1. (a) $t = 0, -3$, $(x, y) = (0, 0), (-21, 0)$
   (b) $\dfrac{dy}{dx} = \dfrac{2t+3}{1-4t}$. The graph has intercepts as in (a); it decreases to a minimum at $(-6, -\frac{9}{4})$, then increases to the origin.
   (c) Area: $\frac{63}{2}$
   (d) $\int_{-3}^{0} \sqrt{(1-4t)^2 + (2t+3)^2}\, dt$
2. (a) The cardioid and circle are pretty standard — they both hit the origin, have the x-axis as central, and the cardioid has another x-intercept at $(2, 0)$, the circle at $(3, 0)$.
   (b) Area: π
3. (a) $\displaystyle\int_0^x \frac{t^2\, dt}{1+t^4} = \sum_{n=0}^{\infty} (-1)^n \frac{x^{4n+3}}{4n+3}$
   (b) The interval of convergence: $-1 \le x \le 1$
   (c) $\dfrac{109}{2688} \pm \dfrac{1}{22528}$
4. (a) $\dfrac{x - \sin x}{x^3} = \displaystyle\sum_{n=0}^{\infty} (-1)^n \frac{x^{2n}}{(2n+3)!}$
   (b) $\displaystyle\lim_{x \to 0} \frac{x - \sin x}{x^3} = \frac{1}{6}$
5. Tangent plane: $x - y + 2z = \frac{\pi}{2}$; Normal line: $\{x = 1 + t,\ y = 1 - t,\ z = \frac{\pi}{4} + 2t\}$.
6. (a) $D_{\boldsymbol{u}} f = \frac{1}{\sqrt{2}}$
   (b) Direction: $-\nabla f = \langle -1, 8, 0 \rangle$ (normalize); Rate of *decrease*: $\sqrt{65}$
7. $\boldsymbol{T} = \frac{1}{\sqrt{5}} \langle 2, \sin t, \cos t \rangle$, $\boldsymbol{N} = \langle 0, \cos t, -\sin t \rangle$, $\kappa = \dfrac{1}{5t}$, $a_{\boldsymbol{T}} = \sqrt{5}$, $a_{\boldsymbol{N}} = t$
8. Use: $\dfrac{\partial u}{\partial r} = \dfrac{\partial u}{\partial x} \cos\theta + \dfrac{\partial u}{\partial y} \sin\theta$ and $\dfrac{\partial u}{\partial \theta} = \dfrac{\partial u}{\partial x}(-r \sin\theta) + \dfrac{\partial u}{\partial y}(r \cos\theta)$ (and some simple algebra).
9. CPs: (0,0) is a saddle point, (1,1) is a local min.
10. Max value is 6, attained at $(3, \frac{3}{2}, 1)$
11. The integrals:
    (a) $1 - \cos 4$ (b) $\frac{\pi}{4}(e - 1)$ (c) $\frac{\pi}{8}$
12. The volume: 4