

Options:

A. In an isochoric process pressure remains constant.

B. In an isothermal process the temperature remains constant.

C. In an adiabatic process $PV^{\gamma} =$ constant

D. In an adiabatic process the system is insulated from the surroundings.

Answer: A

Solution:

In isochoric process, volume is kept constant. If pressure is kept constant, it is an isobaric process.

Question63

At 10° C the value of the density of a fixed mass of an ideal gas divided by it pressure is x. At 110°C this ratio is (2008)

Options:

A. $\frac{10}{110}x$

B. $\frac{283}{383}x$

C. x

D. $\frac{383}{283}x$

Answer: B

Solution:

Mass of the gas $= m$.
At a fixed temperature and pressure, volume is fixed.
Density of the gas $\rho = \frac{m}{V} \Rightarrow \frac{m}{V \cdot P} = \frac{m}{nRT} = x$
$\therefore xT$ = constant.
At $10°C$ i.e., $283K$, $xT = x \cdot 283K$ ...(i)
At $110°C$, $xT = x' \cdot 383K$ ...(ii)
From eq. (i) and(ii) we get
$x' = \frac{283}{383}x$

Question64

If Q,E and W denote respectively the heat added, change in internal energy and the work done in a closed cyclic process, then (2008)

Options:

A. $E = 0$

B. $Q = 0$

C. $W = 0$

D. $Q = W = 0$

Answer: A

Solution:

Solution:
Internal energy depends only on the initial and final states of temperature and not on the path. In a cyclic process, as initial and final states are the same, the internal energy change is zero. Hence E is ΔU, the internal energy change

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Question65

An engine has an efficiency of $\frac{1}{6}$. When the temperature of sink is reduced by 62°C its efficiency is doubled. Temperatures of the source is (2007)

Options:

A. 37°C

B. 62°C

C. 99°C

D. 124°C

Answer: C

Solution:

Solution:
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, $\frac{T_2}{T_1} = \frac{5}{6}$...(i)
When the temperature of the sink is decreased by 62°C (or 62K), 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, $2T_1 = 3\left[\frac{5}{6}\right]T_1 - 186$ [using (i)]
$\therefore \left[\frac{5}{2} - 2\right]T_1 = 186$ or, $\frac{T_1}{2} = 186$
or, $T_1 = 372K = 99°C$

Question66

A Carnot engine whose sink is at 300K 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?

(2006)

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Options:

A. 380K

B. 275K

C. 325K

D. 250K

Answer: D

Solution:

Solution:

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

$\Rightarrow \frac{T_2}{T_1} = 1 - \eta = 1 - \frac{40}{100} = \frac{3}{5}$

$\therefore T_1 = \frac{5}{3} \times T_2 = \frac{5}{3} \times 300 = 500K$

Increase in efficiency $= 50\%$ of $40\% = 20\%$

New efficiency, $\eta' = 40\% + 20\% = 60\%$

$\frac{T_2}{T'_1} = 1 - \frac{60}{100} = \frac{2}{5}$

$T'_1 = \frac{5}{2} \times T_2 = \frac{5}{2} \times 300 = 750K$

Increase in temperature of source $= T'_1 - T_1 = 750 - 500 = 250K$

Question67

The molar specific heat at constant pressure of an ideal gas is $\left(\frac{7}{2}\right)R$. The ratio of specific heat at constant pressure to that at constant volume is
(2006)

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Options:

A. $\frac{9}{7}$

B. $\frac{7}{5}$

C. $\frac{8}{7}$

D. $\frac{5}{7}$

Answer: B

Solution:

Molar specific heat at constant pressure

$C_P = \frac{7}{2}R$

$\therefore C_V = C_P - R = \frac{7}{2}R - R = \frac{5}{2}R$

$\therefore \frac{C_P}{C_V} = \frac{(7/2)R}{(5/2)R} = \frac{7}{5}$

Question68

An ideal gas heat engine operates in Carnot cycle between 227°C and 127°C. It absorbs 6×10^4 cal of heat at higher temperature. Amount of heat converted to work is (2005)

Options:

A. 4.8×10^4 cal

B. 6×10^4 cal

C. 2.4×10^4 cal

D. 1.2×10^4 cal

Answer: D

Solution:

$1 - \frac{T_2}{T_1} = 1 - \frac{Q_2}{Q_1}$

$\Rightarrow 1 - \frac{400}{500} = 1 - \frac{Q_2}{6 \times 10^4}$

$\Rightarrow Q_2 = 4.8 \times 10^4$ cal

Net heat converted into work = $6.0 \times 10^4 - 4.8 \times 10^4 = 1.2 \times 10^4$ cal.

