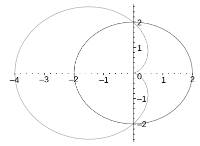
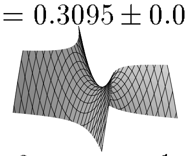
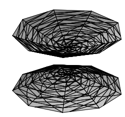
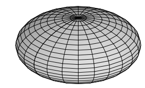
1. (a) The cardioid and circle are pretty standard — they have intersections at $\theta = \frac{\pi}{2}, \frac{3\pi}{2}$, *i.e.* at $(0, \pm 2)$. Graph: 

   (b) Area: $5\pi - 8$ (c) Circumference: 16

2. $\frac{1}{2} + \frac{1}{16}x + \frac{1\cdot 3}{2\cdot 2!8^2}x^2 + \frac{1\cdot 3\cdot 5}{2\cdot 3!8^3}x^3 + \frac{1\cdot 3\cdot 5\cdot 7}{2\cdot 4!8^4}x^4 + \cdots + \frac{1\cdot 3\cdot 5\cdot 7\cdots(2n-1)}{n!2^{3n+1}}x^n + \cdots$; $R = 4$.

3. (a) $\displaystyle\sum_{n=0}^{\infty} \frac{(-1)^n}{(2n+1)!(4n+3)} x^{4n+3}$, $|R_2(x)| \leq 0.000324$

   (b) $\frac{13}{42} \pm \frac{1}{1320} = 0.3095 \pm 0.00076$

4. (a) Graph:  (b) Graph:  (c) Graph: 

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

6. (a) The paths $x = 0$ and $y = x$ give different limits $(0, \frac{5}{3})$ so the limit does not exist.

   (b) $f_x(0,0) = f_y(0,0) = 0$ because $f(x,y)$ is constant along the x and y axes.

7. (a) $2/\sqrt{141}$, (b) $\sqrt{40}$ in direction $\langle -1, 0, 3\rangle$

8. (a) $\nabla f = \langle -8, 2, 4\rangle$ so the plane is $-4x + y + 2z = 9$

   (b) $x = -1 + 5t$, $y = 1 + 8t$, $z = 2 + 6t$

9. (a) 0 (b) $\frac{\partial w}{\partial x} = f'$, $\frac{\partial w}{\partial t} = cf'$, $\frac{\partial^2 w}{\partial x^2} = f''$, $\frac{\partial^2 w}{\partial t^2} = c^2 f''$ so qed

10. CPs: $(0,0)$ is a saddle point, $(-1,-1)$ is a local max, $(1,1)$ is a local max.

11. The point furthest away is $\left(-\frac{1}{\sqrt{14}}, -\frac{2}{\sqrt{14}}, -\frac{3}{\sqrt{14}})\right)$.

12. (a) $\frac{1}{3}(2\sqrt{2} - 1)$ (b) $\frac{\pi}{8}(1 - \mathrm{e}^{-9})$

13. $\frac{\pi}{8}$ 14. $\frac{4}{3}$