

***Calculus Volume 3 1st edition Strang Solutions  
Manual***

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# Calculus

## Volume 3

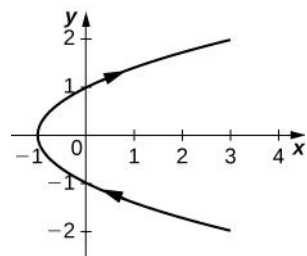
**Chapter 1**  
**Parametric Equations and Polar Coordinates**  
**1.1 Parametric Equations**

**Section Exercises**

**For the following exercises, sketch the curves below by eliminating the parameter  $t$ . Give the orientation of the curve.**

1.  $x = t^2 + 2t, y = t + 1$

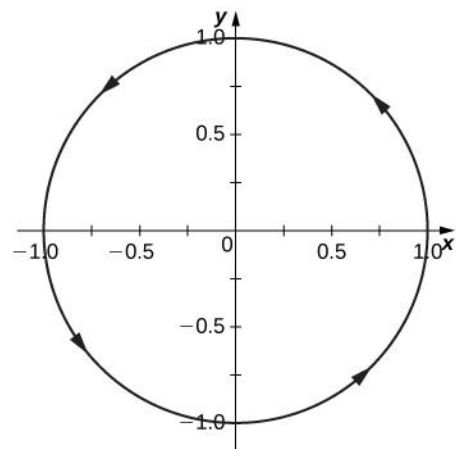
Answer:



orientation: bottom to top

2.  $x = \cos(t), y = \sin(t), (0, 2\pi]$

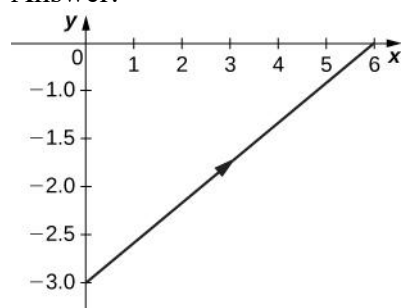
Answer:



orientation: counterclockwise

3.  $x = 2t + 4$ ,  $y = t - 1$

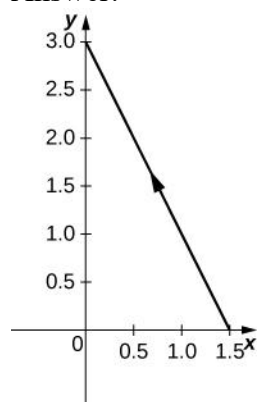
Answer:



orientation: left to right

4.  $x = 3 - t$ ,  $y = 2t - 3$ ,  $1.5 \leq t \leq 3$

Answer:

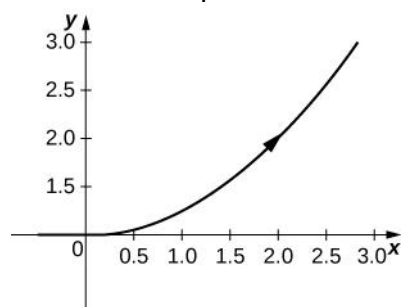


orientation: right to left

**For the following exercises, eliminate the parameter and sketch the graphs.**

5.  $x = 2t^2$ ,  $y = t^4 + 1$

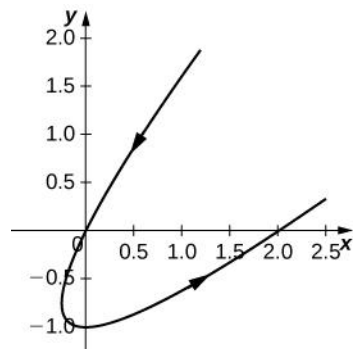
Answer:  $y = \frac{x^2}{4} + 1$



For the following exercises, use technology (CAS or calculator) to sketch the parametric equations.

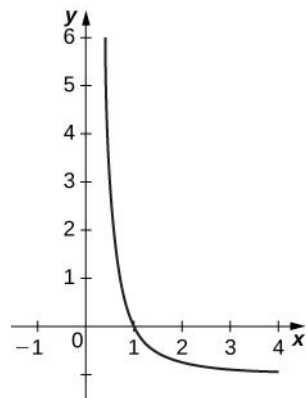
6. [T]  $x = t^2 + t, \quad y = t^2 - 1$

Answer:



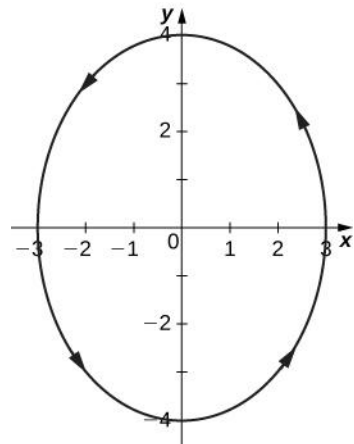
7. [T]  $x = e^{-t}, \quad y = e^{2t} - 1$

