PHYSICS

BOOKS - DISHA PUBLICATION PHYSICS (HINGLISH)

THERMODYNAMICS

Jee Main 5 Years At A Glance

1. One mole of an ideal monoatomic gas is taken along the path ABCA as shown in the PV diagram. The maximum temperature attained by the gas along the path BC is given by:

A. $\frac{25}{2}\frac{P_0V_0}{R}$

B. $\frac{25}{4}\frac{P_0V_0}{R}$

C. $\frac{25}{16}\frac{P_0V_0}{R}$

D. $\frac{5}{8}\frac{P_0V_0}{R}$

Answer: A

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2. A Carnot's engine works as refrigerator between $250K$ and 300K. It receives 500 cal heat from the reservoir at the lower temperature. The amount of work done in each cycle to operate the refrigerator is :

A. 420 J

B. 2100 J

C. 772 J

D. 2520 J

Answer: A

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3. 200 g of water is heated from $40^{\circ} C \text{to} 60^{\circ} C$. Ignoring the slight expansion of water , the change in its internal energy is closed to (Given specific heat of water = $4184 J / kg / K$):

A. 167.4 kJ

B. 8.4 kJ

C. 4.2 kJ

D. 16.7 kJ

Answer: D

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4. An ideal gas goes through a v reversible cycle $a \rightarrow b \rightarrow c \rightarrow d$ has the V - T diagram shown below. Process $d \rightarrow a$ and $b \rightarrow c$ are adiabatic.

The corresponding P - V diagram for the process is (all figures are schematic and not drawn to scale):

A.

B.

C.

D.

Answer: B

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5. Consider an ideal gas confined in an isolated closed chamber. As the gas undergoes an adiabatic expansion, the average time of collision between molecules increase as V^q, where V is the volume of the gas. The value of q is : $\left(\gamma = \frac{C_p}{C_v}\right)$

A. $\frac{\gamma + 1}{2}$

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

C. $\frac{3\gamma + 5}{6}$

D. $\frac{3\gamma - 5}{6}$

Answer: A

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6. During an adibatic compression ,830 J of work is done on 2 moles of a diatomic ideal gas to reduce its volume by 50%. The change in its temperature is nearly:

A. 40 K

B. 33 K

C. 20 K

D. 14 K

Answer: C

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7. One mole of a diatomic ideal gas undergoes a cyclic process ABC as shown in figure. The process BC is adiabatic. The temperatures at A, B and C are 400 K, 800 K and 600 K respectively. Choose the correct statement:

A. The change in internal energy in whole cyclic process is 250 R.

B. The change in internal energy in the process CA is 700 R,

C. The change in internal energy in the process AB is -350 R.

D. The change in internal energy in the process BC is

-500 R,

Answer: D

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Exercise 1 Concept Builder Topic Zeroth Low And First Law Of Thermodynamics

1. When two bodies A and B are in thermal equilibrium

A. the kinetic energies of all the molecules of A and B will be equal

B. the potential energies of all the molecules of A and B will be equal

C. the internal energies of the two bodies will be equal

D. the average kinetic energy of the molecules of the two bodies will be equal

Answer: C

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2. Temperature is a measurement of coldness or hotness of an object. This definition is based on

A. zeroth law of thermodynamics

B. first law of thermodynamics

C. second law of thermodynamics

D. Newton's law of cooling

Answer: A

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3. In changing the state of thermodynamics from A to B state, the heat required is Q and the work done by the system is W. The change in its internal energy is

A. Q+W

B. Q-W

C. Q

D. $\frac{Q-W}{2}$

Answer: B

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4. The internal energy change in a system that has absorbed $2kcal$ of heat and done $500J$ of work is

A. 8900 J

B. 6400 J

C. 5400 J

D. 7900 J

Answer: D

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5. 110 J of heat is added to a gaseous system, whose internal energy change is 40J. Then the amount of external work done is

A. 150 J

B. 70 J

C. 110 J

D. 40 J

Answer: B

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6. 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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7. At a given temperature the internal energy of a substance

A. in liquid state is equal to that in gaseous state

B. in liquid state is less than that in gaseous state

C. in liquid state is more than that in gaseous state

D. is equal for the three states of matter

Answer: B

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8. If the amount of heat given to a system is 3 5 J and the amount of work done on the system is 15 J, then the change in internal energy of the system is

A. $-50J$

B. 20 J

C. 30 J

D. 50 J

Answer: D

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9. Which of the following is incorrect regarding the first law of thermodynamics?

