Question ID beca03de

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: beca03de

A rectangle has a length that is 15 times its width. The function $y = (15w)(w)$ represents this situation, where y is the area, in square feet, of the rectangle and $y > 0$. Which of the following is the best interpretation of $15w$ in this context?

A. The length of the rectangle, in feet

B. The area of the rectangle, in square feet

C. The difference between the length and the width of the rectangle, in feet

D. The width of the rectangle, in feet

ID: beca03de Answer

Correct Answer: A

Rationale

Choice A is correct. It's given that a rectangle has a length that is 15 times its width. It's also given that the function $y = 15ww$ represents this situation, where y is the area, in square feet, of the rectangle and $y > 0$. The area of a rectangle can be calculated by multiplying the rectangle's length by its width. Since the rectangle has a length that is 15 times its width, it follows that w represents the width of the rectangle, in feet, and $15w$ represents the length of the rectangle, in feet. Therefore, the best interpretation of $15w$ in this context is that it's the length of the rectangle, in feet.

Choice B is incorrect. This is the best interpretation of y, not $15w$, in the given function.

Choice C is incorrect and may result from conceptual errors.

Choice D is incorrect. This is the best interpretation of w, not $15w$, in the given function.

Question Difficulty: Medium

Question ID f89af023

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: f89af023

A rectangular volleyball court has an area of 162 square meters. If the length of the court is twice the width, what is the width of the court, in meters?

A. 9

B. 18

C. 27

D. 54

ID: f89af023 Answer

Correct Answer: A

Rationale

Choice A is correct. It's given that the volleyball court is rectangular and has an area of 162 square meters. The formula for the area of a rectangle is $A = \ell \cdot w$, where A is the area, ℓ is the length, and w is the width of the rectangle. It's also given that the length of the volleyball court is twice the width, thus $\ell = 2w$. Substituting the given value into the formula for the area of a rectangle and using the relationship between length and width for this rectangle yields $162 = (2w)(w)$. This equation can be rewritten as $162 = 2w^2$. Dividing both sides of this equation by 2 yields $81 = w^2$. Taking the square root of both sides of this equation yields $\pm 9 = w$. Since the width of a rectangle is a positive number, the width of the volleyball court is 9 meters.

Choice B is incorrect because this is the length of the rectangle. Choice C is incorrect because this is the result of using 162 as the perimeter rather than the area. Choice D is incorrect because this is the result of calculating w in the equation $162 = 2w + w$ instead of $162 = (2w)(w)$.

Question Difficulty: Medium

Question ID e53add44

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: e53add44

$S(n) = 38{,}000a^n$

The function S above models the annual salary, in dollars, of an employee n years after starting a job, where a is a constant. If the employee's salary increases by 4% each year, what is the value of a ?

A. 0.04

B. 0.4

C. 1.04

D. 1.4

ID: e53add44 Answer

Correct Answer: C

Rationale

Choice C is correct. A model for a quantity S that increases by a certain percentage per time period n is an exponential function in the form $S(n) = I\left(1 + \frac{r}{100}\right)^n$, where I is the initial value at time $n = 0$ for r% annual increase. It's given that the annual increase in an employee's salary is 4%, so $r = 4$. The initial value can be found by substituting 0 for n in the given function, which yields $S(0) = 38{,}000$. Therefore, $I = 38{,}000$. Substituting these values for r and I into the form of the exponential function $S(n) = I\left(1 + \frac{r}{100}\right)^n$ yields $S(n) = 38{,}000\left(1 + \frac{4}{100}\right)^n$, or $S(n) = 38{,}000(1.04)^n$. Therefore, the value of a in the given function is 1.04.

Choices A, B, and D are incorrect and may result from incorrectly representing the annual increase in the exponential function.

Question Difficulty: Medium

Question ID 926c246b

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 926c246b

$D = 5{,}640(1.9)^t$

The equation above estimates the global data traffic D, in terabytes, for the year that is t years after 2010. What is the best interpretation of the number 5,640 in this context?

