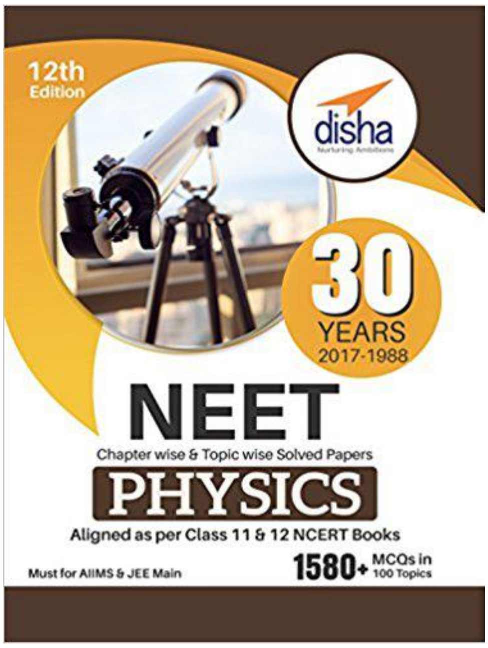
Previous Years Problems on Thermodynamics for NEET

This Chapter " Previous Years Problems on Thermodynamics for NEET" is taken from our Book:



ISBN : 9789386320636

Product Name : 30 Years NEET Chapter-wise & Topic-wise Solved Papers Physics (2017 - 1988)

Product Description : • NEET Chapter-wise + Topic-wise Solved Papers Physics is the thoroughly revised and updated 12th edition and it contains the past year papers of NEET 2017 to 1988 distributed in 28 Topics.

• The Questions have been arranged from 2017 to 1988 such that the students encounter the latest questions first. Further each chapter has been further divided into 3-4 topics each.

• The Topics have been arranged exactly in accordance to the NCERT books so as to make it 100 percent convenient to Class 11 and 12 students.

• The fully solved CBSE Mains papers of 2011 and 2012 (the only Objective CBSE Mains paper held) have also been incorporated in the book topic-wise.

• The book also contains NEET 2013 along with the Karnataka NEET 2013 paper.

• The detailed solutions of all questions are provided at the end of each chapter to bring conceptual clarity.

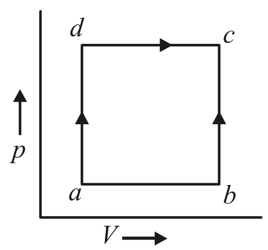
• The book contains around 1600+ milestone problems in Physics

Chapter

11 Thermodynamics

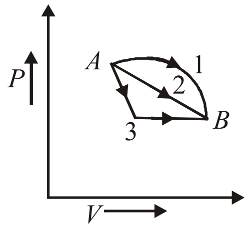
Topic 1: First Law of Thermodynamics

1. A system is taken from state a to state c by two paths adc and abc as shown in the figure. The internal energy at a is $U_a = 10$ J. Along the path adc the amount of heat absorbed $\delta Q_1 = 50$ J and the work done $\delta W_1 = 20$ J whereas along the path abc the heat absorbed $\delta Q_2 = 36$ J. The amount of work done along the path abc is **[NEET Kar. 2013]**



(a) 6 J (b) 10 J
(c) 12 J (d) 36 J

2. An ideal gas goes from state A to state B via three different processes as indicated in the P-V diagram : **[2012M]**



If Q_1, Q_2, Q_3 indicate the heat a absorbed by the gas along the three processes and ΔU_1, ΔU_2, ΔU_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 $\Delta U_1 > \Delta U_2 > \Delta U_3$

3. The internal energy change in a system that has absorbed 2 kcals of heat and done 500 J of work is: **[2009]**
(a) 6400 J (b) 5400 J
(c) 7900 J (d) 8900 J

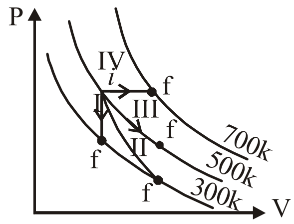
4. 110 joules of heat is added to a gaseous system whose internal energy is 40J. Then the amount of external work done is **[1993]**
(a) 150 J (b) 70 J
(c) 110 J (d) 40 J

5. Which of the following is not thermodynamical function ? **[1993]**
(a) Enthalpy (b) Work done
(c) Gibb's energy (d) Internal energy

6. First law of thermodynamics is consequence of conservation of **[1988]**
(a) work (b) energy
(c) heat (d) all of these