A. It is a restatement of principle of conservation of energy.

B. It is applicable to cyclic processes

C. It introduces the concept of entropy

D. It introduces the concept of intcrnol energy

Answer: D

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

A. AQ

B. AW

C. AU and AQ

D. AU

Answer: A

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11. A gas is compressed from a volume of 2m3 to a volume of 1 m^3 at a constant pressure of 100 N/m^2. Then it is heated at constant volume by supplying 150 J of energy. As a result, the internal energy of the gas:

A. increases by 250 J

B. decreases by 250 J

C. increases by 50 J

D. decreases by 50 J

Answer: A

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Exercise 1 Concept Builder Topic 2 Specific Heat Capacity Thermodynamics Processes

1. A closed system undergoes a process $1 \rightarrow 2$ for which the values W_{1-2} and Q_{1-2} are 50 kJ and -20 kJ respectively. If the system is returned to state 1 and $Q_{2 \rightarrow 1}$ is + 10 kJ the work done $W_{2 \rightarrow 1}$ is:

A. 40 kJ

B. 50 kJ

C. $-60kJ$

D. $-50kJ$

Answer: C

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2. In the P-V diagram, I is the initial state and F is the final state. The gas goes from I ot F by (i) IAF, (ii) IBF, (iii) ICF. The heat absorbed by the gas is:

A. The same in all three processes

B. the same in (i) and (ii)

C. greater in (i) than in (ii)

D. the same in (i) and (iii)

Answer: C

3. A monatomic 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 $\gamma = \frac{5}{3}$)

A. 64 P

B. 32 P

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

D. 16 P

Answer: C

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4. 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 a T_i, the value of a is

A. 8

B. 4

C. 3

D. 5

Answer: B

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5. In the following P-V diagram two adiabatics cut two isothermals at temperatures T_1 and T_2 (fig). The value of $\frac{V_a}{V_d}$ will be:

A. $\frac{V_b}{V_c}$

B. $\frac{V_c}{V_b}$

C. $\frac{V_d}{V_a}$

D. $V_b V_c$

Answer: A

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6. During an adiabatic process of an ideal gas, if P is proportional to $\frac{1}{V^{1.5}}$, then the ratio of specific heat capacities at constant pressure to that at constant volume for the gas is

A. 1.5

B. 0.25

C. 0.75

D. 0.4

Answer: A

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7. A system goes from A to B via two processes I and II as shown in figure. If ΔU_1 and ΔU_2 are the changes in internal energies in the processes I and II respectively, then:

A. relation between ΔU_1 and ΔU_2 can not be determined

B. $\Delta U_1 = \Delta U_2$

C. $\Delta U_1 < \Delta U_2$

D. $\Delta U_1 > \Delta U_2$

Answer: B

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8. In P-V diagram shown in figure ABC is a semicircle. The work done in the process ABC is P(N/m^2)

A. 4 J

B. $-\frac{\pi}{2}$ J

C. $\frac{\pi}{2}$ J

D. zero

Answer: C

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9. The relation between U, p and V for an ideal gas in an adiabatic process is given by relation $U = a + bpV$. Find the value of adiabatic exponent (γ) of this gas.

A. $\frac{b+1}{b}$

B. $\frac{b+1}{a}$

C. $\frac{a+1}{b}$

D. $\frac{a}{a+b}$

Answer: A

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10. For an ideal gas graph is shown for three processes. Process 1, 2 and 3 are respectively.

