1 Instructor's Guide

1.1 Notes:

This activity is identical to Vector Surface and Volume Elements except uses a scalar approach to find surface, and volume elements. Therefore, this version of the activity does not require knowledge of the $d\vec{r}$ vector, cross products, and dot products which can make this activity more accessible to students earlier in a course on electricity and magnetism.

This activity can be done simultaneously with Pineapples and Pumpkins where students or the instructor cut volume elements out of pineapples and/or pumpkins.

1.2 Introduction

In a previous activity, Vector Differential–Curvilinear, students are asked to find the line element, $d\ell$, along each side of an "infinitesimal box" in cylindrical and spherical coordinates. Using the $d\ell$, they are now asked to construct the area (dA) and volume (dV) elements in each coordinate system. This prepares students to integrate scalar-valued functions in curvilinear coordinates.

Student handout

Find the formulas for the differential surface dA and volume $d\tau$ elements (little chopped pieces of the surface and/or volume) for a plane, for a finite cylinder (including the top and bottom), and for a hemisphere. Make sure to draw an appropriate figure.

2 Intructor's Guide

2.1 Student Conversations

- In selecting pieces of $d\vec{r}$ to compose differential areas and volumes, students at this stage will still be forgetting important pieces like s's and r's for angular geometry and especially $\sin\theta$ in spherical coordinates.
- Be sure students are sensemaking their answers and get them to notice any mistakes by having them do dimensional analysis, checking that they have the right number of differentials on each side of their equations, and that they can draw the slice of geometry their creating or picture and describe it in their head.

2.2 Wrap Up

Be sure to highlight the ones groups had more difficulty with, with at least one example in each coordinate system When describing the geometry being chopped up, it is helpful to use the pumpkin and pineapple slices and hold them up as you talk to the class so they can see you gesture at them and make this example into a more memerable example that they can conjure in problems later themselves.