Chapter 9

Applications of Trigonometric Functions

9.5 Simple Harmonic Motion; Damped Motion

1. $d = -5\cos(\pi t)$

2. $d = -10\cos\left(\frac{2\pi}{3}t\right)$

3. $d = -6\cos(2t)$

4. $d = -4\cos(4t)$

5. $d = -5\sin(\pi t)$

6. $d = -10\sin\left(\frac{2\pi}{3}t\right)$

7. $d = -6\sin(2\,t)$

8. $d = -4\sin(4t)$

9. $d = 5\sin(3t)$
   (a) Simple harmonic
   (b) 5 meters
   (c) $\frac{2\pi}{3}$ seconds
   (d) $\frac{3}{2\pi}$ oscillation/second

10. $d = 4\sin(2\,t)$
    (a) Simple harmonic
    (b) 4 meters
    (c) π seconds
    (d) $\frac{1}{\pi}$ oscillation/second

11. $d = 6\cos(\pi t)$
    (a) Simple harmonic
    (b) 6 meters
    (c) 2 seconds
    (d) $\frac{1}{2}$ oscillation/second

12. $d = 5\cos\left(\frac{\pi}{2}t\right)$
    (a) Simple harmonic
    (b) 5 meters
    (c) 4 seconds
    (d) $\frac{1}{4}$ oscillation/second

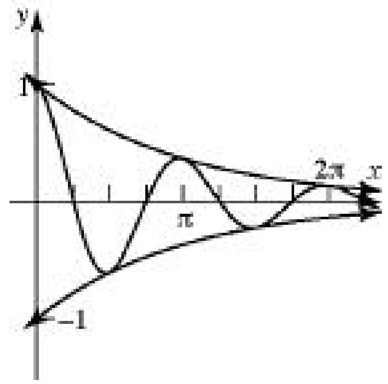
13. $d = -3\sin\left(\frac{1}{2}t\right)$
    (a) Simple harmonic
    (b) 3 meters
    (c) 4π seconds
    (d) $\frac{1}{4\pi}$ oscillation/second

14. $d = -2\cos(2t)$
    (a) Simple harmonic
    (b) 2 meters
    (c) π second
    (d) $\frac{1}{\pi}$ oscillation/second

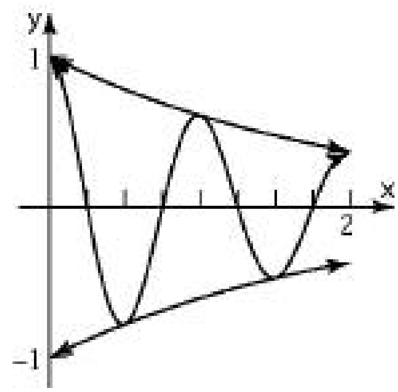
15. $d = 6 + 2\cos(2\pi t)$
   (a) Simple harmonic
   (b) 2 meters
   (c) 1 second
   (d) 1 oscillation/second

16. $d = 4 + 3\sin(\pi t)$
   (a) Simple harmonic
   (b) 3 meters
   (c) 2 second
   (d) $\frac{1}{2}$ oscillation/second

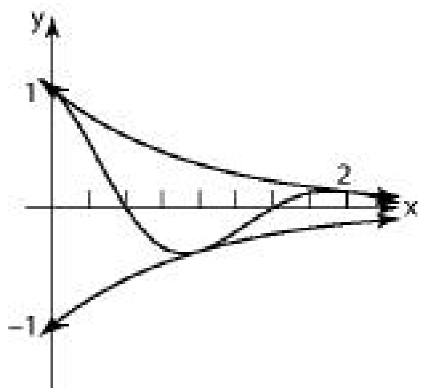
17. $d(t) = e^{-t/\pi}\cos(2t), \quad 0 \le t \le 2\pi$



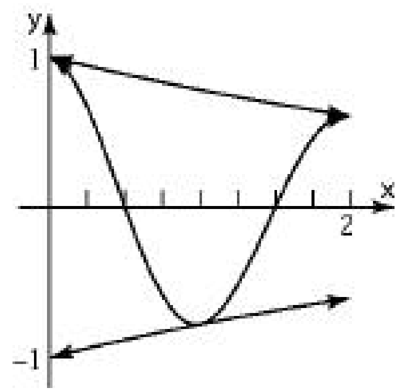
18. $d(t) = e^{-t/2\pi}\cos(2t), \quad 0 \le t \le 2\pi$



