

**Algebra II & IB Math SL problem bank**

Note source to differentiate course application

**Topic="Writing Linear Equations"**

**Source="cjh" Difficulty=2**

1. What is the equation of the line with slope 2 passing through the point  $(1, 2)$ ?  
Difficulty=3
2. Find the equation of the line with slope  $2e^2$  passing through the point  $(1, e^2)$ . State your answer in the form  $y = mx + b$ .

**Topic="Inverse of Functions"**

**Source="Regents" Difficulty=3**

3. What is the inverse of  $f(x) = -6(x - 2)$ ?  
Difficulty=6
4. What is the inverse of  $f(x) = \frac{x + 1}{x - 2}$ ?
5. Given  $f^{-1}(x) = -\frac{3}{4}x + 2$ , what equation represents  $f(x)$ ?

**Topic="Solving Quadratics"**

**Source="IB" Difficulty=4**

factor and state the solutions

Difficulty=5

6. What are the roots of the equation  $x^2 + 2x + 5 = 0$ ?
7. What are the exact solutions to the equation  $4x^2 + 98 = 0$ ?
8. What are the zeros of  $P(m) = (m^2 - 4)(m^2 + 1)$ ?
9. The function  $f(x) = \frac{x - 3}{x^2 + 2x - 8}$  is undefined for what value or values of  $x$ ?  
Difficulty=6
10. What are the solutions to  $x + 3 - \frac{4}{x - 1} = 5$ ?
11. Solve for all values of  $p$ :  $\frac{3p}{p - 5} - \frac{2}{p + 3} = \frac{p}{p + 3}$
12. Solve for  $x$ :  $\frac{1}{x} - \frac{1}{3} = -\frac{1}{3x}$

**Topic="Vertex Form of a Quadratic"**

**Source="IB" Difficulty=3**

13. Given the function  $f(x) = (x - 1)(x + 3)$ . State the  $x$ -intercepts of the graph of  $f$ . Find the coordinates of the vertex of the graph of  $f$ .

**Topic="Using the Discriminant"**

**Source="IB" Difficulty=5**

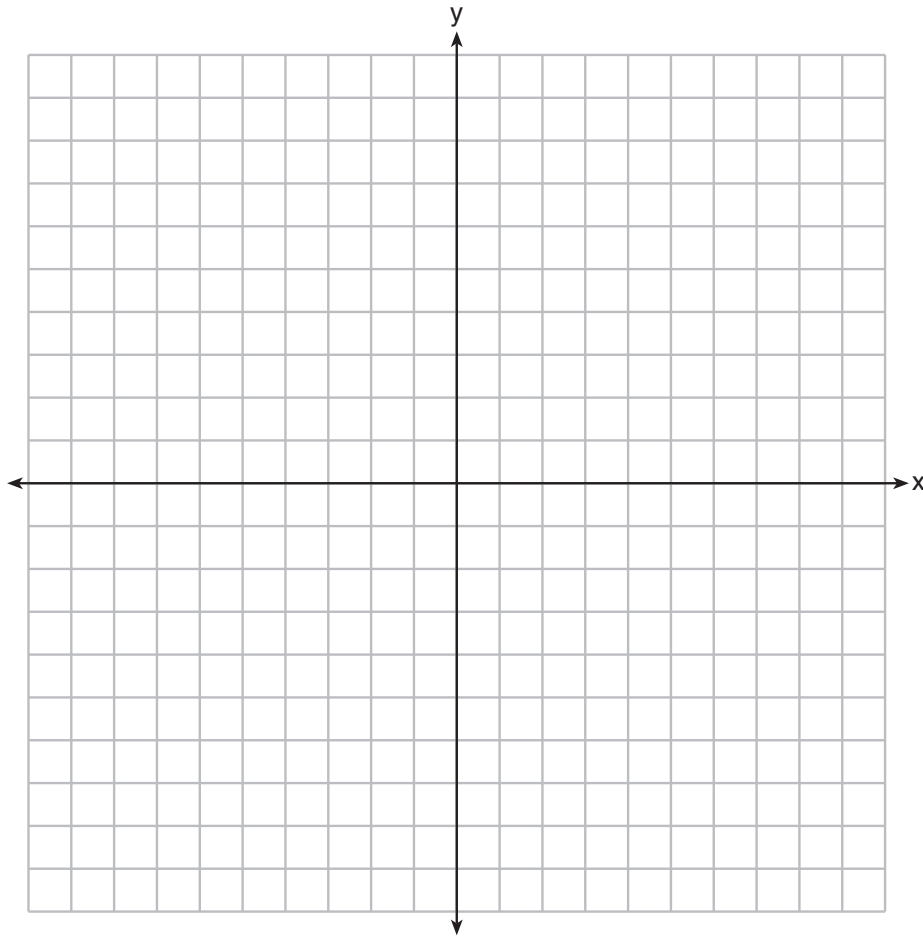
14. The equation  $x^2 + (k + 2)x + 2k = 0$  has two distinct real roots. Find the possible values of  $k$ .

**Topic="Graphing Polynomial Functions"**

**Source="Regents" Difficulty=5 Calc=2**

15. What are the zeros for  $f(x) = x^4 - 4x^3 - 9x^2 + 36x$ ?
16. What are the zeros for  $f(x) = x^4 + x^3 - 19x^2 + 11x + 30$ ?
17. What are the zeros for  $f(x) = x^4 + 5x^3 - 8x^2 - 12x$ ?
18. The zeros for  $f(x) = x^4 - 4x^3 - 9x^2 + 36x$  are
- (a)  $\{0, \pm 3, 4\}$
  - (b)  $\{0, 3, 4\}$
  - (c)  $\{0, \pm 3, -4\}$
  - (d)  $\{0, 3, 4\}$
19. What are the values, to the *nearest tenth*, of the solutions of  $p(x) = q(x)$  if  $p(x) = x^3 + 3x^2 - 3x - 1$  and  $q(x) = 3x + 8$ ?
20. Given the function  $f(x) = x^3 - 2x^2 - 5x + 6$ .
- (a) Write down the  $y$ -intercept.
  - (b) Find the  $x$ -intercepts, rounding to the nearest hundredth.
  - (c) Describe the end behavior of the function. (use language like "As  $x$  goes to positive infinity,  $y$  goes to...")

- (d) Graph the function on the grid below, carefully passing through the correct intercepts.

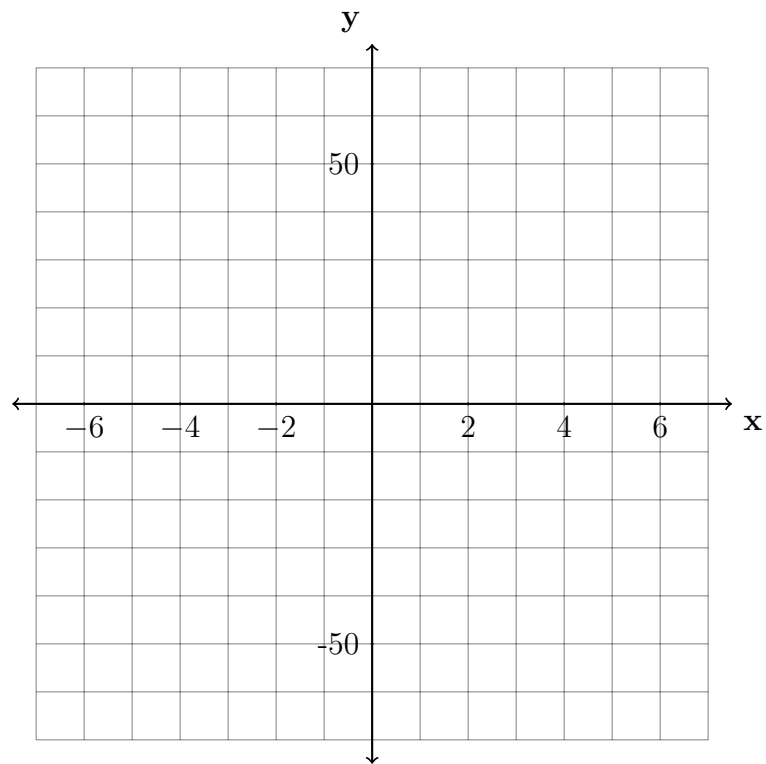


21. Given the function  $f(x) = x^3 - 5x^2 - 4x + 20$ .

(a) Find the zeros of  $f$ .

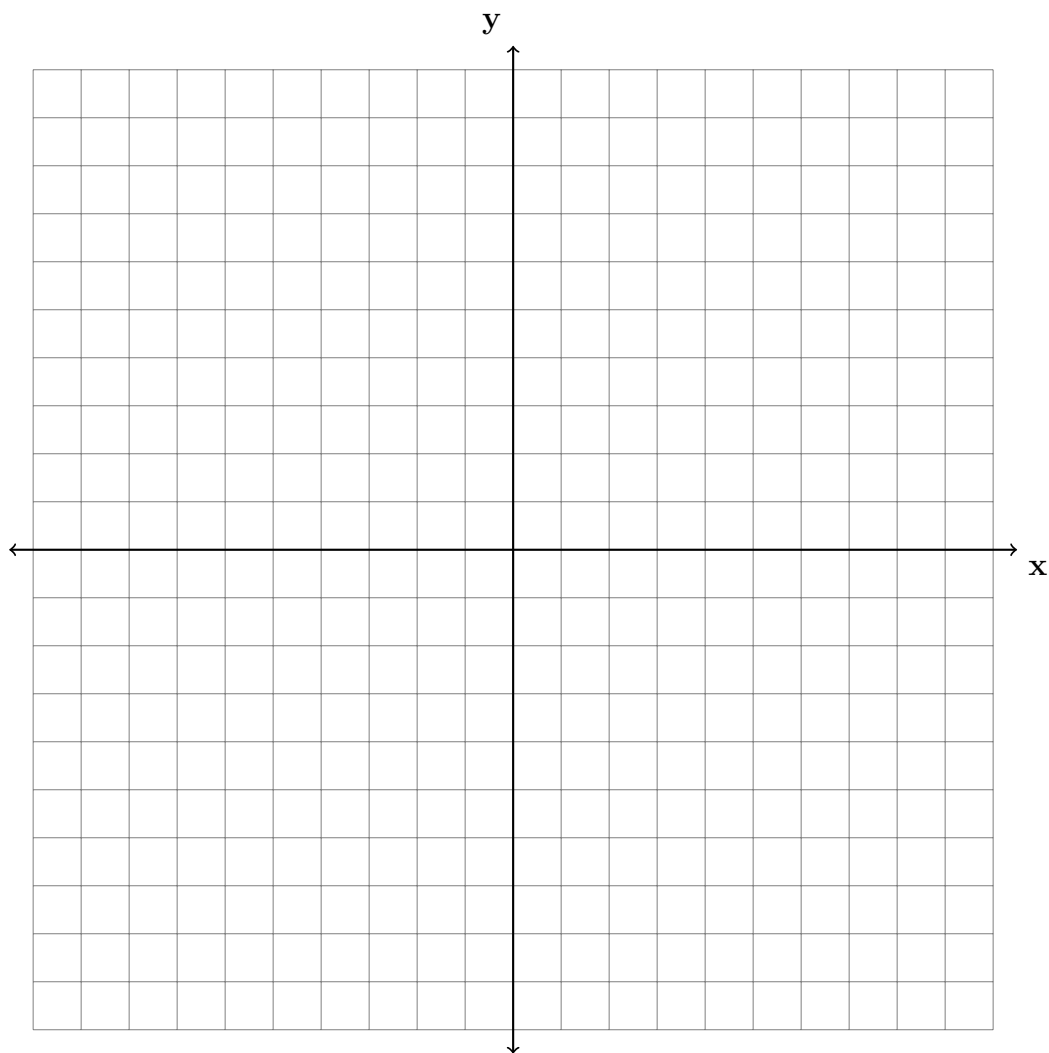
(b) Write down  $f(x)$  in factored form.

(c) Graph the function on the grid below, carefully passing through the correct  $x$ - and  $y$ -intercepts.



22. Find algebraically the zeros for  $p(x) = x^3 + x^2 - 4x - 4$ .

On the set of axes below, graph  $y = p(x)$ .



