Exam 1 comments

(1.) a,b) Remember that it is an important part of defining the force (or fields) to include the vector direction as well as magnitude.

c) The key difference is that electrostatic forces tend to cancel between large objects because they have equal numbers of positive and negative charges. The individual charges exert much larger forces than gravitation. The size of the masses doesn't matter since each bit of mass comes with a charge as well. It is only when the charges cancel that gravity becomes important.

(2) b) An electrical potential is always a difference. You are always measuring from some point where $V=0$.

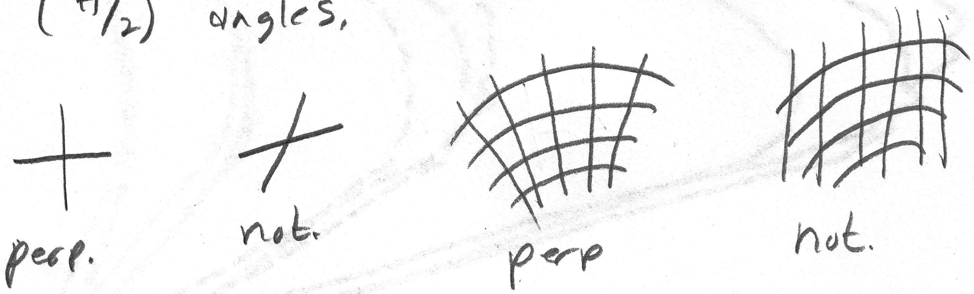
d) Be careful about assumptions. I specifically state not to assume anything about the relative sizes of the charges, yet most treated them as if $|q_1| = |q_2|$.

d contd) In order to solve this problem, you need to use the principal of superposition. Write the field for each charge at the same point. This means that this point won't necessarily be the same distance from both charges. This differences is what allows a solution for any combination of charges.

③ a) -You always need the number of field lines to be proportional to the size of the charge. Thus, 2q must have twice as many lines as q.

-Also, you need to draw enough lines to make the shape of the field clear. -Field lines end on charge.

b) -Equipotential lines are perpendicular to field lines. This means that they meet at 90° ($\pi/2$) angles.



c) -Electric field lines must leave a conductor perpendicular to the surface.

-Also, points/corners have a greater charge density and so more field lines. The degree of pointiness determines how much greater.

d) - Equipotential lines cannot cross. Ever. Different equipotential lines correspond to different potentials. If they cross, the potential has 2 values at one point. That just can't be.

- Equipotential lines do not start or end, either on charges or otherwise

(4) Volume of sphere $= \frac{4}{3}\pi r^3$

- Area of sphere $= 4\pi r^2$

- The symbol Q_{enc} in Gauss's Law refers to all of the charge inside your surface. This means that if I have a gaussian surface at $r > R_1$ and there is a charge distribution on the surface at R_1, that charge is part of Q_{enc}.

- Be careful of the distinction between Volume and Area. Know which you need + use it.

- Review how to plot functions. Many times the plots given didn't match the functions you found. If you have a function like V that has different values in different regims, just plot each function in the appropriate regim.

- $|\vec{E}|$ can have discontinuities, V cannot.
- Be aware of what quantities in a problem are variables vs. constants. In this problem, $\underline{r}$ is a varible, the coordinate, while R_1, R_2 are constants. If a function (such as V) depends only on constants in a given region, it is a constant itself. If you know a function should be varying (because of a charge, for instance), then check that it has a variable in it, and confirm that this is the correct variable.
- To find V, one must integrate **Starting** at the point where $\underline{V=0}$, and ending at the point of interest. If $\vec{E}\cdot d\vec{l}$ takes different forms along the way (integrating accross regions), then you need to add up the seperate contributions.

e.g. $$V(r)=\int_{\infty}^{r}\vec{E}\cdot d\vec{l} = \int_{\infty}^{R_2}\vec{E}_{III}\cdot d\vec{l} + \int_{R_2}^{R_1}\vec{E}_{II}\cdot dl + \int_{R_1}^{r}\vec{E}_{I}\cdot d\vec{l}$$

where $V(\infty)=0$

Remember the meaning of $dq = \sigma\, dA$

$dq = \rho\, dV,$

$dq = \lambda\, dl.$

These are charges. So while things like $\sigma = \frac{dq}{dA}$ have some useful meaning mathematically, it is well outside the scope of our course. Rearranging differentials like this should be reserved for coordinates when trying to change them. e.g.

$$y = r\cos\theta \rightarrow \frac{dy}{d\theta} = r\sin\theta$$

$$dy = r\sin\theta\, d\theta.$$

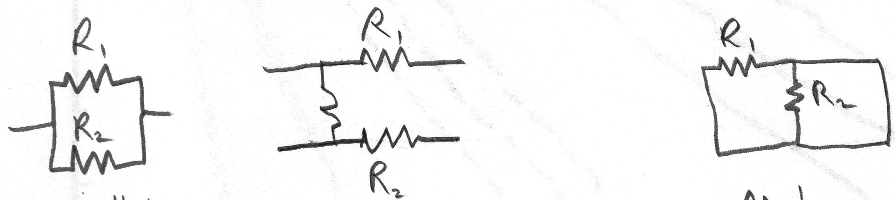
- You don't always need to do an integral. Integrals are only needed when one of the quantities your result depends on is changing in the region you need it. So, if I am sitting on the surface of a sphere, for instance, my radius isn't changing so I needn't integrate it. I can just multiply by whatever it is I was looking for, like the area $4\pi r^2$.
- A "shell" means a hollow shape. A shell may have thickness (between R_1 + R_2) or be infinitely thin (just "at R").

(5) - When applying the junction rule, add up all the currents coming in and subtract those going out. You can't have the same current twice!

- Ohm's law $V=IR$ holds for each individual resister. Do not add up voltages and apply them to each resister to find the current. That is what Kirchoff's laws are for. You can only apply $V=IR$ directly if you have a single R.

- Follow the rules. If you apply Kirchoff's rules, it will get you through the problem.

- 2 circuit elements cannot be in parallel if the are conneted by another.



parallel   Not in parallel   Not in Series

Circuit elements cannot be in series if there is a junction between them.

(6.) - Since there is a net charge on the conductor, that net charge will spread out if it can. Since there is no external applied field, no +/- charge will be induced.

- When the material conducts, electrons move freely. When it doesn't, they are stuck in place.

- Without asymmetrical external conditions, there is nothing to give a lopsided charge distribution to the object.

(7) - You can solve this by either calculating the potential directly with an integral, or treating the dielectrics as capacitors in series.

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

- You cannot add $K_1 + K_2$. This would be like having both dielectrics in the same place.