PHYSICS

BOOKS - CENGAGE PHYSICS (ENGLISH)

ARCHIVES 1 VOLUME 6

Fill In The Blank

1. One mole of a mono-atomic ideal gas is mixed with one mole of a diatomic ideal gas.

The molar specific heat of the mixture at constant volume is ......

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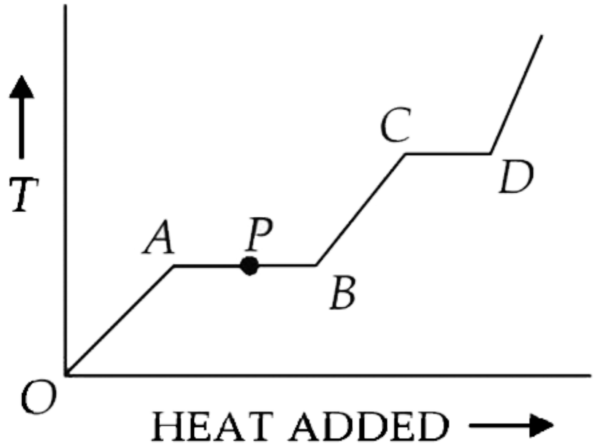
2. The variation of temperature of a material as heat is given to it at a constant rate is shown in the figure. The material is in solid state at the point O. The state of the material at the point P is.....



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3. During an experiment, an ideal gas is found to obey an additional law $VP^2 = cons\tan t$, The gas is initially at a temperature T, and volume V. When it expands to a volume $2V$, the temperature becomes.......

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4. 300 grams of water at $25^\circ C$ is added to 100 grams of ice at $0^\circ C$. The final temperature of the mixture is _____ $\hat{}\ \circ C$

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5. The earth receives its surface radiation from the sun at the rate of 1400 W/m^2. The distance of the centre of the sun from the surface of the earth is 1.5×10^{11} m and the radius of the sun is 7.0×10^{8} m. Treating sun as a black body, it follows from the above data that its surface temeperature is

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6. A solid copper sphere of density ρ, specific heat c and radius r is at temperature T_1. It is suspended inside a chamber whose walls are at temperature $0K$. What is the time required for the temperature of sphere to drop to T_2? Take the emmissivity of the sphere to be equal to e.

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7. A point source of heat of power P is placed at the centre of a spherical shell of mean radius R. The material of the shell has thermal conductivity K. Calculate the thickness of the shell if temperature difference between the outer and inner surfaces of the shell in steady state is T.

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8. A substance of mass M kg requires a power input of P wants to remain in the molten state at its melting point. When the power source is turned off, the sample completely solidifies in time t seconds. The latent heat of fusion of the substance is ....

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9. A container of volume V is divided into two equal parts by a screen. One part has an ideal gas at 300K and the other part is vacuum. The whole system is thermally isolated from the surroundings. When the screen is removed, the gas expands to occupy the whole volume. Its temperature will now be ....

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10. An ideal gas with pressure P, volume V and temperature T is expanded isothermally to a volume 2V and a final pressure P_i, If the same gas is expanded adiabatically to a volume 2V, the final pressure P_a. The ratio of the specific heats of the gas is 1.67. The ratio $\frac{P_a}{P_1}$ is ....

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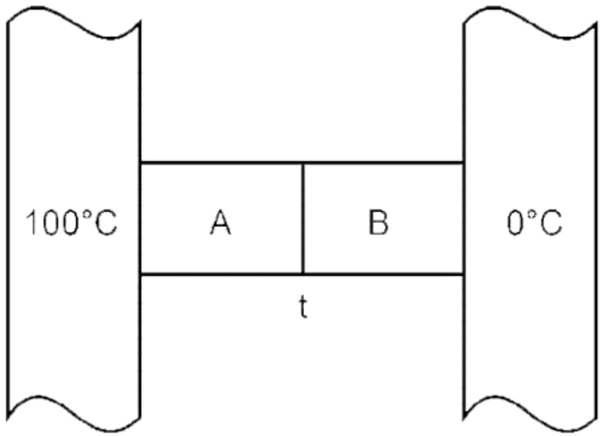
11. Two metal cubes A and B of same size are arranged as shown in Figure. The extreme ends of the combination are maintained at the indicated temperatures. The arrangement is thermally insulated. The coefficients of thermal conductivity of A and B are $300 W / m^{\circ} C$ and $200 W / m^{\circ} C$, respectively.

After steady state is reached the temperature t of the interface will be ......



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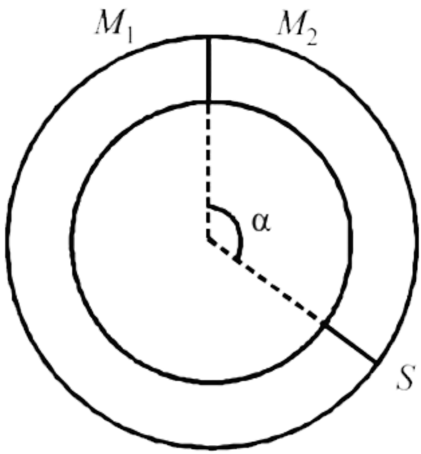
12. A ring shaped tube contain two ideal gases with equal masses and molar masses $M_1 = 32$ and $M_2 = 28$.

The gases are separated by one fixed partition P and another movable stopper S which can move freely without friction inside the ring. The angle α as shown in the figure is ...... degrees.



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13. A gas thermometer is used as a standard thermometer for measurement of temperature. When the gas container of the thermometer is immersed in water at its triple point $273.16K$, the pressure in the gas thermometer reads $3.0 \times 10^4 N/m^2$. When the gas container of the same thermometer is immersed in another system, the gas pressure reads $3.5 \times 10^4 N/m^2$. The temperature of this system is therefore ________.$^\circ C$.

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14. Earth receives $1400W/m^2$ of solar power. If all the solar energy falling on a lens of area $0.2m^2$ is focused on to a block of ice of mass 280 grams, the time taken to melt the ice will be..... Minutes. (Latent heat of fusion of ice= $3.3 \times 10^5 J/kg$.)

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True False

1. The root-mean square speeds of the molecules of different ideal gases, maintained at the same temperature are the same.

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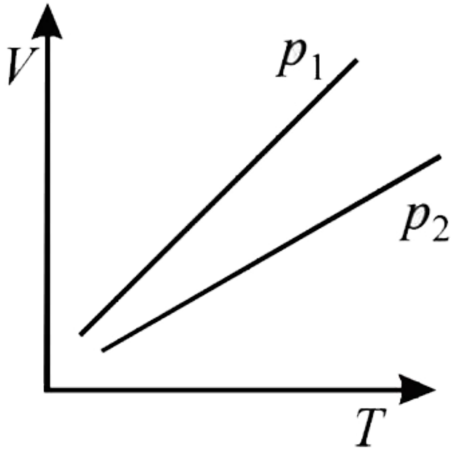
2. The volume V versus temperature T graphs for a certain amount of a perfect gas at two pressure p_1 and p_2 are as shown in Fig. Show that p_1 is less than p_2.



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3. Two different gases at the same temperature have equal root mean square velocities?