A. Isobaric, adiabatic, isochoric

B. Adiabatic, isobaric, isochoric

C. Isochoric, adiabatic, isobaric

D. Isochoric, isobaric, adiabatic

Answer: D

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11. An ideal gas is initially at P_1, V_1 is expands to P_2, V_2 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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12. Four curves A, B, C and D are drawn in the figure for a given amount of a gas. The curves which represent adiabatic and isothermal changes are:

A. C and D respectively

B. D and C respectively

C. A and B respectively

D. B and A respectively

Answer: C

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13. An ideal gas A and a real gas B have their volumes increases from $V \to 2V$ under isothermal condtitions. The increase in internal energy

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: B

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14. A cube of side 5 cm made of iron and having a mass of 1500 g is heated from 25° C to 400° C. The specific heat for iron is 0.12 cal/g°C and the coefficient of volume expansion is $3.5 \times 10^{-5} / ^\circ C$, the change in the internal energy of the cube is (atm pressure = $1 \times 10^5 N/m^2$)

A. 320 kJ

B. 282 kJ

C. 141 kJ

D. 423 kJ

Answer: B

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15. At 27° a gas is suddenly compersssed such that its pressure become $\frac{1}{8}th$ of original pressure. Temperature of the gas will be $(\lambda = 5/3)$

A. 450 K

B. 300 K

C. -142° C

D. 327° C

Answer: C

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16. An ideal gas of mass m in a state A goes to another state B via three different processes as shown in fig. If Q_1, Q_2 and Q_3 denote the heat absorbed by the gas along the three paths, then:

A. $Q_1 < Q_2 < Q_3$

B. $Q_1 = Q_2 = Q_3$

C. $Q_1 = Q_2 > Q_3$

D.]

Answer: A

17. When an ideal gas $(\gamma = 5/3)$ is heated under constant pressure, what percentage of given heat energy will be utilized in doing external work ?

A. 0.4

B. 0.3

C. 0.6

D. 0.2

Answer: A

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18. There are two processes ABC and DEF. In which of the process is the amount of work done by the gas greater?

A. ABC

B. DEF

C. Equal in both processes

D. In cannot be predicted

Answer: B

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19. Unit mass of liquid of volume V_1 completely turns into a gas of volume V_2 at constant atmospheric pressure P and temperature T. The latent heat of vaporization is "L". Then the change in internal energy of the gas is

A. zero

B. $P(V_2 - V_1)$

C. $L - P(V_2 - V_1)$

D. L

Answer: C

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20. The temperature of $5 mol$ of gas which was held at constant volume was change from $100^\circ C$ to $120^\circ C$. The change in internal energy was found to ve $80 J$. The total heat capacity of the gas at constant volume will be equal to

A. 8 joule per K

B. 0.8 joule per K

C. 4.0 joule per K

D. 0.4 joule per K

Answer: C

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21. During an adiabatic process an object does 100J of work and its temperature decreases by 5K. During another process it does 25J of work and its temperature decreases by 5K. Its heat capacity for 2^{nd} process is

A. 20 J/K

B. 24 J/K

C. 15 J/K

D. 100 J/K

Answer: C

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22. A mass of ideal gas at pressure P is expanded isothermally to four times the original volume and then slowly compressed adiabatically to its original volume. Assuming γ to be 1.5, the new pressure of the gas is

A. 2P

B. P

C. 4P

D. P/2

Answer: A

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23. On P-V coordinates, the slope of an isothermal curve of a gas at a pressure P = IMPa and volume V= 0.0025 m^3 is equal to $-400Mpa/m^3$. If $Cp/Cv = 1.4$, the slope of the adiabatic curve passing through this point is :

A. $-56Mpa/m^3$

B. $-400Mpa/m^3$

C. $-560Mpa/m^3$

D. None of these

Answer: C

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24. An ideal gas at atmospheric pressure is adiabatically compressed so that its density becomes 32 times ofits initial value. If the final pressure of gas is 128 atmospheres, the value of γ of the gas is :

A. 1.5

B. 1.4

C. 1.3

D. 1.6

Answer: B

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25. 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 ....

A. $2^{-1/3}$

B. $2^{1/3}$

C. $2^{2/3}$

D. $2^{-2/3}$

Answer: D

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26. A thermodynamic system is taken from state A to B along A CB and is brought back to A along BDA as shown in the FT diagram. The net work done during the complete cycle is given by the area:

A. $P_1ACBP_2P_1$

B. $ACBB'A'A$

C. ACBDA

D. ADBB'A'A

Answer: C

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27. One mole of an ideal gas at an initial temperature true 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 $5/3$, the final temperature of the gas will be

A. (T-4)K

B. (T+2.4)K

C. (T-2.4) K

D. (T+4)K

Answer: A

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28. An ideal gas at $27^{\circ} C$ is compressed adiabatically to $8/27$ of its original volume. If $\gamma = 5/3$, then the rise in temperature is

