PHYSICS

BOOKS - FULL MARKS PHYSICS (TAMIL ENGLISH)

HEAT AND THERMODYNAMICS

In Textual Solved Examples

1. 'A lake has more rain'.

(b) 'A hot cup of coffee has more heat'.

What is wrong in these two statements?

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2. A student comes to school by a bicycle whose tire is filled with air at a pressure 240 kPa at 27° C. She travels 8 km to reach the school and the temperature of the bicycle tire increases to 39° C. What is the change in pressure in the tire when the student reaches school?

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3. When a person breaths, his lungs can hold up to 5.5 Litre of air at body temperature $37^{\circ} C$ and atmospheric pressure $(1 \mathrm{~atm}=101 \mathrm{~kPa})$. This Air contains 21% oxygen. Calculate the number of oxygen molecules in the lungs.

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4. Calculate the volume of one mole of any gas at STP and at room temperature (300K) with the same pressure 1 atm.

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5. Estimate the mass of air in your class room at NTP. Here NTP implies normal temperature (room temperature) and 1 atmospheric pressure.

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6. Eiffel tower is made up of iron and its height is roughly 300 m. During winter season (January) in France the temperature is 2°C and in hot summer its average temperature 25°C. Calculate the change in height of Eiffel tower between summer

and winter. The linear thermal expansion coefficient for iron $\alpha = 10 \times 10^{-6} \text{ per } {}^{\circ}C$

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7. If 5 L of water at $50^{\circ}C$ is mixed with 4L of water at $30^{\circ}C$, what will be the final temperature of water? Take the specific heat capacity of water as $4184 Jkg^{-1}K^{-1}$

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8. A hot water cools from $92^\circ C$ to $84^\circ C$ in 3 minutes when the room temperature is $27^\circ C$. How long will it take for it to cool from $65^\circ C$ to $60^\circ C$?

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9. The power radiated by a black body A is E_A and the maximum energy radiated was at the wavelength λ_A.The power radiated by another black body B is $E_B = NE_A$ and the radiated

energy was at the maximum wavelength, $\frac{3}{4}\lambda_A$. What is the value of N?

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10. When you mix a tumbler of hot water with one bucket of normal water, what will be the direction of heat flow? Justify.

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11. A student had a breakfast of 200 food calories. He thinks of burning this energy by drawing water

from the well and watering the trees in his school. Depth of the well is about 25 m. The pot can hold 25 L of water and each tree requires one pot of water. How many trees can he water? (Neglect the mass of the pot and the energy spent by walking. $\left(\text{Take g} = 10ms^{-2}\right)$

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12. A person does 30 kJ work on 2 kg of water by stirring using a paddle wheel. While stirring, around 5 kcal of heat is released from water through its container to the surface and

surroundings by thermal conduction and radiation. What is the change in internal energy of the system?

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13. Jogging every day is good for health. Assume that when you jog a work of 500 kJ is done and 230 kJ of heat is given off. What is the change in internal energy of your body?

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14. Give an example of a quasi-static process. Consider a container of gas with volume V, pressure P and temperature T. If we add sand particles one by one slowly on the top of the piston, the piston will move inward very slowly. This can be taken as almost a quasi- static process. It is shown in the figure.

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15. Calculate the work done by the torque.

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16. A 0.5 mole of gas at temperature 300 K expands isothermally from an initial volume of 2 L to 6 L

(a) What is the work done by the gas?

(b) Estimate the heat added to the gas?

(c) What is the final pressure of the gas?

$\left(\text{The value of gas constant, R} = 8.31 \text{ J mol}^{-1}K^{-1}\right)$

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17. Match the following

1.	J.J. Thomson	(a)	Atomic model for hydrogen atom
2.	Rutherford	(b)	Theoretical atom model
3.	Geiger and Marsden	(c)	Nucleus
4.	Neils Bohr	(d)	Scattering of alpha particles

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18. We often have the experience of pumping air into bicycle tyre using hand pump. Consider the air inside the pump as a thermodynamic system having volume V at atmospheric pressure and room temperature, $27^{\circ} C$. Assume that the nozzle

of the tyre is blocked and you push the pump to a volume $1/4$ of V. Calculate the final temperature of air in the pump? (For air, since the nozzle is blocked air will not flow into tyre and it can be treated as an adiabatic compression). Take γ for air $= 1.4$

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19. The following graph shows a V-T graph for isobaric processes at two different pressures. Identify which one occurs at higher pressure.

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20. One mole of an ideal gas initially kept in a cylinder at pressure 1 MPa and temperature $27^{\circ}C$ is made to expand until its volume is doubled.

(a) How much work is done if the expansion is (i) adiabatic (ii) isobaric (iii) isothermal?

(b) Identify the processes in which workdone is least and is maximum.

(c) Show each process on a PV diagram.

(d) Name the processes in which the heat transfer is maximum and minimum.

$(\text{Take } \gamma = 5/3 \text{ and } R = 8.3 Jmol^{-1}K^{-1})$

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21. 500 g of water is heated from $30^{\circ}C$ to $60^{\circ}C$. Ignoring the slight expansion of water, calculate the change in internal energy of the water? (Specific heat of water $4184J/kgK$) .

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22.

	List - I		List - II
i.	$p \vee p \equiv p, p \wedge p \equiv p$	a)	Identity law
ii.	$p \vee (q \vee r) = (p \vee p) \vee r$	b)	Idempotent law
iii.	$p \vee (q \vee r) = (p \wedge p) \vee (p \wedge r)$	c)	Associative law
iv.	$p \vee \text{II} = \text{II}$	d)	Distributive law

The correct match is

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23. Give an example of irreversible reaction

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24. During a cyclic process, a heat engine absorbs 500 J of heat from a hot reservoir, does work and ejects an amount of heat 300 J into the surroundings (cold reservoir). Calculate the efficiency of the heat engine?

