MCQ 50 marks

1. **C.** 38.60 m

Explanation: Let the depth be h and g = 9.8 ms^{-2}

Here, $T_1 = 277\,K$, $T_2 = 293\,K$, $V_2 = 5V_1$, $P_2 = P_a = 1.013 \times 10^5\,Pa$

Pressure at the bottom, $P_1 = P_a + h\rho g = 1.013 \times 10^5 + 9780.4h$

Again, $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

So, $P_1 = \frac{1.013\times10^5\times5\times277}{293} = 478841.30\,Pa$

Therefore, $h = \frac{478841.30-101300}{9780.4} = 38.60\,m$

2. **A.** 85.23 cm Hg

Explanation: The total number of moles is conserved, so $\frac{P_0(V_1+V_2)}{RT_0} = \frac{P'V_1}{RT_1'} + \frac{P'V_2}{RT_2'}$

Here, $T_0 = 293\,K$, $T_1' = 373\,K$, $T_2' = 293\,K$

Given, $\frac{70\times600}{293} = P'(\frac{500}{373} + \frac{100}{293})$

Or, $143.345 = 1.68178P'$

Therefore, $P' = 85.23$ cm Hg

3. **D.** 900 m^3

Explanation: $V_2 = \frac{P_1V_1T_2}{P_2T_1}$

Here, $T_1 = 300\,K$, $T_2 = 270\,K$

So, $V_2 = \frac{1\times500\times270}{0.5\times300}$

Therefore, $V_2 = 900\,m^3$

4. **B.** 2.5×10^{25}

Explanation: $N = \frac{PVN_A}{RT}$, with P and V fixed in an open room

So, $\Delta N = n_i - n_f = \frac{PVN_A}{R}(\frac{1}{T_i} - \frac{1}{T_f})$

Here, $T_i = 290\,K$, $T_f = 300\,K$, $N_A = 6.023 \times 10^{23}\,mol^{-1}$

Therefore, $\Delta N = \frac{1\times10^5\times30\times6.023\times10^{23}}{8.314} \times \frac{10}{290\times300} \approx 2.5 \times 10^{25}$

A negative value is wrong because molecules leave the room on heating, so $n_i > n_f$.

5. **C.** 329°C

Explanation: $c_{rms} = \sqrt{\frac{3RT}{M}}$, and the condition gives $\frac{T_{SO_2}}{M_{SO_2}} = \frac{T_{O_2}}{M_{O_2}}$

Here, $M_{SO_2} = 64$, $M_{O_2} = 32$, $T_{O_2} = 301\,K$

So, $T_{SO_2} = \frac{64}{32} \times 301 = 602\,K$

Therefore, $T = 602 - 273 = 329°C$

602 is in kelvin, not Celsius; 301 K is the temperature of O_2.

6. **D.** 141255.91 K

Explanation: Given, $c_{rms} = v_{esc}$, so $\sqrt{\frac{3kT}{m}} = \sqrt{2gR_e}$

So, $T = \frac{2mgR_e}{3k}$

Here, $g = 9.8\,ms^{-2}$, $R_e = 6.37 \times 10^6\,m$, $k = 1.37 \times 10^{-23}\,JK^{-1}$

Therefore, $T = \frac{2\times4.65\times10^{-26}\times9.8\times6.37\times10^6}{3\times1.37\times10^{-23}} = \frac{5.8056\times10^{-18}}{4.11\times10^{-23}} = 141255.91\,K$

7. **B.** 1.62×10^4 J

Explanation: $E = \frac{f}{2}nRT$, where $T = 300\,K$

Helium, $E_1 = \frac{3}{2} \times 1 \times 8.314 \times 300 = 3741.3\,J$

Oxygen, $E_2 = \frac{5}{2} \times 2 \times 8.314 \times 300 = 12471\,J$

Therefore, $E = 3741.3 + 12471 = 16212.3\,J \approx 1.62 \times 10^4\,J$

8. **C.** $\lambda_2 = \frac{2}{3}\lambda_1$

Explanation: $\lambda = \frac{kT}{\sqrt{2}\pi\sigma^2P}$, so $\lambda \propto \frac{T}{P}$

