TIPS FOR TESTS

I want you to approach "solving a problem" as an *expert* does, that is someone with a good physics background. There are no hard-and-fast rules but you might want to follow this strategy or, at least, keep it in mind. I try to follow this approach when I solve problems for you in-class.

Model the problem: (a) try to associate the problem with the appropriate physics principles, or models or equations that apply, e.g., motion in one-dimension, Newton's second law, conservation of energy, and (b) write down any reasonable assumptions or estimations that you think you may need to solve the problem (not always necessary).

Visualize: (a) Draw diagrams to help you visualize the problem, including a coordinate system. Show the direction of motion (the velocity, the acceleration, etc), or the forces, etc., using arrows to indicate their direction. (b) Write down the relevant *known* quantities and *unknown* quantities. (c) Don't be afraid to draw additional diagrams, sketches or plots to help you identify the physics of what's going on in every part of the problem. (d) At this stage you should have developed a step-by-step strategy for how you are going to obtain the solution.

Solve: (a) Write down the *relevant* general equations (**not** every equation you can think of!) . (b) Solve for the required unknown quantity; this step will likely require manipulation or the combining of several equations. (c) Don't be tempted to substitute numbers into equations until you have developed the strategy for solving for the required unknown quantity. (d) When you input numbers in to the equation(s), make sure they have the correct (SI) units.

Assess: Check your answer by asking the following questions. (a) Are the *units* correct? (b) Does the result have the correct *sign* or *direction*? (c) Does the result make *sense*?

In order to receive full credit for numerical problems on a test, you **must show your working** in an orderly and clear way. That means, if you follow the strategy I describe above, you will have to

(a) draw a sketch,

(b) show the equations and expressions you are using, and

(c) show your progression through the problem in a step-by-step fashion.

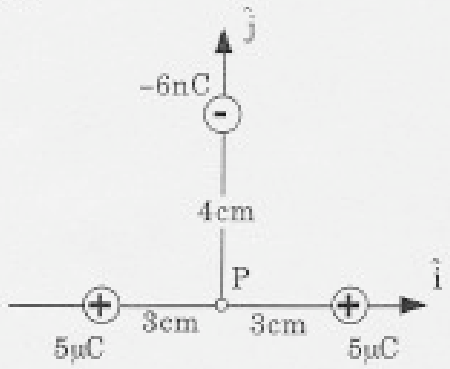
You will note that is exactly what I do when I work through problems in class. ***DO NOT SIMPLY PUT A COLLECTION OF NUMBERS ON THE PAGE AND CHECK AN ANSWER WITH NO EXPLANATION***.

On the next three pages I provide "real life" examples taken a test of ***what you should try to do*** and ***what you should try to avoid***! You will see that in the "good" examples it was very easy for us to see what was being done and if there had been any mistakes, we would have spotted them. Solutions like these are easy to grade and, if there's a simple mistake, we can award partial credit. Please try to provide solutions like the good examples. If you follow the rules outlined here, it will be much easier for us to award partial credit and so your test scores should improve!

If you follow these general rules you will certainly get better test scores. Use this approach when solving the homework problems or the on-line test problems and it will become familiar to you.

Below is an excellent example of how a question on a test should be answered. Note, there is a sketch identifying the forces, which were labeled. The expressions used to determine the forces and the electric fields were clearly written out and the calculations followed an orderly pattern. Try to follow this example (please)!

[1]



Two, 5μC point charges are placed on the x-axis at distances of ±3cm from the origin, P, as shown alongside. A third charge, of −6nC, is placed 4cm from P along the y-axis.

(a) What is the force on the −6nC charge?
(b) What is the electric field at P due to the three charges?

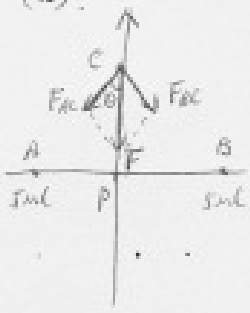
Give your answers in terms of the unit vectors $\hat{i}$ and $\hat{j}$.

(a)
- ○ $1.73\hat{j}$ N
- ✗ $-0.173\hat{j}$ N ✓ (2)
- ○ 0
- ○ $-3.46\hat{j}$ N
- ○ $3.46\hat{j}$ N

(b)
- ○ $(10.0\times10^{7}\hat{i}+3.38\times10^{4}\hat{j})$ N/C
- ○ $3.38\times10^{7}\hat{j}$ N/C
- ○ $-3.38\times10^{4}\hat{j}$ N/C (2)
- ○ $(5.0\times10^{7}\hat{i}+3.38\times10^{4}\hat{j})$ N/C
- ✗ $3.38\times10^{4}\hat{j}$ N/C ✓

SOLUTION:

(a).