Topic 2: Specific Heat Capacity & Thermodynamic Processes

7. Thermodynamic processes are indicated in the following diagram : **[2017]**



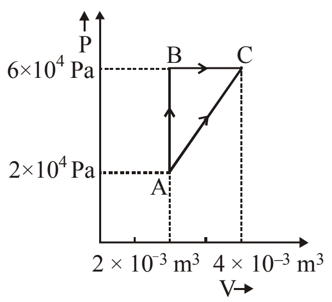
Match the following

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

(a) $P \rightarrow C, Q \rightarrow A, R \rightarrow D, S \rightarrow B$
(b) $P \rightarrow C, Q \rightarrow D, R \rightarrow B, S \rightarrow A$
(c) $P \rightarrow D, Q \rightarrow B, R \rightarrow A, S \rightarrow C$
(d) $P \rightarrow A, Q \rightarrow C, R \rightarrow D, S \rightarrow B$

8. A gas is compressed isothermally to half its initial volume. The same gas is compressed separately through an adiabatic process until its volume is again reduced to half. Then : ***[2016]***
(a) Compressing the gas isothermally will require more work to be done.
(b) Compressing the gas through adiabatic process will require more work to be done.
(c) Compressing the gas isothermally or adiabatically will require the same amount of work.
(d) Which of the case (whether compression through isothermal or through adiabatic process) requires more work will depend upon the atomicity of the gas.

9. Figure below shows two paths that may be taken by a gas to go from a state A to a state C.

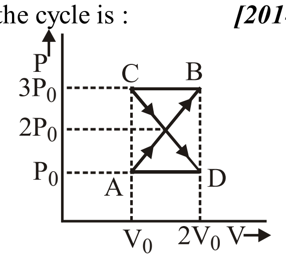


In process AB, 400 J of heat is added to the system and in process BC, 100 J of heat is added to the system. The heat absorbed by the system in the process AC will be ***[2015]***
(a) 500 J (b) 460 J
(c) 300 J (d) 380 J

10. An ideal gas is compressed to half its initial volume by means of several processes. Which of the process results in the maximum work done on the gas? ***[2015 RS]***
(a) Isobaric (b) Isochoric
(c) Isothermal (d) Adiabatic

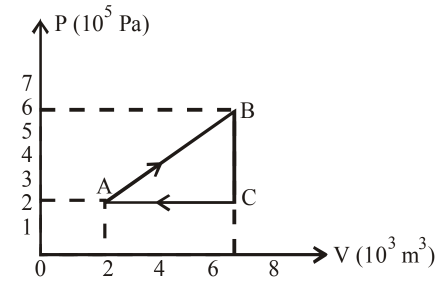
11. A monoatomic gas at a pressure P, having a volume V expands isothermally to a volume 2V and then adiabatically to a volume 16V. The final pressure of the gas is : (take $\gamma = \frac{5}{3}$) ***[2014]***
(a) 64P (b) 32P
(c) $\frac{P}{64}$ (d) 16P

12. A thermodynamic system undergoes cyclic process ABCDA as shown in fig. The work done by the system in the cycle is : ***[2014]***



(a) P_0V_0
(b) $2P_0V_0$
(c) $\frac{P_0V_0}{2}$
(d) Zero

13. A gas is taken through the cycle $A \rightarrow B \rightarrow C \rightarrow A$, as shown in figure. What is the net work done by the gas ? ***[2013]***

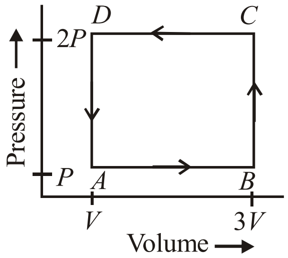


(a) 1000 J (b) zero
(c) – 2000 J (d) 2000 J

14. During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its temperature. The ratio of $\frac{C_p}{C_v}$ for the gas is ***[2013]***
(a) 2 (b) $\frac{5}{3}$
(c) $\frac{3}{2}$ (d) $\frac{4}{3}$

15. Which of the following relations does not give the equation of an adiabatic process, where terms have their usual meaning? ***[NEET Kar. 2013]***
(a) $P^{\gamma}T^{1-\gamma}$ = constant
(b) $P^{1-\gamma}\,T^{\gamma}$ = constant
(c) PV^{γ} = constant
(d) $TV^{\gamma-1}$ = constant

16. A thermodynamic system is taken through the cycle $ABCD$ as shown in figure. Heat rejected by the gas during the cyclic process is :**[2012]**

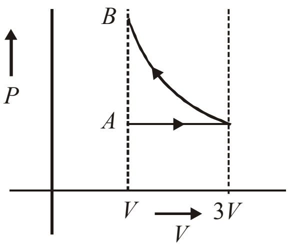


(a) 2PV (b) 4PV

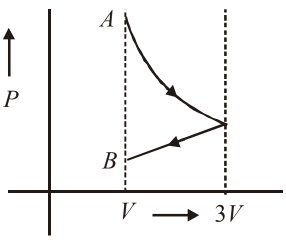
(c) $\frac{1}{2}$ PV (d) PV

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

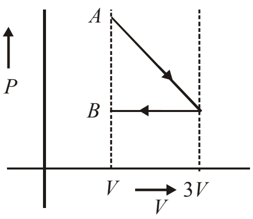
(a)



