1. Section 3-1

1. $z = -\frac{1}{3}x + \frac{11}{3} - \frac{1}{3}y$
3. $z = -\frac{1}{2}x + 3 - \frac{1}{4}y$
5. $3x + 4y + 2z = 13$
7. $z = x + y - 1$
9. $z = -x + 2 - y$
11. $x = 1$
13. $x = 1$
15. $z = 2x + 2y - 2$
17. $z = 3x + 4y + 2$
19. $z = x + y - 1$
21. $z = x - 4 + 2y$
23. $12t^{11}$
25. 0
27. 0

2. Section 3-2

1. $x^2 + y^2 = z^2$
3. $x^2 + y^2 + z^2 = 1$
5. $\dfrac{x^2}{4} + \dfrac{y^2}{9} + \dfrac{z^2}{4} = 1$
7. $x^2 - y^2 + z^2 = 1$
9. $x^2 + y^2 - z^2 = 1$
11. $\left(x^2 + y^2\right) z^2 = 1$

13.	$\mathbf{r}_u = \langle v\cos u, -v\sin u, 0\rangle$	$\mathbf{r}_v = \langle \sin u, \cos u, 1\rangle$	orthogonal
15.	$\mathbf{r}_u = \langle \cos u\cos v, -\sin u, \cos u\sin v\rangle$	$\mathbf{r}_v = \langle -\sin u\sin v, 0, \sin u\cos v\rangle$	orthogonal
17.	$\mathbf{r}_u = \langle e^v\cos u, -e^v\sin u, 0\rangle$	$\mathbf{r}_v = \langle e^v\sin u, e^v\cos u, -e^{-v}\rangle$	orthogonal

19. $\mathbf{L}(du, dv) = \left\langle \frac{\sqrt{3}}{2}, \frac{1}{2}, \frac{\pi}{3} \right\rangle + \left\langle \frac{1}{2}, \frac{-\sqrt{3}}{2}, 1 \right\rangle du + \left\langle \frac{\sqrt{3}}{2}, \frac{1}{2}, \frac{\pi}{3} \right\rangle dv$

    $\mathbf{L}(du, dv) = \left\langle \frac{\sqrt{3}}{2} + \frac{du}{2} + \frac{\sqrt{3}}{2}dv, \frac{1}{2} - \frac{\sqrt{3}}{2}du + \frac{1}{2}dv, \frac{\pi}{3} + du + \frac{\pi}{3}dv \right\rangle$

21. $\mathbf{L}(du, dv) = \left\langle 1, \sqrt{3}, 2 \right\rangle + \left\langle \sqrt{3}, -1, 0 \right\rangle du + \left\langle \frac{1}{2}, \frac{1}{2}\sqrt{3}, 1 \right\rangle dv$

    $\mathbf{L}(du, dv) = \left\langle 1 + du\sqrt{3} + \frac{1}{2}dv, \sqrt{3} - du + \frac{\sqrt{3}}{2}dv, 2 + dv \right\rangle$

23. $\mathbf{L}(du, dv) = \left\langle 0, -e, e^{-1} \right\rangle + \left\langle -e, 0, 0 \right\rangle du + \left\langle 0, -e, -e^{-1} \right\rangle dv$

    $\mathbf{L}(du, dv) = \left\langle -e\ du, -e - e\ dv, e^{-1} - e^{-1}dv \right\rangle$

25.	$\mathbf{r}(u, v) = \langle u, u\sin(v), u\cos(v)\rangle$	orthogonal
	$\mathbf{r}_u = \langle 1, \sin v, \cos v\rangle$	$\mathbf{r}_v = \langle 0, u\cos v, -u\sin v\rangle$
27.	$\mathbf{r}(u, v) = \left\langle u, \left(u - u^2\right)\sin(v), \left(u - u^2\right)\cos(v)\right\rangle$	orthogonal
	$\mathbf{r}_u = \langle 1, (1 - 2u)\sin v, (1 - 2u)\cos v\rangle$	$\mathbf{r}_v = \left\langle 0, \left(u - u^2\right)\cos v, -\left(u - u^2\right)\sin v\right\rangle$
29.	$\mathbf{r}(u, v) = \langle u, \cosh(u)\sin(v), \cosh(u)\cos(v)\rangle$	orthogonal
	$\mathbf{r}_u = \langle 1, \sinh u\sin v, \sinh u\cos v\rangle$	$\mathbf{r}_v = \langle 0, \cosh u\cos v, -\cosh u\sin v\rangle$