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25. A steam engine boiler is maintained at $250^{\circ} C$ and water is converted into steam. This steam is used to do work and heat is ejected to the surrounding air at temperature 300K. Calculate the maximum efficiency it can have?

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26. There are two Carnot engines A and B operating in two different temperature regions. For Engine A the temperatures of the two reservoirs are $150^{\circ} C$ and $100^{\circ} C$. For engine B the

temperatures of the reservoirs are $350^{\circ} C$ and $300^{\circ} C$. Which engine has lesser efficiency?

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27. A referigertor has COP of 3 . How much work must be supplied to a refrigertor in order to remove $200 J$ of heart from its interior?

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Textual Evaluation Solved I Multiple Choice Questions

1. In hot summer after a both the body 's

A. internal energy decreases

B. internal energy increases

C. heat decreases

D. no change in internal energy and heat

Answer: A

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2. The graph between volume and temperature in Charles'law is

A. an ellipse

B. a circle

C. a straight line

D. a parabola

Answer: C

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3. When a cycle tyre suddenly bursts, the air inside the tyre expands. This process is.....

A. Isothermal

B. adiabatic

C. isobaric

D. isochoric

Answer: B

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4. An ideal gas passes from one equllibrium state (P_1, V_1, T_1, N) to anoter equilibrium state $(2P_1, 3V_1, T_2, N)$ Then

A. $T_1 = T_2$

B. $T_1 = \frac{T_2}{6}$

C. $T_1 = 6T_2$

D. $T_1 = 3T_2$

Answer: B

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5. When a unifrom rod is heated which of the following quantity of the rod will increase

A. mass

B. weight

C. center of mass

D. moment of inertia

Answer: D

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6. When food is cooked in a vessel by keeping the lid closed, after some time the steam pushes the lid outward. By considering the steam as a thermodynamic system, then in the cooking process .....

A. $Q > 0, W > 0$

B. $Q < 0, W > 0$

C. $Q > 0, W < 0$

D. $Q < 0, W < 0$

Answer: A

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7. When you exercise in the morning, by considering your body as thermodynamic system, which of the following is true?

A. $\Delta U > 0, W > 0$

B. $\Delta U < 0, W > 0$

C. $\Delta U < 0, W < 0$

D. $\Delta U = 0, W > 0$

Answer: B

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8. A hot cup of coffee is kept on the table , After some time is attains a thernal equilibrium with the surrounding By considering the air molecules

in the room as a thermodynamic system which of the following is true

A. $\Delta U > 0, Q = 0$

B. $\Delta U > 0, W < 0$

C. $\Delta U > 0, Q > 0$

D. $\Delta U = 0, Q > 0$

Answer: C

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9. A distant star emits radiation with maximum intensity at 350 nm. The temperature of the star is

A. 8280 K

B. 5000 K

C. 7260 K

D. 9044 K

Answer: A

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10. identify the state variables given here ?

A. Q, T, W

B. P, T, U

C. Q, W

D. P, T, Q

Answer: B

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11. In an isochoric process we have

A. $W = 0$

B. $Q = 0$

C. $\Delta U = 0$

D. $\Delta T = 0$

Answer: A

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12. The efficiency of a heat engine working between the freezing point and boiling point of water is

A. $6.25\ \%$

B. $20\ \%$

C. $26.8\ \%$

D. $12.5\ \%$

Answer: C

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13. An Ideal refrigerator has a freezer at temperature $-12^{\circ}C$. The coefficient of

performance of the engine is 5. The temperature of the air (to which the heat ejected) is

A. $50^{\circ} C$

B. $45.2^{\circ} C$

C. $40.2^{\circ} C$

D. $37.5^{\circ} C$

Answer: C

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Textual Evaluation Solved Ii Short Answer Questions

1. An object contains more heat -Is it a right statement ? If not why ?

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2. Obtain an ideal gas law from Boyle's and Charles' law.

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3. Define one mole.

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4. Define spectific heat capacity and give its unit .

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5. Define molar specific heat capacity .

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6. What is thermal expansion ?

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7. Give the expressions for linear, area and volume thermal expansions.

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8. Define latent heat capacity . Give its unit

Watch Video Solution

9. State Stefan-Boltzmann law.

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10. What is Wien's law ?

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11. Define thermal conductivity. Give its unit.

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12. What is black body ?

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13. What is thermodynamic system ? Give example

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14. Whatere the different types of thermodynamic systems ?

Watch Video Solution

15. What is meant by thermal equilibrium ?

Watch Video Solution

16. What is meant by state variable ? Give example

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17. What are intensive and extensive variables ? Give examples.

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18. What is an equation of state ? Give an example

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19. State Zeroth law of thermodynamic .

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20. Define the internal energy of the system

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21. Are internal energy and heat energy the same ?

Exaplain .

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22. Define one calorie.

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23. Explain Joule's Experiment of the mechanical equivalent of heat.

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24. State the first law of thermodynamics.

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25. Can we measure the temperature of the object by touching it ?

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26. Give the sign convention for Q and W.

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27. Define the quasi-static process.

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28. Give the expression for work done by the gas .

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29. What is PV diagram ?

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30. Why the specific heat capacity of constant pressure is greater than the specific heat capacity at constant volume?

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31. Give the equation of state for an isothermal process.

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32. Define isothermal process. Derive an expression for work done in isothermal . process.

