so $\int_C \underset{\sim}{F} \cdot d\underset{\sim}{r} = \iint_S (\text{curl } \underset{\sim}{F}) \cdot d\underset{\sim}{S} = \iint_S (\text{curl } \underset{\sim}{F}) \cdot \underset{\sim}{n} \; dS$

But the normal vector field $\underset{\sim}{n}$ to the plane $z - x = 2$ is $\frac{1}{\sqrt{2}}\langle -1, 0, 1\rangle$, and so

$$\int_C \underset{\sim}{F} \cdot d\underset{\sim}{r} = \frac{1}{\sqrt{2}} \iint_S \langle 3, 1, 2\rangle \cdot \langle -1, 0, 1\rangle \; dS$$

$$= -\frac{1}{\sqrt{2}} \iint_S 1 \; dS = -\frac{1}{\sqrt{2}} \text{area}(S)$$

To calculate the area of S, parametrise it by $x = u \quad y = v \quad z = 2+u$ for $(u,v) \in D = \{(u,v) : u^2+v^2 \le 1\}$.

$\underset{\sim}{r}_u = \langle 1, 0, 1\rangle$

$\underset{\sim}{r}_v = \langle 0, 1, 0\rangle$

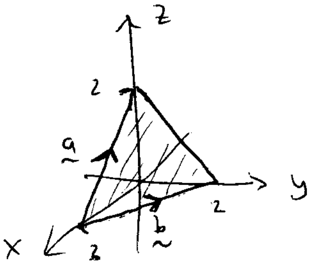
$\underset{\sim}{r}_u \times \underset{\sim}{r}_v = \langle -1, 0, 1\rangle$

$$\int_C \underset{\sim}{F} \cdot d\underset{\sim}{r} = -\frac{1}{\sqrt{2}} \text{area}(S)$$

$$= -\frac{1}{\sqrt{2}} \iint_D |\underset{\sim}{r}_u \times \underset{\sim}{r}_v| \; dA = -\iint_D 1 \; dA$$

$$= -\text{area}(D) = \underline{\underline{-\pi}}$$

(2) The triangle is the boundary of the part of the plane $x + y + z = 2$ in the first octant; call this surface S. Since C is oriented counter-clockwise, S is oriented upwards. The normal vector field to S pointing in the right direction is $\frac{1}{\sqrt{3}}\langle 1, 1, 1\rangle$.



curl $\underset{\sim}{F} = \langle -1, -1, -1\rangle$, so

$$\int_C \underset{\sim}{F} \cdot d\underset{\sim}{r} = \iint_S (\text{curl } \underset{\sim}{F}) \cdot \underset{\sim}{n} \; dS$$

$$= \iint_S -\sqrt{3} \; dS$$

$$= -\sqrt{3} \; \text{area}(S)$$

$$= -\frac{\sqrt{3}}{2} |\underset{\sim}{a} \times \underset{\sim}{b}| \quad \text{(see picture)}$$

$$= -\frac{\sqrt{3}}{2} \left| \langle -2, 0, 2\rangle \times \langle -2, 2, 0\rangle \right|$$

$$= \underline{\underline{-6}}$$