3. Section 3-3

1. $y = 4x^2$
3. $y = 2x$
5. $\frac{x^2}{16} + \frac{y^2}{9} = 1$
7. $x = \frac{y^2}{4} - 4$
9. $x^2 + y^2 = 1$

11. unit square with lower left vertex at $(1, 5)$
13. unit square
15. region between x-axis, $x = \frac{y^2}{4} - 1$, and $x = 1 - \frac{y^2}{4}$
17. region between x-axis, $y = x$, $y = e^{-2}x$ and $xy = 1$

19. $\begin{bmatrix} \frac{1}{2} & -\frac{1}{2}\sqrt{3} \\ \frac{1}{2}\sqrt{3} & \frac{1}{2} \end{bmatrix}$ $\quad y = -x\frac{\sqrt{3}+2}{-1+2\sqrt{3}}$

21. $\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$ $\quad y = 1$

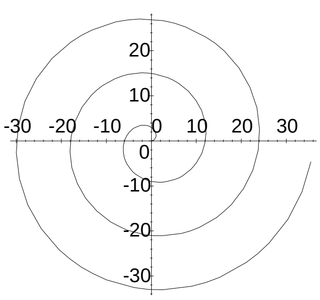
23. $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$ $\quad y = -x - 2$

25. $u^2 + \frac{v^2}{4} = 1$
27. $u^2 - v^2 = 2$
29. $\frac{u^2}{16} + \frac{v^2}{9} = 1$

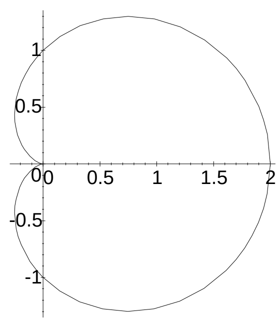
4. Section 3-4

1. a. $(-2, 0)$ b. $(-1, 0)$ c. $\left(\frac{3\sqrt{3}}{2}, \frac{3}{2}\right)$ d. $(1, -\sqrt{3})$

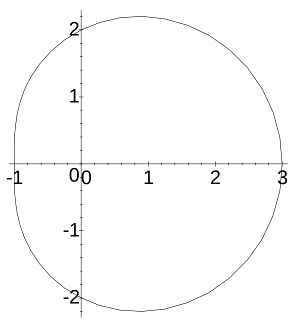
3.



5.



7.



9.	$r = 4$	21.	$r = 2\cos(\theta)$
11.	$r = \sec(\theta)$	23.	$r = \sqrt{2\sec(\theta)\csc(\theta)}$
13.	$r = \dfrac{2}{\sin(\theta) - 3\cos(\theta)}$	25.	$p = 3$, $\varepsilon = \frac{3}{4}$
15.	$r = \sec(\theta)\tan(\theta)$	27.	$p = 2$, $\varepsilon = 0.2$
17.	$r = \dfrac{\cos\theta \pm \sqrt{1 + 15\sin^2\theta}}{8\sin^2\theta}$	29.	$p = 2$, $\varepsilon = 0.5$
19.	$r = \sqrt{2\sec(\theta)\csc(\theta)}$		

5. Section 3-5

1.	$\mathbf{w} = \langle 1, 2\rangle$, $J = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$, $\mathbf{z} = \langle 3, -1\rangle$	15.	$\mathbf{v} = \langle -2, -1\rangle$
3.	$\mathbf{w} = \langle 1, 3\rangle$, $J = \begin{bmatrix} 2uv & u^2 \\ v^2 & 2uv \end{bmatrix}$, $\mathbf{z} = \langle 36, 108\rangle$	17.	$dA = 2dudv$
5.	$\mathbf{w} = \langle 1, 0\rangle$, $J = \begin{bmatrix} \sec(v) & u\sec(v)\tan(v) \\ \tan(v) & u\sec^2(v) \end{bmatrix}$, $\mathbf{z} = \langle 1, 0\rangle$	19.	$dA = \left(6u^2 + 2v^2\right) dudv$
7.	$\mathbf{v} = \left\langle \frac{-\sqrt{2}}{2}, \frac{\sqrt{2}}{2} \right\rangle$	21.	$dA = 4\lvert u\rvert\, dudv$
9.	$\mathbf{v} = \langle 2, 4\rangle$	23.	$dA = 12\lvert u\rvert\, dudv$
11.	$\mathbf{v} = \langle -\sqrt{3}, 0\rangle$	25.	$dA = 2e^{2u} dudv$
13.	$\mathbf{v} = \left\langle -\frac{\pi}{8}\sqrt{2}, \sqrt{2} + \frac{\pi}{8}\sqrt{2} \right\rangle$	27.	$dA = \lvert\cos(2u)\rvert\, dudv$

