

# Classroom Voting Questions: Precalculus

## The Coordinate Plane

1. Find the coordinates of the point which is 3 units below the x-axis and 4 units to the right of the y-axis.
  - (a)  $(3, 4)$
  - (b)  $(-3, 4)$
  - (c)  $(4, -3)$
  - (d)  $(-4, -3)$
2. In which quadrant is  $x < 0$  and  $y < 0$ ?
  - (a) I
  - (b) II
  - (c) III
  - (d) IV
3. Find the distance between  $(2, -5)$  and  $(6, -2)$ .
  - (a) 25
  - (b) 5
  - (c)  $\sqrt{113}$
  - (d)  $\sqrt{23}$

4. Based upon the distances between each pair of points, we can conclude that the points  $(-5, 6)$ ,  $(0, 8)$ , and  $(-3, 1)$  form the vertices of what kind of triangle?
- (a) Equilateral
  - (b) Isosceles
  - (c) Right
  - (d) Both (b) and (c)
5. The endpoints of a line segment are  $(1, -5)$  and  $(-7, 4)$ . What are the coordinates of the midpoint?
- (a)  $(-6, -1)$
  - (b)  $(.4, 4.5)$
  - (c)  $(8, -9)$
  - (d)  $(-3, -.5)$
6. There is at least one point in the coordinate plane with  $x$ -coordinate  $-2$  which is at most 5 units from the point  $(2, 3)$ .
- (a) True, and I am very confident.
  - (b) True, but I am not very confident.
  - (c) False, but I am not very confident.
  - (d) False, and I am very confident.

7. There is at least one point in the coordinate plane with  $x$ -coordinate  $-2$  and  $y$ -coordinate greater than 4 which is at most 5 units from the point  $(2, 3)$ .
- (a) True, and I am very confident.
  - (b) True, but I am not very confident.
  - (c) False, but I am not very confident.
  - (d) False, and I am very confident.
8. Under what conditions will the distance from the point  $(2, 3)$  to the point  $(-2, y)$  be greater than 5 units?
- (a)  $y > 6$
  - (b)  $y < 1$
  - (c)  $0 < y < 5$
  - (d) None of the above.
9. Name the center and radius of the circle whose equation is  $(x + 2)^2 + y^2 = 100$ .
- (a) Center =  $(2, 0)$ , radius = 10
  - (b) Center =  $(-2, 0)$ , radius = 100
  - (c) Center =  $(0, 2)$ , radius = 100
  - (d) Center =  $(-2, 0)$ , radius = 10

10. Find the center and radius of the circle given by the equation  $x^2 + y^2 - 10x + 6y = 3$ .
- (a) Center:  $(-5, 3)$ ; radius: 37
  - (b) Center:  $(5, -3)$ ; radius: 37
  - (c) Center:  $(-5, 3)$ ; radius:  $\sqrt{37}$
  - (d) Center:  $(5, -3)$ ; radius:  $\sqrt{37}$
11. The point  $(4, -1)$  is on the circle with center  $(1, 2)$  and radius 5.
- (a) True, and I am very confident.
  - (b) True, but I am not very confident.
  - (c) False, but I am not very confident.
  - (d) False, and I am very confident.
12. The point  $(-8, -3)$  is on the graph of the equation  $(x + 8)^2 + (y + 1)^2 = 4$ .
- (a) True, and I am very confident.
  - (b) True, but I am not very confident.
  - (c) False, but I am not very confident.
  - (d) False, and I am very confident.
13. A diameter of a circle has endpoints  $(4, -3)$  and  $(-2, 5)$ . What is the equation of this circle?

- (a)  $(x - 1)^2 + (y - 1)^2 = 10$
- (b)  $(x - 1)^2 + (y - 1)^2 = 25$
- (c)  $(x + 1)^2 + (y + 1)^2 = 100$
- (d)  $(x - 3)^2 + (y + 1)^2 = 10$

14. The point  $(1, 4)$  is inside of the graph of the circle described by the equation

$$(x - 3)^2 + (y + 1)^2 = 26.$$

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

15. Find the equation for the lower half of the circle whose equation is  $x^2 + y^2 = 9$ .

- (a)  $y = \sqrt{9 - x^2}$
- (b)  $y = -\sqrt{9 - x^2}$
- (c)  $x = \sqrt{9 - y^2}$
- (d)  $x = -\sqrt{9 - y^2}$

## Polar Coordinates

16. A point has polar coordinates  $(r, \theta) = \left(3, \frac{5\pi}{6}\right)$ . Find the point's rectangular coordinates.

(a)  $\left(-\frac{3\sqrt{3}}{2}, \frac{3}{2}\right)$

(b)  $\left(-\frac{\sqrt{3}}{2}, \frac{1}{2}\right)$

(c)  $\left(-\frac{3}{2}, \frac{3\sqrt{3}}{2}\right)$

(d)  $\left(-\frac{1}{2}, \frac{\sqrt{3}}{2}\right)$

17. Give Cartesian coordinates for the point with polar coordinates  $(2, \pi)$ .

(a)  $(0, 2)$

(b)  $(-2, 0)$

(c)  $(2, 0)$

(d)  $(0, -2)$

18. A point has rectangular coordinates  $(x, y) = (-1, -\sqrt{3})$ . Which one of the following are polar coordinates for the point?

(a)  $\left(2, \frac{7\pi}{6}\right)$

(b)  $\left(-2, \frac{7\pi}{6}\right)$

(c)  $\left(-2, \frac{\pi}{3}\right)$

(d)  $\left(-2, \frac{4\pi}{3}\right)$

19. Give Cartesian coordinates for the point with polar coordinates  $\left(3, \frac{\pi}{6}\right)$ .

(a)  $(\sqrt{3}, 1)$

(b)  $\left(\frac{3}{2}, \frac{3\sqrt{3}}{2}\right)$

(c)  $\left(\frac{3\sqrt{3}}{2}, \frac{3}{2}\right)$

(d)  $\left(\frac{\sqrt{3}}{2}, \frac{1}{2}\right)$

20. Give polar coordinates  $(r, \theta)$  for the point with Cartesian coordinates  $(6, 8)$ .

(a)  $(.93, 10)$

(b)  $(10, .93)$

- (c)  $(10, 4.13)$
- (d)  $(100, .93)$

21. Give polar coordinates  $(r, \theta)$  for the point with Cartesian coordinates  $(-6, -8)$ .

- (a)  $(10, 5.36)$
- (b)  $(10, .93)$
- (c)  $(10, 4.07)$
- (d)  $(10, 2.21)$

22. Give polar coordinates  $(r, \theta)$  for the point with Cartesian coordinates  $(0, -2)$ .

- (a)  $(4, \pi)$
- (b)  $(4, \frac{3\pi}{2})$
- (c)  $(2, \pi)$
- (d)  $(2, \frac{3\pi}{2})$

23. True or False: A point in the  $xy$ -plane has a unique representation in polar coordinates.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.



(d) False, and I am very confident.

24. Which of the following polar coordinates represent the point with Cartesian coordinates  $(-1, 0)$ ?

(a)  $(-1, 0)$

(b)  $(1, \pi)$

(c)  $(1, -\pi)$

(d)  $(-1, 2\pi)$

(e) more than one of the above

(f) all of the above

25. The equation  $r = 2$  represents what type of graph in the Cartesian plane?

(a) horizontal line

(b) vertical line

(c) a line through the origin

(d) circle

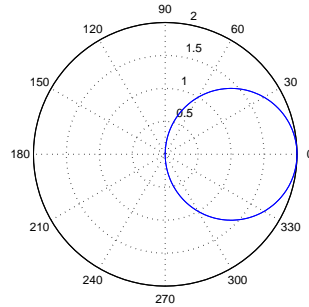
26. The equation  $\theta = \frac{\pi}{3}$  represents what type of graph in the Cartesian plane?

(a) horizontal line

(b) vertical line

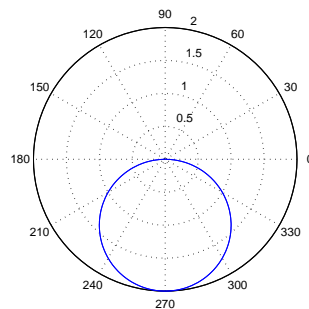
- (c) a line through the origin
- (d) circle

27. The following graph is which function expressed using polar coordinates?



- (a)  $r = 2 \sin \theta$
- (b)  $r = 1$
- (c)  $r = \cos \theta$
- (d)  $r = 2 \cos \theta$

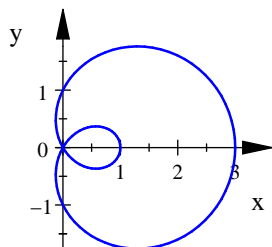
28. The following graph is which function expressed using polar coordinates?



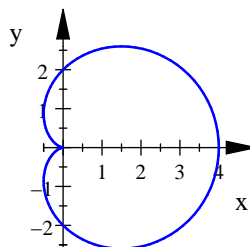
- (a)  $r = -2 \sin \theta$
- (b)  $r = \cos \theta$
- (c)  $r = -\cos \theta$
- (d)  $r = 2 \cos \theta$

29. Which of the following is a plot of the polar equation  $r = 1 + 2 \cos \theta$ ?

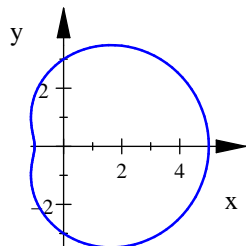
a)



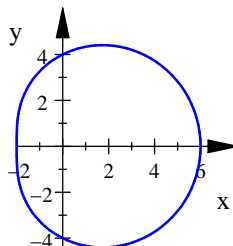
b)



c)



d)



## Parametric Equations

30. The graph of the line  $y = 2x$  can be represented with the parametric equations  $x(t) = t$  and  $y(t) = 2t$ . As  $t$  increases, from which direction is this line traced out in the  $xy$ -plane?

- (a) The line is traced from left to right.
  - (b) The line is traced from right to left.
  - (c) This cannot be determined.
31. The graph of the line  $y = 2x$  can also be represented with the parametric equations  $x(t) = -t$  and  $y(t) = -2t$ . As  $t$  increases, from which direction is this line traced out in the  $xy$ -plane?
- (a) The line is traced from left to right.
  - (b) The line is traced from right to left.
  - (c) This cannot be determined.
32. The graph of the line  $y = 2x$  can also be represented with the parametric equations  $x(t) = t^3$  and  $y(t) = 2t^3$ . Consider the segment of this line from the point  $(1, 2)$  to the point  $(27, 54)$ . If  $t$  represents time, how does the rate at which the line segment is traced out using this parameterization change as the value of  $t$  increases from  $t = 1$  to  $t = 3$ ?
- (a) The line is traced out more rapidly as  $t$  increases.
  - (b) The line is traced out more slowly as  $t$  increases.
  - (c) The rate does not change.
  - (d) This cannot be determined.

33. The graph of the line  $y = 2x$  can also be represented with the parametric equations  $x(t) = t^3$  and  $y(t) = 2t^3$ . Consider the segment of this line from the point  $(1, 2)$  to the point  $(27, 54)$ . If  $t$  represents time, how does the rate at which the line segment is traced out using this parameterization compare to the rate at which it is traced out using the parameterization  $x(t) = t, y(t) = 2t$ ?
- (a) The line is traced out more rapidly using  $x(t) = t^3$  and  $y(t) = 2t^3$ .
  - (b) The line is traced out more slowly using  $x(t) = t^3$  and  $y(t) = 2t^3$ .
  - (c) The rate does not change.
  - (d) This cannot be determined.
34. True or False: Any given curve in the  $xy$ -plane can be represented with a unique pair of parametric equations.
- (a) True, and I am very confident.
  - (b) True, but I am not very confident.
  - (c) False, but I am not very confident.
  - (d) False, and I am very confident.
35. Find a parametric representation for the curve  $y = x^2$ .

- (a)  $x(t) = t$  and  $y(t) = t^2$
- (b)  $x(t) = -t$  and  $y(t) = t^2$
- (c)  $x(t) = 1 - t$  and  $y(t) = 1 - 2t + t^2$
- (d) more than one of the above
- (e) all of the above

36. Motion around the unit circle  $x^2 + y^2 = 1$  can be represented by the parametric equations  $x(t) = \cos t$  and  $y(t) = \sin t$ . In which direction is the motion around the circle as  $t$  increases?

- (a) The motion is clockwise.
- (b) The motion is counterclockwise.
- (c) The direction of motion cannot be determined with the given information.

37. Which of the following parameterizations would represent motion around the unit circle at twice the rate of the parametrization  $x(t) = \cos t$  and  $y(t) = \sin t$ ?

- (a)  $x(t) = 2 \cos t$  and  $y(t) = 2 \sin t$
- (b)  $x(t) = \frac{1}{2} \cos t$  and  $y(t) = \frac{1}{2} \sin t$
- (c)  $x(t) = \cos(2t)$  and  $y(t) = \sin(2t)$ ?
- (d)  $x(t) = \cos\left(\frac{1}{2}t\right)$  and  $y(t) = \sin\left(\frac{1}{2}t\right)$ ?

## Lines and Parabolas

38. For what value or values of  $a$  is the line described by  $y - (-1) = a(x - 2)$  parallel to the line described by  $3x - 2y + 6 = 0$ ?
- (a)  $a = 2$ .
  - (b)  $a = 3$ .
  - (c)  $a = 2/3$ .
  - (d)  $a = 3/2$ .
  - (e) There are more than one possible values for  $a$ .
39. For what value or values of  $a$  is the line described by  $y - 6 = a(x + 1)$  perpendicular to the line described by  $x - 3y + 6 = 0$ ?
- (a)  $a = 1$ .
  - (b)  $a = -1$ .
  - (c)  $a = 3$ .
  - (d)  $a = -3$ .
  - (e) There are more than one possible values for  $a$ .
40. What are the slope,  $m$ , and the y-intercept of the line with the equation  $y = 2x + 4$ ?

- (a)  $m = 4$  and y-intercept  $(0, 2)$
- (b)  $m = 2$  and y-intercept  $(0, 4)$
- (c)  $m = 2$  and y-intercept  $(4, 0)$
- (d)  $m = 4$  and y-intercept  $(2, 0)$

41. What is the slope of the line with the equation  $2x + 3y = 6$ ?

- (a) 6
- (b)  $\frac{2}{3}$
- (c)  $-\frac{2}{3}$
- (d) 0

42. What is the slope of the line  $y = 3$ ?

- (a) 3
- (b) 0
- (c) 1
- (d) It has no slope.

43. Which of the following is the equation of a parabola with vertex  $(-3, 0)$ ?

- (a)  $y = (x - 3)^2$
- (b)  $y = x^2 - 3$



(c)  $y = (x + 3)^2$

(d)  $y = x^2 + 3$

44. Find the maximum value of  $f(x) = -4(x - 5)^2 - 3$ .

(a) 5

(b) -5

(c) 3

(d) -3

45. Find the minimum value of  $y = 3x^2 + 6x - 8$ .

(a) -8

(b) -11

(c) -1

(d) -6

46. What is the minimum value of  $f(x) = 2x^2 - 8x + 11$ ?

(a) 11

(b) 3

(c) 2

(d) -1

47. Find the minimum value of  $f(x) = 2(x + 3)^2 + 7$ .

- (a) 2
- (b) 3
- (c) -3
- (d) 7

48. Is  $y = 11$  a maximum or a minimum value for  $f(x) = -\frac{1}{2}(x + 1)^2 + 11$ ?

- (a) Maximum, and I am very confident.
- (b) Maximum, and I am not very confident.
- (c) Minimum, and I am not very confident.
- (d) Minimum, and I am very confident.

49. A parabola has vertex  $(3, -5)$  and passes through the point  $(1, -3)$ . Write the standard form of the quadratic function that satisfies these conditions.

- (a)  $f(x) = \frac{1}{2}(x - 3)^2 - 5$
- (b)  $f(x) = -\frac{3}{4}(x - 1)^2 - 3$
- (c)  $f(x) = 2(x + 3)^2 + 5$
- (d)  $f(x) = 2(x - 3)^2 - 5$

50. What is the y-intercept of the line with the equation  $2x + 3y = 6$ ?

- (a)  $(0, 6)$
- (b)  $(6, 0)$
- (c)  $(2, 0)$
- (d)  $(0, 2)$

51. Find the slope of the line that passes through the points  $(1, 1)$  and  $(2, 4)$ .

- (a) 3
- (b)  $\frac{1}{3}$
- (c)  $\frac{5}{3}$
- (d)  $\frac{3}{5}$

52. Find the equation of the line that passes through the points  $(1, 1)$  and  $(2, 4)$ .

- (a)  $y = 3x$
- (b)  $y = 3x + 1$
- (c)  $y = 3x - 2$
- (d)  $y = 3x + 4$

53. Find the point-slope form for the equation of the line that passes through the points  $(1, 1)$  and  $(2, 4)$ .

- (a)  $y - 1 = 3(x - 1)$

- (b)  $y - 4 = 3(x - 2)$
- (c)  $y - 1 = 3x - 1$
- (d)  $y - 4 = 3x - 2$
- (e) more than one of the above

54. True or False: Given two points which determine a line, there is a unique point-slope form of the equation for the line.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

55. What is the slope of the line perpendicular to the line  $2x + 3y = 6$ ?

- (a)  $\frac{2}{3}$
- (b)  $\frac{3}{2}$
- (c)  $-\frac{2}{3}$
- (d) 0

56. The net sales for Amazon were approximately \$10.72 billion in 2006 and \$19.15 billion in 2008. Using only this information, write a linear equation  $S(t)$  for the

net sales in any year, where  $S$  is net sales in billions of dollars and  $t$  is the year. (*source: Amazon.com quarterly reports*)

(a)  $S(t) = 10.72 + 8.43(t - 2006)$

(b)  $S(t) = 4.215t + 2006$

(c)  $S(t) = 10.72 + 4.215(t - 2006)$

(d)  $S(t) = 10.72 + 4.215(t + 2006)$

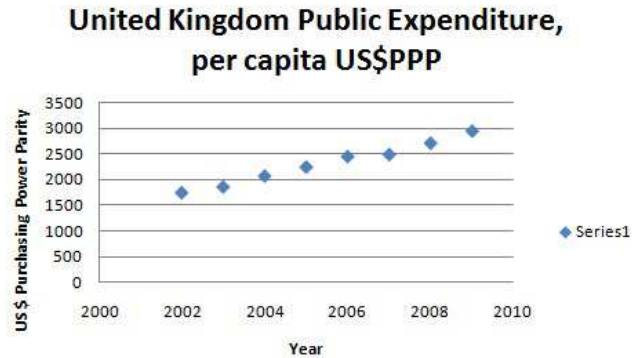
57. The linear model from the previous problem predicts that Amazon's net sales will be \$23.37 billion in 2009 and \$27.58 billion in 2010. Amazon's actual net sales for 2009 and 2010 were \$24.52 billion and \$34.21 billion, respectively. Do you think a linear model is appropriate for extrapolation? (*source: Amazon.com quarterly reports*)

(a) Yes

(b) No

58. According to the OECD (Organization of Economic Cooperation and Development), the per capita public expenditure on health in the United Kingdom (in US dollars with purchasing power parity) was the following:

Year	2002	2003	2004	2005	2006	2007
US \$ (PPP)	1742.8	1854.7	2066.3	2239.1	2442.8	2481.3



(source: <http://www.oecd.org/>)

Which of the following would be an appropriate linear model for health expenditure  $H$  as a function of the year  $t$ ?

- (a)  $H(t) = 1742.8 + 111.9(t - 2002)$
- (b)  $H(t) = 1742.8 + 170.28(t - 2002)$
- (c)  $H(t) = 2701.6 + 233(t - 2008)$
- (d) Two of the above.
- (e) All of the above.

59. True or False: The graph of a quadratic is always either concave up or concave down.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.

- (c) False, but I am not very confident.  
(d) False, and I am very confident.
60. Put the quadratic  $f(x) = x^2 - 6x + 10$  into vertex form by completing the square. Where is the vertex?
- (a)  $f(x) = (x - 3)^2 + 1$  with vertex at  $(-3, 1)$   
(b)  $f(x) = (x + 3)^2 + 1$  with vertex at  $(-3, -1)$   
(c)  $f(x) = (x - 3)^2 + 1$  with vertex at  $(3, 1)$   
(d)  $f(x) = (x + 3)^2 + 1$  with vertex at  $(-3, 1)$
61. For  $t$  in seconds, the height of a baseball in feet is given by the function  $f(t) = -16t^2 + 32t + 5$ . Find the maximum height reached by the baseball.
- (a) 5 feet  
(b) 21 feet  
(c) 5001 feet  
(d) 16 feet
62. True or False: If  $f(x) = (x + 3)(x + 5)$ , then the zeros of  $f$  are  $x = -3$  and  $x = -5$ .
- (a) True, and I am very confident.  
(b) True, but I am not very confident.  
(c) False, but I am not very confident.