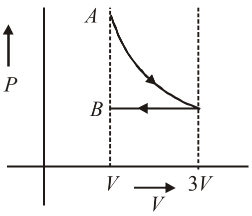
(b)



(c)



(d)



18. During an isothermal expansion, a confined ideal gas does –150 J of work against its surroundings. This implies that **[2011]**

(a) 150 J heat has been removed from the gas
(b) 300 J of heat has been added to the gas
(c) no heat is transferred because the process is isothermal
(d) 150 J of heat has been added to the gas

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

(a) 28 atm (b) 68.7 atm
(c) 256 atm (d) 8 atm

20. If ΔU and ΔW represent the increase in internal energy and work done by the system respectively in a thermodynamical process, which of the following is true? **[2010, 1998]**

(a) $\Delta U = -\Delta W,$ in an adiabatic process
(b) $\Delta U = \Delta W,$ in an isothermal process
(c) $\Delta U = \Delta W,$ in an adiabatic process
(d) $\Delta U = -\Delta W,$ in an isothermal process

21. In thermodynamic processes which of the following statements is not true? **[2009]**

(a) In an isochoric process pressure remains constant
(b) In an isothermal process the temperature remains constant
(c) In an adiabatic process PV^{γ} = constant
(d) In an adiabatic process the system is insulated from the surroundings

22. If Q, E and W denote respectively the heat added, change in internal energy and the work done in a closed cyclic process, then: **[2008]**

(a) W = 0 (b) Q = W = 0
(c) E = 0 (d) Q = 0

23. One mole of an ideal gas at an initial temperature of T K does 6R joules 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 gas will be **[2004]**

(a) $(T-4)K$ (b) $(T+2.4)K$
(c) $(T-2.4)K$ (d) $(T+4)K$

24. An ideal gas at 27ºC is compressed adiabatically to $\frac{8}{27}$ of its original volume. The rise in temperature is $\left(\gamma = \frac{5}{3}\right)$ *[1999]*
(a) 475ºC (b) 402ºC
(c) 275ºC (d) 175ºC

25. If the ratio of specific heat of a gas at constant pressure to that at constant volume is γ, the change in internal energy of a mass of gas, when the volume changes from V to $2V$ at constant pressure P, is *[1998]*
(a) $\frac{R}{(\gamma - 1)}$ (b) PV
(c) $\frac{PV}{(\gamma - 1)}$ (d) $\frac{\gamma PV}{(\gamma - 1)}$

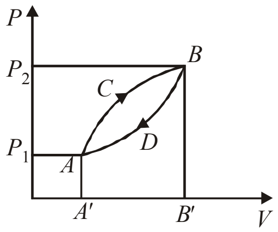
26. A sample of gas expands from volume V_1 to V_2. The amount of work done by the gas is greatest, when the expansion is *[1997]*
(a) adiabatic (b) isobaric
(c) isothermal (d) equal in all cases

27. An ideal gas undergoing adiabatic change has the following pressure-temperature relationship
(a) $P^{\gamma-1}T^{\gamma}$ = constant *[1996]*
(b) $P^{\gamma}T^{\gamma-1}$ = constant
(c) $P^{\gamma}T^{1-\gamma}$ = constant
(d) $P^{1-\gamma}T^{\gamma}$ = constant

28. A diatomic gas initially at 18ºC is compressed adiabatically to one eighth of its original volume. The temperature after compression will be
(a) 18ºC (b) 668.4ºK *[1996]*
(c) 395.4ºC (d) 144ºC

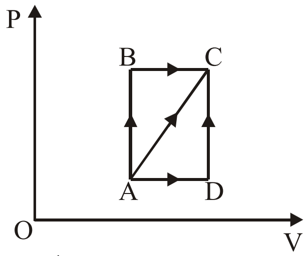
29. An ideal gas A and a real gas B have their volumes increased from V to $2V$ under isothermal conditions. The increase in internal energy
(a) will be same in both A and B *[1993]*
(b) will be zero in both the gases
(c) of B will be more than that of A
(d) of A will be more than that of B

30. A thermodynamic system is taken from state A to B along ACB and is brought back to A along BDA as shown in the PV diagram. The net work done during the complete cycle is given by the area *[1992]*



(a) $P_1ACBP_2P_1$ (b) $ACBB'A'A$
(c) $ACBDA$ (d) $ADBB'A'A$

31. A thermodynamic process is shown in the figure. The pressures and volumes corresponding to some points in the figure are



