1. In the above problem, the useful work done by the engine is -

(a) 100 joule (b) 500 joule
(c) 1000 joule (d) 150 joule

2. A Carnot engine works between ice point and steam point. Its efficiency will be -

(a) 26.81 % (b) 53.36 %
(c) 71.23 % (d) 85.42 %

3. A Cannot engine works between 200ºC and 0ºC. Another Carnot engine works between 0ºC and –200ºC. In both cases the working substance absorbs 4 kilocalories of heat from the source. The efficiency of first engine will be –

(a) $\frac{100}{473}$ (b) $\frac{200}{473}$
(c) $\frac{200}{273}$ (d) $\frac{273}{373}$

4. In the above problem, the efficiency of second engine will be –

(a) $\frac{100}{273}$ (b) $\frac{173}{273}$
(c) $\frac{200}{273}$ (d) $\frac{273}{373}$

5. In the above problem, the output work of second engine is

(a) 2.93×10^3 calorie (b) 8.4×10^3 calorie
(c) 2×10^3 joule (d) 2.93×10^3 Joule

6. Even Carnot engine cannot give 100% efficiency because we cannot :
(a) prevent radiation
(b) find ideal sources
(c) reach absolute zero temperature
(d) eliminate friction

7. In a Carnot engine, low temperature of reservoir (sink) is 7°C. Its efficiency is 50%. To increase efficiency to 70% by how much temperature of source is to be raised, keeping the temperature of sink constant.
(a) 840 K (b) 280 K
(c) 560 K (d) 373 K

8. Which statement is incorrect ?

(a) All reversible cycles have same efficiency
(b) Reversible cycle has more efficiency than an irreversible one
(c) Carnot cycle is a reversible one
(d) Carnot cycle has the maximum efficiency in all cycles

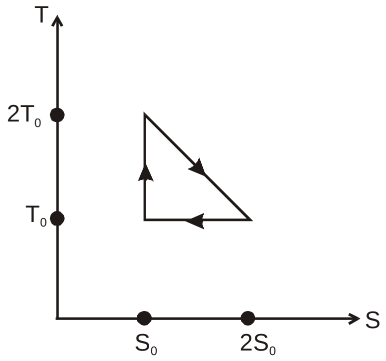
9. An ideal gas heat engine operates in Cannot cycle between 227ºC and 127ºC. It absorbs 6×10^4 cal of heat at higher temperature. Amount of heat converted to work is :

(a) 2.4×10^4 cal (b) 6×10^4 cal
(c) 1.2×10^4 cal (d) 4.8×10^4 cal

10. 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 :

(a) 275 K (b) 325 K
(c) 250 K (d) 380 K

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



(a) $\frac{1}{2}$ (b) $\frac{1}{4}$
(c) $\frac{1}{3}$ (d) $\frac{2}{3}$

12. The work of 146 kJ is performed in order to compress one kilo mole of a gas adiabatically and in this process the temperature of the gas increases by 7 ºC. The gas is

($R = 8.3\ J\ mol^{-1}\ K^{-1}$)
(a) diatomic
(b) triatomic
(c) mixture of monoatomic and diatomic
(d) monoatomic

13. The coefficient of performance of a carnot refrigertor working between 30° C and 0° C is

(a) 10 (b) 1
(c) 9 (d) 0

14. An Ideal gas heat engine operated in a carnot's cycle between 227° C and 127° C . It absorbs 6×10^4 J at high temperature. The amount of heat converted into work is

(a) 4.8×10^4 J (b) 3.5×10^4 J
(c) 1.6×10^4 J (d) 1.2×10^4 J

15. Efficiency of carnot engine is 100% if

(a) $T_2 = 273$ K (b) $T_2 = 0$ K
(c) $T_1 = 273$ K (d) $T_1 = 0$ K

16. A Carnot engine operates between 227° C and 27°C. Efficiency of the engine will be

(a) $\frac{1}{3}$ (b) $\frac{2}{5}$
(c) $\frac{3}{4}$ (d) $\frac{3}{5}$

17. A scientist says that the efficiency of his heat engine which operates at source temperature 127°C and sink temperature 27° C is 26% then

(a) It is impossible
(b) It is possible but less probable
(c) It is quite probable
(d) Data are incomplete]