A. The estimated amount of increase of data traffic, in terabytes, each year

B. The estimated percent increase in the data traffic, in terabytes, each year

C. The estimated data traffic, in terabytes, for the year that is t years after 2010

D. The estimated data traffic, in terabytes, in 2010

ID: 926c246b Answer

Correct Answer: D

Rationale

Choice D is correct. Since t represents the number of years after 2010, the estimated data traffic, in terabytes, in 2010 can be calculated using the given equation when $t = 0$. Substituting 0 for t in the given equation yields $D = 5{,}640(1.9)^0$, or $5{,}640(1) = 5{,}640$. Thus, 5,640 represents the estimated data traffic, in terabytes, in 2010.

Choice A is incorrect. Since the equation is exponential, the amount of increase of data traffic each year isn't constant. Choice B is incorrect. According to the equation, the percent increase in data traffic each year is 90%. Choice C is incorrect. The estimated data traffic, in terabytes, for the year that is t years after 2010 is represented by D, not the number 5,640.

Question Difficulty: Medium

Question ID 341ba5db

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 341ba5db

$$g(x) = x^2 + 55$$

What is the minimum value of the given function?

A. 0

B. 55

C. 110

D. $3{,}025$

ID: 341ba5db Answer

Correct Answer: B

Rationale

Choice B is correct. For a quadratic function defined by an equation of the form $gx = ax - h^2 + k$, where a, h, and k are constants and $a > 0$, the minimum value of the function is k. In the given function, $a = 1$, $h = 0$, and $k = 55$. Therefore, the minimum value of the given function is 55.

Choice A is incorrect. This is the value of x for which the given function reaches its minimum value, not the minimum value of the function.

Choice C is incorrect and may result from conceptual or calculation errors.

Choice D is incorrect and may result from conceptual or calculation errors.

Question Difficulty: Medium

Question ID 50e40f08

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 50e40f08

$$f(x) = (x + 6)(x - 4)$$

If the given function f is graphed in the *xy*-plane, where $y = f(x)$, what is the *x*-coordinate of an *x*-intercept of the graph?

ID: 50e40f08 Answer

Correct Answer: -6, 4

Rationale

The correct answer is either -6 or 4. The *x*-intercepts of a graph in the *xy*-plane are the points where $y = 0$. Thus, for an *x*-intercept of the graph of $y = fx$, $0 = fx$. Substituting 0 for fx in the equation $fx = x + 6x$ - 4 yields $0 = x + 6x$ - 4. By the zero product property, $x + 6 = 0$ and x - 4 = 0. Subtracting 6 from both sides of the equation $x + 6 = 0$ yields $x =$ - 6. Adding 4 to both sides of the equation x - 4 = 0 yields $x = 4$. Therefore, the *x*-coordinates of the *x*-intercepts of the graph of $y = fx$ are -6 and 4. Note that -6 and 4 are examples of ways to enter a correct answer.

Question Difficulty: Medium

Question ID be0c419e

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: be0c419e

Immanuel purchased a certain rare coin on January 1. The function $f(x) = 65(1.03)^x$, where $0 \leq x \leq 10$, gives the predicted value, in dollars, of the rare coin x years after Immanuel purchased it. What is the best interpretation of the statement "$f(8)$ is approximately equal to 82" in this context?

A. When the rare coin's predicted value is approximately 82 dollars, it is 8% greater than the predicted value, in dollars, on January 1 of the previous year.

B. When the rare coin's predicted value is approximately 82 dollars, it is 8 times the predicted value, in dollars, on January 1 of the previous year.

C. From the day Immanuel purchased the rare coin to 8 years after Immanuel purchased the coin, its predicted value increased by a total of approximately 82 dollars.