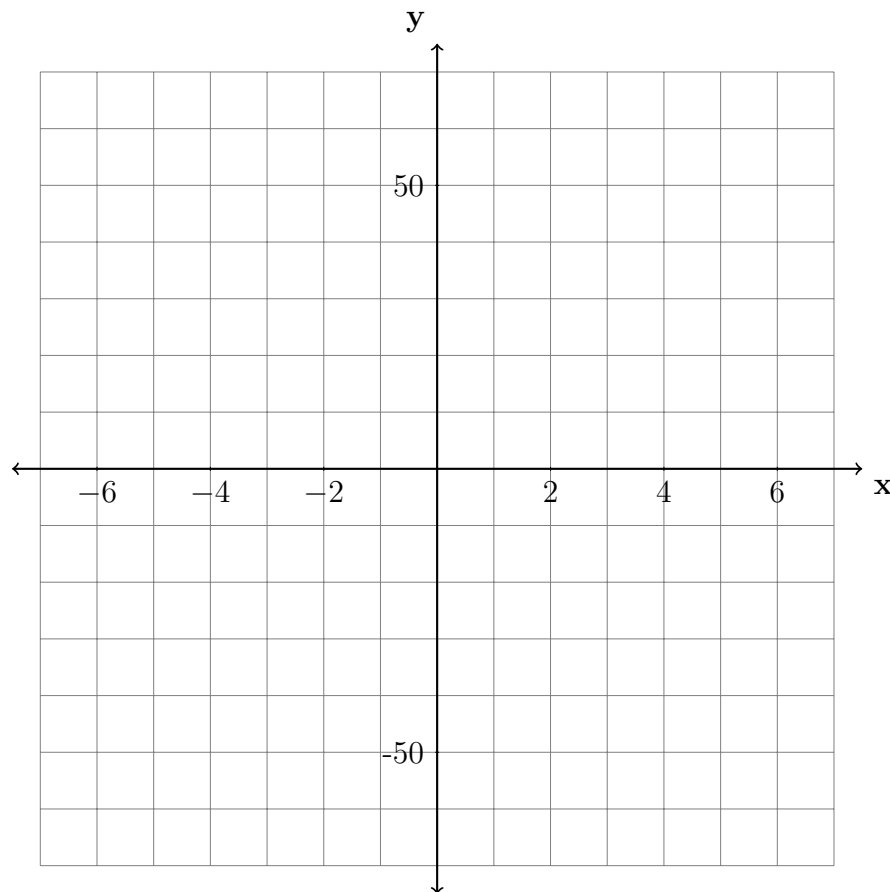
23. Given the function  $f(x) = x^3 - 4x^2 - 4x - 7$ .

x	f(x)
-4	
-3	
-2	
-1	
0	
1	
2	
3	
4	
5	

(a) Using the calculator table function, complete the  $y$  values.

(b) Graph the function on the grid below.

(c) Using the calculator graph-solve function, find the roots of the function, rounded to the *nearest hundredth*.



24. The function below models the average price of gas in a small town since January 1st.

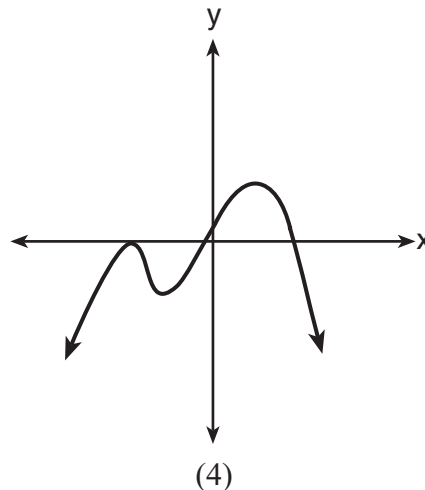
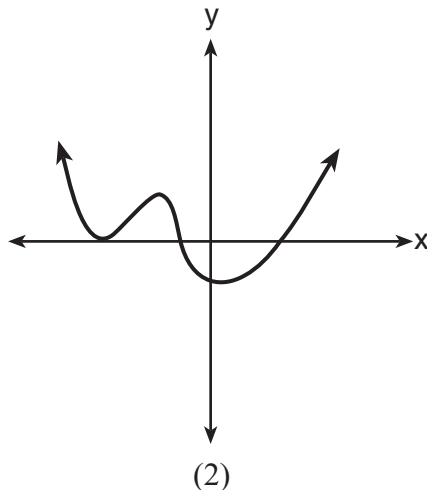
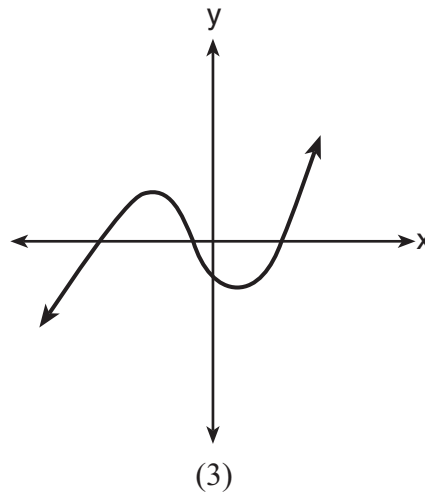
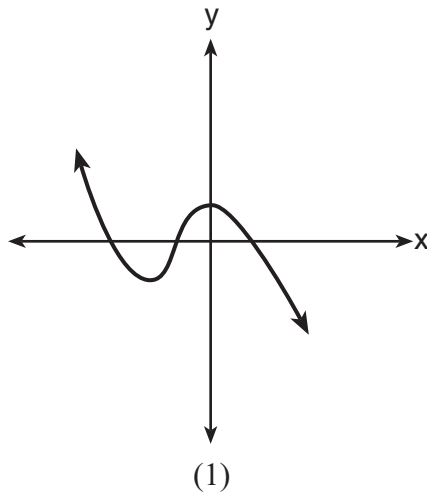
$$G(t) = -0.0049t^4 + 0.0923t^3 - 0.56t^2 + 1.166t + 3.23, \text{ where } 0 \leq t \leq 10.$$

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If  $G(t)$  is the average price of gas in dollars and  $t$  represents the number of months since January 1st, the absolute maximum  $G(t)$  reaches over the given domain is about what value, to the nearest cent?

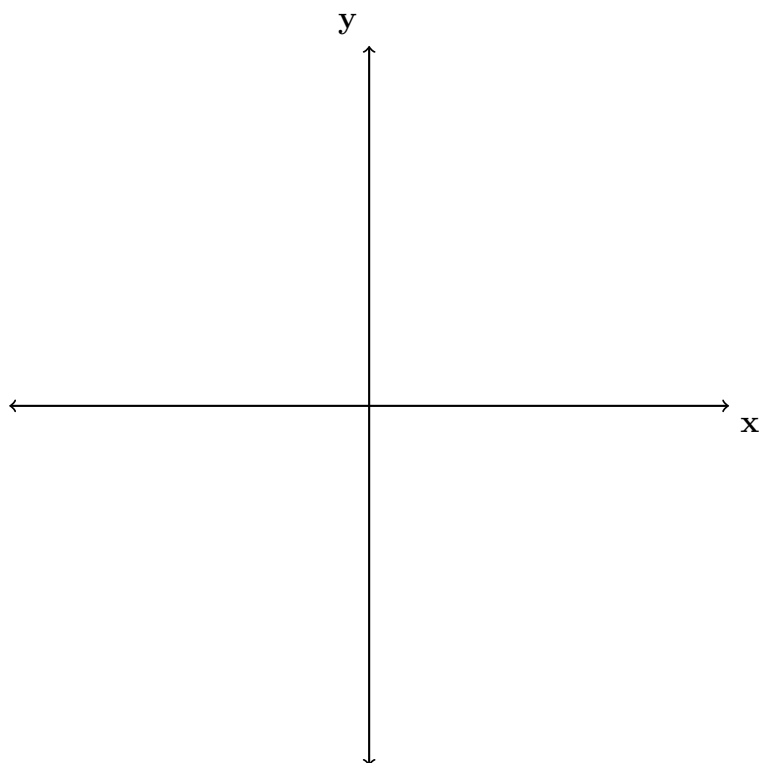
25. Which graph has the following characteristics?

- three real zeros
- as  $x \rightarrow -\infty$ ,  $f(x) \rightarrow -\infty$
- as  $x \rightarrow \infty$ ,  $f(x) \rightarrow \infty$



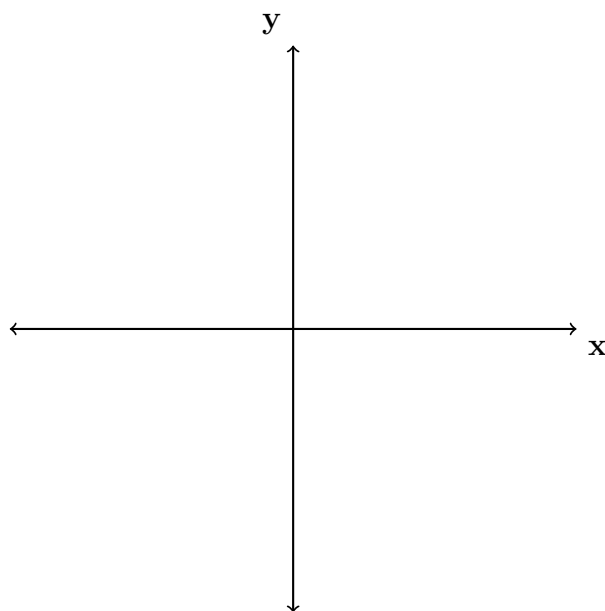
26. Sketch a graph with the following characteristics:

- three real zeros
- as  $x \rightarrow +\infty$ ,  $f(x) \rightarrow -\infty$
- as  $x \rightarrow -\infty$ ,  $f(x) \rightarrow +\infty$



27. Sketch a graph with the following characteristics:

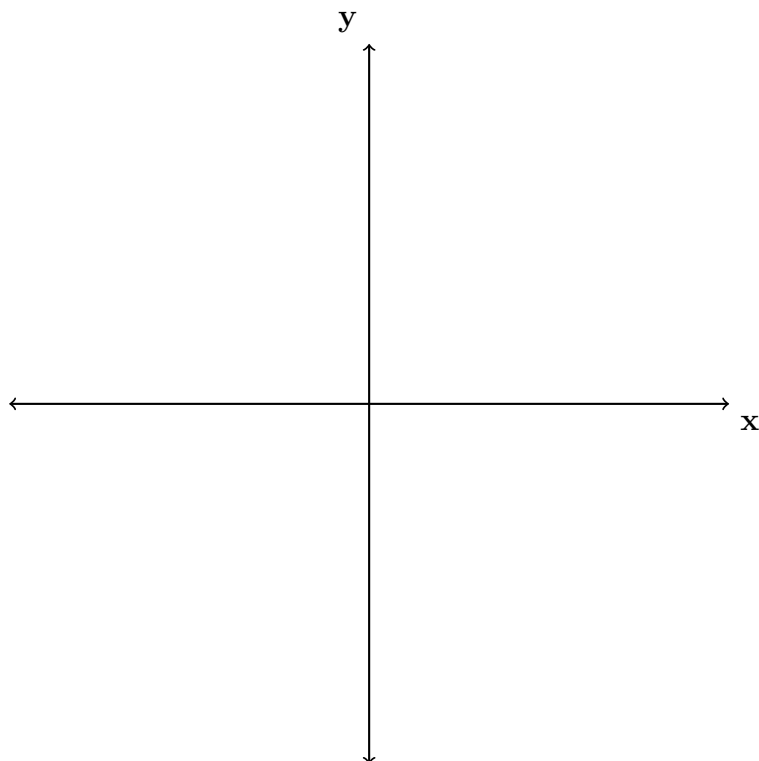
- polynomial function of order four
- a positive leading coefficient
- four real zeros



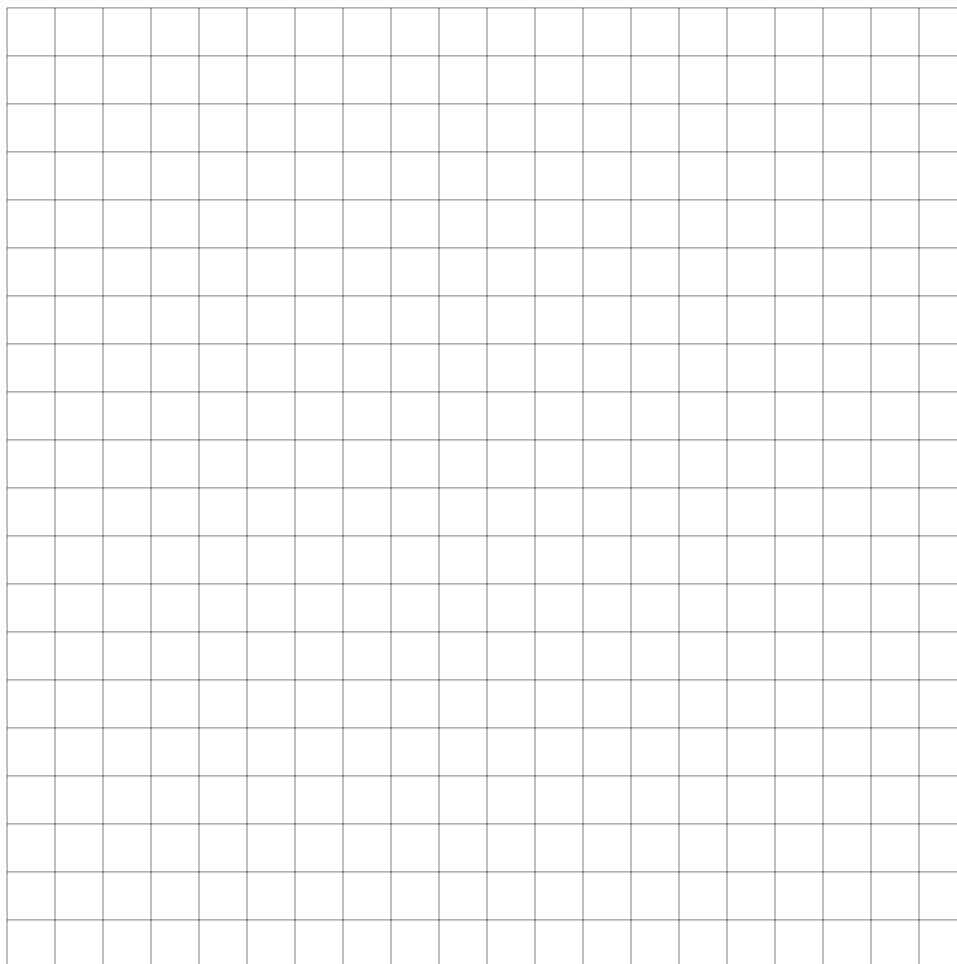
28. The graph of the function  $p(x)$  is sketched below.



