Converting Temperature

E82 – K to °R to °F to °C and Back

E82

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Converting Temperatures

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- There are four standard temperature units you need to know.
  - Kelvin or K
  - Celsius or °C
  - Rankine or °R or R
  - Fahrenheit or °F
- Two of them, K and °R, can be converted to each other with dimensional equations (simple multiplication and division).
- Conversions among any other pairs requires equations.

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Temperatures vs. Temperature Intervals

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- If you are using a thermometer or thermistor (or similar devices), you are measuring a *temperature*.
- If you are using or calculating the *difference* between two temperatures, you are using a *temperature interval*.

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Temperature Equations

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$T(\text{K}) = T(°\text{C}) + 273.15$ $\quad T(\text{K}) = \frac{5}{9}T(°\text{R})$ $\quad T(\text{K}) = \frac{5}{9}\left[T(°\text{F}) - 32\right] + 273.15$

$T(°\text{C}) = T(\text{K}) - 273.15$ $\quad T(°\text{C}) = \frac{5}{9}\left[T(°\text{R}) - 491.67\right]$ $\quad T(°\text{C}) = \frac{5}{9}\left[T(°\text{F}) - 32\right]$

$T(°\text{F}) = \frac{9}{5}T(\text{K}) - 459.67$ $\quad T(°\text{F}) = \frac{9}{5}T(°\text{C}) + 32$ $\quad T(°\text{F}) = T(°\text{R}) - 459.67$

$T(°\text{R}) = \frac{9}{5}T(\text{K})$ $\quad T(°\text{R}) = T(°\text{F}) + 459.67$ $\quad T(°\text{R}) = \frac{9}{5}T(°\text{C}) + 491.67$

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Temperature Interval Equations

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$$\Delta T(\mathrm{K}) = \Delta T(^\circ\mathrm{C}) \qquad \Delta T(\mathrm{K}) = \frac{5}{9}\Delta T(^\circ\mathrm{R}) \qquad T(\mathrm{K}) = \frac{5}{9}\Delta T(^\circ\mathrm{F})$$

$$\Delta T(^\circ\mathrm{C}) = \Delta T(\mathrm{K}) \qquad \Delta T(^\circ\mathrm{C}) = \frac{5}{9}\Delta T(^\circ\mathrm{R}) \qquad \Delta T(^\circ\mathrm{C}) = \frac{5}{9}\Delta T(^\circ\mathrm{F})$$

$$\Delta T(^\circ\mathrm{F}) = \frac{9}{5}\Delta T(\mathrm{K}) \qquad \Delta T(^\circ\mathrm{F}) = \frac{9}{5}\Delta T(^\circ\mathrm{C}) \qquad \Delta T(^\circ\mathrm{F}) = \Delta T(^\circ\mathrm{R})$$

$$\Delta T(^\circ\mathrm{R}) = \frac{9}{5}\Delta T(\mathrm{K}) \qquad \Delta T(^\circ\mathrm{R}) = \Delta T(^\circ\mathrm{F}) \qquad \Delta T(^\circ\mathrm{R}) = \frac{9}{5}\Delta T(^\circ\mathrm{C})$$

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Example 1

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Over a limited temperature range, the heat capacity of liquid acetone is

$$C_p\left[\frac{\mathrm{kJ}}{\mathrm{mol}\bullet{}^\circ\mathrm{C}}\right] = 0.1230 + 0.000186T \text{ where } T \text{ is in } {}^\circ\mathrm{C}$$

What is the heat capacity formula with T in K, °R and °F?

$$C_p\left[\frac{\mathrm{kJ}}{\mathrm{mol}\bullet\mathrm{K}}\right]\frac{1\mathrm{K}}{1^\circ\mathrm{C}} = 0.1230 + 0.000186\left(T - 273.15\right) \text{ where } T \text{ is in K}$$

$$C_p\left[\frac{\mathrm{kJ}}{\mathrm{mol}\bullet\mathrm{K}}\right] = 0.0722 + 0.000186T \text{ where } T \text{ is in K}$$

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Example 1 (cont.)

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$$C_p\left[\frac{\text{kJ}}{\text{mol}\bullet{}^\circ\text{R}}\right]\frac{9^\circ\text{R}}{5^\circ\text{C}} = 0.1230 + 0.000186\left(\frac{5}{9}\left[T - 491.67\right]\right) \text{ where } T \text{ is in } {}^\circ\text{R}$$

$$C_p\left[\frac{\text{kJ}}{\text{mol}\bullet{}^\circ\text{R}}\right] = 0.04011 + 0.00005741T \text{ where } T \text{ is in } {}^\circ\text{R}$$

$$C_p\left[\frac{\text{kJ}}{\text{mol}\bullet{}^\circ\text{F}}\right]\frac{9^\circ\text{F}}{5^\circ\text{C}} = 0.1230 + 0.000186\left(\frac{5}{9}\left[T - 32\right]\right) \text{ where } T \text{ is in } {}^\circ\text{F}$$

$$C_p\left[\frac{\text{kJ}}{\text{mol}\bullet{}^\circ\text{F}}\right] = 0.06650 + 0.00005741T \text{ where } T \text{ is in } {}^\circ\text{F}$$

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