D. 8 years after Immanuel purchased the rare coin, its predicted value is approximately 82 dollars.

ID: be0c419e Answer

Correct Answer: D

Rationale

Choice D is correct. It's given that the function $fx = 651.03^x$ gives the predicted value, in dollars, of a certain rare coin x years after Immanuel purchased it. It follows that fx represents the predicted value, in dollars, of the coin x years after Immanuel purchased it. Since the value of $f8$ is the value of fx when $x = 8$, it follows that "$f8$ is approximately equal to 82" means that fx is approximately equal to 82 when $x = 8$. Therefore, the best interpretation of the statement "$f8$ is approximately equal to 82" in this context is 8 years after Immanuel purchased the rare coin, its predicted value is approximately 82 dollars.

Choice A is incorrect and may result from conceptual errors.

Choice B is incorrect and may result from conceptual errors.

Choice C is incorrect and may result from conceptual errors.

Question Difficulty: Medium

Question ID a31417d1

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: a31417d1

From 2005 through 2014, the number of music CDs sold in the United States declined each year by approximately 15% of the number sold the preceding year. In 2005, approximately 600 million CDs were sold in the United States. Of the following, which best models *C*, the number of millions of CDs sold in the United States, *t* years after 2005?

A. $C = 600(0.15)^t$

B. $C = 600(0.85)^t$

C. $C = 600(1.15)^t$

D. $C = 600(1.85)^t$

ID: a31417d1 Answer

Correct Answer: B

Rationale

Choice B is correct. A model for a quantity C that decreases by a certain percentage per time period t is an exponential equation in the form $C = I\left(1 - \frac{r}{100}\right)^t$, where I is the initial value at time $t = 0$ for r% annual decline. It's given that C is the number of millions of CDs sold in the United States and that t is the number of years after 2005. It's also given that 600 million CDs were sold at time $t = 0$, so $I = 600$. This number declines by 15% per year, so $r = 15$. Substituting these values into the equation produces $C = 600\left(1 - \frac{15}{100}\right)^t$, or $C = 600(0.85)^t$.

Choice A is incorrect and may result from errors made when representing the percent decline. Choices C and D are incorrect. These equations model exponential increases in CD sales, not exponential decreases.

Question Difficulty: Medium

Question ID 6ecdbcb4

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 6ecdbcb4

$$f(x) = (x + 6)(x + 5)(x - 4)$$

The function f is given. Which table of values represents $y = f(x) - 3$?

A.

x	y
-6	-9
-5	-8
4	1

B.

x	y
-6	-3
-5	-3
4	-3

C.

x	y
-6	-3
-5	-2
4	7

D.

x	y
-6	3
-5	3
4	3

ID: 6ecdbcb4 Answer

Correct Answer: B

Rationale

Choice B is correct. It's given that $fx = (x + 6)(x + 5)(x - 4)$ and $y = f(x) - 3$. Substituting $(x + 6)(x + 5)(x - 4)$ for fx in the equation $y = f(x) - 3$ yields $y = (x + 6)(x + 5)(x - 4) - 3$. Substituting -6 for x in this equation yields $y = (-6 + 6)(-6 + 5)(-6 - 4) - 3$, or $y = -3$. Substituting -5 for x in the equation $y = (x + 6)(x + 5)(x - 4) - 3$ yields $y = (-5 + 6)(-5 + 5)(-5 - 4) - 3$, or $y = -3$. Substituting 4 for x in the equation $y = (x + 6)(x + 5)(x - 4) - 3$ yields

$y = (4 + 6)(4 + 5)(4 - 4) - 3$, or $y = -3$. Therefore, when $x = -6$ then $y = -3$, when $x = -5$ then $y = -3$, and when $x = 4$ then $y = -3$. Thus, the table of values in choice B represents $y = f(x) - 3$.

Choice A is incorrect. This table represents $y = x - 3$ rather than $y = f(x) - 3$.

Choice C is incorrect. This table represents $y = x + 3$ rather than $y = f(x) - 3$.

Choice D is incorrect. This table represents $y = fx + 3$ rather than $y = f(x) - 3$.

Question Difficulty: Medium

Question ID 203774bc

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 203774bc

The product of two positive integers is 546. If the first integer is 11 greater than twice the second integer, what is the smaller of the two integers?

