on 10/7/08 6:48 PM Mariella Dorr wrote:

I am pressed with time and see my group of middle graders on a six week rotation. **I need to come up with some interesting hands on activities for the different forms of energy.** We covered potential and kinetic energy through the use of pendulums. I have done many small experiments such as prisms refracting and reflecting light, rubberbands on match boxes, and closed and open circuits. Any fresh and simple investigations for light, sound, heat, radiant, electrical, chemical and mechanical energy?

Thanks

--

Mariella Dorr
Science Teacher (K-5)
Layer Elementary School
4201 S.R. 419
Winter Springs, FL 32708
Phone: (407) 871-8078

Have you looked at the NEED website? There is an extensive collection or all kinds of energy curricula: http://www.need.org/curriculum.php

Conoco Phillips also had some workshops and developed "Science of Energy" units which are available here: http://www.need.org/conocophillips/.

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Ellen Loehman
loehman@aps.edu

Mariella,

Showing conversions from one form of energy to another is always useful. For example, if the students shine light on a photocell and use it to power a small motor, they'll see the conversion of light to electrical to mechanical energy.

BTW, I'm curious as to why you include "radiant" energy on your list, as distinct from light and heat.

Regards,
Matt

==

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On Oct 8, 2008, at 8:38 AM, Matt Bobrowsky wrote:

Sorry, I should have said, "... as distinct from light." (Technically, heat does not radiate.)

Matt

I'm not sure what you mean by the statement "heat does not radiate."

Objects that are at a different temperature than their environment lose or gain thermal energy. One of the ways that occurs is by radiation. Heat is the energy transferred as a result of a temperature difference.

In the context of these ideas, I can't make sense of "heat does not radiate," since heat is not something that has a temperature.

wondering,

joe

ps, sorry about the cross listing, but this is a very important conceptual issue for both physics and elementary.

Joseph J. Bellina, Jr. Ph.D.
Professor of Physics
Saint Mary's College
Notre Dame, IN 46556

Sorry about the confusion, Joe. I'll try to clarify. We traditionally talk about heat transfer occurring by conduction, convection, or radiation. We're talking about the radiation part here. My point is that when an object cools by radiation, what's being radiated is electromagnetic radiation (infrared, mostly, until you get up to stellar temperatures). So, I was saying that one shouldn't talk about "heat" being radiated. For example, the energy we receive from the sun gets here in the form of electromagnetic radiation. Only after that radiation is absorbed by the earth do we have an increase in heat here. In short, what a hot object is radiating is E-M radiation, not "heat." That's the reason I was asking why "radiant" energy was on the list in addition to light.

Matt

Mariella, go to www.need.org and find a workshop or online materials. Their Science of Energy kit is excellent for transformations, and their EnergyWorks kit is excellent for learning the very basics of energy. I am using E.W. with my daughter's 4th grade class right now and they're really having a good time. You can e-mail them (info@need.org) to find out if there are any workshops coming up in your area.

Caryn Turrel
Greenwood, IN

Matt,
What I read into your description is a confusion between heat and temperature. The radiation that is absorbed by the earth increases the temperature of the earth. The transfer of energy from the sun is what we call heat, though some would like to abandon the word.
So I have to disagree with your last statement, hot objects in the presence of cool ones do indeed radiate and that is radiated we call heat. The result of the transfer of energy, is an increase in temperature of the cooler object, and a decrease in temperature of the warmer one, assuming of course no other sources of energy.

cheers,

joe

Joseph J. Bellina, Jr. Ph.D.

Matt Bobrowsky wrote:
Joe,

So perhaps we're talking about terminology here. You wrote:

> ... hot objects in the presence of cool ones do indeed
> radiate and that is radiated we call heat.

Yes, hot objects radiate and lose energy that way. But calling what is radiated "heat" is at least misleading, and, I would argue, wrong. Remember that heat is the random motion of molecules in an object. That is not what is radiated. Students should understand that it is E-M waves that are radiated. I wouldn't want to confuse them by calling that radiation "heat."

Matt

Matt,

"Heat" is any energy in transition from a hotter body to a cooler body.

The "random motion of molecules", that is, the "average random translational kinetic energy" of molecules determines the temperature of a body.

