

Re: Capacitor and Force

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- *From:* "Jon Slaughter" <Jon_Slaughter@xxxxxxxxxxx>
 - *Date:* Sun, 14 Oct 2007 00:19:18 GMT
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"The Phantom" <phantom@xxxxxxx> wrote in message
<news:nji2h3t085k1vn56l672m34qh80ov8b994@xxxxxxxxxxx>

On Sat, 13 Oct 2007 17:15:03 -0500, "Jon Slaughter"
<Jon_Slaughter@xxxxxxxxxxx> wrote:

<SNIP>

Jon, please consider this simple example; perhaps then you will see why Phantom's explanation is right on. Consider two point charges, let's say equal magnitude and opposite polarity, separated by a distance x . They are attracted with force F . If I have another identical pair, they will also be attracted by F . So if the two pairs are at a distance from each other much greater than x , the total force will be $2 \cdot f$. But if I bring them together, so the like charges are at the same points, the force will be 2^2 or 4 times as much. OK? It really DOES matter how in space the charges are distributed.

I never said it didn't matter.

Cut and pasted right out of your post of 10/12/07 5:18 AM with an obvious single letter typo fixed:

"If you have charges then you have forces. Some think that the

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distribution
matters but it doesn't."

Its nice how you take it out of context. BTW, theres nothing in the quote that says volume integrals are wrong or anything.

It says distributions don't matter and they don't because all are done the same way... by a volume integral. Any one is conceptually the same as any other.

Now maybe I said that when you reduce the plates to a point that it doesn't matter and I guess it shouldn't have said that... but for an approximation it shouldn't as you can assume point charges and get a resonable approximation in most cases(if the two ojects are far enough apart then it will work just fine).

Take two plates 1m x 1m and put them 100000m apart. Don't you think that for all practical purposes each plate looks like a point charge to the other? Why? Because the vector between any two "charges" is approximately if the plates were pointed...

i.e., $1/100000$ is very small. In the case of two plates very close one has L/r where L is very large compared to r so the ratio is large and the vectors have a wide range of angles.

volume integrals are not exact.

They are exact if the object being analyzed is a mathematical construct. If the object is real, like the earth, then we can't do a volume integral because we don't have a mathematical description of the density at every point in the interior.

Physics is used to describe reality.... everything is a proximation and there are no mathematical exacts. Hence sometimes getting an order of magnitude appromixation is good enough.

Its a matter of how accurate one wants and I was just trying to estimate the result. The problem is that I was calcuating the force between all charge "pairs" which is Q^2 but this is wrong because its more like Q^2/A . So my estimation was flawed and not the fact that I can't assume they are concentrated at a point. Its just that when I do that I should have realized what I was doing which was

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essentially making the interacting force the same for all charged particle pairs (this is not true for plates... just take the opposite corner of the opposite plate).

1 2
* *
* *
* *
* *
* *
* *
* 3

if 1 and 2 are the particles that we are trying to find the force on then its simply Coulombs force. But with 1 and 3 its also coulombs force but the component in orthogonal to the plate is very small... I did not take this into account in my approximation. Essentially what I did was treat the force between 1 and 3 as the same as 1 and 2... hence the grossly over approximation. Bu only looking at the forces between directly opposite charges (like 1 and 2) then its much closer and should be a lower bound.

e.g.,

1 2
3 4
5 6
7 8

and compute the forces between 1 2, 3 4, 5 6, etc.. and add them up. In this case since they are all the same (because of the approximation) its really just as if they were point charges but we have $k \cdot (Q/A)^2 / r^2 = \text{force between 1 and 2}$. Now adding all the forces on one plate is same as multiplying by A so that its $k \cdot Q^2 / A / r^2$.

This of course assumes all forces that are at angles, like 1 4, 1 6, 1 8, etc.. are 0. This is not the case but for small d most of the orthogonal components are very small.

As Phantom says, the SAME is true for gravitational attraction; two massive plates separated by x where x is small compared with the extent of the plates will not be attracted with the same force

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as two
point masses separated by x .

Hmm, so what your saying is that the force of gravity due to the earth, i.e., $m \cdot g$, is wrong?

What your saying is that any time someone wanted to calculate there weight they would have to compute a volume integral?

This is simply not true. We assume the earth as a point mass and compute its force.

What I said was:

"It's true that in the gravitational case the concept of a center of gravity can be used, but how do you think the location of the center of gravity is found? In extended bodies with a high degree of symmetry, such as a sphere, it's obvious where it is. But in the general case, you must integrate over the volume of the object."

duh. I don't know what your caught up so much about volume integrals. Obviously you have to do that in any case. everything involving volume in volume integral. thats what the hell volume integrals are for... to do calculations over volumes...

But let me see you do even a simple volume integral that is not a special case found in a calculus book by hand. Now do two nested volume integrals and lets see how far you get.

The fact of the matter is, you can say what you want but everything in physics is a approximation... and guess what? All those volume integrals your caught up on... they were derived by approximations(that is how you prove integration in the first placed and that is how all integrals(lebesque, stieljies, reimann, gauge, etc..) are all defined.

When the is a high degree of symmetry then one usually uses that to simplify the problem if doing it by hand.