- (d) False, and I am very confident.
63. True or False: Every quadratic function has two real zeros.
- (a) True, and I am very confident.
  - (b) True, but I am not very confident.
  - (c) False, but I am not very confident.
  - (d) False, and I am very confident.
64. True or False: There is a unique parabola with  $x$ -intercepts at  $x = 1$  and  $x = 4$ .
- (a) True, and I am very confident.
  - (b) True, but I am not very confident.
  - (c) False, but I am not very confident.
  - (d) False, and I am very confident.
65. True or False: If a parabola is concave up, its vertex is its minimum point.
- (a) True, and I am very confident.
  - (b) True, but I am not very confident.
  - (c) False, but I am not very confident.
  - (d) False, and I am very confident.



66. True or False: The quadratic  $f(x) = ax^2 + bx + c$  opens downward if  $a > 0$ .

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

### **Functions and Change**

67. In the given equation, is  $y$  a function of  $x$ ?

$$y = x + 2$$

- (a) Yes, and I am very confident
- (b) Yes, but I am not very confident
- (c) No, but I am not very confident
- (d) No, and I am very confident

68. In the given equation, is  $y$  a function of  $x$ ?

$$x + y = 5$$

- (a) Yes, and I am very confident
- (b) Yes, but I am not very confident

- (c) No, but I am not very confident
- (d) No, and I am very confident

69. In the given equation, is  $y$  a function of  $x$ ?

$$x^3 + y = 5$$

- (a) Yes, and I am very confident
- (b) Yes, but I am not very confident
- (c) No, but I am not very confident
- (d) No, and I am very confident

70. In the given equation, is  $y$  a function of  $x$ ?

$$x^2 + y^2 = 5$$

- (a) Yes, and I am very confident
- (b) Yes, but I am not very confident
- (c) No, but I am not very confident
- (d) No, and I am very confident

71. The set of points  $(x, y)$  which satisfy the equation  $(x - 1)^2 + (y + 3)^2 = 5^2$  can be represented via a mathematical function relating the  $x$  and  $y$  variables.

- (a) True, and I am very confident.

- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

72. Does the table represent a function,  $y = f(x)$ ?

$x$	1	2	3	4
$f(x)$	2	3	2	4

- (a) Yes, and I am very confident
- (b) Yes, but I am not very confident
- (c) No, but I am not very confident
- (d) No, and I am very confident

73. Does the table represent a function,  $y = f(x)$ ?

$x$	1	2	2	4
$f(x)$	2	3	1	3

- (a) Yes, and I am very confident
- (b) Yes, but I am not very confident
- (c) No, but I am not very confident
- (d) No, and I am very confident

74. Does this sentence describe a function? Wanda is two years older than I am.

- (a) Yes, and I am very confident
- (b) Yes, but I am not very confident
- (c) No, but I am not very confident
- (d) No, and I am very confident

75. The rule which assigns to each college student (at this exact point in time) a number equal to the number of college credits completed by that student is a function.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

76. The rule which assigns to each car (at this exact point in time) the names of every person that has driven that car is a function.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

77. Could this table represent a linear function?

$x$	1	2	3	4
$f(x)$	1	2	4	8

- (a) Yes, and I am very confident
- (b) Yes, but I am not very confident
- (c) No, but I am not very confident
- (d) No, and I am very confident

78. Could this table represent a linear function?

$x$	1	2	3	4
$f(x)$	-12	-9	-6	-3

- (a) Yes, and I am very confident
- (b) Yes, but I am not very confident
- (c) No, but I am not very confident
- (d) No, and I am very confident

79. Could this table represent a linear function?

$x$	1	2	4	8
$f(x)$	12	14	16	18

- (a) Yes, and I am very confident
- (b) Yes, but I am not very confident
- (c) No, but I am not very confident
- (d) No, and I am very confident

80. Could this table represent a linear function?

$x$	1	2	4	8
$f(x)$	10	9	7	3

- (a) Yes, and I am very confident
- (b) Yes, but I am not very confident
- (c) No, but I am not very confident
- (d) No, and I am very confident

81. True or False? All linear functions are examples of direct proportionality.

- (a) True, and I am very confident
- (b) True, but I am not very confident
- (c) False, but I am not very confident
- (d) False, and I am very confident

82. Find the domain of the function  $f(x) = \frac{1}{x-2}$ .

- (a)  $x = 2$
- (b)  $x \neq 2$
- (c)  $x < 2$
- (d) all real numbers

83. Find the domain of the function  $g(t) = \frac{2+t}{\sqrt{t-7}}$ .

- (a)  $t > 7$
- (b)  $t \geq 7$
- (c)  $t = 7$

(d) all real numbers

84. Which of the following functions has its domain identical with its range?

(a)  $f(x) = x^2$

(b)  $g(x) = \sqrt{x}$

(c)  $h(x) = x^4$

(d)  $i(x) = |x|$

85. The slope of the line connecting the points (1,4) and (3,8) is

(a)  $-\frac{1}{2}$

(b)  $-2$

(c)  $\frac{1}{2}$

(d)  $2$

86. Which one of these lines has a different slope than the others?

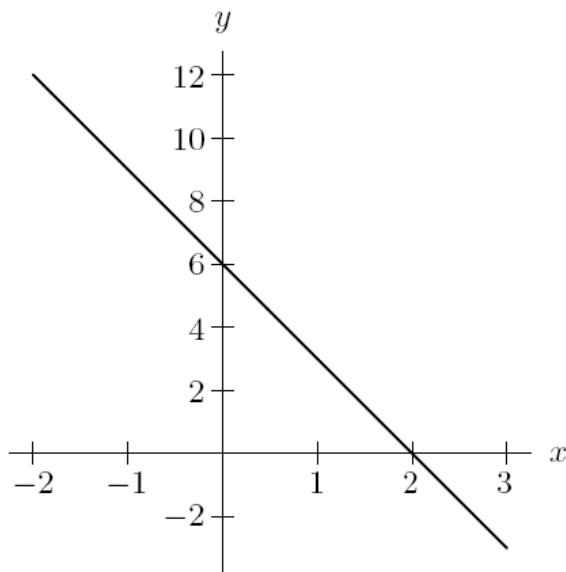
(a)  $y = 3x + 2$

(b)  $3y = 9x + 4$

(c)  $3y = 3x + 6$

(d)  $2y = 6x + 4$

87. The graph below represents which function?



- (a)  $y = 6x + 6$
- (b)  $y = -3x + 6$
- (c)  $y = -3x + 2$
- (d)  $y = -x + 6$
- (e)  $y = 6x - 2$
- (f)  $y = x - 2$

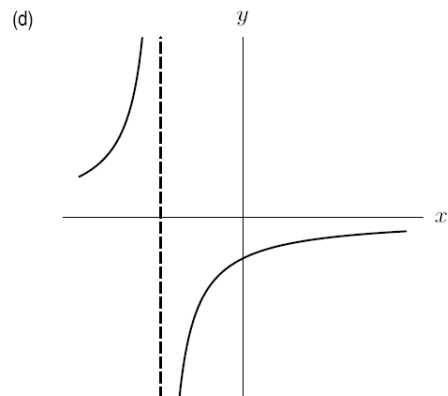
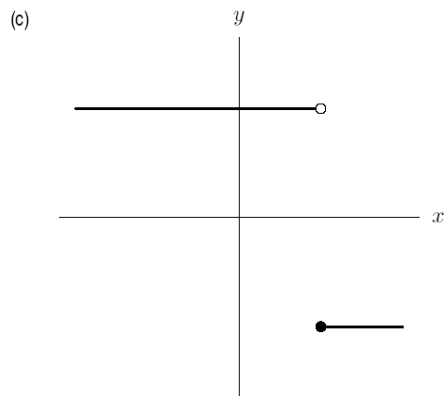
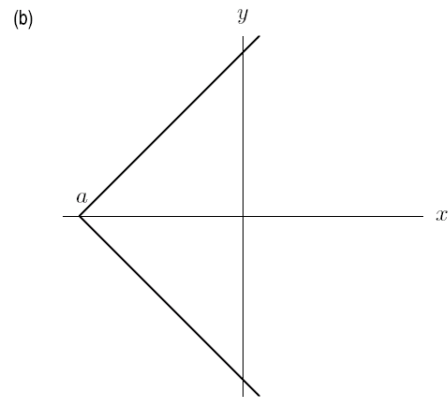
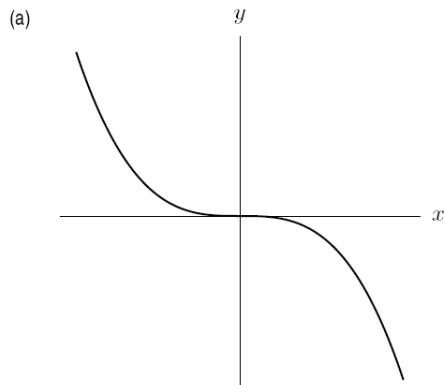
88. Which of the following functions is not increasing?

- (a) The elevation of a river as a function of distance from its mouth
- (b) The length of a single strand of hair as a function of time
- (c) The height of a person from age 0 to age 80



(d) The height of a redwood tree as a function of time

89. Which of these graphs does not represent  $y$  as a function of  $x$ ?



90. Calculate the average rate of change of the function  $f(x) = x^2$  between  $x = 1$  and  $x = 3$ .

- (a) 8
- (b) 4
- (c)  $\frac{1}{4}$
- (d) 0

91. The EPA reports the total amount of Municipal Solid Waste (MSW), otherwise known as garbage, produced in the U.S. for the years 2005 through 2009:

Year	2005	2006	2007	2008	2009
Millions of tons	252.4	251.3	255	249.6	243

(source: <http://www.epa.gov/osw/nonhaz/municipal/>)

What are the appropriate units for the average rate of change in the amount of garbage produced between any two given years?

- (a) millions of tons
  - (b) tons
  - (c) millions of tons per year
  - (d) tons per year
92. The EPA reports the total amount of Municipal Solid Waste (MSW), otherwise known as garbage, produced in the U.S. for the years 2005 through 2009:

Year	2005	2006	2007	2008	2009
Millions of tons	252.4	251.3	255	249.6	243

(source: <http://www.epa.gov/osw/nonhaz/municipal/>)

What is the average rate of change in the amount of MSW produced from 2005 to 2007?

- (a) 2.6 million tons per year
- (b) 2.6 million tons
- (c) 1.3 million tons
- (d) 1.3 million tons per year

93. The EPA reports the total amount of Municipal Solid Waste (MSW), otherwise known as garbage, produced in the U.S. for the years 2005 through 2009:

Year	2005	2006	2007	2008	2009
Millions of tons	252.4	251.3	255	249.6	243

(source: <http://www.epa.gov/osw/nonhaz/municipal/>)

What is the average rate of change in the amount of MSW produced from 2007 to 2009?

- (a)  $-6$  million tons per year
- (b) 6 million tons per year
- (c)  $-12$  million tons per year
- (d) 12 million tons per year

94. Find the difference quotient  $\frac{f(x+h)-f(x)}{h}$  for the function  $f(x) = 2x^2 - x + 3$ . Simplify your answer.

- (a)  $\frac{2h^2-h+3}{h}$

- (b)  $2h - 1$
- (c)  $\frac{4xh+2h^2-2x+h+6}{h}$
- (d)  $4x + 2h - 1$

95. When the temperature is  $0^\circ C$  it is  $32^\circ F$  and when it is  $100^\circ C$  it is  $212^\circ F$ . Use these facts to write a linear function to convert any temperature from Celsius to Fahrenheit.

- (a)  $C(F) = \frac{5}{9}F - \frac{160}{9}$
- (b)  $F(C) = C + 32$
- (c)  $F(C) = \frac{5}{9}C - \frac{160}{9}$
- (d)  $F(C) = \frac{9}{5}C + 32$

96. Let  $f(x) = 1 + 4x^2$ . True or False:  $f(\frac{1}{2}) = \frac{f(1)}{f(2)}$ .

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

97. Let  $f(x) = 1 + 4x^2$ . True or False:  $f(a + b) = f(a) + f(b)$ .

- (a) True, and I am very confident.

- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

98. Let  $f(x) = \frac{1}{x+2}$ . Find a value of  $x$  so that  $f(x) = 6$

- (a)  $-\frac{11}{6}$
- (b)  $\frac{13}{6}$
- (c)  $\frac{1}{8}$
- (d) none of the above

99. True or False:  $\sqrt{x^2} = x$ .

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

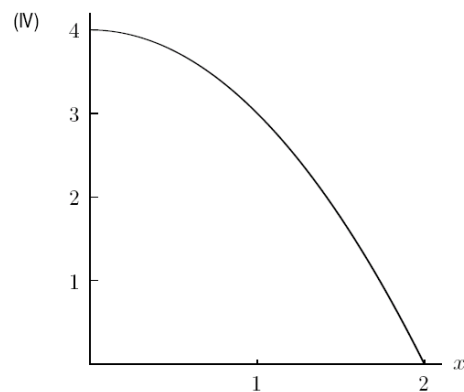
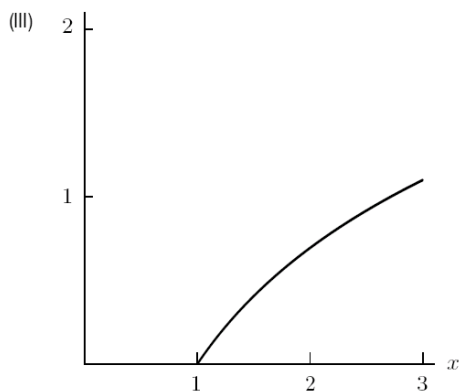
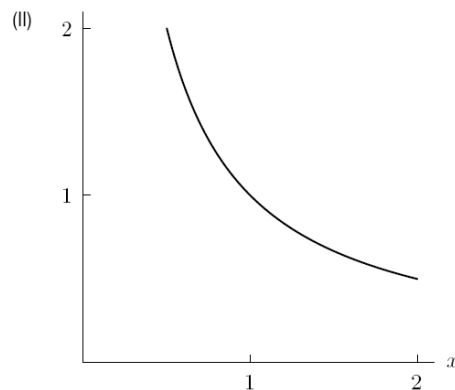
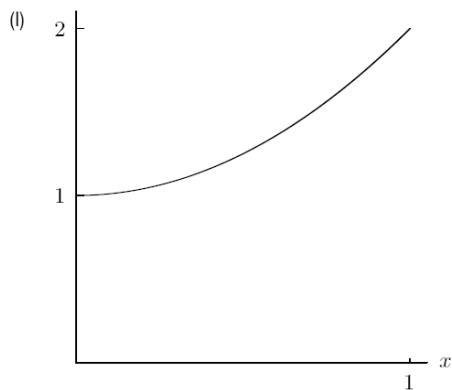
### **Exponential Functions**

100. The graph of a function is either concave up or concave down.

- (a) True, and I am very confident
- (b) True, but I am not very confident

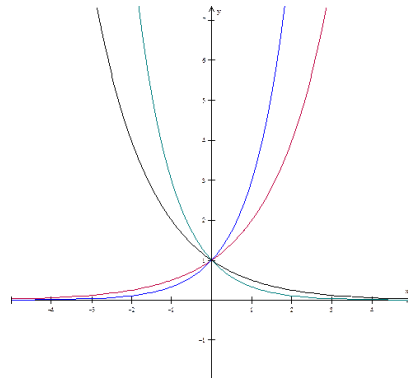
- (c) False, but I am not very confident
- (d) False, and I am very confident

101. Which graph shows a function that is decreasing and concave up? Which graph shows a function that is increasing and concave down?



- (a) I, II
- (b) IV, I
- (c) II, I
- (d) II, III
- (e) IV, III

102. Which exponential function has the largest base?



- (a) red
- (b) blue
- (c) green
- (d) black

103. Every exponential function has a vertical intercept.

- (a) True, and I am very confident
- (b) True, but I am not very confident
- (c) False, but I am not very confident
- (d) False, and I am very confident

104. Every exponential function has a horizontal intercept.

- (a) True, and I am very confident
- (b) True, but I am not very confident
- (c) False, but I am not very confident

(d) False, and I am very confident

105. An exponential function of the form  $f(x) = k \cdot a^x$  will always pass through the point  $(0, 1)$ .

(a) True, and I am very confident.

(b) True, but I am not very confident.

(c) False, but I am not very confident.

(d) False, and I am very confident.

106. If \$5,000 is invested at 4 % annual interest, compounded continuously, the value of the investment after  $t$  years is  $V(t) = 5000e^{0.04t}$ . What is the value after  $t = 15$  years?

(a) \$5204.05

(b) \$9110.59

(c) \$13591.41

(d) \$78060.81

107. Let  $f(x) = ab^x$ , with  $b > 0$ . Then  $\frac{f(x+h)}{f(x)} =$

(a)  $b^h$

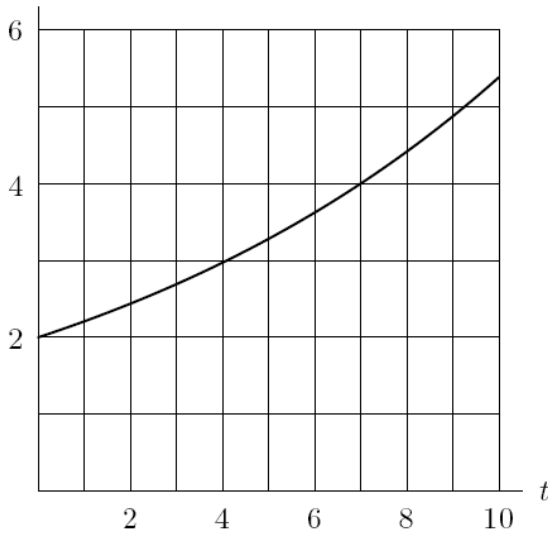
(b)  $h$

(c)  $b^{x+h} - b^x$



(d)  $a$

108. Estimate the doubling time for the exponential growth shown in the figure below.



- (a) 4
- (b) 5
- (c) 7
- (d) 10

109. The exponential function  $y = 3 \cdot \left(\frac{1}{2}\right)^x$  could be an appropriate model for exponential growth.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

110. Find the equation for an exponential function that passes through the points (1,2) and (3,18).

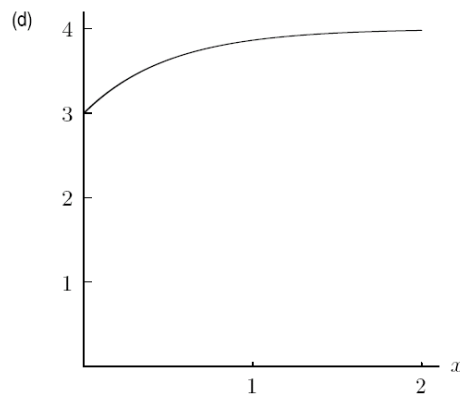
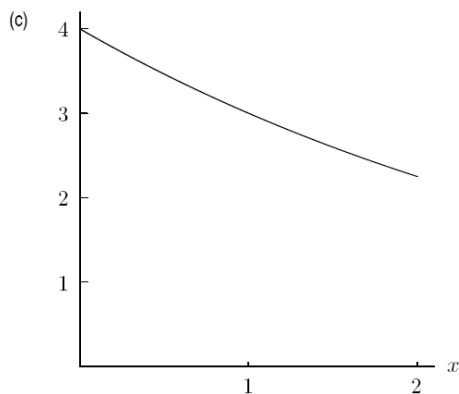
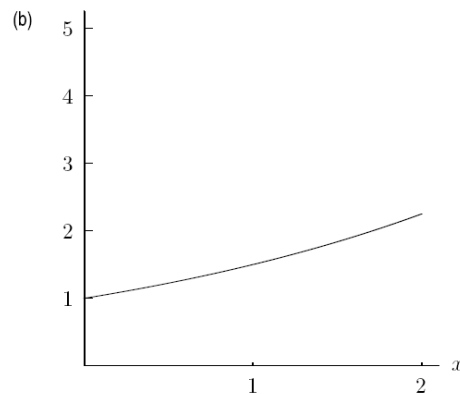
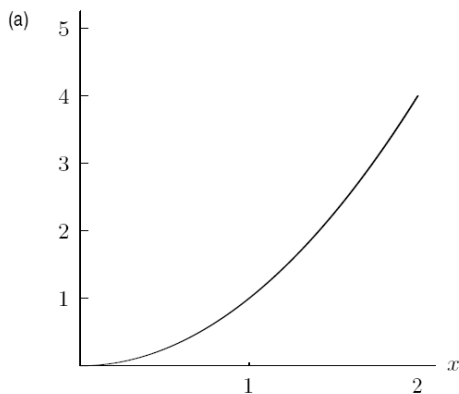
(a)  $f(t) = 2 \cdot 9^t$

(b)  $f(t) = \left(\frac{2}{9}\right) 9^t$

(c)  $f(t) = \left(\frac{2}{3}\right) 3^t$

(d)  $f(t) = 2 \cdot 3^t$

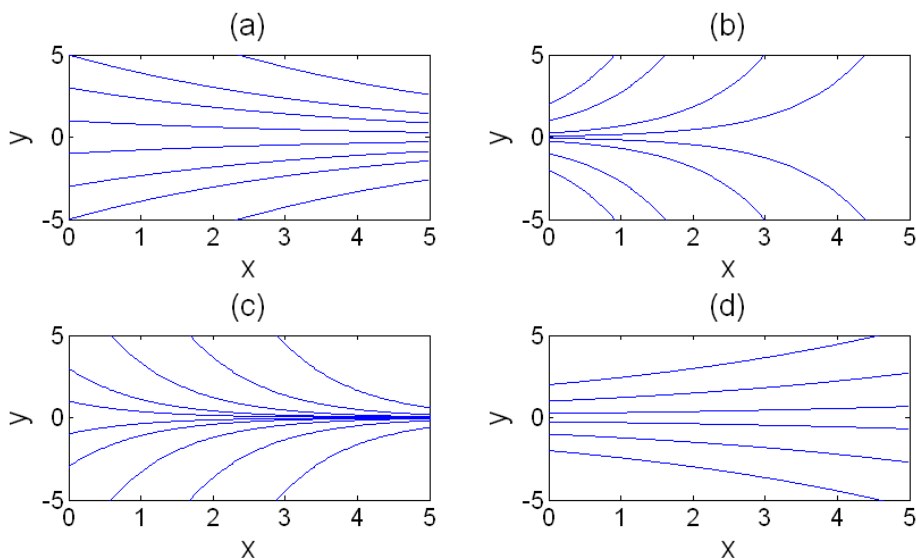
111. Which of the following graphics could be that of  $y = ab^x$  if  $b > 1$ ?