$F_{AC} = k\frac{Q_A \cdot Q_C}{r_{AC}^2} = k\frac{Q_B \cdot Q_C}{r_{BC}^2} = F_{BC}$

$= 9.0\times10^{9} \times \frac{5\times10^{-6}\times6\times10^{-9}}{(\sqrt{3^2+4^2}\times10^{-2})^2}$

$= 1.08\times10^{-1} \doteq$ ~~1.08~~ N
0.108

$|F(\hat{j})| = F_{AC}\cdot\cos\theta + F_{AC}\cdot\cos\theta$

$= 0.108 \times \frac{4}{\sqrt{3^2+4^2}} \times 2$

$=$ ~~3.64~~ 0.173 N
(pointing downwards)

(b). $E_P(\hat{i}) = k\frac{Q_B}{r_{AP}^2} - k\frac{Q_C}{r_{BP}^2} = 0$

$E_P(\hat{j}) = k\frac{Q_C}{r_{CP}^2} = 9.0\times10^{9} \times \frac{6\times10^{-9}}{(4\times10^{-2})^2}$

$= 3.38\times10^{4}$ N/C.

$\therefore \vec{E}_P = 3.38\times10^{4}\,\hat{j}$ N/C. ✓ 6

$F(\hat{i}) = F_{AC}\cdot\sin\theta - F_{BC}\cdot\sin\theta = 0.$

$\therefore \vec{F} = -0.173\,\hat{j}$ N.

(2)

Here is another problem with a well structured answer. Again, there is a labeled sketch and the expressions used in the calculations are shown. It is easy to follow the working ... had there been an error, we would have easily spotted where it occured. Please try to provide solutions like this example!

[2]

Two table tennis balls, each of mass 10 gm, carry equal charges. One is fixed at the bottom of a 30° incline while the other is on the slope, as shown. If the separation between the balls is 15 cm, (a) what is the charge on each ball? (You can neglect the gravitational attraction between the balls and any frictional forces.)

- ○ 1.10×10^{-3} C
- ○ 1.23×10^{-6} C
- ✓ 3.50×10^{-7} C
- ○ 4.95×10^{-7} C
- ○ 1.22×10^{-13} C

(b) If, instead, the distance apart was twice as large (i.e., 30cm) what would be the "new" charge on each ball?

- ○ 4 times bigger.
- ✓ twice as big.
- ○ one-half as big.
- ○ one-quarter as big.

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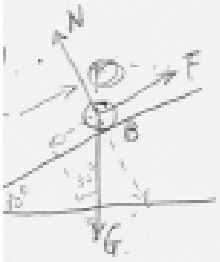
SOLUTION:



(a)

For ball B, $F = G \cdot \sin 30^\circ = k\frac{Q^2}{r^2}$

$10 \times 10^{-3} \times 9.8 \times 0.5 = 9.0 \times 10^9 \times \frac{Q^2}{(15 \times 10^{-2})^2}$

$Q^2 = 3.50 \times 10^{-7}$ C

(b) If $r' = 2r$, $k\frac{Q'^2}{r'^2} = G \cdot \sin 30^\circ = k\frac{Q^2}{r^2}$

$r' = 2r$.

$Q' = 2Q$

∴ twice as big.

Here is an example of a solution to the same problem, but it is essentially impossible to figure out what the strategy was for solving the problem. There are no equations nor description, and so it is not easy to tell what the numbers written down shown actually represent. The answers selected are not correct and I have no idea where the error occurred; were they a guess? It is simply not clear whether the person has any idea how to solve such a problem. As a result, it is not possible to give any partial credit

[2]

Two table tennis balls, each of mass 10 gm, carry equal charges. One is fixed at the bottom of a 30° incline while the other is on the slope, as shown. If the separation between the balls is 15 cm, (a) what is the charge on each ball? (You can neglect the gravitational attraction between the balls and any frictional forces.)

X
- ◉ 1.10×10^{-3} C
- ○ 1.23×10^{-6} C
- ○ 3.50×10^{-7} C
- ○ 4.95×10^{-7} C
- ○ 1.22×10^{-13} C

(b) If, instead, the distance apart was twice as large (i.e., 30cm) what would be the "new" charge on each ball?

X
- ○ 4 times bigger.
- ○ twice as big.
- ◉ one-half as big.
- ○ one-quarter as big.

$9 \times 10^{9} \cdot \frac{9,9_2}{(0.015)^2} \cdot (\sin 30^\circ)$

1.6×10^{-19}

SOLUTION:

$\frac{\cos 30^\circ}{0.15}$

This is not an isolated example ... I'm afraid that quite a number of students have produced answers like this over the years I have been teaching. I hope you now understand that such answers are very difficult to judge for partial credit. Instead, please try to follow the ideas I have outlined above; then both you and I will be happy with the results!

RGJ
January 2007