JEE MAIN ANSWER KEY & SOLUTIONS

SUBJECT :- PHYSICS
CLASS :- 11th **PAPER CODE :- CWT-12**
CHAPTER :- KTG & THERMODYNAMICS

ANSWER KEY

1.	(B)	**2.**	(A)	**3.**	(C)	**4.**	(B)	**5.**	(B)	**6.**	(A)	**7.**	(A)
8.	(C)	**9.**	(A)	**10.**	(A)	**11.**	(C)	**12.**	(C)	**13.**	(B)	**14.**	(D)
15.	(C)	**16.**	(C)	**17.**	(D)	**18.**	(C)	**19.**	(A)	**20.**	(D)	**21.**	159
22.	500	**23.**	2.5kJ	**24.**	300m	**25.**	7730	**26.**	72	**27.**	750	**28.**	2
29.	900	**30.**	20										

SOLUTIONS

1. (B)

Sol. For adiabatic process dQ = 0

dQ = 0

$\therefore$ dU + dW = 0

or $\frac{dW}{dU} = -1$

2. (A)

Sol. Efficiency of all reversible cycles depends upon temperature of source and sink which will be different.

3. (C)

Sol. Tr. K.E. = $\frac{3}{2}nRT = \frac{3}{2}PV$

$\frac{E_{Tr}}{V} = \frac{3}{2}P$

$E = \frac{3}{2}P$

4. (B)

Sol From the conservation of the energy we have , Initial internal energy= Dissociation energy + final internal energy

$\frac{5}{2}\times 4\times 2\times 500$

$= 2000 + \frac{3}{2}\times 2\times 2\times T' + \frac{5}{2}\times 3\times 2\times T'$

$T' = \frac{8000}{21} = 100\ T$

T = 4

5. (B)

Sol. $\Delta Q = M,S,\Delta T$

$= 100 \times 10^{-3} \times 4.184 \times 20$

$= 8.4 \times 10^{3}$

$\Delta Q = 8.4$ kJ, $\Delta W = 0$

$\Delta Q = \Delta u + \Delta W$

$\therefore$ $\Delta u = 8.4$ kJ. **Ans.**

6. (A)

Sol. From first law of thermodynamics,

$Q = \Delta U + W$

For path iaf,

$50 = \Delta U + 20$

$\therefore$ $\Delta U = U_f - U_i = 30$ cal

For path ibf,

or $Q = \Delta U + W$

$W = Q - \Delta U$

$= 36 - 30 = 6$ cal.

7. (A)

Sol. According to Mayer's relation,

$C_p - C_v = \frac{R}{m} = \frac{R}{28}$

8. (C)

Sol. Work does not characterize the thermodynamic state of matter, it is a path function gives only relationship between two quantities.

9. (A)

Sol. $\frac{dP}{P} = -\gamma\frac{dV}{V}$ (For adiabatic

$0.5 = -1.4\frac{dV}{V}$

$\therefore$ Volume decrease by 0.36%

10. (A)

Sol. We know that for ideal gas $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (at constant pressure)

$\Rightarrow T_2 = \frac{V_2}{V_1} \times T_1 = \frac{3V}{V} \times 273$

$= 3 \times 273$ K

$\Rightarrow$ $T_2 = 819\text{ K} = 819 - 273$

$= 546°C$

11. (C)

Sol. $\Delta U = Q = 1^2 \times 100 \times 5 \times 60\text{ J} = 30\text{ KJ}$

12. (C)

Sol. $V_{av} = \sqrt{\frac{8KT}{\pi m}}$, as T = constant

$\therefore \quad V_{av}$ = constant

13. (B)

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

$$T_1 V^{\frac{7}{5}-1} = T_2(32V)^{\frac{7}{5}-1}$$

$$\frac{T_2}{T_1} = \frac{1}{(32)^{2/5}} = \frac{1}{4}$$

$$\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{1}{4} = \frac{3}{4}$$

14. (D)

Sol. dQ = dW + dU

dQ = PdV + dU

dQ = nRdT + dU

$$dQ = \frac{2dU}{f} + dU$$

$$\frac{dU}{dQ} = \frac{1}{\left(\frac{2}{f}+1\right)}$$

$$\frac{dU}{dQ} = \frac{5}{7}$$

15. (C)

Sol. Efficiency of the Carnot engine is given by

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

where T_1 = temperature of source

T_2 = temperature of sink

Given η = 50% = 0.5, T_2 = 500 K

Substituting in relation (i), we have

$$0.5 = 1 - \frac{500}{T_1} \quad \text{or} \quad \frac{500}{T_1} = 0.5$$

$$\therefore \quad T_1 = \frac{500}{0.5} = 1000 \text{ K}$$

Now, the temperature of sink is changed to T_2 and the efficiency becomes 60% i.e., 0.6.

Using relation (i), we get

$$0.6 = 1 - \frac{T_2}{1000}$$

$$\text{or } \frac{T_2}{1000} = 1 - 0.6 = 0.4 \text{ or}$$

T_2 = 0.4 × 1000 = 400 K

16. (C)

Sol. PV^{γ} = constant

T_1 = 273 + 27 = 300K

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

T_2 = 273 + 927 = 1200K

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

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

$\Rightarrow 2^{1-1.4}(300)^{1.4} = P_2^{1-1.4}.(1200)^{1.4}$

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

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

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

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

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

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

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

17. (D)

Sol. The rms velocity of the molecule of a gas of molecular weight M at kelvin temperature T is given by,

$$C_{rms} = \sqrt{\left(\frac{3\,RT}{M}\right)}$$

Let M_O and M_H are molecular weights of oxygen and hydrogen and T_O and T_H the corresponding Kelvin temperature at which C_{rms} is same for both gases.