Here, $\frac{\lambda_2}{\lambda_1} = \frac{T_2}{T_1} \times \frac{P_1}{P_2} = 2 \times \frac{1}{3}$

Therefore, $\lambda_2 = \frac{2}{3}\lambda_1$

9. **A. The root mean square speed will be 9.5 ms^{-1} greater than the average speed**

Explanation: Here, $c_{avg} = \frac{24+104+114}{3} = 80.67\,ms^{-1}$

Again, $c_{rms} = \sqrt{\frac{24^2+104^2+114^2}{3}} = \sqrt{\frac{24388}{3}} = 90.16\,ms^{-1}$

So, $c_{rms} - c_{avg} = 90.16 - 80.67 \approx 9.5\,ms^{-1}$

Therefore, $c_{rms} > c_{avg}$ and the difference is 9.5 ms^{-1}

10. **D.** $2.344 \times 10^{20}\,cm^{-3}$

Explanation: $\lambda = \frac{1}{\sqrt{2}\pi\sigma^2n_V}$, so $n_V = \frac{1}{\sqrt{2}\pi\sigma^2\lambda}$

Here, $\sigma = 2.0 \times 10^{-8}\,cm$, $\lambda = 2.4 \times 10^{-6}\,cm$

So, $n_V = \frac{1}{1.4142\times3.1416\times4.0\times10^{-16}\times2.4\times10^{-6}}$

Therefore, $n_V \approx 2.34 \times 10^{20}\,cm^{-3}$

11. **B.** 13.5°C

Explanation: $\theta = \theta_1 - G(\theta_1 - \theta_2)$

Here, $\theta_1 = 30°C$, $\theta_2 = 20°C$, $G = 1.65$

So, $\theta = 30 - 1.65 \times 10 = 30 - 16.5$
Therefore, $\theta = 13.5°C$

12. **D.** 2.06×10^5 Pa
Explanation: Absolute pressure in Feni, $P_1 = 1.8 \times 10^5 + 1.0 \times 10^5 = 2.8 \times 10^5$ Pa
Here, $T_1 = 303$ K, $T_2 = 288$ K, volume constant
So, $P_2 = P_1 \times \frac{T_2}{T_1} = 2.8 \times 10^5 \times \frac{288}{303} = 2.66 \times 10^5$ Pa
Therefore, gauge pressure $= 2.66 \times 10^5 - 0.6 \times 10^5 = 2.06 \times 10^5$ Pa
2.66×10^5 Pa is the absolute pressure, not the gauge pressure.

13. **A.** $3.125 \times 10^6\ m^3 s^{-4}$
Explanation: Let $P = c_{rms} c_{avg} c_{mp} = \sqrt{\frac{48}{\pi}}(\frac{RT}{M})^{3/2}$
So, $\frac{dP}{dT} = 6\sqrt{\frac{3}{\pi}}(\frac{R}{M})^{3/2}\sqrt{T}$
Here, $\frac{R}{M} = 259.81$, $T(25) = 300(1 + 0.02 \times 25) = 450$ K, $\frac{dT}{dt} = T_0\alpha = 6\ Ks^{-1}$
Again, $\frac{dP}{dT} = 6 \times 0.9772 \times 4187.9 \times 21.213 = 5.209 \times 10^5$
Therefore, $\frac{dP}{dt} = \frac{dP}{dT} \cdot \frac{dT}{dt} = 5.209 \times 10^5 \times 6 \approx 3.125 \times 10^6\ m^3 s^{-4}$

14. **A.** 27.79 mol
Explanation: Let the strip of thickness dz at height z have $dn = \frac{PA\,dz}{RT_0(1+\alpha z)}$
So, $n = \frac{PA}{RT_0}\int_0^H \frac{dz}{1+\alpha z} = \frac{PA}{RT_0\alpha}\ln(1 + \alpha H)$
Here, $1 + \alpha H = 2$ and $\ln 2 = 0.693147$
Therefore, $n = \frac{1 \times 10^5 \times 0.1}{8.314 \times 300 \times 0.1} \times 0.693147 = 40.093 \times 0.693147 = 27.79$ mol
40.09 mol results from not multiplying by ln 2.