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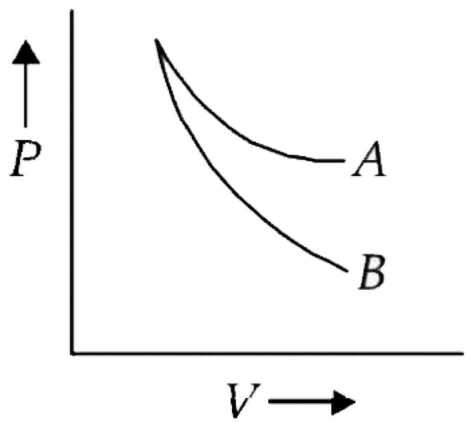
4. The curves A and B in the figure shown P-V graphs for an isothermal and an adiabatic process for an idea gas. The isothermal process is represented by the curve A.



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5. The rms speed of oxygen molecules in a gas in a gas is v. If the temperature is doubled and the oxygen molecules dissociate into oxygen atoms, the rms speed will become

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6. At a given temperature, the specific heat of a gas at constant pressure is always greater than its specific heat at constant volume.

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7. Two spheres of the same materials have radii 1 m and 4 m and temperatures 4000 K and 2000 K resectively the energy radiated per second by the first sphere is

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Single Correct

1. A wall is made of equally thick layers A and B of different matierals. Thermal conduvtivity of

A is twice that of B. In the stedy state, the temperature difference across the wall is $36^{\circ}C$. The temperature difference across the layer A is

A. $6^{\circ}C$

B. $12^{\circ}C$

C. $18^{\circ}C$

D. $24^{\circ}C$

Answer: B

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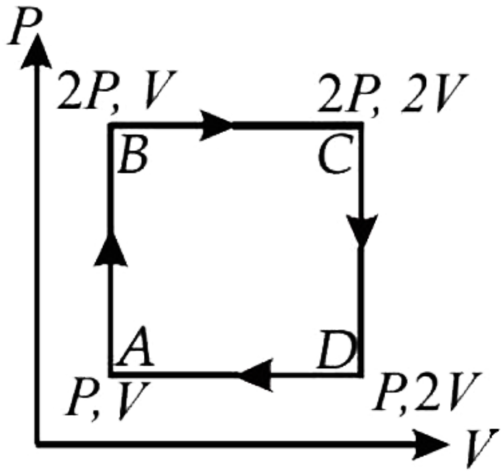
2. An ideal monoatomic gas is taken round the cycle ABCDA as shown in the P-V diagram. The work done during the cycle is



A. PV

B. $2PV$

C. $1/2$

D. zero

Answer: A

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3. At room temperature, the rms speed of the molecules of a certain diatomic gas is found to be 1930m/s. The gas is

A. H_2

B. F_2

C. O_2

D. CI_2

Answer: A

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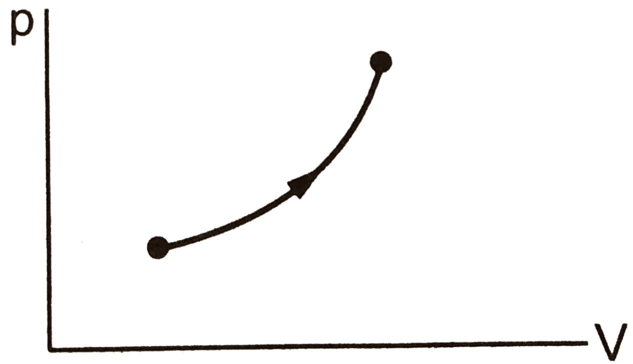
4. 70 calories of heat is required to raise the temperature of 2 mole of an ideal gas at constant pressure from $30^\circ C$ to $35^\circ C$. The amount of heat required to raise the temperature of the same gas through the same range at constant volume is



A. 30

B. 50

C. 70

D. 90

Answer: B

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5. Some steam at $100^\circ C$ is passed into 1.1 kg of water constained in a calorimeter of water equivalent 20 gm at $15^\circ C$ so that the temperature of the calorimeter and its contained rises to $80^\circ C$ What is the mass of steam condensing (in kg).

A. 0.130

B. 0.065

C. 0.260

D. 0.135

Answer: A

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6. If one mole of a mono-atomic gas $(\gamma = 5/3)$ is mixed with one mole of a diatomic gas $(\gamma = 7/5)$, the value of γ for the mixture is :

A. 1.40

B. 1.50

C. 1.53

D. 3.07

Answer: B

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7. A cylinder of radius R made of a material of thermal conductivity K_1 is surrounded by a cylindrical shell of inner radius R and outer radius 2R made of a material of thermal conductivity K_2. The two ends of the combined system are maintained at two different temperatures. There is no loss of heat across the cylindrical surface and the system is in steady state. The effective thermal conductivity of the system is

(a) $K_1 + K_2$ (b) $K_1 K_2 / (K_1 + K_2)$

(c)$(K_1 + 3K_2) / 4$

(d) $(3K_1 + K_2) / 4$.

A. $K_1 + K_2$

B. $\frac{K_1 K_2}{(K_1 + K_2)}$

C. $\frac{(K_1 + 3K_2)}{4}$

D. $\frac{(3K_1 + K_2)}{4}$

Answer: C

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8. When an ideal diatomic gas is heated at constant pressure the fraction of the heat energy supplied which increases the internal energy of the gas is

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

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

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

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

Answer: D

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9. Three closed vessels (A),(B) and C are at the same temperature (T) and contain gases which obey Maxwell distribution law of velocities. Vessel (A) contains O_2, (B) only (N_2) and (C) mixture of equal quantities of O_2 and

$N_2. Iftheavera \geq speedoftheO\_(2)$

$mo \leq ces \in vessel(A)isv\_(1)t\hat{o}fN\_(2)$

$mo \leq ces \in vessel(B)isv\_(2)$

$. thentheavera \geq speedoftheO\_(2)$`

molecules in vessel (C) is.

A. $\dfrac{(v_1 + v_2)}{2}$

B. v_1

C. $(v_1 v_2)^{1/2}$

D. $\sqrt{3kT/M}$

Answer: B

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10. Three rods of identical area of cross-section and made from the same metal from the sides of an isosceles triangle. ABC, right angled at B. The points A and B are maintained at temperatures T and $\sqrt{2}T$ RESPECTIVELY. In the steady state the temperature of the point C is T_C.

Assuming that only heat conduction takes place , $\frac{T_C}{T}$ is equal to

A. $\dfrac{1}{2\left(\sqrt{2}-1\right)}$

B. $\dfrac{3}{\sqrt{2}+1}$

C. $\dfrac{1}{\sqrt{3}\left(\sqrt{2}-1\right)}$

D. $\dfrac{1}{\sqrt{2}+1}$

Answer: B

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11. Two metallic spheres S_1 and S_2 are made of the same material and have got identical surface finish. The mass of S_1 is thrice that of S_2. Both the spheres are heated to the same high temperature and placed in the same room having lower temperature but are thermally insulated from each other. the ratio of the initial rate of cooling of S_1 to that of S_2 is

$(a)\frac{1}{3}(b)\frac{1}{\sqrt{3}}(c)\frac{\sqrt{3}}{1}(d)\left(\frac{1}{3}\right)^{\frac{1}{3}}$

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

B. $\frac{1}{\sqrt{3}}$

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

D. $\left(\frac{1}{3}\right)^{\frac{1}{3}}$

Answer: D

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12. The temperature of an ideal gas is increased from 120 K to 480 K. If at 120 K, the rms velocity of the gas molecules is v_{rms} then at 480 K, it becomes

A. $4v$

B. $2v$

C. $v/2$

D. $v/4$

Answer: B

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13. The average translational energy and the rms speed of molecules in a sample of oxygen gas at $300K$ are $6.21 \times 10^{-21} J$ and $484m/s$, respectively. The corresponding values at

$600K$ are nearly (assuming ideal gas behaviour)

