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Teaching College Physics

Teaching college students' physics is a challenge. I teach physics at TCI The College of Technology located in New York City. The college was founded by Guglielmo Marconi in 1907. I teach in the EET (Electronic Engineering Department). Our college is accredited by The Middle States Association of Colleges and Schools, and the New York State Department of Education. In addition the EET Department is accredited by TAC of ABET. The program is designed to last 4 semesters and the degree awarded is AAS.

The college today has over 4000 students and 100 different languages are spoken. Students are represented by two classifications, foreign students and inner city students. Those students in the EET department have a desire to learn. The foreign students usually have a strong academic background but they frequently have difficulty with English. The inner city students usually have a mediocre academic background and require remediation.

The challenge of teaching physics is ongoing. When I started to teach, I taught the lessons the same way I was taught. When I went to MIT, I attended lectures and had recitation classes to review problems. The professor wrote problems on the board and then solved the problems. This method does not work at our college. Although students take notes, they usually do poorly on examinations.

It was at a workshop I attended for college professors given by Prentice Hall where I first heard that graduates of Engineering and Engineering Technology programs are very proficient in fixing things however, if you ask them to explain how they fixed it, they do so very poorly. Even if you ask them to write a paper explaining how they fixed something they are unable to do so with any competence. The lecturer said that Engineering and Engineering Technology students are very deficient in written and verbal communication and encouraged us to attempt to correct these deficiencies.

The lecture gave me the impetus to have all of my students write compositions about the current physics chapter we were working on. I soon changed the writing requirements from manual to using Microsoft Word because so many students had poor handwriting. I instructed the students on how to make an email form which they could use for their compositions. The students were then required to attach the composition to an email and then send the email to me.

Figure 1 is a paragraph from the physics PHY201 syllabus .
WRITING:

Each week students are required to write a composition about the chapter. The composition should be saved as a word document and submitted As an attachment by email.
Figure 1

The student compositions where now easy to read but usually were not very interesting. To help my students improve their understanding of physics I decided to have them write about the homework problems. Physics problems are usually a minimum of four or five lines. Students are required to solve the problems. The most frequently asked question is, "What equation should I use to solve this problem?" I explain that in the Scientific Method one of the first steps

is to formulate the problem. I point out that before you formulate a problem you have to understand the physics of that problem.
In the classroom, when problem solving is the objective, I start solving homework problems by asking students to read the problem out loud. As they read the problem, I draw a diagram of the problem on the board. I often have students read the problem again to make certain that my picture contains all of the data presented in the problem. I ask the students to read the second problem and at the board I draw a second diagram. Usually four diagrams are on the board before any equation is written.

Next I return to the first diagram and ask the class to look at their text books to see if using the diagram I can explain the problem. If I missed a fact or wrote an error on the board, students will suggest a correction. When I can look at the board and tell the students what the problem is about, they are impressed. So then I say "A picture is worth a thousand words."

At this point I ask "What law of physics is applicable to each problem?" When the class decides on the proper law of physics, I write the first equation which will be used to solve the first problem. After each diagram has an equation I proceed to solve the problems. Frequently students say you make it look so easy. I explain that when you understand the physics the solutions seem easy. After all of the problems have been solved, I usually select the hardest problem and then ask a team to come up and solve the same problem. My students are placed in teams. To familiarize the students with great physicists I choose the names of teams to be Maxwell, Fermi, Einstein, and Newton. I would ask the Newton team to come to the board and explain the most difficult problem on the board which I have already solved.

The first student usually begins with the equation. I say," stop", and the second student is called upon. I say, "Please start from the beginning and explain the physics of the problem." Then, I say "Explain how to solve the problem." I teach the students not to substitute numbers into the solution until the second to the last line. This enables the students to check the dimensions on each side of the equation. This checking insures that the result will be dimensionally correct. I explain that when the solution is algebraic you have solved a thousand problems. However, once you insert numbers into the problem you have solved only one problem.

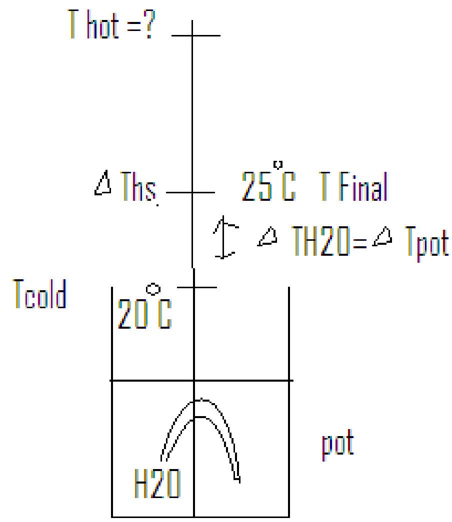
Each Newton team member explains the problem. At the conclusion the team asks the class a question. "Have we have explained this problem properly and do you have any questions? " There are times that I will ask" What would happen if the initial conditions were changed?" This question enables the students to have a better understanding of the physics of the problem.