$C_{rms(O)} = C_{rms(H)}$

$$\sqrt{\left(\frac{3\,RT_O}{M_O}\right)} = \sqrt{\left(\frac{3\,RT_H}{M_H}\right)}$$

$$\text{Hence, } \frac{T_O}{M_O} = \frac{T_H}{M_H}$$

T_O = 273 + 47 = 320 K

M_O = 32, M_H = 2

$$\therefore T_H = \frac{2}{32} \times 320 = 20 \text{ K}$$

18. (C)

Sol. Adiabatic Bulk modulus $B = -V\dfrac{dP}{dV}$

$= \gamma P = \gamma \dfrac{nRT}{V}$

$\therefore \dfrac{B_i}{B_f} = \dfrac{T_0}{V_0} \times \dfrac{V}{T} = \dfrac{T_0}{V_0} \times \dfrac{V_0/8}{4T_0} = \dfrac{1}{32}$

19. (A)

Sol. Number of moles of He = $\dfrac{1}{4}$

Now $T_1 (5.6)^{\gamma-1} = T_2 (0.7)^{\gamma-1}$

$T_1 = T_2\left(\dfrac{1}{8}\right)^{2/3}$

$4T_1 = T_2$

Work done $= -\dfrac{nR[T_2 - T_1]}{\gamma - 1}$

$= -\dfrac{\frac{1}{4}R[3T_1]}{\frac{2}{3}} = -\dfrac{9}{8}RT_1$

20. (D)

Sol. $\dfrac{v_{Rms_{He}}}{v_{Rms_{Ar}}} = \dfrac{\sqrt{\dfrac{3RT}{m_{He}}}}{\sqrt{\dfrac{3RT}{m_{Ar}}}}$

$= \sqrt{\dfrac{m_{Ar}}{m_{He}}} = \sqrt{\dfrac{40}{4}} = \sqrt{10} \approx 3.16$

21. 159

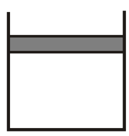
Sol. $kl_0 = 10^5 A$

$\left(10^5 + \dfrac{kx}{A}\right) = P = \left(10^5 + \dfrac{l_0}{5A}\right) = 1.2 \times 10^5$

$V = V_0 + Ax = A(l_0 + x) = 1.2\, V_0$

$= 1.2\, Al_0 \Rightarrow x = \dfrac{l_0}{5A} \qquad \dfrac{P_0V_0}{T_0} = \dfrac{PV}{T}$

$T = \dfrac{PV}{P_0V_0}T_0 = \dfrac{1.2 \times 10^5 \times 1.2V_0}{10^5 \times V_0} \times 273$



$\Rightarrow 300 \times 1.44 = 432K$

$\Rightarrow T = 432 - 273 = 159\ °C$

22. 500

Sol. $\dfrac{\text{Work done}}{\text{Total Heat given}} \times 100 = \eta$

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

23. 2.5 kJ

Sol. $W_{gas} + W_{spring} + W_{after} = 0$

$W_{gas} - \dfrac{1}{2} \times 25 \times 10^3 \times$

$(0.2)^2 - 10^5 \times 0.05 \times 0.4 = 0$

$W_{gas} = 2500\ T = 2.5\ kJ]$

24. 300 m/s

Sol. R.M.S. value for the four molecules is

$= \sqrt{\dfrac{(100)^2 + (100)^2 + (300)^2 + (500)^2}{4}}$

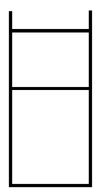
$= 100\sqrt{\dfrac{1+1+9+25}{4}}$ m/s

= 300 m/s Ans.]

25. 7730 K

26. 72

Sol. $(p_0 + h_{\rho g})\, v_0 = (p_0 - h_{\rho g})v$



$(H + 8) \times 4 = (H - 8) \times 5$

$4H + 32 = 5H - 40$

$72 = H$

27. 750

Sol. $W = W_1\left[\dfrac{1-(p_2 - p_0)^2}{(p_0 - p_1)^2}\right] \simeq 750J]$

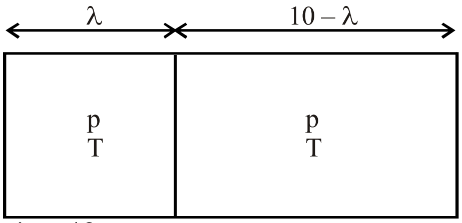
28. 2

Sol. $PV_1 = n_1RT$

$PA\ell = \frac{m}{32}RT$

$PA(10 - \ell) = \frac{m}{8}RT$

$\frac{\ell}{10-\ell} = \frac{1}{4}$



$4\ell = 10 - \ell$

$\ell = 2$ cm]

29. 900

Sol. $(p_0 + 100) \times 400 = (p_0 - 100) \times 500$

$100p_0 = 100 \times 900$

$p_0 = 900$ m

30. 20

Sol. $p_i = p_0 + \frac{kx}{A} = 2 \times 10^5$ P

$p_f = 2 \times 10^5 + 10^6 x$

$v_i = 1A$

$v_f = (1 + x)A$

$\frac{PV}{T}$ = const.

$$\frac{2\times10^5 \times 1A}{T_0} = \frac{2\times10^5 + 10^6 x}{2T_0} \times (1 + x)A$$

$$2.4 = \frac{(2+10x)(1+x)}{2}$$

$2.4 = (1 + 5x)(1 + x)$

$2.4 = 1 + 5x^2 + 6x$

$5x^2 + 6x - 1.4 = 0$

$$x = \frac{-6+\sqrt{36+4\times5\times1.4}}{10} = 0.2 \text{ m} = 20 \text{ cm}$$