A. $12.42 \times 10^{-21} J, 968 m/s$

B. $8.78 \times 10^{-21} J, 684 m/s$

C. $6.21 \times 10^{-21} J, 968 m/s$

D. $12.42 \times 10^{-21} J, 684 m/s$

Answer: D

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14. The intensity of radiation emitted by the sun has its maximum value at a wavelength of 510 nm and that emitted by the North star has the maximum value at 350 nm. If these stars behave like black bodies, then the ratio of the surface temperature of the sun and North star is

A. 1.46

B. 0.69

C. 1.21

D. 0.83

Answer: B

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15. The average translational kinetic energy of O_2 (molar mass 32) molecules at a particular temperature is 0.048 eV. The translational kinetic energy of N_2 (molar mass 28) molecules in eV at the same temperature is

A. 0.0015

B. 0.003

C. 0.048

D. 0.768

Answer: C

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16. A vessel contains 1 mole of O_2 gas (molar mass 32) at a temperature T. The pressure of the gas is p. An identical vessel containing one mole of the gas (molar mass 4) at a temperature 2T has a pressure of

A. $P/8$

B. P

C. $2/P$

D. $8/P$

Answer: C

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17. A spherical black body with a radius of 12 cm radiates 450 watt power at $500K$. if the radius were halved and the temperature doubled, the power radiated in watt would be

A. 225

B. 450

C. 900

D. 1800

Answer: D

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18. A vessel contains a mixture of one mole of Oxygen and two moles of Nitrogen at 300 K. The ratio of the average kinetic energy per O_2 molecule to that per N_2 molecule is :

A. $1:1$

B. $1:2$

C. $2:1$

D. $2:1$

Answer: A

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19. Two identical cylinders A and B with frictionless pistons contain the same ideal gas at the same temperature and the same voluem V. The mass of gas $Aism_A$ and $t\hat{o}fBism_B$ .The gs in eah cylinder is notw allowed to expand isothermally to the same final volume 2V . The change in the pressure in A and B are found ot be ΔP and $1.5\Delta P$ respecitvely Then

A. $4m_A = 9m_B$

B. $2m_A = 3m_B$

C. $3m_A = 2m_B$

D. $9m_A = 4m_B$

Answer: C

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20. Two cylinders A and B fitted with pistons contain equal amounts of ideal diatomic gas at $300K$. The piston of A is free to move while that of B is held fixed, The same amount of heat is given to the gas in each cylinder. If the rise in temperature of the gas in A is $30K$, then the rise in temperature of the gas in B is

A. $30K$

B. $18K$

C. $50K$

D. $42K$

Answer: D

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21. A black body is at a temperature of 2880 K. The energy of radiation emitted by this object with wavelength between 499 nm and 500 nm is U_1, between 999 nm and 1000 nm is U_2 and between 1499 nm and 1500 nm is U_3 Wien's constant $b = 2.88 \times 10^6 nm - K$ Then

A. $U_1 = 0$

B. $U_3 = 0$

C. $U_1 > U_2$

D. $U_2 > U_1$

Answer: D

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22. A gas mixture coinsists of (2) moles of oxygen and (4) moles of argon at temperature (T). Neglecting all vibrational modes, the total internal energy of the system is (jee 1999)

(a) 4 RT (b) 15 RT (c) 9 RT (d) 11 RT.

A. $4RT$

B. $15RT$

C. $9RT$

D. $11RT$

Answer: D

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23. A monatomic ideal gas, initially at temperature T_1 is enclosed in a cylinder fitted with a frictionless pistion. The gas is allowed to expand adiabatically to a temperature T_2. By releasing the piston suddenly. IF L_1 and L_2 are th lengths of the gas column before and after expansion respectively, then T_1 / T_2 is given by

A. $\left(\frac{L_1}{L_2}\right)^{2/3}$

B. $\frac{L_1}{L_2}$

C. $\frac{L_2}{L_1}$

D. $\left(\frac{L_2}{L_1}\right)^{2/3}$

Answer: D

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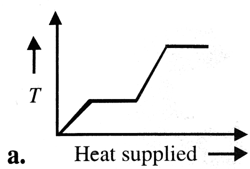
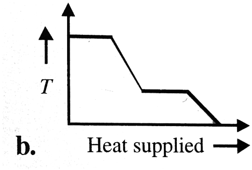
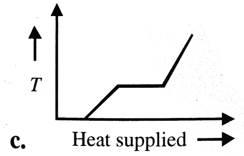
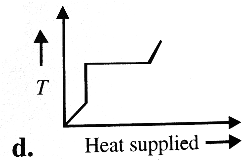
24. A block of ice at $-8^{\circ}C$ is slowly heated and converted to steam at $100^{\circ}C$. Which of the following curves represents the phenomena qualitatively?

A. 

B. 

C. 

D. 

Answer: A

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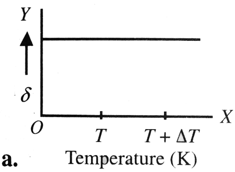
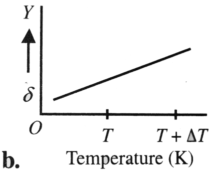
25. An ideal gas is initially at temperature T and volume V. ITS volume is increased by ΔV

due to an increase in temperature ΔT, pressure remaining constant. The quantity $\delta = \Delta V / V\Delta T$ varies with temperature as

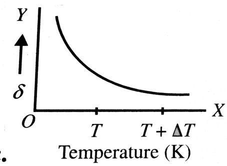
A. a.



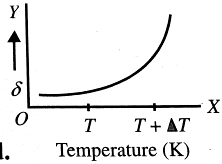
B. b.



C. c.



D. d.



Answer: C

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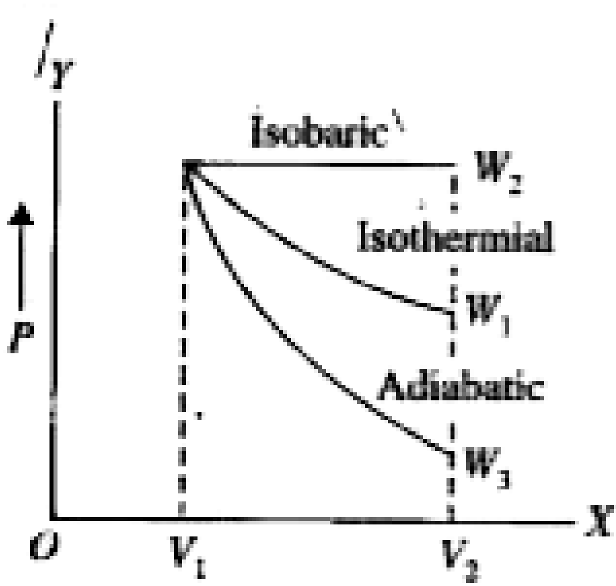
26. Starting from the same initial conditions, an ideal gas expands from volume $V_1 \rightarrow V_2$ in three different ways. The work done by the gas is W_1 if he process is purely isothermal, W_2 if purely isobaric and W_3 if purely adiabatic.

