**Thread NSTA Newton's 2nd law question**

Tue 10/18/2011 9:21 PM

On 18 October 2011 22:21, Nanette Fladung <[nanfladung@gmail.com](mailto:nanfladung@gmail.com)> wrote:

I'm looking at a lab that has student send a toy car down a ramp and measure the distance it travels.  Then they add mass to the car and repeat.  Again add mass and repeat.  
  
This is supposed to relate to Newton's 2nd law somehow.    
Acceleration should be the same for each car.... mass is changing.. and they are measuring distance?  
I can't see how this is supposed to relate to F=ma.    
  
Does more mass = more force = greater distance?    
  
If so how do I explain to the students that a greater distance is equal to more force?   
  
Or am I just totally off my rocker?  
  
Nanette

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**RESPONSES**

The key here is that "a" is "g", that is, the acceleration of gravity. And, that is constant. And, yes, with greater mass there is greater force - but the acceleration is constant and identical for all and everything.  
Cheers,  
Edward

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If I understand it right, the cart his the bottom of the ramp and rolls to a stop.  Acceleration on the ramp will be the same, but gravitational force on the larger mass is greater.  All runs have the same acceleration, so the ratio F/m is also the same for all masses.  The more massive cart hits the bottom of the ramp with the same velocity, but more momentum, mv.  The more momentum, the farther it coasts.

I’m not sure where the lab goes from there.  If they timed the car, they could work out the acceleration as it slows down, and calculate its velocity at the bottom of the ramp.  But that should be the same for each run no matter what the mass.   Maybe that’s the point?  
  
Bob Warzeski

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Dropping objects from a defined height will result in identical results, no matter the mass. However, the terminal momentium will increase with increased mass.  
If you have a class with fortitude, you may remind them of the Official Table of Drops, published by the Home Office of the British Empire and which relates to the length of hangman's rope to be used and which depends upon the weigh of the condemned in which the terminal momentium had to be sufficient to break the neck but not as much as to cause decapitation (as occured in Iraq).  
<http://en.wikipedia.org/wiki/Official_Table_of_Drops>

Edward Werner Cook [ewcook@caprilands.org]

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From: "E. Robert Warzeski" <robert.warzeski@att.net>

Date: Tue, 18 Oct 2011 22:20:18 -0500

To: Scott Fletcher <SFletcher@nwcath.org>

Conversation: Newton's 2nd law

Subject: Re: Newton's 2nd law

Nope. Gravitational acceleration is the same. Gravitational force is what we conventionally call weight, the "Force due to gravity". Weight depends upon mass. Gravitational acceleration does not. As long as the carts are rolling down the same ramp, at the same incline, they will all experience the same acceleration. Same principle as if they were falling vertically:

Everything falls at an acceleration of 9.80 m/s2 (near the surface of the

Earth) if you can ignore air resistance.

Bob Warzeski

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How far the car coasts shouldn't depend on its momentum but on its kinetic energy---IF the force of friction is the same on all. But friction is proportional to weight! So theoretically they should all coast the same distance too. Sounds like a terrible lab. Do something else.  
  
Richard E. Barrans Jr., Ph.D., M.Ed.  
Department of Physics and Astronomy  
University of Wyoming

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Robert's comment's are spot-on.

It is also ***sometimes easier to look at this situation using energy.***

Which car/mass combination has the greatest potential energy at the top of the ramp?

Which car/mass combination will have the greatest kinetic energy at the bottom of the ramp?

If an object has more KE than another object will it travel farther, the same distance, or shorter distance, other factors such as friction being equal?

Answers to these questions will drive your students to think about physics concepts in ways that can be verified by collecting data.

To bring the lesson home, ask students to share other situations where the same concept applies.  For example, when I used to take my kids sledding, I noticed that when we went down together on the same sled, we coasted a lot farther distance.  Why is that?

Making physics relevant to students' lives is a key ingredient to excite students about learning more about physics.

When I taught in the classroom I was always able to interest students to go deeper with their thinking when I challenged them that if they gain a better understanding of physics, they can apply that knowledge to be better athletes, dancers, musicians, etc.

Wayne  
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Greetings  
  
"The more momentum, the farther it coasts."    
  
This is not true. Momentum describes a property of a moving object. It's  magnitude is equal to its mass times its velocity. To change the momentum, an outside must act on the object to change its velocity.   
  
Once an object leaves the ramp, it will continue to move at a constant velocity unless acted upon by an outside force. Thus a force , not gravitational force, must act on the object to slow it down until it stops.  
  
a = F/m.  as I like to think about it, relates what happens to an object, F, and the effect on the mass, its acceleration. Once the force ceases to act, then a force acting on the object for a time t, determines how far an object will go.  
  
Dick

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I tend to agree that the lab is not great.  With that being said you've got:

Dr. Barrans saying:

*How far the car coasts shouldn't depend on its momentum but on its kinetic energy---IF the force of friction is the same on all. But friction is proportional to weight! So theoretically they should all coast the same distance too. Sounds like a terrible lab. Do something else.  
  
Richard E. Barrans Jr., Ph.D., M.Ed.  
Department of Physics and Astronomy  
University of Wyoming*

*On Oct 19, 2011, at 7:01 AM, Wayne A. Fisher wrote:*

and Wayne Fisher saying:

*To bring the lesson home, ask students to share other situations where the same concept applies.  For example, when I used to take my kids sledding, I noticed that when we went down together on the same sled, we coasted a lot farther distance.  Why is that?*

These seem to be opposed statements.  Now, the carts should be losing their energy through 3 areas:

1) rolling friction between the wheel and the ground (very minor loss).

2) Energy lost at the wheels' bearings. s.

3) Loss due to air resistance

Area 1's energy loss will be proportional to the mass - meaning they would end at the same point if this was the only loss.

Area 2's energy loss depends on the style of bearing - If the bearings are tightly held then the frictional loss won't just be due to the mass pressing on top of them, so the bearings might be losing a base amount of energy + an amount of energy proportional to the mass, or they could be losing it all proportional to the mass.  So this could cause a differential on where the items end up

Area 3's energy loss is not proportional to the mass at all, but is proportional to the area facing the wind - so most likely the energy loss due to air resistance will enable the cars to end at different spots.

However, Wayne Fisher's example seems to suggest that even for sliding friction that heavier items will stop later.  Unfortunately in the snow case there are two other possible things going on:

#1) Plowing into the snow - this is akin to air resistance - except that one might sink further into the snow complicating the matter

#2) Regelation - with snow the snow will melt with a heavier weight creating a water barrier that reduces friction!  But if you are under a certain weight (really pressure), this won't happen....

So what's going on is often a bit more complicated than we think.  Not a great lab for an introductory concept.  Because if they intend to show that the acceleration is the same, it may not show that with confidence.  If they intended to show that the different items stop further out (a very indirect argument for more force), then it may not show that with confidence. However in my experience most students though will easily buy into the argument that more force = more distance - and that's unfortunate, because that's not at all what Newton's laws say - in fact it may lend credence to Aristotle's old ideas that things in their natural state will rest.

I think a more typical way to do this is to have a mass hung over a pulley, pull a car (or even a block of wood) across a flat surface and time it.  Then you have known forces pulling known masses and you know the time it traveled a set distance.

-William

William Katzman

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