A computer program to draw electric field lines for *n* point-charges

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Overview

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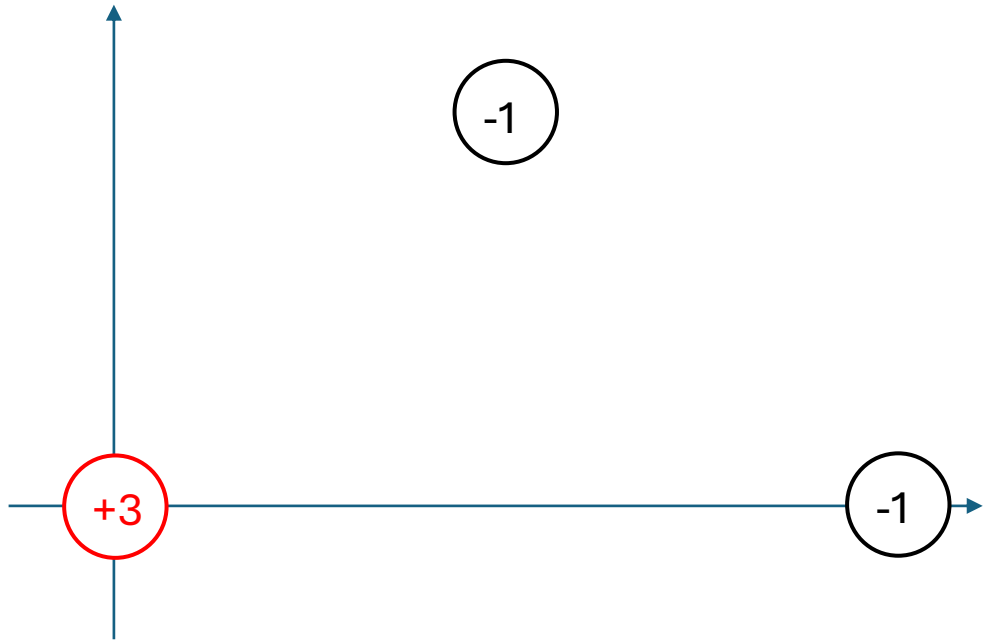
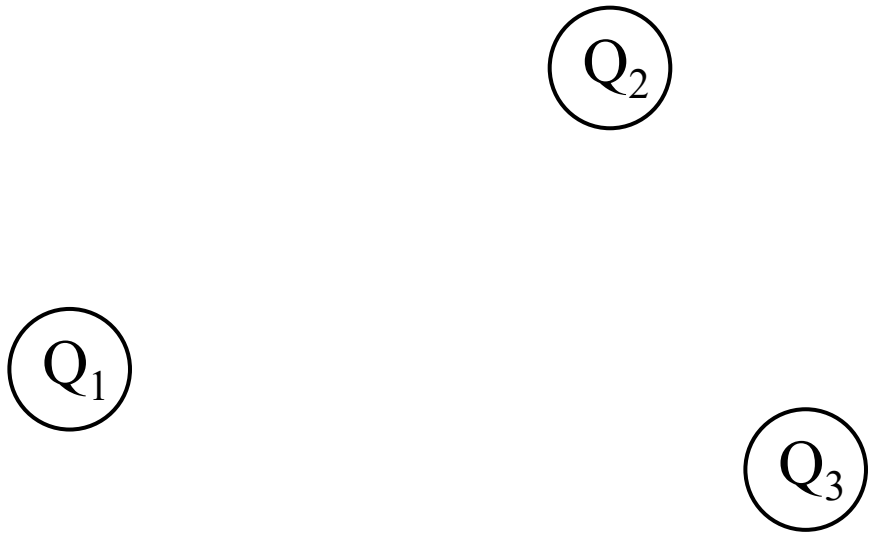
Motivation

Can you draw the electric field lines for these 3 point-charges?



Problem

Draw the electric field lines for a group of point-charges.



Solution

Write a program to draw electric field lines.