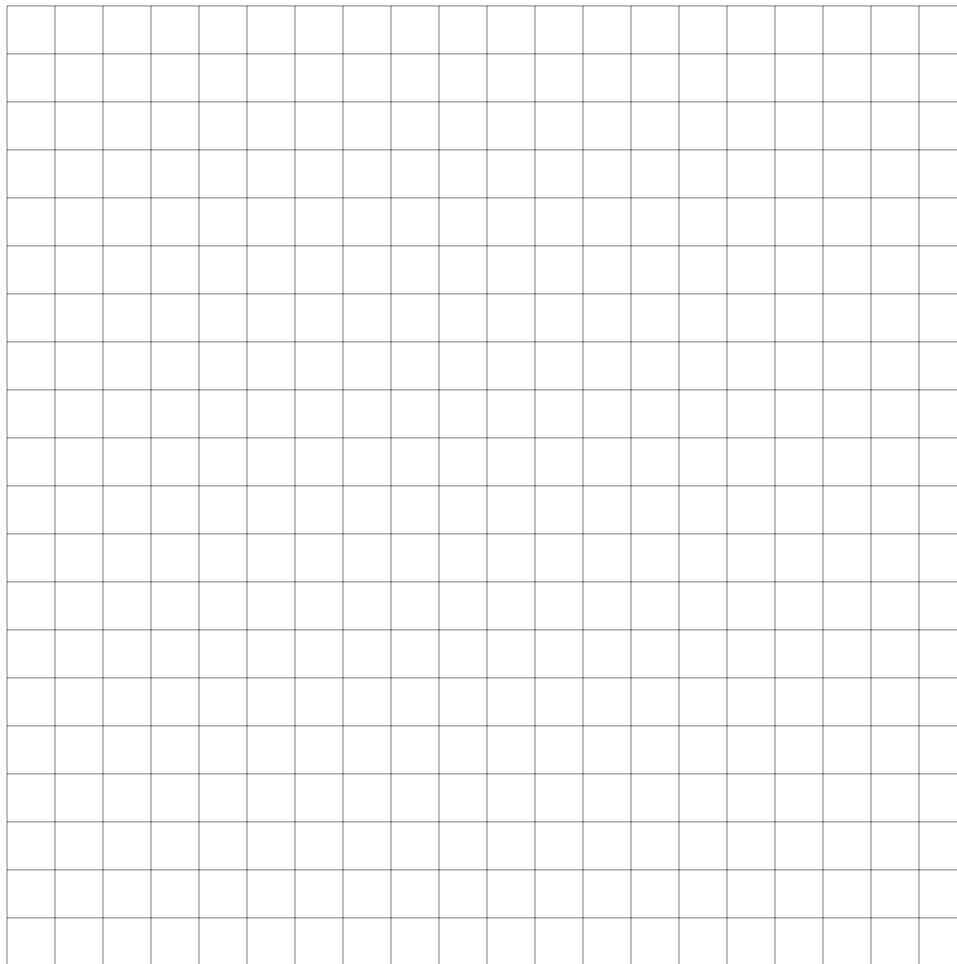
29. On the axes below, sketch a possible function  $p(x) = (x - a)(x - b)(x + c)$ , where  $a$ ,  $b$ , and  $c$  are positive,  $a > b$ , and  $p(x)$  has a positive  $y$ -intercept of  $d$ . Label all intercepts.



30. The zeros of a quartic polynomial function  $h$  are  $-1, \pm 2$ , and  $3$ . Sketch a graph of  $y = h(x)$  on the grid below.



31. The zeros of a cubic polynomial function  $f$  are  $-1, 2$ , and  $3$ . Sketch a graph of  $y = f(x)$  on the grid below.

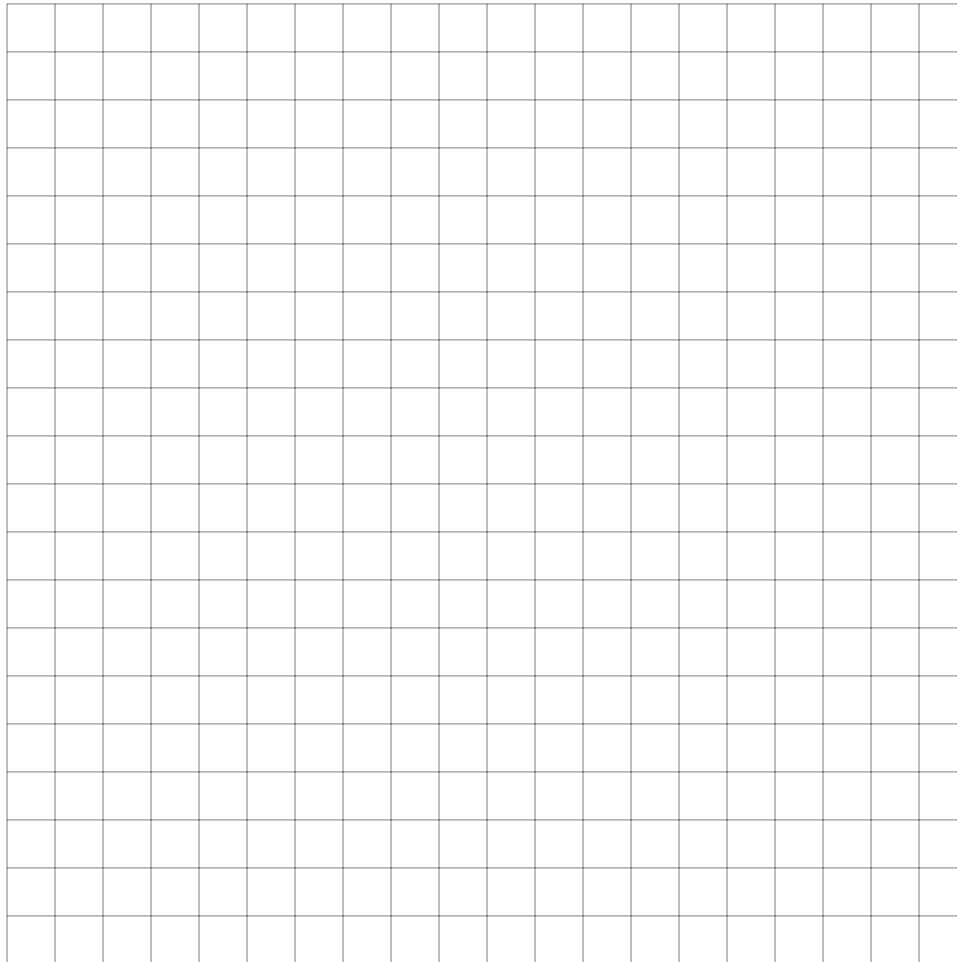


32. On the grid below, sketch a cubic polynomial whose zeros are 1, 3, and  $-2$ .

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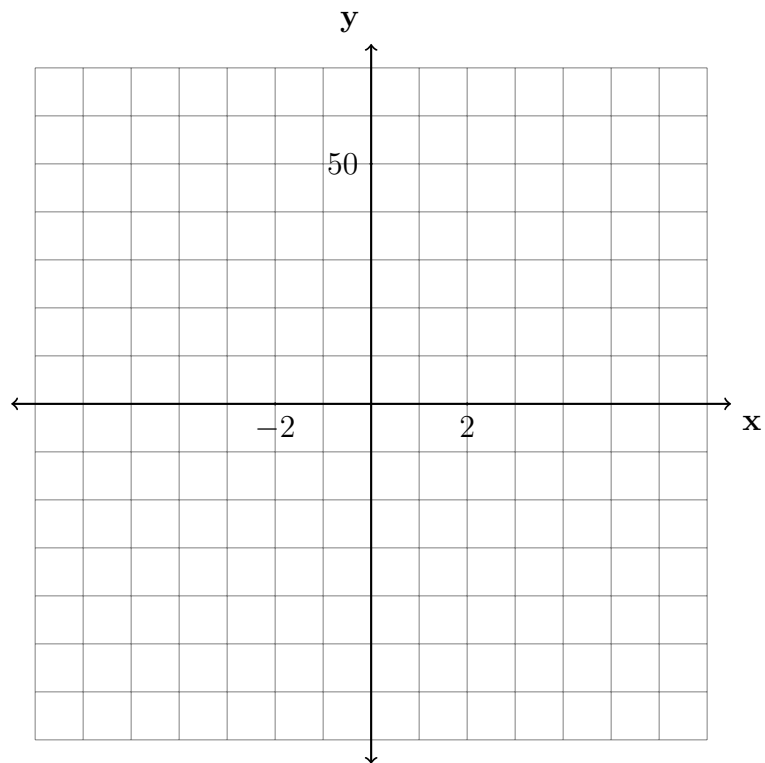
10 March 2018

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Difficulty=6

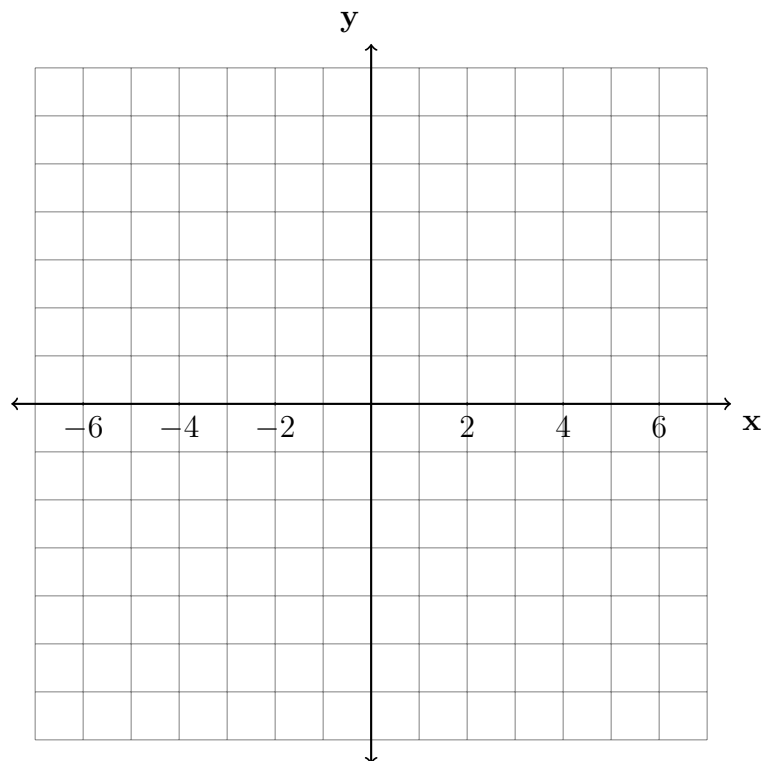
33. The graph of  $y = f(x)$  is shown below. The function has a leading coefficient of 1.



Write an equation for  $f(x)$ .

The function  $g$  is formed by translating function  $f$  left 2 units. Write an equation for  $g(x)$ .

34. The graph of  $y = f(x)$  is shown below. The function has a leading coefficient of 1.



Write an equation for  $f(x)$ .

The function  $g$  is formed by translating function  $f$  left 3 units. Write an equation for  $g(x)$ .

35. A polynomial equation of degree three,  $p(x)$ , is used to model the volume of a rectangular box. The graph of  $p(x)$  has  $x$  intercepts at  $-2$ ,  $10$ , and  $14$ . Which statements regarding  $p(x)$  could be true?
- A. The equation of  $p(x) = (x - 2)(x + 10)(x + 14)$ .
  - B. The equation of  $p(x) = -(x + 2)(x - 10)(x - 14)$ .
  - C. The maximum volume occurs when  $x = 10$ .
  - D. The maximum volume of the box is approximately 56.
36. Algebraically determine whether the function  $j(x) = x^4 - 3x^2 - 4$  is odd, even, or neither.

**Topic="Polynomial Identities"**

**Source="Regents" Difficulty=5**

37. Given:  $f(x) = 2x^2 + x - 3$  and  $g(x) = x - 1$   
Express  $f(x) \bullet g(x) - [f(x) + g(x)]$  as a polynomial in standard form.
38. Given:  $f(x) = x^2 + x - 2$  and  $g(x) = x - 1$   
Express  $2 \bullet g(x) - f(x)$  as a polynomial in standard form.