Question69

Which of the following processes is reversible? (2005)

Options:

A. Transfer of heat by conduction

B. Transfer of heat by radiation

C. Isothermal compression

D. Electrical heating of a nichrome wire.

Answer: C

Solution:

Solution:
Isothermal compression is reversible, for example, Carnot cycle, heat engine.

Question70

The equation of state for 5g of oxygen at a pressure P and temperature T , when occupying a volume V , will be
(2004)

Options:

A. $PV = \left(\frac{5}{32}\right) RT$

B. $PV = 5RT$

C. $PV = \left(\frac{5}{2}\right) RT$

D. $PV = \left(\frac{5}{16}\right) RT$

Answer: A

Solution:

As $PV = nRT$
$n = \dfrac{m}{\text{molecular mass}} = \dfrac{5}{32}$
$\Rightarrow PV = \left(\dfrac{5}{32}\right) RT$

Question71

One mole of an ideal gas at an initial temperature of TK does 6R joule of work adiabatically. If the ratio of specific heats of this gas at constant pressure and at constant volume is $\frac{5}{3}$, the final temperature of gas will be
(2004)

Options:

A. $(T\ + 2.4)K$

B. $(T\ - 2.4)K$

C. $(T\ + 4)K$

D. $(T\ - 4)K$

Answer: D

Solution:

Work done in adiabatic process is given as

$W\ = \frac{-1}{\gamma - 1}(P_f V_f - P_i V_i)$

$6R = \frac{-1}{\frac{5}{3} - 1} R(T_f - T_i)$ [Using PV = RT]

$\Rightarrow T_f - T_i = -4$

$\therefore T_f = (T\ - 4)K$

Question72

An ideal gas heat engine operates in a Carnot cycle between 227°C and 127°C. It absorbs 6 kcal at the higher temperature. The amount of heat (in kcal) converted into work is equal to
(2003)

Options:

A. 4.8

B. 3.5

C. 1.6

D. 1.2

Answer: D

Solution:

Efficiency of Carnot engine $= \frac{W}{Q_1} = 1 - \frac{T_2}{T_1}$

$\frac{W}{6} = 1 - \frac{400}{500} = \frac{1}{5}$

$\Rightarrow W\ = \frac{6}{5} = 1.2\,\text{kcal}$

Question73

The efficiency of Carnot engine is 50% and temperature of sink is 500K. If temperature of source is kept constant and its efficiency raised to 60%, then the required temperature of sink will be
(2002)

Options:

A. 100K

B. 600K

C. 400K

D. 500K

Answer: C

Solution:

Efficiency (η) of a carnot engine is given by

$\eta = 1 - \frac{T_2}{T_1}$, where T_1 is the temperature of the source and T_2 is the temperature of the sink.

Here, $T_2 = 500K$

$\therefore 0.5 = 1 - \frac{500}{T_1}$

$\Rightarrow T_1 = 1000K$

Now, $\eta = 0.6 = 1 - \frac{T'_2}{1000}$ (T'_2 is the new sink temperature)

$\Rightarrow T'_2 = 400K$

Question74

A scientist says that the efficiency of his heat engine which work at source temperature 127°C and sink temperature 27°C is 26% then
(2001)

Options:

A. it is impossible

B. it is possible but less probable

C. it is quite probable

D. data are incomplete.

Answer: A

Solution:

Solution:
Efficiency is maximum in Carnot engine which is an ideal engine.
$\eta = \frac{400 - 300}{400} \times 100\% = 25\%$
∴ efficiency 26% is impossible for his heat engine.