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33. Express the change in internal energy in terms of molar specific heat capacity .

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34. Apply first law for (a) an isothermal (b) adiabatic (c) isobaric processes.

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35. Give the equation of state for an adiabatic process.

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36. Give an equation state for an isochoric process.

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37. If the piston of a container is pushed fast inward .Will the ideal gas equation be valid in the intermediate stage ? If not, Why ?

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38. Define the following terms: (a) Isothermal process (b) adiabatic process (c) isobaric proces (d) isochoric process.

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39. What is a cyclic process ?

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40. What is meant by reversible and irreversible processes ?

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41. State Clausius form of the second law of thermodynamics.

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42. State Kelvin- Planck statement of second law of thermodynamics.

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43. Define heat engine .

Watch Video Solution

44. What are processes involves in a Carnot engine?

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45. Can the given heat energy be completely converted to work in a cyclic process? If not , when can the heat can completely converted to work ?

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46. State the second law of thermodynamics in therms of entropy.

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47. Why does heat flow from a hot object to a cold object?

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48. Obtain the Coefficient of performance (COP). (β).

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Textual Evaluation Solved Iii Long Answer Questions

1. Explain the meaning of heat and work with suitable examples.

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2. Discuss the ideal gas laws.

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3. What is thermal expansion?

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4. Describe the anomalous expansion of water: How is it helpful in our lives?

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5. Explain Calorimetry and derive an expression for final temperature when two thermodynamic systems are mixed.

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6. Discuss various modes of heat transfer.

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7. State Newton's II law of motion.

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8. Explain Wien's law and why our eyes are sensitive only to visible rays?

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9. State of chemical equilibrium is :

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10. Explain Joule's Experiment of the mechanical equivalent of heat.

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11. Derive the expression for the work done in a volume change in a thermodynamic system.

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12. Derive Mayer's relation for an ideal gas.

Watch Video Solution

13. In an isothermal process

Watch Video Solution

14. Give an expression for work done in an isothermal process.

Watch Video Solution

15. Define an adiabatic process.

Watch Video Solution

16. Give the equation of state for an adiabatic process.

Watch Video Solution

17. What is a isobaric process ?

Watch Video Solution

18. Explain in detail the isochoric process.

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19. What are the limitations of the first law of thermodynamics?

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20. Define heat engine .

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21. Explain in detail about IPR.

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22. Derive the expression for Carnot engine efficiency.

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23. State the second law of thermodynamics in therms of entropy.

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24. Explain in detail the working of a refrigerator.

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Textual Evaluation Solved Iv Conceptual Questions

1. Calculate the number of moles air is in the inflated balloon at room temperature as shown in the figure.

The radius of the balloon is 10 cm, and pressure inside the balloon is 180 kPa

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2. In the planet Mars, the average temperature is around $-53^{\circ}C$ and atmospheric pressure is 0.9 kPa. Calculate the number of moles of the molecules in unit volume in the planet Mars? Is this greater than that in earth ?

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3. One mole of PCl_5 is heated in one litre closed container. If 0.6 mole of chlorine is found at equilibrium, calculate the value of equilibrium constant.

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4. The temperature of uniform rod of length L having a coefficient of linear expansion α_L is changed by ΔT . Calculate the new moment of inertia of the uniform rod about axis passing through its center and perpendicular to an axis of the rod.

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5. Define the following terms: (a) Isothermal process (b) adiabatic process (c) isobaric proces

(d) isochoric process.

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6. A man starts bicycling in the morning at a temperature around $25^{\circ}C$ he checked the pressure of tire which is equal to be 500 Kpa. Afternoon he found that the absolute pressure in the tyre is increased to 520 Kpa. By assuming the expansion of tyre is negligible what is the temperature of type at afternoon ?

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7. Normal human body of the temperature is $98.6^{\circ} F$. During high fever if the temperature increases to $104^{\circ} F$ what is the change in peak wavelength that emitted by our body ?

(Assume human body is a black body)

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8. In an adiabatic expansion of the air the volume is increased by 4% what is pereentage change in pressure ? (For air y = 1.4)

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9. In a petrol engine (internal combustion engine) air at atmospheric pressure and temperature of $20^{\circ} C$ is compressed in the cylinder by the piston to $1/8$ of its original volume . Calculate the termperature of the compressed air .

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10. Fill in the blanks.

	A	B	C
a.	Photoelectric effect	Experimental study by	.....
b.	Photoemissive cell	.....	Burglar's alarm
c.	de-Broglie wavelength	$\lambda = \frac{h}{mv}$	λ = ...
d.	$h\upsilon = \frac{1}{2} m v_{max}^2 + \phi_0$	$h\upsilon$ = ...	$\frac{1}{2} m v_{max}^2 = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$

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11. An ideal gas is taken in a cyclic process as shown in the figure. Calculate

(a) work done by the gas. (b) work done on the gas

(c) Net work done in the process

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12. For a given ideal gas 6×10^5 J heat energy is supplied and the volume of gas is increased from 4 m^3 to $6m^3$ at atmospheric pressure . Calculate

(a) the work done by the gas (b) Change in internal energy of the gas

(c) graph this process in PV and TV diagram

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13. Suppose a person wants to increase the efficieny of the reversible heat engine that is operating between $100^\circ C$ and $300^\circ C$

He had two ways to increase the efficiency .

(a) By decreasing the cold reservoir temperature from $100^\circ C$ to $50^\circ C$ and keeping the hot reservoir temperature of the hot reservoir from

$300^\circ C$ to $350^\circ C$ by keeping the cold reservoir temperature constnat which is the suitable method ?