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39. If  $p(x) = ab^x$  and  $r(x) = cd^x$ , then  $p(x) \bullet r(x)$  equals

(a)  $ac(b + d)^x$

(b)  $ac(b + d)^{2x}$

(c)  $ac(bd)^x$

(d)  $ac(bd)^{x^2}$

40. If  $g(c) = 1 - c^2$  and  $m(c) = c + 1$ , then which statement is *not* true?

(a)  $g(c) \bullet m(c) = 1 + c - c^2 - c^3$

(b)  $g(c) + m(c) = 2 + c - c^2$

(c)  $m(c) - g(c) = c + c^2$

(d)  $\frac{m(c)}{g(c)} = \frac{-1}{1 - c}$

41. Algebraically determine the values of  $h$  and  $k$  to correctly complete the identity stated below.

$$2x^3 - 10x^2 + 11x - 7 = (x - 4)(2x^2 + hx + 3) + k$$

42. Algebraically determine the values of  $h$  and  $k$  to correctly complete the identity stated below.

$$10x^2 - 11x - 7 = (x - 2)(hx + 9) + k$$

43. Algebraically determine the values of  $h$  and  $k$  to correctly complete the identity stated below.

$$2x^3 - 5x^2 + 12x - 5 = (2x - 1)(x^2 - hx + k)$$

44. The expression  $(x + a)(x + b)$  can not be written as

(a)  $a(x + b) + x(x + b)$

(b)  $x^2 + (a + b)x + ab$

(c)  $x^2 + abx + ab$

(d)  $x(x + a) + b(x + a)$

Difficulty=6

45. Verify the following Pythagorean identity for all values of  $x$  and  $y$ :

$$(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$$

46. A manufacturing company has developed a cost model,  $C(x) = 0.15x^3 + 0.01x^2 + 2x + 120$ , where  $x$  is the number of items sold, in thousands. The sales price can be modeled by  $S(x) = 30 - 0.01x$ . Therefore, revenue is modeled by  $R(x) = x \cdot S(x)$ .

The company's profit,  $P(x) = R(x) - C(x)$ , could be modeled by what polynomial?

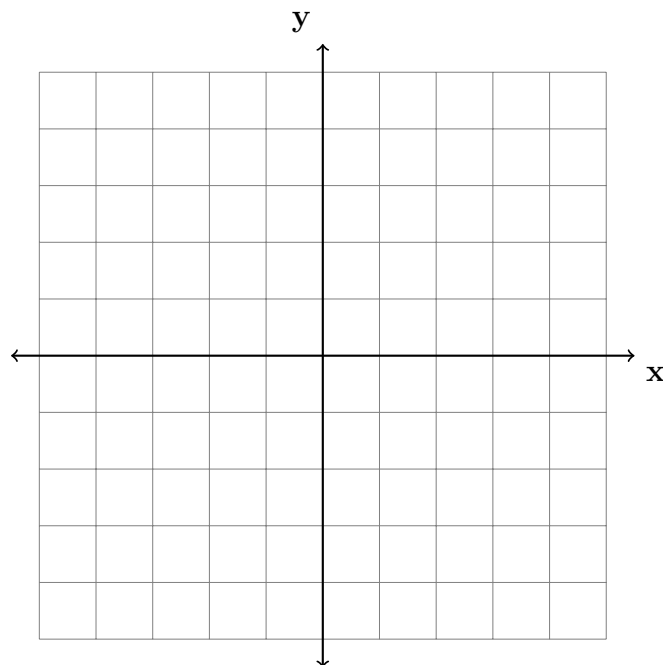


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47. Sally's high school is planning their spring musical. The revenue,  $R$ , generated can be determined by the function  $R(t) = -33t^2 + 360t$ , where  $t$  represents the price of a ticket. The production cost,  $C$ , of the musical is represented by the function  $C(t) = 700 + 5t$ . What is the highest ticket price, to the *nearest dollar*, they can charge in order to not lose money on the event?

Difficulty=4

48. What is the quotient when  $x^2 - 3x - 40$  is divided by  $x + 5$ ?
49. What is the quotient when  $x^3 + 3x^2 - x + 2$  is divided by  $x - 1$ ?
50. What is the quotient when  $3x^3 + 9x^2 + 8x + 5$  is divided by  $x + 2$ ?
51. What is the quotient when  $x^3 - 13x - 12$  is divided by  $x - 4$ ?
52. What is the quotient when  $10x^3 - 3x^2 - 7x + 3$  is divided by  $2x - 1$ ?
53. Determine whether the binomial  $x + 2$  is a factor of  $f(x) = x^3 + x^2 - 16x - 16$
54. Determine whether the binomial  $x + 3$  is a factor of  $f(x) = 3x^3 + 10x^2 - x - 12$
55. Determine if  $x - 5$  is a factor of  $2x^3 - 4x^2 - 7x - 10$ . Explain your answer.
56. Given that  $x - 2$  is a factor of  $f(x) = 3x^3 - 9x^2 + 8x - 4$ . What is the value of  $f(2)$ ?
57. When  $g(x)$  is divided by  $x + 4$ , the remainder is 0. Given  $g(x) = x^4 + 3x^3 - 6x^2 - 6x + 8$ , which conclusion about  $g(x)$  is true?
- (a)  $g(4) = 0$
  - (b)  $g(-4) = 0$
  - (c)  $x - 4$  is a factor of  $g(x)$ .
  - (d) No conclusion can be made regarding  $g(x)$ .
58. The graph of  $p(x)$  is shown below.



- What is the remainder when  $p(x)$  is divided by  $x + 4$ ?
59. Which binomial is a factor of  $x^4 - 4x^2 - 4x + 8$ ?
- (a)  $x - 2$
  - (b)  $x + 2$
  - (c)  $x - 4$
  - (d)  $x + 4$
60. Which binomial is *not* a factor of the expression  $x^3 - 11x^2 + 16x + 84$ ?
- (a)  $x + 2$
  - (b)  $x - 6$
  - (c)  $x + 4$
  - (d)  $x - 7$
61. The expression  $\frac{x^3 + 2x^2 + x + 6}{x + 2}$  is equivalent to
- (a)  $x^2 + 3$
  - (b)  $x^2 + 1 + \frac{4}{x + 2}$
  - (c)  $2x^2 + x + 6$
  - (d)  $2x^2 + 1 + \frac{4}{x + 2}$

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62. The expression  $\frac{4x^3 + 5x + 10}{2x + 3}$  is equivalent to
- (a)  $2x^2 + 3x - 7 + \frac{31}{2x + 3}$
- (b)  $2x^2 - 3x + 7 - \frac{11}{2x + 3}$
- (c)  $2x^2 + 2.5x + 5 + \frac{15}{2x + 3}$
- (d)  $2x^2 - 2.5x - 5 - \frac{20}{2x + 3}$
63. Simplify the expression  $\frac{4x^3 + 9x - 5}{2x - 1}$ , where  $x \neq \frac{1}{2}$ .
64. Given  $f(x) = 3x^2 + 7x - 20$  and  $g(x) = x - 2$ , state the quotient and remainder of  $\frac{f(x)}{g(x)}$ , in the form  $q(x) + \frac{r(x)}{g(x)}$ .
65. If  $p(x) = 2x^3 - 3x + 5$ , what is the remainder of  $p(x) \div (x - 5)$ ?
66. Use long division to determine the quotient and remainder of  $(x^3 + 4x^2 - 8x - 6) \div (x + 2)$ .
67. Use long division to determine the quotient and remainder of  $(x^3 - 7x^2 + 15x - 9) \div (x - 3)$ .
68. Use long division to determine the quotient and remainder of  $(x^3 + 4x^2 - 8x - 6) \div (x + 2)$ .
69. Given that the remainder when  $f(x) = x^3 - 3x^2 + 2x + 125$  is divided by  $x + 4$  is  $-5$ . What is the value of  $f(-4)$ ?
70. Given  $r(x) = x^3 - 4x^2 + 4x - 6$ , find the value of  $r(2)$ .

What does your answer tell you about  $x - 2$  as a factor of  $r(x)$ ? Explain.

71. Over the set of integers, factor the expression  $4x^3 - x^2 + 16x - 4$  completely.

**Topic="Solving Linear Systems"**

**Source="Regents" Difficulty=5**

72. Solve the following system of equations:

$$y = -2x + 14$$

$$3x - 4z = 2$$

$$3x - y = 16$$

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73. Solve the following system of equations algebraically for all values of  $x$ ,  $y$ , and  $z$ :

$$x + y + z = 1$$

$$2x + 4y + 6z = 2$$

$$-x + 3y - 5z = 11$$

(Note: requires algebraic work, perhaps matrix notation would do)

**Topic="Modeling Rationals"**

**Source="Regents" Difficulty=5**

74. Mallory wants to buy a new window air conditioning unit. The cost for the unit is \$329.99. If she plans to run the unit three months out of the year for an annual operating cost of \$108.78, which function models the cost per year over the lifetime of the unit,  $C(n)$ , in terms of the number of years,  $n$ , that she owns the air conditioner?

(a)  $C(n) = 329.99 + 108.78n$

(b)  $C(n) = 329.99 + 326.34n$

(c)  $C(n) = \frac{329.99 + 108.78n}{n}$

(d)  $C(n) = \frac{329.99 + 326.34n}{n}$

**Topic="Operations with Complex Numbers"**

**Source="Regents" Difficulty=5**

75. Express  $(1 - i)^3$  in  $a + bi$  form.
76. What is the expression  $6xi^3(-4xi + 5)$  is equivalent to?
77. Given  $i$  is the imaginary unit,  $(2 - yi)^2$  in simplest form is what?
78. Simplify the expression  $(3k - 2i)^2$ , where  $i$  is the imaginary unit.
79. Simplify  $xi(i - 7i)^2$ , where  $i$  is the imaginary unit.
80. Nicole tried to find the product of  $(2 + 4i)$  and  $(3 - i)$ , and her work is shown below.
- $$\begin{aligned} &(2 + 4i)(3 - i) \\ &= 6 - 2i + 12i - 4i^2 \\ &= 6 + 10i - 4i^2 \\ &= 6 + 10i - 4(1) \\ &= 6 + 10i - 4 \\ &= 2 + 10i \end{aligned}$$
- Identify the error in the process shown and determine the correct product of  $(2 + 4i)$  and  $(3 - i)$ .

**Topic="Radicals and Rational Exponents"****Source="Regents" Difficulty=4**

81. The solution set for the equation  $\sqrt{x+14} - \sqrt{2x+5} = 1$  is

- (a)  $\{-6\}$
- (b)  $\{2\}$
- (c)  $\{18\}$
- (d)  $\{2, 22\}$

82. Solve algebraically for all values of  $x$ :

$$\sqrt{x-4} + x = 6$$

Difficulty=5

83. Write  $\sqrt[3]{x} \cdot \sqrt{x}$  as a single term with a rational exponent.

84. What does  $\left(\frac{-54x^9}{y^4}\right)^{\frac{2}{3}}$  equal?

85. The expression  $\left(\frac{m^2}{m^{\frac{1}{3}}}\right)^{-\frac{1}{2}}$  is equivalent to

- (a)  $-\sqrt[6]{m^5}$
- (b)  $\frac{1}{\sqrt[6]{m^5}}$
- (c)  $-m\sqrt[5]{m}$
- (d)  $\frac{1}{m\sqrt[5]{m}}$

86. When  $b > 0$  and  $d$  is a positive integer, the expression  $(3b)^{\frac{2}{d}}$  is equivalent to what expressed as a radical?

87. For  $x \neq 0$ , which expressions are equivalent to one divided by the sixth root of  $x$ ?

$$\text{I. } \frac{\sqrt[6]{x}}{\sqrt[3]{x}} \quad \text{II. } \frac{x^{\frac{1}{6}}}{x^{\frac{1}{3}}} \quad \text{III. } x^{-\frac{1}{6}}$$

88. Explain how  $(-8)^{\frac{4}{3}}$  can be evaluated using properties of rational exponents to result in an integer answer.

