Sections 2.6 and 8.6
Temperature Conversions

An Introduction to Chemistry

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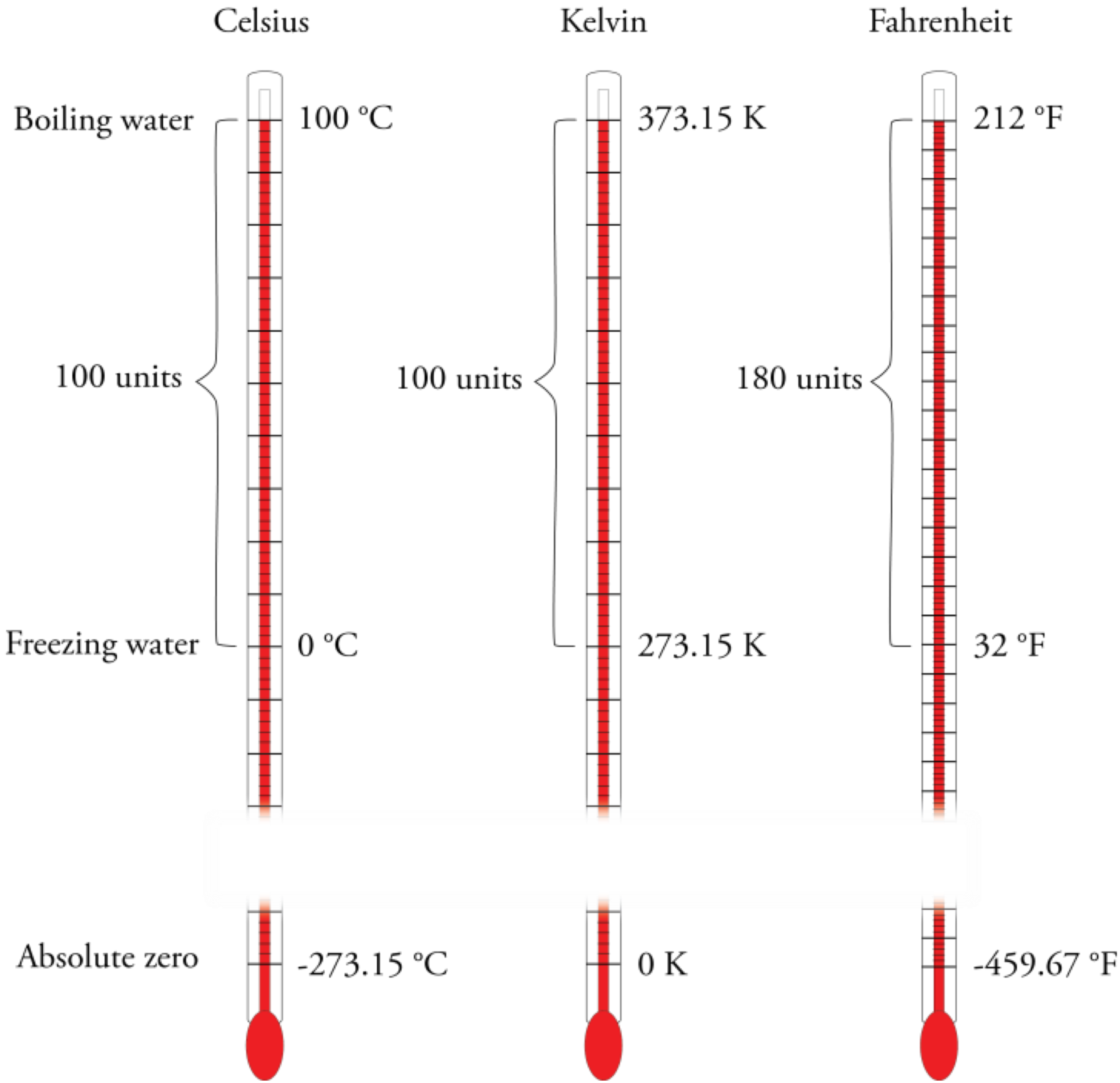
Temperature Scales



Temperature Conversions

- We will use the following equations to convert a temperature reported in one of these systems to the equivalent temperature in another.

$$? \,^\circ\mathrm{F} = \text{number of } ^\circ\mathrm{C} \left(\frac{1.8\,^\circ\mathrm{F}}{1\,^\circ\mathrm{C}}\right) + 32\,^\circ\mathrm{F}$$

$$? \,^\circ\mathrm{C} = (\text{number of } ^\circ\mathrm{F} - 32\,^\circ\mathrm{F}) \left(\frac{1\,^\circ\mathrm{C}}{1.8\,^\circ\mathrm{F}}\right)$$

$$? \,\mathrm{K} = \text{number of } ^\circ\mathrm{C} + 273.15$$

$$? \,^\circ\mathrm{C} = \text{number of K} - 273.15$$

- Note that the numbers 1.8, 32, and 273.15 in these equations all come from definitions, so they are all exact.