It appears you are confusing temperature with the transfer of thermal energy from a hotter body to a cooler body.

The best way to avoid confusion is to always think of HEAT as a VERB.

Brad Huff
Fresno, CA

I don't think that heat is defined as the random motion of molecules in an object.

My understanding is that heat is a process of transferring energy from a hotter object to a cooler one. Temperature is a measure of the average kinetic energy level of particle motion.

Ron Brandt
NJ

My understanding is that heat is a process....

Ron, heat is not a process; it is a form of energy.

"Heat" is any energy in transition from a hotter body to a cooler body.

Not necessarily. There's a difference between heat and light. The energy coming to us from the sun is light, not heat.

Matt

CRC -- 63rd ed. pg. F-95:

"Heat -- Energy transferred by a thermal process. Heat can be measured in terms of the dynamical units of energy, as the erg, joule, etc., or in terms of the amount of energy required to produce a definite thermal change in some substance, as, for example, the energy required per degree to raise the temperature of a unit mass of water at some temperature (calorie, Btu)."

Giambattista, et. al. "College Physics 2nd ed.", p. 488 --
"Heat is energy in transit between two objects or systems due to a temperature difference between them."

Ohanian & Markert, "Physics for Engineers and Scientists, 3rd ed.", pg. 629 --
"In the language of physics, heat is the thermal energy transferred from a hotter body to a colder body. The relationship of heat to thermal energy is analogous to the relationship of work to mechanical energy..."

If those definitions are used, I would argue that if the energy is transferred between the (hotter) sun and the (colder) earth, then it is a thermal energy transfer, regardless of the form the energy took in being transferred, if the transfer resulted in a measurable temperature change.

Peter Schoch

We could sit here and argue about this all day. The point is that there can be more than one way to define heat, and people are arguing about it from different definitions. If someone wants to post a thesis about the definitions of heat, feel free.

I don't agree. There are now national standards in science education, and agreed upon language among practicing physics and physics educators. It is now as arbitrary as you suggest.

Now I am no physicist, but I doubt that calling light a form of heat is a useful way to
circumvent student's conceptual confusion, unless you mean heat = energy.

We have alot to talk about.

Light is electromagnetic radiation just like infrared, they both are means of transporting energy from the sun to the earth. In that sense, both are a form of heat, the transfer of energy from a hotter object to a cooler one.

Please read Arnold Arons on teaching introductory physics.

joe

Interesting discussion. My opinion is that all of these definitions are human constructs that were developed from particular perspectives. Given our current understanding that things we call matter seem to morph into things we call energy at some level, and how all forms of energy interactions and matter-energy interactions seem to be mediated by

particle/wavelike exchanges, isn't it a spectrum if you look closely enough and at certain perspectives. When my fingers type the keys to this e-mail what type of energy do they transfer to the keys? Is it mechanical because the objects move, or electromagnetic that becomes mechanical because my finger and the key don't really touch but repel each others electron cloud of, or is it light that becomes mechanical because the repulsion is mediated by the exchange of photons, or....?
So, I think from certain perspectives it is not incorrect to think of heat energy and light and even mechanical energy and, yes, matter as the same thing

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Some history may be useful.

Joule's original work in the late 1700's.

He used a mass block and a system of pulleys, pulling on a stiring device (paddle wheel) in a can of water. As the block dropped, the stirring device turned and caused an increase in the temperature of the water. He was not only able to determine the kinetic energy equivalent of heat, but could determine the relative specific heat of liquid substances by repeating the same experiment with different fluids.

So heat is a form of energy, and heating is the process by which heat energy is transferred from a hotter to a colder object.

This, along with Lavoisier, was an important step in changng the understanding away from the previous caloric theory.

Ron Brandt
NJ

From: physics-request@list.nsta.org on behalf of Scott Orshan
Sent: Thu 10/9/2008 9:20 AM
To: physics@list.nsta.org
Subject: Re: Seven forms of energy

My contention is that there are only two real forms of energy outside the nucleus.

One is electromagnetic radiation, carried in photons.

The other is what we call Potential Energy - the energy stored by doing work against a restorative force. (Of which there are only two: gravity and electromagnetism.)

Everything else is another name for these, or some sort of aggregate.