Then



A. $W_2 > W_1 > W_3$

B. $W_2 > W_3 > W_1$

C. $W_1 > W_2 > W_3$

D. $W_1 > W_3 > W_2$

Answer: A

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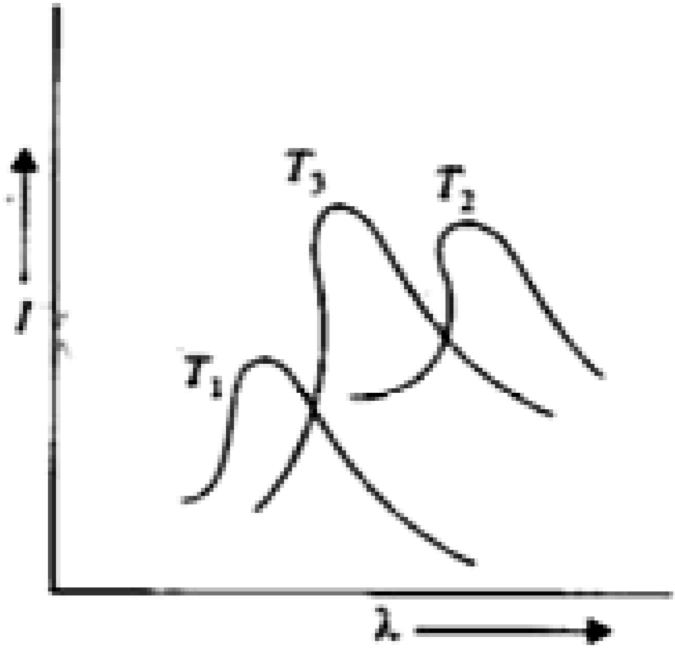
27. The plots of intensity versus wavelength fro three black bodies at temperatures T_1, T_2 and T_3 respectively and shown in Fig. 15.11.1.

Their temperatures are such that



A. $T_1 > T_2 > T_3$

B. $T_1 > T_3 > T_2$

C. $T_2 > T_3 > T_1$

D. $T_3 > T_2 > T_1$

Answer: B

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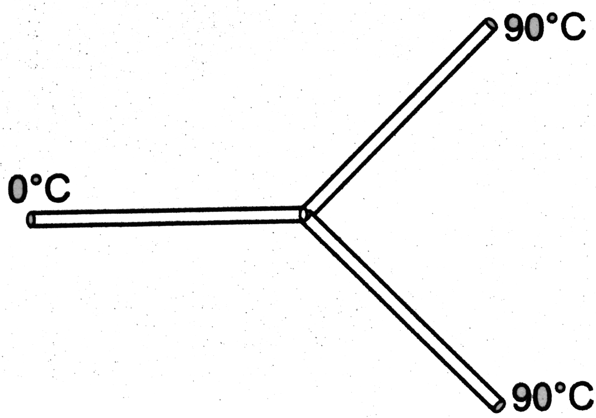
28. Three rods made of the same material and having the same cross-section have been joined as shown in the figure. Each rod is of the same length. The left and right ends are kept at $0^\circ C$ and $90^\circ C$, respectively. The temperature of junction of the three rods will be

(a) $45^\circ C$ (b) $60^\circ C$

(c) $30^\circ C$ (d) $20^\circ C$.



A. $45^\circ C$

B. $60^\circ C$

C. $30^\circ C$

D. $20^\circ C$

Answer: B

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29. In a given process on an ideal gas, dW = 0 and $dQ < 0$. Then for the gas

A. the temperature will decrease

B. the volume will increase

C. the pressure will remain constant

D. the temperature will increase

Answer: A

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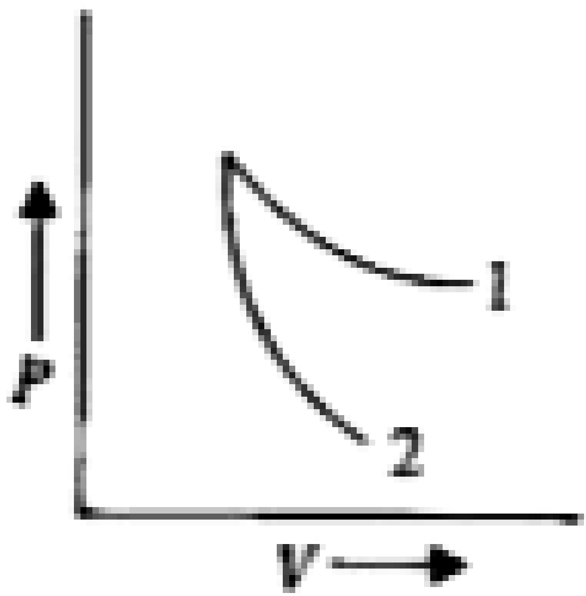
30. P-V plots for two gases during adiabatic processes are shown in Fig. 15.9.6. Plot 1 and 2 should correspond respectively to



A. He and O_2

B. O_2 and He

C. He and Ar

D. O_2 and N_2

Answer: B

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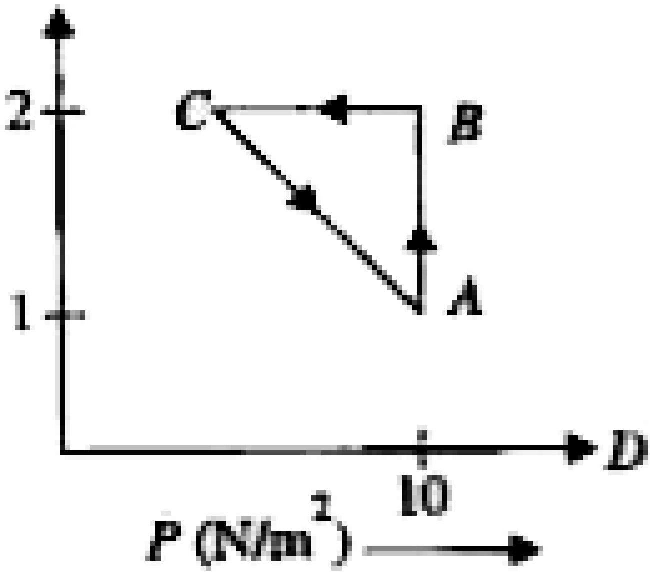
31. An ideal gas is taken through cycle $A \rightarrow B \rightarrow C - A$, as shown in Fig. IF the net heat supplied to the gas in the cycle is 5 J, the work done by the gas in the process $C \rightarrow A$ is



A. $-5J$

B. $-10J$

C. $-15J$

D. $-20J$

Answer: A

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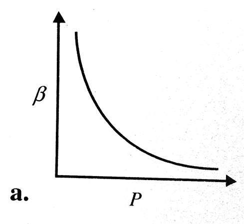
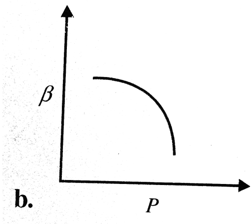
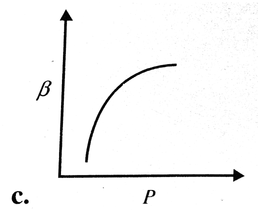
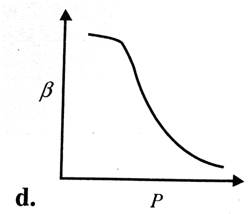
32. Which of the following graphs correctly represents the variation of $\beta = -\frac{dV/dP}{V}$ with P for an ideal gas at constant temperature?

A. 

B. 

C. 

D. 