89. Explain how  $\left(3^{\frac{1}{5}}\right)^2$  can be written as the equivalent radical expression  $\sqrt[5]{9}$ .

90. Explain why  $81^{\frac{3}{4}}$  equals 27.

91. Given the equal terms  $\sqrt[3]{x^5}$  and  $y^{\frac{5}{6}}$ , determine and state  $y$ , in terms of  $x$ .

**Topic="Powers of Powers"****Source="Regents" Difficulty=6**

92. If  $n = \sqrt{a^5}$  and  $m = a$ , where  $a > 0$ , express  $\frac{n}{m}$  as
- (a) a radical with positive, integer exponents
  - (b) an expression with a fractional exponent
93. According to a pricing website, Indroid phones lose 58% of their cash value over 1.5 years. Which expression can be used to estimate the value of a \$300 Indroid phone in 1.5 years?
- (a)  $300e^{-0.87}$
  - (b)  $300e^{-0.63}$
  - (c)  $300e^{-0.58}$
  - (d)  $300e^{-0.42}$
94. The function  $p(t) = 110e^{0.03922t}$  models the population of a city, in millions,  $t$  years after 2010. As of today, consider whether the following two statements are true or false:
- (a) The current population is 110 million.
  - (b) The population increases continuously by approximately 3.9% per year.
95. Last year, the total revenue for Home Style, a national restaurant chain, increased 5.25% over the previous year. If this trend were to continue, which expression could the company's chief financial officer use to approximate their monthly percent increase in revenue? [Let  $m$  represent months.]
- (a)  $(1.0525)^m$
  - (b)  $(1.0525)^{\frac{12}{m}}$
  - (c)  $(1.00427)^m$
  - (d)  $(1.00427)^{\frac{m}{12}}$
96. For a given time,  $x$ , in seconds, an electric current,  $y$ , can be represented by  $y = 2.5(1 - 2.7^{-.10x})$ . Which equation is *not* equivalent?
- (a)  $y = 2.5 - 2.5(2.7^{-.10x})$
  - (b)  $y = 2.5 - 2.5((2.7^2)^{-.05x})$
  - (c)  $y = 2.5 - 2.5\left(\frac{1}{2.7^{.10x}}\right)$
  - (d)  $y = 2.5 - 2.5(2.7^{-2})(2.7^{.05x})$

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97. Iridium-192 is an isotope of iridium and has a half-life of 73.83 days. If a laboratory experiment begins with 100 grams of Iridium-192, the number of grams,  $A$ , of Iridium-192 present after  $t$  days would be

$$A = 100 \left( \frac{1}{2} \right)^{\frac{t}{73.83}}$$

Which equation approximates the amount of Iridium-192 present after  $t$  days?

- (a)  $A = 100 \left( \frac{73.83}{2} \right)^t$
- (b)  $A = 100 \left( \frac{1}{147.66} \right)^t$
- (c)  $A = 100(0.990656)^t$
- (d)  $A = 100(0.116381)^t$
98. A student studying public policy created a model for the population of Detroit, where the population decreased 25% over a decade. He used the model  $P = 714(0.75)^d$ , where  $P$  is the population, in thousands,  $d$  decades after 2010. Another student, Suzanne, wants to use a model that would predict the population after  $y$  years. Suzanne's model is best represented by
- (a)  $P = 714(0.6500)^y$
- (b)  $P = 714(0.8500)^y$
- (c)  $P = 714(0.9716)^y$
- (d)  $P = 714(0.9750)^y$

**Topic="Exponential Equations, Exponential Growth, Exponential Decay"**  
**Source="Regents" Difficulty=5 (note: exponential regression problems)**

99. If the function  $g(x) = ab^x$  represents exponential growth, which statement about  $g(x)$  is false?
- (a)  $a > 0$  and  $b > 1$
- (b) The  $y$ -intercept is  $(0, a)$ .
- (c) The asymptote is  $y = 0$ .
- (d) The  $x$ -intercept is  $(b, 0)$
100. A certain pain reliever is taken in 220 mg dosages and has a half-life of 12 hours. The function  $A = 220 \left( \frac{1}{2} \right)^{\frac{t}{12}}$  can be used to model this situation, where  $A$  is the amount of pain reliever in milligrams remaining in the body after  $t$  hours. According to this function, which statement is true?

**Algebra II & IB Math SL problem bank**

- (a) Every hour, the amount of pain reliever remaining is cut in half.
- (b) In 12 hours, there is no pain reliever remaining in the body.
- (c) In 24 hours, there is no pain reliever remaining in the body.
- (d) In 12 hours, 110 mg of pain reliever is remaining.

101. Which function represents exponential decay?

- (a)  $y = 2^{0.3t}$
- (b)  $y = 1.2^{3t}$
- (c)  $y = \left(\frac{1}{2}\right)^{-t}$
- (d)  $y = 5^{-t}$

102. The function  $M(t)$  represents the mass of radium over time,  $t$ , in years.

$$M(t) = 100e^{\frac{\left(\ln \frac{1}{2}\right)t}{1590}}$$

Determine if the function  $M(t)$  represents growth or decay. Explain your reasoning.

103. One of the medical uses of Iodine-131 (I-131), a radioactive isotope of iodine, is to enhance x-ray images. The half-life of I-131 is approximately 8.02 days. A patient is injected with 20 milligrams of I-131. Determine, to the *nearest day*, the amount of time needed before the amount of I-131 in the patient's body is approximately 7 milligrams.
104. An equation to represent the value of a car after  $t$  months of ownership is  $v = 32,000(0.81)^{\frac{t}{12}}$ . Which statement is *not* correct?
- (a) The car lost approximately 19% of its value each month.
  - (b) The car maintained approximately 98% of its value each month.
  - (c) The value of the car when it was purchased was \$32,000.
  - (d) The value of the car 1 year after it was purchased was \$25,920.
105. A payday loan company makes loans between \$100 and \$1000 available to customers. Every 14 days, customers are charged 30% interest with compounding. In 2013, Remi took out a \$300 payday loan. Which expression can be used to calculate the amount she would owe, in dollars, after one year if she did not make payments?
- (a)  $300(.30)^{\frac{14}{365}}$
  - (b)  $300(1.30)^{\frac{14}{365}}$
  - (c)  $300(.30)^{\frac{365}{14}}$
  - (d)  $300(1.30)^{\frac{365}{14}}$



**Algebra II & IB Math SL problem bank**

106. Judith puts \$5000 into an investment account with interest compounded continuously. What is the approximate annual rate is needed for the account to grow to \$9110 after 30 years?

107. Jasmine decides to put \$100 in a savings account each month. The account pays 3% annual interest, compounded monthly. How much money,  $S$ , will Jasmine have after one year?

(a)  $S = 100(1.03)^{12}$

(b)  $S = \frac{100 - 100(1.0025)^{12}}{1 - 1.0025}$

(c)  $S = 100(1.0025)^{12}$

(d)  $S = \frac{100 - 100(1.03)^{12}}{1 - 1.03}$

108. Jim is looking to buy a vacation home for \$172,600 near his favorite southern beach.

The formula to compute a mortgage payment,  $M$ , is  $M = P \cdot \frac{r(1+r)^N}{(1+r)^N - 1}$  where  $P$  is the principal amount of the loan,  $r$  is the monthly interest rate, and  $N$  is the number of monthly payments. Jim's bank offers a monthly interest rate of 0.305% for a 15-year mortgage.

With no down payment, determine Jim's mortgage payment, rounded to the nearest dollar.

Algebraically determine and state the down payment, rounded to the *nearest dollar*, that Jim needs to make in order for his mortgage payment to be \$1100.

109. Using the formula below, determine the monthly payment on a 5-year car loan with a monthly percentage rate of 0.625% for a car with an original cost of \$21,000 and a \$1000 down payment, to the *nearest cent*.

$$P_n = PMT \left( \frac{1 - (1+i)^{-n}}{i} \right)$$

$P_n$  = present amount borrowed

$n$  = number of monthly pay periods

$PMT$  = monthly payment

$i$  = interest rate per month

The affordable monthly payment is \$300 for the same time period. Determine an appropriate down payment, to the *nearest dollar*.

**Algebra II & IB Math SL problem bank**

110. Seth's parents gave him \$5000 to invest for his 16th birthday. He is considering two investment options. Option  $A$  will pay him 4.5% interest compounded annually. Option  $B$  will pay him 4.6% compounded quarterly.

Write a function of option  $A$  and option  $B$  that calculates the value of each account after  $n$  years.

Seth plans to use the money after he graduates from college in 6 years. Determine how much more money option  $B$  will earn than option  $A$  to the *nearest cent*.

Algebraically determine, to the nearest tenth of a year, how long it would take for option  $B$  to double Seth's initial investment.

111. A rabbit population doubles every 4 weeks. There are currently five rabbits in a restricted area. If  $t$  represents the time, in weeks, and  $P(t)$  is the population of rabbits with respect to time, about how many rabbits will there be in 98 days?
112. Researchers in a local area found that the population of rabbits with an initial population of 20 grew continuously at the rate of 5% per month. The fox population had an initial value of 30 and grew continuously at the rate of 3% per month.
- Find, to the *nearest tenth of a month*, how long it takes for these populations to be equal.

113. Pedro and Bobby each own an ant farm. Pedro starts with 100 ants and says his farm is growing exponentially at a rate of 15% per month. Bobby starts with 350 ants and says his farm is steadily decreasing by 5 ants per month.

Assuming both boys are accurate in describing the population of their ant farms, after how many months will they both have approximately the same number of ants?

114. In New York State, the minimum wage has grown exponentially. In 1966, the minimum wage was \$1.25 an hour and in 2015, it was \$8.75. Algebraically determine the rate of growth to the *nearest percent*.
115. A radioactive substance has a mass of 140 g at 3 p.m. and 100 g at 8 p.m. Write an equation in the form  $A = A_0 \left(\frac{1}{2}\right)^{\frac{t}{h}}$  that models this situation, where  $h$  is the constant representing the number of hours in the half-life,  $A_0$  is the initial mass, and  $A$  is the

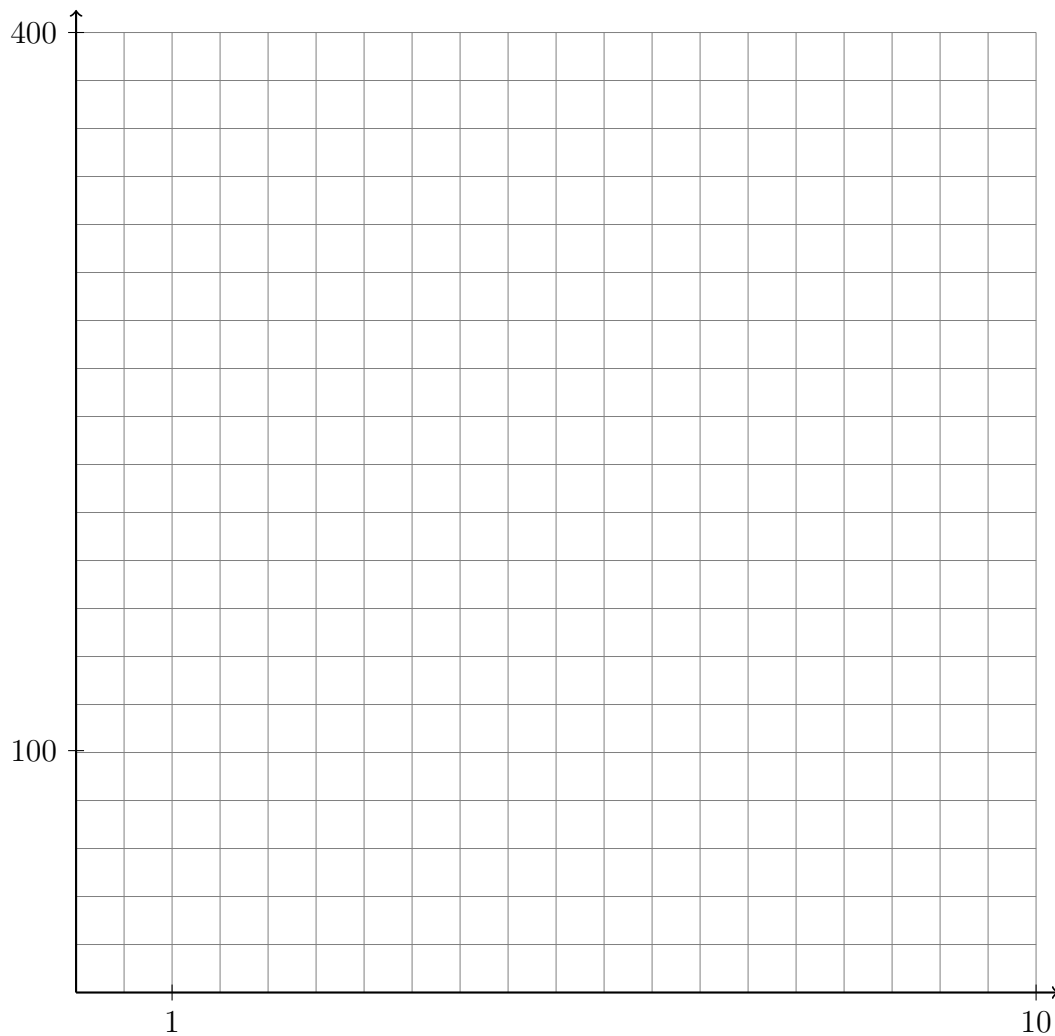
**Algebra II & IB Math SL problem bank**

mass  $t$  hours after 3 p.m.

Using this equation, solve for  $h$ , to the *nearest ten thousandth*.