Question75

The $\left(\frac{W}{Q}\right)$ of a Carnot engine is $\frac{1}{6}$, now the temperature of sink is reduced by 62°C then this ratio becomes twice, therefore the initial temperature of the sink and source are respectively (2000)

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Options:

A. 33°C, 67°C

B. 37°C, 99°C

C. 67°C, 33°C

D. 97K , 37K

Answer: B

Solution:

Solution:
$\frac{1}{6} = 1 - \frac{T_2}{T_1}$ or $\frac{5}{6} = \frac{T_2}{T_1}$
Now, $\frac{1}{3} = 1 - \frac{T_2 - 62}{T_1} = 1 - \frac{5}{6} + \frac{62}{T_1}$
$T_1 = 62 \times 6 = 99°C$ and $T_2 = 37°C$

Question76

To find out degree of freedom, the expression is (2000)

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Options:

A. $f = \frac{2}{\gamma - 1}$

B. $f = \frac{\gamma + 1}{2}$

C. $f = \frac{2}{\gamma + 1}$

D. $f = \frac{1}{\gamma + 1}$

Answer: A

Solution:

Here, gamma $= 1 + \frac{2}{f}$
where f is the degree of freedom
$\therefore \frac{2}{f} = \gamma - 1$ or $f = \frac{2}{\gamma - 1}$

Question77

An ideal gas at 27°C is compressed adiabatically to $\frac{8}{27}$ of its original volume. The rise in temperature is (Take $\gamma = \frac{5}{3}$)
(1999)

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Options:

A. 275K

B. 375K

C. 475K

D. 175K

Answer: B

Solution:

$TV^{\gamma - 1} =$ constant (adiabatic).
$\therefore (300)(V_0)^{2/3} = (V_f)^{2/3}T$

$T = 300\left(\frac{27}{8}\right)^{\frac{2}{3}} = 300 \times \left(\frac{3}{2}\right)^{3 \times \frac{2}{3}} = 675K$
Temperature rise $= 675 - 300 = 375K$

Question78

The degrees of freedom of a triatomic gas is
(1999)

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Options:

A. 6

B. 4

C. 2

D. 8

Answer: A

Solution:

3 translational, 3 rotational.

Question79

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 a mass of gas, when the volume changes from V to $2V$ at constant pressure P, is (1998)

Options:

A. $\frac{PV}{(\gamma-1)}$

B. PV

C. $\frac{R}{(\gamma-1)}$

D. $\frac{\gamma PV}{(\gamma-1)}$

Answer: A

Solution:

Change in internal energy,

$\Delta U = nC_V\Delta T$

$= \frac{nR\Delta T}{(\gamma-1)} = \frac{nP\Delta V}{(\gamma-1)} = \frac{nP(2V-V)}{\gamma-1}$

For one mole, $n = 1$.

$\therefore \Delta U = \frac{PV}{(\gamma-1)}$

Question80

We consider a thermodynamic system. If ΔU represents the increase in

its internal energy and W the work done by the system, which of the following statements is true?
(1998)

Options:

A. $\Delta U = -W$ in an isothermal process

B. $\Delta U = W$ in an isothermal process

C. $\Delta U = -W$ in an adiabatic process

D. $\Delta U = W$ in an adiabatic process

Answer: C

Solution:

According to first law of thermodynamics
$\Delta Q = \Delta U + W$
For an adiabatic process, $\Delta Q = 0$.
$\therefore \Delta U = -W$

Question81

The efficiency of a Carnot engine operating with reservoir temperature of 100°C and −23°C will be
(1997)

Options:

A. $\frac{373 + 250}{373}$

B. $\frac{373 - 250}{373}$

C. $\frac{100 + 23}{100}$

D. $\frac{100 - 23}{100}$

Answer: B

Solution:

Solution:
Reservoir temperature $(T_1) = 100°C = 373K$
and $T_2 = -23°C = 250K$
The efficiency of a Carnot engine
$\eta = \frac{T_1 - T_2}{T_1} = \frac{373 - 250}{373}$

Question82

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
(1997)

Options:

A. adiabatic

B. equal in all cases

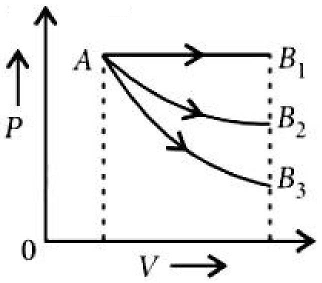
C. isothermal

D. isobaric.

Answer: D

Solution:

Solution:
During expansion, work is performed by the gas. The isobaric expansion is represented by the horizontal straight line AB_1, since the adiabatic curve is steeper than the isothermal curve, the adiabatic expansion curve (AB_3) must lie below the isothermal curve (AB_2) as shown in the given figure



since area under AB_1, is maximum, the work done is maximum in case of isobaric expansion.