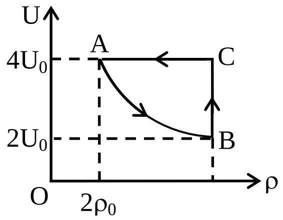
18. If an ideal flask containing hot coffee is shaken, the temperature of the coffee will :

(a) decrease
(b) increase
(c) remain same
(d) decrease if temperature is below 4ºC and increase if temperature is equal to or more than 4ºC

19. A heat engine employing a Carnot cycle with an efficiency of η = 10% is used as a refrigerating machine, the thermal reservoirs being the same. The refrigerating efficiency $\in$ is

(a) 12 (b) 8
(c) $\frac{1}{10}$ (d) 9

20. Figure shows the variation of internal energy 'U' with the density of one mole of monoatomic gas for a thermodynamic cycle ABCA. AB process is a rectangular hyperbola. The amount of work done in the process A $\rightarrow$ B is :



(a) $\frac{2U_0}{3}$ (b) $-\frac{2U_0}{3}$ (c) $\frac{4U_0}{3}$ (d) $-\frac{4U_0}{3}$

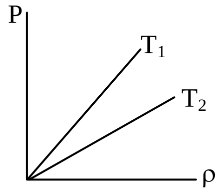
21. For nitrogen $C_P - C_V = x$ and for argon, $C_P - C_V = y$. The relation between x and y is given by -

(a) x = y (b) x = 7y (c) y = 7x (d) $x = \frac{1}{2}y$

22. An ideal gas is found to obey an additional law VP^2 = constant. The gas is initially at temperature T and volume V. When it expends to a volume 2 V, the temperature becomes-

(a) $T/\sqrt{2}$ (b) 2T (c) $2T\sqrt{2}$ (d) 4 T

23. The Fig. shows graphs of pressure versus density for an ideal gas at two temperatures T_1 and T_2. Then from the graph -



(a) $T_1 = T_2$ (b) $T_1 > T_2$
(c) $T_1 < T_2$ (d) nothing can be predicted

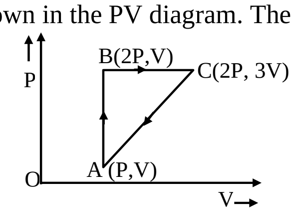
24. 10 g of ice at 0^0C is mixed with 100 g of water at 50^0 C. What is the resultant temperature of mixture?
(a) 31.2^0C (b) 32.8^0C (c) 36.7^0C (d) 38.2^0C

25. 80 g of water at 30^0C are poured on a large block of ice at 0^0C. The mass of ice that melts is -
(a) 1600 g (b) 30 g (c) 150 g (d) 80 g

26. Heat required to convert 1 gm of ice at 0^0C into steam at 100^0C is -
(a) 100 cal (b) 0.01 kilo calorie
(c) 720 cal (d) 1 kilo calorie

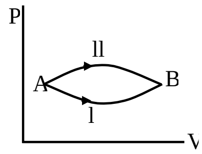
27. A gas expands adiabatically at constant pressure such that its temperature $T \propto 1/\sqrt{V}$. The value of $\gamma = (C_P / C_V)$ of the gas is
(a) 1.30 (b) 1.50 (c) 1.67 (d) 2.00

28. An ideal gas is taken through a cycle ABCA as shown in the PV diagram. The work done during the cycle is –



(a) $\frac{1}{2}$ PV (b) 2 PV (c) 4 PV (d) PV

29. 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)$\Delta U_2 < \Delta U_1$
(b)$\Delta U_2 > \Delta U_1$
(c) Relation between ΔU_1 and ΔU_2 cannot be determined
(d) $\Delta U_1 = \Delta U_2$

30. In the above que., work done during the cyclic process ABCDA is
(a) 1600 J (b) 1500 J (c) 600 J (d) 900 J

1. (b) $\frac{\text{Work done}}{\text{Total Heat given}} \times 100 = \eta$

$W = \frac{50}{100} \times 1000 = 500$ J

2. (a) $\eta = \left(1 - \frac{T_2}{T_1}\right) \times 100$ $T_2 = 0°C = 273$ K

$= \left(1 - \frac{273}{373}\right) \times 100$ $T_1 = 100°C = 373$ K

$= 26.81\%$

3. (b) $\eta = \left(1 - \frac{T_2}{T_1}\right) \times 100 = \left(1 - \frac{273}{473}\right) \times 100$

$= \frac{200}{473} \times 100$ in % or $\eta = \frac{200}{473}$ in fraction

4. (c) $\eta = \left(1 - \frac{T_2}{T_1}\right) \times 100 = \left(1 - \frac{73}{273}\right) = \frac{200}{273}$

5. (a)Work = output of second engine

$W_2 = \text{Heat given} \times \eta_1$

$= \frac{4 \times 10^3 \times 200}{273}$ cal

$= 2.93 \times 10^3$ cal.