15. **C.** 9.25°C
Explanation: Here, vapour pressure present $f = 0.50 \times 17.5 = 8.75$ mm Hg, which is the saturated pressure at the dew point
Again, the pressure difference between 9°C and 10°C is $9.2 - 8.6 = 0.6$ mm Hg
Extra pressure needed $= 8.75 - 8.6 = 0.15$ mm Hg
So, $\Delta T = \frac{0.15}{0.6} = 0.25°C$
Therefore, dew point $= 9 + 0.25 = 9.25°C$

16. **D.** 37036.34 K
Explanation: $T = \frac{PV}{nR} = \frac{1}{nR}(P_0V - \alpha V^3)$
For maximum T, $\frac{dT}{dV} = \frac{1}{nR}(P_0 - 3\alpha V^2) = 0$
So, $V = \sqrt{\frac{P_0}{3\alpha}} = \sqrt{\frac{4}{3}} = 1.1547\ m^3$
Therefore, $T_{max} = \frac{1}{8.314}[4 \times 10^5 \times 1.1547 - 1 \times 10^5 \times (1.1547)^3] = \frac{307920}{8.314} \approx 37036$ K

17. **C.** 52°C
Explanation: Let the final temperature be T_f, with $U = \frac{3}{2}nRT$
By energy conservation, $\frac{3}{2}R(T_1 - T_f) = \frac{3}{2}R(T_f - T_2)$ since $n_1 = n_2$
So, $T_f = \frac{T_1+T_2}{2} = \frac{340+310}{2} = 325$ K
Therefore, $t_f = 325 - 273 = 52°C$

18. **A.** 0.71°C
Explanation: By conservation of internal energy, $\frac{5}{2}n_{air}RT_{air} + \frac{3}{2}n_{He}RT_{He} = (\frac{5}{2}n_{air} + \frac{3}{2}n_{He})RT_f$
Here, $T_{air} = 273$ K, $T_{He} = 333$ K
So, $625 \times 273 + 7.5 \times 333 = (625 + 7.5)T_f$
Or, $173122.5 = 632.5T_f$, so $T_f = 273.71$ K
Therefore, $t_f = 273.71 - 273 = 0.71°C$

19. **B.** 20.91°C**, vapour will flow from outside into the room.**
Explanation: $\theta_{dew} = \theta_1 - G(\theta_1 - \theta_2)$, so $15 = 30 - 1.65(30 - \theta_2)$
So, $30 - \theta_2 = \frac{15}{1.65} = 9.09$, hence $\theta_2 = 20.91°C$
Again, vapour pressure inside $f_{in} = 0.50 \times 31.83 = 15.915$ mm Hg
Vapour pressure outside $f_{out} = 0.65 \times 25.25 = 16.41$ mm Hg
Therefore, since $f_{out} > f_{in}$, water vapour flows from outside into the room.

20. **A.** 42.22°C
Explanation: Here, $n_1 = \frac{48}{32} = 1.5$ mol ($f_1 = 5$), $n_2 = \frac{8}{4} = 2$ mol ($f_2 = 3$), $T_1 = 333$ K, $T_2 = 293$ K
By conservation of internal energy, $\frac{5}{2} \times 1.5 \times 333 + \frac{3}{2} \times 2 \times 293 = (\frac{5}{2} \times 1.5 + \frac{3}{2} \times 2)T_f$
So, $1248.75 + 879 = 6.75T_f$
Or, $T_f = \frac{2127.75}{6.75} = 315.22$ K
Therefore, $t_f = 315.22 - 273 = 42.22°C$

21. **B.** 320 Hz
Explanation: The source is the same, so the frequency f is unchanged and $\lambda = \frac{v}{f}$

Given, $\lambda_{water} - \lambda_{air} = \frac{v_{water} - v_{air}}{f} = 3.375$
Here, $v_{water} - v_{air} = 1425 - 345 = 1080\ ms^{-1}$
Therefore, $f = \frac{1080}{3.375} = 320\ Hz$

