

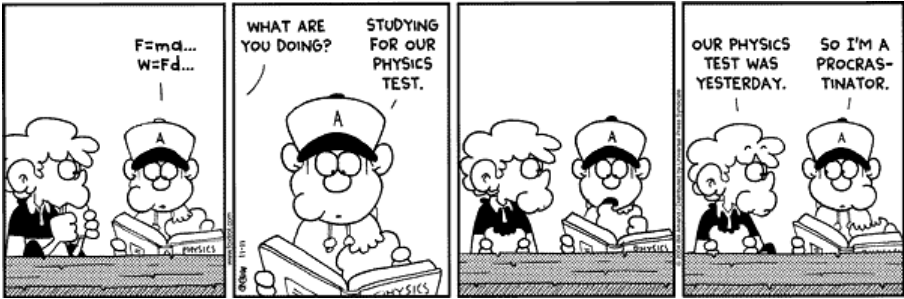
October 10, 2011

Physics 131

Prof. E. F. Redish

■ Theme Music: Van Morisson
Checkin' It Out

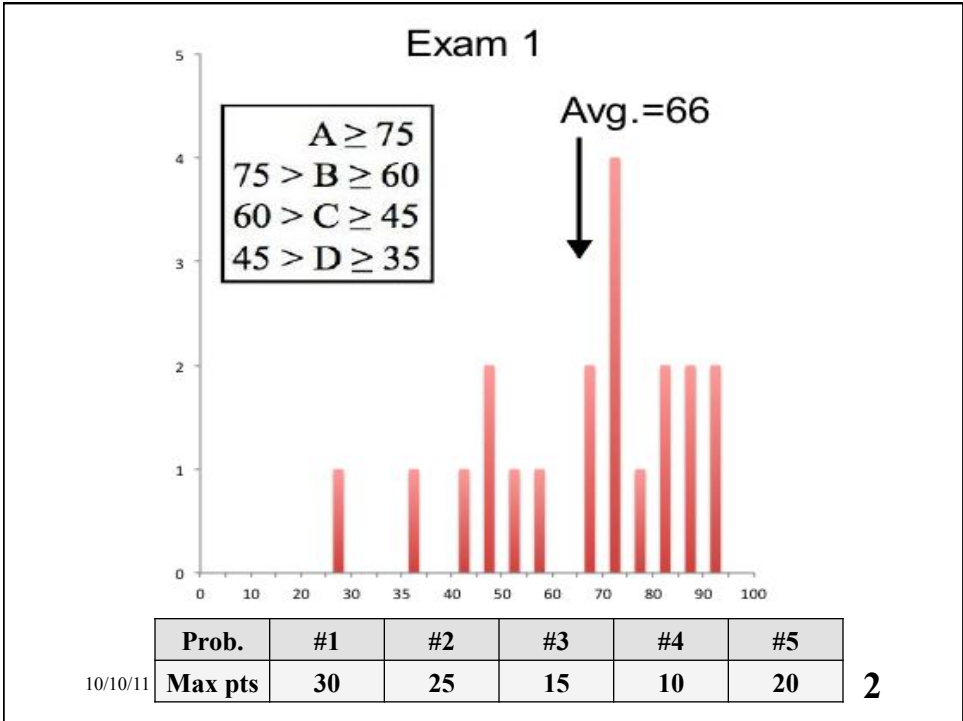
■ Cartoon: Bill Amend
FoxTrot



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Results on individual problems

Problem 1	71%
Problem 2	61%
Problem 3	64%
Problem 4	51%
Problem 5	76%

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	1.1	1.2	1.3	1.4	1.5	1.6
A	70%	5%	35%	30%	0%	5%
B	10%	5%	5%	15%	70%	5%
C	5%	0%	10%	5%	30%	90%
D	0%	85%	0%	0%	0%	0%
E	5%	10%	50%	35%	0%	0%
F	15%	0%	0%	15%	0%	0%

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Problem 4

Consider the following conversation between two biology students.

Liz: I work in a microbiology lab and in our experiments we are often manipulating the motion of objects suspended in a fluid. To get these objects to move at a constant speed, we have to apply a force that is proportional to the velocity of the object.

Jack: That can't be right. In physics, I learned that force is equal to the mass of the object times the acceleration of the object.

Do you agree with Liz or Jack? Are the perspectives of these two students consistent or contradictory? . *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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- I agree with both these students; their perspectives are consistent. Newton's 2nd law states that the force acting on an object is its mass times its acceleration. However, when an object is moving through a fluid, resistive forces must be taken into consideration. Viscosity is a resistive force that occurs when an object is moving through the liquid. This viscosity force is directly proportional to the speed of the object. Therefore, in order to move at constant speed, the applied force must be directly proportional to the velocity, as Liz says. However, this is not to say Jack's statement does not hold true. The acceleration of the object will still be the net force divided by the mass. Newton's laws are the framework for all motion.

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Depending on the situation, both can be correct; Jack, because according to N2, $F^{\text{net}} = ma$. Therefore, applying a constant force will increase the velocity... However, this situation will only occur when there are no opposing forces resisting the forward motion. In reality, an object moving in fluid will experience viscosity and drag forces and that will resist the applied force. In order to move an object at a constant speed a constant force must be applied that is equal and opposite to the sum of the resistive forces. When this is also the case, Liz is also correct. If you want a higher velocity, you need to apply a larger force, which will then be opposed by a larger resistive force as well. This is what Liz means by applying a force that is proportional to an object's velocity to maintain a constant speed. At constant velocity, $F^{\text{net}} = 0$, so $a = 0$ and F^{net} is still $= ma$. Therefore, both are correct.

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