A. 7

B. 14

C. 39

D. 78

ID: 203774bc Answer

Correct Answer: B

Rationale

Choice B is correct. Let x be the first integer and let y be the second integer. If the first integer is 11 greater than twice the second integer, then $x = 2y + 11$. If the product of the two integers is 546, then $xy = 546$. Substituting $2y + 11$ for x in this equation results in $2y + 11y = 546$. Distributing the y to both terms in the parentheses results in $2y^2 + 11y = 546$. Subtracting 546 from both sides of this equation results in $2y^2 + 11y - 546 = 0$. The left-hand side of this equation can be factored by finding two values whose product is $2\text{-}546$, or $-1{,}092$, and whose sum is 11. The two values whose product is $-1{,}092$ and whose sum is 11 are 39 and -28. Thus, the equation $2y^2 + 11y - 546 = 0$ can be rewritten as $2y^2 + 28y - 39y - 546 = 0$, which is equivalent to $2yy - 14 + 39y - 14 = 0$, or $2y + 39y - 14 = 0$. By the zero product property, it follows that $2y + 39 = 0$ and $y - 14 = 0$. Subtracting 39 from both sides of the equation $2y + 39 = 0$ yields $2y = -39$. Dividing both sides of this equation by 2 yields $y = -\frac{39}{2}$. Since y is a positive integer, the value of y is not $-\frac{39}{2}$. Adding 14 to both sides of the equation $y - 14 = 0$ yields $y = 14$. Substituting 14 for y in the equation $xy = 546$ yields $x14 = 546$. Dividing both sides of this equation by 14 results in $x = 39$. Therefore, the two integers are 14 and 39, so the smaller of the two integers is 14.

Choice A is incorrect and may result from conceptual or calculation errors.

Choice C is incorrect. This is the larger of the two integers.

Choice D is incorrect and may result from conceptual or calculation errors.

Question Difficulty: Medium

Question ID c4cd5bcc

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: c4cd5bcc

In the *xy*-plane, the *y*-coordinate of the *y*-intercept of the graph of the function *f* is *c*.
Which of the following must be equal to *c* ?

A. $f(0)$

B. $f(1)$

C. $f(2)$

D. $f(3)$

ID: c4cd5bcc Answer

Correct Answer: A

Rationale

Choice A is correct. A y-intercept is the point in the xy-plane where the graph of the function crosses the y-axis, which is where $x = 0$. It's given that the y-coordinate of the y-intercept of the graph of function f is c. It follows that the coordinate pair representing the y-intercept must be $(0,c)$. Therefore, c must equal $f(0)$.

Choices B, C, and D are incorrect because $f(1)$, $f(2)$, and $f(3)$would represent the y-value of the coordinate where $x = 1$, $x = 2$, and $x = 3$, respectively.

Question Difficulty: Medium

Question ID 735a0a00

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 735a0a00

$$y = 0.25x^2 - 7.5x + 90.25$$

The equation gives the estimated stock price y, in dollars, for a certain company x days after a new product launched, where $0 \leq x \leq 20$. Which statement is the best interpretation of $(x, y) = (1, 83)$ in this context?

A. The company's estimated stock price increased $\$83$ every day after the new product launched.

B. The company's estimated stock price increased $\$1$ every 83 days after the new product launched.

C. 1 day after the new product launched, the company's estimated stock price is $\$83$.

D. 83 days after the new product launched, the company's estimated stock price is $\$1$.

ID: 735a0a00 Answer

Correct Answer: C

Rationale

Choice C is correct. In the given equation, x represents the number of days after a new product launched, where $0 \leq x \leq 20$, and y represents the estimated stock price, in dollars, for a certain company. Therefore, the best interpretation of $x, y = 1, 83$ in this context is that 1 day after the new product launched, the company's estimated stock price is $\$ 83$.

Choice A is incorrect and may result from conceptual errors.

Choice B is incorrect and may result from conceptual errors.