$P_A = 3 \times 10^4\ Pa$
$V_A = 2 \times 10^{-3}\ m^3$
$P_B = 8 \times 10^4\ Pa$
$V_D = 5 \times 10^{-3}\ m^3$.
In process AB, 600 J of heat is added to the system and in process BC, 200 J of heat is added to the system. The change in internal energy of the system in process AC would be *[1991]*
(a) 560 J (b) 800 J
(c) 600 J (d) 640 J

32. At 27° C a gas is compressed suddenly such that its pressure becomes (1/8) of original pressure. Final temperature will be ($\gamma = 5/3$)
(a) 420 K (b) 300K *[1989]*
(c) – 142°C (d) 327°C

Topic 3: Carnot Engine, Refrigerator & Second Law of Thermodynamics

33. A carnot engine having an efficiency of $\frac{1}{10}$ as heat engine, is used as a refrigerator. If the work done on the system is 10 J, the amount of energy absorbed from the reservoir at lower temperature is :- *[2017, 2015]*
(a) 90 J (b) 99 J
(c) 100 J (d) 1 J

34. A refrigerator works between 4°C and 30°C. It is required to remove 600 calories of heat every second in order to keep the temperature of the refrigerated space constant. The power required is: (Take 1 cal = 4.2 joules) ***[2016]***
(a) 2.365 W (b) 23.65 W
(c) 236.5 W (d) 2365 W

35. The coefficient of performance of a refrigerator is 5. If the inside temperature of freezer is –20°C, then the temperature of the surroundings to which it rejects heat is ***[2015 RS]***
(a) 41°C (b) 11°C
(c) 21°C (d) 31°C

36. 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? ***[NEET Kar. 2013]***
(a) $\frac{T_1 + T_2}{2}$ (b) $\frac{T_1 - T_2}{2}$
(c) $T_1 T_2$ (d) $\sqrt{T_1 T_2}$

37. When 1 kg of ice at 0°C melts to water at 0°C, the resulting change in its entropy, taking latent heat of ice to be 80 cal/°C, is ***[2011]***
(a) 273 cal/K (b) 8 × 104 cal/K
(c) 80 cal/K (d) 293 cal/K

38. An engine has an efficiency of 1/6. When the temperature of sink is reduced by 62°C, its efficiency is doubled. Temperature of the source is
(a) 37°C (b) 62°C ***[2007]***
(c) 99°C (d) 124°C

39. A Carnot engine whose sink is at 300 K has an efficiency of 40%. By how much should the temperature of source be increased so as to increase, its efficiency by 50% of original efficiency ? ***[2006]***
(a) 325 K (b) 250 K
(c) 380 K (d) 275 K

40. Which of the following processes is reversible? ***[2005]***
(a) Transfer of heat by conduction
(b) Transfer of heat by radiation
(c) Isothermal compression
(d) Electrical heating of a nichrome wire

41. An ideal gas heat engine operates in Carnot cycle between 227°C and 127°C. It absorbs 6 × 10^4 cals of heat at higher temperature. Amount of heat converted to work is ***[2005]***
(a) 4.8 × 10^4 cals (b) 6 × 10^4 cals
(c) 2.4 × 10^4 cals (d) 1.2 × 10^4 cals

42. A Carnot engine whose efficiency is 50% has an exhaust temperature of 500 K. If the efficiency is to be 60% with the same intake temperature, the exhaust temperature must be (in K) ***[2002]***
(a) 800 (b) 200
(c) 400 (d) 600

43. An ideal gas heat engine operates in a Carnot cycle between 227ºC and 127ºC. It absorbs 6 kcal at the higher temperature. The amount of heat (in kcal) converted into work is equal to ***[2002]***
(a) 1.2 (b) 4.8
(c) 3.5 (d) 1.6

44. The temperature of source and sink of a heat engine are 127ºC and 27ºC respectively. An inventor claims its efficiency to be 26%, then:
(a) it is impossible ***[2001]***
(b) it is possible with high probability
(c) it is possible with low probability
(d) data are insufficient.

45. A reversible engine converts one-sixth of the heat input into work. When the temperature of the sink is reduced by 62ºC, the efficiency of the engine is doubled. The temperatures of the source and sink are ***[2000]***
(a) 99ºC, 37ºC (b) 80ºC, 37ºC
(c) 95ºC, 37ºC (d) 90ºC, 37ºC

46. The efficiency of a Carnot engine operating between the temperatures of 100ºC and –23ºC will be ***[1997]***
(a) $\frac{100+23}{100}$ (b) $\frac{100-23}{100}$
(c) $\frac{373+250}{373}$ (d) $\frac{373-250}{373}$

47. An ideal carnot engine, whose efficiency is 40% receives heat at 500 K. If its efficiency is 50%, then the intake temperature for the same exhaust temperature is ***[1995]***
(a) 600 K (b) 700 K
(c) 800 K (d) 900 K

