

October 8, 2013

Physics 131

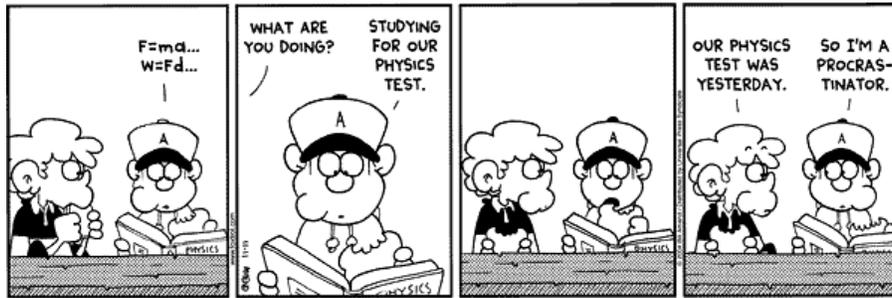
Prof. E. F. Redish

■ **Theme Music: Van Morrison**

Checkin' It Out

■ **Cartoon: Bill Amend**

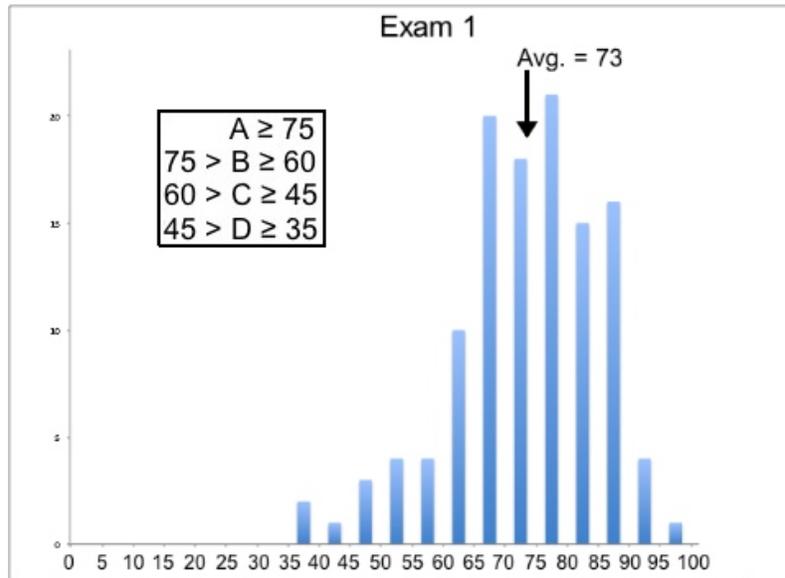
FoxTrot



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Prob.	#1	#2	#3	#4	#5
Max pts	25	25	15	10	25

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Results on individual problems

Problem 1	68%
Problem 2	87%
Problem 3	82%
Problem 4	76%
Problem 5	54%

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	1.1	1.2	1.3	1.4
A	0%	18%	42%	35%
B	20%	65%	6%	6%
C	63%	6%	1%	2%
D	0%	0%	3%	13%
E	0%	0%	17%	15%
F	1%	1%	1%	1%
N	15%	10%	29%	27%

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Problem 4

Two students, Justin and Taylor, are discussing Newton's third law, which says that when objects interact with each other they satisfy the following principle:

If object A exerts a force on object B, then object B exerts a force back on object A and the two forces are equal and opposite

They are asked to consider four situations concerning two identical cars and a much heavier truck.

- The two cars hit each other coming from opposite directions at equal speeds.
- One car is parked and the other car crashes into it.
- One car is parked and the truck crashes into it.
- The truck is pushing the car because the car's engine cannot start.

They are speeding up.

Justin says, "It will only hold in the first case." Taylor says, "No, I think some of the other cases might also work." What do you think?

Note: This is an essay question. Your answer will be judged not solely on its correctness, but for its depth, coherence, and clarity.

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Sample essay

Taylor is correct. N3 is an absolute for such physical situations. Justin may argue that $F=ma$ and therefore (Case 2) the cars should theoretically accelerate away from each other at the same acceleration. He is forgetting that $a = F_{\text{net}}/m$ is an equation that relies on NET FORCE and since the ramming car's wheels push against the ground much harder than the stationary car's, the net force acting on the cars is not the same so the accelerations of the cars will be different. For cases 3&4, the explanation is the same. As long as they are in contact, the car & truck are an N# pair. Once again, you must look at the NET FORCE acting on the objects to determine what will happen to them. We must also take into account mass to determine what the accelerations will be; since the truck has greater mass than the car, with the net force on both equal, the truck will accelerate as a lesser magnitude.