Choice D is incorrect and may result from conceptual errors.

Question Difficulty: Medium

Question ID 78d5f91a

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 78d5f91a

$f(x)=x^3+3x^2-6x-1$

For the function *f* defined above, what is the value of $f(-1)$?

A. -11

B. -7

C. 7

D. 11

ID: 78d5f91a Answer

Correct Answer: C

Rationale

Choice C is correct. Substituting -1 for x in the given function f gives $f(-1)=(-1)^3+3(-1)^2-6(-1)-1$, which simplifies to $f(-1)=-1+3(1)-6(-1)-1$. This further simplifies to $f(-1)=-1+3+6-1$, or $f(-1)=7$.

Choice A is incorrect and may result from correctly substituting -1 for x in the function but incorrectly simplifying the resulting expression to $f(-1)=-1-3-6-1$, or -11. Choice B is incorrect and may result from arithmetic errors. Choice D is incorrect and may result from correctly substituting -1 for x in the function but incorrectly simplifying the expression to $f(-1)=1+3+6+1$, or 11.

Question Difficulty: Medium

Question ID d675744f

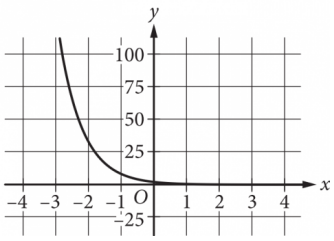
Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: d675744f

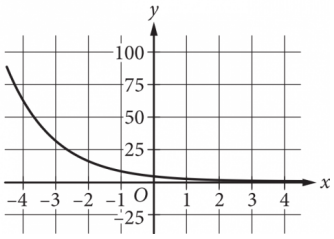
$y = 4(2^x)$

Which of the following is the graph in the *xy*-plane of the given equation?

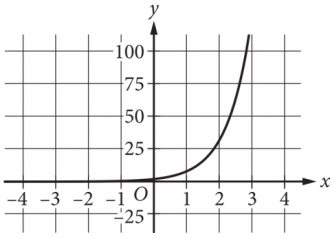
A.



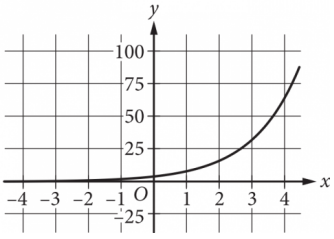
B.



C.



D.



ID: d675744f Answer

Correct Answer: D

Rationale

Choice D is correct. The y-intercept of the graph of an equation is the point $(0,b)$, where b is the value of y when $x = 0$. For the given equation, $y = 4$ when $x = 0$. It follows that the y-intercept of the graph of the given equation is $(0,4)$. Additionally, for the given equation, the value of y doubles for each increase of 1 in the value of x. Therefore, the graph contains the points $(1,8)$, $(2,16)$, $(3,32)$, and $(4,64)$. Only the graph shown in choice D passes through these points.

Choices A and B are incorrect because these are graphs of decreasing, not increasing, exponential functions. Choice C is incorrect because the value of y increases by a growth factor greater than 2 for each increase of 1 in the value of x.

Question Difficulty: Medium

Question ID 67f4b449

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 67f4b449

The function $f(w) = 6w^2$ gives the area of a rectangle, in square feet (ft^2), if its width is w ft and its length is 6 times its width. Which of the following is the best interpretation of $f(14) = 1{,}176$?

A. If the width of the rectangle is 14 ft, then the area of the rectangle is $1{,}176$ ft^2.

B. If the width of the rectangle is 14 ft, then the length of the rectangle is $1{,}176$ ft.

C. If the width of the rectangle is $1{,}176$ ft, then the length of the rectangle is 14 ft.

D. If the width of the rectangle is $1{,}176$ ft, then the area of the rectangle is 14 ft^2.

ID: 67f4b449 Answer

Correct Answer: A

Rationale

Choice A is correct. The function f gives the area of the rectangle, in ft^2, if its width is w ft. Since the value of $f14$ is the value of fw if $w = 14$, it follows that $f14 = 1{,}176$ means that fw is $1{,}176$ if $w = 14$. In the given context, this means that if the width of the rectangle is 14 ft, then the area of the rectangle is $1{,}176$ ft^2.