ANSWER KEY																	
1	(a)	**7**	(a)	**13**	(a)	**18**	(a) or (d)	**23**	(a)	**28**	(b)	**33**	(a)	**38**	(c)	**43**	(a)
2	(a)	**8**	(b)	**14**	(c)	**19**	(c)	**24**	(b)	**29**	(b)	**34**	(c)	**39**	(b)	**44**	(a)
3	(c)	**9**	(b)	**15**	(a)	**20**	(a)	**25**	(c)	**30**	(c)	**35**	(d)	**40**	(c)	**45**	(a)
4	(b)	**10**	(d)	**16**	(a)	**21**	(a)	**26**	(b)	**31**	(a)	**36**	(d)	**41**	(d)	**46**	(d)
5	(b)	**11**	(c)	**17**	(d)	**22**	(c)	**27**	(d)	**32**	(c)	**37**	(d)	**42**	(c)	**47**	(a)
6	(b)	**12**	(d)														

Hints & Solutions

1. (a) From first law of thermodynamics

$$Q_{\text{adc}} = \Delta U_{adc} + W_{adc}$$
$$50\text{ J} = \Delta U_{adc} + 20\text{ J}$$
$$\Delta U_{adc} = 30\text{ J}$$

Again, $Q_{abc} = \Delta U_{abc} + W_{abc}$

$$W_{abc} = Q_{abc} - \Delta U_{abc}$$
$$= Q_{abc} - \Delta U_{adc}$$
$$= 36\text{ J} - 30\text{ J}$$
$$= 6\text{ J}$$

2. (a) Initial and final condition is same for all process

$\Delta U_1 = \Delta U_2 = \Delta U_3$

from first law of thermodynamics

$\Delta Q = \Delta U + \Delta W$

Work done

$\Delta W_1 > \Delta W_2 > \Delta W_3$ (Area of P.V. graph)

So $\Delta Q_1 > \Delta Q_2 > \Delta Q_3$

3. (c) According to first law of thermodynamics

$Q = \Delta U + W$

$\Delta U = Q - W$

$= 2 \times 4.2 \times 1000 - 500 = 8400 - 500$

$= 7900$ J

4. (b) $\Delta Q = \Delta U + \Delta W$

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

5. (b) Work done is not a thermodynamical function.

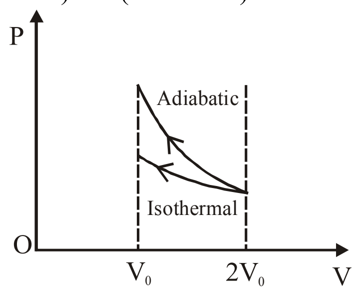
6. (b) The first law of thermodynamics is just a conservation of energy.

7. (a) Process I volume is constant hence, it is isochoric

In process IV, pressure is constant hence, it is isobaric

8. (b) W_{ext} = negative of area with volume-axis

W(adiabatic) > W(isothermal)



9. (b) In cyclic process ABCA

$Q_{cycle} = W_{cycle}$

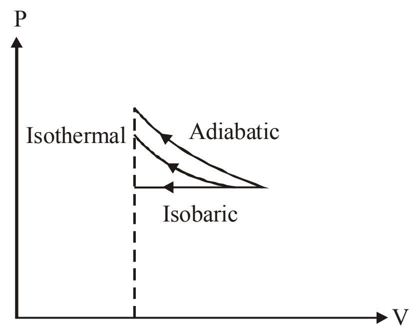
$Q_{AB} + Q_{BC} + Q_{CA}$ = ar. of ΔABC

$$+400 + 100 + Q_{C\to A} = \frac{1}{2}(2 \times 10^{-3})(4 \times 10^{4})$$

$\Rightarrow \quad Q_{C\to A} = -460$ J

$\Rightarrow \quad Q_{A\to C} = +460$ J

10. (d) Since area under the curve is maximum for adiabatic process so, work done (W = PdV) on the gas will be maximum for adiabatic process



11. (c) For isothermal process $P_1V_1 = P_2V_2$

$\Rightarrow$ $PV = P_2(2V) \Rightarrow P_2 = \frac{P}{2}$

For adiabatic process

$P_2V_2^\gamma = P_3V_3^\gamma$

$\Rightarrow \left(\frac{P}{2}\right)(2v)^\gamma = P_3 16v)^\gamma$

$\Rightarrow P_3 = \frac{3}{2}\left(\frac{1}{8}\right)^{5/3} = \frac{P}{64}$

12. (d) Work done by the system in the cycle

= Area under P-V curve and V-axis

$= \frac{1}{2}(2P_0 - P_0)(2V_0 - V_0) + \left[-\left(\frac{1}{2}\right)(3P_0 - 2P_0)(2V_0 - V_0)\right]$

$= \frac{P_0V_0}{2} - \frac{P_0V_0}{2} = 0$

13. (a) W_{net} = Area of triangle ABC

$= \frac{1}{2} AC \times BC$

$= \frac{1}{2} \times 5 \times 10^{-3} \times 4 \times 10^5 = 1000$ J

14. (c) According to question $P \propto T^3$

But as we know for an adiabatic process the pressure $P \propto T^{\frac{\gamma}{\gamma-1}}$.