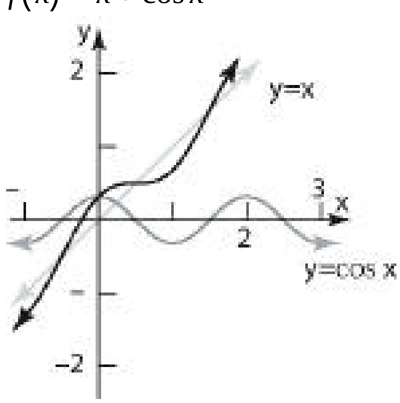
19. $d(t) = e^{-t/2\pi}\cos(t), \quad 0 \le t \le 2\pi$



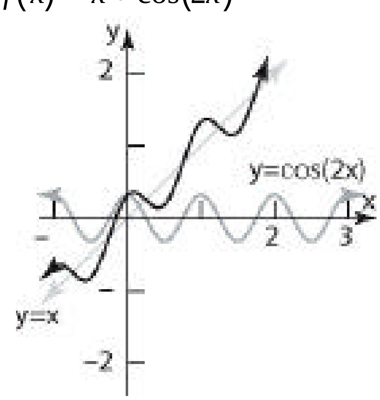
20. $d(t) = e^{-t/4\pi}\cos(t), \quad 0 \le t \le 2\pi$



