```
In[1]:= ContourPlot3D[(y^2) / 9 - (z^2) / 4 == x / 5,
          {x, -5, 5}, {y, -4, 6}, {z, -3, 7}]
```

Out[1]=

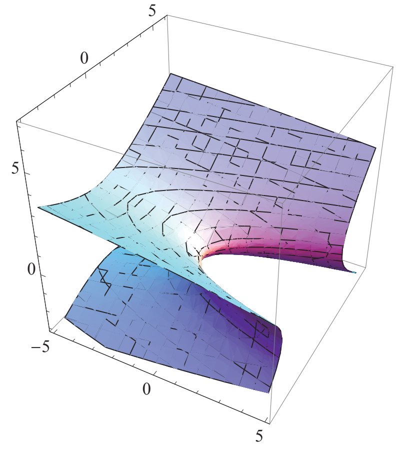


Figure 10

```
In[2]:= ContourPlot3D[(y^2) / 9 - (z^2) / 4 == x / 5,
          {x, -5, 5}, {y, -4, 6}, {z, -3, 7},
          ContourStyle → Opacity[0.5], Mesh → None]
```

Out[2]=

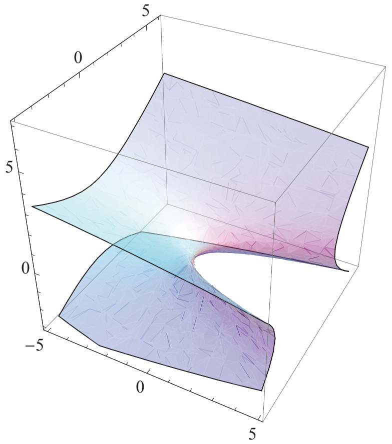


Figure 11

11.6 **Exercises**

1–8 Identify the surface defined by the equation and match it to the appropriate graph (labeled A–H).

1. $x^2 = 2(1-y)$

2. $y^2 - 4y + z^2 = 4$

3. $\dfrac{y^2}{5} - \dfrac{z^2}{8} = \dfrac{x}{6}$

4. $\dfrac{x^2}{9} + \dfrac{z^2}{4} = \dfrac{y^2}{25}$

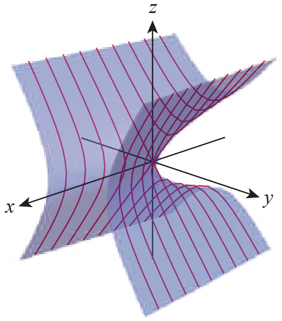
5. $\dfrac{x^2}{16} + \dfrac{y^2}{9} + \dfrac{z^2}{4} = 1$

6. $6y^2 + 4z^2 - 3x^2 = 12$

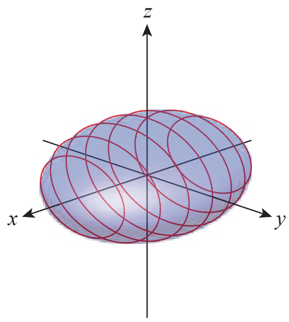
7. $5x^2 - 8y^2 + 32y - 10z^2 + 20z = 82$

8. $15x^2 + 30x - 20y + 12z^2 + 55 = 0$

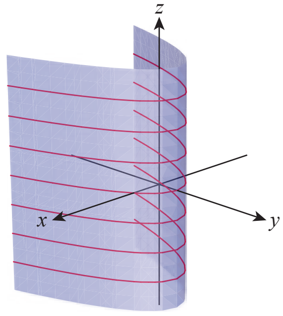
A.



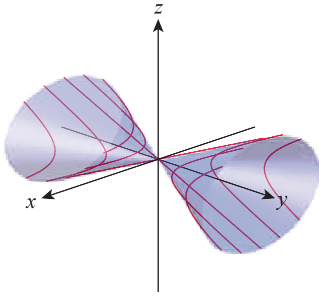
B.



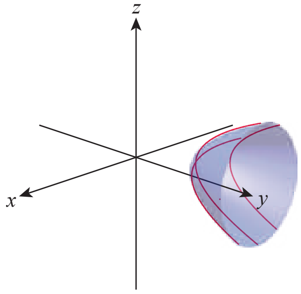
C.



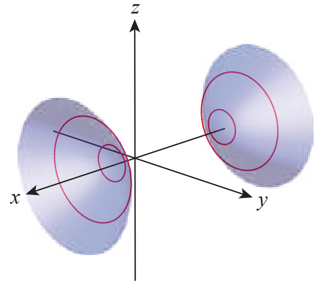
D.



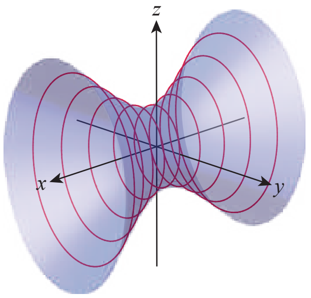
E.