Question83

The value of critical temperature in terms of van der Waals' constant a and b is given by
(1996)

Options:

A. $T_C = \frac{8a}{27Rb}$

B. $T_C = \frac{27a}{8Rb}$

C. $T_C = \frac{a}{2Rb}$

D. $T_C = \frac{a}{27Rb}$

Answer: A

Solution:

Solution:
A Vander Waals equation is given by:
$$\left(P + \frac{a}{V^2}\right)(V - b) = RT$$
Where, a and b are constant
Solving above equation,
$$P = \frac{RT}{V - b} - \frac{a}{V^2}$$
Taking derivative of P w.r.t volume
$$\frac{\partial P}{\partial V} = 0$$
$$\frac{\partial^2 P}{\partial V^2} = 0$$
So, P becomes:
$$\frac{\partial P}{\partial V} = -\frac{RT}{(V - b)^2} + \frac{2a}{V^3} = 0$$
$$\frac{2a}{V^3} = \frac{RT}{(V - b)^2} \ldots\ldots\ldots (1)$$
$$\frac{a}{V^4} = \frac{RT}{2V(V - b)^2} \ldots\ldots\ldots\ldots\ldots (2)$$
Taking double derivative again,
$$\frac{\partial^2 P}{\partial V^2} = \frac{2RT}{(V - b)^3} - \frac{6a}{V^4} = 0$$
Ol $\frac{RT}{(V - b)^3} = \frac{3a}{V^4}$
Put equation (2) in above equation
$$\frac{RT}{(V - b)^3} = \frac{3RT}{2V(V - b)^2}$$
On rearranging, $3V - 3b = 2V$
$V_c = 3b$
V_C is critical volume Use this value in equation (1)
$$\frac{RT}{4b^2} = \frac{2a}{27b^3}$$
$$T_c = \frac{8a}{27Rb}$$
T_C is critical temperature.

Question84

An ideal gas, undergoing adiabatic change, has which of the following pressure temperature relationship?
(1996)

Options:

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

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

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

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

Answer: B

Solution:

For the adiabatic change, $PV^{\gamma} =$ constant
And for ideal gas, $V = \frac{RT}{P} \propto \frac{T}{P}$
Therefore $P^{1-\gamma}T^{\gamma} =$ constant.

Question85

A diatomic gas initially at 18°C is compressed adiabatically to one eighth of its original volume. The temperature after compression will be (1996)

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Options:

A. 395.4°C

B. 144°C

C. 18°C

D. 887.4°C

Answer: A

Solution:

Solution:

Initial temperature $(T_1) = 18°C = (273 + 18) = 291K$ and $V_2 = \left(\frac{1}{8}\right)V_1$
For adiabatic compression, $TV^{\gamma-1} =$ constant
or $T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$
Therefore $T_2 = T_1\left(\frac{V_1}{V_2}\right)^{\gamma-1}$
$= 291 \times (8)^{1.4-1} = 291 \times (8)^{0.4}$
$= 291 \times 2.297 = 668.4K. = 395.4°C$

Question86

At 0K which of the following properties of a gas will be zero? (1996)

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Options:

A. vibrational energy

B. density

C. kinetic energy

D. potential energy.

Answer: C

Question87

An ideal Carnot engine, whose efficiency is 40%, receives heat at 500K. If its efficiency is 50%, then the intake temperature for the same exhaust temperature is
(1995)

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Options:

A. 800K

B. 900K

C. 600K

D. 700K

Answer: C

Solution:

Efficiency of Carnot engine (η_1) = 40% = 0.4
Heat intake = 500K and New efficiency (η_2) = 50% = 0.5.