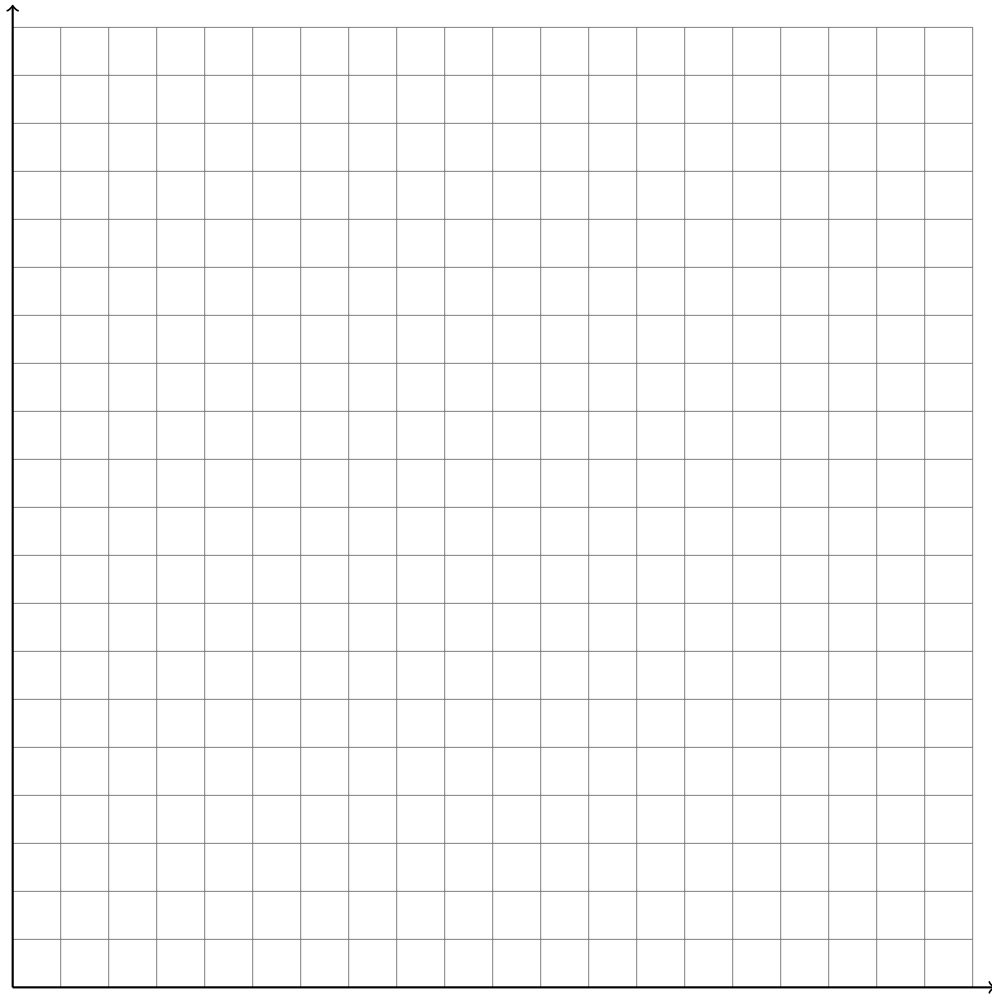
Determine when the mass of the radioactive substance will be 40 g. Round your answer to the *nearest tenth of an hour*.

116. Graph  $y = 400(.85)^{2x} - 6$  on the set of axes below.



117. The value of a certain small passenger car based on its use in years is modeled by  $V(t) = 28482.698(0.684)^t$ , where  $V(t)$  is the value in dollars and  $t$  is the time in years. Zach had to take out a loan to purchase the small passenger car. The function  $Z(t) = 22151.327(0.778)^t$ , where  $Z(t)$  is measured in dollars, and  $t$  is the time in years, models the unpaid amount of Zach's loan over time.

Graph  $V(t)$  and  $Z(t)$  over the interval  $0 \leq t \leq 5$ , on the set of axes below.



State when  $V(t) = Z(t)$ , to the *nearest hundredth*, and interpret its meaning in the context of the problem.

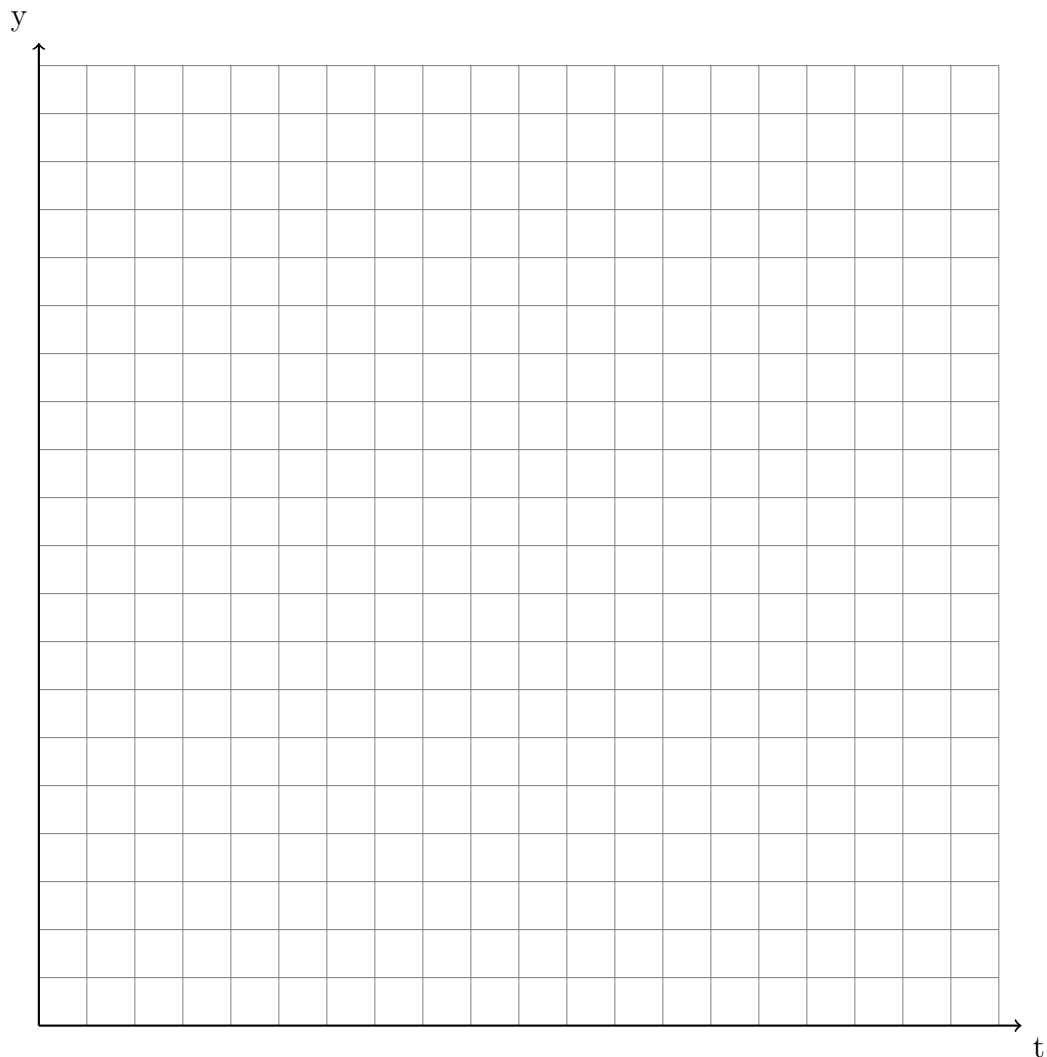
Zach takes out an insurance policy that requires him to pay a \$3000 deductible in case of a collision. Zach will cancel the collision policy when the value of his car equals his deductible. To the nearest year, how long will it take Zach to cancel this policy? Justify your answer.

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118. Drugs break down in the human body at different rates and therefore must be prescribed by doctors carefully to prevent complications, such as overdosing. The breakdown of a drug is represented by the function  $N(t) = N_0(e)^{-rt}$ , where  $N(t)$  is the amount left in the body,  $N_0$  is the initial dosage,  $r$  is the decay rate, and  $t$  is time in hours. Patient A,  $A(t)$ , is given 800 milligrams of a drug with a decay rate of 0.347. Patient B,  $B(t)$ , is given 400 milligrams of another drug with a decay rate of 0.231.

Write two functions,  $A(t)$  and  $B(t)$ , to represent the breakdown of the respective drug given to each patient.

Graph each function on the set of axes below.



To the *nearest hour*,  $t$ , when does the amount of the given drug remaining in patient

$B$  begin to exceed the amount of the given drug remaining in patient  $A$ ?

The doctor will allow patient  $A$  to take another 800 milligram dose of the drug once only 15% of the original dose is left in the body. Determine, to the *nearest tenth of an hour*, how long patient  $A$  will have to wait to take another 800 milligram dose of the drug.

**Algebra II & IB Math SL problem bank**

**Topic="Sequences"**

**Source="Regents" Difficulty=4**

119. At her job, Pat earns \$25,000 the first year and receives a raise of \$1000 each year. The explicit formula for the  $n$ th term of this sequence is  $a_n = 25,000 + (n - 1)1000$ . What rule best represents the equivalent recursive formula?
120. Given  $f(9) = 2$ , which function can be used to generate the sequence  $-8, -7.25, -6.5, -5.75, \dots$ ?
- (a)  $f(n) = -8 + 0.75n$
  - (b)  $f(n) = -8 - 0.75(n - 1)$
  - (c)  $f(n) = -8.75 + 0.75n$
  - (d)  $f(n) = -0.75 + 8(n - 1)$
121. The eighth and tenth terms of a sequence are 64 and 100. If the sequence is either arithmetic or geometric, the ninth term can not be
- (a)  $-82$
  - (b)  $-80$
  - (c)  $80$
  - (d)  $82$

**Topic="Series"**

**Source="Regents" Difficulty=5**

122. A ball is dropped from a height of 32 feet. It bounces and rebounds 80% of the height from which it was falling. What is the total downward distance, in feet, the ball traveled up to the 12th bounce?
123. Brian deposited 1 cent into an empty non-interest bearing bank account on the first day of the month. He then additionally deposited 3 cents on the second day, 9 cents on the third day, and 27 cents on the fourth day. What would be the total amount of money in the account at the end of the 20th day if the pattern continued?

**Topic="Modeling Trigonometric Functions"**

**Source="Regents" Difficulty=3**

124. The volume of air in a person's lungs, as the person breathes in and out, can be modeled by a sine graph. A scientist is studying the differences in this volume for people at rest compared to people told to take a deep breath. When examining the graphs, should the scientist focus on the amplitude, period, or midline? Explain your choice.
125. Relative to the graph of  $y = 3 \sin x$ , what is the shift of the graph of  $y = 3 \sin(x + \frac{\pi}{3})$ ?

## Algebra II &amp; IB Math SL problem bank

- (a)  $\frac{\pi}{3}$  right
- (b)  $\frac{\pi}{3}$  left
- (c)  $\frac{\pi}{3}$  up
- (d)  $\frac{\pi}{3}$  down

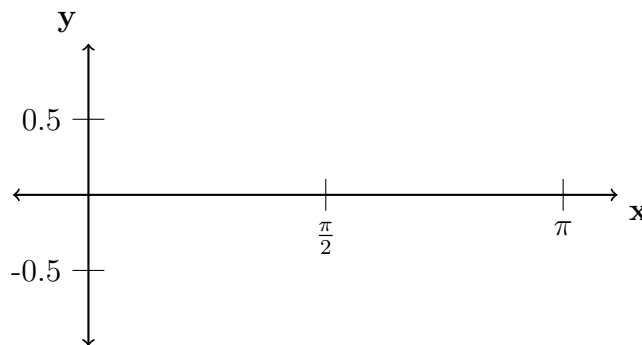
126. As  $x$  increases from 0 to  $\frac{\pi}{2}$ , the graph of the equation  $y = 2 \tan x$  will

- (a) increase from 0 to 2
- (b) decrease from 0 to 2
- (c) increase without limit
- (d) decrease without limit

127. Given the parent function  $p(x) = \cos x$ , which phrase best describes the transformation used to obtain the graph of  $g(x) = \cos(x + a) - b$ , if  $a$  and  $b$  are positive constants?