22. **D.** 680 m, 1.5 s
Explanation: Here, $d_1 = \frac{vt_1}{2} = \frac{340 \times 1.5}{2} = 255\ m$
Again, $d_2 = \frac{340 \times 2.5}{2} = 425\ m$
So, $D = d_1 + d_2 = 680\ m$
The third echo path is $d_1 + D + d_2 = 1360\ m$, so $t_3 = \frac{1360}{340} = 4.0\ s$
Therefore, the interval = 4.0 − 2.5 = 1.5 s

23. **A.** 0.1π
Explanation: Comparing, $A = 0.05\ m$, $\omega = 100\pi\ rads^{-1}$, $k = 2\pi\ radm^{-1}$
So, $v_{p,max} = A\omega = 0.05 \times 100\pi = 5\pi\ ms^{-1}$
Again, $v = \frac{\omega}{k} = \frac{100\pi}{2\pi} = 50\ ms^{-1}$
Therefore, ratio $= \frac{5\pi}{50} = 0.1\pi$

24. **C.** 0 m, $20\pi\ ms^{-1}$
Explanation: Phase angle, $\theta = 200\pi t - 4\pi x = 200\pi(0.02) - 4\pi(0.5) = 2\pi$
So, displacement $y = 0.1 \sin 2\pi = 0\ m$
Again, $v_p = \frac{dy}{dt} = 0.1 \times 200\pi \cos\theta$
Therefore, $v_p = 20\pi \cos 2\pi = 20\pi\ ms^{-1}$

25. **B.** $500\pi^2\ ms^{-2}$, $5 \times 10^6\pi^2\ Wm^{-2}$
Explanation: Here, $A = 0.05\ m$, $\omega = 100\pi\ rads^{-1}$
So, $a_{p,max} = A\omega^2 = 0.05 \times (100\pi)^2 = 500\pi^2\ ms^{-2}$
Again, $I = \frac{1}{2}\varrho v\omega^2 A^2$
Therefore, $I = \frac{1}{2} \times 8000 \times 50 \times (100\pi)^2 \times (0.05)^2 = 5 \times 10^6\pi^2\ Wm^{-2}$

26. **D.** 8 N, $200\ ms^{-1}$
Explanation: Here, $v_1 = \sqrt{\frac{T_1}{m}} = \sqrt{\frac{400}{0.01}} = 200\ ms^{-1}$
Again, $f_1 = \frac{v_1}{2L} = \frac{200}{2 \times 0.5} = 200\ Hz$
Differentiating $f = \frac{1}{2L\sqrt{m}} T^{1/2}$, $\frac{df}{dT} = \frac{f}{2T}$ so $\Delta T = 2T_1 \frac{\Delta f}{f_1}$
Therefore, $\Delta T = 2 \times 400 \times \frac{2}{200} = 8\ N$

27. **A.** $0.08\pi^2\ J$
Explanation: Here, $k = 2\pi$ so $\lambda = 1\ m$ and $\omega = 100\pi\ rads^{-1}$
Maximum particle velocity, $v_{p,max} = 0.04 \times 100\pi \sin(2\pi x) = 4\pi \sin(2\pi x)$
So, $E = \int_0^1 \frac{1}{2} m\, v_{p,max}^2\, dx = 0.16\pi^2 \int_0^1 \sin^2(2\pi x)\, dx$
Therefore, $E = 0.16\pi^2 \times \frac{1}{2} = 0.08\pi^2\ J$

28. **C.** 31.62 m, $2.125\ Nm^{-2}$
Explanation: Here, $I = 10^{-12} \times 10^{10} = 10^{-2}\ Wm^{-2}$
So, from $I = \frac{P_{source}}{4\pi r^2}$, $10^{-2} = \frac{40\pi}{4\pi r^2}$ or $r = \sqrt{1000} = 31.62\ m$
Again, $P_{rms} = \sqrt{I\varrho v} = \sqrt{10^{-2} \times 1.29 \times 350} = \sqrt{4.515}$
Therefore, $P_{rms} = 2.125\ Nm^{-2}$
4.515 is the value before taking the square root, so it is not a pressure.

