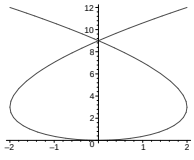
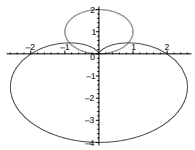
1. (a) $t = 0, \pm\sqrt{3}$, $(x, y) = (0, 0), (0, 9)$

   (b) $\dfrac{dy}{dx} = \dfrac{2t}{1-t^2}$. $\dfrac{d^2y}{dx^2} = \dfrac{2+2t^2}{3(1-t^2)^3}$.
   HT: $t = 0$, $(x, y) = (0, 0)$.
   VT: $t = \pm 1$, $(x, y) = (\pm 2, 3)$. Graph:



   (c) Area: $\frac{72\sqrt{3}}{5}$ (d) Length: $12\sqrt{3}$

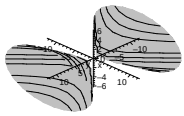
2. (a) The cardioid and circle are pretty standard — they both hit the origin, and also have intersections at $\theta = \frac{\pi}{6}, \frac{5\pi}{6}$, *i.e.* at $\left(\pm\frac{\sqrt{3}}{2}, \frac{1}{2}\right)$. Graph:



   (b) Area: $\frac{7\pi}{3} - 4\sqrt{3}$

3. (a) $\displaystyle\sum_{n=0}^{\infty} (-1)^n \frac{x^{4n+1}}{n!(4n+1)}$ (b) $-\infty < x < \infty$ (c) $\dfrac{22757}{46080} = 0.493859\,(\pm 10^{-4})$

4. $\displaystyle\sum_{n=0}^{\infty} \frac{(n+2)! \cdot 3^n}{2 \cdot n!} x^n$; $|R_2(x)| \le 0.000324$



5. Tangent plane: $\frac{3}{2}x - \frac{1}{2}y - 2z = 2$. Graph:

6. (a) Direction: $\nabla f = \langle -2, -1 \rangle$ (b) Slope of incline: $\sqrt{5}$ Bonus: $\theta = 65.9°$

7. $\boldsymbol{T} = \frac{1}{1+2t^2}\langle 1, 2t, 2t^2 \rangle$, $\boldsymbol{N} = \frac{1}{1+2t^2}\langle -2t, 1-2t^2, 2t \rangle$, $\kappa = \frac{2}{(1+2t^2)^2}$, $a_{\boldsymbol{T}} = 4t$, $a_{\boldsymbol{N}} = 2$

8. (a) Use: $\dfrac{\partial z}{\partial x} = 2x f'$ and $\dfrac{\partial z}{\partial y} = -2y f'$ (and some simple algebra).

   (b) $\dfrac{\partial z}{\partial y} = -\dfrac{F_y}{F_x} = -\dfrac{xz\cos(yz) + \cos(xz) - xz}{xy\cos(yz) - xy\sin(xz) - xy}$

9. CPs: $\left(\frac{4}{3}, \frac{2}{3}\right)$ is a saddle point, $(4, 2)$ is a local min.

10. Min value is 92, attained at $(1, 8, 2)$

11. (a) $\frac{1}{2}\sin 1$ (b) $\frac{16\pi}{5}$

12. π^2 13. $\mathrm{e}^2 - 1$