(Kinetic energy is not real. If I change my frame of reference, I can make an object's kinetic energy change, or even go to zero. It's an artifact.)

Scott

On Wed, Oct 8, 2008 at 5:09 PM, John J. D'Alessandro <help@mrdalessandro.com> wrote:

Hi,

I am not a thermodynamics expert, but I do have a masters in physics, and I stress about understanding things I teach.

"Heat" is the energy transferred from a hotter object to a cooler object. The process is necessary for heat to exist, and there is no heat without the thermal transfer, but the heat is some form of energy.

"Temperature" is the measure of the average of the kinetic energy of the molecules of an object (relative to the center of mass of the object). It is a relation of the motion of the particles in the object, as well as the mass of the particles, and it really measures a very specific type of energy.

"Internal energy" is sometimes noted as the "molecular kinetic energy" as well as the "Potential energy" within the molecules and between the molecules, and relates to phase changes and total "heat content," which is not a frequently used phrase, as it confuses people in context of heat.

So, the example I give when comparing this is an iceberg in the arctic ocean.

Which has the higher temperature? Well, approximately, neither, as they are made of the same material and since they exist in a state AT the point of fusion, they must be the same state (I realize that the berg is more fresh water than the saltwater of the sea, but excuse that for the sake of argument). So, they should have the same temperature.

Which has more heat? NEITHER! AN OBJECT can not have heat. Heat is only in existence in the process of exchange. Why? That is the way it is defined.

Where is the heat? In this case, there is not ANY HEAT. Since they are the same temperature, on average, neither the berg nor the sea transfer energy.

Which has more internal energy? This is where the sea wins. It is HUGE, so it has a lot of mass, and it is liquid, so 1. even if its temperature (average molecular KE) is the same as the berg, there is more mass so more total KE and 2. the "stored" energy of the hydrogen bonds in the ice are broken, so we would have to take that energy out of the water to freeze it.

How can heat be transferred?
1. conduction...basically, the molecules of the hotter substance bump into

the molecules of the cooler substance more often and/or more energetically, so they on average give over energy to the particles of the cooler substance, making it hotter. Think if you have a bunch of boys playing tag (high particle activity) next to a bunch of girls reading (low particle activity). At the point where the groups meet, at times the boys will run in the girls, making them move (increasing the activity of the low side, while decreasing the activity of the high side). Assuming the some of the girls start to play tag, and some of the boys start to read, we have a system that came into equilibrium through conduction. The heat transfer is really a microscopic mechanical transfer of energy (and some little intermolecular EM...)

2. convection...basically, a large collection of molecules from the high temperature substance moves energetically into a cooler substance. This is boiling...large pockets of hot water end up going up to the cooler water all at once. Using the metaphor from above, this would be a group of the boys running headlong into the middle of the group of girls. Once there, some of the girls move over to let the boys play. The heat transfer is very much a mechanical transfer of hot stuff into cool stuff.

3. radiation...this is glowing. The sun radiates heat to the earth. It does so in the form of electromagnetic radiation, some of which is visible light. In this case, the light is heat. You and I glow because we radiate IR light into the cooler air around us (we just can't see in the spectrum, but the Predators can!) Since there is a transfer of energy from hot to cool, that energy is referred to as heat.

I hope this was helpful, not too boring, and not too condescending.
help@mrdalessandro.com

I have had great success with students thinking about potential energy as stored in fields. This makes much more sense that the energy being dtored in the object. For example, when we teach students to solve energy prolems involving gravitational potential enery, we say "the 2 kg mass has 100 J of gravitaiton potential energy because it is 5 meters above the ground." This is really incorrect. We should say "there are 100 J of energy stored in the graviattional field between the mass and the Earth. This is 100 J of energy that will be converted to other forms of energy if the object falls to the ground."

____

This was all good, but I disagree that an object doesn't have heat. It has internal thermal energy equivalent to the change in heat energy content between the temperature it's at and some reference temperature. We can refer all heat contents to absolute zero. It is BECAUSE of a heat content difference (a thermal gradient, if you will) that heat can flow "downhill" from a hotter object to a colder one.

--- Steve >>>>

I prefer to think of heat as the transfer of energy by contact, not by radiation.