Answer: A

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33. An ideal black body at room temperature is thrown into a furnance.It is observed that

A. initially it is the darkest body and later the brightest

B. it is the darkest body at all times

C. it cannot be distinguished at all times

D. initially it is the darkest body and later it cannot be distinguished

Answer: A

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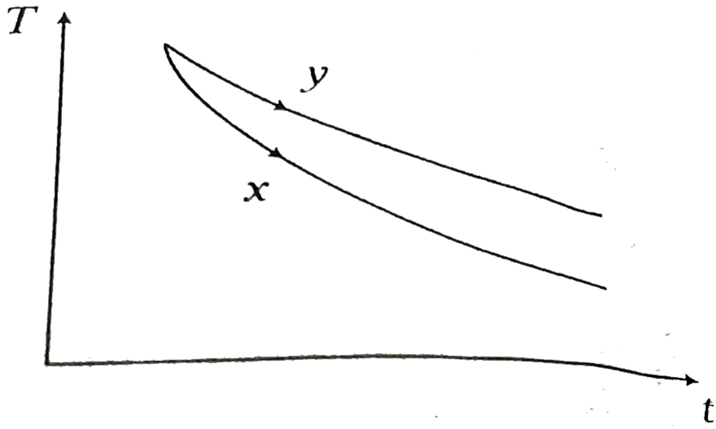
34. The graph, shown in the adjacement diagram, represents the variation of temperature (T) of two bodies, x and y having same surface area, with time (t) due to the emissions of radiation. Find the correct relation b etween the emissivity (e) and absorpitivity (a) of two bodies



A. $E_x > E_y$ and $a_x < a_y$

B. $E_x < E_y$ and $a_x > a_y$

C. $E_x > E_y$ and $a_x > a_y$

D. $E_x < E_y$ and $a_x < a_y$

Answer: C

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35. Two rods, one of aluminium and the other made of steel, having initial length l_1 and l_2 are connected together to from a single rod of length $l_1 + l_2$. The coefficients of linear expansion for aluminium and steel are α_a and α_s and respectively. If the length of each rod increases by the same amount when their temperature are raised by $t^0 C$, then find the ratio $l_1 / (l_1 + l_2)$

A. α_s / α_a

B. α_a / α_s

C. $\alpha_s / (\alpha_a + \alpha_s)$

D. $\alpha_a / (\alpha_s + \alpha_s)$

Answer: C

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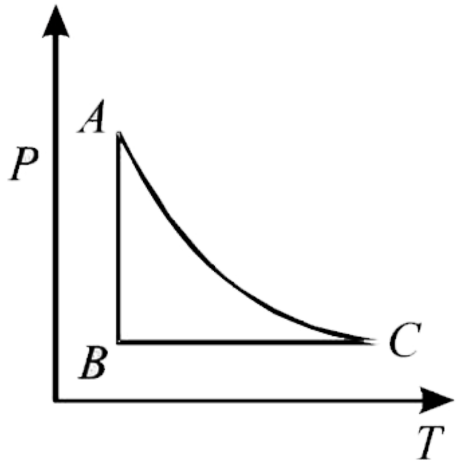
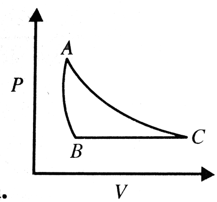
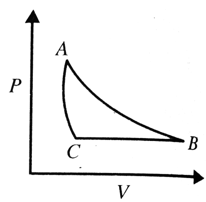
36. The PT diagram for an ideal gas is shown in the figure, where AC is an adiabatic process, find the corresponding PV diagram.



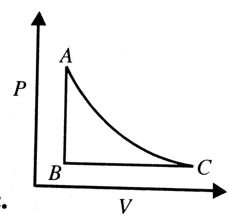
A. a.

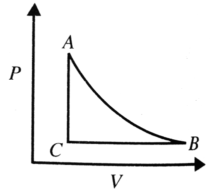


B. b.



C. c.



D. d. 

Answer:

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37. 2kg of ice at $-20^\circ C$ is mixed with 5kg of water at $20^\circ C$ in an insulating vessel having a negligible heat capacity. Calculate the final mass of water remaining in the container. It is given that the specific heats of water & ice are

$1 kcal / kg /^{\circ} C$ and 0.5

$kcal / kg /^{\circ} C$ while the latent heat of fusion

of ice is $80 kcal / kg$

A. $7 kg$

B. $6 kg$

C. $4 kg$

D. $2 kg$

Answer: B

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38. Three discs, A, B and C having radii 2m, 4m and6m respectively are coated with carbon black on their outer surfaces. The wavelengths corresponding to maximum intensity are $300nm$, $400nm$ and $500nm$, respectively. The power radiated by them are Q_A, Q_B and Q_C respectively

(a) Q_A is maximum (b) Q_B is maximum (c) Q_C is maximum (d) $Q_A = Q_B = Q_C$

A. Q_A will be maximum

B. Q_B will be maximum

C. Q_C will be maximum

D. $Q_A = Q_B = Q_C$

Answer: B

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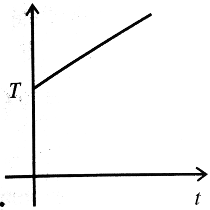
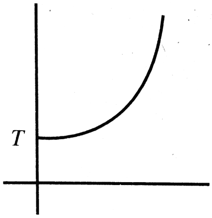
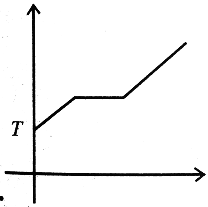
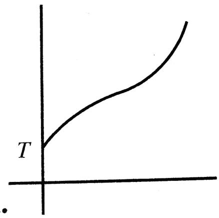
39. Liquefied oxygen at 1 atmosphere is heated from 50 K to 300 K by supplying heat at a constant rate. The graph that correctly shows the relationship between temperature and time is :

A. a. 

B. b. 

C. c. 

D. d. 

Answer: C

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40. Two identical rods are connected between two containers. One of them is at 100°C. If rods are connected in paralle then the rate of melting of ice is $g_1 gs^{-1}$. If they are connected in series then the rate is $g_2 gs^{-1}$. The ratio g_2/g_1 is

A. 2

B. 4

C. $1/2$

D. $1/4$

Answer: D

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41. An ideal gas is initially at P_1, V_1 is expands to P_2, V_2 isothermally and then compressed adiabatically to the same volume V_1 and pressure P_3. If W is the net work done by the gas in complete process which of the following is true.

A. $W > 0, P_3 > P_1$

B. $W < 0, P_3 > P_1$

C. $W > 0, P_3 < P_1$

D. $W < 0, P_3 < P_1$

Answer: B

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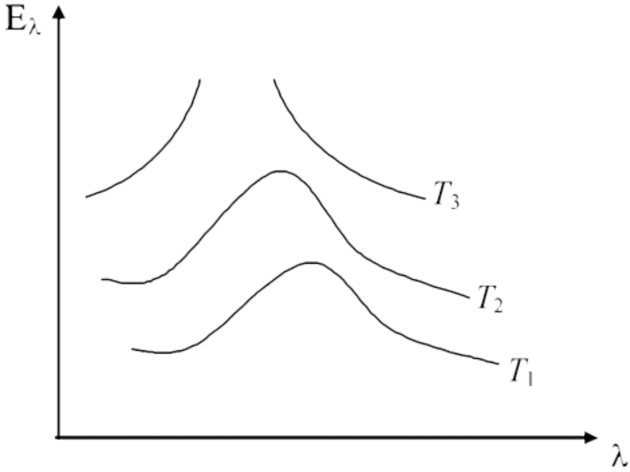
42. Variation of radiant energy emitted by sun, filament of tungsten lamp and welding arc as a function of its wavelength is shown in figure. Which of the following option is the correct match?



A. Sun-T_3, tungsten filament-T_1, welding arc-T_2

B. Sun-T_2, tungsten filament-T_1, welding arc-T_3

C. Sun-T_3, tungsten filament-T_2, welding arc-T_1

D. Sun-T_1, tungsten filament-T_2, welding arc-T_3

Answer: A

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43. In which of the following process convection of does not take place primarily ?