112. “During 1988, Nicaragua’s inflation rate averaged 1.3% a day.” Which formula represents the above statement? Assume  $t$  is measured in days.

- (a)  $I = I_0 e^{0.013t}$
- (b)  $I = I_0 (1.013)^t$
- (c)  $I = I_0 (1.013)^t$
- (d)  $I = I_0 (1.3)^t$

113. Graph (a) shows several functions of the form  $y(x) = Q_0 e^{k_a x}$  with several different values of  $Q_0$  but the same value of  $k_a$ . Graph (b) shows several functions of the form  $y(x) = Q_0 e^{k_b x}$  with several different values of  $Q_0$  but the same value of  $k_b$ , and similarly for graphs (c) and (d). Rank the constants  $k_a, k_b, k_c$  and  $k_d$  from smallest to largest.



- (a)  $k_b < k_d < k_a < k_c$
- (b)  $k_d < k_c < k_b < k_a$
- (c)  $k_c < k_a < k_d < k_b$
- (d)  $k_a < k_b < k_c < k_d$

114. Which of the following is an exponential function which has a  $y$  intercept of 4 and goes through the point (2,9)?

(a)  $f(x) = 4 \cdot 1.25^x$

(b)  $f(x) = 4 \cdot 1.5^x$

(c)  $f(x) = 4 \cdot 2.25^x$

(d)  $f(x) = 2 \cdot 1.25^x$

(e)  $f(x) = 2 \cdot (\sqrt{9/2})^x$

(f)  $f(x) = 2 \cdot 1.5^x$

115. Which of the following is an exponential function which goes through the points (2,3) and (3,1)?

(a)  $f(x) = \frac{3}{4} \cdot 2^x$

(b)  $f(x) = 12 \cdot \frac{1}{2}^x$

(c)  $f(x) = 12 \cdot \frac{1}{4}^x$

(d)  $f(x) = 27 \cdot \frac{1}{3}^x$

116. The following table shows the net sales at Amazon.com from 2003 to 2010 (*source: Amazon.com quarterly reports*):

Year	2003	2004	2005	2006	2007	2008
Billions of dollars	\$5.26	\$6.92	\$8.49	\$10.72	\$14.84	\$19.1

What would be the most appropriate type of function to model this data?

- (a) linear
- (b) exponential
- (c) power
- (d) It is impossible to tell from the data.

117. The following table shows the net sales at Amazon.com from 2003 to 2010 (*source: Amazon.com quarterly reports*):

Year	2003	2004	2005	2006	2007	2008
Billions of dollars	\$5.26	\$6.92	\$8.49	\$10.72	\$14.84	\$19.1

If the net sales are modeled using an exponential function  $S(t) = a \cdot b^t$ , where  $S$  is the net sales in billions of dollars, and  $t$  is the number of years after 2003, which of the following is an appropriate value for the base,  $b$ ?

- (a) 1.31
- (b) 5.26
- (c) 34.21
- (d) 6.5

118. The following table shows the net sales at Amazon.com from 2003 to 2010 (*source: Amazon.com quarterly reports*):

Year	2003	2004	2005	2006	2007	2008
Billions of dollars	\$5.26	\$6.92	\$8.49	\$10.72	\$14.84	\$19.1

If the net sales are modeled using an exponential function  $S(t) = a \cdot b^t$ , where  $S$  is the net sales in billions of dollars, and  $t$  is the number of years after 2003, which of the following is an appropriate value for  $a$ ?

- (a) 34.21
  - (b) 1
  - (c) 1.31
  - (d) 5.26
119. Which is better at the end of one year: An account that pays 8% annual interest compounded quarterly or an account that pays 7.95% interest compounded continuously?
- (a) 8% quarterly
  - (b) 7.95% continuously
  - (c) They are the same.
  - (d) There is no way to tell.

120. Caffeine leaves the body at a continuous rate of 17% per hour. How much caffeine is left in the body 8 hours after drinking a cup of coffee containing 100 mg of caffeine?
- (a) 389.62 mg
  - (b) 22.52 mg
  - (c) 25.67 mg
  - (d) There is no way to tell.
121. Caffeine leaves the body at a continuous rate of 17% per hour. What is the hourly growth factor?
- (a) .156
  - (b) .17
  - (c) .844
  - (d) There is no way to tell.

**New Functions From Old: Compositions, Inverses, and Transforms**

122. The functions  $f$  and  $g$  have values given in the table below. What is the value of  $f(g(0))$ ?

$x$	-2	-1	0	1	2
$f(x)$	1	0	-2	2	-1
$g(x)$	-1	1	2	0	-2

- (a) -2
- (b) -1
- (c) 0
- (d) 1
- (e) 2

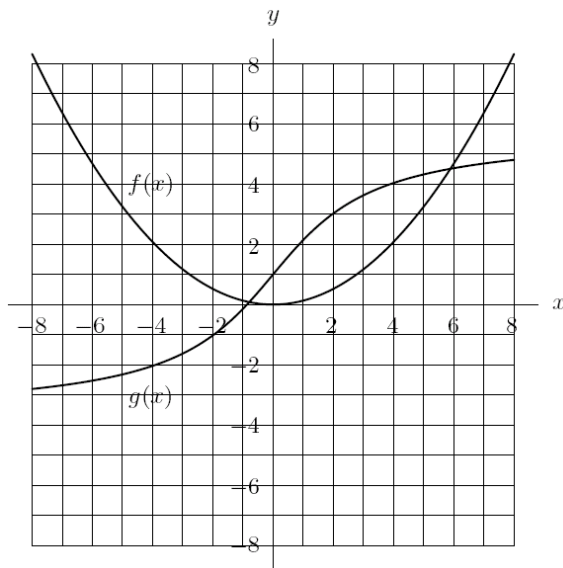
123. The functions  $f$  and  $g$  have values given in the table below. If  $f(g(x)) = 1$ , then what is  $x$ ?

$x$	-2	-1	0	1	2
$f(x)$	1	0	-2	2	-1
$g(x)$	-1	1	2	0	-2

- (a) -2
- (b) -1
- (c) 0
- (d) 1
- (e) 2

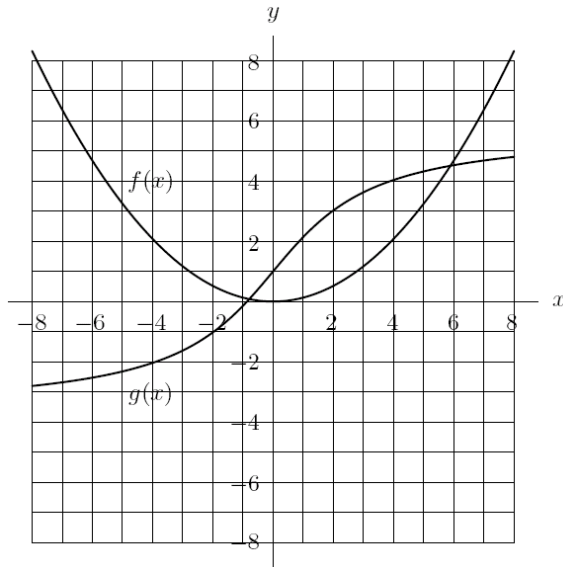
124. The graphs of  $f$  and  $g$  are shown in the figure below. Estimate the value of  $g(f(3))$ .





- (a) -1
- (b) 0
- (c) 1
- (d) 2
- (e) 3
- (f) 5

125. The graphs of  $f$  and  $g$  are shown in the figure below. Estimate the value of  $f(g(2))$ .

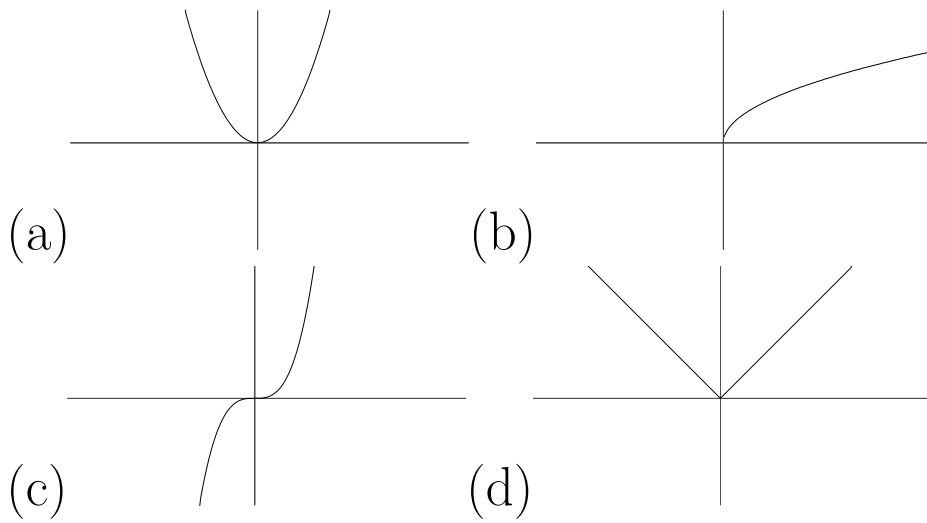


- (a) -1
- (b) 0
- (c) 1
- (d) 2
- (e) 3
- (f) 5

126. If  $P = f(t) = 3 + 4t$ , find  $f^{-1}(P)$ .

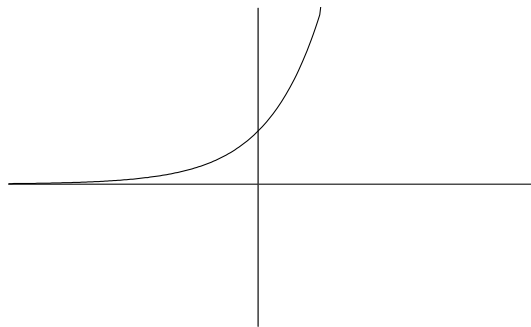
- (a)  $f^{-1}(P) = 3 + 4P$
- (b)  $f^{-1}(P) = \frac{P-3}{4}$
- (c)  $f^{-1}(P) = \frac{P-4}{3}$
- (d)  $f^{-1}(P) = 4(P + 3)$
- (e)  $f^{-1}(P) = \frac{P+3}{4}$

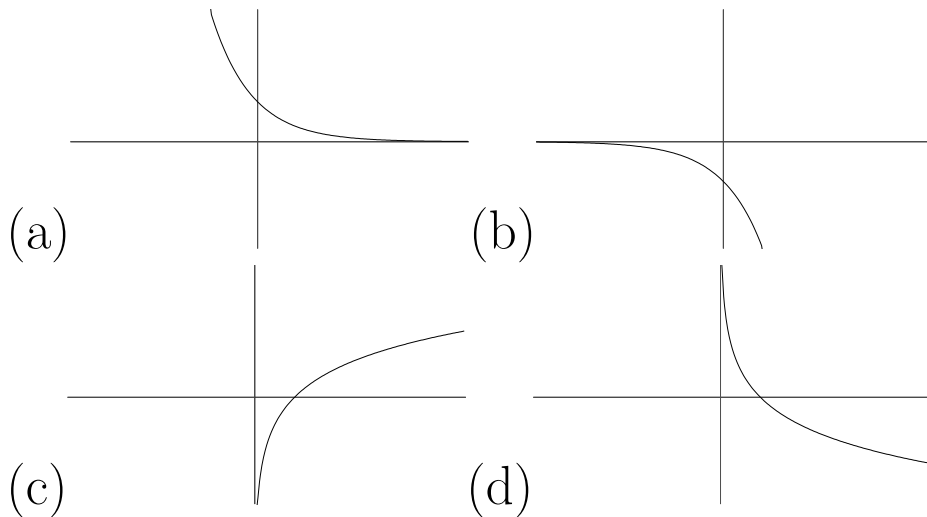
127. Which of these functions has an inverse?



- (a) (a) only
- (b) (b) only
- (c) (c) only
- (d) (d) only
- (e) (a) and (b)
- (f) (b) and (c)

128. The following is a graph of  $f(x)$ . Which graph below is the inverse?





129. Given that  $f(x) = \sqrt[5]{\frac{x^3 - 72}{800}}$ , find  $f \circ f^{-1}(437)$ .

- (a) 104,316.73
- (b) 1671.2
- (c) 437
- (d) 10.08

130. If  $f(x) = \frac{x}{x^2 + 1}$ , what is  $f^{-1} \circ f(-2)$ ?

- (a)  $-\frac{2}{5}$
- (b)  $\frac{2}{3}$
- (c)  $-\frac{5}{2}$
- (d)  $-2$

131. If  $(4, -2)$  is a point on the graph of  $y = f(x)$ , which of the following points is on the graph of  $y = f^{-1}(x)$ ?

(a)  $(-2, 4)$

(b)  $(-4, 2)$

(c)  $(\frac{1}{4}, -\frac{1}{2})$

(d)  $(-\frac{1}{4}, \frac{1}{2})$

132. Find the inverse of  $f(x) = \frac{1}{x}$ .

(a)  $f^{-1}(x) = \frac{x}{1}$

(b)  $f^{-1}(x) = x$

(c)  $f^{-1}(x) = \frac{1}{x}$

(d)  $f^{-1}(x) = xy$

133. A function is given in Figure 1.10 below. Which one of the other graphs could be a graph of  $f(x + h)$ ?

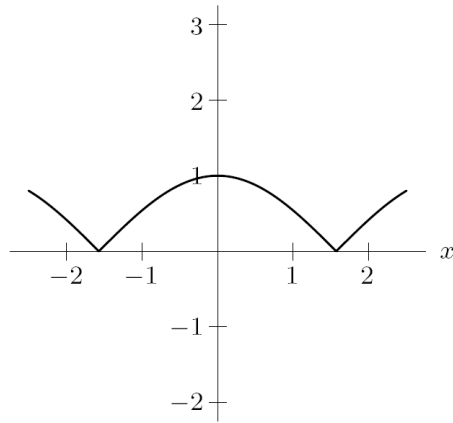
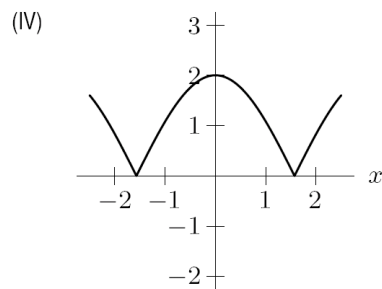
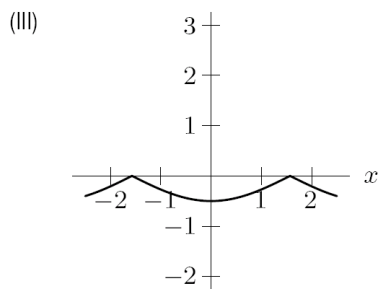
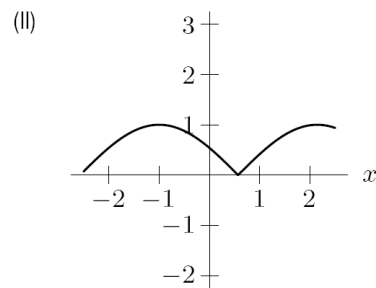
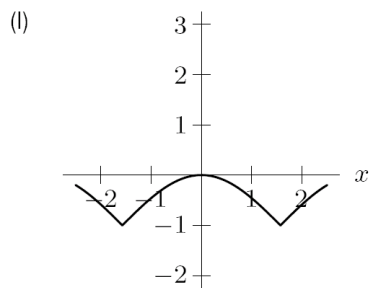


Figure 1.10



- (a) I
- (b) II
- (c) III
- (d) IV

134. How is the graph of  $y = 2^{x-1} + 3$  obtained from the graph of  $y = 2^x$ ?

- (a) Move 1 down and 3 right

- (b) Move 1 left and 3 up
- (c) Move 1 up and 3 right
- (d) Move 1 right and 3 up

135. The function  $f(x)$  goes through the point  $A$  with coordinates  $(2,3)$ .  $g(x) = 2f(\frac{1}{3}x - 2) + 4$ . What are the coordinates of point  $A$  in the function  $g(x)$ ?

- (a)  $(4, 10)$
- (b)  $(4, -\frac{5}{2})$
- (c)  $(12, 10)$
- (d)  $(-\frac{4}{3}, 10)$
- (e)  $(-\frac{4}{3}, -\frac{5}{2})$

136. The point  $(4, 1)$  is on the graph of a function  $f$ . Find the corresponding point on the graph of  $y = f(x - 2)$ .

- (a)  $(6, 1)$
- (b)  $(2, 1)$
- (c)  $(4, 3)$
- (d)  $(4, -1)$

137. The point  $(6, 1)$  is on the graph of a function  $f$ . Find the corresponding point on the graph of  $y = f(2x)$ .

- (a)  $(12, 1)$

- (b)  $(3, 1)$
- (c)  $(6, 2)$
- (d)  $(6, \frac{1}{2})$

138. Given the graph of a function  $f(x)$ , what sequence of activities best describes the process you might go through to graph  $g(x) = 5f(-x)$ ?

- (a) Expand the graph by a factor of 5, then reflect it across the  $y$ -axis.
- (b) Expand the graph by a factor of 5, then reflect it across the  $x$ -axis.
- (c) Reflect the graph across the  $y$ -axis, then expand it by a factor of 5.
- (d) Reflect the graph across the  $x$ -axis, then expand it by a factor of 5.
- (e) More than 1 of the above.
- (f) None of the above.

139. Given the graph of a function  $f(x)$ , what sequence of activities best describes the process you might go through to graph  $g(x) = -f(x) + 2$ ?

- (a) Move the graph up 2 units, then reflect it across the  $x$ -axis.



- (b) Move the graph up 2 units, then reflect it across the  $y$ -axis.
- (c) Reflect the graph across the  $y$ -axis, then move it up by 2 units.
- (d) Reflect the graph across the  $x$ -axis, then move it up 2 units.
- (e) More than 1 of the above.
- (f) None of the above.
140. Take the function  $f(x)$  and “Shift the function right  $h$  units. Reflect the result across the  $y$ -axis, then reflect the result across the  $x$ -axis. Finally shift the result up  $k$  units.” The end result is:
- (a)  $f(x + h) + k$
- (b)  $f(x - h) + k$
- (c)  $-f(-x - h) + k$
- (d)  $-f(-x + h) + k$
141. Given  $f(x) = x + 1$  and  $g(x) = 3x^2 - 2x$ , what is the composition  $g(f(x))$ .
- (a)  $3x^2 - 2x + 1$
- (b)  $(3x^2 - 2x)(x + 1)$
- (c)  $3x^2 + 4x + 1$

(d)  $3(x + 1)^2 - 2x$

142. Write  $h(x) = e^{3x/2}$  as a composition of functions:  
 $f(g(x))$ .  $f(x) = \underline{\hspace{2cm}}$ ,  $g(x) = \underline{\hspace{2cm}}$ .