A. 475° C

B. 402° C

C. 275° C

D. 175° C

Answer: B

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29. If the ratio of specific heat of a gas of constant pressure to that at constant volume is γ, the change in internal energy of the mass of gas, when the volume changes from V to $2V$ at constant pressure p is

A. $\frac{R}{\gamma - 1}$

B. PV

C. $\frac{PV}{\gamma - 1}$

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

Answer: C

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30. An ideal gas is taken around the cycle ABCA as shown in the P-V diagram. The net work done by the gas during the cycle is equal to

A. $12P_1V_1$

B. $6P_1V_1$

C. $3P_1V_1$

D. P_1V_1

Answer: C

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31. The pressure inside a tyre is 4 atm at $27^\circ C$.If the tyre bursts suddenly, its final temperature will be

A. $300(4)^{7/2}$

B. $300(4)^{2/7}$

C. $300(2)^{7/2}$

D. $300(4)^{-2/7}$

Answer: D

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32. A diatomic gas initally at $18^\circ C$ is compressed adiabtically to one- eighth of its original volume. The temperature after compression will be

A. 18° C

B. 887° C

C. 327° C

D. 395.5° C

Answer: D

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33. The pressure of an ideal gas varies with volume as P= aV, where a is a constant. One mole of the gas is allowed to undergo expansion such that its volume becomes 'm' times its initial volume. The work done by the gas in the process is

A. $\frac{\alpha V}{2}(m^2-1)$

B. $\frac{\alpha^2 V^2}{2}(m^2-1)$

C. $\frac{\alpha}{2}(m^2-1)$

D. $\frac{\alpha V^2}{2}(m^2-1)$

Answer: D

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Exercise 1 Concept Builder Topic 3 Carnot Engine Refigerator And Second Law Of Thermodynamics

1. A Carnot enginer abosrbs an amount Q of heat from a reservoir at an absolute temperature T and rejects heat to a sink at a temperature of $T/3$. The amount of heat rejects is

A. $\frac{Q}{4}$

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

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

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

Answer: B

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2. If an air conditioner is put in the middle of a room and started working

A. the room can be cooled slightly

B. the temperature of the room will not change

C. the room will become slightly warmer

D. the same temperature will be attained in the room as by putting it on the window in the standard position

Answer: C

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3. A carnot engine takes in 3000 kcal of heat from a reservoir at 627°C and gives it to a sink at 27°C. The work done by the engine is

A. 4.2×10^6 J

B. 8.4×10^6 J

C. 16.8×10^6 J

D. zero

Answer: B

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4. In Carnot engine, efficiency is 40% at hot reservoir temperature T. For efficiency 50% , what will be the temperature of hot reservoir?

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

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

C. 6T

D. $\frac{6T}{5}$

Answer: D

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5. "Heat cannot by itself flow from a body at lower temperature to a body at higher temperature" is a statement or consequence of

A. second law of thermodynamics

B. conservation of momentum

C. conservation of mass

D. first law of thermodynamics

Answer: A

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6. The temperature-entropy diagram of a reversible engine cycle is given in the figure. TA Its efficiency is

A. $\frac{1}{4}$

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

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

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

Answer: D

7. An ideal Carnot's engine whose efficiency 40% receives heat of 500K. If the efficiency is to be 50% then the temperature of sink will be

A. 900 K

B. 600 K

C. 700 K

D. 800 K

Answer: B

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8. A heat engine has an efficiency η.Temperatures of source and sink are each decreased by 100 K. The efficiency of the engine

A. remains constant

B. becomes 1

C. decreases

D. increases

Answer: D

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9. The cofficient of performance of a refrigerator is 5. If the temperature inside freezer is $-20^\circ C$, the temperature of the surroundings to which it rejects heat is :

A. 41° C

B. 11° C

C. 21° C

D. 31° C

Answer: D

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10. If the energy input to a Carnot engine is thrice the work it performs then, the fraction of energy rejected to the sink is

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

B. $\frac{1}{4}$

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

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

Answer: D

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11. An engine operates by taking n moles of an ideal gas through the cycle ABCDA shown in figure. The thermal efficiency of the engine is: (Take C_v =1.5 R, where R is gas constant)

A. 0.24

B. 0.15

C. 0.32

D. 0.08

Answer: B

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12. An ideal gas heat engine operates in Carnot cycle between $227^{\circ}C$ and $127^{\circ}C$. It absorbs $6x10^{4}cals$ of heat at higher temperature. Amount of heat converted to work is

A. 4.8×10^{4} cals

B. 6×10^{4} cals

C. 2.4×10^{4} cals

D. 1.2×10^{4} cals

Answer: D

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13. A carnot engine takes 300 cal. of heat at 500 k and rejects 150 cal of heat to the sink. The temperature (in k) of sink is ________.