Rules for drawing electric field lines:

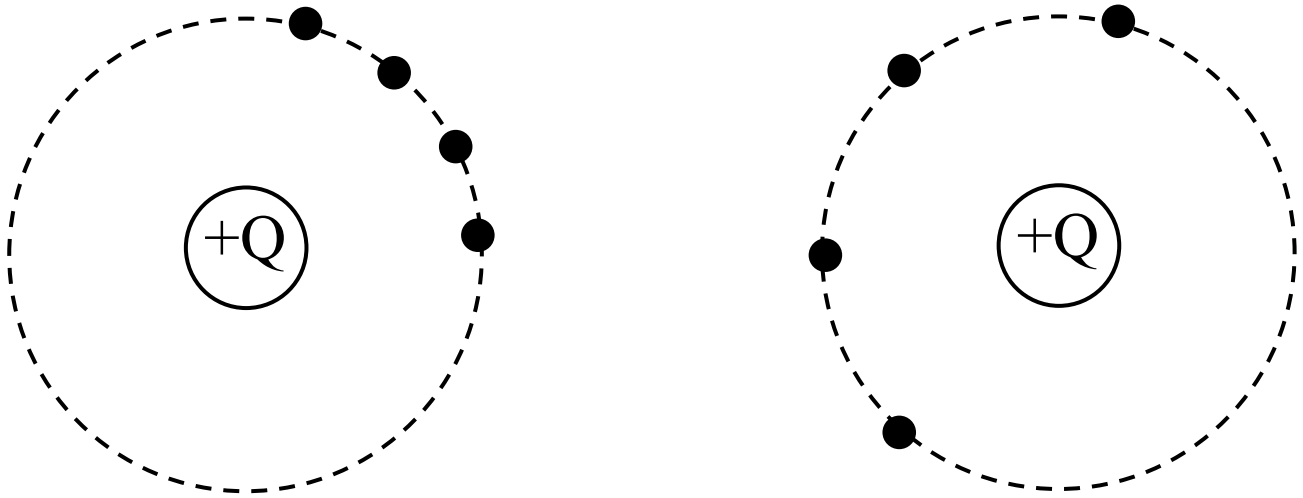
Lines begin at positive charges or infinity.

Line is tangent to electric field.

Lines end at negative charges or infinity.

Start

Lines begin at positive charges (and infinity if net charge is negative.)



Ten points on a circle of small radius centered at a positive charge.

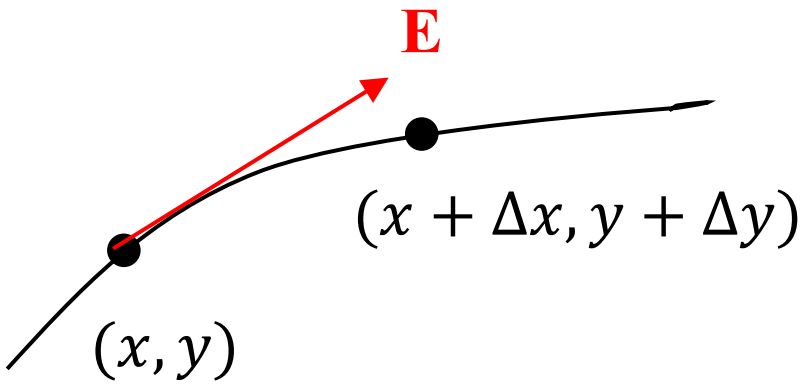
For flexibility, starting position and spacing can be changed.

Start

If net charge is negative, reverse the sign of all charges and reverse the direction of all field lines.

Next Point

Line is tangent to electric field.



