Re: Mass and Energy

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From: Keith P Walsh (*keith.p.walsh_at_btinternet.com*)
Date: 09/03/04

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On 1 Sep 2004 09:47:47 −0700, hhc314@yahoo.com (Harry Conover) wrote:

>Keith P Walsh <keith.p.walsh@btinternet.com> wrote in message news:<uvi4j05bjh472rh47nv2dkkln9md39j2os@4ax.com>...
>>
>> "If you burn hydrogen gas in oxygen gas you create water, but you also
>> produce a lot of light and heat. Energy, or mass, has been expelled
>> from the material. So even before you make any measurements you can be
>> sure, by Einstein's rule (I.e. E=mc^2), that the water must be lighter
>> in weight than the hydrogen and oxygen that made it."
>>
>> I would suggest that anyone who is unable to recognise the veracity of
>> this statement doesn't really understand what the equation E=mc^2
>> means.
>>
>> Would anyone disagree?
>>
>> Keith P Walsh
>
>Sure Keith, I would disagree.
>
>First, whe you burn hydrogen gas in oxygen, the flame is essentially
>invisible.
>
>Second, the heat from a hydrogen/oxygen torch has a high temperature,
>but produces very little heat. In pop science demonstrations, this
>allow you to run your hand through the flame and then turn around and
>melt fused quartz.
>
>This impresses only the tourists in the crowd.
>
>Of course this is simply a demonstration of simple chemistry, and
>since the products of combustion of hydrogen and oxygen exactly equate
>to the mass of the inputs, E=MC^2 is not demonstrated.
>
>I believe you need to learn to distingush nuclear reaction from simple
>chemical reactions, as does Niger Calder (but this is only my
>opinion).

>
> *Harry C.*

Harry,

Thank you for your message.

I think that you have fallen foul of a common misconception, which is that since all of the atoms comprising the molecules in the reactants of this reaction can be identified and accounted for in the composition of the molecules of the products, then no mass can have been lost.

But the behavior of matter at this scale does not obey any such rule.

The amount of energy required by the various component atoms in order for them to exist in their "reactant state" is greater than the amount of energy that they need to exist in their "product state". The difference in energy between these two states is equal to the amount of energy given off in the reaction. (The combustion of hydrogen in oxygen is an exothermic reaction.)

I'm sure that you agree with this perfectly well so far.

However, in order to appreciate the true meaning of the equation E=mc^2, it is necessary to recognise that the energy given off in the reaction must have contributed to the mass of the reactants before the reaction took place. And that this amount of energy must be accounted for by a reduction in the total rest mass of the products as compared to that of the reactants.

In other words, if you measured the (rest) mass of the reactants (hydrogen and oxygen) the value you obtain would include a proportion which is equal to the energy given off in the reaction, according to the relationship E=mc^2.

And if you then measure the (rest) mass of the products (water), this amount of mass is missing because it has been released and dissipated to the surroundings as (different forms of) "energy".

In short, it is not possible to derive useful energy from an exothermal chemical reaction (or any other physical process) without there being some sacrifice of (rest) mass from the initial state.

An important point to note is that the misconception which I described initially carries the implication that the masses of molecular systems are defined absolutely by the numbers of the different species of atoms from which they are comprised.

This is not so.

The total mass of the system is also dependent upon the particular arrangement into which the atoms are combined.

For example, two moles of H2O weigh less than the combined weight of two moles of H2 and one mole of O2.

This is expressed by the equation:

2H2 + O2 = 2H2O + Energy

Remember that the "energy" in this equation is energy which contributed to the rest mass of the reactants, but does not contribute to the rest mass of the products.

And Nigel Calder and I are not the only people who understand this.

In all sincerity, and without any intention of gratuitous abuse, I believe that the lack of understanding displayed by your contribution to this discussion is typical of the widespread ignorance which exists, even in "scientific" circles, regarding these matters, and that this ignorance represents a serious obstacle to the advancement of a broader understanding of nature.

Keith P Walsh