A. 1000 K

B. 750 K

C. 250 K

D. 125 K

Answer: C

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14. A refrigerator works between $0^{\circ}C$ and $27^{\circ}C$. Heat is to be removed from the refrigerated space at the rate of 50 kcal/ minute, the power of the motor of the refrigerator is

A. 0.346 kW

B. 3.46 kW

C. 34.6 kW

D. 346 kW

Answer: A

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15. A reversible engine converts one-sixth of the heat input into work. When the temperature of the sink is reduced by $62^\circ C$, the efficiency of the engine is doubled. The temperatures of the source and sink are

A. $99^\circ C, 37^\circ$ C

B. $80^\circ C, 37^\circ$ C

C. 95° C, 37° C

D. $90^\circ C, 37^\circ$ C

Answer: A

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Exercise 2 Concept Applicator

1. A perfect gas goes from state A to another state B by absorbing 8 x 10^5 J of heat and doing 6.5 x 10^5 J of external work. It is now transferred between the same two states in another process in which it absorbs 10^5 J of heat. Then in the second process,

A. work done by gas is 10^5 J

B. work done on gas is 10^5 J

C. work done by gas is 0.5×10^5 J

D. work done on the gas is 0.5×10^5 J

Answer: D

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2. Figure shows the variation of internal energy (U) with the pressure (P) of 2.0 mole gas in cyclic process abcda. The temperature of gas at c and d are 300 K and 500 K. Calculate the heat absorbed by the gas during the process.

A. 400 R ln 2

B. 200 R ln 2

C. 100 R ln 2

D. 300 R ln 2

Answer: A

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3. One kg of water at $373K$ is converted into steam at the same temperature. The volume $1cm^3$ of water becomes $1671cm^3$ on boiling. Calculate the change in internal energy of the system , if heat of vaporisation is $540calg^{-1}$. Given standard atmospheric pressure $= 1.013 \times 10^5 Nm^{-2}$.

A. $\approx$ 167 cal

B. $\approx$ 500 cal

C. 540 cal

D. 581 cal

Answer: B

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4. The equation of state for a gas is given by $PV = \eta RT + \alpha V$, where η is the number of moles and α a positive constant. The intinal pressure and temperature of 1 mol of the gas contained in a cylinder is P_0 and T_0, respectively. The work done by the gas when its temperature doubles isobarically will be

A. $\frac{P_0 T_0 R}{P_0 - \alpha}$

B. $\frac{P_0 T_0 R}{P_0 + \alpha}$

C. P_0T_0R ln 2

D. P_0T_0R

Answer: A

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5. A carbot freezer takes heat from water at $0^\circ C$ inside it and rejects it to the room at a temperature of $27^\circ C$. The latent heat of ice is $336 \times 10^3 Jkg^{-1}$. If 5kg of water at $0^\circ C$ is converted into ice at $0^\circ C$ by the freezer, then the energy consumed by the freezer is close to :

A. 1.51×10^5 J

B. 1.68×10^6 J

C. 1.71×10^7 J

D. 1.67×10^5 J

Answer: D

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6. One mole of an ideal gas at temperature T was cooled isochorically till the gas pressure fell from P to $\frac{P}{n}$. Then, by an isobaric process, the gas was restored to the initial temperature. The net amount of heat absorbed by the gas in the process is

A. nRT

B. $\frac{RT}{n}$

C. $RT(1 - n^{-1})$

D. $RT(n - 1)$

Answer: C

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7. An ideal gas has temperature T_1 at the initial state i shown in the P- V [diagram. The gas has a higher temperature T_2 at the final states a and b, which it can reach the paths shown. The change in entropy is:

A. greatest in a

B. greatest in b

C. same in a and b

D. nothing can be said

Answer: B

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8. A carnot engine absorbs $1000J$ of heat energy from a reservoir at $127^\circ C$ and rejecs $600J$ of heat energy during each cycle. Calculate (i) efficiency of the engine, (ii) temperature of sink, (iii) amount of useful work done per cycle.

