

1.57 Air temperature rises from a morning low of 42°F to an afternoon high of 70°F .

- (a) Express these temperatures in $^{\circ}\text{R}$, K , and $^{\circ}\text{C}$.
- (b) Determine the temperature *change* in $^{\circ}\text{F}$, $^{\circ}\text{R}$, K , and $^{\circ}\text{C}$ from morning low to afternoon high.
- (c) What conclusion do you draw about temperature *change* for $^{\circ}\text{F}$ and $^{\circ}\text{R}$ scales?
- (d) What conclusion do you draw about temperature *change* for $^{\circ}\text{C}$ and K scales?

KNOWN: Morning low temperature and afternoon high temperature, both in $^{\circ}\text{F}$.

FIND: (a) Express these temperatures in $^{\circ}\text{R}$, K , and $^{\circ}\text{C}$, (b) temperature *change* in $^{\circ}\text{F}$, $^{\circ}\text{R}$, K , and $^{\circ}\text{C}$ from morning low to afternoon high, (c) conclusion about temperature *change* for $^{\circ}\text{F}$ and $^{\circ}\text{R}$ scales, (d) conclusion about temperature *change* for $^{\circ}\text{C}$ and K scales.

SCHEMATIC AND GIVEN DATA:

$$T_{\text{low}} = 42^{\circ}\text{F}$$

$$T_{\text{high}} = 70^{\circ}\text{F}$$

ANALYSIS:

- (a) First convert temperatures from $^{\circ}\text{F}$ to $^{\circ}\text{R}$ using Eq. 1.18 to solve for temperatures in $^{\circ}\text{R}$

$$T(^{\circ}\text{F}) = T(^{\circ}\text{R}) - 459.67 \rightarrow T(^{\circ}\text{R}) = T(^{\circ}\text{F}) + 459.67$$

$$T_{\text{low}} (^{\circ}\text{R}) = 42^{\circ}\text{F} + 459.67 = \mathbf{501.67^{\circ}\text{R}}$$

$$T_{\text{high}} (^{\circ}\text{R}) = 70^{\circ}\text{F} + 459.67 = \mathbf{529.67^{\circ}\text{R}}$$

Next apply Eq. 1.16 to solve for temperature in K

$$T(^{\circ}\text{R}) = 1.8T(\text{K}) \rightarrow T(\text{K}) = T(^{\circ}\text{R})/1.8$$

$$T_{\text{low}} (\text{K}) = 501.67^{\circ}\text{R}/1.8 = \mathbf{278.71 \text{ K}}$$

$$T_{\text{high}} (\text{K}) = 529.67^{\circ}\text{R}/1.8 = \mathbf{294.26 \text{ K}}$$

Finally, apply Eq. 1.17 to solve for temperature in $^{\circ}\text{C}$

$$T(^{\circ}\text{C}) = T(\text{K}) - 273.15$$

$$T_{\text{low}} (^{\circ}\text{C}) = 278.71 \text{ K} - 273.15 = \mathbf{5.56^{\circ}\text{C}}$$

$$T_{\text{high}} (^{\circ}\text{C}) = 294.26 \text{ K} - 273.15 = \mathbf{21.11^{\circ}\text{C}}$$

- (b) Temperature change, ΔT , is $T_{\text{high}} - T_{\text{low}}$. Calculating the differences yields

$$\Delta T(^{\circ}\text{F}) = 70^{\circ}\text{F} - 42^{\circ}\text{F} = \mathbf{28^{\circ}\text{F}}$$

$$\Delta T(^{\circ}\text{R}) = 529.67^{\circ}\text{R} - 501.67^{\circ}\text{R} = \underline{28^{\circ}\text{R}}$$

$$\Delta T(\text{K}) = 294.26 \text{ K} - 278.71 \text{ K} = \underline{15.55 \text{ K}}$$

$$\Delta T(^{\circ}\text{C}) = 21.11 ^{\circ}\text{C} - 5.56 ^{\circ}\text{C} = \underline{15.55^{\circ}\text{C}}$$

(c) For $^{\circ}\text{F}$ and $^{\circ}\text{R}$ scales, the temperature *change* is the same since a Rankine degree and a Fahrenheit degree are the same temperature unit.

(d) For $^{\circ}\text{C}$ and K scales, the temperature *change* is the same since a Kelvin degree and a Celsius degree are the same temperature unit.