Of course, in the case of a real object such as the earth, we can't do a volume integral because we don't have a mathematical description of the density at every point in the extended body; we must simply measure the force. Having done so, we can treat the problem as though the entire mass were concentrated at the center of gravity, as I never denied, but plainly

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asserted.

Well, your hung up on volume integrals likes something special. Its basic calculus. But you have an easy time saying that one should use them... I challenge you to compute the total force between two parallel plates using the the full volume integrals(or even surface integrals if you want). You cannot use the approximation that the site you gave uses where the plates are infinite, i.e., where E is constant between the plates and there is no fringe effect.

I'll be waiting for your solution, in full, to the problem. Lets see how far you really get.

Do you even happen to know what an elliptical integral is? if not then your going to have a lot of fun.

e.g.,

$$F = G*mE*m/r^2 = m*a ==> g = G*mE/r^2$$

which works

$$mE = 5.97*10^{24} \text{ kg,}$$

$$G = 6.67*10^{-11}$$

$$r = 6.356*10^6$$

and gives $g = 9.8 \text{ m/s}^2$

So assuming points isn't a wrong idea as you and phantom are trying to make

it out to be. The problem is that it needs to be applied correctly which

I

didn't do. Theres nothing wrong with assuming point charges for a first

approximation though... don't know why you guys are trying to make it out

to

be bad.

Because it gives answers that are wrong by orders of magnitude? That's hardly what I'd call even a first approximation.

Nope, it was actually only off by a factor of 2. I made a mistake in the logic which is why it was so wrong... that is not hte fault of the approximation by my fault for using bad logic.

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Guess what? even the site you used to prove me wrong, which I have no problem with that specifically as it showed me that I was in error, is using an approximation.

The problem I have with you is that you keep bring up volume integrals like its a big deal. Its not. Its basic calculus. Almost all volume integrals are intractable and initially that is what I actually did but couldn't compute the integral... even had maple try and it came up with nothing...

but since your a genius with volume integrals I want to see you do it. (what it sounds like is you like tossing the word around but you have no experience with them.)

Again though, if you think computing two nested volume integrals is fun then
by all means go ahead and do it. I'll be waiting for your result.

It's not a matter of fun. It's a matter of getting the correct result.
And you can find a lot of this sort of thing worked out in Roark's Formulas:

http://www.amazon.com/gp/offer-listing/0071210598/ref=pd_bbs_sr_olp_1/102-8481842-1092946?ie=UTF8

if you don't want to do it yourself, or if you want to check your own results.

Actually I have enough books... but when you can show me your work for the parallel plates

Here's the integral you have to compute, I'll write it as a surface integral since that is more appropriate for this case.

We will assume the surface charge density is constant to make your life much easier (of course your not even going to attempt to do them... doubt you ever actually did a surface integral in your life)

$$k \cdot (Q/A)^2 \cdot \left(\int \int \frac{dS_1 - dS_2}{|dS_1 - dS_2|^{3/2}} \right)$$

where, of course, the integral is the differential form of coulombs law, i.e., $dF = k \cdot dq_1 \cdot dq_2 \cdot r / r^3$.

It sounds to me like you don't know much about what your talking about. True you see see my problem after you found a site that did a similar example but from your first post

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$$F = k \cdot (CV)^2 / r^2$$

So for a ceramic capacitor of 20nF with $V = 20V$, $F \approx 3.6N$.

The $(CV)^2$ term alone has a value of $16 \cdot 10^{-14}$, so the force can't be anywhere near 3.6N"

is just utter nonsense and says you have no idea what your talking about(because its basic algebra to see your wrong). Shit, there are two other factors involved there yet you completely ignore them like they have no effect(and it really only takes r).

But even if I ignore that as a lapse of ignorance there still ist he problem of you tossing the term volume integrals around like it means something. Believe me, I do know that any time your doing with any type of object and you are computing something over that object you must integrate(even if its a point).

But since you throw it around willy nilly it sounds like you actually never computed one or you would know that its not an easy thing and in general can only be done numerically. Now this case we have a nested integral and so its going to be 10 orders of magnitude more difficult except in special cases where there is a high degree of symmetry(the highest being a point).

Again though, since you seem to love doing volume integrals I'd like to be shut up by having you compute the one above(for all I know you might be able to do it but I seriously doubt it). Of course I'm sure if you do do it then you will make some approximation somewhere(such as the normal force is constant everywhere) and you might actually be able to do it. (but I want to see it in the general case that I described above).

Its one thing to be able to toss these terms around but do you actually have any practical experience with them?

Again, my first approximation, when corrected, is not bad at all. (it would be worse for extremely small r of course). So I'm glad you brought what you said to my attention so I could correct the approximation but I hope you see that its not wrong(after all its an approximation). But I hope you realize that your volume integrals are not as ubiquitous as you think. Whats the point of using the volume integrals if you cannot compute them. (sure you can do it numerically but in this case it is actually somewhat difficult because of the time complexity in the general case(since its 6 integrals))

Usually one starts with a first order approximation and moves on when they need better approximations. I have mine with my corrected approximation. Its good enough for what I am doing. Maybe later I'll try to find a better one or use the ones that already exist for constant force. In any case I

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want you do solve the surface integrals I have since you seem to think they are easy.