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14. A Carnot engine whose efficiency is 45% takes heat from a source maintained at a temperature of $327^\circ C$ .To have an engine of efficiency 60% what must be the intake temperature for the same exhaust (sink) temperature

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15. An ideal refrigerator keeps its content at $0^{\circ}C$ while the room temperature is $27^{\circ}C$ .Calculate its coefficient of performance.

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Additional Questions Solved I Choose The Correct Answer From The Following

1. The coefficient of volume expansion of a solid is x times the coefficient of superficial expansion. Then x is

A. 1.5

B. 2

C. 2.5

D. 3

Answer: a

2. A solid metal ball has a spherical cavity. If the ball is heated, the volume of the cavity will

A. increase

B. decrease

C. remain unaffected

D. remain unaffected but the slope of the cavity will change.

Answer: a

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3. A metal sheet with a circular hole is heated. The hole will

A. contract

B. expand

C. remain unaffected

D. contract of expand depending on the value of the liner expansion coefficient.

Answer: b

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4. The length of a metal rod at $0^\circ C$ is 0.5m. When it is heated, its length increases, by 2.7 mm.The final temperature of the rod is (coefficient of

linear expansion of the metal $= 90 \times 10^{-6} / ^{\circ} C$).....

A. $20^{\circ} C$

B. $30^{\circ} C$

C. $40^{\circ} C$

D. $60^{\circ} C$

Answer: d

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5. A bimetal made of copper and iron strips welded together is straight at room temperature. It is held vertically with iron strip towards left and copper strip towards right. If this bimetal is heated, it will

A. remain straight

B. bend towards right

C. bend towards left

D. bend forward

Answer: c

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6. When water is heated from $0^\circ C$ to $10^\circ C$, its volume ..... .

A. decreases

B. increases

C. first increases and then increase

D. first decreases and then increases.

Answer: d

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7. A block of wood is floating on water at $0^\circ C$ with a certain volume 'V' above the water level. The temperature of water is slowly raised to $20^\circ C$. How does the volume 'V' change with the rise in temperature ?

A. remain unchanged

B. decrease continuously

C. decrease till $4^\circ C$ and then increase.

D. increase till $4^\circ C$ and then decrease.

Answer: a

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8. An iron tyre is to be fitted on a wooden wheel 0.1m in diameter. The miameter of the tyre is 6 mm smaller than that of the wheel. The tyre should be heated by a temperature of (coefficient of volume expansion or iron is $3.6 \times 10^{-5} / {}^{\circ} C$)..... .

A. $167^{\circ} C$

B. $334^{\circ} C$

C. $500^{\circ} C$

D. $1000^{\circ} C$

Answer: a

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9. A Steel rod of length 25 cm has a cross - sectional area of $0.8cm^2$. The force required to stretch this rod by the same amount as the expansion produced by heating it through $10^\circ C$ is (coefficient of linear expansion of steel is $10^{-5}/^\circ C$ and Young's modulus of steel is $2 \times 10^{10} N/m^2$)..... .

A. (a) 40 N

B. (b) 80 N

C. (c) 120 N

D. (d) 160 N

Answer: d

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10. Which of the following will make the volume of an ideal gas four times ?

A. double the absolute temperature and double the pressure.

B. Halve the absolute temperature and double the pressure.

C. Quarter the absolute temperature at constant pressure.

D. Quarter the pressure at constant temperature.

Answer: d

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11. A perfect gas at $27^\circ C$ is heated at constant pressure so as to double its volume. The temperature of the gas becomes.

A. $54^\circ C$

B. 150 K

C. $327^\circ C$

D. 300K

Answer: c

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12. An air bubble doubles in radius on rising from the bottom of a lake to its surface. If the atmospheric pressure is equal to that of a column of water of height H, the depth of lake is

A. (a) H

B. (b) 2H

C. (c) 7H

D. (d) 8H

Answer: c

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13. The mass of 1 litre of helium under a pressure of 2 atm and at a temperature of $27^{\circ} C$ is

A. 0.16 g

B. 0.32 g

C. 0.48 g

D. 0.64 g

Answer: b

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14. Pressure exerted by a perfect gas is equal to ..... .

A. mean kinetic energy per unit volume

B. half of mean kinetic energy per unit volume

C. one - third of mean kinetic energy per unit volume

D. two - thirds of mean kinetic energy per unit volume

Answer: d

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15. Two vessels A and B contain the same ideal gas. The volume of B is twice that of A, the pressure in B is twice that in A and the temperature of B is twice that of A. The ratio of the number of gas molecules in A and B is

A. $1:2$

B. $2:1$

C. $1:4$

D. $4:1$

Answer: a

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16. According to Boyle's law, $PV = C$ when the temperature of the gas remains constant. The value of C depends on

A. temperature of the gas

B. nature of the gas

C. quantity of the gas

D. both temperature and quantity of the gas.

Answer: d

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17. The pressure of a gas contained in a closed vessel is increased by 0.4% when when heated by $1^\circ C$. The initial temperature was

A. 250 K

B. $250^\circ C$

C. 25 K

D. $25^\circ C$

Answer: a

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18. A difference of temperature of $25^{\circ}C$ is equivalent to a difference of

A. $25^{\circ}F$

B. $45^{\circ}F$

C. $67^{\circ}F$

D. $77^{\circ}F$

Answer: b

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19. A temperature at which both the Fahrenheit and the centigrade scales have the same value is

A. 40°

B. -40°

C. 20

D. -20°

Answer: b

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20. If the temperature of patient is $40^\circ C$, his temperature on the Fahrenheit scale will be

A. $72^\circ F$

B. $96^\circ F$

C. $100^\circ F$

D. $104^\circ F$

Answer: d

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21. The correct value of $0^{\circ} C$ on the Kelvin scale is

.....

