Measurement

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Phys 211, Lecture 2, Aug 25, 2015

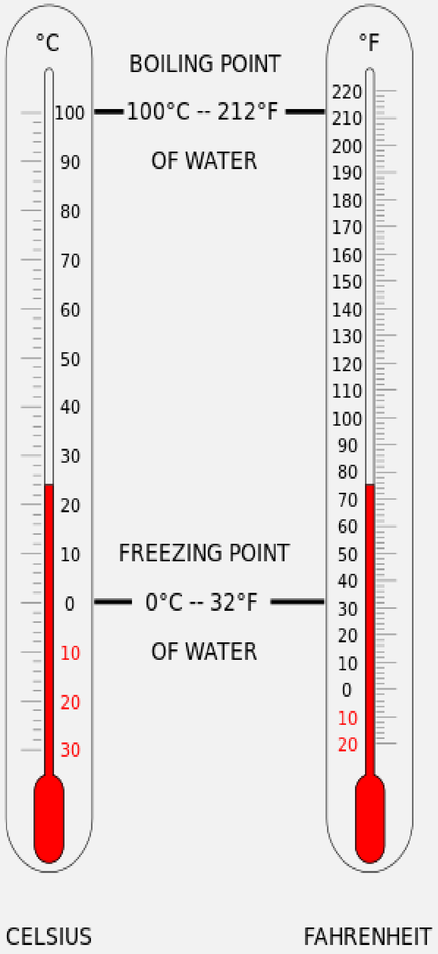
Converting Units

- Converting degree Celsius (°C) to degree Fahrenheit (°F)

Let C denote the value (in Celsius) corresponding to the value F (in Fahrenheit) of the same temperature. Notice their linear relationship. Assume a slope (m) and an intercept (b). Looking at the scales (C,F) = { (0, 32), (100, 212) } must lie on the line given by the equation $C = mF + b$. Solving for m and b, we get

$$m = 5/9, \qquad b = -(5/9) \times 32$$

$$\boxed{C = \frac{5}{9}(F - 32)}$$



Clicker Question 1 (30 s)

Choose a one degree interval on the scale
(Example interval 59 -> 60 degrees)

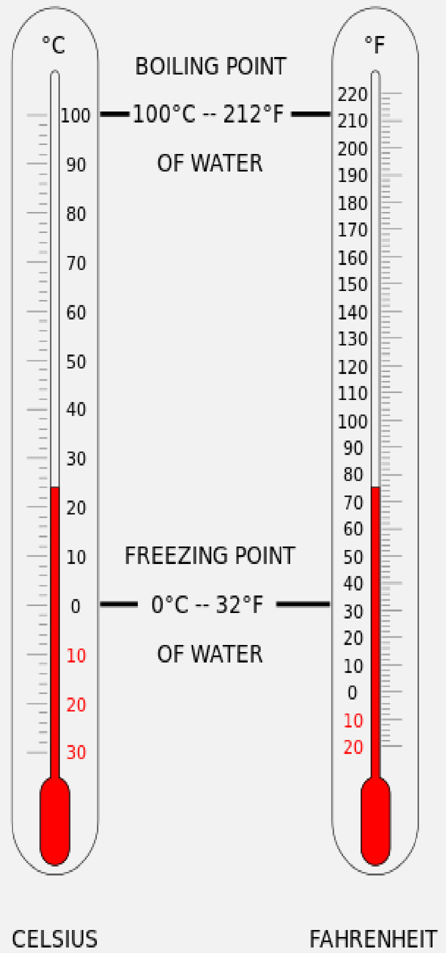
Which one is hotter?

A. A rise in 1 °F is hotter than a rise in 1 °C

B. A rise in 1 °C is hotter than a rise in 1 °F

C. They are both equal

D. Cannot be determined



Clicker Question 1 (30 s)

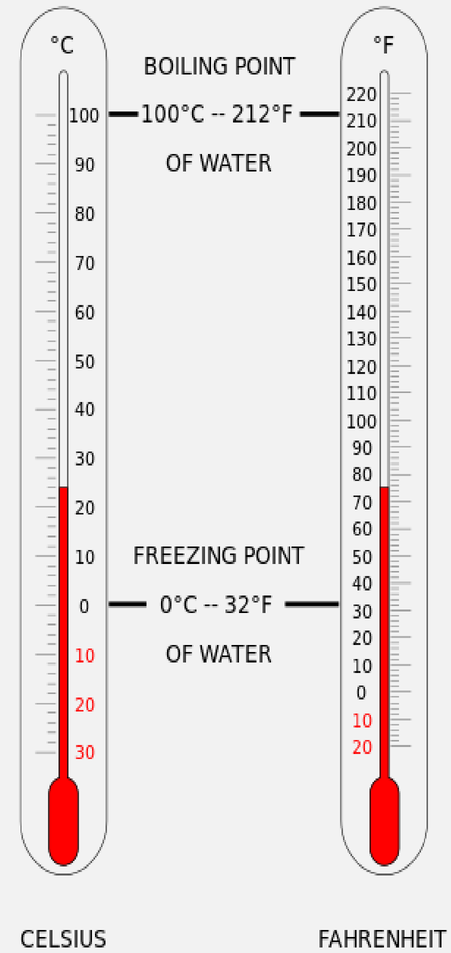
Is there a number where the Celsius and the Fahrenheit scales measure an identical temperature ?

A. 32 °F = 32 °C

B. 1 °F = 1 °C

C. 212 °F = 212 °C

D. -40 °F = -40 °C



Vectors: Introduction

- Introduction
  - Vectors
  - Scalars
- Components
  - Graphical representation of 2D, 3D vectors
  - Addition using tip-to-tail method
  - Unit vectors
  - Algebraic addition, subtraction of vectors
  - Null vector
  - Commutative, Associative properties of addition
- See slides from Lecture 3 for more
- Additional material (see next set of slides) -- Optional

Dimensions

- Dimensions of fundamental units
  - [L]=Length, [M]=Mass, [T]=Time, [θ]=Temperature
- Dimensions of derived units:
  - Volume = $[L]^3$, Area = $[L]^2$, Density $[M]/[L]^3 = [M][L]^{-3}$
- Dimensional Consistency:

Consider $E = mc^?$

Both sides of this equation must be dimensionally consistent

$[E] = [m][c]^y$

$[M]^1[L/T]^2 = [M]^x\,[L/T]^y$

$x = 1$, $y = 2$, so $E = mc^2$

Dimension describes the derived units in terms of fundamental units.

Uncertainty and Errors

- **Ideal or Perfect World**
- All physical quantities are perfectly measured
- Measuring instruments are perfect
- Humans are perfect
- Measured Value = True Value
- Uncertainty in measurement: NONE, ZERO
- Error in measurement = ZERO
- Example: 2.4 m

- **Real World (that we live in)**
- All physical quantities are (im)perfectly measured
- Measuring instruments are (im)perfect
- Humans are (im)perfect
- Measured Value ≠ True Value
- Uncertainty in measurement: NOT ZERO
- Sources of error
  - Human/Instrumental Error (Systematic Error)
  - Random (or statistical) Error
- Example: 2.4 ± 0.1 m

Precision/Accuracy