A. 20% and -43° C

B. 40% and -33° C

C. 50% and -20° C

D. 70% and -10° C

Answer: B

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9. 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 $A \rightarrow B$ B is isothermal

B. heat flows out of the gas during the path

$B \to C \to D$

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

D. no work is done by the gas in the cycle ABCDA

Answer: B

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10. An ideal gas is subjected to cyclic process involving four thermodynamics states, the amounts of heat (Q) and work (W) involved in each of these states.

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

$W_1 = 2500J, W_2 = -1000J, W_3 = -1200J, W_4 = xJ$

The ratio of the net work done by the gas to the total heat absorbed by the gas is η. The values of x and η respectively are

A. 500, 7.5%

B. 700, 10.5%

C. 1000, 21%

D. 1500, 15%

Answer: B

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11. One mole of an ideal gas goes from an initial state A to final state B via two processs : 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 process in (figure)

A.

B.

C.

D.

Answer: D

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12. A monoatomic ideal gas, initially at temperature T_1, is enclosed in a cylinder fitted with a friction less piston. The gas is allowed to expand adiabatically to a temperature T_2 by releasing the piston suddenly. If L_1 and L_2 are the length of the gas column before expansion respectively, then $\frac{T_1}{T_2}$ 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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13. A diatomic ideal gas is used in a Carnot engine as the working substance. If during the adiabatic expansion part of the cycle the volume of the gas increase from V to 32V, the efficiency of the engine is

A. 0.5

B. 0.75

C. 0.99

D. 0.25

Answer: B

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14. Two identical containers A and B have frictionaless pistons. They contain the same volume of an ideal gas at the same temperature. The mass of the gs in A is m_A and that B is m_B . The gas in each cylinder is now allowed to expand isothermally to double the intial volume. The chages in the pressure in A and B are fopund to be Δ and $1.5\Delta p$ respectively.

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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15. On P-V coordinates, the slope of an isothermal curve of a gas at a pressure P = IMPa and volume V= 0.0025 m^3 is equal to $-400Mpa/m^3$. If $C_p/C_v = 1.4$, the slope of the adiabatic curve passing through this point is :

A. $-56Mpa/m^3$

B. $-400Mpa/m^3$

C. $-560Mpa/m^3$

D. None of these

Answer: C

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16. 0.5 mole of an ideal gas at constant temperature 27° C kept inside a cylinder of length L and cross-section area A closed by a massless piston.

The cylinder is attached with a conducting rod of length L, cross-section area (1/9) m^2 and thermal conductivity k, whose other end is maintained at 0° C. If piston is moved such that rate of heat flow through the conducing rod is constant then velocity of piston when it is at height Z from the bottom of cylinder is : [neglect any kind of heat loss from system]

A. $\left(\frac{k}{R}\right)$ m/sec

B. $\left(\frac{k}{10R}\right)$ m/sec

C. $\frac{k}{100R}$ m/sec

D. $\left(\frac{k}{1000R}\right)$ m/sec

Answer: C

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17. 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?

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

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

C. $T_1 T_2$

D. $\sqrt{T_1 T_2}$

Answer: D

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18. The above p-v diagram represents the thermodynamic cycle of.an engine, operating with an ideal monatomic gas. The amount of heat, extracted from the source in a single cycle is:

A. $p_o v_o$

B. $\left(\frac{13}{2}\right)p_o v_o$

C. $\left(\frac{11}{2}\right)p_o v_o$

D. $4p_o v_o$

Answer: B

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19. A certain diatomic gas has the same specific heats as an ideal gas but a slightly different equation of state : $PV = R(T + \alpha T^2), \alpha = 0.001K^{-1}$. The temperature of the gas is raised from $T_1 = 300K$ to T_2 at constant pressure. It is found that work done on the gas is 70% higher than what would be on an ideal gas. Choose the correct statement(s)