Then I tell the entire class to go to the computers and write about this problem.The class sees my solution and then listens to three students explain the same problem. Then they write about the problem. This method has improved my students' comprehension and enjoyment of physics. Their enthusiasm towards physics is gratifying.

Below are three sample compositions written by students in my physics class.

Composition 1

The problem is that a hot iron horseshoe of a mass 0.4kg just forged and is dropped into 1.05L of water in a 0.3kg iron pot with an initial temperature of 20.0°C. if the final equilibrium temperature is 25.0°C, estimate the initial temperature of the hot horseshoe.



We are looking for the initial temperature of the Hot iron horseshoe before it was dropped in the water. We can find the initial temperature by looking for the temperature change between the hot horseshoe and the equilibrium temperature of the pot, water, and horseshoe. The change in temperature for water and pot is 5°C.

The iron horse shoe lost heat when it is placed into the water, and water gained heat vice versa. So the change in heat of the horseshoe is equal to the change in heat of water plus the pot.

$M_{HS}C_{HS}\Delta T_{HS} = M_{H2O}C_{H2O}\Delta T_{H2O}+M_{pot}C_{pot}\Delta T_{pot}$ solve for ΔT_{HS}

$$\Delta T_{HS} = \frac{M_{H2O}C_{H2O}\Delta T_{H2O}+M_{pot}C_{pot}\Delta T_{pot}}{M_{HS}C_{HS}}$$ now substitute the known values.

$$\Delta T_{Hot} - 25°C = \frac{1.05_{kg}x4186_{J/kgc}x5°_{C} +0.3_{kg}x450_{J/kgc}x5°_{C}}{0.4kgx450_{J/kgc}}$$

$$\Delta T_{Hot} - 25°C = 125.84°C$$

from the table on page. 499
specific heat for
Liquid Water=$4186_{J/kgc}$
Iron=$450_{J/kgc}$

ΔT_{Hot} is equal to 125.84°C plus 25°C which is around 151°C.

This composition illustrates the concepts equating the heat lost to the heat gained in a heat transfer process.

Composition 2

Gauss's Law which is explained in Chapter 22 helps us to understand the relationship between electric charge and electric field, which gives us the equation $\oint \mathbf{E} \cdot d\mathbf{A} = \frac{Q_{encl}}{\epsilon_0}$.

The field just outside a 3.50-cm-radius metal is 2.75 x 10^2 N/C and points towards the ball. If asked to find the charge that resides on the ball we can find out the charge thanks to Guass's Law. We know that we don't have to integrate so we can simplify Gauss's Law to $\mathbf{EA} = \frac{Q_{encl}}{\epsilon_0}$. Since we are trying to find the charge we can solve for the equation $\mathbf{EA}\epsilon_0 = Q_{encl}$. We know that the area of a sphere is $4\pi r^2$ so we can substitute this for A and get the equation $\mathbf{E}4\pi r^2\ \epsilon_0 =$

Q_{encl}. We can go on to substitute because we now that $k = \frac{1}{4\pi\,\epsilon_0}$. Based on this we can $\frac{Er^2}{K} = Q$. The reason we come to this equation is based on the information we are given. We know that the energy of the sphere is 2.75 x 10^2 N/C and the radius of the sphere. Given these two facts we can find what the charge is, which is -3.74x10^{-11}C.

This composition illustrates how to calculate the charge on a conducting sphere using Gauss's Law

Composition 3

Hello my name is T M and I want to talk about chapter 29 problem #12, with is a loop passing through a magnetic field of 0.65 Tesla, and we are trying to find out how much force is in the loop when it is in the magnetic field. 25% of the loop is in the field. The length of the loop is 0.35 meters, the height is 0.375 meters and the resistance is 0.28ohms. The loop is passing through the field with a velocity of 3.4 meters. We are going to first find the area of the loop that is inside the field, which is L*H, which would be 0.35m * 0.375m and that, would give us 0.13 meters squared. Then we are going to find the magnetic flux with is the magnetic field times the area, which is 0.65 Tesla times the loop of area in the field. So that would be 0.13 meters squared times 0.65 Tesla, and that would give us 0.08 Tesla meters squared. Now we are going to find the time of the loop passing inside the magnetic field, which is equal to the distance over the velocity which 0.375 meters over 3.4 meters per second with gives us 0.11 seconds. Now we are going to find the voltage, which is the area of the loop that is inside the magnetic field over the time, which would be 0.08 Tesla meters squared over 0.11 seconds, which would come out to 0.72 volts. Next we are going to find the current which is the voltage over the resistance that would be 0.72 volts over 0.28 ohms and that would come out to 2.57 amps, then we are going to find the power which is the voltage times the current and that is 0.72 volts times 2.57 amps and the power would come out to 1.85 watts. So now we can find the force of the part of the loop that is inside the magnetic field, which would be power over velocity and that would be 1.85 watts over 3.4 meters per second. So the force would be0.54N.

This composition explains how to calculate the force necessary to remove a circular loop from a magnetic field.

It is a goal of physics teachers to inspire the students with the world of physics. Students often consider physics as mathematics. It is a privilege to teach physics and to try to increase the knowledge transfer to my students.