1. To explore the vector field properties of $E$ open this [applet](#). Select configuration A, moves around the two charges and observe how the vectors change. Can you move only one charge in such a way that none of the vectors changes? If so describe how

If you place one charge exactly on top of the other, what happen to the vectors?

Now, choose Configuration B, which of the charges are positive?

Can you arrange the positions of the four charges in such a way that there is at least one point where the total $E$ is zero? If so, draw below such configuration.

Click *toggle between filed vectors and filed lines*, you should see the field lines, which charge has the greater positive charge? which charge has the smaller negative charge?

2. Find the unknown charge. Open this [applet](#) and answer the following questions

What is the value of the unknown charge?

Is the charge due to an excess of electrons or a deficit of electrons?

Calculate the number of electrons (excess or deficit) that are needed to produce the observed field.

3. Motion of a test charge in an external Electric field. Open this [applet](#). With the charge set at $10^{-8}$ C, initial velocity at 50cm/s and zero $E$, press play. How does the charge moves?

Set $E = 3 \times 10^4$ N/C, how does the particle move?

Which value of the $E$ does make the charge to collide with the green dot on the right side of the screen?

What happen if you now change the initial speed to 100cm/s? Does the charge still hit the green dot? Why?

With initial velocity of 100cm/s and same $E$ of above, to which value the charge has to change to hit again the green dot?
4. In the diagram below, charges $q_1$ and $q_2$ are equal in magnitude and opposite in sign. At each of the dots, draw vectors showing the electric fields $E_1$ and $E_2$ due to the charges and the net electric field $E_{net}$ due to both charges. Make the length of your vectors such that they indicate the relative strength of the field at each of the points.

![Diagram showing electric fields due to charges $q_1$ and $q_2$.]

5. In the diagram below, show the net electric field at each of the dots. Indicate the relative strength of the field by the length of your vectors. The magnitudes of the charges are the same.

![Diagram showing net electric field at various locations.

6. Rank the strength of the electric field at the locations shown. Explain your results.

![Diagram with locations marked 1, 2, and 3, showing electric field vectors at each location.]}
7. An initially **uncharged** metal ball is suspended by an insulating thread between oppositely charged plates.

   (a) What is the net charge on the ball when it is between the plates? (positive, negative, zero)

   (b) Is the ball polarized? If so, show the charge distribution using pluses and minuses.

   (c) Is there a net force on the ball? If so, in which direction?

8. A **charged** metal ball is lowered into a hollow metal container without the ball touching the sides of the container.

   (a) Use pluses and minuses to show the charge distribution on the inside and outside surfaces of the container.

   (b) The ball is now allowed to touch the inside of the container. Again, show the charge distribution on the container. Show the charge, if any, on the ball.

   (c) The ball is now removed from the container. Show the final charge distribution on the container and the charge, if any, on the ball.
9. An electron is fired with an initial velocity, as indicated, into the region between oppositely charged parallel plates. Sketch the path of the electron.

10. A triangle with charges fixed at each corner is placed between charged parallel plates. Each of the bottom corners have charge +q and the top corner has charge -2q. (Neglect gravity.)

(a) Draw vectors showing the relative forces on each charge.

(b) Is the object in equilibrium? If not, draw the equilibrium orientation of the triangle.

(c) When the triangle is in its equilibrium orientation, will it move to the right, to the left, rotate, or remain at rest?

11. Find the value of electric field at the point P located at distance \( d = 5.8 \text{cm} \) from the center of a ring of radius \( a = 12 \text{ mm} \) and total charge of 2.5 micro Coulombs