6. (c) The efficiency of Carnot engine is,

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

Where T_1 is the temperature of the source and T_2 that of sink.

Since, $\frac{T_2}{T_1} = \frac{Q_2}{Q_1}$ So, $\eta = 1 - \frac{Q_2}{Q_1}$

To obtain 100% efficiency (i.e., $\eta = 1$), Q_2 must be zero that is, if a sink at absolute zero would be available, all the heat taken from the source would have been converted into work. The temperature of sink means a negative temperature on the absolute scale at which the efficiency of engine is greater than unity. This would be a violation of the 2nd law of thermodynamics. Hence, a negative temperature on the absolute scale is impossible. Hence, we cannot reach absolute zero temperature.

7. (d) Initially $\eta = \frac{T_1 - T_2}{T_1}$ $\Rightarrow$ $0.5 = \frac{T_1 - (273 + 7)}{T_1}$

$\Rightarrow$ $\frac{1}{2} = \frac{T_1 - 280}{T_1}$ $\Rightarrow$ $T_1 = 560K$

Finally $\eta_1' = \frac{T_1' - T_2}{T_1}$ $\Rightarrow$ $0.7 = \frac{T_1' - (273+7)}{T_1'}$ $\Rightarrow$ $T_1' = 933K$

Increase in temperature =933-560 = 273K

8. (a)Efficiency of all reversible cycles depends upon temperature of source and sink which will be different.

9. (c) The heat converted to work is the amount of heat that remains after going through sink.

From the relation

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

Given $Q_1 = 6 \times 10^4$ cal,

$T_1 = 227 + 273 = 500K$

$T_2 = 127 + 273 = 400\ K$

$\therefore \quad \frac{Q_2}{6 \times 10^4} = \frac{400}{500} \quad \Rightarrow \quad Q_2 = \frac{4}{5} \times 6 \times 10^4 = 4.8 \times 10^4$ cal

Now, heat converted to work = $Q_1 - Q_2$

$= 6.0 \times 10^4 - 4.8 \times 10^4$

$= 1.2 \times 10^4$ cal

Note : Carnot cycle consists of following four stages :

(i) Isothermal expansion (ii) Adiabatic expansion

(iii) isothermal compression (iv) Adiabatic compression

After doing the calculations for different processes, we achieve the relation

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

10. (c) The efficiency of Carnot engine is defined as the ratio of work done to the heat supplied i.e.,

$$\eta = \frac{\text{Work done}}{\text{Heat supplied}} \frac{\text{fd; kx; k dk; Z}}{\text{i zÙkÅ'ek}} = \frac{W}{Q_1} = \frac{Q_1 - Q_2}{Q_1}$$

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

Here, T_1 is the temperature of source and T_2 is the temperature of sink

As given, $\eta = 40\% = \frac{40}{100} = 0.4$

and $T_2 = 300K$

So, $0.4 = 1 - \frac{300}{T_1} \Rightarrow T_1 = \frac{300}{1-0.4} = \frac{300}{0.6} = 500K$

Let temperature of the source be increased by xK, then efficiency becomes

$\eta' = 40\% + 50\%$ of η

$= \frac{40}{100} + \frac{50}{100} \times 0.4$

$= 0.4 + 0.5 \times 0.4 = 0.6$

Hence, $0.6 = 1 - \frac{300}{500+x} \Rightarrow \frac{300}{500+x} = 0.4 \Rightarrow 500 + x = \frac{300}{0.4} = 750$

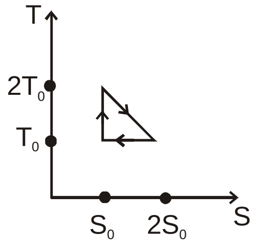
$\therefore \quad x = 750 - 500 = 250$ K

11. (c) According to the figure

$Q_1 = T_0S_0 + \frac{1}{2} T_0S_0 = \frac{3}{2} T_0S_0$

$Q_2 = T_0 (2S_0 - S_0) = T_0S_0$

$Q_3 = 0$



$\eta = \frac{W}{Q_1}$

$= \frac{Q_1 - Q_2}{Q_1}$

$= 1 - \frac{Q_2}{Q_1} = 1 - \frac{2}{3} = \frac{1}{3}$

12. (a)For adiabatic :), $W = \frac{P_1V_1 - P_2V_2}{\gamma - 1} = \frac{nR(T_1 - T_2)}{\gamma - 1}$

Putting values, we get $\gamma = 1.4$, hence diatomic.

