1.56 $\vec{v} = 6\hat{x} + yz^2\hat{y} + (3y+z)\hat{z}$

First segment, $x = z = 0,\; y = y \Rightarrow d\vec{l} = dy\,\hat{y}$

$\vec{v}\cdot d\vec{l} = yz^2$ by $z = 0$ so $\vec{v}\cdot d\vec{l} = 0$

Second segment,

$z = -2y + 2 = 2(1-y) \Rightarrow dz = -2dy \quad ; x = 0$

$d\vec{l} = dy\,\hat{y} + 2\,dy\,\hat{z} = (\hat{y} - 2\hat{z})dy$

$\vec{v}\cdot d\vec{l} = yz^2 - 2(3y+z) = y(2-2y)^2 - 2(3y+2-2y)$

$= y(4 - 8y + 4y^2) - (2y+4) = 4y^3 - 8y^2 + 4y - 2y - 4$

$\int_1^0 (4y^3 - 8y^2 + 2y + 4)\,dy = \left[y^4 - \frac{8}{3}y^3 + y^2 - 4y\right]_1^0 = -\left[1 - \frac{4}{3} + 1 - 4\right] = 2 + \frac{8}{3}$

Third segment

$x = y = 0,\quad z = z \Rightarrow d\vec{l} = dz\,\hat{z}$

$\vec{v}\cdot d\vec{l} = (3y+z)dz = z\,dz$

$\int_2^0 z\,dz = \frac{1}{2}z^2\Big|_2^0 = 0 - \frac{1}{2}(2)^2 = -2$ so $\oint \vec{v}\cdot d\vec{l} = 2 + \frac{8}{3} - 2 = \frac{8}{3}$

$$(\nabla\times\vec{v}) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 6 & yz^2 & 3y+z \end{vmatrix} = \hat{i}(3 - 2yz) + \hat{j}(0-0) + \hat{k}(0-0)$$

$$= (3 - 2yz)\hat{i}$$

$\int_S (3 - 2yz)\,dy\,dz = \int_0^1\int_0^{2-2y} (3 - 2yz)\,dz\,dy = \int_0^1 \left[3z - yz^2\right]_0^{2-2y} dy$

$3(2-2y) - y(2-2y)^2 = 6 - 6y - y(4 - 8y + 4y^2) = 6 - 6y - 4y + 8y^2 - 4y^3$

$= -4y^3 + 8y^2 - 10y + 6$

$\Rightarrow \int_S (3 - 2yz)\,dA = \left[-y^4 + \frac{8}{3}y^3 - 5y^2 + 6y\right]_0^1 = -1 + \frac{8}{3} - 5 + 6 = \frac{8}{3}$