29. **B.** 0.05 m, $5\pi\ ms^{-1}$, $500\pi^2\ ms^{-2}$
Explanation: The phase difference is 90°, so the resultant amplitude is $A = \sqrt{0.03^2 + 0.04^2} = 0.05\ m$
So, $y = 0.05 \sin(100\pi t + \delta)$
Here, $v_{p,max} = \left|\frac{dy}{dt}\right|_{max} = A\omega = 0.05 \times 100\pi = 5\pi\ ms^{-1}$
Therefore, $a_{p,max} = \left|\frac{d^2y}{dt^2}\right|_{max} = A\omega^2 = 0.05 \times (100\pi)^2 = 500\pi^2\ ms^{-2}$

30. **D.** 80 dB
Explanation: Here, $I_1 = 10^{-12} \times 10^8 = 10^{-4}\ Wm^{-2}$
So, $I_2 = \frac{9P_1}{4\pi(30)^2} = \frac{P_1}{4\pi(10)^2} = I_1$
Therefore, $\beta_2 = 10 \log_{10} \frac{10^{-4}}{10^{-12}} = 80\ dB$

31. **A.** $2.814\ Nm^{-2}$
Explanation: Here, $I = 10^{-12} \times 10^{10} = 10^{-2}\ Wm^{-2}$
So, $P_{max} = \sqrt{2I\varrho v}$
Therefore, $P_{max} = \sqrt{2 \times 0.01 \times 1.2 \times 330} = \sqrt{7.92} = 2.814\ Nm^{-2}$

32. **C.** 300 Hz
Explanation: $f \propto \frac{1}{L}\sqrt{T}$, so $f_2 = f_1 \frac{L_1}{L_2}\sqrt{\frac{T_2}{T_1}}$
Here, $L_2 = 0.64\ m$, $\frac{T_2}{T_1} = 1.44$
Therefore, $f_2 = 200 \times \frac{0.8}{0.64} \times \sqrt{1.44} = 200 \times 1.25 \times 1.2 = 300\ Hz$

33. **C.** 92 Hz, 184 Hz
Explanation: Here, the number of steps is 24 − 1 = 23, each raising the frequency by 4 Hz

So, $f_{24} = f_1 + 23 \times 4 = f_1 + 92$
Given, $f_{24} = 2f_1$, so $2f_1 = f_1 + 92$
Therefore, $f_1 = 92$ Hz and $f_{24} = 184$ Hz

34. **A.** $23.69\ \text{Jm}^{-3}$
Explanation: Here, $A = 0.02$ m, $\omega = 100\pi\ \text{rads}^{-1}$
So, $u = \frac{1}{2}\varrho\omega^2 A^2$
Therefore, $u = \frac{1}{2} \times 1.2 \times (100\pi)^2 \times (0.02)^2 = 2.4\pi^2 = 23.69\ \text{Jm}^{-3}$

35. **B.** 0.667
Explanation: Given, $\frac{v}{2L_o} = \frac{3v}{4L_c}$
So, $4L_c = 6L_o$
Therefore, $\frac{L_o}{L_c} = \frac{4}{6} = 0.667$

36. **D.** $158.07\ \text{ms}^{-1}$
Explanation: Mass per unit length, $m = \varrho\pi r^2 = 8000 \times \pi \times (0.5 \times 10^{-3})^2 = 6.283 \times 10^{-3}\ \text{kgm}^{-1}$
So, $v = \sqrt{\frac{T}{m}}$
Therefore, $v = \sqrt{\frac{157}{6.283 \times 10^{-3}}} = 158.07\ \text{ms}^{-1}$

37. **B.** 13.98 dB**,** $3.18 \times 10^{-3}\ \text{Wm}^{-2}$
Explanation: Here, $I_2 = \frac{P}{4\pi r_2^2} = \frac{100}{4\pi(50)^2} = 3.18 \times 10^{-3}\ \text{Wm}^{-2}$
Again, $I \propto \frac{1}{r^2}$ so $\Delta\beta = 10\log_{10}\frac{I_1}{I_2} = 20\log_{10}\frac{r_2}{r_1}$
Therefore, $\Delta\beta = 20\log_{10} 5 = 13.98$ dB