$$\frac{\Delta y}{\Delta x} \approx \frac{E_y}{E_x}$$

To prevent large step size

If $\left|\frac{E_y}{E_x}\right| < 1$ take small step *ds* in *x*

and $$\Delta y = \frac{E_y}{E_x}\Delta x$$

If $\left|\frac{E_y}{E_x}\right| > 1$ take small step *ds* in *y*

and $$\Delta x = \frac{E_x}{E_y}\Delta y$$

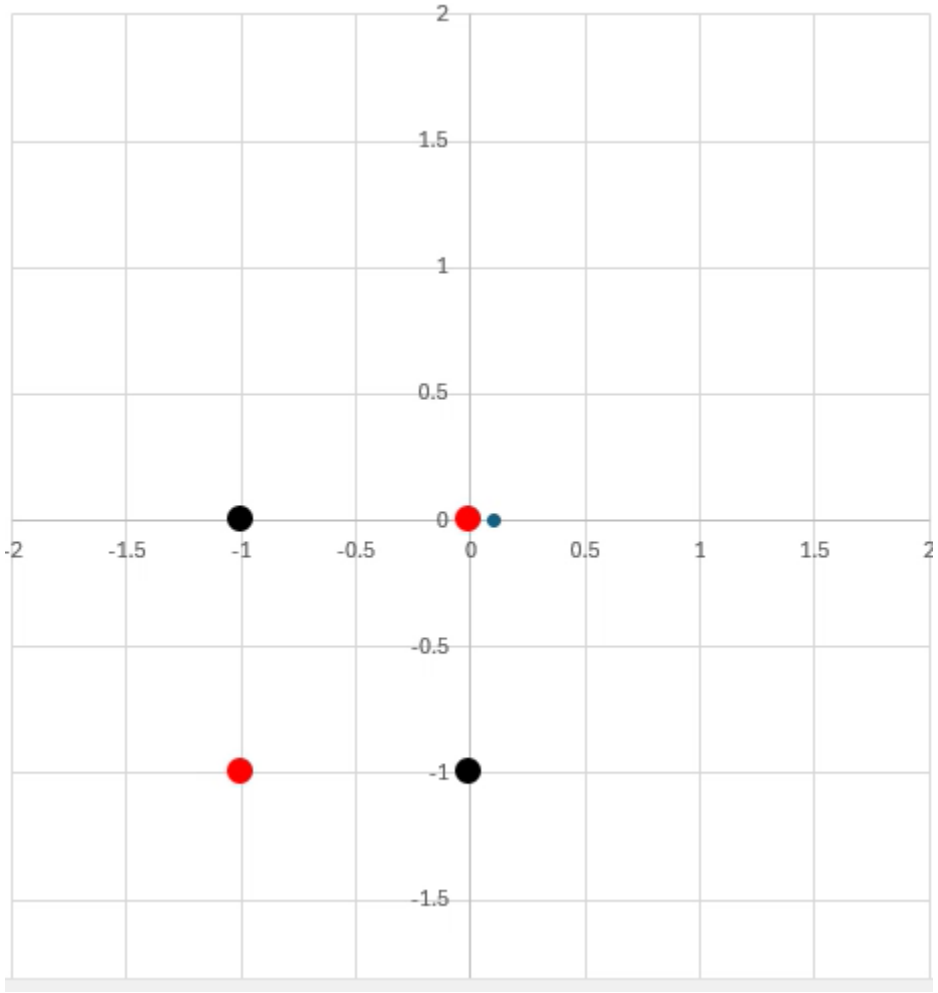
Stop

Lines end at negative charges or infinity.