Choice B is incorrect and may result from conceptual errors.

Choice C is incorrect and may result from conceptual errors.

Choice D is incorrect and may result from interpreting fw as the width, in ft, of the rectangle if its area is w ft^2, rather than as the area, in ft^2, of the rectangle if its width is w ft.

Question Difficulty: Medium

Question ID f44a29a8

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: f44a29a8

An object's kinetic energy, in joules, is equal to the product of one-half the object's mass, in kilograms, and the square of the object's speed, in meters per second. What is the speed, in meters per second, of an object with a mass of 4 kilograms and kinetic energy of 18 joules?

A. 3

B. 6

C. 9

D. 36

ID: f44a29a8 Answer

Correct Answer: A

Rationale

Choice A is correct. It's given that an object's kinetic energy, in joules, is equal to the product of one-half the object's mass, in kilograms, and the square of the object's speed, in meters per second. This relationship can be represented by the equation $K = \frac{1}{2}mv^2$, where K is the kinetic energy, m is the mass, and v is the speed. Substituting a mass of 4 kilograms for m and a kinetic energy of 18 joules for K results in the equation $18 = \left(\frac{1}{2}\right)(4)v^2$, or $18 = 2v^2$. Dividing both sides of this equation by 2 yields $9 = v^2$. Taking the square root of both sides yields $v = -3$ and $v = 3$. Since speed can't be expressed as a negative number, the speed of the object is 3 meters per second.

Choice B is incorrect and may result from computation errors. Choice C is incorrect. This is the value of v^2 rather than v. Choice D is incorrect. This is the value of $4v^2$ rather than v.

Question Difficulty: Medium

Question ID d71f6dbf

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: d71f6dbf

The height, in feet, of an object x seconds after it is thrown straight up in the air can be modeled by the function $h(x) = -16x^2 + 20x + 5$. Based on the model, which of the following statements best interprets the equation $h(1.4) = 1.64$?

A. The height of the object 1.4 seconds after being thrown straight up in the air is 1.64 feet.

B. The height of the object 1.64 seconds after being thrown straight up in the air is 1.4 feet.

C. The height of the object 1.64 seconds after being thrown straight up in the air is approximately 1.4 times as great as its initial height.

D. The speed of the object 1.4 seconds after being thrown straight up in the air is approximately 1.64 feet per second.

ID: d71f6dbf Answer

Correct Answer: A

Rationale

Choice A is correct. The value 1.4 is the value of x, which represents the number of seconds after the object was thrown straight up in the air. When the function h is evaluated for x = 1.4, the function has a value of 1.64, which is the height, in feet, of the object.

Choices B and C are incorrect and may result from misidentifying seconds as feet and feet as seconds. Additionally, choice C may result from incorrectly including the initial height of the object as the input x. Choice D is incorrect and may result from misidentifying height as speed.

Question Difficulty: Medium

Question ID 6676f055

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 6676f055

$f(\theta) = -0.28(\theta - 27)^2 + 880$

An engineer wanted to identify the best angle for a cooling fan in an engine in order to get the greatest airflow. The engineer discovered that the function above models the airflow $f(\theta)$, in cubic feet per minute, as a function of the angle of the fan θ, in degrees. According to the model, what angle, in degrees, gives the greatest airflow?

A. −0.28

B. 0.28

C. 27

D. 880

ID: 6676f055 Answer

Correct Answer: C

Rationale

Choice C is correct. The function f is quadratic, so it will have either a maximum or a minimum at the vertex of the graph. Since the coefficient of the quadratic term (−0.28) is negative, the vertex will be at a maximum. The equation $f(\theta) = -0.28(\theta - 27)^2 + 880$ is given in vertex form, so the vertex is at $\theta = 27$. Therefore, an angle of 27 degrees gives the greatest airflow.