The efficiency (η) = $1 - \frac{T_2}{T_1}$ or $\frac{T_2}{T_1} = 1 - \eta$

For first case, $\frac{T_2}{500} = 1 - 0.4$or $T_2 = 300K$

For second case, $\frac{300}{T_1} = 1 - 0.5$ or $T_1 = 600K$

Question88

In an adiabatic change, the pressure and temperature of a monatomic gas are related as $P \propto T^C$, where C equals
(1994)

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Options:

A. $\frac{3}{5}$

B. $\frac{5}{3}$

C. $\frac{2}{5}$

D. $\frac{5}{2}$

Answer: D

Solution:

Solution:
For adiabatic change, $PV^{\gamma} =$ constant
$\Rightarrow P\left(\frac{RT}{\rho}\right)^{\gamma} =$ constant
$\Rightarrow P^{1-\gamma}T^{\gamma} =$ constant
$\Rightarrow P \propto T^{\frac{-\gamma}{1-\gamma}}$
Therefore, the value of constant, $C = \frac{\gamma}{(\gamma - 1)}$
For monoatomic gas, $\gamma = \frac{5}{3}$.
Therefore $C = \frac{\frac{5}{3}}{\left(\frac{5}{3}\right) - 1} = \frac{\frac{5}{3}}{\frac{2}{3}} = \frac{5}{2}$.

Question89

Which of the following is not thermodynamical function? (1993)

Options:

A. Enthalpy

B. Work done

C. Gibb's energy

D. Internal energy

Answer: B

Solution:

Solution:
Work done is not a thermodynamical function.

Question90

110 joule of heat is added to a gaseous system whose internal energy is 40J, then the amount of external work done is (1993)

Options:

A. 150J

B. 70J

C. 110J

D. 40J

Answer: B

Solution:

Solution:
$\Delta Q = \Delta U + \Delta W$
$\Rightarrow \Delta W = \Delta Q - \Delta U = 110 - 40 = 70$ J

Question91

An ideal gas A and a real gas B have their volumes increased from V to 2V under isothermal conditions. The increase in internal energy (1993)

Options:

A. will be same in both A and B

B. will be zero in both the gases

C. of B will be more than that of A

D. of A will be more than that of B.

Answer: C

Solution:

Solution:
There will be no change in the internal energy of the ideal gas. But for the real gas, the increase in internal energy takes place because of the work done against the intermolecular forces.

Question92

The number of translational degrees of freedom for a diatomic gas is

(1993)

Options:

A. 2

B. 3

C. 5

D. 6

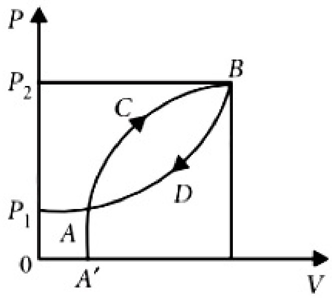
Answer: B

Solution:

Solution:
Number of translational degrees of freedom are same for all types of gases that is 3 .

Question93

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 (1992)



Options:

A. $P_1ACBP_2P_1$

B. ACBB′A′A

C. ACBDA

D. ADBB′A′A

Answer: C

Solution:

Solution:
Work done = Area under curve ACBDA

Question94

If for a gas, $\frac{R}{C_V}$ = 0.67, this gas is made up of molecules which are (1992)

Options:

A. diatomic

B. mixture of diatomic and polyatomic molecules

C. monoatomic

D. polyatomic.

Answer: C

Solution:

Solution:
since $\frac{R}{C_V} = 0.67 \Rightarrow \frac{C_P - C_V}{C_V} = 0.67$
$\Rightarrow \gamma = 1.67 = \frac{5}{3}$
Hence gas is monoatomic.

Question95

For hydrogen gas $C_P - C_V$ = a and for oxygen gas $C_P - C_V$ = b, so the relation between a and b is given by (1991)

Options:

A. a = 16b

B. 16b = a

C. a = 4b

D. a = b

Answer: D

Solution:

Solution:
$C_P - C_V = R$ for all gases.

Question96

Three containers of the same volume contain three different gases. The masses of the molecules are m_1, m_2 and m_3 and the number of molecules in their respective containers are N_1, N_2 and N_3. The gas pressure in the containers are P_1, P_2 and P_3 respectively. All the gases are now mixed and put in one of these containers. The pressure P of the mixture will be
(1991)

Options:

A. $P < (P_1 + P_2 + P_3)$

B. $P = \frac{P_1 + P_2 + P_3}{3}$

C. $P = P_1 + P_2 + P_3$

D. $P > (P_1 + P_2 + P_3)$

Answer: C

Solution:

Solution:
According to Dalton's law of partial pressure, we have $P = P_1 + P_2 + P_3$