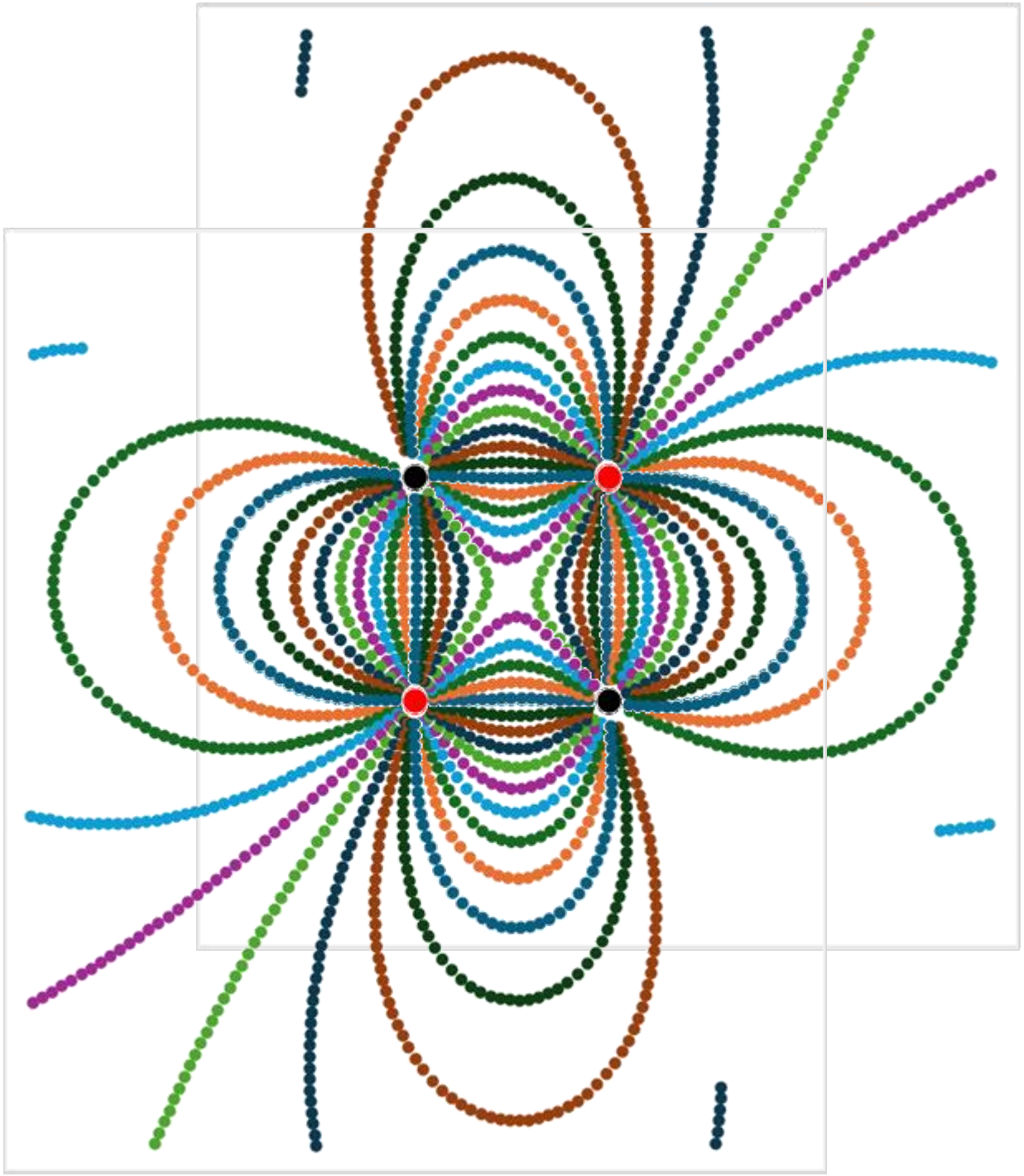
Stop and begin new line when current line is within a small radius of a negative charge.

In case a line goes out to infinity, stop and begin new line after a maximum number of steps are taken.

