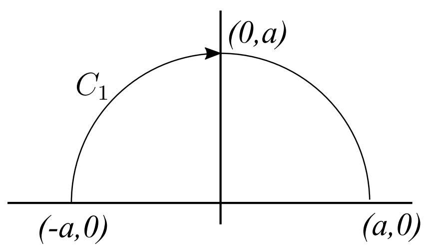
1. **Verify the divergence theorem with the vector field $\vec{A} = \vec{r}$ over a spherical region bounded by the surface of the sphere $x^2 + y^2 + z^2 = R^2$.**

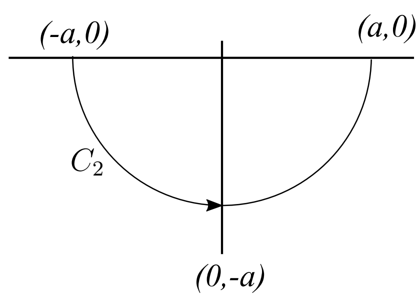
2. **Find the volume of the tetrahedron whose vertices are** $(0, 0, 0)$, $(a, 0, 0)$, $(0, b, 0)$, $(0, 0, c)$**.**

3. **Evaluate $\int_P^Q \vec{\mathbf{A}} \cdot \vec{\mathbf{dl}}$ for $\vec{\mathbf{A}} = y\hat{\mathbf{i}} - x\hat{\mathbf{j}}$ along the following arcs of a circle of radius a: $P \equiv (-a, 0)$; $Q \equiv (a, 0)$.**

   (a) $(-a, 0) \to (0, a) \to (a, 0)$



   (b) $(-a, 0) \to (0, -a) \to (a, 0)$



   (c) a loop, forward along (a) and backward along (b)

   (d) Let I be the value of the loop integral evaluated in (c). Verify that at the origin

$$|\vec{\nabla} \times \vec{A}| = \lim_{a \to 0} I/(\pi a^2)$$

4. Consider $\vec{\mathbf{A}} = x^2\hat{\mathbf{i}} + y^2\hat{\mathbf{j}} + z^2\hat{\mathbf{k}}$

(a) Evaluate $\oint_S \vec{\mathbf{A}} \cdot \vec{\mathbf{da}}$ where S is a cubical surface given by the planes $x = a \pm l; \quad y = b \pm l; \quad z = c \pm l$.

(b) Verify that at the point (a, b, c),

$$\vec{\nabla} \cdot \vec{A} = \lim_{l \to 0} \frac{1}{8l^3} \oint_S \vec{\mathbf{A}} \cdot \vec{\mathbf{da}}$$

5. Let $\vec{A} = \hat{r}$. Evaluate $\int_S \vec{A} \cdot \vec{da}$ over the surface of a sphere given by the equation $x^2 + y^2 + z^2 = a^2$.