Test 1 P161 Spring 2008

Solutions

1) $V = \text{constant}$, $Q = n C_V \Delta T$

To find n, use Ideal Gas Law: $n = \frac{PV}{RT} = \frac{P_f V_f}{R T_f}$

$$\Rightarrow Q = \frac{P_f V_f}{R T_f} C_V (T_f - T_i) = \frac{(30 \times 10^3 \text{ Pa})(0.40 \text{ m}^3)(28.0 \frac{\text{J}}{\text{mol}})(270\text{K} - 380}{(8.314 \frac{\text{J}}{\text{mol}\cdot\text{K}})(270\text{ K})}$$

$$Q = -16{,}000 \text{ J} = -16 \text{ kJ} \quad \text{(B)}$$

2) (B)

3) $e = \frac{T_H - T_C}{T_H} = 1 - \frac{T_C}{T_H} \Rightarrow T_H = \frac{T_C}{1 - e}$

But $e = 0.65 \Rightarrow T_H = \frac{(273\text{K} + 15\text{K})}{1 - 0.65} = 823 \text{ K}$

$$T_H = 550°\text{C} \quad \text{(A)}$$

4) (C)

5) For isothermal process $W = nRT \ln \frac{V_f}{V_i}$

$$W = (6.0 \text{ mol})(8.314 \frac{\text{J}}{\text{mol}\cdot\text{K}})(790\text{ K}) \ln\left(\frac{0.15 \text{ m}^3}{0.03 \text{ m}^3}\right)$$

$$W = 63{,}000 \text{ J} = 63 \text{ kJ} \quad \text{(B)}$$

6) $v_{rms} = \sqrt{\frac{3kT}{m}} \Rightarrow \frac{v_{rms}(f)}{v_{rms}(i)} = \sqrt{\frac{T_f}{T_i}}$

$v_{rms}(f) = v_{rms}(i)\sqrt{T_f/T_i}$ But $T = \frac{PV}{nR}$

$= v_{rms}(i)\sqrt{\frac{P_f V_f}{P_i V_i}} = v_{rms}(i)\sqrt{\frac{(2P_i)(2V_i)}{P_i V_i}}$

$= 2\, v_{rms}(i)$ (E)

7) (c)

8) $\left.\begin{array}{l} Q_v = mL_v \\ Q_F = mL_F \end{array}\right\} \Rightarrow \frac{L_v}{L_f} = \frac{Q_v}{Q_f}$

But $\frac{dQ}{dt} = \text{const} \equiv A \Rightarrow Q = A \cdot \Delta t \Rightarrow \frac{L_v}{L_f} = \frac{\cancel{A}\,\Delta t_v}{\cancel{A}\,\Delta t_f}$

From graph $\frac{L_v}{L_f} \cong \frac{7.2}{2.1} \cong 3.4$ ie (A)

9) (B)

10) $n = \frac{PV}{RT}$, $m = Mn = \frac{MPV}{RT}$

$$m = \frac{\left(20.2\ \frac{g}{mol}\right) * \left(\frac{10^{-3}\,kg}{g}\right)\left(3.3\ atm * \frac{1.013 \times 10^5\ Pa}{atm}\right)\left(3.2\,L * \frac{10^{-3}\,m^3}{L}\right)}{\left(8.314\ \frac{J}{mol \cdot K}\right)\left(330\ K\right)}$$

$m = 7.8 \times 10^{-3}\ kg$ (E)

11.) $v_{rms} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M}}$

$$\frac{v_{He}}{v_{O_2}} = \sqrt{\frac{M_{O_2}}{M_{He}}} = \sqrt{\frac{2 \times 16\ g/mol}{4.0\ g/mol}}$$

$$= 2.8 \quad (E)$$

12) $\frac{dQ}{dt} = kA\frac{\Delta T}{L}$ If $L \to L/2$

$r \to r/2$

$\Rightarrow A = \pi r^2 \to A/4$

$$\frac{\left(\frac{dQ}{dt}\right)_f}{\left(\frac{dQ}{dt}\right)_i} = \frac{kA_f\frac{\Delta T}{L_f}}{kA_i\frac{\Delta T}{L_i}} = \frac{A_f L_i}{A_i L_f} = \frac{\left(\frac{A_i}{4}\right)L_i}{A_i\left(L_i/2\right)} = \frac{1}{2}$$

or $\left(\frac{dQ}{dt}\right)_f = \frac{1}{2}\left(\frac{dQ}{dt}\right)_i = \frac{1}{2}\left(10.0\ \frac{J}{s}\right) = 5.0\ J/s$ (c)

13) For isothermal processes, $U = const$

$\Rightarrow \Delta U = 0$ (A)