A. 273.15 K

B. 272.85 K

C. 273 K

D. 72.2 K

Answer: a

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22. When a gas in a closed vessel was heated so as to increase its temperature by $5^{\circ}C$, there occurred an increase of 1% in its pressure, the original temperature of the gas was ..... .

A. $50^{\circ}C$

B. $227^{\circ}C$

C. $273^{\circ}C$

D. $500^{\circ}C$

Answer: b

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23. A perfect gas at $27^\circ C$ is heated at constant pressure so as to double its volume. The temperature of the gas becomes.

A. $600^\circ C$

B. $54^\circ C$

C. $327^\circ C$

D. $300^\circ C$

Answer: c

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24. Temperature can be expressed as a derived qqantity in terms of ..... .

A. length and mass

B. mass and time

C. length, mass and time

D. none of these

Answer: d

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25. The equation of state corresponding to 8 g of O_2 is

A. $PV = 8RT$

B. $PV = RT/4$

C. $PV = RT$

D. $PV = RT/2$

Answer: b

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26. At a given volume and temperature, the pressure of a gas ..... .

A. varies inversely as its mass

B. varies inversely as the square of its mass

C. varies linearly as its mass

D. is independent of its mass

Answer: c

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27. Oxygen boils at $-183^{\circ}C$. This temperature in Fahrenheit scale is ..... .

A. -215.7°

B. -297.4°

C. -310.6°

D. -373.2°

Answer: b

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28. A centigrade and a Fahrenheit thermometer are dipped in boiling water. The water temperature is lowered until the Fahrenheit thermometer registered at $140^{\circ}F$. What is the fall in temperature as registered by the centigrade thermometer ?

A. 80°

B. 60°

C. 40°

D. 30°

Answer: c

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29. The change in temperature of a body is $50^{\circ} C$.

The change on the kelvin scale is ..... .

A. 50 K

B. 323 K

C. 70 K

D. 30 K

Answer: a

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30. Mercury themometers can be used to measure temperature up to ..... .

A. $260^\circ C$

B. $100^\circ C$

C. $360^\circ C$

D. $500^\circ C$

Answer: c

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31. For an ideal gas ___

A. attractive

B. repulsive

C. very large

D. zero

Answer: d

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32. Device used to measure very high temperature is ..... .

A. Pyrometer

B. Thermometer

C. Bolometer

D. calorimeter

Answer: a

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33. Two metal rods A and B are having their initial lengths in the ratio $2:3$, and coefficients of linear expansion in the ratio $3:4$. When they are heated through same temperature difference the ratio of their linear expansions is ..... .

A. $1:2$

B. $2:3$

C. $3:4$

D. $4:3$

Answer: a

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34. Boyles' law is applicable in ..... .

A. isochoric process

B. isothermal process

C. isobaric pressure

D. both (a) and (b)

Answer: b

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35. A rod, when heated from $0^{\circ}C$ to $50^{\circ}C$, expands by 1.0 mm. Another rod, twice as long as the first at $0^{\circ}C$ and of the same material, is heated from $0^{\circ}C$ to $25^{\circ}C$. The second rod will expand by ..... .

A. 0.5 mm

B. 1.0 mm

C. 2.0 mm

D. 4.0 mm

Answer: b

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36. A container contains hydrogen gas at pressure P and temperature T. Another identical container contains helium gas at pressure 2P and temperature $T/2$. The ratio of the number of molecules of the two gases is

A. $1:4$

B. $4:1$

C. $1:2$

D. $2:1$

Answer: a

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37. Density of water is maximum at the temperature of ..... .

A. $32^\circ F$

B. $39.2^\circ F$

C. $42^\circ F$

D. $40^\circ F$

Answer: b

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38. The equation of state for 5g of oxygen at a pressure P and temeprature T, when occupying a volume V, will be

A. $PV = (5/32)RT$

B. $PV = 5RT$

C. $PV = (5/2)RT$

D. $PV = (5/16)RT$

Answer: a

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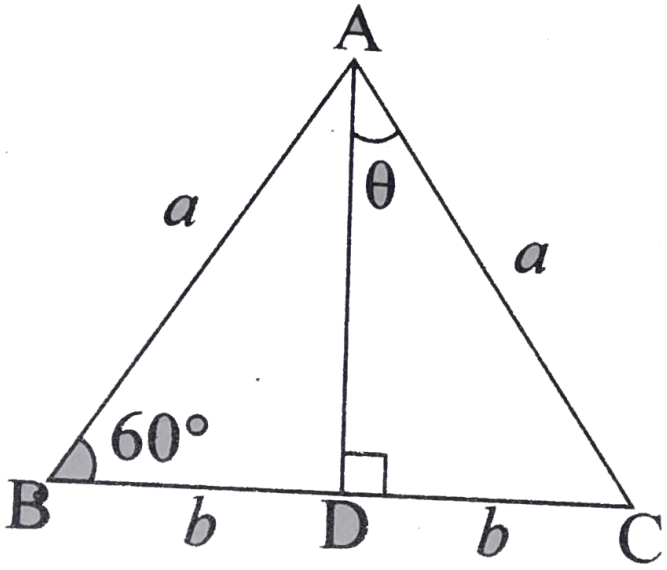
39. In the given diagram θ is .....



