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Question 1

$$V = 89 \text{ m}^3$$

$$n = 6000 \text{ mol}$$

$$T_0 = 270 \text{ K}$$

$$T_1 = 350 \text{ K}$$

$$R = 8.314 \text{ J mol}^{-1}$$

$$p_0 V = n R T_0$$

$$p_0 = \frac{n R T_0}{V}$$

$$p_0 = \frac{(6000 \text{ mol})(8.314 \text{ J mol}^{-1})(270 \text{ K})}{89 \text{ m}^3}$$

$$p_0 = 151333 \text{ Pa} \approx 0.15 \text{ MPa}$$

Question 2

$$V = 3.2 \text{ L}$$

$$p_0 = 3.3 \text{ atm}$$

$$T_0 = 330 \text{ K}$$

$$M = 20.2 \text{ g mol}^{-1}$$

$$R = 0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1}$$

$$m = ?$$

$$p_0 V = n R T_0$$

$$p_0 V = \left(\frac{m}{M}\right) R T_0$$

$$m = \frac{p_0 V M}{R T_0}$$

$$m = \frac{(3.3 \text{ atm})(3.2 \text{ L})(20.2 \text{ g mol}^{-1})}{(0.0821 \text{ atm mol}^{-1} \text{ K}^{-1})(330 \text{ K})}$$

$$m = 7.87 \text{ L} = 0.00787 \text{ m}^3$$

$$= 7.87 \times 10^{-3} \text{ m}^3 \approx 7.9 \times 10^{-3} \text{ m}^3$$

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Question 3

$$V_0 = 12.0 \text{ m}^3$$

$$T_0 = 22.0^\circ\text{C} = 295 \text{ K}$$

$$P_0 = 101 \text{ kPa}$$

$$T_1 = -30^\circ\text{C} = 243 \text{ K}$$

$$P_1 = 20.0 \text{ kPa}$$

$$V_1 = ?$$

$$pV = nRT$$

$$nR = \frac{P_0 V_0}{T_0} = \frac{P_1 V_1}{T_1}$$

$$V_1 = \frac{P_0 V_0 T_1}{T_0 P_1}$$

$$V_1 = \frac{(101 \text{ kPa})(12.0 \text{ m}^3)(243 \text{ K})}{(295 \text{ K})(20.0 \text{ kPa})}$$

$$V_1 = 49.9 \text{ m}^3$$

Question 4

$$n_0 = 0.020 \text{ mol}$$

$$P_0 = 1.5 \text{ atm}$$

$$T_0 = 290 \text{ K}$$

$$M = 14.0 \text{ g mol}^{-1}$$

$$\rho = ?$$

$$pV = nRT$$

$$pV = \left(\frac{m}{M}\right)RT$$

$$\rho = \frac{m}{V}, m = \rho V$$

$$pV = \frac{\rho VRT}{M}$$

$$\rho = \frac{pM}{RT}$$

$$\rho = \frac{(1.5 \text{ atm})(14.0 \text{ g mol}^{-1})}{(0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1})(290 \text{ K})}$$

$$\rho = 0.882 \text{ g L}^{-1} = 0.000882 \text{ kg L}^{-1}$$

$$= 0.882 \text{ kg m}^{-3} \approx 0.90 \text{ kg m}^{-3}$$

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Question 5

$$m_{\text{piston}} = 50 \text{ kg}$$

$$T_0 = 30^\circ\text{C} = 303 \text{ K}$$

$$T_1 = 300^\circ\text{C} = 573 \text{ K}$$

$$w = 10 \text{ cm} = 0.10 \text{ m}$$

$$h = ?$$

$$pV = nRT$$

$$\frac{nR}{p} = \frac{V_0}{T_0} = \frac{V_1}{T_1}$$

$$V_1 = \frac{V_0 T_1}{T_0}$$

$$\pi \left(\frac{d}{2}\right)^2 h_1 = \frac{\pi \left(\frac{d}{2}\right)^2 h_0 T_1}{T_0}$$

