1. Complete the following steps to compute the flux integral below. (Hint: no actual integration is required below.)

\[ \int \int_S (\text{curl} \vec{F}) \cdot d\vec{S} \]

(a) Compute curl \( \vec{F} \) for \( \vec{F} = \langle -y, x, z \rangle \).

(b) Compute the area of \( S \) if the surface \( S \) is the equilateral triangle with vertices \( P(1,0,0), Q(0,1,0) \) and \( R(0,0,1) \).

(c) Compute the upward unit normal \( \vec{n} \) for surface \( S \) above.

(d) Show curl \( \vec{F} \cdot \vec{n} \) is a constant on the surface \( S \).

(e) Finally compute the flux using two of the numbers above.

2. Find \( f \) so that \( \nabla f = \vec{F} = \langle y, x+y \rangle \) and use \( f \) to find the line integral \( \int_C \vec{F} \cdot d\vec{r} \) if \( C \) is the curve pictured below from \((2,2)\) to \((-20,0)\).

3. Vector, scalar or nonsense. \( P \) and \( Q \) are points in 3-space, \( f = f(x,y,z) \) is a scalar field, \( \vec{r}(t) \) or \( \vec{r}(u,v) \) is a parametric equation of a curve \( C \) or a surface \( S \), and \( \vec{F} = \vec{F}(x,y,z) \) and \( \vec{G} = \vec{G}(x,y,z) \) are vector fields. Determine if the given object is a scalar field, a vector field or nonsense.

A. \( \frac{\partial f}{\partial x} \)  
B. \( \vec{F} \times \vec{G} \)  
C. \( \vec{F} \vec{G} \)  
D. \( \frac{\partial \vec{r}}{\partial u} \)  
E. \( \vec{F} - \vec{G} \)  
F. curl \( f \)  
G. grad \( \vec{G} \)  
H. \( \vec{F} \cdot \vec{G} \)  
I. div grad(f)  
J. curl curl \( \vec{F} \)

4. By evaluating both integrals, check Green’s theorem

\[ \oint_{\partial D} \vec{F} \cdot d\vec{r} = \iint_D Q_x - P_y \, dA \]

when \( D = \{(x,y): x^2 + y^2 \leq 16\} \) is the disk of radius 4 and \( \vec{F} = \langle -xy, 2x \rangle \).

5. Find the flux of \( \vec{F} = \langle 2, y, 2z \rangle \) over the upward oriented surface \( S \) given by the portion of \( z = 1-x^2-y^2 \) that lies in the first octant. Explicitly give \( \vec{r} \), your parametrization with limits, your \( d\vec{S} \) with the correct sign for the normal orientation and with the correct differentials. and your \( \vec{F}(\vec{r}) \).