Choices A and B are incorrect and may be the result of misidentifying which value in a quadratic equation in vertex form represents the vertex. Choice D is incorrect. This choice identifies the maximum value of $f(\theta)$ rather than the value of θ for which $f(\theta)$ is maximized.

Question Difficulty: Medium

Question ID dd8ac009

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: dd8ac009

Time (years)	Total amount (dollars)
0	670.00
1	674.02
2	678.06

Sara opened a savings account at a bank. The table shows the exponential relationship between the time t, in years, since Sara opened the account and the total amount d, in dollars, in the account. If Sara made no additional deposits or withdrawals, which of the following equations best represents the relationship between t and d?

A. $d = 0.006$msup

B. $d = 670$msup

C. $d =$ msup

D. $d =$ msup

ID: dd8ac009 Answer

Correct Answer: B

Rationale

Choice B is correct. It's given that the relationship between t and d is exponential. The table shows that the value of d increases as the value of t increases. Therefore, the relationship between t and d can be represented by an increasing exponential equation of the form $d = a1 + b^t$, where a and b are positive constants. The table shows that when $t = 0$, $d = 670$. Substituting 0 for t and 670 for d in the equation $d = a1 + b^t$ yields $670 = a1 + b^0$, which is equivalent to $670 = a1$, or $670 = a$. Substituting 670 for a in the equation $d = a1 + b^t$ yields $d = 6701 + b^t$. The table also shows that when $t = 1$, $d = 674.02$. Substituting 1 for t and 674.02 for d in the equation $d = 6701 + b^t$ yields $674.02 = 6701 + b^1$, or $674.02 = 6701 + b$. Dividing both sides of this equation by 670 yields $1.006 = 1 + b$. Subtracting 1 from both sides of this equation yields $b = 0.006$. Substituting 0.006 for b in the equation $d = 6701 + b^t$ yields $d = 6701 + 0.006^t$. Therefore, of the choices, choice B best represents the relationship between t and d.

Choice A is incorrect and may result from conceptual or calculation errors.

Choice C is incorrect and may result from conceptual or calculation errors.

Choice D is incorrect and may result from conceptual or calculation errors.

Question Difficulty: Medium

Question ID 281a4f3b

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 281a4f3b

A certain college had 3,000 students enrolled in 2015. The college predicts that after 2015, the number of students enrolled each year will be 2% less than the number of students enrolled the year before. Which of the following functions models the relationship between the number of students enrolled, $f(x)$, and the number of years after 2015, x ?

A. $f(x) = 0.02(3{,}000)^x$

B. $f(x) = 0.98(3{,}000)^x$

C. $f(x) = 3{,}000(0.02)^x$

D. $f(x) = 3{,}000(0.98)^x$

ID: 281a4f3b Answer

Correct Answer: D

Rationale

Choice D is correct. Because the change in the number of students decreases by the same percentage each year, the relationship between the number of students and the number of years can be modeled with a decreasing exponential function in the form $f(x) = a(1-r)^x$, where $f(x)$ is the number of students, a is the number of students in 2015, r is the rate of decrease each year, and x is the number of years since 2015. It's given that 3,000 students were enrolled in 2015 and that the rate of decrease is predicted to be 2%, or 0.02. Substituting these values into the decreasing exponential function yields $f(x) = 3{,}000(1-0.02)^x$, which is equivalent to $f(x) = 3{,}000(0.98)^x$.

Choices A, B, and C are incorrect and may result from conceptual errors when translating the given information into a decreasing exponential function.

Question Difficulty: Medium

Question ID 100030d9

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 100030d9

A rubber ball bounces upward one-half the height that it falls each time it hits the ground. If the ball was originally dropped from a distance of 20.0 feet above the ground, what was its maximum height above the ground, in feet, between the third and fourth time it hit the ground?