38. **C.** 100 Hz
Explanation: Here, $v_1 = \sqrt{\frac{100}{0.01}} = 100\ \text{ms}^{-1}$ and $v_2 = \sqrt{\frac{100}{0.04}} = 50\ \text{ms}^{-1}$
So, from $f = \frac{n_1 v_1}{2L_1} = \frac{n_2 v_2}{2L_2}$ we get $100n_1 = 50n_2$, i.e. $n_2 = 2n_1$
For the minimum frequency, $n_1 = 1$, $n_2 = 2$
Therefore, $f = \frac{1 \times 100}{2 \times 0.5} = 100$ Hz

39. **B.** 0.65 m**,** $350\ \text{ms}^{-1}$
Explanation: Here, $k = 10\pi$ so $\lambda = \frac{2\pi}{k} = 0.2$ m
So, $v = \frac{\omega}{k} = \frac{3500\pi}{10\pi} = 350\ \text{ms}^{-1}$
Again, the resonant length is $L = (2n-1)\frac{\lambda}{4} = (2n-1) \times 0.05$ m
Therefore, for $n = 7$, $L = 13 \times 0.05 = 0.65$ m
0.50 m is an even multiple of 0.05 m, so it is not a resonant length.

40. **A. 119.3 kg**
Explanation: For an ideal gas, the density of air $\varrho \propto \frac{P}{T}$ and the carrying capacity $m \propto \varrho$
$\frac{m_2}{m_1} = \frac{P_2/T_2}{P_1/T_1} = \frac{0.75}{1.0} \times \frac{300}{330} = 0.6818$
$m_2 = 175 \times 0.6818 = 119.3$ kg

41. **D.** 270 m**,** $360\ \text{ms}^{-1}$
Explanation: In the first case, the clap interval is $t_1 = \frac{60}{40} = 1.5$ s, so $d_1 = \frac{v \times 1.5}{2} = 0.75v$
In the second case, $t_2 = \frac{60}{60} = 1.0$ s, so $d_2 = d_1 - 90 = 0.5v$
So, $0.75v - 90 = 0.5v$ or $0.25v = 90$
Therefore, $v = 360\ \text{ms}^{-1}$ and $d_1 = 0.75 \times 360 = 270$ m

42. **D.** 2.5 cm**,** $120\ \text{cms}^{-1}$**,** 3 cm
Explanation: The stationary wave amplitude is $2a = 5$ cm, so each component has $a = 2.5$ cm
Here, $k = \frac{\pi}{3}\ \text{radcm}^{-1}$, $\omega = 40\pi\ \text{rads}^{-1}$
So, $v = \frac{\omega}{k} = \frac{40\pi}{\frac{\pi}{3}} = 120\ \text{cms}^{-1}$
Therefore, the distance between nodes $= \frac{\lambda}{2} = \frac{\pi}{k} = 3$ cm

43. **A.** 3.823 km
Explanation: Here, $v = \frac{\omega}{k} = \frac{69.53\pi}{0.6283} = 347.65\ \text{ms}^{-1}$ and the explosion height is $H = 150 \times 5 = 750$ m
Distance travelled by sound, $S_E = 347.65 \times 5 = 1738.25$ m and $S_J = 347.65 \times 7 = 2433.55$ m
So, horizontal positions when hearing, $x_E = \sqrt{1738.25^2 - 750^2} = 1568.1$ m and $x_J = \sqrt{2433.55^2 - 750^2} = 2315.1$ m
Again, Jeff hears 2 s after Elon; in that time Elon walks another $30 \times 2 = 60$ m, so $x'_E = 1508.1$ m
Therefore, distance $= 1508.1 + 2315.1 = 3823.2\ \text{m} \approx 3.823$ km
3.953 km is the distance at the instant Elon heard, and 3.883 km comes from adding positions at different instants.

44. **A.** 57.51 cm**, the length must be decreased by** 1.80 cm
Explanation: Wax lowers the frequency of B; since the beats decrease, B was higher than the

pipe
So, $f_{pipe} = 256 - 8 = 248$ Hz
Here, $L = \frac{v}{2f_{pipe}} = \frac{285.25}{2\times248} = 0.5751$ m = 57.51 cm
Again, for resonance with B, $L' = \frac{285.25}{2\times256} = 0.5571$ m = 55.71 cm
Therefore, $L - L' = 1.80$ cm decrease is needed
54.00 cm is wrong, because with a pipe at 264 Hz the beats would increase on waxing.