- (a) right  $a$  units, up  $b$  units
- (b) right  $a$  units, down  $b$  units
- (c) left  $a$  units, up  $b$  units
- (d) left  $a$  units, down  $b$  units

128. Which equation is represented by the graph shown below?



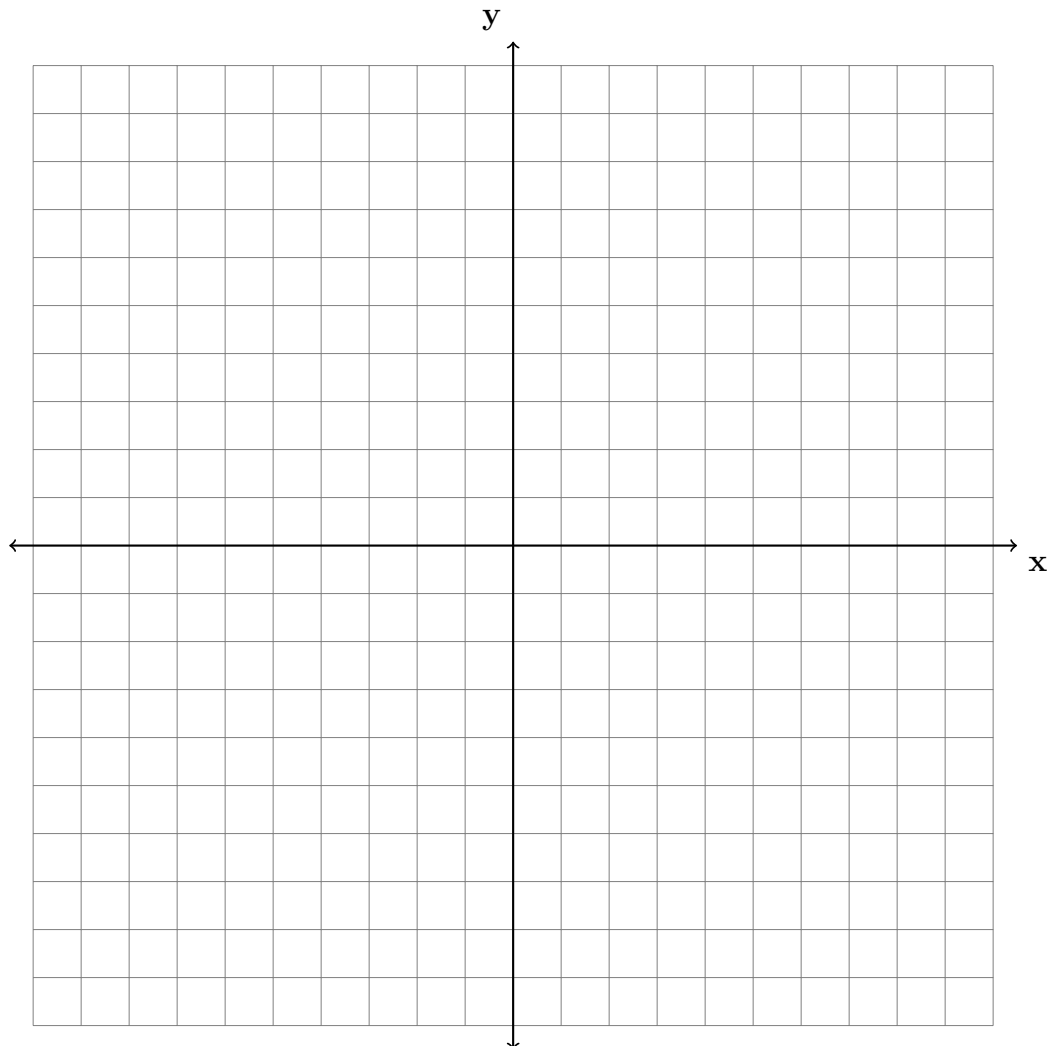
- (a)  $y = \frac{1}{2} \cos 2x$
- (b)  $y = \frac{1}{2} \cos x$
- (c)  $y = \cos x$
- (d)  $y = 2 \cos \frac{1}{2}x$

129. The Ferris wheel at the landmark Navy Pier in Chicago takes 7 minutes to make one full rotation. The height,  $H$ , in feet, above the ground of one of the six-person cars can be modeled by  $H(t) = 70 \sin \left( \frac{2\pi}{7}(t - 1.75) \right) + 80$ , where  $t$  is time, in minutes. Using  $H(t)$  for one full rotation, what is this car's minimum height, in feet?



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130. The voltage used by most households can be modeled by a sine function. The maximum voltage is 120 volts, and there are 60 cycles *every second*. Which equation best represents the value of the voltage as it flows through the electric wires, where  $t$  is time in seconds?
- (a)  $V = 120 \sin(t)$
  - (b)  $V = 120 \sin(60t)$
  - (c)  $V = 120 \sin(60\pi t)$
  - (d)  $V = 120 \sin(120\pi t)$
131. The hours of daylight,  $y$ , in Utica in days,  $x$ , from January 1, 2013 can be modeled by the equation  $y = 3.06 \sin(0.017x - 1.40) + 12.23$ . How many hours of daylight, to the *nearest tenth*, does this model predict for February 14, 2013?
132. On the axes below, graph one cycle of a cosine function with amplitude 3, period  $\frac{\pi}{2}$ , midline  $y = -1$ , and passing through the point  $(0, 2)$ .

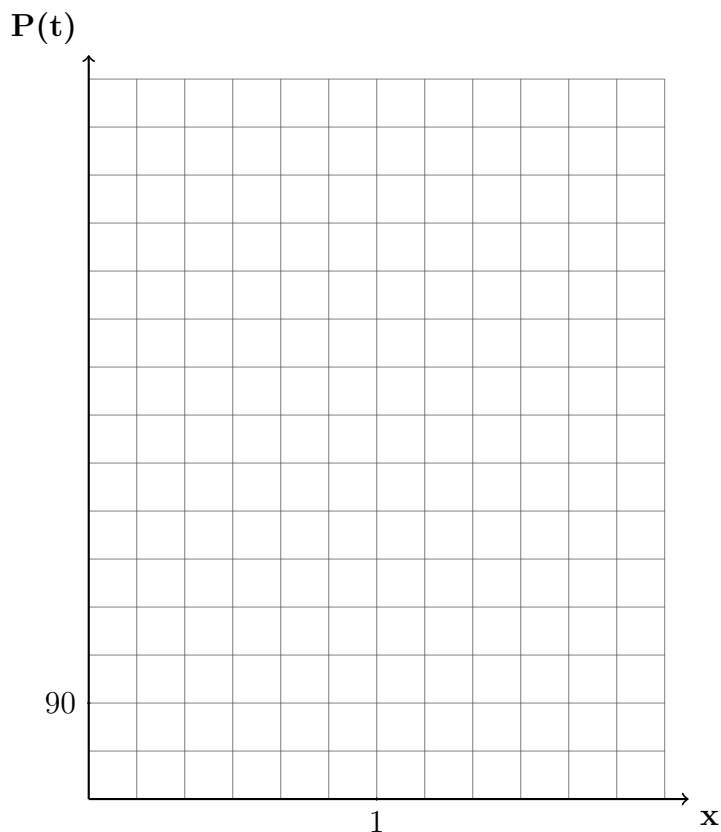


**Algebra II & IB Math SL problem bank**

133. Based on climate data that have been collected in Bar Harbor, Maine, the average monthly temperature, in degrees F, can be modeled by the equation  $B(x) = 23.914 \sin(0.508x - 2.116) + 55.300$ . The same governmental agency collected average monthly temperature data for Phoenix, Arizona, and found the temperatures could be modeled by the equation  $P(x) = 20.238 \sin(0.525x - 2.148) + 86.729$ . Which statement can not be concluded based on the average monthly temperature models  $x$  months after starting data collection?
- (a) The average monthly temperature variation is more in Bar Harbor than in Phoenix.
  - (b) The midline average monthly temperature for Bar Harbor is lower than the midline temperature for Phoenix.
  - (c) The maximum average monthly temperature for Bar Harbor is  $79^\circ$  F, to the nearest degree.
  - (d) The minimum average monthly temperature for Phoenix is  $20^\circ$  F, to the nearest degree.
134. The resting blood pressure of an adult patient can be modeled by the function  $P$  below, where  $P(t)$  is the pressure in millimeters of mercury after time  $t$  in seconds.

$$P(t) = 24 \cos(3\pi t) + 120$$

On the set of axes below, graph  $y = P(t)$  over the domain  $0 \leq t \leq 2$ .



**Algebra II & IB Math SL problem bank**

Determine the period of  $P$ . Explain what this value represents in the given context.

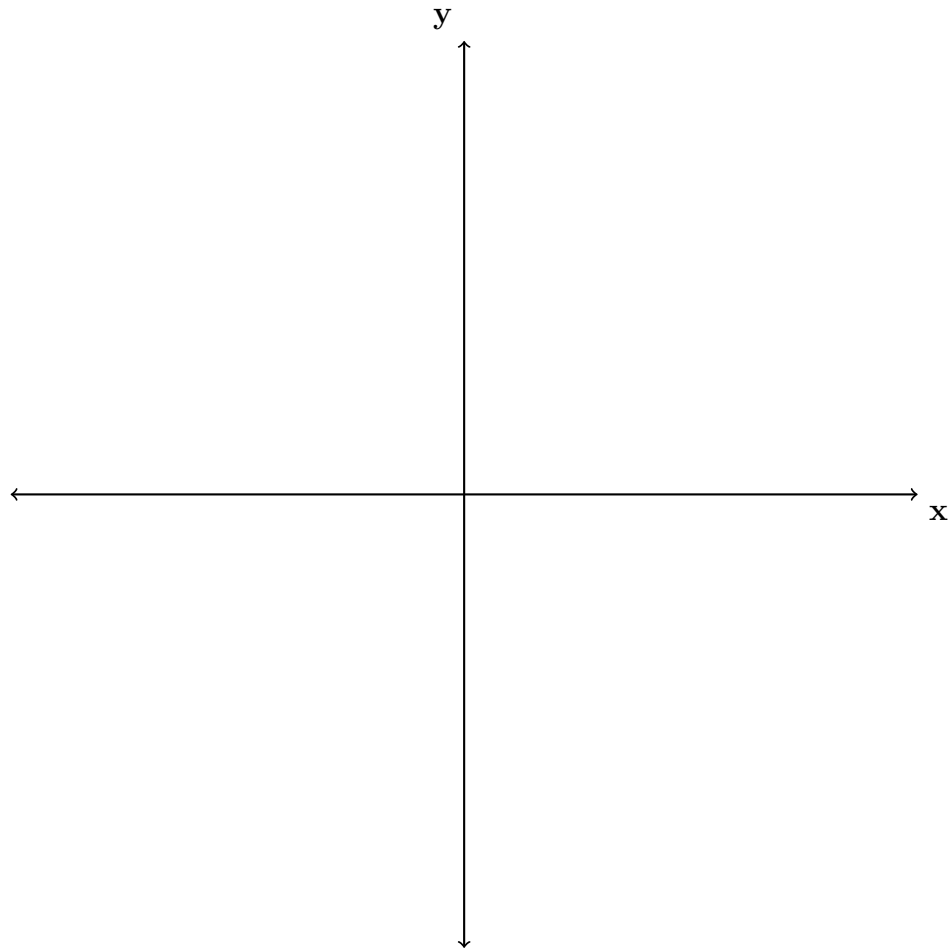
Normal resting blood pressure for an adult is 120 over 80. This means that the blood pressure oscillates between a maximum of 120 and a minimum of 80. Adults with high blood pressure (above 140 over 90) and adults with low blood pressure (below 90 over 60) may be at risk for health disorders. Classify the given patient's blood pressure as low, normal, or high and explain your reasoning.

135. Consider the function  $h(x) = 2\sin(3x) + 1$  and the function  $q$  represented in the table below.

$x$	$q(x)$
-2	-8
-1	0
0	0
1	-2
2	0

Determine which function has the *smaller* minimum value for the domain  $[-2, 2]$ . Justify your answer.

136. a) On the axes below, sketch at least one cycle of a sine curve with an amplitude of 2, a midline at  $y = -\frac{3}{2}$ , and a period of  $2\pi$ .



b) Explain any differences between a sketch of  $y = 2 \sin \left( x - \frac{\pi}{3} \right) - \frac{3}{2}$  and the sketch from part *a*.

**Topic="Evaluating Radical Expressions"**

**Source="Regents"**

**Difficulty=6**

137. Solve the equation  $\sqrt{2x-7} + x = 5$  algebraically, and justify the solution set.

138. The speed of a tidal wave,  $s$ , in hundreds of miles per hour, can be modeled by the equation  $s = \sqrt{t} - 2t + 6$ , where  $t$  represents the time from its origin in hours. Algebraically determine the time when  $s = 0$ .

How much faster was the tidal wave traveling after 1 hour than 3 hours, to the *nearest mile per hour*? Justify your answer.

**Topic="Evaluating Logarithmic Expressions"****Source="IB"****Difficulty=4**139. Let  $\log_3 p = 6$  and  $\log_3 q = 7$ .(a) Find  $\log_3 p^2$ (b) Find  $\log_3 \left(\frac{p}{q}\right)$ (c) Find  $\log_3 (9p)$ 

Difficulty=5

140. If  $ae^{bt} = c$ , where  $a$ ,  $b$ , and  $c$  are positive, then  $t$  equals what?141. What is the solution to  $8(2^{x+3}) = 48$ ?142. To the *nearest tenth*, what is the value of  $x$  that satisfies  $2^x = -2x + 11$ ?