So, $\frac{\gamma}{\gamma - 1} = 3 \Rightarrow \gamma = \frac{3}{2}$ or, $\frac{C_p}{C_v} = \frac{3}{2}$

15. (a) Adiabatic equations of state are

PV^γ = constant

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

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

16. (a) $\because$ Internal energy is the state function.

$\therefore$ In cyclie process; $\Delta U = 0$

According to 1st law of thermodynamics

$\boxed{\Delta Q = \Delta U + W}$

So heat absorbed

$\Delta Q = W$ = Area under the curve

$= -(2V)(P) = -2PV$

So heat rejected = 2PV

17. (d) 1st process is isothermal expansion which is only correct shown in option (d)

2nd process is isobaric compression which is correctly shown in option (d)

18. (a) or (d)

If a process is expansion then work done is positive so answer will be (a).

But in question work done by gas is given –150J so that according to it answer will be (d).

19. (c) $T_1 = 273 + 27 = 300$K

$T_2 = 273 + 927 = 1200$K

For adiabatic process,

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

$\Rightarrow P_1^{1-\gamma} T_1^\gamma = P_2^{1-\gamma} T_2^\gamma$

$\Rightarrow \left(\frac{P_2}{P_1}\right)^{1-\gamma} = \left(\frac{T_1}{T_2}\right)^\gamma$

$\Rightarrow \left(\frac{P_1}{T_2}\right)^{1-\gamma} = \left(\frac{T_2}{T_1}\right)^\gamma$

$\left(\frac{P_1}{P_2}\right)^{1-1.4} = \left(\frac{1200}{300}\right)^{1.4}$

$\left(\frac{P_1}{P_2}\right)^{-0.4} = (4)^{1.4}$

$\left(\frac{P_2}{P_1}\right)^{0.4} = 4^{1.4}$

$P_2 = P_1 4^{\left(\frac{1.4}{0.4}\right)} = P_1 4^{\left(\frac{7}{2}\right)}$

$= P_1 (2^7) = 2 \times 128 = 256$ atm

20. (a) By first law of thermodynamics,

$\Delta Q = \Delta U + \Delta W$

In adiabatic process, $\Delta Q = 0$

$\therefore \quad \Delta U = -\Delta W$

In isothermal process, $\Delta U = 0$

$\therefore \quad \Delta Q = \Delta W$

21. (a) In an isochoric process volume remains constant whereas pressure remains constant in isobaric process.

22. (c) In a cyclic process, the initial state coincides with the final state. Hence, the change in internal energy is zero, as it depends only on the initial and final states. But Q & W are non-zero during a cycle process.

23. (a) $T_1 = T$, $W = 6R$ joules, $\gamma = \frac{5}{3}$

$$W = \frac{P_1V_1 - P_2V_2}{\gamma - 1} = \frac{nRT_1 - nRT_2}{\gamma - 1}$$

$$= \frac{nR(T_1 - T_2)}{\gamma - 1}$$

$$n = 1, T_1 = T \Rightarrow \frac{R(T - T_2)}{5/3 - 1} = 6R$$

$\Rightarrow T_2 = (T{-}4)$K

24. (b) T = 27°C = 300 K

$$\gamma = \frac{5}{3};\quad V_2 = \frac{8}{27}V_1;\quad \frac{V_1}{V_2} = \frac{27}{8}$$

From adiabatic process we know that

$$T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$$

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} = \left(\frac{27}{8}\right)^{\frac{5}{3}-1}$$

$$\frac{T_2}{T_1} = \frac{9}{4} \Rightarrow T_2 = \frac{9}{4} \times T_1 = \frac{9}{4} \times 300 = 675\,K$$

$T_2 = 675 - 273$°C = 402°C

25. (c) Change in internal energy is equal to work done in adiabatic system

$\Delta W = -\Delta U$ (Expansion in the system)

$$= -\frac{1}{\gamma - 1}(P_1V_1 - P_2V_2)$$

$$\Delta U = \frac{1}{1-\gamma}(P_2V_2 - P_1V_1)$$

Here, $V_1 = V, V_2 = 2V$

$$\therefore\quad \Delta U = \frac{1}{1-\gamma}[P \times 2V - PV] = \frac{PV}{1-\gamma}$$

$$\Rightarrow \Delta U = -\frac{PV}{\gamma - 1}$$

26. (b) In thermodynamics for same change in volume, the work done is maximum in isobaric process because in $P - V$ graph, area enclosed by curve and volume axis is maximum in isobaric process.