(a)  $e^x, 3x/2$

(b)  $3x/2, e^x$

(c)  $x, e^{3x/2}$

(d)  $x/2, 3e^x$

143. If  $f(x) = x^2 + 6$  and  $g(x) = x - 3$ , what is  $f \circ g(x)$ ?

(a)  $x^2 + 3$

(b)  $x^2 - 6x + 15$

(c)  $x^2 - 3$

(d)  $x^3 - 3x^2 + 6x - 18$

144. Which of the following functions IS invertible?

(a)  $f(x) = -x^4 + 7$

(b)  $g(x) = e^{3x/2}$

(c)  $h(x) = \cos(x)$

(d)  $k(x) = |x|$

145. Let  $f(x) = x - 2$  and  $g(x) = 3 - x^2$ . Find  $g(f(2))$ .

- (a) -3
- (b) 0
- (c) 3
- (d) 2

146. If  $P = f(t) = 3 + 4t$ , find  $f^{-1}(7)$ .

- (a) 31
- (b)  $\frac{1}{7}$
- (c) 0
- (d) 1

147. Let  $f(x) = x^2$  and  $g(x) = x + 2$ . True or false? The domain of the function  $\frac{f}{g}$  is  $\mathbb{R}$ , all real numbers.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

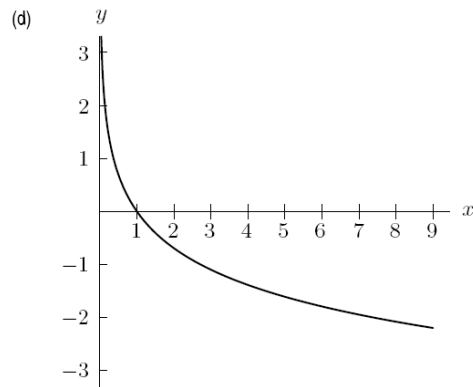
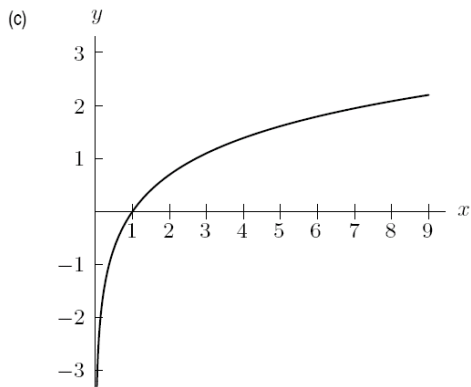
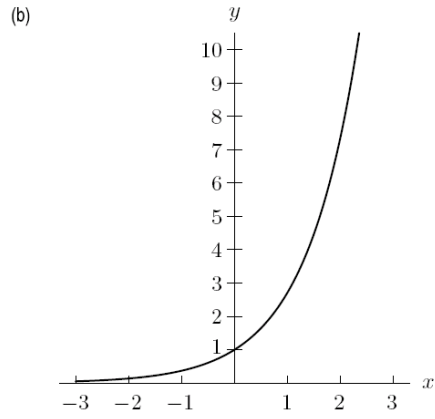
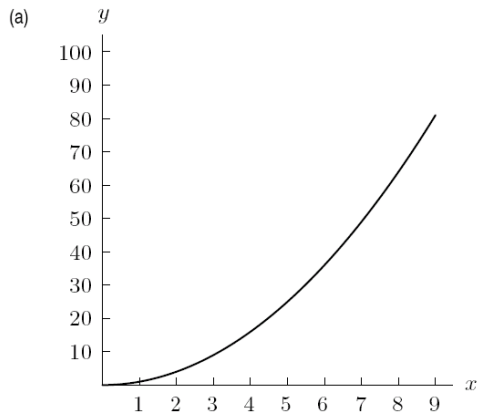
148. Let  $f(x) = x^2 - 4$  and  $g(x) = \sqrt{x}$ . Find  $(g \circ f)(x)$  and the domain of  $g \circ f$ .

- (a)  $\sqrt{x^2 - 4}$ ; Domain:  $(-\infty, -2] \cup [2, \infty)$
- (b)  $x - 4$ ; Domain:  $\mathbb{R}$

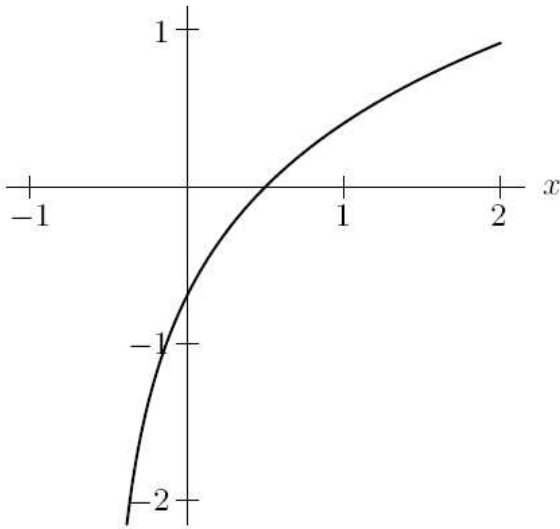
- (c)  $x - 4$ ; Domain:  $[0, \infty)$
- (d)  $\sqrt{x^2 - 4}$ ; Domain:  $[0, \infty)$
- (e)  $\sqrt{x}(x^2 - 4)$ ; Domain:  $[0, \infty)$

### Logarithmic Functions

149. A logarithmic function of the form  $f(x) = \log_a x$  will always pass through the point  $(1, 0)$ .
- (a) True, and I am very confident.
  - (b) True, but I am not very confident.
  - (c) False, but I am not very confident.
  - (d) False, and I am very confident.
150. Which is a graph of  $y = \ln x$ ?



151. The graph below could be that of

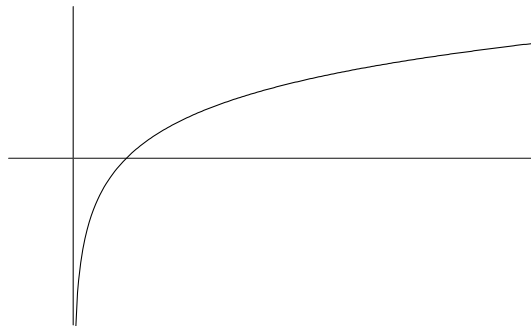


(a)  $y = \ln x + \frac{1}{2}$

(b)  $y = \ln x - \frac{1}{2}$

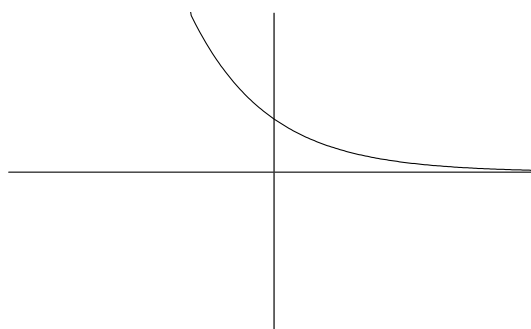
- (c)  $y = \ln \left( x + \frac{1}{2} \right)$
- (d)  $y = \ln \left( x - \frac{1}{2} \right)$

152. Which equation matches this graph?



- (a)  $y = b^x$  with  $b > 1$
- (b)  $y = b^x$  with  $0 < b < 1$
- (c)  $y = \log_b x$  with  $b > 1$
- (d)  $y = \log_b x$  with  $0 < b < 1$

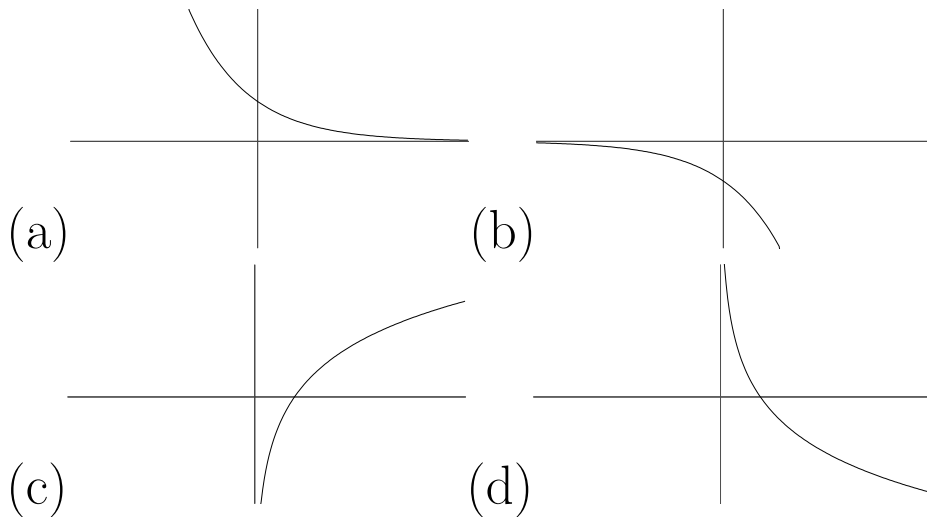
153. Which equation matches this graph?



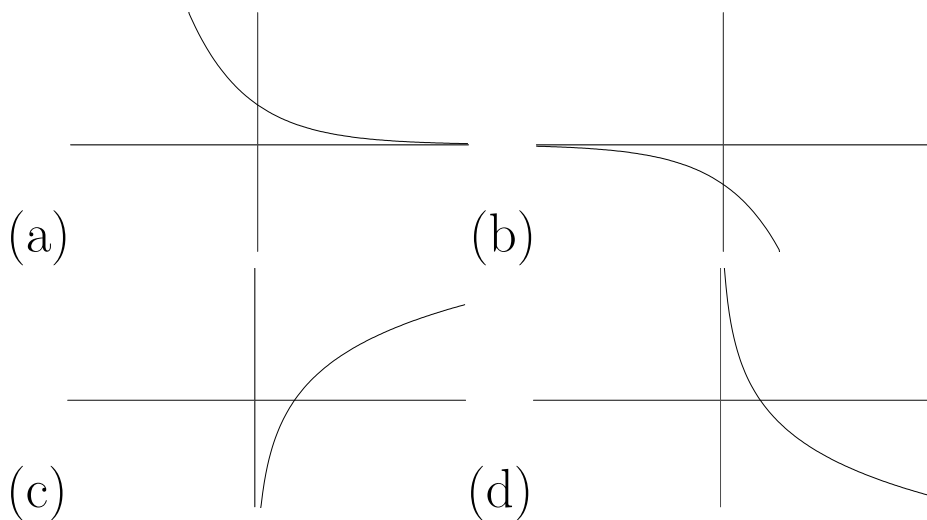
- (a)  $y = b^x$  with  $b > 1$
- (b)  $y = b^x$  with  $0 < b < 1$

- (c)  $y = \log_b x$  with  $b > 1$
- (d)  $y = \log_b x$  with  $0 < b < 1$

154. Which of the following is a graph of  $y = \log_2 x$ ?



155. Which of the following is a graph of  $y = \log_{\frac{1}{2}} x$ ?



156. Which of the following functions have vertical asymptotes of  $x = 3$ ?

- (a)  $y = \ln(x/3)$
- (b)  $y = \ln(x - 3)$
- (c)  $y = \ln(x + 3)$
- (d)  $y = 3 \ln x$

157.  $\log \left( \frac{M-N}{M+N} \right) =$

- (a)  $2 \log M$
- (b)  $2 \log N$
- (c)  $-2 \log N$
- (d)  $\log(M - N) - \log(M + N)$

158. If  $\log_{10}(x - a) = n$ , then  $x =$

- (a)  $10^{a+n}$
- (b)  $a + 10^n$
- (c)  $n + 10^a$
- (d)  $n + a^{10}$

159. What is the exponential form of  $\log_r m = j$ ?

- (a)  $r^j = m$
- (b)  $j^r = m$
- (c)  $m^j = r$
- (d)  $r^m = j$



160. What is the logarithmic form of  $k^p = d$ ?

(a)  $\log_d k = p$

(b)  $\log_k d = p$

(c)  $\log_p d = p$

(d)  $\log_k p = d$

161. What is the value of  $\log_{11} 86$ ? (Calculators are allowed.)

(a) .4049

(b) .5383

(c) 1.8576

(d)  $-2.0564$

162. What is  $3 = \log_2 8$  in exponential form?

(a)  $2^8 = 3$

(b)  $3^2 = 8$

(c)  $8^3 = 2$

(d)  $2^3 = 8$

163. What is  $k = \log_m q$  in exponential form?

(a)  $m^k = q$

(b)  $k^q = m$

(c)  $m^q = k$

(d)  $q^m = k$

164. What is  $4^2 = 16$  in logarithmic form?

(a)  $\log_2 4 = 16$

(b)  $\log_4 16 = 2$

(c)  $\log_4 2 = 16$

(d)  $\log_{16} 4 = 2$

165. What is  $3^{-1} = \frac{1}{3}$  in logarithmic form?

(a)  $\log_3(-1) = \frac{1}{3}$

(b)  $\log_{-1} \frac{1}{3} = 3$

(c)  $\log_{\frac{1}{3}} 3 = -1$

(d)  $\log_3 \frac{1}{3} = -1$

166. What is the inverse of the following function:

$$P = f(t) = 16 \ln(14t)$$

(a)  $f^{-1}(P) = \frac{1}{14}e^{16P}$

(b)  $f^{-1}(P) = \frac{1}{14}e^{P/16}$

$$(c) f^{-1}(P) = \frac{1}{14} \ln(P/16)$$

$$(d) f^{-1}(P) = \frac{\ln 16}{14} P$$

167. Solve for  $x$  if  $8y = 3e^x$ .

$$(a) x = \ln 8 + \ln 3 + \ln y$$

$$(b) x = \ln 3 - \ln 8 + \ln y$$

$$(c) x = \ln 8 + \ln y - \ln 3$$

$$(d) x = \ln 3 - \ln 8 - \ln y$$

168. Solve for  $x$  if  $y = e + 2^x$

$$(a) x = \frac{\ln y - 1}{\ln 2}$$

$$(b) x = \frac{\ln(y-1)}{\ln 2}$$

$$(c) x = \frac{\ln y}{\ln 2} - 1$$

$$(d) x = \frac{\ln(y-e)}{\ln 2}$$

169. Write the following expression using a single logarithmic function:

$$\ln(2x^3 + 1) + 5 \ln(3 - x) - \ln(6x^5 + 2x + 1).$$

$$(a) \ln(-6x^5 + 2x^3 - 7x + 15)$$

$$(b) \ln[(2x^3 + 1)(15 - 5x)(-6x^5 - 2x - 1)]$$

$$(c) \ln \left( \frac{(2x^3 + 1)(3 - x)^5}{6x^5 + 2x + 1} \right)$$

$$(d) \ln \left( \frac{(2x^3 + 1)(15 - 5x)}{6x^5 + 2x + 1} \right)$$

170.  $\log \left( \frac{a^4 b^7}{c^5} \right) =$

(a)  $\log(a^4) + \log(b^7) + \log(c^5)$

(b)  $4 \log a + 7 \log b - 5 \log c$

(c)  $28 \log ab - 5 \log c$

(d)  $\frac{28}{5} (\log a + \log b - \log c)$

(e) None of the above

171. Simplify the following expression:  $\ln \left( \frac{\sqrt{x^2 + 1}(x^3 - 4)}{(3x - 7)^2} \right)$ .

(a)  $\frac{1}{2} \ln(x^2 + 1) + \ln(x^3 + 4) - 2 \ln(3x - 7)$

(b)  $\ln \left( \frac{1}{2}(x^2 + 1) \right) + \ln(x^3 + 4) - 2 \ln(3x - 7)$

(c)  $\ln(x^2 + 1) \ln(x^3 + 4) \ln(3x - 7)$

(d)  $\ln[(x^2 + 1)(x^3 + 4)(3x - 7)]$

172. 25 rabbits are introduced to an island, where they quickly reproduce and the rabbit population grows according to an exponential model  $P(t) = P_0 e^{kt}$  so

that the population doubles every four months. If  $t$  is in months, what is the value of the continuous growth rate  $k$ ?

- (a)  $k = \frac{1}{2} \ln 4$
- (b)  $k = \frac{1}{4} \ln 2$
- (c)  $k = \frac{1}{50} \ln \frac{4}{25}$
- (d)  $k = \frac{4}{25} \ln \frac{1}{50}$
- (e) None of the above

173. Simplify  $(\log_{16} 4) \left( \log_3 \frac{1}{9} \right)$ .

- (a)  $\frac{16}{3}$
- (b)  $\frac{4}{9}$
- (c) 1
- (d) -1

### Angles

174. The angles  $-12^\circ$  and  $102^\circ$  are

- (a) complementary
- (b) supplementary

(c) neither

175. The angles  $24^\circ$ ,  $36^\circ$ , and  $30^\circ$  are

(a) complementary

(b) supplementary

(c) neither

176. The angles  $30^\circ$  and  $150^\circ$  are

(a) complementary

(b) supplementary

(c) neither

177. The angles  $2^\circ$  and  $88^\circ$  are

(a) complementary

(b) supplementary

(c) neither

178. In what quadrant is the terminal side of  $215^\circ$ ?

(a) I

(b) II

(c) III

(d) IV

179. In what quadrant is the terminal side of  $-300^\circ$ ?

- (a) I
- (b) II
- (c) III
- (d) IV

180. Which of the following angles is coterminal with a standard position angle of  $215^\circ$ ?

- (a)  $45^\circ$
- (b)  $145^\circ$
- (c)  $-145^\circ$
- (d)  $-215^\circ$

181. Find the smallest positive angle coterminal with  $-980^\circ$ .

- (a)  $260^\circ$
- (b)  $100^\circ$
- (c)  $60^\circ$
- (d)  $20^\circ$

182. What is the radian measure of a  $216^\circ$  angle?

- (a)  $108\pi$

- (b)  $\frac{5\pi}{6}$
- (c)  $\frac{6\pi}{5}$
- (d)  $\frac{8\pi}{9}$

183. What is the degree measure of a  $\frac{5\pi}{3}$  angle?

- (a)  $150^\circ$
- (b)  $300^\circ$
- (c)  $250^\circ$
- (d)  $330^\circ$

184. In what quadrant is the terminal side of a standard position angle with radian measure  $\frac{8\pi}{3}$  radians?

- (a) I
- (b) II
- (c) III
- (d) IV

185. Which of the following angles is complementary to an angle of  $\frac{\pi}{3}$  radians?



- (a)  $\frac{\pi}{6}$
- (b)  $\frac{\pi}{4}$
- (c)  $\frac{\pi}{3}$
- (d)  $\frac{\pi}{2}$

186. You walk 200 meters around a circular track with a radius of 100 meters. Give an angle in radians that represents your final position relative to your starting position.

- (a) 2 radians
- (b) 100 radians
- (c)  $\frac{1}{2}$  radian
- (d)  $2\pi$  radians

187. Find the length of the arc spanned by an angle of 3 radians on a circle of radius 2 feet.

- (a) 2 radians
- (b) 3 radians
- (c) 6 radians
- (d) 1.5 radians

188. Consider a circle of radius  $r$  having a central angle  $\theta$  (measured in radians). If  $s$  is the length of the arc of the circle corresponding to  $\theta$ , then  $s = r\theta$ .

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and am very confident.