Calc=2

143. For which values of  $x$ , rounded to the *nearest hundredth*, will  $|x^2 - 9| - 3 = \log_3 x$ ?144. When  $g(x) = \frac{2}{x+2}$  and  $h(x) = \log(x+1) + 3$  are graphed on the same set of axes, what coordinate pair represents their point of intersection?145. If  $f(x) = 3|x| - 1$  and  $g(x) = 0.03x^3 - x + 1$ , an approximate solution for the equation  $f(x) = g(x)$  is

(a) 1.96

(b) 11.29

(c)  $(-0.99, 1.96)$ (d)  $(11.29, 32.87)$ 146. The  $x$ -value of which function's  $x$ -intercept is larger,  $f$  or  $h$ ? Justify your answer.

$$f(x) = \log(x - 4)$$

x	h(x)
-1	6
0	4
1	2
2	0
3	-2

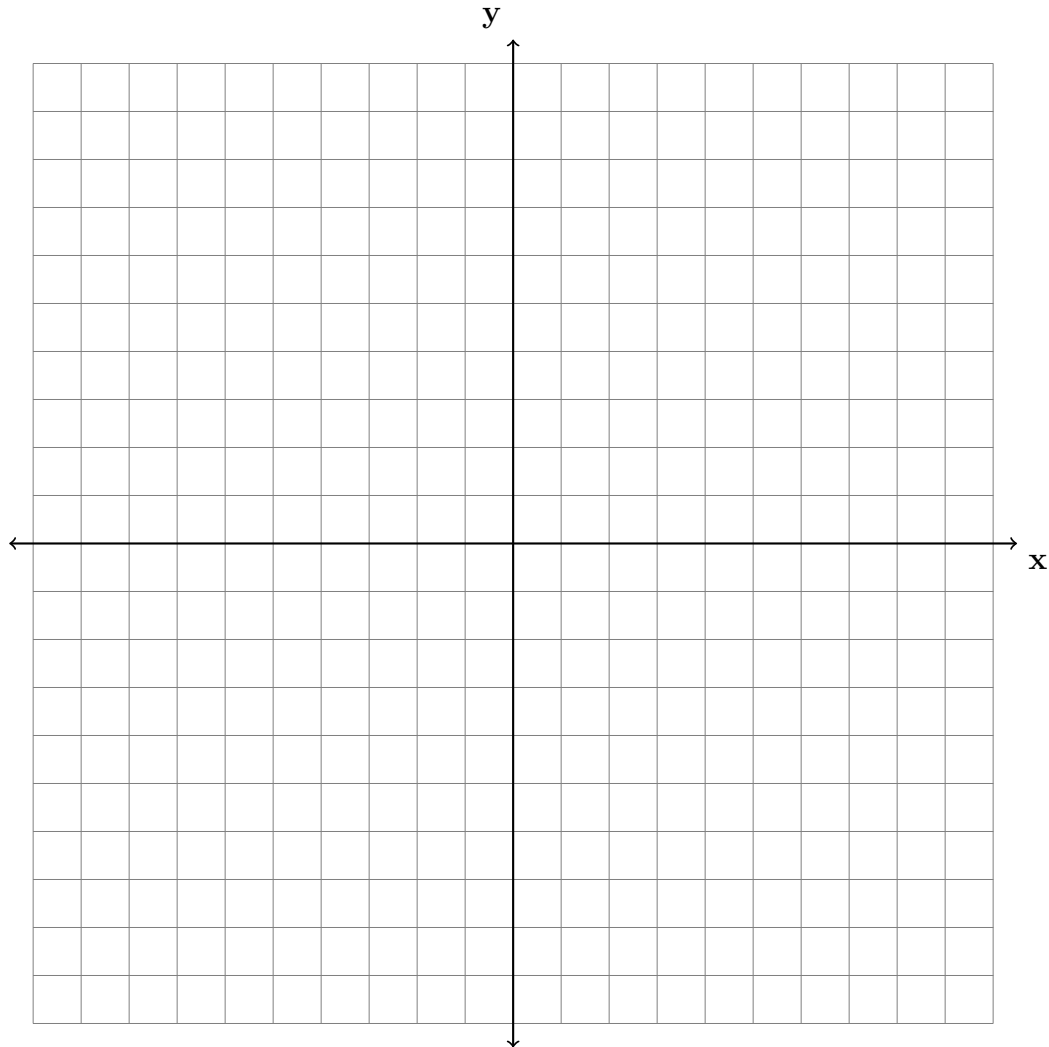
**Topic="Graphing Logarithmic Functions"**

**Source="IB" Difficulty=5 Calc=2**

147. Which statement about the graph of  $c(x) = \log_6 x$  is false?

- (a) The asymptote has equation  $y = 0$ .
- (b) The graph has no  $y$ -intercept.
- (c) The domain is the set of positive reals.
- (d) The range is the set of all real numbers.

148. Graph  $y = \log_2(x + 3) - 5$  on the set of axes below. Use an appropriate scale to include both intercepts.



Describe the behavior of the given function as  $x$  approaches  $-3$  and as  $x$  approaches positive infinity.

**Topic="Experimental design - not actual category"**

**Source="Regents" Difficulty=4 Calc=1**

149. Which statement about statistical analysis is *false*?
- (a) Experiments can suggest patterns and relationships in data.
  - (b) Experiments can determine cause and effect relationships.
  - (c) Observational studies can determine cause and effect relationships.
  - (d) Observational studies can suggest patterns and relationships in data.
150. Describe how a controlled experiment can be created to examine the effect of ingredient  $X$  in a toothpaste.
151. An orange-juice processing plant receives a truckload of oranges. The quality control team randomly chooses three pails of oranges, each containing 50 oranges, from the truckload. Identify the sample and the population in the given scenario.

State *one* conclusion that the quality control team could make about the population if 5% of the sample was found to be unsatisfactory.

**Topic="Probability of Compound Events"**

**Source="IB" Difficulty=4 Calc=1**

152. Two events  $A$  and  $B$  are such that  $P(A) = 0.2$  and  $P(A \cup B) = 0.5$ .
- (a) Given that  $A$  and  $B$  are mutually exclusive, find  $P(B)$ .
  - (b) Given that  $A$  and  $B$  are independent, find  $P(B)$ .
153. Given events  $A$  and  $B$ , such that  $P(A) = 0.6$ ,  $P(B) = 0.5$ , and  $P(A \cup B) = 0.8$ , determine whether  $A$  and  $B$  are independent or dependent.
154. Sean's team has a baseball game tomorrow. He pitches 50% of the games. There is a 40% chance of rain during the game tomorrow. If the probability that it rains given that Sean pitches is 40%, it can be concluded that these two events are
- (a) independent
  - (b) dependent
  - (c) mutually exclusive

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(d) complements

155. The probability that Gary and Jane have a child with blue eyes is 0.25, and the probability that they have a child with blond hair is 0.5. The probability that they have a child with both blue eyes and blond hair is 0.125. Given this information, the events blue eyes and blond hair are
- . I: dependent
  - . II: independent
  - . III: mutually exclusive

156. Data collected about jogging from students with two older siblings are shown in the table below.

	Neither Sibling Jogs	One Sibling Jogs	Both Siblings Jogs
Student Does Not Jog	1168	1823	1380
Student Jogs	188	416	400

Using these data, determine whether a student with two older siblings is more likely to jog if one sibling jogs or if both siblings jog. Justify your answer.

157. A student is chosen at random from the student body at a given high school. The probability that the student selects Math as the favorite subject is  $\frac{1}{4}$ . The probability that the student chosen is a junior is  $\frac{116}{459}$ . If the probability that the student selected is a junior or that the student chooses Math as the favorite subject is  $\frac{47}{108}$ , what is the exact probability that the student selected is a junior whose favorite subject is Math?

Are the events “the student is a junior” and “the student’s favorite subject is Math” independent of each other? Explain your answer.

**Topic=“Conditional Probability”****Source=“IB” Difficulty=5 Calc=1**

158. Given events  $A$  and  $B$ , such that  $P(A) = 0.6$ ,  $P(B) = 0.5$ , and  $P(A \cup B) = 0.8$ , determine whether  $A$  and  $B$  are dependent or independent. Justify your answer.

Difficulty=6

159. A study was designed to test the effectiveness of a new drug. Half of the volunteers received the drug. The other half received a sugar pill. The probability of a volunteer receiving the drug and getting well was 40%. What is the probability of a volunteer getting well, given that the volunteer received the drug?



**Algebra II & IB Math SL problem bank****Topic="Normal Distributions"****Source="IB" Difficulty=4 Calc=2**

160. The random variable  $X$  is normally distributed with mean 20 and standard deviation 5.

(a) Find  $P(X \leq 22.9)$ .

(b) Given that  $P(X < k) = 0.55$ , find the value of  $k$ .

Source="Regents" Difficulty=4 Calc=2

161. There are 440 students at Thomas Paine High School enrolled in U.S. History. On the April report card, the students' grades are approximately normally distributed with a mean of 79 and a standard deviation of 7. Students who earn a grade less than or equal to 64.9 must attend summer school. Approximately how many students must attend summer school for U.S. History?
162. A suburban high school has a population of 1376 students. The number of students who participate in sports is 649. The number of students who participate in music is 433. If the probability that a student participates in either sports or music is  $\frac{974}{1376}$ , what is the probability that a student participates in both sports and music?

**Topic="Using Trigonometry to Find Area"****Source="IB" Difficulty=4 Calc=2**

163. The area of triangle ABC is 80 sq. cm,  $AB = 18$  cm,  $AC = x$  cm and  $\hat{BAC} = 50^\circ$ . Find  $x$ .

**Differentiate each function.**

164.  $f(x) = 2x^3 - x^2 + 6$

165.  $g(x) = \frac{1}{x^4}$

166.  $h(x) = 3\sqrt{x}$

167.  $f(x) = (x - 2)(x + 2)$

168.  $g(x) = \frac{2}{(3x)^2}$

169.  $h(x) = 6e^x + \sqrt{x^3}$

170.  $f(x) = 6 \ln x$

171.  $g(x) = \frac{\sin x}{\pi}$

172.  $h(x) = \log_3 x$

**Find the equation of the tangent or normal line to the function at the given point.**

173. The tangent to  $y = 4x^2$  at  $x = 1$

174. The tangent to  $y = 3x^2 - e^x$  at  $x = 2$

175. The normal line to  $y = \ln(e^{x^2})$

**Use the product, quotient, or chain rule to differentiate each function.**

176.  $y = 2xe^x$

177.  $y = x^2 \cos x$

178.  $f(x) = \frac{x^2 - 8}{x + 1}$

179.  $g(x) = \frac{x}{x^2 - x + 6}$

180.  $y = (3x^3 - x^2 + 4)^4$

181.  $y = \ln 2x^2 - 3x$

182.  $y = \cos \frac{x^3}{\pi}$

183.  $y = \sqrt{\cos 3x}$

**Local extrema: find the value(s) of  $x$  for which the function has a local minimum or maximum.**

184.  $f(x) = 8x^2 - 24x + 7$ .

185.  $g(x) = x^3 - 4x^2 - 6x + 5$

186.  $h(x) = 2 \ln x - x + 4$

**Rates of change and motion equations**

187. The path of a diver is modeled by the function  $s(t) = -4.9t^2 + 4.9t + 10$  where  $s$  is the diver's height above the water in meters.

(a) What is the initial height from which the diver begins her dive?

(b) What is the initial velocity of the diver?

(c) What is the maximum height above the water and at what point in time is that height reached?

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- (d) When does the diver enter the water?
  - (e) At what velocity does she enter the water?
188. The position of an object is given by the function  $s(x) = 5 \sin x + x$  over the interval  $\{0 \leq x \leq 2\pi\}$
- (a) What is the object's initial velocity?
  - (b) At what value of  $x$  is the object at its maximum distance from its starting point?
  - (c) What is its average velocity over the period from  $x = 0$  to when it achieves its maximum distance?
  - (d) Over what interval is the object moving in the negative direction?
189. A particle moves along a horizontal line with its displacement given by the function  $s(t) = 20t - 100 \ln t$ , for  $t > 1$ .
- (a) Find the velocity of the particle.
  - (b) Over what period is the particle moving to the left?
  - (c) Show that the velocity of the particle is always increasing.

**Unit conversions**

190. The two common systems of temperature measurement, Fahrenheit and Celsius, are based on the freezing and boiling points of water. In the Fahrenheit system, water freezes at  $32^\circ\text{F}$  and boils at  $212^\circ\text{F}$ . In the Celsius (or centigrade) system, the freezing and boiling points of water are  $0^\circ\text{C}$  and  $100^\circ\text{C}$ , respectively.
- (a) Show that  $1^\circ\text{C} = \frac{9}{5}^\circ\text{F}$ .
  - (b) On the graph below, plot and label the freezing and boiling points of water, and draw a straight line representing the mapping  $^\circ\text{F} \rightarrow ^\circ\text{C}$ .
  - (c) What is the Fahrenheit equivalent of  $20^\circ\text{C}$ ? Label it on the graph as "room temperature."
  - (d) Determine an algebraic expression for a temperature in Celsius,  $C(x)$ , as a function of the temperature in Fahrenheit,  $x$ .
  - (e) Solve for the temperature for which the Fahrenheit and Celsius measures are the same, that is,  $C(x) = x$ .