

COMPILATION: Normal force + friction: one or two?

Date: Thu, 19 Dec 2002

From: Rob Spencer <rspencer@KIVA.NET>

Does anyone get any mileage out of calling the normal force and the friction force components of a single surface force? I realize that N and friction are related. μ is what determines the relative sizes of these components (as opposed to angles determining the relative sizes of components for forces like tension.). Any thoughts?

Date: Fri, 20 Dec 2002

From: Vonnie Hicks <VMHicks@AOL.COM>

Concerning Rob Spencer's view of friction and normal forces as being two components of surface force, I find that to be most useful. For instance, we always tend to talk about vehicles moving around a curve that is either flat or perfectly banked. When I took an actual picture of a motorcycle on a curve in a race - which curve was neither flat nor perfectly banked - as a practical application for AP-C, the problem was enormously difficult if Normal and friction were considered separately. But the net surface force, resultant of friction and Normal, exactly determined the angle of lean of the motorcycle and reduced the problem to F_{surface} and F_{weight} vectors only, summing to $F_{\text{centripetal}}$. A student figured that out about the third year I used the problem, and eliminated about a page of messy trig and simultaneous equations.

Date: Fri, 20 Dec 2002

From: Paul Gregg Swackhamer <pswackhamer@GLENBROOK.K12.IL.US>

Hi Rob,

Dwain Desbien of Estrella Mountain Community College (in AZ) makes a strong case for making the surface force one force.

I still use two forces, friction and support, because of their different mechanisms. Depends on what fish you are frying. *I like the mechanisms to be explicit...models of the supporting object, jagged, adhesive surfaces for friction and springy surfaces for support.* Dwain, if I remember his argument correctly, likes the elegance of the force arguments that a single force provides, and he has remarkable results from his students to back up his practice.

Date: Sun, 22 Dec 2002

From: Brenda Royce <brroyce@ATTBI.COM>

I had my own epiphany on why μ must be the ratio of F_f and F_n soon after getting involved in modeling (as I thought more about 'what does this mean?' for each part of the curriculum), and so have tried to integrate that idea into our discussion of friction. I have not referred to F_f and F_n as a single surface force, but rather as *two ways of interacting in the contact between two surfaces* (with F_f being zero if there is no 'attempt' to slide). One of my labs is to explore how these two are related.

I can't say it is understood as well as I would like even in the face of direct evidence and discussion (to give some context, I teach freshman physics in a college prep program), but students do seem to understand better now than before I tried to draw out this relationship. I suspect one of the conceptual problems behind the resistance is that students have a hard time letting go of the idea that weight and normal force are always equal, and so they think that it is the weight that affects the friction (and then layer that with some difficulty distinguishing weight and mass!). I do think *μ is better understood when they realize that the two forces MUST be proportional to one another because you can't change the way two specific surfaces interact without changing both F_n and F_f .*