Here's something to think about - If I transfer EM radiation from a cold microwave oven to a warm cup of water, it's going to make the water warmer. The radiation does not have to come from a "hotter" object (one with a higher temperature), just one that has an energy source that can be transformed into EM radiation.

If you stand too close to a powerful radio antenna, even if it it is outside in freezing cold weather, you will be warmed.

The only way that the definition of heat as the transfer of thermal energy from a hotter object to a colder object is fully true is when the transfer is by contact.

Scott

I can use the ***difference*** in kinetic energy to do work. Actually, I can't. Only a force can do work. Kinetic energy is a convenient mathematical construct to reformulate Newton's Second law, but you can't say that an object has a definite kinetic energy, since it changes with the reference frame.

In physics class, you would say that an object sitting on a table has KE=0, but viewed from the Sun, it has tremendous KE.

The only true physical relationships are Newton's Second, Coulomb's law, the equivalent for the magnetisim, and Universal Gravitation. These define the relationships between force and distance/motion. Everything else is derivative (not a calculus derivative).

Newton's Third also applies in principle. (There's no such thing as Newton's First - it's just Newton's Second with a=0.)

The whole universe of matter is made up of particles accelerating each other due to the fundamental forces between them, as well as the absorption or release of photons.

The only real fundamentals are Force, Position, Time, Mass and Electromagnetic Energy.

Scott

Matt Bobrowsky wrote:

Scott,

You can tell that kinetic energy is not an artifact since you can use it to do work. Or, you can convert it to one of the two forms of energy that you already recognize.

Matt

From: physics-request@list.nsta.org [mailto:physics-request@list.nsta.org] **On Behalf Of** Huffhaus
Sent: Thursday, October 09, 2008 3:56 PM
To: Scott Orshan
Cc: physics@list.nsta.org
Subject: Re: Seven forms of energy

Scott,

The only fundamental quantities are: Length, Time, Mass, and Electric Charge.

Brad Huff
Fresno, Ca

Hi, all,

I was really TRYING to ignore this thread…

The fundamental quantities are time, length, mass, temperature, electric CURRENT, luminosity, and amount of items. Here is the link to the Bureau of standards, http://www.bipm.org/en/si/base_units/, the people who set SI.

Just because you do not like other people's standards does not mean yours are better (or worse) or right (or wrong), but it does mean you are using non-standard definitions, and you have to be careful NOT TO DO THAT when you are an educator. We are conveyors of the present scientific paradigms, not the frontier-makers.

Kinetic energy is as real as any of the other forms. If two objects collide, they interact using forces. Absolutely. However, that interaction can be described using kinetic energy, also. There is no simple way to get rid of it by putting the observer in some other reference frame. The system of two objects would have the same conservation of mechanical energies in any reference frame, no matter what at any speed. So, it the KE absolute? No. Is it real? Yes.

There are still 4 real forces…gravitational, electromagnetic, strong nuclear, and weak nuclear. We have unified EM, Strong, and Weak in extreme conditions, but still not gravity. Gravitational PE, EM PE, and the Nuke PEs are real, and so is mass. We can convert energy from the last three forms to mass and we can convert mass into those forms.

The electromagnetic particle is just one particle that expresses these interactions. I am not a nuclear physicist, so I won't go into talking about gluons and such, but they are, normally, distinct particles. We have attempted to, unsuccessfully so far, find the particle or quanta of gravitational interaction, but it probably exists. Here is the wiki…http://en.wikipedia.org/wiki/Fundamental_interaction

About how real Newton's 2 is…It is a law, which makes it effectively a definition, to explain forces. What causes those forces? Newton never really said, and couldn't. It took Maxwell to lock up EM, Einstein to start to explain gravity. Newton is the old paradigm. We teach it, but it is not, in modern QM and relativity, "true." It is true at sublight speeds, and for every real-world problem, but it is not universally true.

So far, conservation of energy is literally, and universally, true (although, not in context of some forms of string theory) as long as we consider the mass-energy equivalence.

What are the real fundamentals? Planck's constant, the particles of interaction, the speed of light. Do we work at this level in high school? For the most part, no. Are they always going to be the fundamentals? Probably not.