So, the choice (b) is correct.

27. (d) We know that in adiabatic process,

PV^{γ} = constant ....(1)

From ideal gas equation, we know that

$PV = nRT$

$V = \frac{nRT}{P}$ ....(2)

Puttingt the value from equation (2) in equation (1),

$$P\left(\frac{nRT}{P}\right)^{\gamma} = \text{constant}$$

$P^{(1-\gamma)}\, T^{\gamma}$ = constant

28. (b) Initial temperature (T_1) = 18°C = 291 K

Let Initial volume $(V_1) = V$

Final volume $(V_2) = \frac{V}{8}$

According to adiabatic process,

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

According to question, $T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$

$$\Rightarrow T_2 = 293\left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$\Rightarrow T_2 = 293(8)^{\frac{7}{5}-1} = 293 \times 2.297 = 668.4\text{K}$$

$$\left[\text{For diatomic gas } \gamma = \frac{C_p}{C_v} = \frac{7}{5}\right]$$

29. (b) Under isothermal conditions, there is no change in internal energy.

30. (c) Work done = Area under curve $ACBDA$

31. (a) Since AB is an isochoric process, so, no work is done. BC is isobaric process,

$\therefore\ W = P_B \times (V_D - V_A) = 240$ J

$\Delta Q = 600 + 200 = 800$ J

Using $\Delta Q = \Delta U + \Delta W$

$\Rightarrow \Delta U = \Delta Q - \Delta W = 800 - 240 = 560$ J

32. (c) $T_1^{\gamma} P_1^{1-\gamma} = T_2^{\gamma} P_2^{1-\gamma}$

$$\Rightarrow \left(\frac{T_2}{T_1}\right)^{\gamma} = \left(\frac{P_1}{P_2}\right)^{1-\gamma}$$

$$\Rightarrow T_2 = T_1 \cdot \left(\frac{P_1}{P_2}\right)^{\frac{1-\gamma}{\gamma}} = 300 \times (8)^{-2/5} = 142\text{°C}$$

33. (a) Given, efficiency of engine, $\eta = \frac{1}{10}$

work done on system W = 10J

Coefficient of performance of refrigerator

$$\beta = \frac{Q_2}{W} = \frac{1-\eta}{\eta} = \frac{1-\frac{1}{10}}{\frac{1}{10}} = \frac{\frac{9}{10}}{\frac{1}{10}} = 9$$

Energy absorbed from reservoir

$Q_2 = \beta w$

$Q_2 = 9 \times 10 = 90\,J$

34. (c) Coefficient of performance of a refrigerator,

$$\beta = \frac{Q_2}{W} = \frac{T_2}{T_1 - T_2}$$

(Where Q_2 is heat removed)

Given: $T_2 = 4°C = 4 + 273 = 277\,k$

$T_1 = 30°C = 30 + 273 = 303\,k$

$$\therefore \quad \beta = \frac{600 \times 4.2}{W} = \frac{277}{303 - 277}$$

$\Rightarrow \quad W = 236.5$ joule

Power $P = \frac{W}{t} = \frac{236.5\,\text{joule}}{1\,\text{sec}} = 236.5$ watt.

35. (d) Coefficient of performance,

$$\text{Cop} = \frac{T_2}{T_1 - T_2}$$

$$5 = \frac{273 - 20}{T_1 - (273 - 20)} = \frac{253}{T_1 - 253}$$

$5T_1 - (5 \times 253) = 253$

$5T_1 = 253 + (5 \times 253) = 1518$

$\therefore T_1 = \frac{1518}{5} = 303.6$

or, $T_1 = 303.6 - 273 = 30.6 \cong 31°C$

36. (d) Efficiency of engine *A*, $\eta_1 = 1 - \frac{T}{T_1}$,

Efficiency of engine *B*, $\eta_2 = 1 - \frac{T_2}{T}$

Here, $\eta_1 = \eta_2$

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

37. (d) Change in entropy is given by

$$dS = \frac{dQ}{T} \text{ or } \Delta S = \frac{\Delta Q}{T} = \frac{mL_f}{273}$$

$$\Delta S = \frac{1000 \times 80}{273} = 293\,\text{cal/K}.$$

38. (c) Since efficiency of engine is $\eta = 1 - \frac{T_2}{T_1}$

According to problem,

$$\frac{1}{6} = 1 - \frac{T_2}{T_1} \quad \text{..........(1)}$$

When the temperature of the sink is reduced by 62°C, its efficiency is doubled

$$2\left(\frac{1}{6}\right) = 1 - \frac{T_2 - 62}{T_1} \quad \text{..........(2)}$$

Solving (1) and (2) $T_2 = 372\,K$

$T_1 = 99°C =$ Temperature of source.