6. Section 3-6

1. a. $\left(\frac{3}{2}, \frac{3}{2}\sqrt{3}, 3\right)$ b. $(0, 7, 0)$ c. $(5, 0, 0)$ d. $(-4, 0, -2)$

3. a. $\left(-\frac{3}{2}\sqrt{3}, 0, \frac{3}{2}\right)$ b. $\left(\frac{7}{2}\sqrt{2}, \frac{7}{2}\sqrt{2}, 0\right)$ c. $(-1, 0, 0)$ d. $(0, 0, 5)$

In 5-11, substitute the value for r into the parameterization

$$\mathbf{r}(\theta, z) = \langle r\cos(\theta), r\sin(\theta), z\rangle$$

In 13-19 amd 23, substitute the value for ρ into the parameterization

$$\mathbf{r}(\phi, \theta) = \langle \rho\sin(\phi)\cos(\theta), \rho\sin(\phi)\sin(\theta), \rho\cos(\phi)\rangle$$

In 25-19, substitute the value for r into the parameterization

$$\mathbf{r}(t) = \langle r\cos(t), r\sin(t), r\rangle$$

5. $r = 5,$

7. $r = \sqrt{z^2+1}$

9. $r = \dfrac{2}{3\cos(\theta) + 4\sin(\theta)}$

11. $r = z$

13. $\rho = 5$

15. $\rho = \csc(\phi)\sec(\theta)$

17. $\rho = \sqrt{-\sec(2\phi)}$

19. $\rho = \dfrac{1}{\cos(\phi) + 2\sin(\phi)\sin(\theta)}$

21. $\phi = \pi/4,\ \mathbf{r}(\rho,\theta) = \frac{\rho}{\sqrt{2}}\langle\cos(\theta), \sin(\theta), 1\rangle$

23. $\rho = \sec(\phi)\sin(2\theta)$

25. $r = \dfrac{1}{1 - \frac{1}{2}\cos(\theta)}$

27. $r = \dfrac{2}{1 - \cos(\theta)}$

29. $r = \dfrac{1}{1 - 2\cos(\theta)}$

7. Section 3-7

1. $\mathbf{n} = \left\langle \frac{-1}{\sqrt{2}}, 0, \frac{1}{\sqrt{2}} \right\rangle$

3. $\mathbf{n} = \langle 0, \sin(u), \cos(u)\rangle$

5. $\mathbf{n} = \frac{1}{\sqrt{2}}\langle \sin(u), \cos(u), -1\rangle$

7. $\mathbf{n} = \dfrac{\langle -e^{-u}, -e^{u}, 2\rangle}{\sqrt{e^{-2u} + e^{2u} + 4}}$

9. $\mathbf{n} = \dfrac{1}{\sqrt{2z^2+1}}\ \langle x, y, -z\rangle$

11. $\mathbf{n} = \left\langle \frac{2}{3}, \frac{2}{3}, \frac{1}{3}\right\rangle$

13. $\mathbf{n} = \dfrac{1}{\sqrt{\theta^2 + r^2 z^2}}\langle -\theta\sin\theta, \theta\cos\theta, z\rangle$

15. $\mathbf{n} = \dfrac{\langle \theta\cos\theta - \sin\theta, \theta\sin\theta + \cos\theta, 2z\rangle}{\sqrt{1+\theta^2+4z^2}}$

17. $\boldsymbol{\rho}\cdot\mathbf{r}_u = 4, \quad \boldsymbol{\rho}\cdot\mathbf{r}_v = 2$, not a geodesic