So, in context, we can use Newton's laws, Coulomb's law, Plank's and Stefan-Boltzmann laws, and the 3+1 laws of thermodynamics. We NEED classical mechanics (including kinetic energy) to develop the laws of thermodynamics from scratch; it is even built into some of the definitions.

If anyone finds a credible source that disagrees with anything I have said, I would be ecstatic to read what it has to say. We, as physics teachers, are a smart bunch. We have to realize, though, that we also hold misconceptions and can learn for our entire lives.

Sorry about the rant. I hope I have helped some.

John

Disagree:

We as educators HAVE to be creative.
I have freshman measure by "hand" lengths and "gannon degrees" or any other.
But I agree with your tenant that we need to be CLEAR when we diverge from SI.
And yet to say don't diverge is like saying Pluto is NOT a planet...wellllll... some people defined it as such and just might "flip flop" (oooo I said that word) and change back or even come up with something new.

Overall, I agree, but.... we need to differ and be Creative can-do scientists.

BG

Joe Walsh wrote:

Hi Brad,

Are you saying that temperature can be derived from the average KE of a substance (and therefore from mass, position change or length, and time)? That makes sense. I do love to simplify. And how about luminosity? I can't reduce that to the combo of your 4 quantities since photons have no mass.

Joe

John

You are referring to scientific STANDARDS, not fundamental quantities.

Every measured quantity is a combination of one or more of the following: Length, Time, Mass, or Electric Charge.

Thank you for clearly discussing the four fundamental forces, and energy,

Brad Huff
Fresno, CA

Hi Brad,

Are you saying that temperature can be derived from the average KE of a substance (and therefore from mass, position change or length, and time)? That makes sense. I do love to simplify. And how about luminosity? I can't reduce that to the combo of your 4 quantities since photons have no mass.

Joe

When I said that the fundamentals of the universe are Force, Mass, Position, Time and Electromagnetic energy, I was saying that all phenomenon that we observe can be traced back to these basic building blocks. How we choose to measure these is another story.

I didn't include length, because that is derived from two positions. I don't include anything electromagnetic or gravitational, because I cover that under the fundamental forces.

At the High School level, you can take all of the natural phenomenon, energies, motion formulas, atomic theory, chemistry, biology, and trace them back to the above building blocks.

I don't think that students can have a true understanding of physics without their internal mental model converging back to the fundamentals. If you have an internal model for thermodynamics, and another one for force and acceleration, and they are not connected at the root, then the model is incomplete.

A student should be able to see that a force applied to part of a solid object causes the entire object to accelerate because the rest of it is dragged along by electric forces. They should be able to see that heat and sound are similar, having to do with the transfer of vibrational motion via the electric force.

They should know that mass is basically a count of the protons and neutrons in an object (modified a little by binding energy and the electrons, but fundamentally, it's the protons and neutrons).

I try to work from these fundamentals, and build up to the larger concepts.

Scott

I'm still trying to get a handle on the boundaries for what is considered radiative heating.

The standard definition is an object at a higher temperature sending out EM radiation in the infrared range, and causing a cooler object's temperature to rise.

What about an ice cold battery connected to an ice cold microwave transmitter, causing a nearby cup of water to boil?

What about a cold battery connected to a group of cold infrared LEDs, causing a nearby object to be warmed?

Suppose I have a metal pipe running along the wall. If I pass hot water through it, I'll be able to feel the warmth at a distance due to radiation. If I use the pipe as an antenna, and put high power RF into it, I will also feel warmed at a distance. Is one of these radiative heating, and the other not?

Does radiative heating have to involve IR? Does the IR have to come from a hotter object? Does the radiation have to be black body radiation, or can it be generated by directly converting chemical or electrical energy into the radiation, without having an actual hot object?

Scott

Joe,

First, absolute temperature is directly proportional to the average translational kinetic energy of the molecules of a substance, so it's fundamental dimensions are those of kinetic energy: ML^2/T^2.

Luminosity? That energy per time per area, so its dimensions are M/T, that is, ML^2/T^2 divided by TL^2.

Although photons are massless, Einstein's E = mc^2 fixes that. Photons have a 'mass' equivalence equal to their energy divided by the square of the speed of light.

Brad