Who Needs Negative Integers?

Focusing Question: How can you convert between Celsius, Fahrenheit, and Kelvin?

Background Information (see attached reading; a few key points below)

- Water boils at 100°C or 212°F.
- Water freezes at 0°C or 32°F.
- Kelvin degrees are the same size as Celsius degrees, but the Kelvin scale does not use negative numbers. Zero Kelvin is also known as absolute zero: the lowest temperature possible, at which all molecules are completely still. Water freezes at 273K.

Questions

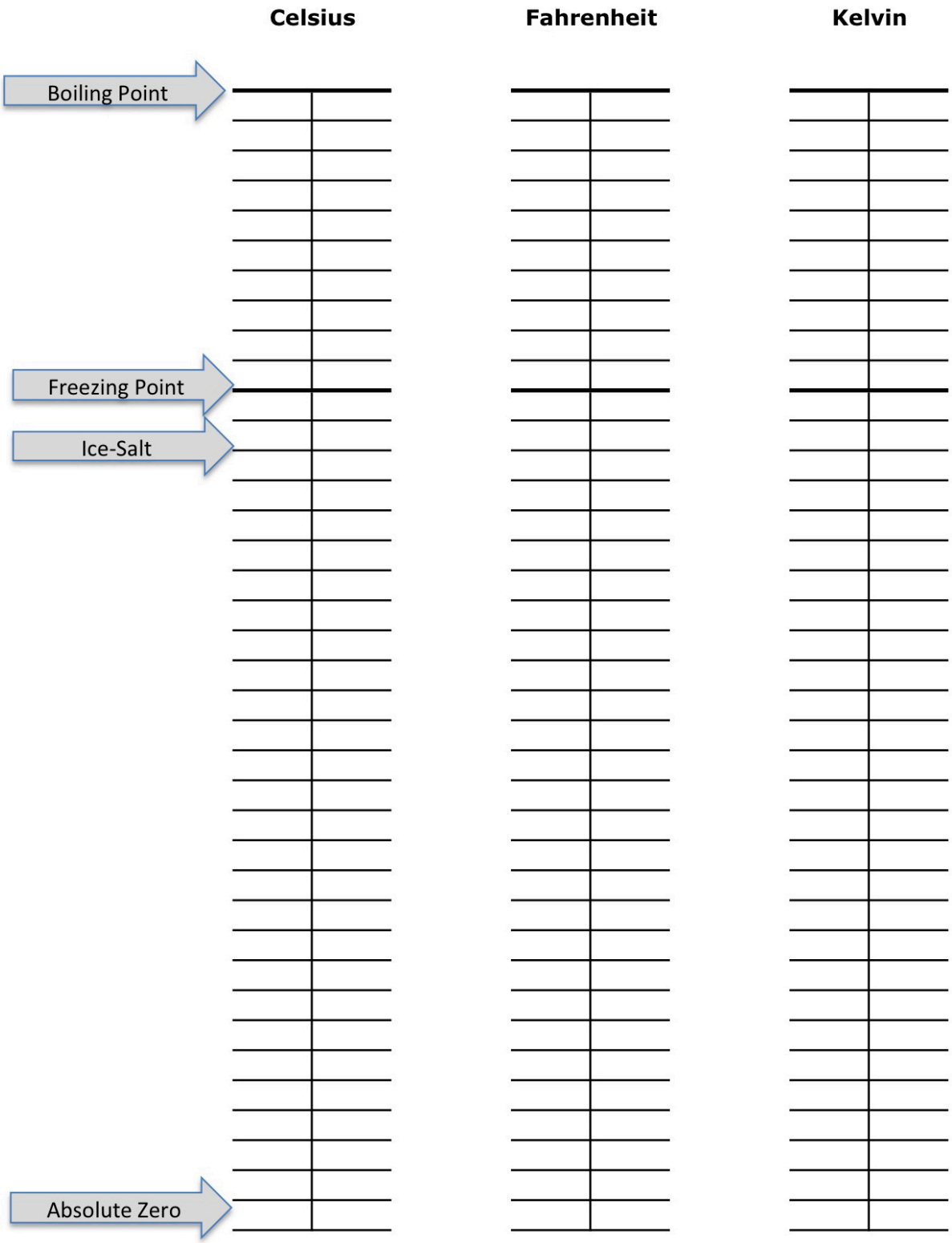
1. On the attached diagram, label the boiling and freezing point of water for each of the three temperature scales.
2. Label 50°C. Using your diagram as a guide, what would this be in Fahrenheit? Kelvin?
3. Label 14°F. Using your diagram as a guide, what would this be in Celsius? Kelvin?
4. Label -50°C. Using your diagram as a guide, what would this be in Fahrenheit? Kelvin?
5. -40 is in the same place for both Fahrenheit and Celsius. Why is this? Could it ever happen again?
6. Find and label absolute zero for all three scales (Note: It will only be *called* zero in Kelvin).

Bonus

1. Label 13°C. What would this be in Fahrenheit? Kelvin?
2. What would 200°C be in Fahrenheit? Kelvin?

Some Things to Think About / Discuss

1. Do negative numbers have a special meaning in terms of temperature?
2. It may seem strange that Fahrenheit chose 180 degrees as the distance between boiling and freezing – to some, 100 seems like a “reasonable” number, but what makes 100 any more “reasonable” than 180? (On a somewhat related not…. Have you ever seen pens sold in packages of 11?)
3. The discovery of absolute zero made it possible to describe temperature without negative integers. Would it be possible to keep track of bank accounts (including debt and loans) without the use of integers? How about sea level?


Celsius
Fahrenheit
Kelvin
Boiling Point
Freezing Point
Ice-Salt
Absolute Zero

Some Common Solutions and Problems

What number is halfway between 212 and 32?

212/2 = 106
If prompted to compare the difference between 212 and 106 with the difference between 32 and 206, most are easily convinced that this doesn't make sense.

When considering whether the two scales would ever meet again, some kids said they *couldn't*, because the numbers *must* move further and further apart if one scale grows by 10 and the other by 18. Some were able to reason that the only reason they met in the first place was that Fahrenheit essentially had a "head start" on Celsius. Others used *empirical evidence* to note that (a) at absolute zero the two scales have grown even further apart or (b) that the two scales *appear to be* diverging (without articulating why this trend would *have* to continue). I suggested a metaphor as evidence: If one student receives $10 a day for the next month and one student receives $18 a day, would they ever have the same amount of money?

Follow-Up Re: Operations With Integers

When the kids do #4, they are forced into the realm of negative integers. Most start at 32 (or at 14 from Question 3) and count back by 18.

32 - 18 = 14; 32 + (-18) = -4
14 - 18 = -4; 14 + (-18)= -4
-4 - 18 = -22; -4 + -18 = -22

However, they do not typically write number sentences like the ones above, and I don't think they would know how to answer those types of questions if presented in isolation from the thermometer context.

Some groups shortened this procedure by reasoning that they would have to count back 5 groups of 18 from the freezing point: i.e. 32-90. This was more difficult to figure out (and some forgot about the 32 and counted back from 0). In any case, they should learn to express this idea in mathematical notation:

5(-18) = -90
32 + (-90) = -58

OR

5(18) = 90
32 – 90 = -58

The same issue comes up for groups who count 27 groups between 32 and absolute zero.