189. If the legs of a right triangle are 8 and 15, how long is the hypotenuse?

- (a)  $\sqrt{23}$
- (b) 17
- (c) 23
- (d) 289

### Evaluating Trigonometric Functions

190.  $\sin 0 =$

- (a) 0
- (b) 1
- (c)  $-1$

191.  $\sin \frac{\pi}{6} =$

(a) 0

(b)  $\frac{1}{2}$

(c)  $\frac{\sqrt{2}}{2}$

(d)  $\frac{\sqrt{3}}{2}$

(e) 1

192.  $\sin \frac{\pi}{2} =$

(a) 0

(b)  $\frac{1}{2}$

(c)  $\frac{\sqrt{2}}{2}$

(d)  $\frac{\sqrt{3}}{2}$

(e) 1

193. Calculate  $\csc(14^\circ)$ .

(a) 4.1336

(b) 1.0095

- (c) 0.0714
- (d) 1.0306

194. In what quadrant is the terminal side of  $\theta$  if  $\sin \theta < 0$  and  $\tan \theta < 0$ ?

- (a) I
- (b) II
- (c) III
- (d) IV

195. Let  $\tan \theta = \frac{1}{2}$  and  $\sin \theta < 0$ . What is  $\cos \theta$ ?

- (a)  $\frac{\sqrt{5}}{5}$
- (b)  $-\frac{\sqrt{5}}{5}$
- (c)  $\frac{2\sqrt{5}}{5}$
- (d)  $\frac{-2\sqrt{5}}{5}$

196. The terminal side of  $\theta$  contains the point  $(-12, 5)$ . What is  $\sec \theta$ ?

- (a)  $-\frac{12}{13}$
- (b)  $-\frac{13}{12}$
- (c)  $\frac{5}{13}$
- (d)  $\frac{13}{5}$

197. Use the unit circle to find  $\cos(300^\circ)$ .

- (a)  $\frac{1}{2}$
- (b)  $-\frac{1}{2}$
- (c)  $\frac{\sqrt{3}}{2}$
- (d)  $-\frac{\sqrt{3}}{2}$

198. Use the unit circle to find  $\tan \frac{7\pi}{6}$ .

- (a)  $\sqrt{3}$
- (b)  $-\sqrt{3}$
- (c)  $\frac{\sqrt{3}}{3}$

(d)  $-\frac{\sqrt{3}}{3}$

199. Use the unit circle to find the value of  $\sin \frac{2\pi}{3}$ .

(a) 0

(b)  $\frac{1}{2}$

(c)  $\frac{\sqrt{2}}{2}$

(d)  $\frac{\sqrt{3}}{2}$

(e) 1

200. What is the reference angle for  $315^\circ$ ?

(a)  $0^\circ$

(b)  $30^\circ$

(c)  $45^\circ$

(d)  $60^\circ$

(e)  $90^\circ$

201. Use the unit circle to find the value of  $\cos \frac{5\pi}{6}$ .

(a)  $\frac{1}{2}$

(b)  $-\frac{1}{2}$

(c)  $\frac{\sqrt{2}}{2}$

(d)  $-\frac{\sqrt{2}}{2}$

(e)  $\frac{\sqrt{3}}{2}$

(f)  $-\frac{\sqrt{3}}{2}$

202. Use trig identities to find  $\csc(20^\circ)$ .

(a)  $\frac{1}{\sec(20^\circ)}$

(b)  $\frac{1}{\cos(20^\circ)}$

(c)  $\sec(70^\circ)$

(d)  $\sin(70^\circ)$

203. Use trig identities to find  $\cot(50^\circ)$ .

(a)  $\frac{\cos(50^\circ)}{\sin(50^\circ)}$

(b)  $\tan(40^\circ)$

(c)  $\frac{1}{\tan(50^\circ)}$

(d) all of the above

204. One end of a straight wire is attached to the top of a pole. The other end of the wire is attached to the ground  $d$  feet from the base of the pole. The wire makes an angle  $\theta$  with the ground. Which expression gives the height of the pole?

(a)  $\frac{d}{\tan \theta}$

(b)  $d \tan \theta$

(c)  $\frac{d}{\tan^{-1} \theta}$

(d)  $d \tan^{-1} \theta$

205. Of the numbers below, which can be substituted for  $x$  to show that the equation  $\sec x = \sqrt{1 + \tan^2 x}$  is not an identity?

(a) 0

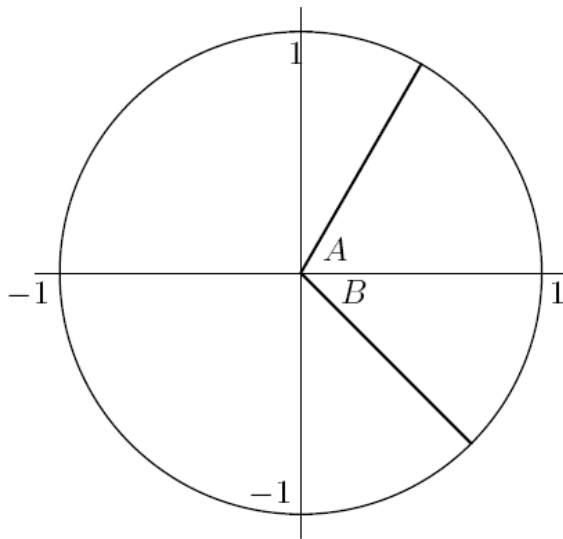
(b)  $\frac{\pi}{2}$

(c)  $\pi$



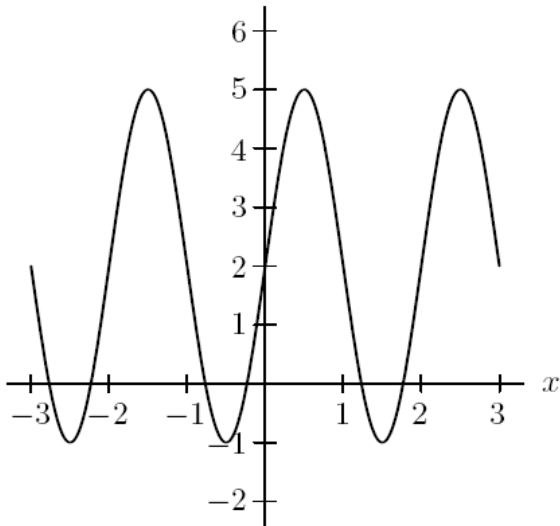
## Trigonometric Functions: Amplitudes, Periods, and Graphs

206. Which of the following is the approximate value for the sine and cosine of angles  $A$  and  $B$  in the figure below.



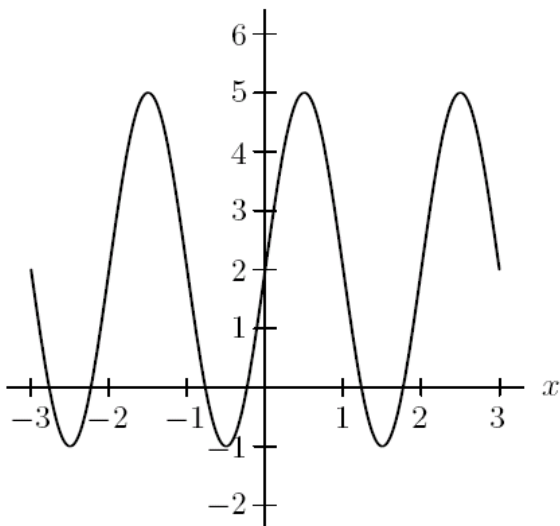
- (a)  $\sin A \approx 0.5$ ,  $\cos A \approx 0.85$ ,  $\sin B \approx -0.7$ ,  $\cos B \approx 0.7$
- (b)  $\sin A \approx 0.85$ ,  $\cos A \approx 0.5$ ,  $\sin B \approx -0.7$ ,  $\cos B \approx 0.7$
- (c)  $\sin A \approx 0.5$ ,  $\cos A \approx 0.85$ ,  $\sin B \approx 0.7$ ,  $\cos B \approx 0.7$
- (d)  $\sin A \approx 0.85$ ,  $\cos A \approx 0.5$ ,  $\sin B \approx 0.7$ ,  $\cos B \approx 0.7$

207. The amplitude and period of the function below are



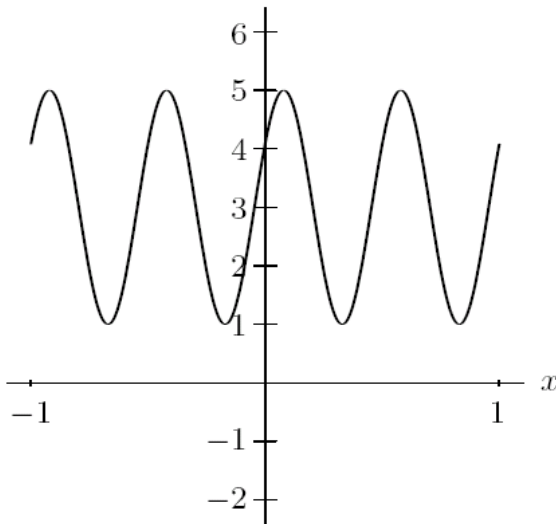
- (a) Amplitude = 2, Period = 2
- (b) Amplitude = 2, Period = 3
- (c) Amplitude = 2, Period =  $1/2$
- (d) Amplitude = 3, Period = 2
- (e) Amplitude = 3, Period =  $1/2$

208. What is the equation of the function shown in the graph?



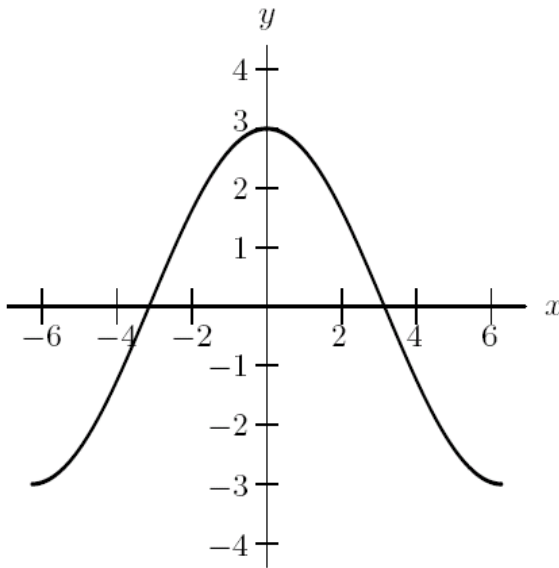
- (a)  $y = 3 \sin(2x) + 2$
- (b)  $y = 3 \cos(2x) + 2$
- (c)  $y = 3 \sin(\pi x) + 2$
- (d)  $y = 3 \cos(\pi x) + 2$
- (e)  $y = 3 \sin(\frac{1}{\pi}x) + 2$
- (f)  $y = 3 \cos(\frac{1}{\pi}x) + 2$

209. The amplitude and period of the function below are



- (a) Amplitude = 2, Period = 2
- (b) Amplitude = 2, Period = 3
- (c) Amplitude = 2, Period =  $1/2$
- (d) Amplitude = 3, Period = 2
- (e) Amplitude = 3, Period =  $1/2$

210. Which of the following could describe the graph below?

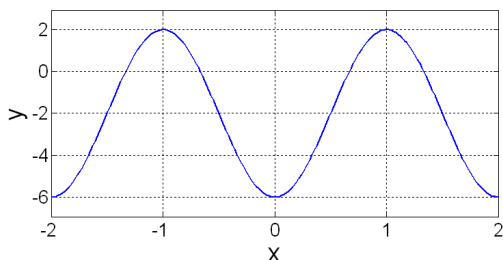


- (a)  $y = 3 \cos(2x)$
- (b)  $y = 3 \cos(x/2)$
- (c)  $y = 3 \sin(2x)$
- (d)  $y = 3 \sin(x/2)$

211. The function  $f(x) = 3 \sin(2x+4)$  is created when you take the function  $g(x) = 3 \sin(2x)$  and you...

- (a) shift it left by 4 units.
- (b) shift it right by 4 units.
- (c) shift it left by 2 units.
- (d) shift it right by 2 units.
- (e) shift it left by 8 units.

212. Which of the following could describe the graph below?

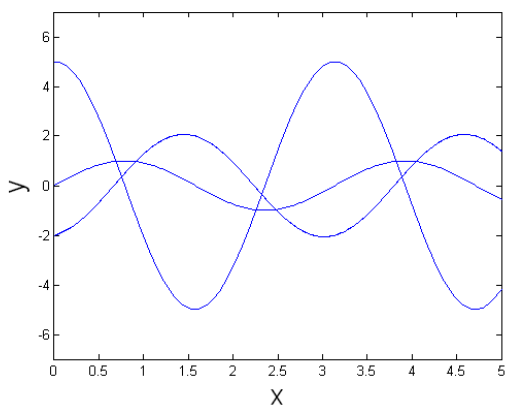
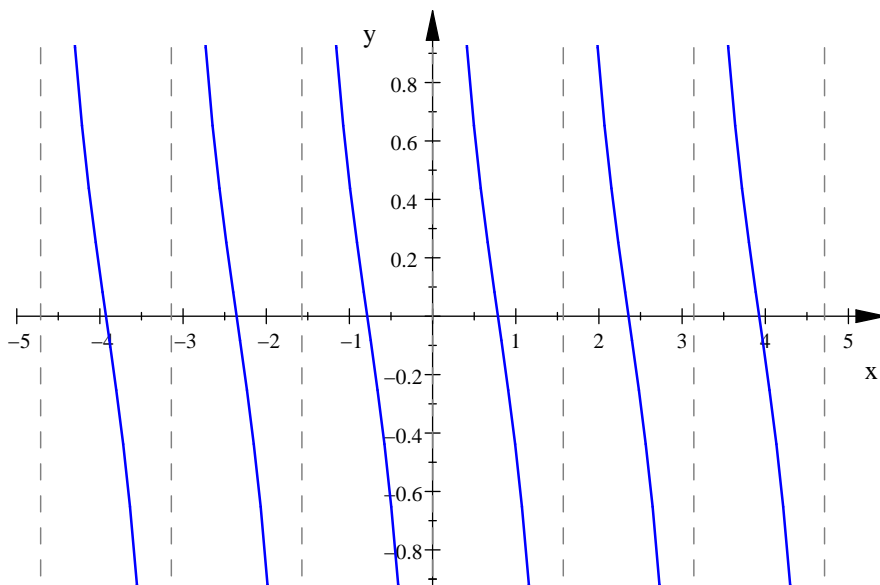


- (a)  $y = 4 \sin \left( \pi x - \frac{\pi}{2} \right) - 2$
- (b)  $y = -4 \sin \left( \pi x + \frac{\pi}{2} \right) - 2$
- (c)  $y = -4 \cos(\pi x) - 2$
- (d)  $y = 4 \cos(\pi(x + 1)) - 2$
- (e) All of the above
- (f) More than one, but not all of the above

213. What is an equation of the function whose graph is given below?

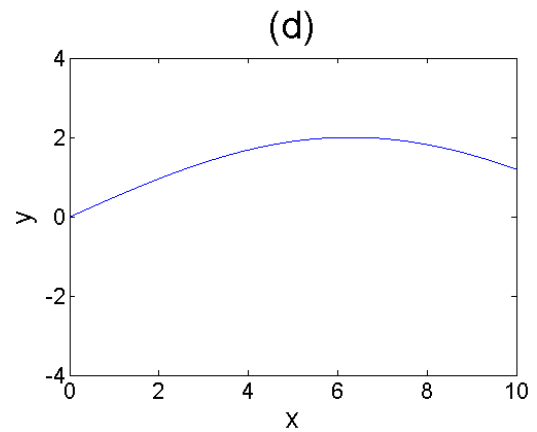
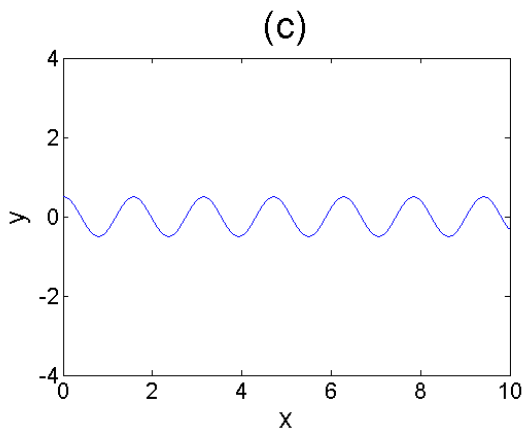
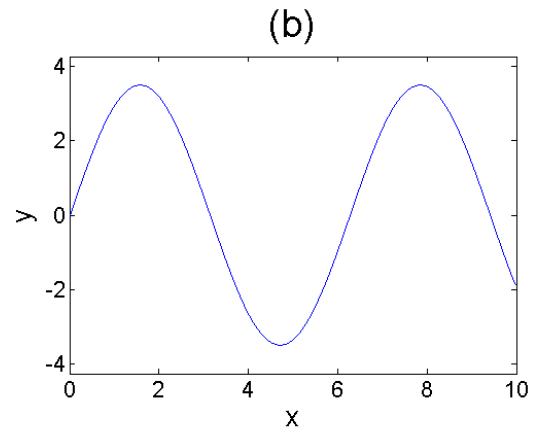
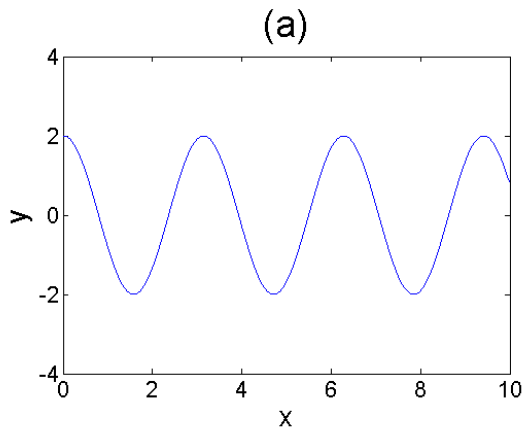
- (a)  $f(x) = \cot x$
- (b)  $f(x) = \cot 2x$
- (c)  $f(x) = \cot \left( x - \frac{\pi}{2} \right)$
- (d)  $f(x) = \cot \left( 2x - \frac{\pi}{2} \right)$

214. Three different functions of the form  $y = A \sin(Bx + C)$  are plotted below. Could these all have the same value of  $B$ ?



- (a) Yes
- (b) No
- (c) Not enough information is given.

215. The functions plotted below are all of the form  $y = A \sin(Bx + C)$ . Which function has the largest value of  $B$ ?



216. What is the phase shift of  $f(x) = \frac{1}{5} \tan\left(2x + \frac{\pi}{2}\right)$ ?

- (a)  $2\pi$
- (b)  $\pi$
- (c)  $\frac{\pi}{2}$
- (d)  $\frac{\pi}{4}$
- (e)  $-2\pi$
- (f)  $-\pi$
- (g)  $-\frac{\pi}{2}$

(h)  $-\frac{\pi}{4}$

217. What is the amplitude of  $f(x) = -3 \sin(2x)$ ?

(a) 3

(b) -3

(c)  $\pi$

(d)  $2\pi$

218. What is the amplitude of  $f(x) = -2 \sin x$ ?

(a) 1

(b) 2

(c) -2

219. What is the period of  $f(x) = -3 \sin(2x)$ ?

(a) 3

(b) -3

(c)  $\pi$

(d)  $2\pi$

220. What is the period of  $f(x) = \frac{1}{5} \tan(2x)$ ?



- (a)  $\frac{1}{5}$
- (b)  $2\pi$
- (c)  $\pi$
- (d)  $\frac{\pi}{2}$
- (e)  $\frac{\pi}{4}$

221. Which of the basic trig functions below are odd functions?

- (a)  $f(x) = \sin(x)$ .
- (b)  $f(x) = \cos(x)$ .
- (c)  $f(x) = \tan(x)$ .
- (d) (a) and (b).
- (e) (a) and (c).
- (f) (b) and (c).
- (g) (a), (b), and (c).
- (h) None of the above.

### **Inverse Trigonometric Functions**

222. What is  $\arcsin\left(\frac{1}{2}\right)$ ?

- (a) 0
- (b)  $\frac{\pi}{6}$
- (c)  $\frac{\pi}{4}$
- (d)  $\frac{\pi}{3}$

223. What is  $\sin^{-1}\left(-\frac{\sqrt{3}}{2}\right)$ ?

- (a)  $\frac{\pi}{3}$
- (b)  $\frac{5\pi}{3}$
- (c)  $-\frac{\pi}{3}$
- (d)  $\frac{4\pi}{3}$

224. What is  $\arcsin(-1)$ ?

- (a)  $\frac{3\pi}{2}$
- (b)  $\frac{\pi}{2}$
- (c)  $-\frac{\pi}{2}$
- (d)  $-\frac{3\pi}{2}$

225. What is  $\arccos\left(\frac{1}{2}\right)$ ?

(a)  $\frac{\pi}{6}$

(b)  $\frac{\pi}{4}$

(c)  $\frac{\pi}{3}$

(d)  $\frac{\pi}{2}$

226. What is  $\cos^{-1}(-1)$ ?

(a) 0

(b)  $\pi$

(c)  $-\pi$

(d)  $2\pi$

227. What is  $\arccos\left(-\frac{\sqrt{2}}{2}\right)$ ?

(a)  $\frac{\pi}{4}$

(b)  $-\frac{\pi}{4}$

(c)  $\frac{3\pi}{4}$

(d)  $\frac{5\pi}{4}$

228. What is  $\tan^{-1}(1)$ ?

(a)  $\frac{\pi}{2}$

(b)  $\frac{\pi}{3}$

(c)  $\frac{\pi}{4}$

(d)  $\frac{\pi}{6}$

229. What is  $\arctan(-\sqrt{3})$ ?

(a)  $\frac{2\pi}{3}$

(b)  $\frac{5\pi}{3}$

(c)  $-\frac{\pi}{3}$

(d)  $-\frac{2\pi}{3}$

230. What is  $\arctan(0)$ ?

(a) 0

(b)  $\frac{\pi}{2}$

- (c)  $\pi$
- (d)  $\frac{3\pi}{2}$

231. True or False:  $\sin^{-1} \left( \sin \left( \frac{5}{4} \right) \right) = \frac{5}{4}$

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

232. True or False:  $\sin \left( \sin^{-1} \left( \frac{5}{4} \right) \right) = \frac{5}{4}$

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

233. True or False:  $\sin^{-1} \left( \sin \frac{\pi}{3} \right) = \frac{\pi}{3}$ .

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.

