16.58. Model: The gas is an ideal gas.
Visualize: Please refer to Figure P16.58.
Solve: **(a)** Using the ideal-gas equation,

$$T_1 = \frac{p_1V_1}{nR} = \frac{\left(1.0\times10^5 \text{ Pa}\right)\left(2.0 \text{ m}^3\right)}{(80 \text{ mol})\left(8.31 \text{ J/mol K}\right)} = 301 \text{ K}$$

Because points 1 and 2 lie on the isotherm, $T_2 = T_1 = 301$ K. The temperature of the isothermal process is 301 K.
(b) The straight-line process $1 \rightarrow 2$ can be represented by the equation

$$p = (3 - V)\times10^5$$

where V is in m^3 and p is in Pa. We can use the ideal gas law to find that the temperature along the line varies as

$$T = \frac{pV}{nR} = (3V - V^2)\times\frac{10^5}{nR}$$

We can maximize T by setting the derivative dT/dV to zero:

$$\frac{dT}{dV} = (3 - 2V_{\text{max}}^2)\times\frac{10^5}{nR} = 0 \Rightarrow V_{\text{max}} = \frac{3}{2} \text{ m}^3 = 1.50 \text{ m}^3$$

At this volume, the pressure is $p_{\text{max}} = 1.5\times10^5$ Pa and the temperature is

$$T_{\text{max}} = \frac{p_{\text{max}}V_{\text{max}}}{nR} = \frac{(1.50\times10^5 \text{ Pa})(1.5 \text{ m}^3)}{(80 \text{ mol})(8.31 \text{ J/mol K})} = 338 \text{ K}$$