Answer:



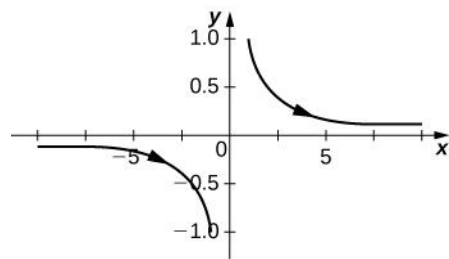
8. [T]  $x = 3 \cos t, \quad y = 4 \sin t$

Answer:



9. [T]  $x = \sec t$ ,  $y = \cos t$

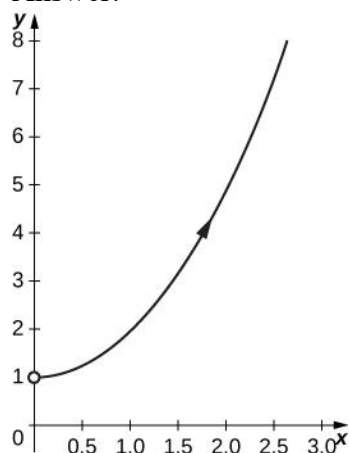
Answer:



For the following exercises, sketch the parametric equations by eliminating the parameter. Indicate any asymptotes of the graph.

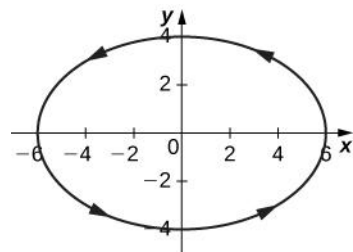
10.  $x = e^t$ ,  $y = e^{2t} + 1$

Answer:



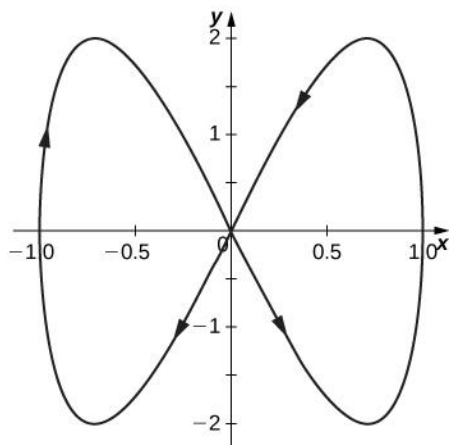
11.  $x = 6 \sin(2\theta)$ ,  $y = 4 \cos(2\theta)$

Answer:



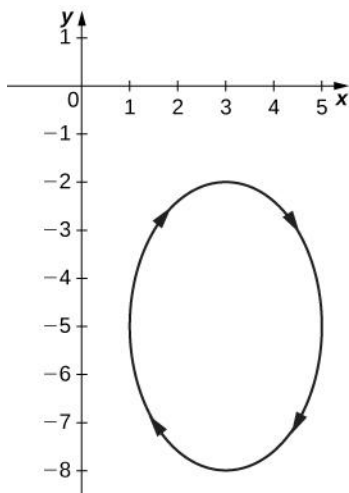
12.  $x = \cos \theta$ ,  $y = 2 \sin(2\theta)$

Answer:



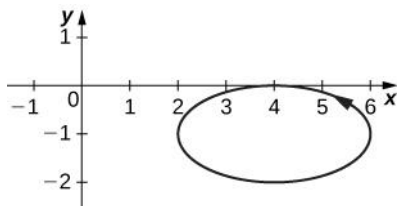
13.  $x = 3 - 2 \cos \theta$ ,  $y = -5 + 3 \sin \theta$

Answer:



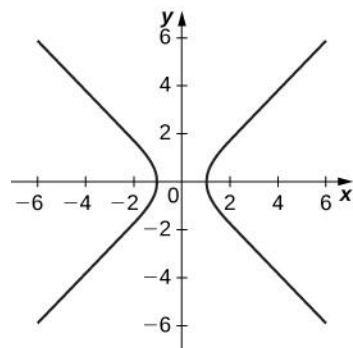
14.  $x = 4 + 2 \cos \theta$ ,  $y = -1 + \sin \theta$

Answer:



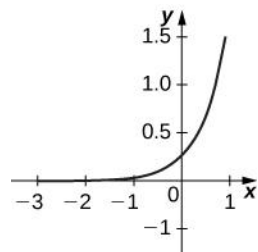
15.  $x = \sec t, \quad y = \tan t$

Answer:

Asymptotes are  $y = x$  and  $y = -x$ 

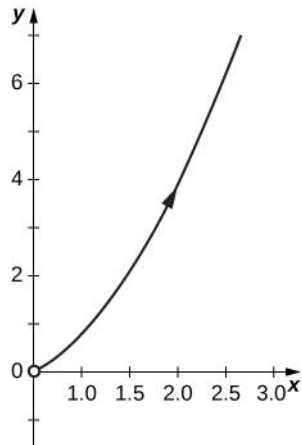
16.  $x = \ln(2t), \quad y = t^2$

Answer:

 $y = 0$  is a horizontal asymptote.