(d) False, and I am very confident.

234. True or False:  $\sin^{-1} \left( \sin \frac{3\pi}{4} \right) = \frac{3\pi}{4}$ .

(a) True, and I am very confident.

(b) True, but I am not very confident.

(c) False, but I am not very confident.

(d) False, and I am very confident.

235. Calculate the exact value of  $\sin \left( \arctan \left( \frac{4}{3} \right) \right)$ . Work this out by hand, without using a calculator.

(a)  $\frac{4}{3}$

(b)  $\frac{3}{4}$

(c)  $\frac{4}{5}$

(d)  $\frac{3}{5}$

236. Calculate the exact value of  $\sin \left( 2 \arctan \left( \frac{4}{3} \right) \right)$ . Work this out by hand, without using a calculator.

(a)  $\frac{24}{25}$

(b)  $\frac{8}{5}$

(c)  $\frac{8}{3}$

(d)  $\frac{12}{25}$

237. A triangle has sides of length  $a$ ,  $b$ , and  $c$  and angles measuring  $\alpha$ ,  $\beta$ , and  $\gamma$  opposite those sides, respectively. If  $a = 3$ ,  $b = 4$ , and  $\gamma = 90^\circ$ , find  $\alpha$ .

(a)  $\alpha = \tan^{-1} \frac{3}{4}$

(b)  $\alpha = \tan^{-1} \frac{4}{3}$

(c)  $\alpha = \cos^{-1} \frac{3}{4}$

(d)  $\alpha = \cos^{-1} \frac{4}{3}$

### **The Sum, Difference, Double, and Half Angle Formulas**

238.  $\sin(90^\circ) = \sin(30^\circ) + \sin(60^\circ)$

(a) True, and I am very confident.

- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

239.  $\cos(30^\circ) = \cos(90^\circ) - \cos(60^\circ)$

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

240.  $\tan(120^\circ) = \tan(90^\circ) + \tan(30^\circ)$

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

241. Use the fact that  $60^\circ + 45^\circ = 105^\circ$  to calculate  $\cos 105^\circ$ .

- (a)  $\frac{\sqrt{2} - \sqrt{6}}{4}$
- (b)  $\frac{\sqrt{6} - \sqrt{2}}{4}$
- (c)  $\frac{\sqrt{6} + \sqrt{2}}{4}$



(d)  $-\frac{1}{2}$

242. Use the sum and difference formulas to calculate  $\cos(57^\circ)\cos(22^\circ) + \sin(57^\circ)\sin(22^\circ)$ .

(a)  $\cos(35^\circ)$

(b)  $\sin(35^\circ)$

(c)  $\cos(79^\circ)$

(d)  $\sin(79^\circ)$

243. Use the sum and difference formulas to calculate  $\sin(44^\circ)\cos(19^\circ) + \cos(44^\circ)\sin(19^\circ)$ .

(a)  $\cos(63^\circ)$

(b)  $\sin(63^\circ)$

(c)  $\cos(25^\circ)$

(d)  $\sin(25^\circ)$

244. Suppose  $\cos \alpha = \frac{3}{5}$  and  $\sin \beta = \frac{5}{13}$ , where  $\alpha$  is in quadrant I and  $\beta$  is in quadrant II. Find  $\sin(\alpha + \beta)$ .

(a)  $-\frac{33}{65}$

(b)  $-\frac{56}{65}$

(c)  $-\frac{58}{65}$

(d) Not enough information is given.

245. Find a simpler form for  $\cos\left(\theta - \frac{3\pi}{2}\right)$ .

(a)  $\sin\theta$

(b)  $-\sin\theta$

(c)  $\cos\theta$

(d)  $-\cos\theta$

246. Use the sum and difference formulas to calculate  $\frac{\tan\left(\frac{\pi}{3}\right) - \tan\left(\frac{\pi}{4}\right)}{1 + \tan\left(\frac{\pi}{3}\right)\tan\left(\frac{\pi}{4}\right)}$ .

(a)  $\tan\left(\frac{\pi}{12}\right)$

(b)  $\tan\left(\frac{7\pi}{12}\right)$

(c)  $\tan\left(\frac{\pi}{7}\right)$

(d)  $\tan(\pi)$

247.  $\sin(90^\circ) = 2\sin(45^\circ)$

(a) True, and I am very confident.

- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

248.  $\cos(120^\circ) = 2 \cos(60^\circ)$

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

249.  $\tan(60^\circ) = 2 \tan(30^\circ)$

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

250. Using the double angle formulas,  $2 \sin(12^\circ) \cos(12^\circ) =$

- (a)  $\sin(6^\circ)$
- (b)  $\sin(24^\circ)$
- (c)  $\cos(6^\circ)$
- (d)  $\cos(24^\circ)$

251.  $\cos 2\theta =$

- (a)  $2 \cos \theta$
- (b)  $2 \sin \theta \cos \theta$
- (c)  $\cos^2 \theta + \sin^2 \theta$
- (d)  $2 \cos^2 \theta - 1$

252. Using the double angle formulas,  $1 - 2 \sin^2(40^\circ) =$

- (a)  $\sin(80^\circ)$
- (b)  $\sin(20^\circ)$
- (c)  $\cos(80^\circ)$
- (d)  $\cos(20^\circ)$

253.  $\sin(30^\circ) = \frac{1}{2} \sin(60^\circ)$

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

254.  $\cos(45^\circ) = \frac{1}{2} \cos(90^\circ)$

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.

(d) False, and I am very confident.

255.  $\tan(90^\circ) = \frac{1}{2} \tan(180^\circ)$

(a) True, and I am very confident.

(b) True, but I am not very confident.

(c) False, but I am not very confident.

(d) False, and I am very confident.

256. Use the half angle formulas to calculate  $\sin\left(\frac{\pi}{8}\right)$ .

(a)  $\sqrt{\frac{1 - \cos\left(\frac{\pi}{8}\right)}{2}}$

(b)  $\sqrt{\frac{1 + \cos\left(\frac{\pi}{8}\right)}{2}}$

(c)  $\sqrt{\frac{1 - \cos\left(\frac{\pi}{4}\right)}{2}}$

(d)  $\sqrt{\frac{1 - \cos\left(\frac{\pi}{16}\right)}{2}}$

257. Use a half-angle formula to calculate  $\cos\left(\frac{5\pi}{8}\right)$ .

(a)  $\sqrt{\frac{1 + \cos\frac{5\pi}{16}}{2}}$

(b)  $-\sqrt{\frac{1 + \cos\frac{5\pi}{16}}{2}}$

(c)  $\sqrt{\frac{1 + \cos\frac{5\pi}{4}}{2}}$

(d)  $-\sqrt{\frac{1 + \cos\frac{5\pi}{4}}{2}}$

### The Law of Sines and the Law of Cosines

258. Given a triangle with angles  $A$ ,  $B$ , and  $C$  and opposite sides  $a$ ,  $b$ , and  $c$ , find the measurements of the remaining angle and sides assuming that  $B = 30^\circ$ ,  $C = 100^\circ$  and  $b = 20$  feet.

(a)  $A = 50^\circ$ ,  $a \approx 39.39$  feet,  $c \approx 30.64$  feet

(b)  $A = 50^\circ$ ,  $a \approx 10.50$  feet,  $c \approx 20.26$  feet

- (c)  $A = 50^\circ$ ,  $a \approx 30.64$  feet,  $c \approx 39.39$  feet
- (d)  $A = 230^\circ$ ,  $a \approx 30.64$  feet,  $c \approx 39.39$  feet

259. A big pine tree has grown so that it is tilted  $3^\circ$  from vertical toward the sun. When its shadow is 20 feet long, the angle of elevation from the tip of its shadow to the top of the tree is  $60^\circ$ . Approximately how tall is the tree (i.e. what is its length)?

- (a) 32 feet
- (b) 38 feet
- (c) 44 feet
- (d) 331 feet

260. True or False: Two angles and a side determine a unique triangle.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

261. True or False: Given the measurements of any two angles and one side of an oblique triangle, the triangle can be completely solved using the law of sines.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

262. True or False: Given the measurements of any two sides and an angle, the law of sines can be used to solve any oblique triangle.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

263. Suppose you are to construct a triangle given the lengths of two sides  $a$  and  $b$  and the measurement of opposite angle  $A$ . How many possible triangles can you construct if  $A$  is acute?

- (a) none
- (b) one
- (c) two
- (d) two of the above
- (e) all of the above



264. Suppose you are to construct a triangle given the lengths of two sides  $a$  and  $b$  and the measurement of opposite angle  $A$ . How many possible triangles can you construct if  $A$  is obtuse?
- (a) none
  - (b) one
  - (c) two
  - (d) two of the above
  - (e) all of the above
265. Given an oblique triangle with sides  $a = 6$  and  $b = 8$ , and opposite angle  $A = 30^\circ$ , find the measurement of opposite angle  $B$ .
- (a)  $B \approx 42^\circ$
  - (b)  $B \approx 138^\circ$
  - (c) either (a) or (b)
  - (d) There is no solution.
266. Given an oblique triangle with sides  $a = 3$  and  $b = 8$ , and opposite angle  $A = 30^\circ$ , find the measurement of opposite angle  $B$ .
- (a)  $B \approx 11^\circ$
  - (b)  $B \approx 42^\circ$

- (c) either (a) or (b)
- (d) There is no solution.

267. A person leaves his house and walks 2 miles west and then 4 miles northwest. Approximately how far is he from home?

- (a) 31.3 miles
- (b) 2.95 miles
- (c) 6 miles
- (d) 5.6 miles

268. Given a triangle with sides  $a = 6$ ,  $b = 8$ , and  $c = 11$ , find opposite angles  $A$ ,  $B$ , and  $C$ .

- (a)  $A \approx 32^\circ$ ,  $B \approx 103^\circ$ ,  $C \approx 45^\circ$
- (b)  $A \approx 45^\circ$ ,  $B \approx 32^\circ$ ,  $C \approx 103^\circ$
- (c)  $A \approx 32^\circ$ ,  $B \approx 45^\circ$ ,  $C \approx 103^\circ$
- (d) There is no solution.

269. Triangle  $ABC$  has sides of length  $a$ ,  $b$ , and  $c$ , and angles of measure  $\alpha$ ,  $\beta$ , and  $\gamma$  opposite those sides, respectively. If  $\alpha = 42^\circ$ ,  $\gamma = 59^\circ$ , and  $b = 45$ , find  $a$ .

- (a)  $\frac{45 \sin 42^\circ}{\sin 79^\circ}$

- (b)  $\frac{45 \sin 42^\circ}{\sin 59^\circ}$
- (c)  $\frac{45 \sin 79^\circ}{\sin 42^\circ}$
- (d)  $\frac{45 \sin 59^\circ}{\sin 42^\circ}$

270. Alan at position  $A$  spots a deer bearing  $S43^\circ E$ . Bob at position  $B$ , 700 meters due east of position  $A$ , spots the deer bearing  $S65^\circ W$ . How far from Alan is the deer?

- (a)  $\frac{700 \sin 43^\circ}{\sin 72^\circ}$  meters
- (b)  $\frac{700 \sin 65^\circ}{\sin 72^\circ}$  meters
- (c)  $\frac{700 \sin 47^\circ}{\sin 108^\circ}$  meters
- (d)  $\frac{700 \sin 25^\circ}{\sin 108^\circ}$  meters

271. Triangle  $ABC$  has sides of length  $a$ ,  $b$ , and  $c$ , and angles of measure  $\alpha$ ,  $\beta$ , and  $\gamma$  opposite those sides, respectively. If  $\alpha = 73^\circ$ ,  $b = 7.0$ , and  $c = 3.0$ , find  $a$ .

- (a)  $58 - 42 \cos 73^\circ$
- (b)  $\sqrt{58 - 42 \cos 73^\circ}$
- (c)  $58 - 21 \cos 73^\circ$

(d)  $\sqrt{58 - 21 \cos 73^\circ}$

272. Triangle  $ABC$  has sides of length  $a$ ,  $b$ , and  $c$ , and angles of measure  $\alpha$ ,  $\beta$ , and  $\gamma$  opposite those sides, respectively. If  $a = 5$ ,  $b = 4$ , and  $c = 2$ , find  $\alpha$ .

(a)  $\cos\left(\frac{5}{16}\right)$

(b)  $\cos^{-1}\left(\frac{5}{16}\right)$

(c)  $\cos\left(-\frac{5}{16}\right)$

(d)  $\cos^{-1}\left(-\frac{5}{16}\right)$

### Solving Trigonometric Equations

273. For  $\theta$  in the interval  $[0, 2\pi)$ , find all solutions of the equation  $\sin \theta = \frac{1}{2}$ .

(a)  $\theta = \frac{\pi}{6}$

(b)  $\theta = \frac{\pi}{6}$  and  $\theta = \frac{5\pi}{6}$

(c)  $\theta = \frac{\pi}{6}$ ,  $\theta = \frac{5\pi}{6}$ ,  $\theta = \frac{7\pi}{6}$ , and  $\theta = \frac{11\pi}{6}$

(d) None of the above

274. Solve the equation  $\tan \theta = 1$ .

(a)  $\theta = \frac{\pi}{4}$

(b)  $\theta = \frac{\pi}{4}$  and  $\theta = \frac{5\pi}{4}$

(c)  $\theta = \frac{\pi}{4} + 2\pi n$ , where  $n$  is any integer

(d)  $\theta = \frac{5\pi}{4} + \pi n$ , where  $n$  is any integer

275. Solve the equation  $\sin \theta \tan \theta = \tan \theta$ .

(a)  $\theta = \frac{\pi}{2} + 2\pi n$ , where  $n$  is any integer

(b)  $\theta = \frac{\pi}{2} + 2\pi n$  and  $2\pi n$ , where  $n$  is any integer

(c)  $\theta = \frac{\pi}{2} + 2\pi n$  and  $\pi n$ , where  $n$  is any integer

(d)  $\pi n$ , where  $n$  is any integer

### **The Trigonometric Form of Complex Numbers**

276. Find  $|7 - 4i|$ .

(a) 3

- (b) 11
- (c)  $\sqrt{33}$
- (d)  $\sqrt{65}$

277. Express  $-3 + 3i$  in trigonometric form, with  $0 \leq \theta < 2\pi$ .

- (a)  $18e^{\frac{\pi}{4}i}$
- (b)  $18e^{\frac{3\pi}{4}i}$
- (c)  $3\sqrt{2}e^{\frac{\pi}{4}i}$
- (d)  $3\sqrt{2}e^{\frac{3\pi}{4}i}$

278. Use De Moivre's Theorem to express  $(1 + i)^{10}$  in the form  $a + bi$ , where  $a$  and  $b$  are real numbers.

- (a) 32
- (b)  $32i$
- (c)  $-32$
- (d)  $-32i$

279. Find the three cube roots of 1.

- (a)  $1, \frac{1}{2} + \frac{\sqrt{3}}{2}i, -\frac{1}{2} + \frac{\sqrt{3}}{2}i$
- (b)  $1, \frac{1}{2} + \frac{\sqrt{3}}{2}i, \frac{1}{2} - \frac{\sqrt{3}}{2}i$
- (c)  $1, -\frac{1}{2} + \frac{\sqrt{3}}{2}i, -\frac{1}{2} - \frac{\sqrt{3}}{2}i$
- (d)  $1, -\frac{1}{2} - \frac{\sqrt{3}}{2}i, \frac{1}{2} - \frac{\sqrt{3}}{2}i$

### Conic Sections

280. Find an equation of a parabola that has vertex at the origin, opens right, and passes through  $(9, -2)$ .

- (a)  $y = \frac{2}{81}x^2$
- (b)  $y = -\frac{2}{81}x^2$
- (c)  $x = \frac{9}{4}y^2$
- (d)  $x = -\frac{9}{4}y^2$

281. Find an equation of the parabola that has vertex  $(2, 1)$  and directrix  $y = 6$ .

- (a)  $(x - 2)^2 = 20(y - 1)$

(b)  $(x - 2)^2 = -20(y - 1)$

(c)  $(y - 1)^2 = 20(x - 2)$

(d)  $(y - 1)^2 = -20(x - 2)$

282. Find the vertices and the endpoints of the minor axis for the ellipse given by the equation  $9x^2 + 4y^2 = 16$ .

(a) vertices:  $(2, 0)$  and  $(-2, 0)$ ; endpoints of minor axis:  $(0, \frac{4}{3})$  and  $(0, -\frac{4}{3})$

(b) vertices:  $(0, 2)$  and  $(0, -2)$ ; endpoints of minor axis:  $(\frac{4}{3}, 0)$  and  $(-\frac{4}{3}, 0)$

(c) vertices:  $(2, 0)$  and  $(-2, 0)$ ; endpoints of minor axis:  $(0, \frac{3}{4})$  and  $(0, -\frac{3}{4})$

(d) vertices:  $(0, 2)$  and  $(0, -2)$ ; endpoints of minor axis:  $(\frac{3}{4}, 0)$  and  $(-\frac{3}{4}, 0)$

283. Find an equation for the ellipse that has vertices at  $(0, 3)$  and  $(0, -3)$  and foci at  $(0, 2)$  and  $(0, -2)$ .

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

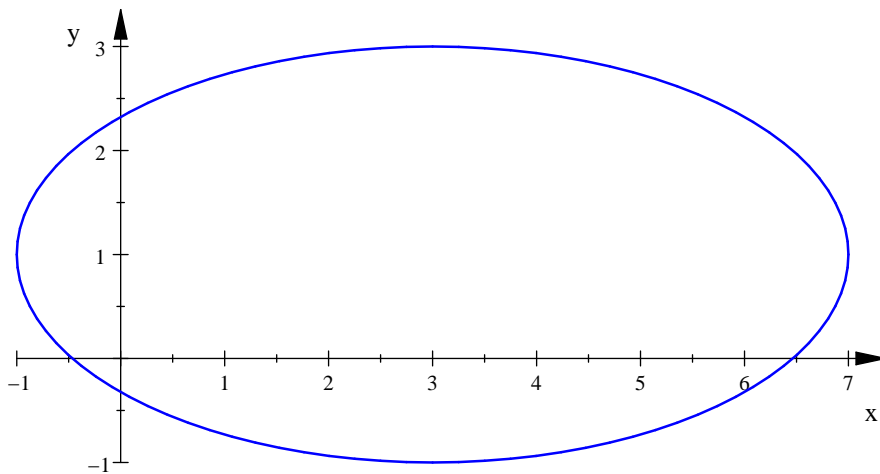
(b)  $\frac{x^2}{9} + \frac{y^2}{4} = 1$

(c)  $\frac{x^2}{5} + \frac{y^2}{9} = 1$



$$(d) \frac{x^2}{9} + \frac{y^2}{5} = 1$$

284. What is the equation of the ellipse graphed below?



$$(a) \frac{(x + 3)^2}{16} + \frac{(y + 1)^2}{4} = 1$$

$$(b) \frac{(x + 3)^2}{64} + \frac{(y + 1)^2}{16} = 1$$

$$(c) \frac{(x - 3)^2}{16} + \frac{(y - 1)^2}{4} = 1$$

$$(d) \frac{(x - 3)^2}{64} + \frac{(y - 1)^2}{16} = 1$$

285. Find equations for the asymptotes of the hyperbola given by the equation  $y^2 - \frac{x^2}{2} = 4$ .

(a)  $y = \pm \frac{1}{2}x$

(b)  $y = \pm \frac{1}{\sqrt{2}}x$

(c)  $y = \pm \sqrt{2}x$

(d)  $y = \pm 2x$

286. Find the center of the hyperbola given by the equation  $4x^2 - 9y^2 + 16x + 18y = 29$ .

(a)  $(2, 1)$

(b)  $(2, -1)$

(c)  $(-2, 1)$

(d)  $(-2, -1)$

### **Powers, Polynomials, and Rational Functions**

287. Which of the following is not a power function?

(a)  $f(x) = 3x^2$

(b)  $f(x) = x^{1.5}$

(c)  $f(x) = 6 \cdot 2^x$

(d)  $f(x) = -3x^{-\pi}$

288. As  $x \rightarrow \infty$ , which function dominates? That is, which function is larger in the long run?

(a)  $0.1x^2$

(b)  $10^{10}x$

289. As  $x \rightarrow \infty$ , which function dominates?

(a)  $0.25\sqrt{x}$

(b)  $25,000x^{-3}$

290. As  $x \rightarrow \infty$ , which function dominates?

(a)  $3 - 0.9^x$

(b)  $\log x$

291. Which function dominates as  $x \rightarrow \infty$ ?

(a)  $x^2$

(b)  $e^x$

292. As  $x \rightarrow \infty$ , which function dominates?

(a)  $x^3$

(b)  $2^x$

293. As  $x \rightarrow \infty$ , which function dominates?

- (a)  $10(2^x)$
- (b)  $72,000x^{12}$

294. Which of these functions dominates as  $x \rightarrow \infty$ ?

- (a)  $f(x) = -5x$
- (b)  $g(x) = 10^x$
- (c)  $h(x) = 0.9^x$
- (d)  $k(x) = x^5$
- (e)  $l(x) = \pi^x$

295. If  $f(x) = ax^2 + bx + c$  is a quadratic function, then the lowest point on the graph of  $f(x)$  occurs at  $x = -b/2a$ .

