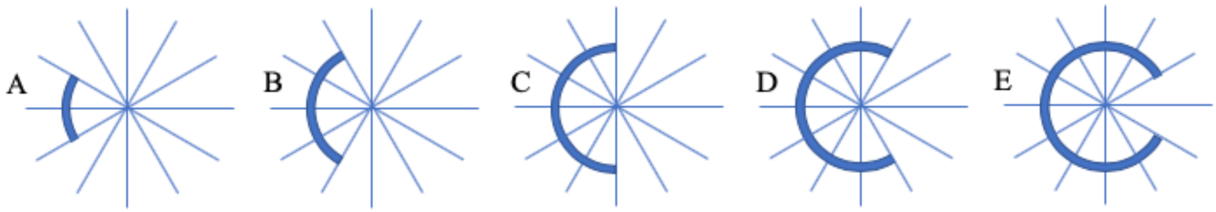
Note: This question came from (or was inspired by) the "Frensley Physics" YouTube site:

FR 6: In each of the above five cases, an arc carries a uniformly-distributed, positive charge (with center of curvature at P). The lines make 30° angles.



a.) Rank the cases based on the strength of the electric field at Point P, from highest to lowest, assuming all five cases have the same *linear charge density*. Explain your reasoning.

--electric fields are vectors;
--a differential bit of charge at an angle theta above the -x-axis will generate a differential electric field at P that has a component in the x-direction and in the -y-direction;
--a differential bit of charge at an angle MINUS theta below the -x-axis will generate a differential electric field at P that has a component in the x-direction and in the +y-direction;
--the y-components of those two fields will add to zero leaving only the x-components, which will add to one another;
--in situation A, there is very little charge, but most of the electric field will be in the x-direction;
--the situation B will have everything that A has along with additional field due to the segment of charge that doesn't exist in A—that extra charge will not have as large an x-component, but the net effect will be that it will produce a NET field at P that is larger than at A;
--for reasons similar to that stated for B, the electric field for C will be larger than A or B, though it will be just a tiny bit larger than B as most of the electric field due to the extra charge (above and beyond that found in B) will produce an E field that is in the y-direction (which cancels);
--the situation D will have everything that C had, except the additional charge will produce a component of E-fld that is now in the -x-direction, essentially making its field identical to that of B;
--and for similar reasons, situation E will produce a field that will be identical to A;
--SOOOOO, from highest to lowest, it goes C, then B and D, then A and E.

b.) Rank the cases based on the strength of the electric field at Point P, assuming all five cases have the *same charge*. Explain your reasoning.

--what makes this different from above is that with the same charge on each ring, then charge densities are now different;

--in this case, the geometry that generates the largest x-component still gets the nod, but because A now has most of it charge generating a field mostly in the x-direction, it produces the largest field at P;
--the next largest will be B, with less charge per unit length and less x-component field (even though it's over a longer distance);
--C has watered the charge density down considerably and again, there is now less x-component than the previous two;
--D has even less charge density, and there is some x-component that is negative;
--E is an even more exaggerative version of D;
--SOOOOO, from highest to lowest: A, B, C, D, E