Example 2.17 and 8.17: "Heavy" water contains the heavy form of hydrogen called deuterium, whose atoms each have one proton, one neutron, and one electron. Heavy water freezes at 38.9 °F. What is this temperature in °C?

- We use the equation for converting Fahrenheit temperatures to Celsius:

$$? \,^{\circ}\mathrm{C} = (38.9\,^{\circ}\cancel{\mathrm{F}} - 32\,^{\circ}\cancel{\mathrm{F}})\left(\frac{1\,^{\circ}\mathrm{C}}{1.8\,^{\circ}\cancel{\mathrm{F}}}\right)$$

- Rounding off the answer can be tricky here. When you subtract 32 from 38.9, you get 6.9. The 32 is exact, so it is ignored when considering how to round off the answer. The 38.9 is precise to the first number after the decimal point, so the answer to the subtraction is reported to the tenths place. There are two significant figures in 6.9, so when we divide by the exact value of 1.8 ºF, we round our answer to two significant figures.

$$? \,^{\circ}\mathrm{C} = (38.9\,^{\circ}\cancel{\mathrm{F}} - 32\,^{\circ}\cancel{\mathrm{F}})\left(\frac{1\,^{\circ}\mathrm{C}}{1.8\,^{\circ}\cancel{\mathrm{F}}}\right) = (6.9\,^{\circ}\cancel{\mathrm{F}})\left(\frac{1\,^{\circ}\mathrm{C}}{1.8\,^{\circ}\cancel{\mathrm{F}}}\right) = \mathbf{3.8\,^{\circ}C}$$

Example 2.18 and 8.18: The compound 1-chloropropane, $CH_3CH_2CH_2Cl$, melts at 46.6 °C. What is this temperature in °F?

- We use the equation for converting Celsius temperatures to Fahrenheit:

$$? \text{ °F} = 46.6 \text{ °}\cancel{\text{C}} \left(\frac{1.8 \text{ °F}}{1 \text{ °}\cancel{\text{C}}} \right) + 32 \text{ °F}$$

Example 2.18 and 8.18: The compound 1-chloropropane, $CH_3CH_2CH_2Cl$, melts at 46.6 °C. What is this temperature in °F?

$$? \,°F = 46.6 \,\cancel{°C} \left(\frac{1.8 \,°F}{1 \,\cancel{°C}} \right) + 32 \,°F = 83.9 \,°F + 32 \,°F = \mathbf{115.9 \,°F}$$

- Because the calculation involves multiplication as well as addition, you need to apply two different rules for rounding off your answer.
- When you multiply 46.6, which has three significant figures, by the exact value of 1.8 ºF, your answer should have three significant figures.
- The answer on the display of the calculator, 83.88, would therefore be rounded off to 83.9.
- You then add the exact value of 32 ºF and report the answer to the tenths place.

Example 2.19 and 8.19: Silver melts at 961 °C. What is this temperature in K?

$$? \text{ K} = 961 \text{ °C} + 273.15 = 1234 \text{ K}$$

- For rounding off our answer, we assumed that 961 ºC came from a measurement, so it is not exact. It is precise to the unit position.
- On the other hand, 273.15 is exact, and has no effect on the uncertainty of our answer.
- We therefore report the answer for our addition to the unit position, rounding off 1234.15 to 1234.

Example 2.20 and 8.20:
Tin(II) sulfide, SnS, melts at 1155 K. What is this temperature in °C?

$$? \,^{o}C = 1155 \text{ K} - 273.15 = 882 \,^{o}C$$

- Because 1155 is precise to the ones place, and 273.15 is exact, we report the answer for our subtraction to the ones place.

Practice

- You can get some practice using percentages as conversion factors by working Exercise 2.11 (8.11) and end-of-chapter problems 103-109.