The Use of Calculators Is Not Permitted On This Exam

1. Let $\mathbf{F} = (2xz + y^2)\mathbf{i} + (z^2 + 2xy)\mathbf{j} + (2yz + x^2 + 1)\mathbf{k}$.
(a) Show that F is conservative and find a function f such that $\mathbf{F} = \nabla f$.
(b) Compute $\int_C \mathbf{F} \cdot \mathbf{dr}$ where C is the curve

$$x = t^5, \qquad y = \cos^3 \pi t/2, \qquad z = \sin^3 \pi t/2, \qquad 0 \le t \le 1.$$

2. Compute $\int_C -y^3\,dx + (x^3 - y)\,dy$ where C is the circle $x^2 + y^2 = 1$ oriented counterclockwise.

3. Use Stokes' theorem to evaluate $\int_C \mathbf{F} \cdot \mathbf{dr}$ where $\mathbf{F} = -3y\mathbf{i} + z^2\mathbf{j} + x\mathbf{k}$ and C is the triangle with vertices $(1, 0, 0)$, $(0, 1, 0)$ and $(0, 0, 1)$ with counterclockwise orientation as viewed from above.

4. Evaluate $\int\int_\Sigma \mathbf{G} \cdot \mathbf{n}\,dS$ where $\mathbf{G}(x, y, z) = x\mathbf{i} + y\mathbf{j} + z^2\mathbf{k}$, $\mathbf{n}$ is the outward normal and Σ is the boundary of the solid region bounded below by the cone $z = \sqrt{x^2 + y^2}$ and above by the plane $z = 1$.