A. it will bend towards the right

B. is will bend towards the left

C. it will not bend but shrink

D. it will neither bend nor shrink

Answer: b

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40. In ideal gas is expanding such that PT^2 = constant. 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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41. A metallic solid sphere is rotating about its diameter as axis of rotation. If the temperature is increased by $200^{\circ}C$. The percentage increase in its moment of inertia is : (coefficient of linear) expansion of the metal $= 10^{-5}/^{\circ}C$)

A. 0.1

B. 0.2

C. 0.3

D. 0.4

Answer: d

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42. The difference between volume and pressure coefficients of an ideal gas is ..... .

A. $\frac{1}{273}$

B. 273

C. $\frac{2}{273}$

D. zero

Answer: d

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43. Which of the following instruments is used in the measurement of temperature above $2000^{\circ} C$?

A. Gas thermometer

B. Pyrometer

C. Bolometer

D. Thermo - electric Pile

Answer: b

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44. At $0^\circ C$, Pressure measured by barometer is 760 mm. What will be the pressure at $100^\circ C$?

A. 760

B. 730

C. 780

D. none of these

Answer: d

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45. The temperature on the new scale, corresponding to a temperature of $39^\circ C$ on the celsius scale?

A. $73^\circ W$

B. $117^\circ W$

C. $200^\circ W$

D. $139^\circ W$

Answer: b

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46. Two balloons are filled, one with pure He gas and the other with air. If the pressure and temperature in both the balloons are same the number of molecules per unit volume is

A. more in both the balloon.

B. more in the air filled balloon.

C. same in both the balloon.

D. in the ratio $1:4$

Answer: c

Watch Video Solution

47. Pressure of an ideal gas is increased by keeping temperature constant. What is the effect on the kinetic energy of molecules?

A. increase

B. no change

C. decrease till $4^{\circ}C$ and then increase.

D. can't be determined

Answer: b

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48. One mole of gas occupies a volume of 200 ml. at 100 mm pressure. What is the volume occupied by two moles of this gas at 400 mm pressure and at same temperature?

A. 50 ml

B. 100 ml

C. 200 ml

D. 400 ml

Answer: b

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49. There is a change in length when a 33000 N tensile force is applied on a steel rod of area of cross - section 10^{-3}. The change of temperature required to produce the same elongation, if the steel rod is heated, is (modulus of elasticity of

steel $= 3 \times 10^{11} N/m^2$, coefficient of linear expansion of steel $= 1.1 \times 10^{-5}/^\circ C$.....

A. $20^\circ C$

B. $15^\circ C$

C. $10^\circ C$

D. $0^\circ C$

Answer: c

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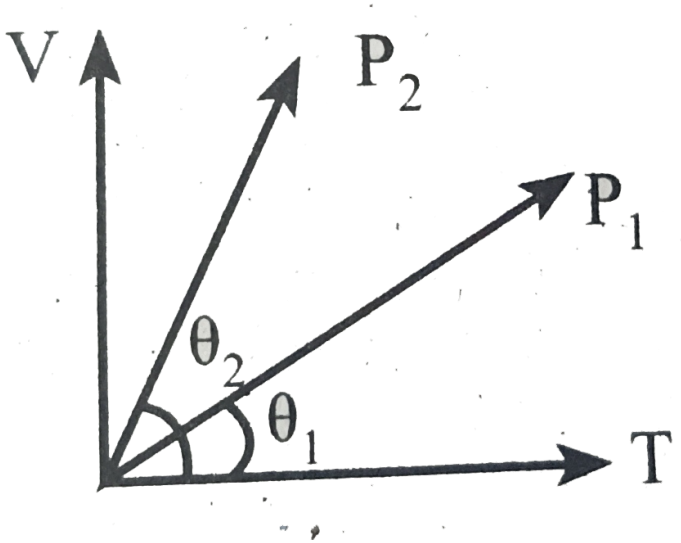
50. In the given (V-T) diagram , what is the relation between $P_1 \text{and} P_2$?



A. $P_2 = P_1$

B. $P_2 > P_1$

C. $P_2 < P_1$

D. cannot be predicted

Answer: c

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51. Boiling water is changing into steam.Under this condition the specific heat of water is ..... .

A. zero

B. one

C. infinite

D. less than one

Answer: c

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52. The first law of thermodynamics is concerned with the conservation of ..... .

A. number of molecules

B. energy

C. number of moles

D. temperature

Answer: b

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53. The gas law $\frac{PV}{T} = \text{constant is true for}$ ..... .

A. isothermal changes only

B. adiabatic changes only

C. both isothermal and adiabatic changes

D. neither isothermal nor adiabatic changes

Answer: c

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54. The pressure - temperature relationship for an ideal gas undergoing adiabatic change is ..... .

A. (a) $P^{1-\gamma}T^{\gamma} = \text{constant}$

B. (b) $P^{\gamma-1}T^{\gamma} = \text{constant}$

C. (c) $P^{\gamma}T^{1-\gamma} = \text{constant}$

D. (d) $P^{\gamma}T^{\gamma-1} = \text{constant}$

Answer: a

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

A. $C_V = 3R/J$

B. $C_P = 3R/J$

C. $C_V = 5R/J$

D. $C_P = 5R/J$

Answer: b

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56. Cooking takes longest time..... .

A. at the sea level

B. at Shimla

C. at mount Everest (if tried)

D. in a submarine 100 m below the surface of water.

Answer: c

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57. A closed bottle containing water at room temperature is taken to the moon and then the lid is opened. The water will ..... .

A. freeze

B. boil

C. decompose into hydrogen and oxygen

D. not change at all.

Answer: b

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58. A gas receives an amount of heat equal to 110 joules and performs 40 joules of work. The change in the internal energy of the gas is ..... .