A. sea and land breeze

B. boiling of water

C. heating air around a furnace

D. warning of glass of bulb due to filament

Answer: D

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44. A spherical body of area A and emissivity $e = 0.6$ is kept inside a perfectly black body.

Total heat radiated by the body at temperature T

A. $0.4\sigma AT^4$

B. $0.8\sigma AT^4$

C. $0.6\sigma AT^4$

D. $1.0\sigma AT^4$

Answer: C

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45. Calorie is defined as the amount of heat required to raise temperature of 1 g of water by $1^\circ C$ and it is defined under which of the following conditions?

A. From $14.5^\circ C$ to $15.5^\circ C$ at 760 mm of Hg

B. From $98.5^\circ C$ to $99.5^\circ C$ at 760 mm of Hg

C. From $13.5^\circ C$ to $14.5^\circ C$ at 76 mm of Hg

D. From $3.5^\circ C$ to $4.5^\circ C$ at 76 mm of Hg

Answer: A

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46. A kettle with 2 litre water at $27^{\circ} C$ is heated by operating coil heater of power 1 kW. The heat is lost to the atmosphere at constant rate $160 J / s$, when its lid is open. In how much time will water heated to $77^{\circ} C$ with the lid open ? (specific heat of water = $4.2 kJ / ^{\circ} C . kg)$

A. 7 min

B. 6 min 2 s

C. 8 min 20 s

D. 14 min

Answer: C

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47. An ideal gas is expanding such that $PT^2 = cons\tan t$. The coefficient of volume expansion of the gas is-

A. $\frac{1}{T}$

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

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

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

Answer: C

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48. A real gas behaves like an ideal gas if its

A. pressure and temperature are both high

B. pressure and temperature are both low

C. pressure in high and temperature is low

D. pressure is low and temperature is high

Answer: D

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49. 5.6 liter of helium gas at STP is adiabatically compressed to 0.7 liter. Taking the initial temperature to be T_1, the work done in the process is

A. $\frac{9}{8}RT_1$

B. $\frac{3}{2}RT_1$

C. $\frac{15}{8}RT_1$

D. $\frac{9}{2}RT_1$

Answer: A

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50. Three very large plates of same area are kept parallel and close to each other. They are considered as ideal black surfaces and have very high thermal conductivity. The first and third plates are maintained at temperature 2T and 3T respectively. The temperature of the middle (i.e. second) plate under steady state condition is

A. $\left(\frac{65}{2}\right)^{1/4} T$

B. $\left(\frac{97}{4}\right)^{1/4} T$

C. $\left(\frac{97}{2}\right)^{1/4} T$

D. $(97)^{1/4} T$

Answer: C

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51. A mixture of 2 moles of helium gas ($(a \rightarrow micmass) = 4a.\,m.\,u$) and 1 mole of argon gas ($(a \rightarrow micmass) = 40a.\,m.\,u$) is kept at 300K in a container. The ratio of the rms speeds $\left(\frac{v_{rms}(helium)}{(v_{rms}(argon))}\right)$ is

A. 0.32

B. 0.45

C. 2.24

D. 3.16

Answer: D

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52. Two moles of ideal helium gas are in a rubber balloon at $30^\circ C$. The balloon is fully expandable and can be assumed to require no energy in its expansion. The temperature of the gas in the balloon is slowly changed to $35^\circ C$. The amount of heat required in raising the temperature is nearly (take R $= 8.31 J/mol.K$)

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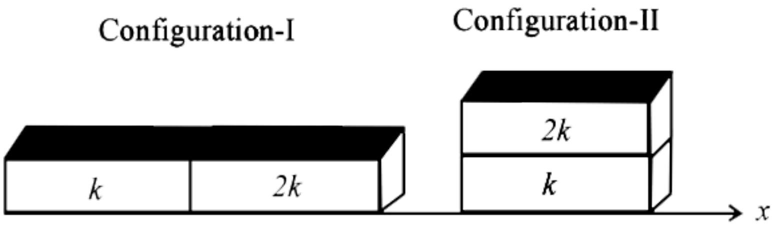
53. Two rectangular blocks, having identical dimensions, an be arranged either in configuration-I or in configuration-II as shown in the figure. One of the blocks has thermal conductivity k and the other 2k. The temperature difference between the ends along the x-axis is the same in both the configurations. It takes 9s to transport a certain amount of heat from the hot end to the cold end in the configuration-I. The time to transport the same amount of heat in the configuration-II is



A. 2.0 s

B. 3.0 s

C. 4.5 s

D. 6.0 s

Answer: A

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54. Two non-reactive monoatomic ideal gases have their atomic masses in the ratio $2:3$. The ratio of their partial pressures, when enclosed in a vessel kept at a constant temperature, is $4:3$. The ratio of their densities is

A. $1:4$

B. $1 : 2$

C. $6 : 9$

D. $8 : 9$

Answer: D

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Multi Correct

1. For an ideal gas

A. The change in internal energy in a constant pressure process from temperature T_1 to T_2 is equal to $nCv(T_2 - T_1)$, where Cv is the molar specific heat at constant volume and n the number of moles of the gas.

B. The change in internal energy of the gas and the work done by the gas are equal in magnitude in an adiabatic process.

C. The internal energy does not change in an isothermal process.

D. No heat is added or removed in an adiabatic process.

Answer: A::B::C::D

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2. An ideal gas is taken from the state A (pressure p, volume V) to the state B (pressure $\frac{p}{2}$, volume 2V) along a straight line path in the p-V diagram. Select the correct statement(s) from the following.

A. The work done by the gas in process A to B exceeds the work that would be done by it if F62the system were taken from A to B along the isotherm.

B. In the T-V diagram, the path AB becomes a part of a parabola.

C. In the P-T diagram, the path AB becomes a part of a hyperbola.

D. In going from A to B, the temperature T of the gas first increases to a maximum value and then decreases.

Answer: A::B::D

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3. Two bodies A and B have thermal emissivities of 0.01 and 0.81 respectively. The outer surface areas of the two bodies are same. The two bodies emit total radiant power at the same rate. The wavelength λ_B corresponding to maximum spectral radiancy from B is shifted from the wavelength corresponding to maximum spectral radiancy in the radiation from A by 1.0 $\mu m.$ If the temperature of A is 5802 K, calculate (a) the temperature of B, (b) wavelength λ_B.

A. the temperature of B is 1934K

B. $\lambda_B = 1.5 \mu m$

C. the temperature of B is 11604K

D. the temperature of B is 2901K

Answer: A::B

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4. From the following statements concerning ideal gas at any given temperature T, select the correct one (s)

A. The coefficient of volume expansion at constant pressure is the same for all ideal gases.

B. The average translational kinetic energy per molecule of oxygen gas is $3kT$, k being the Boltzmann constant.

C. The mean free path of molecules increases with decrease in pressure.

D. In a gaseous mixture, the average translational kinetic energy of the molecules of each component is different.

Answer: A::C

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5. During the melting of a slab of ice at 273 K a atmospheric pressure

A. positive work is done by the ice-water system on the atmosphere

B. positive work is done on the ice-water system by the atmosphere

C. the internal energy of the ice-water system increases

D. the internal energy of the ice-water system decreases

Answer: B::C

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6. Let $\bar{v}$, v_{rms} and v_p respectively denote the mean speed. Root mean square speed, and most probable speed of the molecules in an ideal monoatomic gas at absolute temperature T. The mass of a molecule is m. Then

A. no molecule can have a speed greater than $\sqrt{2}v_{rms}$

B. no molecule can have speed less than $v_p / \sqrt{2}$

C. $v_p < \bar{v} < v_{\text{rms}}$

D. the average kinetic energy of a molecule is $3/4mv_p^2$

Answer: C::D

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7. A bimetallic strip is formed out of two identical strips one of copper and the other of brass. The temperature of the strip goes up by $\Delta T$and the strip bends to from an arc of radius of curvature R. Then R is.

