31.2 What is the ratio of specific heats for $1020°F$ air? Assume $c_{p,air} = 0.249\frac{Btu}{lb_m°R}$ at $1000°R$ and $c_{p,air} = 0.264\frac{Btu}{lb_m°R}$ at $1500°R$.

A. 1.35

B. 1.38

C. 1.40

D. 1.43

The Ratio of Specific Heats is defined as:

$$k = \frac{c_p}{c_v}$$

Another important relationship between the specific heats for a gas is that their difference is the specific gas constant, as such:

$$c_p - c_v = R$$

The Specific Gas Constant for air is:

$$R_{air} = 53.35\frac{ft \cdot lb_f}{lb_m°F}$$

Add 460 to the Temperature in degrees Farenheit to get the temperature in absolute terms i.e. Rankine: $1020°F + 460 = 1480°R$

Since the temperature is between two known states, interpolate:

Temperature $[R°]$	c_p $\left[\frac{Btu}{lb_m \cdot R°}\right]$
1000	0.249
1480	x
1500	0.264

$$\frac{1480 - 1000}{1500 - 1000} = \frac{x - .249}{.264 - .249} \rightarrow x = .2634\frac{Btu}{lb_m \cdot R°}$$

Rearrange and substitute to solve for c_v @1480R:

$$c_p - c_v = R \rightarrow c_v = c_p - R = .2634\frac{Btu}{lb_m \cdot R°} - \frac{53.35\frac{ft \cdot lb_f}{lb_m°F}}{778\frac{ft \cdot lb_f}{Btu}} = .195\frac{Btu}{lb_m \cdot R°}$$

Note the conversion factor required to align the units: $778\frac{ft \cdot lb_f}{Btu}$

Finally, solve for k:

$$k = \frac{c_p}{c_v} = \frac{0.2634\frac{Btu}{lb_m \cdot R°}}{0.195\frac{Btu}{lb_m \cdot R°}} = 1.35$$

Note the value for k at standard conditions is typically 1.4; however, extreme temperature conditions were being investigated here.

Answer A