A. 70 J

B. 150 J

C. 110 J

D. 40 J

Answer: a

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59. For a mono - atomic gas, the molar specific heat at constant pressure divided by the molar gas constant R, is equal to ..... .

A. 2.5

B. 1.5

C. 5.0

D. 3.5

Answer: a

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60. Heat capacity of a substance is infinite. It means ..... .

A. infinite heat is given out

B. infinite heat is taken in

C. no change in temperature whether heat is taken in or given out

D. all of these

Answer: c

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61. We consider a thermodynamic system. If ΔU represent the increase in the its energy and W the work done by the system, which of the following statements is true?

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

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

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

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

Answer: b

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62. The first operation involved in a carnot cycle is

A. isothermal expansion

B. adibatic expansion

C. isothermal compression

D. adiabatic compression

Answer: a

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63. During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature the ratio $\frac{C_p}{C_v}$ for the gas is

A. 2

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

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

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

Answer: d

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

A. The temperature will decrease.

B. the volume will decrease.

C. the pressure will remain constant.

D. the temperature will increase.

Answer: a

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65. In a carnot heat engine 8000J of heat is absorbed from a source at 400 K and 6500 J of heat is rejected to the sink. The temperature of the sink is ..... .

A. 325 K

B. 100 K

C. 200 K

D. 273 K

Answer: a

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66. 2 Kg of water of $60^{\circ}C$ is mixed with 1 kg of water at $30^{\circ}C$ kept in a vessel of heat capacity $220\ \mathrm{J\ K^{-1}}$. The specific heat of water is $4200\ \mathrm{J\ Kg^{-1}K^{-1}}$. Then the final temperature is nearly.

A. (a) $35^{\circ}C$

B. (b) $45^{\circ}C$

C. (c) $55^{\circ}C$

D. (d) $50^{\circ}C$

Answer: d

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67. A carnot engine absorbs heat at $127^\circ C$ and rejects heat at $87^\circ C$. The efficiency of engine is

A. $10\ \%$

B. $30\ \%$

C. $50\ \%$

D. $70\ \%$

Answer: a

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68. The first law of thermodynamics confirms the law of ..... .

A. conservation of momentum

B. conservation of energy

C. flow of heat in a particular direction

D. conservation of heat energy and mechanical energy

Answer: b

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69. The internal energy of an ideal gas depends on

A. only pressure

B. only volume

C. only temperature

D. none of these

Answer: c

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70. An ideal gas heat engine operators in a carnot's cycle between $227^\circ C$ and $127^\circ C$. It

absorbs $6 \times 10^4 J$ at high temperature. The amount of heat converted into work is ..... .

A. $2.4 \times 10^4 J$

B. $4.8 \times 10^4 J$

C. $1.2 \times 10^4 J$

D. $6 \times 10^4 J$

Answer: c

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71. In an isochoric process ..... .

A. $\Delta U = \Delta Q$

B. $\Delta Q = \Delta W$

C. $\Delta U = \Delta W$

D. None of these

Answer: a

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72. The molar specific heat at constant pressure of an ideal gas is $(7/2)R$. The ratio specific heats at

constant pressure to that at constant volume is ..... .

A. $8/7$

B. $5/7$

C. $9/7$

D. $7/5$

Answer: d

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73. If energy dQ is supplied to a gas isochorically, increase in interval in internal energy is dU. Then ..... .

A. $dQ \times dU$

B. $dQ < dU$

C. $dQ = dU$

D. $dQ = -dU$

Answer: c

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74. 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 increases from V to 32 V, the efficiency of the engine is ..... .

A. 0.25

B. 0.5

C. 0.75

D. 0.99

Answer: c

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75. The mechanical equivalent of heat J is :

A. a constant

B. a physical quantity

C. a conversion factor

D. none of the above

Answer: c

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76. Which of the following process is reversible ?

A. transfer of heat by radiation

B. Transfer of heat by conduction

C. Electrical heating of nichrome wire

D. Isothermal compression

Answer: d

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77. An ideal gas heat engine operators in a carnot's cycle between $227^\circ C$ and $127^\circ C$. It absorbs $6 \times 10^4 J$ at high temperature. The amount of heat converted into work is ..... .

A. 1.2×10^4 cal

B. 4.8×10^4 cal

C. 6×10^4 cal

D. 2.4×10^4 cal

Answer: a

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78. Ten moles of an ideal gas at constant temperature 600 K is compressed from 100l to 10L. The work done in the process is ..... .

A. $4.11 \times 10^4 J$

B. $-4.11 \times 10^4 J$

C. $11.4 \times 10^4 J$

D. $-11.4 \times 10^4 J$

Answer: d

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79. A gas is compressed at a constant pressure of $50N/m^2$ from a volume $4m^3$. Energy of 100 J is then added to the gas by heating. Its internal energy is ..... .

A. increased by 400 J

B. increased by 200 J

C. increased by 100 J

D. decreased by 200 J

Answer: a

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

A. $W = 0$

B. $Q = W = O$

C. $E = 0$

D. $Q = o$

Answer: c

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81. A carnot engine takes heat from a reservoir at $627^{\circ}C$ and rejects heat to a sink at $27^{\circ}C$. Its efficiency is

A. $3/5$

B. $1/3$

C. $2/3$

D. $200/209$

Answer: c

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82. A carnot engine operates with source at $127^{\circ} C$ and sink at $27^{\circ} C$. If the source supplies 40 KJ of heat energy, the work done by the engine is

A. 1 KJ

B. 4 KJ

C. 10 KJ

D. 30 KJ

Answer: c

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83. The ratio of the specific heats $\frac{C_P}{C_V} = \gamma$ in terms of degrees of freedom (n) is given by :

A. $\left(1 + \frac{n}{3}\right)$

B. $\left(1 + \frac{2}{n}\right)$

C. $\left(1 + \frac{n}{2}\right)$

D. $\left(1 + \frac{1}{n}\right)$

Answer: b

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84. The heat required to increase the temperature of 4 moles of a mono - atomic ideal gas from 273 K to 473 K constant volume is ..... .