A. proportional to ΔT

B. inversely proportional to ΔT

C. proportional to $|\alpha_B - \alpha_C|$

D. inversely proportional to $|\alpha_B - \alpha_C|$

Answer: B::D

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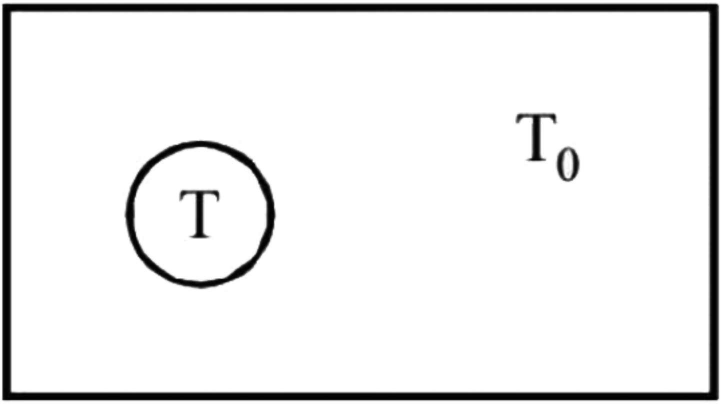
8. A black body of temperature T is inside chamber of T_0 temperature initially. Sun rays are allowed to fall from a hole in the top of chamber. If the temperature of black body (T) and chamber (T_0) remains constant, then



A. Black body will absorb radiation.

B. Black body will absorb less radiation.

C. Black body will emit more energy.

D. Black body will emit energy equal to energy absorbed by it.

Answer: A::D

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9. C_v and C_p denote the molar specific heat capacities of a gas at constant volume and constant pressure, respectively. Then

A. $Cp - Cv$ is larger for a diatomic ideal gas than for a monatomic ideal gas.

B. $Cp + Cv$ is larger for a diatomic ideal gas than for a monatomic ideal gas.

C. Cp / Cv is larger for a diatomic ideal gas than for a monatomic ideal gas.

D. $Cp \cdot Cv$ is larger for a diatomic ideal gas than for a monatomic ideal gas.

Answer: B::D

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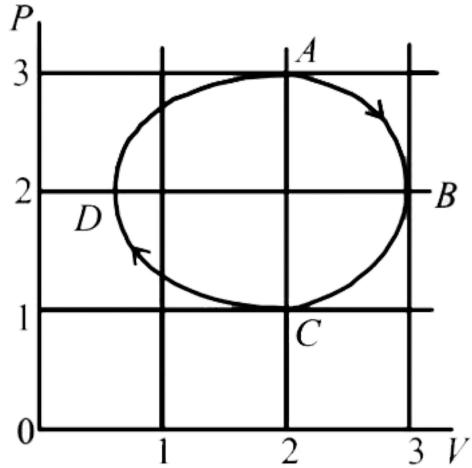
10. The figure shows the P-V plot of an ideal gas taken through a cycle ABCDA. The part ABC is a semi-circle and CDA is half of an ellipse.

Then,



A. the process during the path $A \rightarrow B$ is isothermal

B. heat flows out of the gas during the path $B \rightarrow C \rightarrow D$

C. work done during the path $A \rightarrow B \rightarrow C$ is zero

D. positive work is done by the gas in the cycle ABCDA

Answer: B::D

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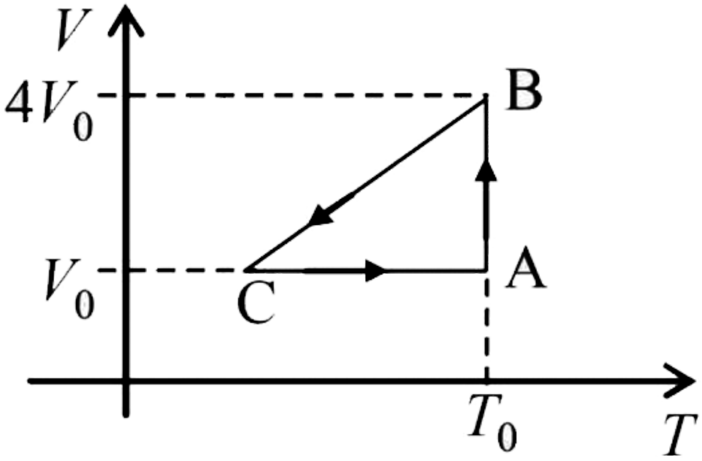
11. One mole of an ideal gas in initial state A undergoes a cyclic process ABCA, as shown in the figure. Its pressure at A is P_0. Choose the correct option (s) from the following



A. Internal energies at A and B are the same

B. Work done by the gas in process AB is $P_0V_0(\ln 4)$

C. Pressure at C is $P_0 / 4$

D. Temperature at C is $T_0/4$

Answer: A::B

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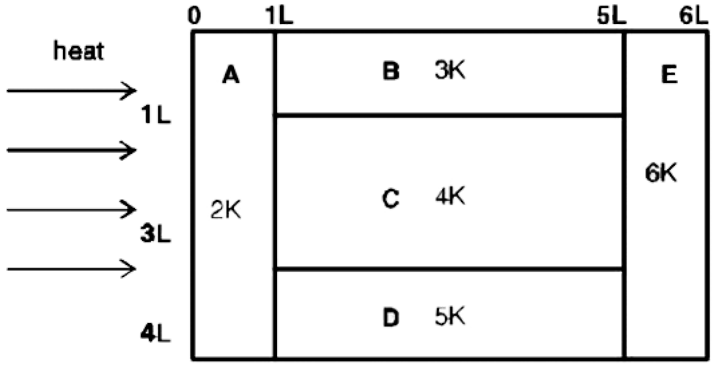
12. A composite block is made of slabs A,B,C,D and E of different thermal conductivities (given in terms of a constant K and sizes (given in terms of length, L) as shown in the figure. All slabs are of same width. Heat 'Q' flows only from left to right through the blocks. Then in steady state



A. Heat flow through slabs A and E is same

B. Heat flow through slab E is maximum

C. Temperature difference across slab E is smallest.

D. Heat flow through C= heat flow through B + heat flow through D.

Answer: A::C::D

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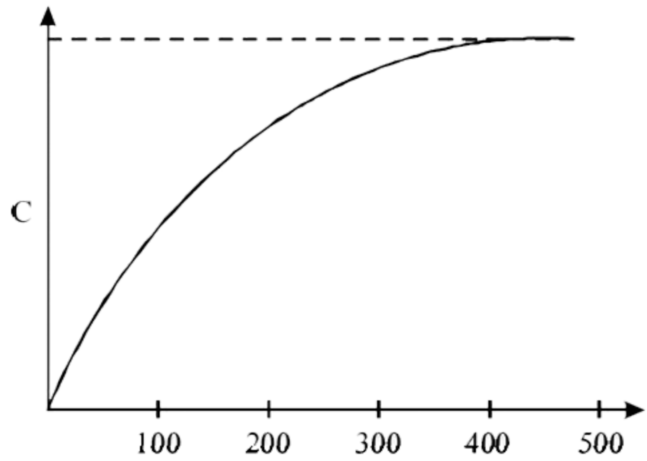
13. The figure below shows the variation of specific heat capacity (C) of a solid as a function of temperature (T). The temperature is increased continuously form 0 to 500K at a constant rate. Ignoring any volume change, the following statement (s) is (are) correct to a reasonable approximation.