13. (c) $K = \frac{T_2}{T_1 - T_2} = \frac{273}{303 - 273} = \frac{273}{30} = 9$

14. (d) $\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{400}{500} = \frac{1}{5} \therefore \eta = \frac{W}{Q} \Rightarrow \frac{1}{5} = \frac{W}{Q} \Rightarrow W = \frac{Q}{5} = \frac{6}{5} \times 10^4 = 1.2 \times 10^4 J$

15. (b) $\eta = 1 = \frac{T_2}{T_1}$ for 100% effocoemcu $\eta = 1$ which gives $T_2 = 0$ K.

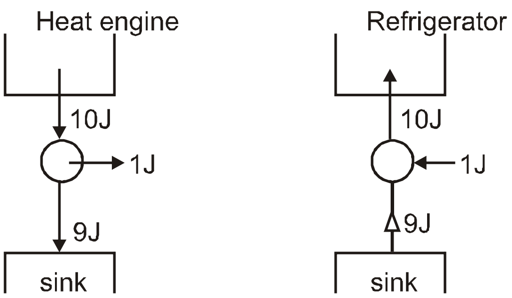
16. (b) $\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{300}{500} = \frac{2}{5}$

17. (a) $\eta_{max} = 1 - \frac{T_2}{T_1} = 1 - \frac{300}{400} = \frac{1}{4} = 25\%$

So 26 % efficiency is impossibel

18. (b)We know that there is no loss of heat in an ideal flask. Therefore mechanical energy wasted in shaking, is changed into heat energy and hence, temperature rises.

19. (d)



$\varepsilon = \frac{9}{1} = 9$

20. (d)

For the process $A \rightarrow B$

$U \alpha \frac{1}{\rho} \quad \Rightarrow \frac{3}{2} RT \, \alpha \frac{1}{\frac{M}{v}}$

Or $T \, \alpha \, V$

So AB is isobaric process (Pressure is constant)

$T_A = \frac{8U_0}{3R}$ [As $4U_0 = 3/2 \, RT_A$]

$V_A = \frac{M}{2\rho_0}$

So $p_A = \frac{16U_0\rho_0}{3M}$ & $V_B = \frac{M}{4\rho_0}$

So $W_{AB} = p[v_B - v_A]$

$\Rightarrow \quad \frac{16U_0\rho_0}{3M}\left[\frac{M}{4\rho_0} - \frac{M}{2\rho_0}\right] = -\frac{16U_0\rho_0}{3M} \times \frac{M}{4\rho_0}$

$\Rightarrow \; -\frac{4U_0}{3}$

21. (a)

$\therefore$ Both are molar specific heat

that's why x = y

22. (a)

$PV = nRT \; \therefore \; P = \frac{nRT}{V}$

VP^2 & wnT

23. (b)

$\frac{P}{V} = \frac{RT}{M}$

24. (d)

Heat given by water = 100 × (50–θ)

& heat taken by ice = 10 × 80 + 10 (θ – 0)

$\Rightarrow 100 \times (50 - \theta) = 80 + 10 (\theta)$

$\Rightarrow \theta = 38.2\,^0C$

25. (b)

80 × m = 80 × 30 × 1

m = 30 gm

26. (c)

$Q = 1 \times 80 + 1 \times 1 \times 100 + 1 \times 540$

$= 720$ cal

27. (b)

In adiabatic

$T V^{\gamma-1} = \text{Constant}$ & $T \propto V^{-\frac{1}{2}}$

$\therefore \gamma - 1 = +\frac{1}{2}$ $\therefore \gamma = \frac{3}{2} = 1.50$

28. (d)

Area under P–V curve

29. (d)

$PV = nRT = \frac{m}{M.W}.RT$

30. (b)

Area of Trapezium

$= \frac{1}{2} \times [3] \times 10^2 = 1.5 \times 10^2 = 1500$ J