1. $\therefore q \propto R^2T^4$

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ice melt = 8 (mass of steam)

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$$A_r = \sqrt{\left(A - A\cos 60^\circ\right)^2 + \left(A\cos 30^\circ\right)^2} = A$$

6. $v=\sqrt{\frac{T}{\mu}}=\sqrt{\frac{\lambda xg}{\lambda}}=\sqrt{xg}$
$$v\frac{dv}{dx}=a=\text{constant}$$

7. $v=\sqrt{\frac{\gamma RT}{M}} \Rightarrow \frac{v_1}{v_2}=\sqrt{\frac{\gamma_1 M_2}{M_1\gamma_2}}$
$$=\sqrt{\frac{7}{5}\times\frac{3}{5}\times\frac{40}{32}}=\sqrt{\frac{21}{25}\times\frac{5}{4}}=\sqrt{\frac{21}{20}}$$

8. $PV = nRT \Rightarrow \frac{PdV}{PV}=\frac{nRdT}{nRT} \Rightarrow \alpha=\frac{dV}{VdT}=\frac{1}{T}$

9. $\Delta x=(\pi-2)r=n\lambda=n\frac{2v}{f} \quad \therefore f=n=\frac{2v}{r(\pi-2)}$

10. $T=\mu v^2=\mu\frac{\omega^2}{k^2}=0.04\frac{\left(\frac{2\pi}{0.04}\right)^2}{\left(\frac{2\pi}{0.50}\right)}=6.25N$

11. Pattern shown in the figure is standing wave Hence particles at position A and B are in phase.

12. $I=\frac{P}{4\pi r^2} \Rightarrow I \propto \frac{1}{r^2} \Rightarrow I \propto A^2 \Rightarrow A^2 \propto \frac{1}{r^2} \Rightarrow A \propto \frac{1}{r}$

13. x = Asin(ky - ωt) is the equation of travelling wave along positive y-direction.

14. $f_0+72=4f_0 \Rightarrow f_0=\frac{72}{3}=24Hz$

15. $K = 10\pi \Rightarrow 2\pi/\lambda = 10\pi \Rightarrow \lambda = 0.2$ m.

16. $-\frac{20}{1}=K\left(\frac{70+50}{2}-30\right) \Rightarrow K=-\frac{2}{3}$
$$-\frac{10}{t}=-\frac{2}{3}\left(\frac{50+40}{2}-30\right) \Rightarrow t = 1 \text{ minute}$$

17. $\frac{KA(20-T)}{2L}+\frac{KA(40-T)}{L}=\frac{KA(T-0)}{2L}$
on solving T = 25°C

18. $f_1=\frac{4v}{2\ell}, f_2=\frac{7v}{4\ell}, f_3=\frac{3v}{2\ell}, f_4=\frac{5v}{4\ell}$
$f_1 : f_2 : f_3 : f_4 = 8:7:6:5$

19. $\frac{\Delta f}{f}=\frac{1}{2}\frac{\Delta T}{T} \qquad \therefore \frac{\Delta f}{400}=\frac{1}{2}\left(\frac{2}{100}\right)$
$\therefore \Delta f = 4Hz$

20. $y = 2A\sin kx \cos\omega t$
This is an equation of standing wave with maximum amplitude 2A
Maximum particle velocity
$v_p = \omega \times \text{amplitude} = \omega \times 2A = 2A$

21. $\frac{k_1A_1+k_2A_2}{A_1+A_2}=\frac{k_1+2k_2}{3}$

22. $\frac{I_1}{I_2}=\frac{f_1^2}{f_2^2}\cdot\frac{A_1^2}{A_2^2}=\frac{25}{16}$

23. $\frac{l_2+e}{l_1+e}=3 \Rightarrow \frac{48+e}{15+e}=3$
$48+e=45+3e \Rightarrow e=1.5cm$

24. $Q_P=nC_P(T_2-T_1) \Rightarrow 140=n\frac{7}{2}R(T_2-T_1)$
$w=nR(T_2-T_1)=40J$

25. $PV^{5/3}=\text{constant}$

26. $\Delta U=0$ (for cyclic process) Q = W

27. $C_P=C_V+R=\frac{5}{2}R \qquad \therefore \gamma=\frac{C_P}{C_V}=\frac{5}{3}$
So $P \propto T^{\frac{\gamma}{\gamma-1}} \propto T^{\frac{5}{2}}$

28. Slope $\propto \gamma \qquad \Rightarrow \gamma_2 > \gamma_1$
(Mono) (Diatomic)

29. Mean free path $(\lambda)=\frac{1}{\sqrt{2}\pi nd^2}$

30. $E_{Trans}=\frac{3}{2}PV$

31. $v_{rms}=\sqrt{\frac{v_1^2+v_2^2+v_3^2+v_4^2}{4}}$
$$=\sqrt{\frac{1^2+2^2+6^2+8^2}{4}}=\sqrt{\frac{105}{4}}$$

32. $PV = nRT \Rightarrow P=\frac{nRT}{V}$
$P \propto T$ it means V is constant.