19. $\boldsymbol{\rho}\cdot\mathbf{r}_u = 32t + 24, \quad \boldsymbol{\rho}\cdot\mathbf{r}_v = -(4t+3)$, not a geodesic

21. $\boldsymbol{\rho}\cdot\mathbf{r}_u = 0, \quad \boldsymbol{\rho}\cdot\mathbf{r}_v = 0$, is a geodesic

23. $\boldsymbol{\rho}\cdot\mathbf{r}_u = 0, \quad \boldsymbol{\rho}\cdot\mathbf{r}_v = 0$, is a geodesic

25. $\boldsymbol{\rho}\cdot\mathbf{r}_u = \sec^2(t) + \tan^2(t), \quad \boldsymbol{\rho}\cdot\mathbf{r}_v = 1$, not a geodesic

27. $\mathbf{r}(t) = \left[\sin(t), \sin(t), \cos(t)\sqrt{2}\right]$, distance $= \frac{\pi\sqrt{2}}{2}$

29. $\mathbf{r}(t) = \langle 2,2,1\rangle\cos(t) + \left\langle \frac{2}{\sqrt{17}}, -\frac{7}{\sqrt{17}}, \frac{10}{\sqrt{17}}\right\rangle\sin(t)$

distance $= \cos^{-1}\left(\frac{8}{9}\right) \approx 0.47588$

8. Section 3-8

1. $ds^2 = 2du^2 + dv^2$
3. $ds^2 = v^2 du^2 + 2dv^2$
5. $ds^2 = du^2 + \sin^2(u)\, dv^2$
7. $ds^2 = \left(9 - 5\cos^2(u)\right) du^2 + 4\sin^2(u)\, dv^2$
9. $ds^2 = \cosh^2(v)\, du^2 + \left(2\cosh^2 v - 1\right) dv^2$
11. $ds^2 = \left(2\sec^4(u) - \sec^2(u)\right) du^2 + \sec^2(u)\, dv^2$
13. $ds^2 = e^{2v} du^2 + \left(e^{2v} + e^{-2v}\right) dv^2$
15. 2π
17. 1
19. π
21. $\frac{4-2\sqrt{3}}{3\sqrt{3}-5}$
23. 2π
25. π
27. 2π
29. 1.45214

9. Section 3-9

1. $\kappa_n(\theta) = \cos^2(\theta)$, $\kappa_1 = 0$, $\kappa_2 = 1$, *Gaussian flat*
3. $\kappa_n(\theta) = 0$, *flat*, minimal, (it's a plane!)
5. $\kappa_n(\theta) = \dfrac{2\sin^2(\theta)}{\left(1+4v^2\right)^{3/2}}$, $\kappa_1 = 0$, $\kappa_2 = \dfrac{2}{\left(1+4v^2\right)^{3/2}}$, Gaussian flat
7. $\kappa_n(\theta) = \dfrac{\cos^2(\theta)}{\cosh^2(u)}$, $\kappa_1 = \dfrac{1}{\cosh^2(u)}$, $\kappa_2 = 0$, Gaussian flat
9. $\kappa_n(\theta) = \dfrac{-\sin(2\theta)}{1+u^2}$, $\kappa_1 = \dfrac{-1}{1+u^2}$, $\kappa_2 = \dfrac{1}{1+u^2}$, Minimal
11. $\kappa_n(\theta) = \dfrac{\sin^2(\theta)}{u\sqrt{2}}$, $\kappa_1 = \frac{1}{u\sqrt{2}}$, $\kappa_2 = 0$, Gaussian flat
13. $\kappa_n(\theta) = \left(2\cos^2(\theta) - 1\right) \operatorname{sech}^2(v)$, $\kappa_1 = \operatorname{sech}^2(v)$, $\kappa_2 = -\operatorname{sech}^2(v)$, Minimal
15. $\kappa_n(\theta) = -\sin(2\theta)\operatorname{sech}^2(v)$, $\kappa_1 = \operatorname{sech}^2(v)$, $\kappa_2 = -\operatorname{sech}^2(v)$, Minimal
17. $K = -4$
19. $K = 0$
21. $K = \dfrac{-2}{v^2\left(4v^2+1\right)^2}$
23. $K = \dfrac{\cos u}{2 + \cos u}$