32. (a) Using Eq. 20-54 for process $D \to A$ gives

$$\begin{aligned} p_D V_D^\gamma &= p_A V_A^\gamma \\ \frac{p_0}{32}(8V_0)^\gamma &= p_0 V_0^\gamma \end{aligned}$$

which leads to

$$8^\gamma = 32 \implies \gamma = \frac{5}{3}$$

which (see §20-9 and §20-11) implies the gas is monatomic.

(b) The input heat is that absorbed during process $A \to B$:

$$Q_\mathrm{H} = nC_p\Delta T = n\left(\frac{5}{2}R\right)T_A\left(\frac{T_B}{T_A} - 1\right) = nRT_A\left(\frac{5}{2}\right)(2-1) = p_0V_0\left(\frac{5}{2}\right)$$

and the exhaust heat is that liberated during process $C \to D$:

$$Q_\mathrm{L} = nC_p\Delta T = n\left(\frac{5}{2}R\right)T_D\left(1 - \frac{T_\mathrm{L}}{T_D}\right) = nRT_D\left(\frac{5}{2}\right)(1-2) = -\frac{1}{4}p_0V_0\left(\frac{5}{2}\right)$$

where in the last step we have used the fact that $T_D = \frac{1}{4}T_A$ (from the gas law in ratio form – see Sample Problem 20-1). Therefore, Eq. 21-10 leads to

$$\varepsilon = 1 - \left|\frac{Q_\mathrm{L}}{Q_\mathrm{H}}\right| = 1 - \frac{1}{4} = 0.75 = 75\% \ .$$