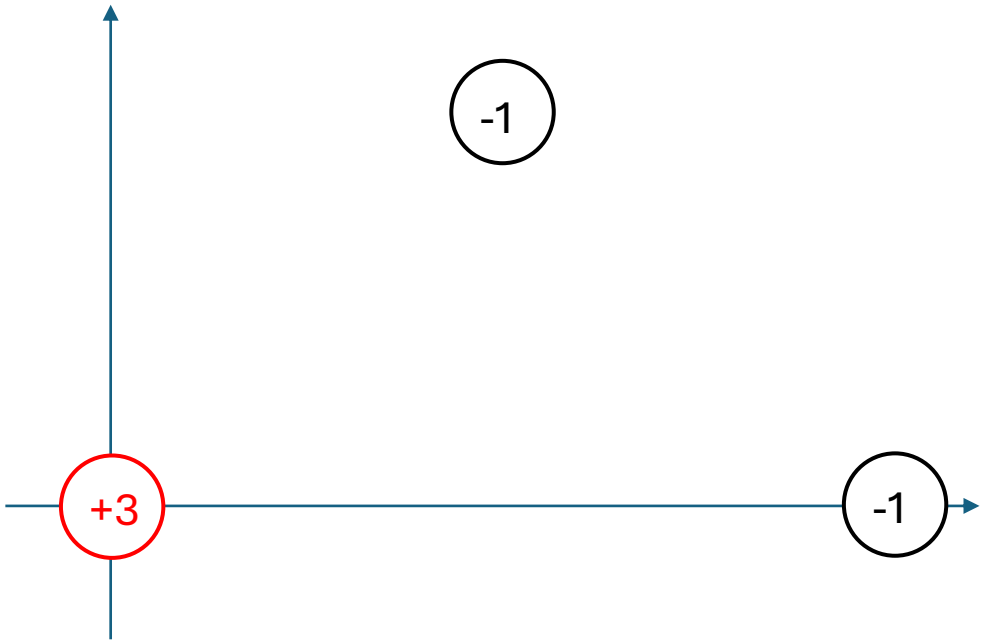
Excel Program



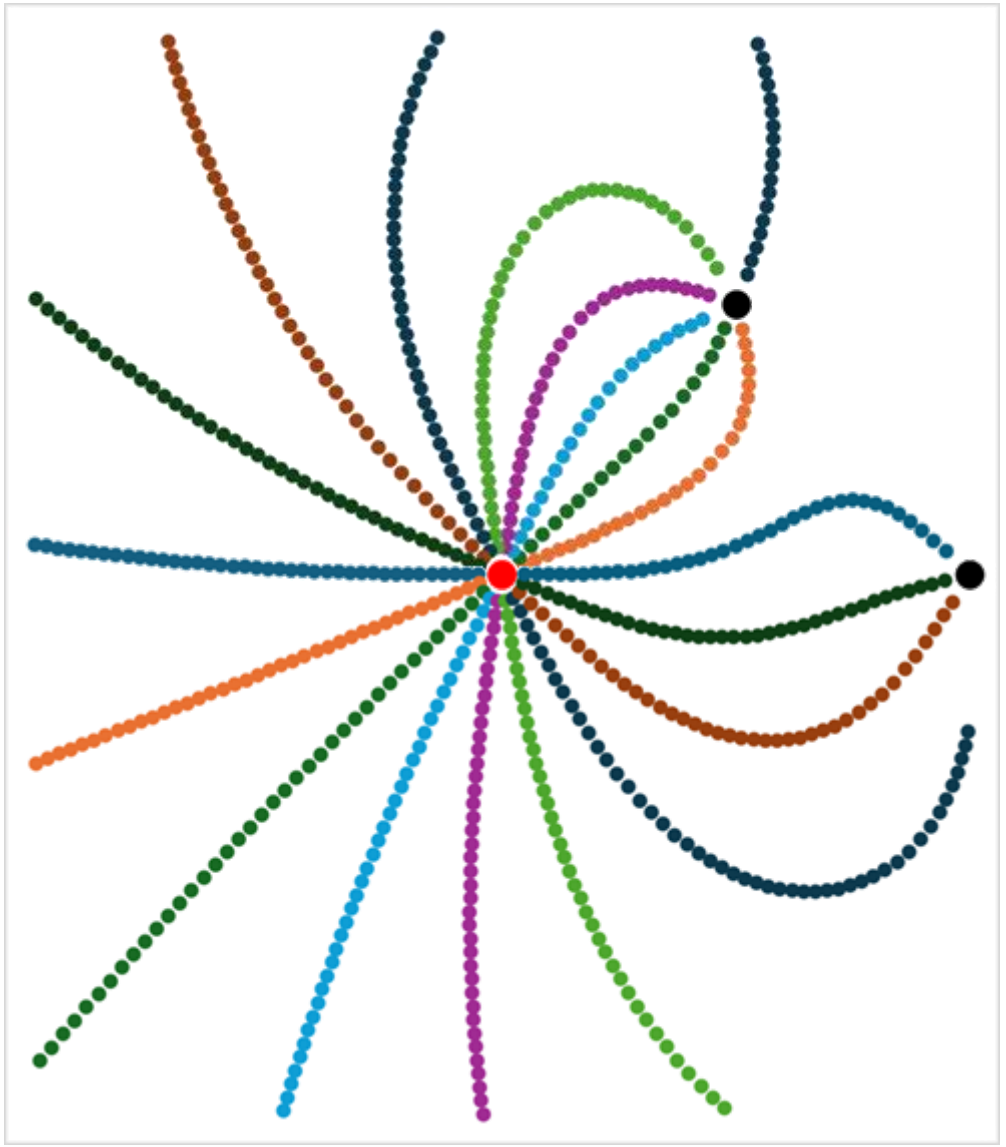
Two Dipoles



Result: Three Unequal Charges



Get all field lines
leaving positive charges



Reversed sign of all charges to get field lines entering negative charges.

Conclusion

It is a nice little project that students can do that teaches:

Principle of superposition in calculating electric field

Application of the concept of derivative in drawing curves