

Note: Only covering sections 10.0-3 in Chapter 10 because other material often covered in chemistry

Movie assignments: I will have your draft grades posted soon (probably tomorrow). Comments are ON THE DRAFTS BUT GRADES WILL BE FOUND ON eCAMPUS! [handed out project drafts]

IF YOU CAN'T FIND YOURS or if you see a zero on eCampus, please email me with what movie you did. Bafflingly, some of you didn't write your name on your project. I have these in my office. This is the last lecture related to test #3.

Test #3 is next Wednesday!

- April 12, 7-10pm, Eiesland G24 as usual. MAKE-UP EXAMS: let me know BY WEDNESDAY APRIL 5.
- Covers Chapters 7-10.
 - Chapter 9, up to 9.8; Chapter 10, up to 10.3.
 - For gravity section, will only test gravitational force, not escape velocity and altitude-dependent GPE.
- Practice test and equation sheet are on my website.
- If you're happy with test 1 and 2 scores, you can skip test 3!

http://sarahspolaor.faculty.wvu.edu/home/physics-101

Today

• Temperature:

• Definition and scales.

Thermal expansion:

- Materials (usually) get bigger with heat.
- · Contract when cold.







Energy always flows from hot to cold object. "Zeroth law of thermodynamics"



Energy always flows from hot to cold object. "Zeroth law of thermodynamics"





Frozen ice cube tray vs. frozen bread - ice cube tray will "feel" colder. This is why sometimes cold things feel wet, by the way—water is really good at transferring heat from your hand so sometimes when you feel something cold, and it is taking heat from your hand, you misinterpret that as a "wet" feeling.



This is exactly how a standard mercury thermometer works. Conducting surface transfers energy easily from one surface (e.g. your skin) to the mercury, which then expands and shows the temperature. You have to keep it in contact long enough to obtain thermal equilibrium or you won't get the right measurement.

Body A has a higher temperature than body B (**not necessarily the same material or size**). Which of the following statements MUST be true?

A. Body A will feel hotter than B.
B. Body A contains more energy than B.
C. If placed in contact with each other, energy will flow from body A to body B.
D. More than one statement is true.

Q97

C, no tries? After first try, say it's not D. The only LAW here is C! It's always true, that's why we call it a law!



It was the first real reproducible temperature scale and was popular for a long time, but was not really well-defined by common ideas. I remember showing you the metric system map and saying that the USA was a little backwards compared to the world. Same thing goes for temperature scales! Basically everywhere else uses celsius. I have noticed on doctors' visits that many if not most hospitals actually use Celsius these days.



Things take much longer to get boiling at high altitude. When I moved here from New Mexico, I had been living at about 1 mile up in the air, about 5000 feet. Stuff took way longer to boil. When I returned here I left my kettle for what should have been a tolerably brief period of time, but instead it was long enough to boil off the water and set my stove on fire!



Kelvin: a more scientific scale. So far as we know, absolute zero is not possible.



Kelvin: a more scientific scale. So far as we know, absolute zero is not possible.

Converting between scales

- Fahrenheit to Celsius
 T_F = T_C x (9/5) + 32
 T_C = (T_F 32) x (5/9)
- Kelvin to Celsius • $T_{K} = T_{C} + 273.15$
 - $T_{\rm C} = T_{\rm K} 273.15$







ANSWER: C.

This first answer is for those REALLY not paying attention :).

Converting Temperature

The temperature *difference* between the inside and outside of a home on a cold winter day is 57.0°F. Express this difference on the Celsius scale.



ANSWER: B.

The STEPPED SCALES of Fahrenheit and Celsius are different!

I wanted to point out that if I had asked this on the Kelvin scale, the answer would have been the same, since the step for kelvin is defined to be the same as celsius! There's a fixed conversion factor between them. In astronomy I find I'm often adding 273 to things.

Converting Temperature

The temperature *difference* between the inside and outside of a home on a cold winter day is 57.0°F. Express this difference on the Celsius scale. What if I asked the question for the Kelvin scale?



ANSWER: B.

The STEPPED SCALES of Fahrenheit and Celsius are different!

I wanted to point out that if I had asked this on the Kelvin scale, the answer would have been the same, since the step for kelvin is defined to be the same as celsius! There's a fixed conversion factor between them. In astronomy I find I'm often adding 273 to things.



Changes with temperature

Properties of materials change with temperature

- Length
- Volume
- Resistance



Ability to store heat (next time)

Joints such as this one are used in bridges to accommodate thermal expansion.

Hotter things become longer e.g. fire alarms, thermometers

- Most solids get bigger when they get hot
 - A 1 meter long bar heated by 1 degree gets bigger by
 - Steel ≈0.01 mm
 - Glass ≈ 0.001 mm





Rails and roads expand and may buckle on a hot day!



Earlier I spoke about kinetic energy of particles. Even atoms vibrate as if they were attached to one another like springs, and hotter atoms vibrate more (they have more energy). This means that they subtend on average larger sizes! So materials generally get larger.

















Note first that we're doing this for length not volume! 27.6 cm.

This may not seem like much, but consider the effect of flooding! Can be really extreme if the ocean keeps warming as it is! Temp has risen about 0.2 degrees over the past 30 years. Makes for great warm swimming but not great in terms of flooding.



Note first that we're doing this for length not volume! 27.6 cm.

This may not seem like much, but consider the effect of flooding! Can be really extreme if the ocean keeps warming as it is! Temp has risen about 0.2 degrees over the past 30 years. Makes for great warm swimming but not great in terms of flooding.



Let's bring this closer to home ...

10.11, revised to Fahrenheit for practice Too many constants and formulas needed to let them do