Evaluate the surface integral

1) $\iint\limits_S x^2 yz\, dS$, S is the part of the plane $z = 1 + 2x + 3y$ that lies above the rectangle $[0,3]\times[0,2]$.

$$\boxed{171\sqrt{14}}$$

2) $\iint\limits_S xy\, dS$, S is the triangular region with vertices $(1, 0, 0)$, $(0, 2, 0)$, and $(0, 0, 2)$.

$$\boxed{\frac{\sqrt{6}}{6}}$$

3) $\iint\limits_S yz\, dS$, S is the part of the plane $x + y + z = 1$ that lies in the first octant.

$$\boxed{\frac{\sqrt{3}}{24}}$$

4) $\iint_S x^2 z^2 \, dS$, S is the part of the cone $z^2 = x^2 + y^2$ that lies between the planes $z = 1$ and $z = 3$.

$$\boxed{\frac{364\sqrt{2}}{3}\pi}$$

5) $\iint_S z \, dS$, S is the surface $x = y + 2z^2$, $0 \le y \le 1$, $0 \le z \le 1$.

$$\boxed{\frac{13\sqrt{2}}{12}}$$

6) $\iint_S xy \, dS$, S is the boundary of the region enclosed by the cylinder $x^2 + z^2 = 1$ and the planes $y = 0$ and $x + y = 2$

$$\boxed{-\frac{1}{4}\left(8 + \sqrt{2}\right)\pi}$$

7) $\iint\limits_S (x^2 z + y^2 z)\, dS$, S is the hemisphere $x^2 + y^2 + z^2 = 4$, $z \geq 0$

$$\boxed{16\pi}$$

8) $\iint\limits_S \sqrt{1 + x^2 + y^2}\, dS$, S is the helicoid with vector equation $\vec{\mathbf{r}}(u,v) = u\cos v\,\mathbf{i} + u\sin v\,\mathbf{j} + v\,\mathbf{k}$, $0 \leq u \leq 1$, $0 \leq v \leq \dfrac{\pi}{2}$.

$$\boxed{\frac{4}{3}\pi}$$

Evaluate the surface integral $\iint\limits_S \vec{\mathbf{F}} \cdot d\vec{\mathbf{S}}$ for the given vector field $\vec{\mathbf{F}}$ and the oriented surface S. In other words, find the flux of $\vec{\mathbf{F}}$ across S. For closed surfaces, use the positive orientation.

9) $\vec{\mathbf{F}}(x, y, z) = xy\,\mathbf{i} + 4x^2\,\mathbf{j} + yz\,\mathbf{k}$, S is the surface $z = xe^y$, $0 \leq x \leq 1$, $0 \leq y \leq 1$, with upward orientation.

$$\boxed{1 - e}$$

10) $\vec{\mathbf{F}}(x,y,z) = x\,\mathbf{i} + y\,\mathbf{j} + z^4\,\mathbf{k}$, S is the part of the cone $z = \sqrt{x^2+y^2}$ beneath the plane $z=1$ with downward orientation.

$$\boxed{\frac{\pi}{3}}$$

11) $\vec{\mathbf{F}}(x,y,z) = y\,\mathbf{j} - z\,\mathbf{k}$, S consists of the paraboloid $y = x^2+z^2$, $0 \le y \le 1$, and the disk $x^2+z^2 \le 1$, $y=1$.

$$\boxed{0}$$

12) $\vec{\mathbf{F}}(x, y, z) = x\,\mathbf{i} + 2y\,\mathbf{j} + 3z\,\mathbf{k}$, S is the cube with vertices $(\pm 1, \pm 1, \pm 1)$.

$$\boxed{48}$$

13) The temperature at the point (x, y, z) in a substance with conductivity $K = 6.5$ is $u(x,\ y,\ z) = 2y^2 + 2z^2$. Find the rate of heat flow inward across the cylindrical surface $y^2 + z^2 = 6$, $0 \le x \le 4$.

$$\boxed{1248\pi}$$