33. $\frac{1}{5}=1-\frac{T_L}{T_H} \Rightarrow \frac{1}{3}=1-\frac{(T_L-50)}{T_H}$

$$\frac{T_L}{T_H}=\frac{4}{5},T_H=\frac{5}{4}T_L \Rightarrow \frac{1}{3}=1-\frac{T_L-50}{\frac{5}{4}T_L} \Rightarrow T_L=300K$$

34. $v_{r.m.s.}=\sqrt{\frac{3RT}{M}} \Rightarrow v_{r.m.s.}=\sqrt{\frac{3PV}{m}}$

$$\frac{(v_{r.m.s.})_B}{(v_{r.m.s.})_A}=\sqrt{\frac{4\times4}{2\times1}}=2\sqrt{2}:1$$

35. $\beta=\frac{T_2}{T_1-T_2}=\frac{Q_2}{w} \Rightarrow \frac{273}{30}=\frac{Q_2}{1} \Rightarrow Q_2 \simeq 9J$

36. $W = 2P_0V_0 \Rightarrow Q_{supplied} = Q_{AB} + Q_{BC}$

$$Q_{AB}=\frac{2P_0V_0}{\left(\frac{5}{3}-1\right)} \Rightarrow Q_{AB}=\frac{6P_0V_0}{2}=3P_0V_0$$

$$Q_{BC}=\frac{\frac{5}{3}\times3P_0V_0}{\frac{5}{3}-1} \Rightarrow Q_{BC}=\frac{15P_0V_0}{2}$$

$$Q_{supplied}=3P_0V_0+\frac{15P_0V_0}{2}=\frac{21P_0V_0}{2} \Rightarrow \eta=\frac{2P_0V_0}{\frac{21P_0V_0}{2}}=\frac{4}{21}$$

37. Work done = Area of triangle

$$=\frac{1}{2}\times v\times 2P=PV$$

38. $\eta=1-\frac{300}{400}=\frac{1}{4}=\frac{w}{Q_1} \Rightarrow w=\frac{Q_1}{4}=10kJ$

39. Area under P-V graph from A to B is equal to work done.

$$\Delta W \ \& =\left(\frac{150+100}{2}\right)\times10^5\times(900-600)$$

$$=3.75\times10^9 \text{ J}$$

40. $PV = nRT \Rightarrow V = nRT/P \Rightarrow T/P = V \Rightarrow V_2 > V_1$

41. $300=T\left(\frac{8}{27}\right)^{\frac{2}{3}}$ $\quad \therefore T=300\times\frac{9}{4}=675K$

Rise $=675-300=375K$

42. Volume is increasing therefore work done will always increase.

43. $C_P-C_V=R$ and $\gamma=\frac{C_P}{C_V};\gamma C_V-C_V=R \Rightarrow C_V=\frac{R}{\gamma-1}$

44. $PV=nRT$ $\quad$ ($n=$ no. of moles)

$$n=\frac{\text{Mass of gas}}{\text{Molar mass}}=\frac{10}{32} \Rightarrow PV=\frac{10}{32}RT$$

45. Work done during process BC by gas

= Area below graph

$$=-\frac{1}{2}(20+50)\times(6-2)=-140 \text{ J}$$

By first law of thermodynamics to the process BC

$Q = \Delta U + W \Rightarrow 60 = \Delta U + (-140) \quad \therefore \Delta U = 200$ J

i.e. $U_C - U_B = 200$ J

$U_C - 50 = 200 \text{ J} \Rightarrow U_C = 250$ J

Answer–Key

1.	4	**2.**	2	**3.**	1	**4.**	1	**5.**	1	**6.**	4	**7.**	1	**8.**	2	**9.**	1	**10.**	4
11.	1	**12.**	3	**13.**	1	**14.**	3	**15.**	1	**16.**	1	**17.**	1	**18.**	3	**19.**	4	**20.**	4
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41.	2	**42.**	3	**43.**	3	**44.**	4	**45.**	3	**46.**	2	**47.**	3	**48.**	4	**49.**	2	**50.**	1
51.	3	**52.**	3	**53.**	4	**54.**	4	**55.**	1	**56.**	3	**57.**	4	**58.**	3	**59.**	4	**60.**	4
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141.	2	**142.**	2	**143.**	4	**144.**	3	**145.**	1	**146.**	2	**147.**	1	**148.**	4	**149.**	2	**150.**	2
151.	2	**152.**	3	**153.**	1	**154.**	3	**155.**	2	**156.**	4	**157.**	2	**158.**	3	**159.**	2	**160.**	1
161.	2	**162.**	4	**163.**	2	**164.**	3	**165.**	4	**166.**	2	**167.**	1	**168.**	1	**169.**	3	**170.**	3
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151.	3	**152.**	1	**153.**	3	**154.**	2	**155.**	4	**156.**	2	**157.**	3	**158.**	3	**159.**	2	**160.**	3
161.	2	**162.**	1	**163.**	4	**164.**	1	**165.**	1	**166.**	1	**167.**	3	**168.**	3	**169.**	2	**170.**	1
171.	2	**172.**	2	**173.**	2	**174.**	2	**175.**	4	**176.**	3	**177.**	1	**178.**	2	**179.**	1	**180.**	4