A. $T_2 = 400K$, internal energy increases by 250 R per mole.

B. $T_2 = 400$ K, internal energy increases by 350 R per mole

C. Total heat absorbed in the process is 450 R per mole.

D. Total heat absorbed in the process is 520 R per mole.

Answer: B

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20. A carnot engine operating between temperatures T_1 and T_2 has efficiency $\frac{1}{6}$. When T_2 is lowered by 62K, its efficience increases to $\frac{1}{3}$. Then T_1 and T_2 are respectively:

A. 372 K and 330 K

B. 330 K and 268 K

C. 310 K and 248 K

D. 372 K and 310 K

Answer: D

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21. For an ideal gas four processes are marked as 1,2,3 and 4 on P-V diagram as shown in figure. The amount of heat supplied to the gas in the process 1, 2,3 and 4 are Q_1, Q_2, Q_3 and Q_4 respectively, then correct order of heat supplied to the gas is - [AB is process-1, AC is process-2, AD is adiabatic process-3 and AE is process-4]

A. $Q_1 > Q_2 > Q_3 > Q_4$

B. $Q_1 > Q_2 > Q_4 > Q_3$

C. $Q_1 > Q_4 > Q_2 > Q_3$

D. $Q_1 < Q_2 < Q_3 < Q_4$

Answer: B

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22. A container with insulating walls is divided into two equal parts by a partition fitted with a valve. One part is filled with an ideal gas at a pressure P and temperature T, whereas the other part is completely evacuated . If the valve is suddenly opened, the pressure and temperature of the gas will be

A. $\frac{p}{2}, T$

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

C. p,T

D. $p, \frac{T}{2}$

Answer: A

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

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

B. $Q_3 > Q_2 > Q_1$ 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

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

A. 2PV

B. 4 PV

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

D. PV

Answer: A

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25. A refrigerator works between $4^\circ C$ and $30^\circ C$. It is required to remove $600cal$ or ies of heat every second in order to keep the temperature of the refrigerator space constant.The power required is (Take $1 cal$ or $ie = 4.2 J$)

A. 2.365 W

B. 23.65 W

C. 236.5 W

D. 2365 W

Answer: C

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26. The specific heat capacity of a metal at low temperature (T) is given as

$$C_p(kJK^{-1}kg^{-1}) = 32\left(\frac{T}{400}\right)^3$$

A 100 gram vessel of this metal is to be cooled from $20^\circ K$ to $4^\circ K$ by a special refrigerator operating at room temperaturte $(27^\circ C)$. The amount of work required to cool the vessel is

A. equal to 0.002 kJ

B. greaterthan 0.148 kJ

C. between 0.148 kJ and 0.028 kJ

D. less than 0.028 kJ

Answer: C

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27. The efficiency of an ideal gas with adiabatic exponent 'y' for the shown cyclic process would be:

A. $\frac{2\ln 2-1}{\gamma/(\gamma-1)}$

B. $\frac{1-2\ln 2}{\gamma/(\gamma-1)}$

C. $\frac{2\ln 2+1}{\gamma/(\gamma-1)}$

D. $\frac{2\ln 2-1}{\gamma/(\gamma+1)}$

Answer: A

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28. Pressure P, volume V and temperature T for a certain gas are related by $P = \frac{AT - BT^2}{V}$, where A and B are constatns .The work done by the gas as its temperature change from T_1 to T_2 while pressure remaining constatn is

A. $A - \frac{B}{2}(T_2 - T_1)$

B. $A(T_2 - T_1) - B(T_2^2 - T_1^2)$

C. $\frac{A}{T}(T_2^2 - T_1^2) - \frac{B}{3}(T_2^3 - T_1^3)$

D. $A(T_2 - T_1)^2 - \frac{B}{3}(T_2 - T_1)^3$

Answer: B

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29. A solid body of constant heat capacity $1J/^\circ C$ is being heated by keeping it contact with reservoirs in two ways:

(i) Sequentially keeping in contact with 2 reservoirs such that each reservoir supplies same amount of heat.

(ii) Sequentially keeping in contact with 8 reservoir such that each reservoir supplies same amount of heat.

In both the cases body is brought from initial temperature 100^C to final temperature $200^\circ C$. Entropy change of the body in the tow cases respectively is :

A. ln2, 2ln 2

B. 2ln2, 8 ln2

C. ln2, 4ln 2

D. ln2, ln2

Answer: D

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