$$h_1 = \frac{T_1}{T_0} h_0$$

$$h_1 = \frac{573 \text{ K}}{303 \text{ K}} h_0$$

$$h_1 = 1.89 h_0$$

Question 6

$$V_0 = 5.0 \text{ L}$$

$$K_{tr} = \frac{3}{2} nRT$$

$$n_{\text{helium}_0} = 1.4 \text{ mol}$$

$$K_{tr} = \frac{3}{2} (1.4 \text{ mol} + 0.70 \text{ mol}) (8.314 \text{ J mol}^{-1} \text{ K}^{-1}) (260 \text{ K})$$

$$n_{\text{oxygen}_0} = 0.70 \text{ mol}$$

$$K_{tr} = 6809 \text{ J} \approx 6.8 \text{ kJ}$$

$$T_0 = 260 \text{ K}$$

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Question 7

$$V_0 = V$$

$$pV = nRT$$

$$V_1 = \frac{1}{2}V$$

$$V = \frac{n}{p} \cdot \frac{RT}{M}$$

$$p_1 = p_0$$

$$V_0 = V \quad \sqrt{\frac{3pV}{m}} = \sqrt{\frac{3RT}{M}} = v$$

$$V_1 = ?$$

$$V_0 = \sqrt{3V_0} = \sqrt{3V_1} = v$$

$$\sqrt{3V} = \sqrt{3V} \sqrt{2^{-1}}$$

$$V_0 = \sqrt{\frac{1}{2}} V_1 = \frac{V_1}{\sqrt{2}}$$

Question 8

$$V'_{rms} = 2V_{rms}$$

$$pV = nRT \rightarrow \sqrt{\frac{3pV}{m}} = \sqrt{\frac{3RT}{M}}$$

$$V_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3pV}{m}}$$

$$V'_{rms} = 2V_{rms}$$

$$\frac{V'_{rms}}{V_{rms}} = 2$$

$$\frac{\sqrt{\frac{3RT'}{M}}}{\sqrt{\frac{3RT}{M}}} = 2$$

$$\frac{T'}{T} = 4$$

$$\frac{V'_{rms}}{V_{rms}} = 2V_{rms}$$

$$\frac{\sqrt{\frac{3p'V}{m}}}{\sqrt{\frac{3pV}{m}}} = 2 \rightarrow \frac{p'}{p} = 4 \rightarrow p' = 4p$$

$$T' = 4T$$

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Question 9

$$n = 10$$

$$i = 0$$

$$v_i = [15 + i] \text{ ms}^{-1}$$

$$v_{\text{rms}} = \sqrt{(v^2)_{\text{avg}}}$$

$$v_{\text{rms}} = \sqrt{\frac{\left[\sum_{i=0}^n v_i^2 \right]}{n+1}}$$

$$v_{\text{rms}} = 20.2 \text{ ms}^{-1}$$

Question 10

$$T_{\text{sun}} = 5800 \text{ K}$$

$$v_{\text{rms}} = ?$$

$$m = 1.67 \times 10^{-27} \text{ kg}$$

$$v_{\text{rms}} = \sqrt{\frac{3kT}{m}}$$

$$v_{\text{rms}} = \sqrt{\frac{3(1.38 \times 10^{-23} \text{ J K}^{-1})(5800 \text{ K})}{1.67 \times 10^{-27} \text{ kg}}}$$

$$v_{\text{rms}} = 11991 \text{ ms}^{-1} \approx 1.20 \times 10^4 \text{ ms}^{-1}$$

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Question 11

$$T_0 = 50.0^\circ\text{C} = 323\text{K}$$

$$T_1 = 100.0^\circ\text{C} = 373\text{K}$$

$$K_{tr,0} = K$$

$$K_{tr,1} = ?$$

$$K_{tr} = \frac{3}{2} nRT$$

$$\frac{3nR}{2} = \frac{K_{tr,0}}{T_0} = \frac{K_{tr,1}}{T_1}$$

$$K_{tr,1} = \frac{T_1}{T_0} K_{tr,0}$$

$$K_{tr,1} = \left(\frac{373\text{K}}{323\text{K}} \right) K$$

$$K_{tr,1} = 1.15 K$$

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