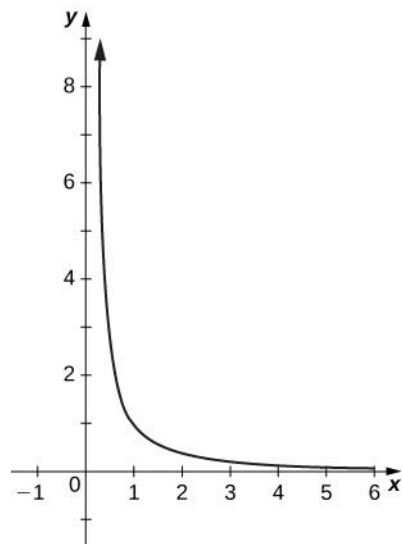
17.  $x = e^t, \quad y = e^{2t}$

Answer:



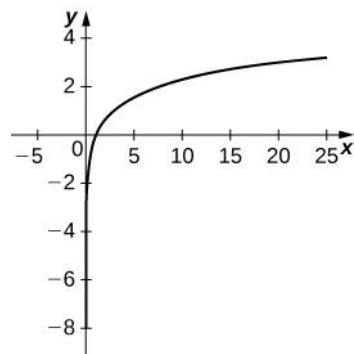
18.  $x = e^{-2t}$ ,  $y = e^{3t}$

Answer:

Horizontal asymptote:  $y = 0$ . Vertical asymptote:  $x = 0$ .

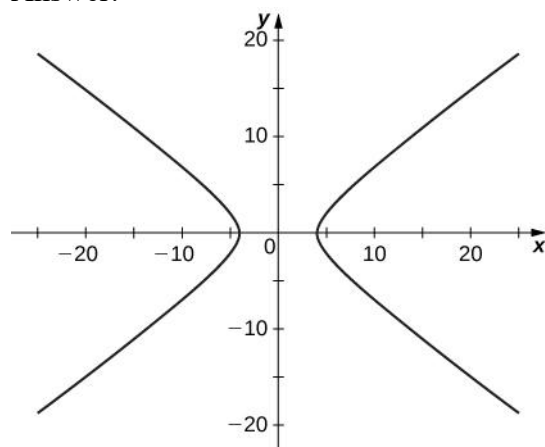
19.  $x = t^3$ ,  $y = 3\ln t$

Answer:



20.  $x = 4 \sec \theta$ ,  $y = 3 \tan \theta$

Answer:



**For the following exercises, convert the parametric equations of a curve into rectangular form. No sketch is necessary. State the domain of the rectangular form.**

21.  $x = t^2 - 1$ ,  $y = \frac{t}{2}$

Answer:  $y = \frac{\sqrt{x+1}}{2}$ ; domain:  $x \in [-1, \infty)$

22.  $x = \frac{1}{\sqrt{t+1}}$ ,  $y = \frac{t}{1+t}$ ,  $t > -1$

Answer:  $y = 1 - x^2$ ; domain:  $x \in (0, \infty)$ .

23.  $x = 4 \cos \theta$ ,  $y = 3 \sin \theta$ ,  $\theta \in (0, 2\pi]$

Answer:  $\frac{x^2}{16} + \frac{y^2}{9} = 1$ ; domain  $x \in [-4, 4]$ .

24.  $x = \cosh t$ ,  $y = \sinh t$

Answer:  $x^2 - y^2 = 1$ ; domain  $x \in [1, \infty) \cup (-\infty, -1]$ .

25.  $x = 2t - 3$ ,  $y = 6t - 7$

Answer:  $y = 3x + 2$ ; domain: all real numbers.

26.  $x = t^2$ ,  $y = t^3$

Answer:  $y = \pm x^{3/2}$ ; domain:  $x \in [0, \infty)$ .

27.  $x = 1 + \cos t$ ,  $y = 3 - \sin t$

Answer:  $(x-1)^2 + (y-3)^2 = 1$ ; domain:  $x \in [0, 2]$ .

28.  $x = \sqrt{t}$ ,  $y = 2t + 4$

Answer:  $y = 2x^2 + 4$ ,  $x \geq 0$ ; domain:  $x \in [0, \infty)$ .