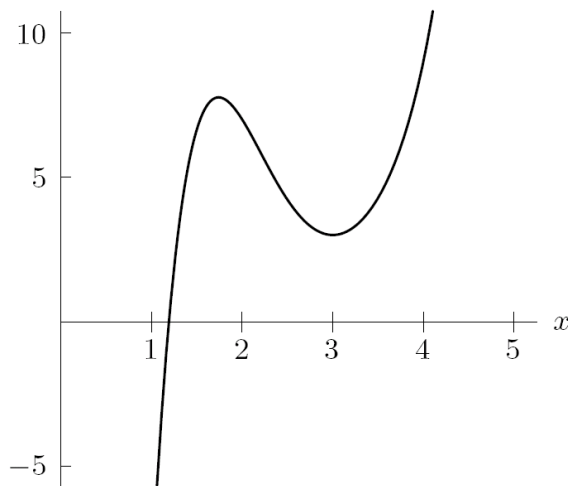
- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

296. Under what condition is the graph of the quadratic function described by  $f(x) = ax^2 + bx + c$  concave down?

- (a)  $a < 0$ .
- (b)  $b < 0$ .

- (c)  $c < 0$ .
- (d) More than one of the above.
- (e) None of the above.

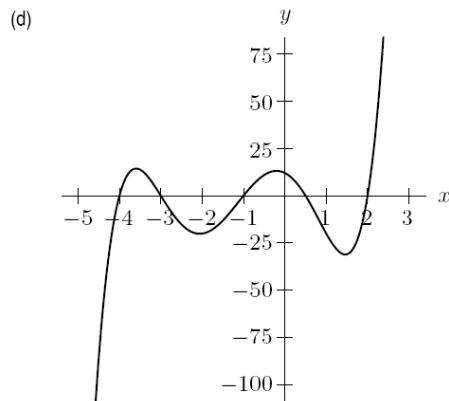
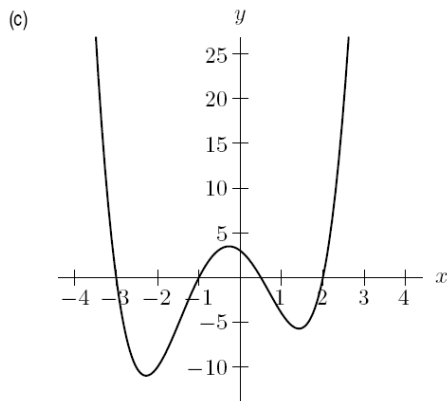
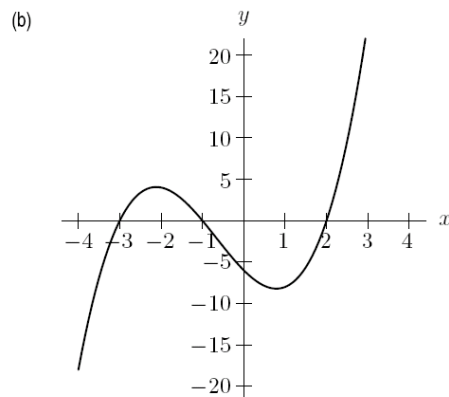
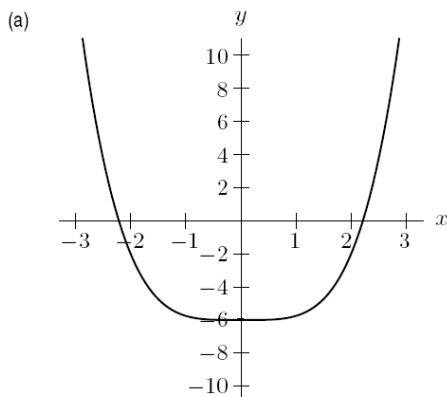
297. What is the degree of the graph of the polynomial in the figure below?



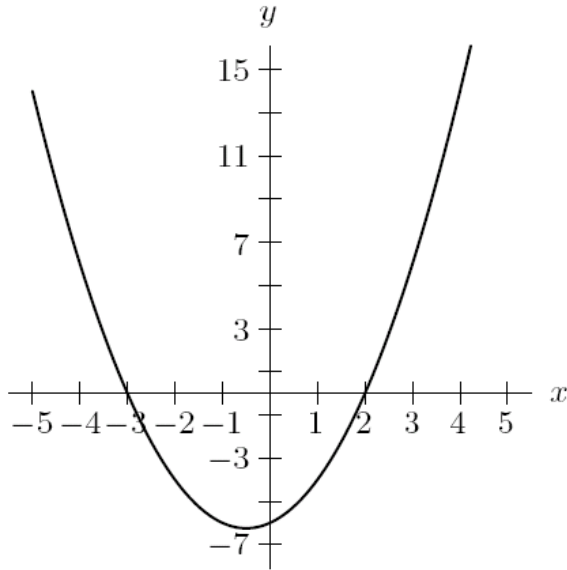
- (a) 3
  - (b) 5
  - (c) Either (a) or (b)
  - (d) Neither (a) nor (b)
  - (e) Any polynomial of degree greater than 2
298. Which of the options below describes a function which is even?
- (a) Any polynomial of even degree.
  - (b) Any polynomial of odd degree.

- (c)  $f(x) = 9x^6 - 3x^2 + 2$ .
- (d)  $f(x) = 3x^4 - 2x^3 + x^2$ .
- (e) More than 1 of the above.
- (f) None of the above.

299. The equation  $y = x^3 + 2x^2 - 5x - 6$  is represented by which graph?



300. The graph below is a representation of which function?

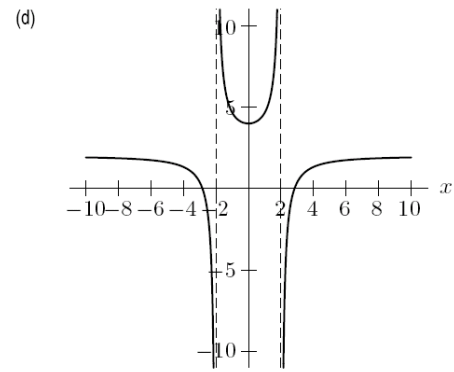
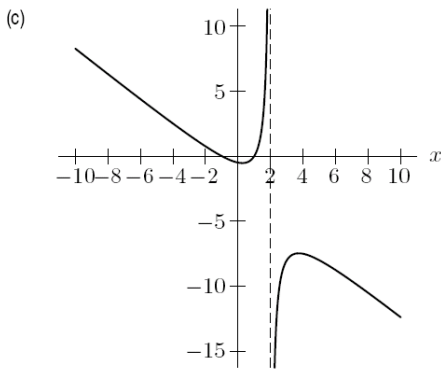
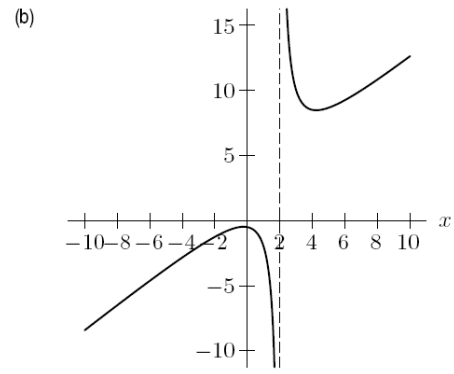
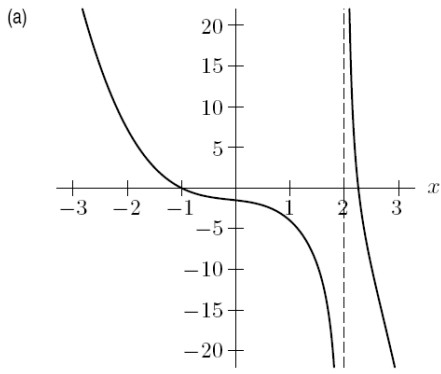


- (a)  $y = 3x + 2$
- (b)  $y = (x - 2)(x + 3)$
- (c)  $y = (x - 6)(x - 2)$
- (d)  $y = (x - 3)(x + 2)$
- (e) none of these

301. Let  $f(x) = \frac{x^2-1}{x+1}$  and  $g(x) = x - 1$ , then  $f(x) = g(x)$ .

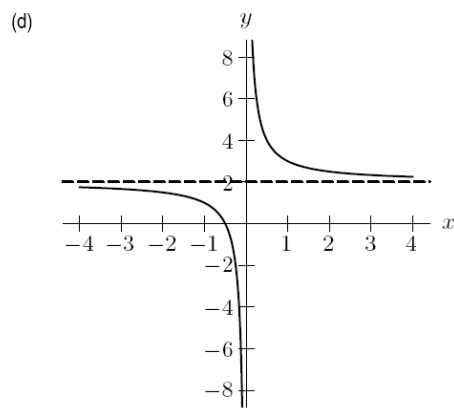
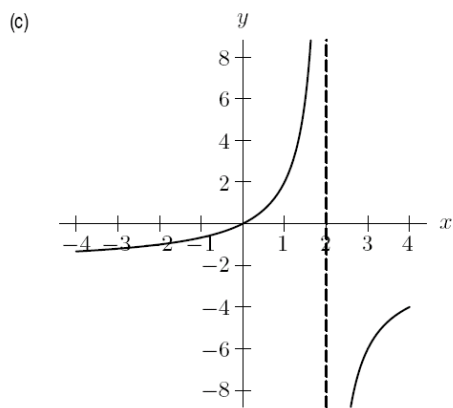
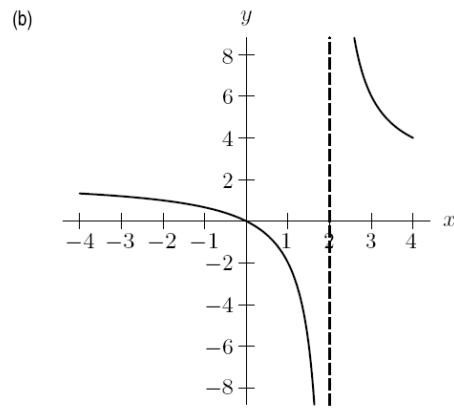
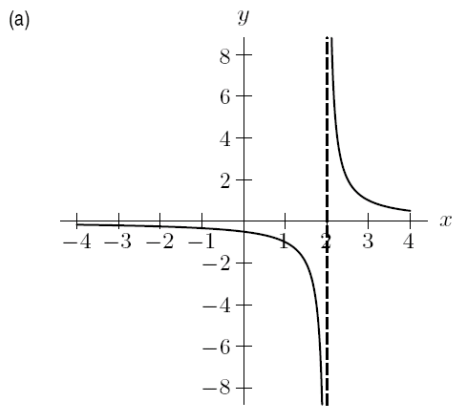
- (a) True, and I am very confident
- (b) True, but I am not very confident
- (c) False, but I am not very confident
- (d) False, and I am very confident

302. Which if the following is a graph for  $y = \frac{1-x^2}{x-2}$ . (No calculators allowed.)



303. Which of the graphs represents  $y = \frac{2x}{x-2}$ ?





## Polynomials, Synthetic Division, and Rational Functions

304. Let  $f(x) = (x - 1)^3(x + 4)^4(x + 7)^2$ . What is the degree of this polynomial?

- (a) 3
- (b) 4
- (c) 9
- (d) 24

305. Let  $f(x) = (x - 1)^3(x + 4)^4(x + 7)^2$ . Where does the graph of this function cross the x-axis?

- (a) 1
- (b) -4 and -7
- (c) 1, -4, and -7

306. Find the polynomial  $f(x)$  with smallest degree that has zeros at  $x = 1$ ,  $x = 2$ , and  $x = 3$  such that  $f(5) = 8$ .

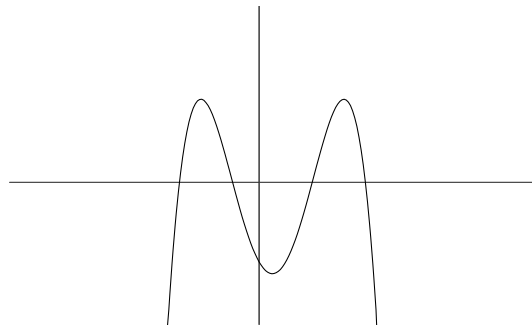
- (a)  $f(x) = (x - 1)(x - 2)(x - 3)$
- (b)  $f(x) = (x - 1)(x - 2)(x - 3)(x - 5)$
- (c)  $f(x) = 8(x - 1)(x - 2)(x - 3)$
- (d)  $f(x) = 8(x - 1)(x - 2)(x - 3)(x - 5)$
- (e)  $f(x) = \frac{1}{3}(x - 1)(x - 2)(x - 3)$
- (f)  $f(x) = \frac{1}{42}(x - 1)(x - 2)(x - 3)$

307. Find the zeros of  $f(x) = (x^2 - 3)^4(x^5 + x^4 - 12x^3)$  and find the multiplicity of each zero.

- (a)  $x = \sqrt{3}$ , mult. 8
- (b)  $x = \sqrt{3}$ , mult. 4;  $x = -\sqrt{3}$ , mult. 4
- (c)  $x = 0$ , mult. 3;  $x = -4$ , mult. 1;  $x = 3$ , mult. 1

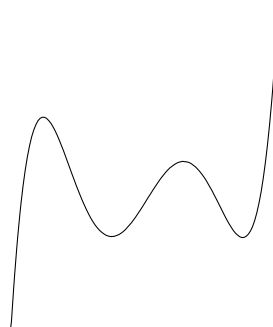
- (d)  $x = 0$ , mult. 3;  $x = -4$ , mult. 1;  $x = 3$ , mult. 1;  
 $x = \sqrt{3}$ , mult. 4;  $x = -\sqrt{3}$ , mult. 4
- (e)  $f(x)$  has no zeros.

308. Which description matches the graph of the polynomial below?



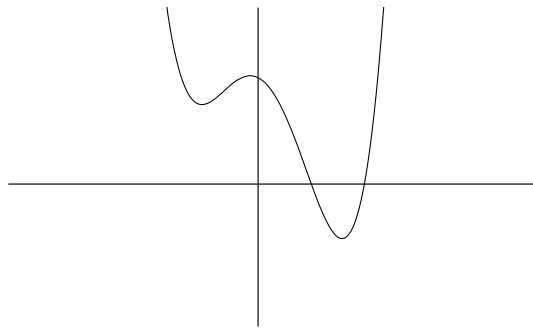
- (a) odd degree, lead coefficient negative
- (b) even degree, lead coefficient negative
- (c) odd degree, lead coefficient positive
- (d) even degree, lead coefficient positive

309. Which description matches the graph of the polynomial below?



- (a) odd degree, lead coefficient negative
- (b) even degree, lead coefficient negative
- (c) odd degree, lead coefficient positive
- (d) even degree, lead coefficient positive

310. Which description matches the graph of the polynomial below?



- (a) odd degree, lead coefficient negative
- (b) even degree, lead coefficient negative
- (c) odd degree, lead coefficient positive
- (d) even degree, lead coefficient positive

311. Use synthetic division to find the remainder of  $(4x^4 - 16x^3 + 7x^2 + 20) \div (x + 2)$ .

- (a) 2
- (b) -16
- (c) -90
- (d) 240

312. What is the remainder of  $(x^4 - 23x^2 - 18x + 40) \div (x + 4)$ ?
- (a) 0
  - (b) -144
  - (c) -320
  - (d) -336
313. You are doing polynomial long-division to find the result of dividing a degree 7 polynomial  $f(x)$  by a degree 3 polynomial  $h(x)$ . What will be the degree of the quotient polynomial  $q(x)$  that you get at the conclusion of the division?
- (a) 3
  - (b) 4
  - (c) 5
  - (d) 6
  - (e) Not enough information to say
314. If  $f(x)$  is a polynomial such that  $f(c) = 0$  for a real number  $c$ , then  $f(x)$  can be written as  $(x - c)g(x)$  for some polynomial  $g(x)$ .
- (a) True, and I am very confident.
  - (b) True, but I am not very confident.

- (c) False, but I am not very confident.
- (d) False, and I am very confident.

315. Find a quadratic polynomial  $f(x)$  with all real coefficients, leading coefficient 1, and zero  $2 + i$ .

- (a)  $f(x) = x^2 - 4x + 5$
- (b)  $f(x) = (x - 2 - i)(x - 2 + i)$
- (c)  $f(x) = x(x - 2 - i)$
- (d) All of the above.
- (e) Two of the above.

316. Determine the possible rational zeros of  $f(x) = 7x^3 + 4x^2 - 45x + 18$ .

- (a)  $\pm 1, \pm \frac{1}{2}, \pm \frac{1}{3}, \pm \frac{1}{6}, \pm \frac{1}{9}, \pm \frac{1}{18}, \pm 7, \pm \frac{7}{2}, \pm \frac{7}{3}, \pm \frac{7}{6},$   
 $\pm \frac{7}{9}, \pm \frac{7}{18}$
- (b)  $\pm 1, \pm 2, \pm 3, \pm 6, \pm 9, \pm 18, \pm \frac{1}{7}, \pm \frac{2}{7}, \pm \frac{3}{7}, \pm \frac{6}{7}, \pm \frac{9}{7},$   
 $\pm \frac{18}{7}$
- (c)  $\pm 1, \pm 7$
- (d)  $\pm 1, \pm 2, \pm 3, \pm 6, \pm 9, \pm 18$

317. Find all zeros of  $f(x) = 5x^3 - 22x^2 + 33x - 10$ . [Hint: Note that  $f(0) = -10$  and  $f(1) = 6$ . Use the Intermediate Value Theorem. (It so happens that the zero the IVT helps locate here is rational.)]

(a)  $x = 0, x = 1, x = \frac{1}{5}$

(b)  $x = 0, x = 1, x = \frac{2}{5}$

(c)  $x = -4, x = 2, x = \frac{2}{5}$

(d)  $x = -2 + i, x = -2 - i, x = \frac{2}{5}$

318. The function  $f(x) = \frac{x^2 + 2x}{x^2 - x - 6}$  has

(a) a hole at  $x = -2$

(b) a vertical asymptote at  $x = 3$

(c) a horizontal asymptote at  $y = 1$

(d) all of the above

319. A polynomial function may have a horizontal asymptote.

(a) True, and I am very confident.

(b) True, but I am not very confident.

- (c) False, but I am not very confident.
- (d) False, and I am very confident.

320. A polynomial function may have a vertical asymptote.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

321. Suppose  $g(x) = a_n x^n + a_{n-1} x^{n-1} + \dots + a_0$  and  $h(x) = b_m x^m + b_{m-1} x^{m-1} + \dots + b_0$  are polynomials, and define the rational function  $f(x) = g(x)/h(x)$ . Then  $f(x)$  has a vertical asymptote at every number  $x$  where  $h(x) = 0$ .

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

322. Suppose  $g(x) = a_n x^n + a_{n-1} x^{n-1} + \dots + a_0$  and  $h(x) = b_m x^m + b_{m-1} x^{m-1} + \dots + b_0$ , and define the rational function  $f(x) = g(x)/h(x)$ . Let  $c$  be a real number such that  $g(c) = 0$  and  $h(c) = 0$ . Then  $f(x)$  has a hole at  $x = c$ .



- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

323. Suppose  $g(x) = a_n x^n + a_{n-1} x^{n-1} + \dots + a_0$  and  $h(x) = b_m x^m + b_{m-1} x^{m-1} + \dots + b_0$ , and define the rational function  $f(x) = g(x)/h(x)$ . Under what conditions could  $f(x)$  have a vertical asymptote at  $x = c$ ?

- (a)  $g(c) = 0$  and  $h(c) \neq 0$ .
- (b)  $g(c) \neq 0$  and  $h(c) = 0$ .
- (c)  $g(c) = 0$  and  $h(c) = 0$ .
- (d) (a) and (b).
- (e) (a) and (c).
- (f) (b) and (c).
- (g) (a), (b), and (c).

324. Identify all of the functions below which are positive only on the domain described by

$$x < -2 \text{ and } x > 4.$$

- (a)  $f(x) = x^2 - 2x - 8$ .
- (b)  $f(x) = x^2 - 6x + 8$ .