45. **C.** 3.005 Nm^{-2}**,** 0.02 W
Explanation: Here, $I = 10^{-12} \times 10^{10} = 0.01$ Wm^{-2}
So, $P_{max} = \sqrt{2I\varrho v} = \sqrt{2 \times 0.01 \times 1.29 \times 350} = 3.005$ Nm^{-2}
Again, energy flowing per second = $I \times S = 0.01 \times 2$
Therefore, the power is 0.02 W

46. **B.** +4.72 cm
Explanation: The frequency is fixed, so from $f = \frac{1}{2L}\sqrt{\frac{Mg}{m}}$ we get $\frac{\sqrt{M_1}}{L_1} = \frac{\sqrt{M_2}}{L_2}$
Here, $\frac{\sqrt{2}}{40} = \frac{\sqrt{2.5}}{L_2}$
So, $L_2 = 40 \times \sqrt{1.25} = 44.72$ cm
Therefore, $\Delta L = 44.72 - 40 = +4.72$ cm (an increase)

47. **C. 9.87%**
Explanation: Initial vapour pressure, $P_1 = 0.70 \times 25.21 = 17.647$ mm Hg
$T_1 = 26 + 273 = 299$ K, $T_2 = 18 + 273 = 291$ K
At constant volume, the number of moles of vapour $n \propto \frac{P}{T}$
On cooling the vapour becomes saturated, so $P_2 = 15.48$ mm Hg (without condensation the pressure would be $17.647 \times \frac{291}{299} = 17.175 >$ 15.48, so condensation occurs)
Fraction condensed = $1 - \frac{n_2}{n_1} = 1 - \frac{15.48 \times 299}{17.647 \times 291}$
$= 1 - 0.9013 = 0.0987$
Hence 9.87% condenses

48. **A.** 2.24×10^{-10} s
Explanation: Mean speed, $\bar{c} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8 \times 8.314 \times 273}{\pi \times 0.032}} \approx 425$ m s^{-1}
Mean time between two successive collisions, $\tau = \frac{\lambda}{\bar{c}} = \frac{9.5 \times 10^{-8}}{425}$
$\tau \approx 2.24 \times 10^{-10}$ s

49. **D. 450 km**
Explanation: Escape velocity, $v_{esc}^2 = \frac{2GM_p}{r}$
and $M_p = \frac{4}{3}\pi r^3 \varrho$
$\Rightarrow v_{esc}^2 = \frac{8}{3}\pi G \varrho r^2$
Root-mean-square speed, $c_{rms}^2 = \frac{3RT}{M}$, where $T = 527 + 273 = 800$ K
From the limiting condition $v_{esc} = c_{rms}$,
$\frac{8}{3}\pi G \varrho r^2 = \frac{3RT}{M}$
$r^2 = \frac{9RT}{8\pi G \varrho M} = \frac{9 \times 8.31 \times 800}{8\pi \times 6.67 \times 10^{-11} \times 5.5 \times 10^3 \times 0.032} \approx 2.03 \times 10^{11}$
$r \approx 4.5 \times 10^5$ m = 450 km

50. **B.** 1.12×10^5 N m^{-2}
Explanation: Initially $P_1 = 1.07 \times 10^5$ Pa, $T_1 = 27 + 273 = 300$ K; finally $T_2 = 40 + 273 = 313$ K
With no liquid water present, the total moles of dry air and vapour and the volume stay constant
(At 40°C the vapour pressure becomes $3.7 \times 10^3 \times \frac{313}{300} \approx 3.9 \times 10^3$ Pa, which is below the saturated vapour pressure at that temperature ($\approx 7.4 \times 10^3$ Pa), so the vapour remains unsaturated)
$\frac{P_2}{P_1} = \frac{T_2}{T_1}$
$P_2 = 1.07 \times 10^5 \times \frac{313}{300} \approx 1.12 \times 10^5$ Pa