For case 4, the force of the truck on the car equals the magnitude of the force of the car on the truck. But looking at net force, the truck is being pushed by the ground harder than the car. Thus the net force for both the car and truck is "forward" (in the direction they both are moving).

Sample essay

I think Taylor is correct. Two objects that interact with each other will always exert an equal and opposite force on each other. So when the two cars hit each other, or the car and the truck hit each other, the forces exerted will be equal and opposite no matter what. What makes the cars move [change their motion] is the net force on each object is not 0. There is frictional force between the wheels and the ground that must be considered. The mass of the vehicles must also be considered. Acceleration is determined by the [net] force exerted on the object divided by the mass of the object. That is why even though the force exerted by the objects on each other must be the same, they can accelerate differently due to differing masses. Justin must be confusing force with acceleration. He thinks the cars must not move in order for the forces to be equal and opposite. This is not the case.

Foothold Principles Newton's Laws



- Newton 0:
 - An object responds to the forces it feels when it feels them.
- Newton 1:
 - An object that feels a net force of 0 keeps moving with the same velocity (which may = 0).
- Newton 2:
 - An object that is acted upon by other objects changes its velocity according to the rule $\vec{a}_A = \vec{F}_A^{net} / m_A$
- Newton 3:
 - When two objects interact the forces they exert on each other are equal and opposite. $\vec{F}_{A \rightarrow B}^{type} = -\vec{F}_{B \rightarrow A}^{type}$

Kinds of Forces

- Forces are what objects do to each other when they interact.
- Some Forces are touching, some at a distance
 - Normal Force N – Weight Force W
 - Tension Force T – Electric Force F^E
 - Resistive Forces f, F^D, F^V – Magnetic Force F^M
- Notation convention.

\vec{F} type of force
(object causing force) → (object feeling force)

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The Newtonian Framework helps us learn to see “hidden” Forces

- Contact forces are hard to measure directly.
- We infer them from Newtonian principles.
- Consistency is a good test as to whether our model of invisible forces is good (and sometimes we can actually measure them)

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Tension: The Spring

- A spring changes its length in response to pulls (or pushes) from opposite directions.
- A simple idealized model is Hooke's Law

$$T = k\Delta L$$

This is a useful model of any system that is stable and has restoring forces when small displacements are made.



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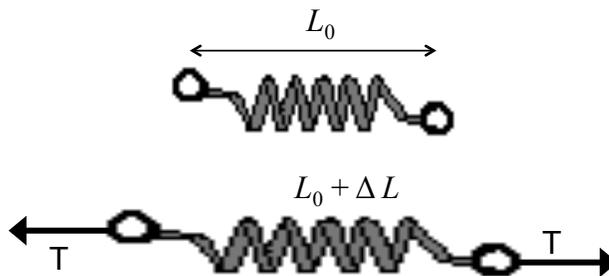
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Spring graphs



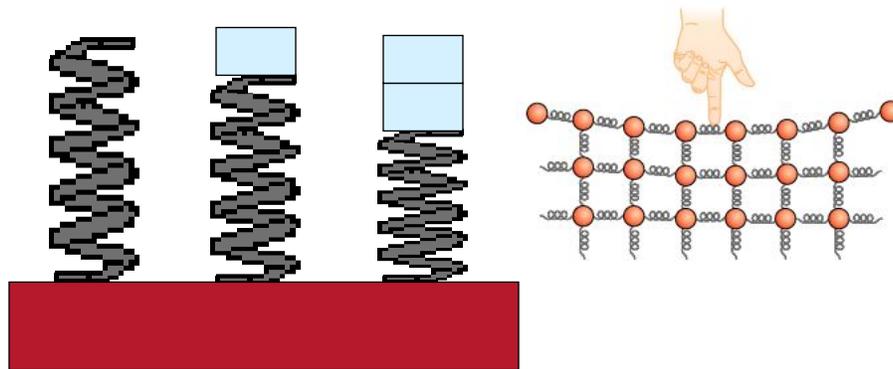
- What does a positive stretch of a spring mean?
A negative one?
- What does the graph of the force vs. stretch of a spring look like
 - For a Hooke's law model spring?
 - For a real spring?



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Normal Force works like a very stiff spring



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