29.  $x = \sec t$ ,  $y = \tan t$ ,  $\pi \leq t < \frac{3\pi}{2}$

Answer:  $y = \sqrt{x^2 - 1}$ ; domain:  $x \in (-\infty, 1]$

30.  $x = 2 \cosh t$ ,  $y = 4 \sinh t$

Answer:  $\frac{x^2}{4} - \frac{y^2}{16} = 1$

31.  $x = \cos(2t)$ ,  $y = \sin t$

Answer:  $y^2 = \frac{1-x}{2}$ ; domain:  $x \in [2, \infty) \cup (-\infty, -2]$ .

32.  $x = 4t + 3$ ,  $y = 16t^2 - 9$

Answer:  $y = (x-3)^2 - 9$ ; domain: all real numbers.

33.  $x = t^2$ ,  $y = 2 \ln t$ ,  $t \geq 1$

Answer:  $y = \ln x$ ; domain:  $x \in [1, \infty)$ .

34.  $x = t^3$ ,  $y = 3 \ln t$ ,  $t \geq 1$

Answer:  $y = \ln x$ ; domain:  $x \in (0, \infty)$ .

35.  $x = t^n$ ,  $y = n \ln t$ ,  $t \geq 1$ , where  $n$  is a natural number

Answer:  $y = \ln x$ ; domain:  $x \in (0, \infty)$ .

36.  $x = \ln(5t)$   
 $y = \ln(t^2)$  where  $1 \leq t \leq e$

Answer:  $y = 2x - \ln 25$ , a linear function; domain:  $x \in [\ln(5), \ln(5) + 1]$ .

37.  $x = 2 \sin(8t)$   
 $y = 2 \cos(8t)$

Answer:  $x^2 + y^2 = 4$ ; domain:  $x \in [-2, 2]$ .

38.  $x = \tan t$   
 $y = \sec^2 t - 1$

Answer:  $y = x^2$ ; domain: all real numbers.

**For the following exercises, the pairs of parametric equations represent lines, parabolas, circles, ellipses, or hyperbolas. Name the type of basic curve that each pair of equations represents.**

39. 
$$\begin{aligned}x &= 3t + 4 \\ y &= 5t - 2\end{aligned}$$

Answer: line

40. 
$$\begin{aligned}x - 4 &= 5t \\ y + 2 &= t\end{aligned}$$

Answer: line

41. 
$$\begin{aligned}x &= 2t + 1 \\ y &= t^2 - 3\end{aligned}$$

Answer: parabola

42. 
$$\begin{aligned}x &= 3 \cos t \\ y &= 3 \sin t\end{aligned}$$

Answer: circle

43. 
$$\begin{aligned}x &= 2 \cos(3t) \\ y &= 2 \sin(3t)\end{aligned}$$

Answer: circle

44. 
$$\begin{aligned}x &= \cosh t \\ y &= \sinh t\end{aligned}$$

Answer: hyperbola

45. 
$$\begin{aligned}x &= 3 \cos t \\ y &= 4 \sin t\end{aligned}$$

Answer: ellipse

46. 
$$\begin{aligned}x &= 2 \cos(3t) \\ y &= 5 \sin(3t)\end{aligned}$$

Answer: ellipse

47. 
$$\begin{aligned}x &= 3 \cosh(4t) \\ y &= 4 \sinh(4t)\end{aligned}$$

Answer: hyperbola

48.  $x = 2 \cosh t$   
 $y = 2 \sinh t$

Answer: hyperbola

49. Show that  $\begin{matrix} x = h + r \cos \theta \\ y = k + r \sin \theta \end{matrix}$  represents the equation of a circle.

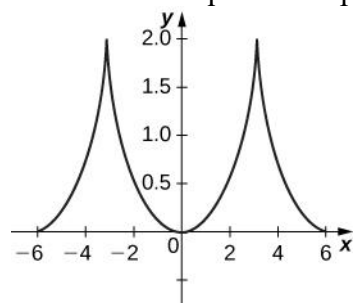
50. Use the equations in the preceding problem to find a set of parametric equations for a circle whose radius is 5 and whose center is  $(-2, 3)$ .

Answer:  $x = -2 + 5 \cos \theta$   
 $y = 3 + 5 \sin \theta$

**For the following exercises, use a graphing utility to graph the curve represented by the parametric equations and identify the curve from its equation.**

51. [T]  $x = \theta + \sin \theta$   
 $y = 1 - \cos \theta$

Answer: The equations represent a cycloid.



52. [T]  $x = 2t - 2 \sin t$   
 $y = 2 - 2 \cos t$

Answer: The equations represent the mirror image of a cycloid, the graph of which is symmetric with the y-axis.