Question97

A thermodynamic process is shown in the figure. The pressure and volumes corresponding to some points in the figure are
$P_A = 3 \times 10^4 Pa$; $V_A = 2 \times 10^{-3} m^3$; $P_B = 8 \times 10^4 Pa$; $V_D = 5 \times 10^{-3} m^3$ In the process AB, 600 J 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 is process AC would be
(1991)

Options:

A. 560 J

B. 800 J

C. 600 J

D. 640 J

Answer: A

Solution:

Solution:
since AB is a isochoric process. So no work is done. BC is isobaric process
$W = P_B \times (V_D - V_A) = 240J$
Therefore $\Delta Q = 600 + 200 = 800J$
Using $\Delta Q = \Delta U + \Delta W$
$\Rightarrow \Delta U = \Delta Q - \Delta W = 800 - 240 = 560J$

Question98

Relation between pressure (P) and energy(E) of a gas is (1991)

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Options:

A. $P = \frac{2}{3}E$

B. $P = \frac{1}{3}E$

C. $P = E$

D. $P = 3E$

Answer: A

Solution:

Solution:
$\frac{1}{3}N\,mc^2 = \frac{2}{3}\left(\frac{1}{2}N\,m\right)c^2 = \frac{2}{3}E$

Question99

One mole of an ideal gas requires 207 J heat to rise 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
(Given the gas constant R = 8.3J / mole K)
(1990)

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Options:

A. 198.7 J

B. 29J

C. 215.3J

D. 124 J

Answer: D

Solution:

Using $C_P - C_V = R$,
C_p is heat needed for raising by $10K$
. $\therefore C_P = 20.7J / mole\,K$
Given $R = 8.3J / mole\,K$
$\therefore C_V = 20.7 - 8.3 = 12.4J / mole\,K$
$\therefore$ For raising by $10K = 124J$

Question100

According to kinetic theory of gases, at absolute zero of temperature (1990)

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Options:

A. water freezes

B. liquid helium freezes

C. molecular motion stops

D. liquid hydrogen freezes.

Answer: C

Solution:

Solution:
According to classical theory all motion of molecules stop at $0K$.

Question101

For a certain gas the ratio of specific heats is given to be $\gamma = 1.5$. For this gas (1990)

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Options:

A. $C_V = \frac{3R}{J}$

B. $C_p = \frac{3R}{J}$

C. $C_p = \frac{5R}{J}$

D. $C_V = \frac{5R}{J}$

Answer: B

Solution:

$\gamma = \frac{C_P}{C_V} = \frac{15}{10} = \frac{3}{2} \Rightarrow C_V = \frac{2}{3}C_P$

$C_P - C_V = \frac{R}{J}$ or $C_P - \frac{2}{3}C_P = \frac{R}{J}$

or $\frac{C_P}{3} = \frac{R}{J}$ or $C_P = \frac{3R}{J}$

Question102

A polyatomic gas with n degrees of freedom has a mean energy per molecule given by
(1989)

Options:

A. $\frac{nkT}{N}$

B. $\frac{nkT}{2N}$

C. $\frac{nkT}{2}$

D. $\frac{3kT}{2}$

Answer: C

Solution:

Solution:

According to law of equipartition of energy, the energy per degree of freedom is $\frac{1}{2}kT$. For a polyatomic gas with n degrees of freedom, the mean energy per molecule $= \frac{1}{2}nkT$

Question103

At constant volume temperature is increased then

(1989)

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Options:

A. collission on walls will be less

B. number of collisions per unit time will increase

C. collisions will be in straight lines

D. collisions will not change.

Answer: B

Solution:

Solution:
As the temperature increases, the average velocity increases. So, the collisions are faster.

Question104

Two containers A and B are partly filled with water and closed. The volume of Ais twice that of B and it contains half theamount of water in B. If both are at thesame temperature, the water vapour in the containers will have pressure in the ratio of (1988)

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Options:

A. 1: 2

B. 1: 1

C. 2: 1

D. 4: 1

Answer: B

Solution:

Vapour pressure does not depend on the amount of substance. It depends on the temperature alone.

Question105

First law of thermodynamics is consequence of conservation of (1988)

Options:

A. work

B. energy

C. heat

D. all of these

Answer: B

Solution:

Conservation of energy