A. 200 R

B. 400 R

C. 800 R

D. 1200 R

Answer: d

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85. The coefficient 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. $21^{\circ}C$

B. $31^{\circ}C$

C. $41^{\circ}C$

D. $11^{\circ}C$

Answer: b

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Additional Questions Solved 2 Marks Questions

1. What is meant by heating ?

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2. What is meant by 'temperature' ? Give its unit.

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3. Define the avogadro's number :

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4. Define thermal capacity.

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5. What is meant by the triple point of water?

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6. What do you meant by change of state of a substance ?

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7. Define coefficient of linear expansion. Give its unit.

Watch Video Solution

8. Define coefficient of area expansion? Give its unit.

Watch Video Solution

9. Define coefficient of Volume expansion ? Give its unit.

Watch Video Solution

10. What is meant by conduction ?

Watch Video Solution

11. What is meant by Convection ?

Watch Video Solution

12. What is meant by Radiation ? Give example.

Watch Video Solution

13. State Newton's law of cooling verify with an experiment.

Watch Video Solution

14. What do you meant by absolute zero temperature ?

Watch Video Solution

15. state prevost theory of heat exchnage .

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16. What is meant by 'Mechanical equilibrium ' ?

Watch Video Solution

17. What is meant by 'chemical equilibrium ' ?

Watch Video Solution

18. What is meant by 'thermodynamic equilibrium '.

Watch Video Solution

19. Define the quasi-static process.

Watch Video Solution

20. Specific heat capacity

Watch Video Solution

21. Define specific heat capacity at constant volume.

Watch Video Solution

22. Define molar specific heat capacity .

Watch Video Solution

23. Define specific heat capacity at constant prossure .

Watch Video Solution

24. What is a isobaric process ?

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25. Explain in detail the isochoric process.

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Additional Questions Solved Numerical Problems

1. The length of a metal wire is l_1 when the tension in it is T_1 and is l_2 when the tension is T_2. The natural length of the wire is:

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2. A Steel rod of length 25 cm has a cross - sectional area of $0.8cm^2$. The force required to stretch this rod by the same amount as the expansion produced by heating it through $10^\circ C$ is (coefficient of linear expansion of steel is

$10^{-5}/^{\circ}C$ and Young's modulus of steel is $2 \times 10^{10} N/m^2$)..... .

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3. The temperature at the bottom of a 40 m deap lake is $12^{\circ}C$ and that at the surface is $35^{\circ}C$. An air bubble of volume $1.0cm^3$ rises from the bottom to the surface. Find its volume. (atmospheric pressure = 10 m of water)

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4. A jar 'A' is filled with an ideal gas characterised by parameters P, V and T and another jar B is filled with an ideal gas with parameters $2P$. $\frac{V}{4}$. And 2T. Find the ratio of the number of molecules in jar A and B.

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5. By what percentage should the pressure of a given mass of a gas be increased so as to decrease its volume by $10\ \%$ at a constant temperature?

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6. A flask is filled with 13 g of an ideal gas at $27^\circ C$ and its temperature is raised to $52^\circ C$. Find the mass of the gas that has to be released to maintain the temperature of the gas in the flask at $52^\circ C$ and the pressure is same as the initial pressure.

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7. A rod of metal - 1 of length 50.0 cm elongates by 0.10 cm when it is heated from $0^\circ C$ to $100^\circ C$. Another rod of metal - 2 of length 80.0. cm

elongates by 0.08 cm for the same rise in temperature. A third rod of length 50.0 cm, made by welding pieces of rod 1 rad and 2 rad placed end to end, elongates by 0.03 cm when it is heated from $0^\circ C$ to $50^\circ C$. Then what is the length of metal - 1 in the third rod at $0^\circ C$?

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8. A balloon is filled at $27^\circ C$ and 1 atm pressure by $500m^3$ He. Then find the volume of He at $-3^\circ C$ and 0.5 mm Hg pressure.

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9. During an experiment an ideal gas is found to obey an additional law $VP^2 =$ constant. The gas is initially at temperature T and Volume V. Find the resulting temperature when it expands to volume 2V.

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10. 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 weights of A and B is :

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11. For a gas the difference between the two specific heates is 4150 J/Kg K. What is the specific heat of the gas at constant volume if the ratio of specific heat is 1.4?

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12. 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 $\gamma(= C_P / C_V)$ to be 1.5, find the new pressure of the gas.

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13. A carnot engine operating between temperature T_1 and T_2 has efficiency $\frac{1}{6}$. When T_2 is lowered by 62 K, its efficiency increases to $\frac{1}{3}$. Then find the values of T_1 and T_2.

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14. A perfect gas goes from state A to state B by absorbing $8 \times 10^5 J$ of heat and doing $6.5 \times 10^5 J$ of external work. It is now transferred between the same two states in another process in which it absorbs $10^5 J$ of heat. In second process. Find the work done in the second process.

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15. A Carnot engine having an efficiency of $\eta = \left(\frac{1}{10}\right)$ as a heat engine is used as a

refrigerators. If the work done on the system is 10 J, what is the amount of energy absorbed from the reservoir at lowest temperature ?

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

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