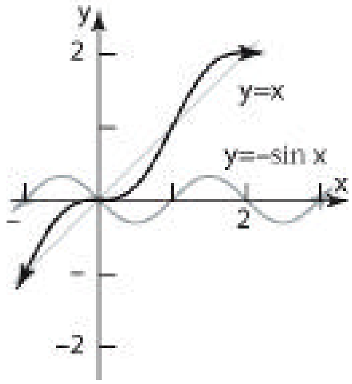
21. $f(x) = x + \cos x$



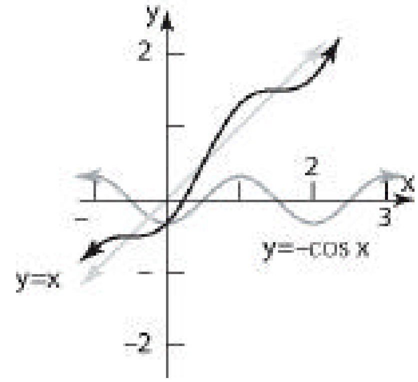
22. $f(x) = x + \cos(2x)$



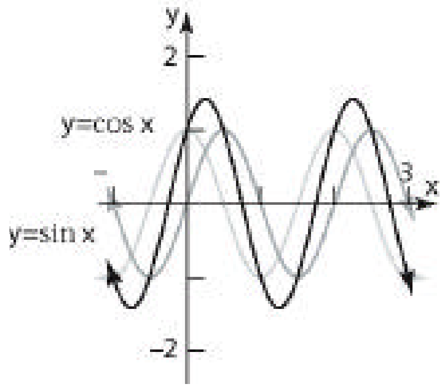
23. $f(x) = x - \sin x$



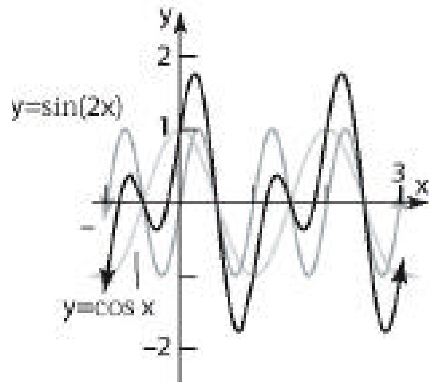
24. $f(x) = x - \cos x$



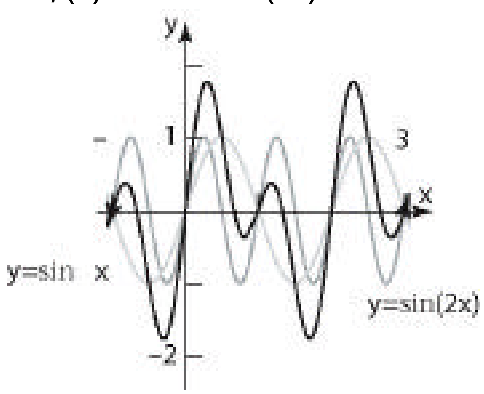
25. $f(x) = \sin x + \cos x$



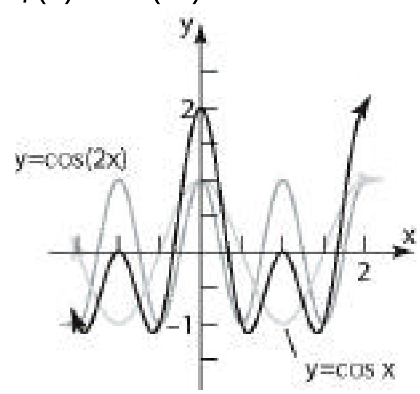
26. $f(x) = \sin(2x) + \cos x$



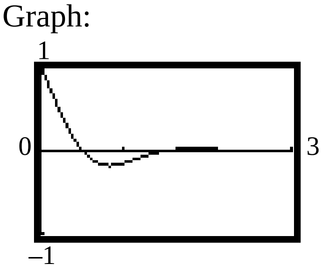
27. $f(x) = \sin x + \sin(2x)$



28. $f(x) = \cos(2x) + \cos x$



29. (a) Graph:



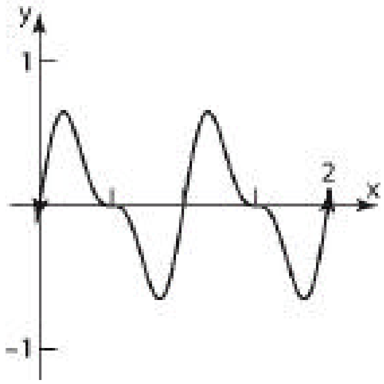
(b) The graph of V touches the graph of $y = e^{-1.9t}$ when $t = 0, 2$.
The graph of V touches the graph of $y = -e^{-1.9t}$ when $t = 1, 3$.

(c)

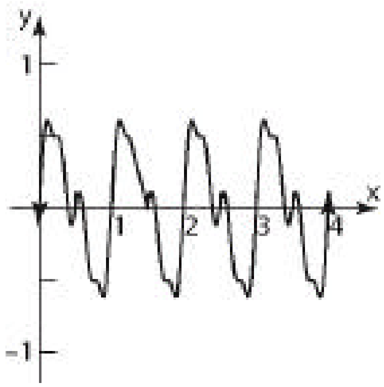
$-0.1 < V < 0.1$

for $0.43 < t < 0.60$ or $t > 1.15$.

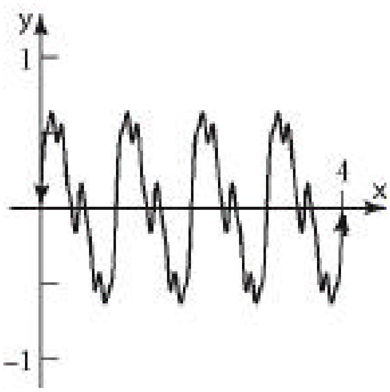
30. (a) $f(x) = \frac{1}{2}\sin(2\pi x) + \frac{1}{4}\sin(4\pi x), \quad 0 \le x \le 2$



(b) $f(x) = \frac{1}{2}\sin(2\pi x) + \frac{1}{4}\sin(4\pi x) + \frac{1}{8}\sin(8\pi x), \quad 0 \le x \le 4$



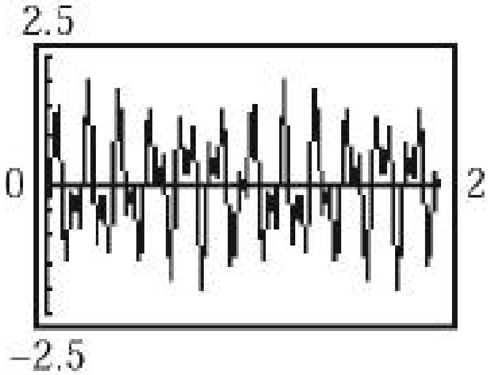
(c) $f(x) = \frac{1}{2}\sin(2\pi x) + \frac{1}{4}\sin(4\pi x) + \frac{1}{8}\sin(8\pi x) + \frac{1}{16}\sin(16\pi x), \quad 0 \le x \le 4$