39. (b) We know that efficiency of Carnot Engine

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

where, T_1 is temp. of source & T_2 is temp. of sink

$$\therefore \quad 0.40 = \frac{T_1 - 300}{T_1} \Rightarrow T_1 - 300 = 0.40T_1$$

$$0.6T_1 = 300 \Rightarrow T_1 = \frac{300}{.6} = \frac{3000}{6} = 500K$$

Now efficiency to be increased by 50%

$$\therefore \quad 0.60 = \frac{T_1 - 300}{T_1} \Rightarrow T_1 - 300 = 0.6T_1$$

$$0.4T_1 = 300 \Rightarrow T_1 = \frac{300}{.4} = \frac{300 \times 10}{4} = 750$$

Increase in temp $= 750 - 500 = 250\,K$

40. (c) For a process to be reversible, it must be quasi-static. For quasi static process, all changes take place infinitely slowly. Isothermal process occur very slowly so it is quasi-static and hence it is reversible.

41. (d) We know that

efficiency of carnot engine =

$$1 - \frac{T_2}{T_1} = 1 - \frac{400}{500} = \frac{1}{5}$$

[$\because T_1 = (273+227)\text{K} = 500\text{ K}$
and $T_2 = (273+127)\text{K} = 400\text{ K}$]

Efficiency of Heat engine $= \dfrac{\text{Work output}}{\text{Heat input}}$

or, $\dfrac{1}{5} = \dfrac{\text{work output}}{6\times10^4}$
$\Rightarrow$ work output $= 1.2 \times 10^4$ cal

42. (c) $\eta = 1 - \dfrac{T_2}{T_1}$ or $\dfrac{50}{100} = 1 - \dfrac{500}{T_1}$

$\Rightarrow T_1 = 1000\ K$

Also, $\dfrac{60}{100} = 1 - \dfrac{T_2}{1000} \Rightarrow T_2 = 400\ K$

43. (a) Efficiency $= \dfrac{T_1 - T_2}{T_1}$

$T_1 = 227 + 273 = 500\text{ K}$

$T_2 = 127 + 273 = 400\text{ K}$

$\eta = \dfrac{500-400}{500} = \dfrac{1}{5}$

Hence, output work

$= (\eta) \times \text{Heat input} = \dfrac{1}{5} \times 6 = 1.2\text{ kcal}$

44. (a) $\eta = 1 - \dfrac{300}{400} = \dfrac{100}{400} = \dfrac{1}{4}$

$\eta = \dfrac{1}{4} \times 100 = 25\%$

Hence, it is not possible to have efficiency more than 25%.

45. (a) Initially the efficiency of the engine was $\dfrac{1}{6}$ which increases to $\dfrac{1}{3}$ when the sink temperature reduces by 62° C.

$\eta = \dfrac{1}{6} = 1 - \dfrac{T_2}{T_1}$, when T_2 = sink temperature

T_1 = source temperature

$\Rightarrow T_2 = \dfrac{5}{6}T_1$

Secondly,

$\dfrac{1}{3} = 1 - \dfrac{T_2 - 62}{T_1} = 1 - \dfrac{T_2}{T_1} + \dfrac{62}{T_1} = 1 - \dfrac{5}{6} + \dfrac{62}{T_1}$

or, $T_1 = 62 \times 6 = 372\text{K} = 372 - 273 = 99^\circ\text{C}$

& $T_2 = \dfrac{5}{6} \times 372 = 310\text{ K} = 310 - 273 = 37^\circ\text{ C}$

46. (d) $\eta = 1 - \dfrac{T_1}{T_2}$

$T_1 = -23^\circ\text{C} = 250\text{ K},\ T_2 = 100^\circ\text{C} = 373\text{K}$

$\eta = 1 - \dfrac{250}{373} = \dfrac{373-250}{373}$

47. (a) Efficiency of carnot engine (η_1) = 40% = 0.4; Initial intake temperature (T_1) = 500K and new efficiency (η_2) = 50% = 0.5.

Efficiency $(\eta) = 1 - \dfrac{T_2}{T_1}$ or $\dfrac{T_2}{T_1} = 1 - \eta$.

Therefore in first case, $\dfrac{T_2}{500} = 1 - 0.4 = 0.6$.

$\Rightarrow T_2 = 0.6 \times 500 = 300\text{K}$

And in second case, $\dfrac{300}{T_1} = 1 - 0.5 = 0.5$

$\Rightarrow T_1 = \dfrac{300}{0.5} = 600\ K$