A. the rate at which heat is absorbed in the range 0-100K varies linearly with temperature T.

B. heat absorbed in increasing the temperature from 0-100K is less than the heat required for increasing the temperature from 400-500K.

C. there is no change in the rate of heat absorption in range 400-500K.

D. the rate of heat absorption increases in the range 200-300K.

Answer: A::B::C::D

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Assertion Reasoning

1. Statement-1: The total translational kinetic energy of fall the molecules of a given mass of an ideal gas is 1.5 times the product of its pressure and its volume because.

Statement-2: The molecules of a gas collide with each other and the velocities of the molecules change due to the collision.

A. If both assertion and reason are true and the reason is correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of assertion.

C. If assertion is true, but the reason is false.

D. If assertion is false, but the reason is true.

Answer: B

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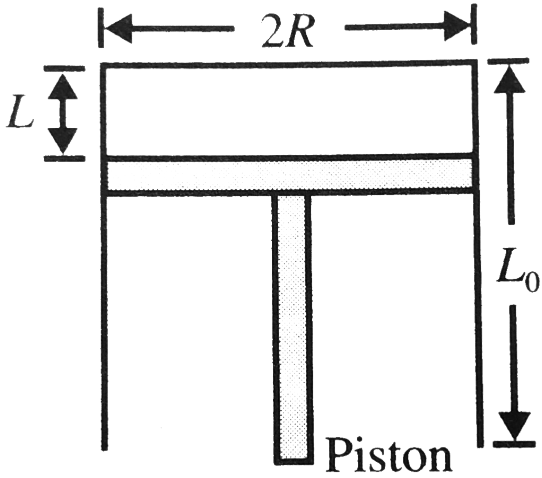
Comprehension

1. A fixed thermally conducting cylinder has a radius R and height L_0. The cylinder is open at its bottom and has a smaller hole at its top. A piston of mass M is held at a distance L from the top surface, as shown in the figure. The atmospheric pressure is P_0.



The piston is now pulled out slowly and held at a distance $2L$ from the top. The pressure in the cylinder between its top and the piston will then be

A. p_0

B. $\frac{p_0}{2}$

C. $\frac{p_0}{2} + \frac{Mg}{\pi R^2}$

D. $\frac{p_0}{2} - \frac{Mg}{\pi R^2}$

Answer: A

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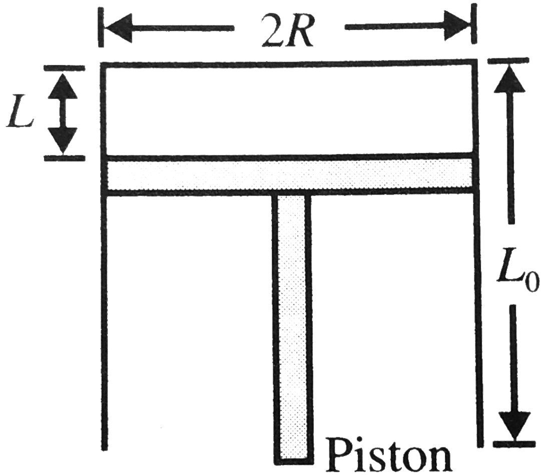
2. A fixed thermally conducting cylinder has a radius R and height L_0. The cylinder is open at its bottom and has a smaller hole at its top. A piston of mass M is held at a distance L from the top surface, as shown in the figure.

The atmospheric pressure is P_0.



The piston is now pulled out slowly and held at a distance $2L$ from the top. The pressure in the cylinder between its top and the piston will then be

A. $\left(\frac{2p_0\pi R^2}{\pi R^2 p_0 + Mg}\right)(2L)$

B. $\left(\frac{p_0 \pi R^2 - Mg}{\pi R^2 p_0}\right)(2L)$

C. $\left(\frac{p_0 \pi R^2 + Mg}{\pi R^2 p_0}\right)(2L)$

D. $\left(\frac{p_0 \pi R^2}{\pi R^2 p_0 - Mg}\right)(2L)$

Answer: D

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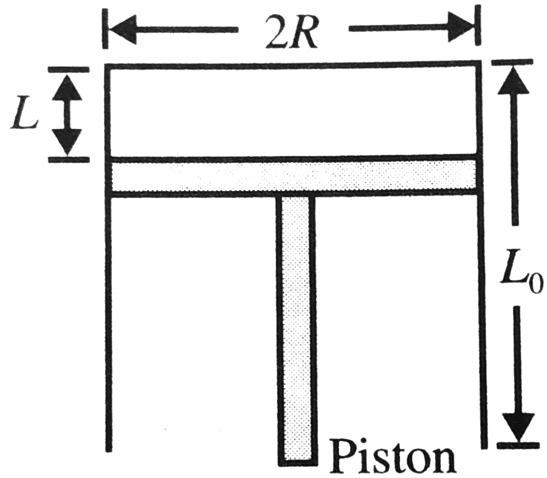
3. A fixed thermally conducting cylinder has a radius R and height L_0. The cylinder is open at its bottom and has a smaller hole at its top. A piston of mass M is held at a distance L

from the top surface, as shown in the figure.

The atmospheric pressure is P_0.



While the piston is at a distance $2L$ from the top, the hole at the top is sealed. The piston is then released to a position where it can stay in equilibrium. In this condition, the distance of the piston from the top is

A.

$$\rho g(L_0 - H)^2 + p_0(L_0 - H) + L_0 p_0 = 0$$

B.

$$\rho g(L_0 - H)^2 - p_0(L_0 - H) - L_0 p_0 = 0$$

C.

$$\rho g(L_0 - H)^2 + p_0(L_0 - H) - L_0 p_0 = 0$$

D.

$$\rho g(L_0 - H)^2 - p_0(L_0 - H) + L_0 p_0 = 0$$

Answer: C

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Integer

1. A metal rod AB of length 10x has its one end A in ice at $0^{\circ} C$, and the other end B in water at $100^{\circ} C$. If a point P one the rod is maintained at $400^{\circ} C$, then it is found that equal amounts of water and ice evaporate and melt per unit time. The latent heat of evaporation of water is $540 cal / g$ and latent heat of melting of ice is $80 cal / g$. If the point P is at a distance of λx from the ice end A, find the value λ. [Neglect any heat loss to the surrounding.]

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2. Two spherical black bodies of radii r_1 and r_2 and with surface temperatures T_1 and T_2 respectively radius the same power . Then, $\frac{r_1}{r_2}$ must be equal to

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3. A diatomic ideal gas is compressed adiabatically to 1/32 of its initial volume. If the initial temperature of the gas is T_i (in Kelvin) and the final temperature is aT_i, the value of a is

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4. Steel wire of length 'L' at $40^{\circ} C$ is suspended from the ceiling and then a mass 'm' is hung from its free end. The wire is cooled down from $40^\circ C \to 30^\circ C$ to regain its original length 'L'. The coefficient of linear thermal expansion of the steel is $10^{-5} / ^\circ C$, Young's modulus of steel is $10^{11} N / m^2$ and radius of the wire is 1mm. Assume that $L > >$ diameter of the wire. Then the value of 'm' in kg is nearly

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