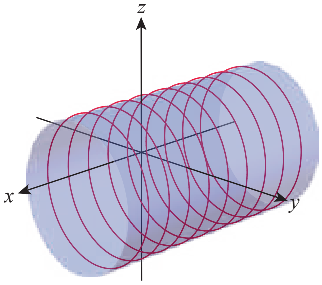
F.



G.



H.



9–16 Sketch the surface by hand. Use cross-sections to help you with your sketch.

9. $x^2+(z-1)^2=1$ **10.** $y^2+\frac{(z-1)^2}{4}=1$

11. $y^2-\frac{(z-1)^2}{4}=1$ **12.** $y^2-\frac{(z-1)}{4}=0$

13. $x^2-6x+2y+11=0$ **14.** $x^2-6x+2y^2+8=0$

15. $\cos\frac{z}{2}-y=1$ **16.** $\ln x-z=0$

17–18 Find the lengths of the major and minor axes as well as the foci of the indicated cross-section of the surface $z=\frac{x^2}{2}+y^2$.

17. $z=4$ **18.** $z=8$

19–20 The intersection of the given plane and the surface from Exercises 17–18 is a parabola. Find the coordinates of its vertex and focus.

19. $x=1$ **20.** $y=1$

21–34 Identify and sketch the quadric surface by hand. Use cross-sections to help you with your sketch.

21. $\frac{x^2}{9}+\frac{y^2}{16}+\frac{(z-2)^2}{4}=1$

22. $\frac{(y+1)^2}{9}+\frac{z^2}{4}=x$

23. $x^2+\frac{9y^2}{16}-\frac{9z^2}{25}-9=0$

24. $3z^2+2y^2=\frac{3x^2}{2}$

25. $3z^2 - 2y^2 = 1 + \frac{3x^2}{2}$

26. $3z^2 + 2y = \frac{3x^2}{2}$

27. $3z^2 + 2y^2 = \frac{3x}{2}$

28. $3z^2 + 2y^2 = 1 - \frac{3x^2}{2}$

29. $2x^2 + 2y^2 = z$

30. $2x^2 + 2y^2 = z^2$

31. $x^2 + 2x - y^2 + z^2 = 0$

32. $x^2 + 2x + 2y^2 + 3z^2 = 8y$

33. $x^2 + 2x - 2y^2 - 3z = 8y + 7$

34. $-x^2 + 2x + 2y^2 - 3z^2 = 8y + 2$

35. Consider the quadric surface of Exercise 29, $2x^2 + 2y^2 = z$. Find the intersection of this surface with the xz-plane. Explain why it is called a "generating curve" of the surface.

36. Find another generating curve for the surface in Exercise 35, and argue that the generating curve of a surface of revolution is not unique. (**Hint:** Consider the intersection of the surface with another coordinate plane.)

37–38 Find the indicated generating curve for the given surface.

37. $x^2 + y^2 = 5z$, the generating curve that lies in the yz-plane

38. $x^2 + z^2 = 1 - 3y^2$, the generating curve that lies in the xy-plane

39–46 Find an equation for the surface that results from rotating the curve about the indicated axis. (**Hint:** See Exercises 35–38.)

39. $x^2 = 2y$; about the y-axis

40. $x = 2y$; about the y-axis

41. $y = \sqrt{z-2}$; about the z-axis

42. $y = \sqrt{1-x^2}$; about the x-axis

43. $x = \frac{a}{c}\sqrt{z^2 + c^2}$; about the z-axis

44. $2xz = 3$; about the x-axis

45. $2xz = 3$; about the z-axis

46. $z = \frac{e^y}{5}$; about the y-axis

47. Assuming that Earth is a perfect ellipsoid with equatorial and polar radii of 6378 and 6357 kilometers, respectively, find the equation of this ellipsoid assuming it is centered at the origin and the axis of rotation is the z-axis.

48. What do you know about a, b, and c if the horizontal cross-sections of the graph of $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ are circles?

49. Prove that all horizontal cross-sections of the ellipsoid $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ have the same eccentricity. Can you make a similar statement about vertical cross-sections? (**Hint:** For a refresher, see the definition of eccentricity in Section 9.5).

50. Find the equation of the set of points in three-dimensional space which are equidistant from the point $(0,0,1)$ and the plane $z = -1$.

Concept Check

51–55 Determine whether the given statement is true or false. In case of a false statement, explain or provide a counterexample.

51. A sphere is not an ellipsoid.

52. A vertical paraboloid whose horizontal cross-sections are circles is not an elliptic paraboloid.

53. If $a = b$ in the equation $\frac{x^2}{a^2} + \frac{y^2}{b^2} - \frac{z^2}{c^2} = 1$ of a hyperboloid, then its horizontal cross-sections are circles.

54. A quadric surface that is a surface of revolution has a unique generating curve.

55. A quadric surface that is a surface of revolution has a unique axis of rotation.

11.6 Technology Exercises

56–63. Use a graphing utility to sketch the cylindrical surfaces of Exercises 9–16.

64–77. Use a graphing utility to sketch the quadric surfaces of Exercises 21–34.