- (c)  $f(x) = (x^2 - 6x + 8)/(x^2 - 4)$ .
- (d) (a) and (b).
- (e) (a) and (c).
- (f) (b) and (c).
- (g) (a), (b), and (c).

325. For what values of  $x$  is

$$2x^3 - x^2 - 15x > 0?$$

- (a)  $x < -5/2$  and  $0 < x < 3$
  - (b)  $-5/2 < x < 0$  and  $x > 3$
  - (c)  $-5/2 < x < 0$  and  $0 < x < 3$
  - (d)  $x < -5/2$  and  $x > 3$
326. Suppose  $g(x) = a_n x^n + a_{n-1} x^{n-1} + \dots + a_0$  and  $h(x) = b_m x^m + b_{m-1} x^{m-1} + \dots + b_0$ , and define the rational function  $f(x) = g(x)/h(x)$ . Under what condition does  $f(x)$  have a horizontal asymptote at  $y = 0$ ?
- (a)  $m > n$ .
  - (b)  $m \geq n$ .
  - (c)  $m = n$ .
  - (d)  $m \leq n$ .
  - (e)  $m < n$ .

(f) Never.

327. Suppose  $g(x) = a_n x^n + a_{n-1} x^{n-1} + \dots + a_0$  and  $h(x) = b_m x^m + b_{m-1} x^{m-1} + \dots + b_0$ , and define the rational function  $f(x) = g(x)/h(x)$ . Under what condition does  $f(x)$  have a horizontal asymptote at  $y = a_n/b_m$ ?

(a)  $m > n$ .

(b)  $m \geq n$ .

(c)  $m = n$ .

(d)  $m \leq n$ .

(e)  $m < n$ .

(f) Never.

328. Suppose  $g(x) = a_n x^n + a_{n-1} x^{n-1} + \dots + a_0$  and  $h(x) = b_m x^m + b_{m-1} x^{m-1} + \dots + b_0$ , and define the rational function  $f(x) = g(x)/h(x)$ . Under what condition does  $f(x)$  have a horizontal asymptote at  $y = b_m/a_n$ ?

(a)  $m > n$ .

(b)  $m \geq n$ .

(c)  $m = n$ .

(d)  $m \leq n$ .

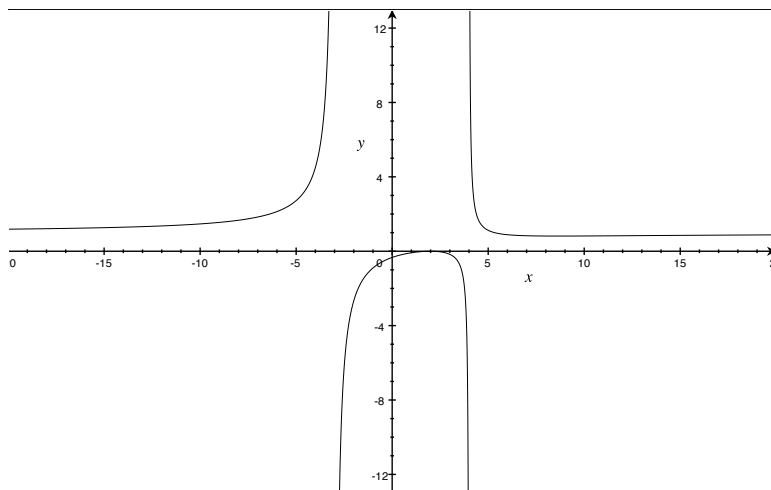
(e)  $m < n$ .

(f) None of the above.

329. Suppose  $g(x) = a_n x^n + a_{n-1} x^{n-1} + \dots + a_0$  and  $h(x) = b_m x^m + b_{m-1} x^{m-1} + \dots + b_0$ , and define the rational function  $f(x) = g(x)/h(x)$ . Under what condition does  $f(x)$  have no horizontal asymptotes?

- (a)  $m > n$ .
- (b)  $m \geq n$ .
- (c)  $m = n$ .
- (d)  $m \leq n$ .
- (e)  $m < n$ .
- (f) None of the above.

330. Based upon the graph of the rational function below, what can you conclude about the degrees of the polynomials in the numerator and the denominator?



- (a) The degree of the numerator is strictly greater than the degree of the denominator.

- (b) The degree of the denominator is strictly greater than the degree of the numerator.
- (c) The degrees of the numerator and denominator are the same.
- (d) Not enough information to draw a conclusion.

### Nonlinear Systems of Equations

331. Find the solutions of the following system of equations.

$$\begin{aligned}4y^2 - x &= 3 \\ y - x &= -2\end{aligned}$$

- (a) The system has no solution.
- (b)  $(-3, -1)$  and  $\left(-\frac{3}{4}, \frac{5}{4}\right)$
- (c)  $\left(\frac{15 \pm \sqrt{13}}{8}, \frac{-1 \pm \sqrt{13}}{8}\right)$
- (d)  $(1, -1)$  and  $\left(\frac{13}{4}, \frac{5}{4}\right)$

## Sequences and Series

332. If the general term for a sequence is  $a_n = 4 + 6n$  then

(a)  $a_3 = 10$

(b)  $a_3 = 16$

(c)  $a_3 = 22$

(d)  $a_3 = 28$

333. Given the sequence  $0, 2, 4, 6, 8, \dots$ , what is the  $a_n$ , noting that  $a_0 = 0$ ?

(a)  $a_n = n + 2$

(b)  $a_n = 2^n$

(c)  $a_n = n^2$

(d)  $a_n = 2n$

334. **True or False** The sequences  $0, 2, 4, 6, 8, \dots$  and  $2, 4, 6, 8, \dots$  have the same  $n^{\text{th}}$  term.

(a) True, and I am very confident

(b) True, but I am not very confident

(c) False, but I am not very confident

(d) False, and I am very confident

335. Given the sequence 15, 30, 60, 120, 240, ..., what is the  $a_n$ , noting that  $a_0 = 15$ ?

(a)  $a_n = n + 15$

(b)  $a_n = 2^n$

(c)  $a_n = 2^n(15)$

(d)  $a_n = n^2$

(e)  $a_n = 2n$

(f) None of the above

336. Given the sequence 10, 7, 4, 1, -2, ..., what is the  $a_n$ , noting that  $a_0 = 10$ ?

(a)  $a_n = n - 3$

(b)  $a_n = 3 - n$

(c)  $a_n = 10 - n$

(d)  $a_n = 10 - 3n$

(e) None of the above

337. Which of the following represents the general term for the sequence 7, 5, 7, 5, 7, ...?

(a)  $a_n = 6 - (-1)^n$

(b)  $a_n = 6 + (-1)^n$

(c)  $a_n = 7 - 2n$

(d)  $a_n = 5 + (-2)^n$

338. What will we get if we add up the infinite series of numbers:  $16 + 8 + 4 + 2 + 1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \dots$ ?

- (a) This infinite sum will reach a number less than 32.
- (b) This infinite sum is equal to 32.
- (c) This infinite sum will reach a number greater than 32.
- (d) Because we're adding up an infinite number of numbers which are all greater than zero, the sum diverges to infinity.

339. What will we get if we add up the infinite series of numbers:  $12 + 4 + \frac{4}{3} + \frac{4}{9} + \frac{4}{27} + \dots$ ?

- (a) This infinite sum will converge to a number less than 18.
- (b) This infinite sum is equal to 18.
- (c) This infinite sum will converge a number between 18 and 19.
- (d) This infinite sum will converge a number greater than 19.
- (e) This infinite sum diverges to infinity.



340. What will we get if we add up the infinite series of numbers:  $1 - \frac{1}{2} + \frac{1}{4} - \frac{1}{8} + \frac{1}{16} + \dots$ ?

- (a) This infinite sum will converge to  $1/2$ .
- (b) This infinite sum will converge to  $2/3$ .
- (c) This infinite sum will converge to  $2$ .
- (d) This is not a geometric series.

341. What will we get if we add up the first 10 terms in the series:  $1 - \frac{1}{2} + \frac{1}{4} - \frac{1}{8} + \frac{1}{16} + \dots$ ?

- (a) 0.663
- (b) 0.664
- (c) 0.666
- (d) 0.667
- (e) 0.668

342. What is  $\sum_{j=1}^5 4j$ ?

- (a) 15
- (b) 20
- (c) 40
- (d) 60

343. Which of the following series is not geometric?

- (a)  $\sum_{n=0}^{\infty} \frac{15}{3^n}$
- (b)  $\sum_{n=5}^{\infty} 12^{2n+4}$
- (c)  $\sum_{n=1}^{\infty} 9^{-n}$
- (d)  $\sum_{n=1}^{\infty} 4^{1/n}$
- (e)  $\sum_{n=0}^{\infty} \frac{5 \cdot 3^n}{7^{3n}}$
- (f) More than one of these is not geometric.

344. Which of the following geometric series converge?

- (a)  $\sum_{n=0}^{\infty} \frac{8}{(-2)^n}$
- (b)  $\sum_{n=5}^{\infty} 6^{3n+2}$
- (c)  $\sum_{n=1}^{\infty} (-4)^{-n}$
- (d)  $\sum_{n=0}^{\infty} \frac{6 \cdot 2^n}{6^{3n}}$
- (e) Exactly two of these converge.
- (f) Exactly three of these converge.

345. True or False: The sequence whose  $n$ th term  $a_n$  is given by  $a_n = 3n - 1$  is arithmetic.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

346. True or False: The sequence whose  $n$ th term  $a_n$  is given by  $a_n = n^2 + 1$  is arithmetic.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

347. Write the formula for the  $n$ th term of the sequence 5, 8, 11, 14, ..., where  $n \geq 1$ .

- (a)  $a_n = 5n + 3$
- (b)  $a_n = 5 + 3n$
- (c)  $a_n = 3n + 2$
- (d)  $a_n = 2n + 3$

348. Suppose that you want to sign up for a home security system. Company A offers the following deal: Your initial payment for the cost of the equipment, installation and the first month of monitoring is \$600. Each month thereafter you pay \$30 to have your system monitored. Which of the following is a formula for the total amount you have paid by the  $n$ th payment,  $n \geq 1$ ?

- (a)  $a_n = 30n + 600$

- (b)  $a_n = 30n + 570$
- (c)  $a_n = 30n + 599$
- (d)  $a_n = 30n$

349. Suppose that you compare the offer from the previous problem with another company. Company B offers the equipment, installation and the first month of monitoring for only \$200, but each month thereafter you pay \$40 for the monitoring fee. Which of the following is a formula for the total amount you have paid by the  $n$ th payment,  $n \geq 1$ ?

- (a)  $a_n = 40n + 160$
- (b)  $a_n = 40n + 200$
- (c)  $a_n = 40n + 199$
- (d)  $a_n = 40n$

350. At first, Company B's offer seems attractive with its low initial payment, but then you realize that there may be more to it than that since their monitoring fee is higher. Will Company B's offer eventually become more expensive than Company A's? If so, when?

- (a) Company B will always be cheaper.
- (b) At the 41st payment, Company B's offer will be more expensive than Company A's offer.

- (c) At the 42nd payment, Company B's offer will be more expensive than Company A's offer.
- (d) Company B will always be more expensive.

351. Find the 20th partial sum of the sequence  $a_n = 3n - 1$ , where  $n \geq 1$ .

- (a) 610
- (b) 59
- (c) 20
- (d) 1220

352. True or False: The sequence whose  $n$ th term is  $a_n = \left(\frac{3}{4}\right)^n$  is geometric.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.
- (d) False, and I am very confident.

353. True or False: The sequence whose  $n$ th term is  $a_n = \left(\frac{3}{4}\right)^n + 1$  is geometric.

- (a) True, and I am very confident.
- (b) True, but I am not very confident.
- (c) False, but I am not very confident.

(d) False, and I am very confident.

354. Represent the annual salary of someone with a starting salary of \$50,000 that increases by 3% each year with a geometric sequence  $a_n$ , where  $n \geq 1$ .

(a)  $a_n = 50,000(1.03)^{n-1}$

(b)  $a_n = 50,000(.03)^{n-1}$

(c)  $a_n = 50,000(1.03)^n$

(d)  $a_n = 50,000(.03)^n$

### **Introduction to Continuity**

355. A drippy faucet adds one milliliter to the volume of water in a tub at precisely one-second intervals. Let  $f$  be the function that represents the volume of water in the tub at time  $t$ . Which of the following statements is correct?

(a)  $f$  is a continuous function at every time  $t$

(b)  $f$  is continuous for all  $t$  other than the precise instants when the water drips into the tub.

(c)  $f$  is not continuous at any time  $t$ .

(d) There is not enough information to know where  $f$  is continuous.

356. A drippy faucet adds one milliliter to the volume of water in a tub at precisely one second intervals. Let  $g$  be the function that represents the volume of water in the tub as a function of the depth of the water,  $x$ , in the tub. Which of the following statements is correct?

- (a)  $g$  is a continuous function at every depth  $x$ .
- (b) there are some values of  $x$  at which  $g$  is not continuous.
- (c)  $g$  is not continuous at any depth,  $x$ .
- (d) not enough information is given to know where  $g$  is continuous.

357. You know the following statement is true:

If  $f(x)$  is a polynomial, then  $f(x)$  is continuous.

Which of the following is also true?

- (a) If  $f(x)$  is not continuous, then it is not a polynomial.
- (b) If  $f(x)$  is continuous, then it is a polynomial.
- (c) If  $f(x)$  is not a polynomial, then it is not continuous.

358. **True or False:** You were once exactly 3 feet tall.

- (a) True, and I am very confident
- (b) True, but I am not very confident
- (c) False, but I am not very confident
- (d) False, and I am very confident

359. **True or False:** At some time since you were born your weight in pounds equaled your height in inches.

- (a) True, and I am very confident
- (b) True, but I am not very confident
- (c) False, but I am not very confident
- (d) False, and I am very confident

360. **True or False:** Along the Equator, there are two diametrically opposite sites that have exactly the same temperature at the same time.

- (a) True, and I am very confident
- (b) True, but I am not very confident
- (c) False, but I am not very confident
- (d) False, and I am very confident

361. Suppose that during half-time at a basketball game the score of the home team was 36 points. **True or False:** There had to be at least one moment in the first half when the home team had exactly 25 points.



- (a) True, and I am very confident
- (b) True, but I am not very confident
- (c) False, but I am not very confident
- (d) False, and I am very confident

362. At what point on the interval  $[-7, 2]$  does the function  $f(x) = \frac{3e^x}{4e^x - 4}$  have a discontinuity?

- (a)  $x = 0$
- (b)  $x = 1$
- (c)  $x = 3$
- (d)  $x = 4$
- (e) There is no discontinuity on this interval.

363. For what value of the constant  $c$  is the function  $f(x)$  continuous, if

$$f(x) = \begin{cases} cx + 9 & \text{if } x \in (-\infty, 5] \\ cx^2 - 9 & \text{if } x \in (5, \infty) \end{cases}$$

- (a)  $c = -\frac{9}{5}$
- (b)  $c = \frac{9}{10}$
- (c)  $c = \frac{9}{25}$
- (d) This is not possible.

## Limits

364. Consider the function:

$$f(x) = \begin{cases} 6 & \text{if } x > 9 \\ 2 & \text{if } x = 9 \\ -x + 14 & \text{if } -7 \leq x < 9 \\ 21 & \text{if } x < -7 \end{cases}$$

- (a)  $\lim_{x \rightarrow 9^-} f(x) = 2$
- (b)  $\lim_{x \rightarrow 9^-} f(x) = 5$
- (c)  $\lim_{x \rightarrow 9^-} f(x) = 6$
- (d)  $\lim_{x \rightarrow 9^-} f(x) = 14$
- (e)  $\lim_{x \rightarrow 9^-} f(x) = 21$

365. **True or False:** As  $x$  increases to 100,  $f(x) = 1/x$  gets closer and closer to 0, so the limit as  $x$  goes to 100 of  $f(x)$  is 0. Be prepared to justify your answer.

- (a) True, and I am very confident
- (b) True, but I am not very confident
- (c) False, but I am not very confident
- (d) False, and I am very confident

366. **True or False:**  $\lim_{x \rightarrow a} f(x) = L$  means that if  $x_1$  is closer to  $a$  than  $x_2$  is, then  $f(x_1)$  will be closer to  $L$  than  $f(x_2)$  is. Be prepared to justify your answer with an argument or counterexample.

- (a) True, and I am very confident
- (b) True, but I am not very confident
- (c) False, but I am not very confident
- (d) False, and I am very confident

367. The reason that  $\lim_{x \rightarrow 0} \sin\left(\frac{1}{x}\right)$  does not exist is:

- (a) because no matter how close  $x$  gets to 0, there are  $x$ 's near 0 for which  $\sin\left(\frac{1}{x}\right) = 1$ , and some for which  $\sin\left(\frac{1}{x}\right) = -1$ .
- (b) because the function values oscillate around 0.
- (c) because  $\frac{1}{0}$  is undefined.
- (d) all of the above

368.  $\lim_{x \rightarrow 0} x^2 \sin\left(\frac{1}{x}\right)$

- (a) does not exist because no matter how close  $x$  gets to 0, there are  $x$ 's near 0 for which  $\sin\left(\frac{1}{x}\right) = 1$ , and some for which  $\sin\left(\frac{1}{x}\right) = -1$ .
- (b) does not exist because the function values oscillate around 0.

- (c) does not exist because  $\frac{1}{0}$  is undefined.
- (d) equals 0
- (e) equals 1

369. You're trying to guess  $\lim_{x \rightarrow 0} f(x)$ . You plug in  $x = 0.1, 0.01, 0.001, \dots$  and get  $f(x) = 0$  for all of these values. In fact you're told that for all  $n = 1, 2, \dots$ ,  $f\left(\frac{1}{10^n}\right) = 0$ . **True or False:** Since the sequence  $f(0.1), f(0.01), f(0.001), \dots$  goes to 0, we know that  $\lim_{x \rightarrow 0} = 0$ .

- (a) True, and I am very confident
- (b) True, but I am not very confident
- (c) False, but I am not very confident
- (d) False, and I am very confident

370. If  $\lim_{x \rightarrow a} f(x) = 0$  and  $\lim_{x \rightarrow a} g(x) = 0$ , then  $\lim_{x \rightarrow a} \frac{f(x)}{g(x)}$

- (a) does not exist.
- (b) must exist.
- (c) can't be determined. Not enough information is given.

371. **True or False:** Consider a function  $f(x)$  with the property that  $\lim_{x \rightarrow a} f(x) = 0$ . Now consider another

function  $g(x)$  also defined near  $a$ . Then  $\lim_{x \rightarrow a} [f(x)g(x)] = 0$ .

- (a) True, and I am very confident
- (b) True, but I am not very confident
- (c) False, but I am not very confident
- (d) False, and I am very confident

372. If a function  $f$  is not defined at  $x = a$ ,

- (a)  $\lim_{x \rightarrow a}$  cannot exist.
- (b)  $\lim_{x \rightarrow a}$  could be 0.
- (c)  $\lim_{x \rightarrow a}$  must approach  $\infty$ .
- (d) none of the above

373. Possible criteria for continuity at a point: *If the limit of the function exists at a point, the function is continuous at that point.* Which of the following examples fits the above criteria but is not continuous at  $x = 0$ ?

- (a)  $f(x) = x$
- (b)  $f(x) = x^2/x$
- (c)  $f(x) = |x|/x$
- (d) None of these show a problem with this criteria.

374. Let  $f(x) = 5x^4 + 18x^3 - 2x + 3$ . As  $x$  gets really big, what becomes the most important (dominant) term in this function?

- (a)  $5x^4$
- (b)  $18x^3$
- (c)  $-2x$
- (d) 3

375. What is

$$\lim_{x \rightarrow \infty} \frac{6x^2 - 5x}{2x^2 + 3}?$$

- (a) 0
- (b) 2
- (c) 3
- (d) 6
- (e) infinity

376. What is

$$\lim_{x \rightarrow \infty} \frac{3x^2 + 5x^3 - 2x + 4}{4x^3 - 5x + 6}?$$

- (a) 0
- (b)  $2/3$
- (c)  $3/4$

- (d)  $5/4$
- (e) infinity

377. What is

$$\lim_{x \rightarrow \infty} \frac{100x^5 - 15x}{x^6 + 3}?$$

- (a) 0
- (b)  $5/6$
- (c) 85
- (d) 100
- (e) infinity

378. What is

$$\lim_{x \rightarrow \infty} \frac{x^2 + 2x + 3}{25x - 7}?$$

- (a) 0
- (b)  $1/25$
- (c)  $3/7$
- (d) 2
- (e) infinity

379. Let  $f(x) = \frac{x^2 - 4x + 3}{x^2 - 1}$ . Evaluate  $\lim_{x \rightarrow -1^+} f(x)$ .

- (a)  $-1$

$$(b) \infty$$

$$(c) -\infty$$