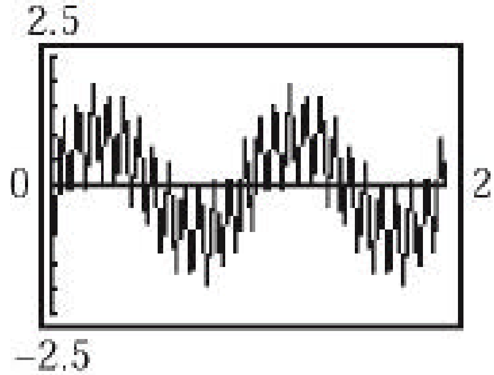
(d) $f(x) = \frac{1}{2}\sin(2\pi x) + \frac{1}{4}\sin(4\pi x) + \frac{1}{8}\sin(8\pi x) + \frac{1}{16}\sin(16\pi x) + \frac{1}{32}\sin(32\pi x)$

$0 \le x \le 4$

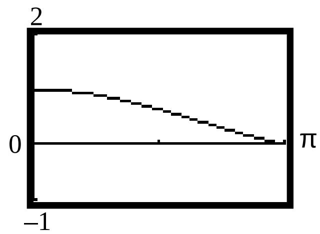
31. $y = \sin(2\pi(852)t) + \sin(2\pi(1209)t)$



32. $y = \sin(2\pi(941)t) + \sin(2\pi(1209)t)$

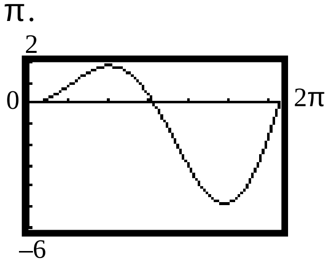


33. Graph $f(x) = \dfrac{\sin x}{x}$:

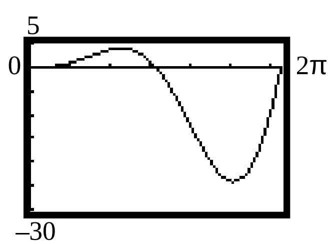


As x approaches $0, \dfrac{\sin x}{x}$ approaches 1.

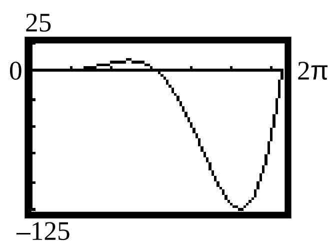
34. The graph will lie between the bounding curves $y = \pm x$, $y = \pm x^2$, $y = \pm x^3$, respectively, touching them at odd multiples of $\dfrac{\pi}{2}$. The x-intercepts of each graph are the multiples of π.



$y = x\sin x$

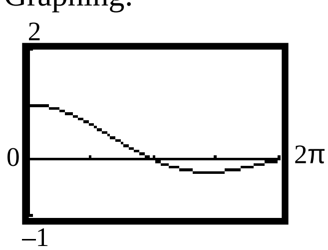


$y = x^2 \sin x$

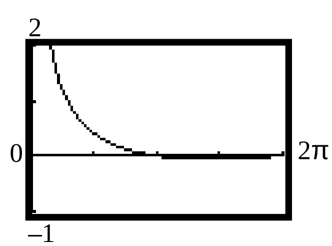


$y = x^3 \sin x$

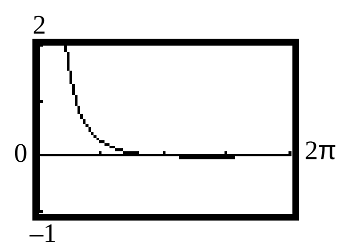
35. Graphing:



$y = \dfrac{1}{x}\sin x$



$y = \dfrac{1}{x^2}\sin x$



$y = \dfrac{1}{x^3}\sin x$

As x gets larger, the graph of $y = \dfrac{1}{x^n}\sin x$ gets closer to $y = 0$.