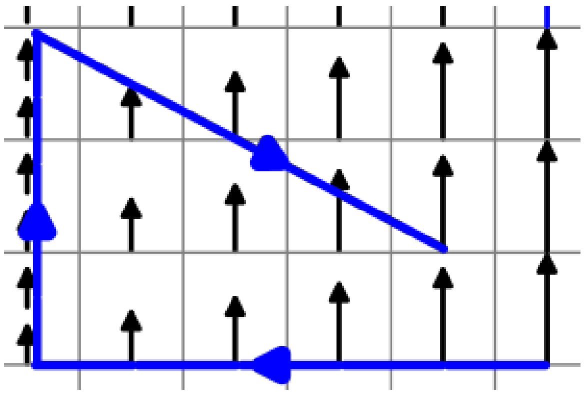
Name: ____________________

Work by an Electric Field

Working in small groups (2 or 3 people), solve as many of the problems below as possible. Try to resolve questions within the group before asking for help. Each group member should then write up solutions in their own words.



Estimate Vector Line Integral: For each segment of the path on the vector field $\vec{F}$ shown, estimate the value of the integral:

$$\int_{\text{path}} \vec{F} \cdot d\vec{r}$$

where the side of each square is 1 cm and the length of the longest arrow is 10 units of $\vec{F}$.

Estimate Work on A Path: The attached vector field represents an electric field. Draw a path starting at the green star and ending at the yellow triangle. Estimate the work done on a test charge by the field along the path you drew. The longest vector shown on the vector field has a magnitude of 15 electric field units.

Prep - change the beginning and end points to vary the level of difficulty of the integration as needed.

Strategies we've seen:

(1) Chop, Multiply & Add (what we most want) Select a path tangent to the electric field, chop up the path, estimate the distance between points and magnitudes of electric fields, multiply, and add.

(2) Estimation with Average Value Estimate an average electric field along the path, estimate the length of the path, and multiply.

(3) Change in Potential (Incorrect) Finding the change in potential by saying that the lengths of the arrows are the values of the potential.

Be on the lookout - Students do not attend to units. This is a good place to discuss how distance on the vector map means can mean physical distance or electric field magnitude.

Units We have intensionally left off SI units for electric field. For electric field, students can either use N/C, which helps students to think about the electric field as force per charge, or V/m, which helps students to think about the electric field as the gradient of the potential. Discussing both is useful.

Path Independence Some students have trouble distinguishing the path independence of the work done by a conservative field and the path independence of the total displacement. These students will argue that the work done on two different paths is the same because the total displacement is the same. It is nice to have a non-conservative field on hand to give to these students to demonstrate that, although the displacement is path independent, the work is not always path independent.

Relate Representations: How is the work done by the electric field related to the surface?

Most students are really surprised by the negative sign here. This is the big bang for this activity.

Activity Evaluation

What was the main point of this activity?

Describe one thing you understand as a result of this activity.

Describe one thing that is confusing after completing this activity.