31.15 Saturated liquid R-123 at a pressure of $60psia$ is pumped to a pressure of $100psia$ and remains a saturated liquid. The refrigerant is then expanded isenthalpically to the original pressure. What is the quality of the resulting mixture?

A. 0.05

B. 0.10

C. 0.15

D. 0.20

Look up the Pressure Versus Enthalpy Curves for Refrigerant 123. Locate the left side of the saturation curve at $60psia$ and consider this State 1. Travelling up and to the right along the saturation curve, the process line for pumping a liquid to a higher pressure and ultimately remaining a saturated liquid, locate the left side of the saturation curve at $100psia$ and consider this State 2. Travel vertically down from State 2 on a line of constant enthalpy, inside the saturation curve, until intersecting the $60psia$ pressure line and consider this State 3. The question asks for the quality at State 3.

Start by finding the enthalpy at State 2. This may be read from the chart with reasonable accuracy, or by interpolating from the table below the chart which provides even greater precision, if time allows.

$$P_2 = 100psia$$

$$h_2 = h_{f@100psia}$$

$P[psia]$	$h_f[\frac{Btu}{lb}]$
97.892	58.918
100	h_2
113.13	61.628

$$\frac{100 - 97.892}{113.13 - 97.892} = \frac{h_2 - 58.918}{61.628 - 58.918}$$

$$h_2 = 59.29\frac{Btu}{lb}$$

The enthalpy at State 3 is equal to the enthalpy at State 2 due to isenthalpic expansion.

$$h_3 = h_2 = 59.29\frac{Btu}{lb}$$

To find the quality at State 3, first specificy h_f and h_g at $p = 60psia$, using the chart if pressed for time or interpolating from the table for maximum precision.

$P\,[psia]$	$h_f\,[\frac{Btu}{lb}]$	$h_g\,[\frac{Btu}{lb}]$
56.36	48.347	112.97
60	h_f	h_g
65.173	50.953	114.333

$$\frac{60 - 56.36}{65.173 - 56.36} = \frac{h_f - 48.347}{50.953 - 48.347}$$

$$h_f = 49.42 \frac{Btu}{lb}$$

$$\frac{60 - 56.36}{65.173 - 56.36} = \frac{h_g - 112.97}{114.333 - 112.97}$$

$$h_g = 113.53$$

Calculate the quality at State 3.

$$\chi = \frac{h_3 - h_f}{h_g - h_f} = \frac{59.29 \frac{Btu}{lb} - 49.42 \frac{Btu}{lb}}{113.53 \frac{Btu}{lb} - 49.42 \frac{Btu}{lb}} = 0.15$$

Answer C