ID: 100030d9 Answer

Rationale

The correct answer is 2.5. After hitting the ground once, the ball bounces to $20.0 \div 2 = 10.0$ feet. After hitting the ground a second time, the ball bounces to $10.0 \div 2 = 5.0$ feet. After hitting the ground for the third time, the ball bounces to $5.0 \div 2 = 2.5$ feet. Note that 2.5 and 5/2 are examples of ways to enter a correct answer.

Question Difficulty: Medium

Question ID c7a187a7

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: c7a187a7

$$f(x) = x^2 - 18x - 360$$

If the given function f is graphed in the *xy*-plane, where $y = f(x)$, what is an *x*-intercept of the graph?

A. $(-12, 0)$

B. $(-30, 0)$

C. $(-360, 0)$

D. $(12, 0)$

ID: c7a187a7 Answer

Correct Answer: A

Rationale

Choice A is correct. It's given that $y = fx$. The *x*-intercepts of a graph in the *xy*-plane are the points where $y = 0$. Thus, for an *x*-intercept of the graph of function f, $0 = fx$. Substituting 0 for fx in the equation $fx = x^2$ - $18x$ - 360 yields $0 = x^2$ - $18x$ - 360. Factoring the right-hand side of this equation yields $0 = x + 12x$ - 30. By the zero product property, $x + 12 = 0$ and x - $30 = 0$. Subtracting 12 from both sides of the equation $x + 12 = 0$ yields $x =$ - 12. Adding 30 to both sides of the equation x - $30 = 0$ yields $x = 30$. Therefore, the *x*-intercepts of the graph of $y = fx$ are -$12, 0$ and $30, 0$. Of these two *x*-intercepts, only -$12, 0$ is given as a choice.

Choice B is incorrect and may result from conceptual or calculation errors.

Choice C is incorrect and may result from conceptual or calculation errors.

Choice D is incorrect and may result from conceptual or calculation errors.

Question Difficulty: Medium

Question ID a26c29f7

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: a26c29f7

The function f is defined by $f(x) = 7x^3$. In the *xy*-plane, the graph of $y = g(x)$ is the result of shifting the graph of $y = f(x)$ down 2 units. Which equation defines function g?

A. $g(x) = \frac{7}{2}x^3$

B. $g(x) = 7x^{\frac{3}{2}}$

C. $g(x) = 7x^3 + 2$

D. $g(x) = 7x^3 - 2$

ID: a26c29f7 Answer

Correct Answer: D

Rationale

Choice D is correct. If the graph of $y = gx$ is the result of shifting the graph of $y = fx$ down k units in the *xy*-plane, the function g can be defined by an equation of the form $gx = fx$ - k. It's given that $fx = 7x^3$ and the graph of $y = gx$ is the result of shifting the graph of $y = fx$ down 2 units. Substituting $7x^3$ for fx and 2 for k in the equation $gx = fx$ - k yields $gx = 7x^3$ - 2 .

Choice A is incorrect and may result from conceptual errors.

Choice B is incorrect and may result from conceptual errors.

Choice C is incorrect. This equation defines a function g for which the graph of $y = gx$ is the result of shifting the graph of $y = fx$ up, not down, 2 units.

Question Difficulty: Medium

Question ID e1391dd6

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: e1391dd6

According to Moore's law, the number of transistors included on microprocessors doubles every 2 years. In 1985, a microprocessor was introduced that had 275,000 transistors. Based on this information, in which of the following years does Moore's law estimate the number of transistors to reach 1.1 million?

A. 1987

B. 1989

C. 1991

D. 1994

ID: e1391dd6 Answer

Rationale

Choice B is correct. Let x be the number of years after 1985. It follows that $\frac{x}{2}$ represents the number of 2-year periods that will occur within an x-year period. According to Moore's law, every 2 years, the number of transistors included on microprocessors is estimated to double. Therefore, x years after 1985, the number of transistors will double $\frac{x}{2}$ times. Since the number of transistors included on a microprocessor was 275,000, or .275 million, in 1985, the estimated number of transistors, in millions, included x years after 1985 can be modeled as $0.275 \cdot 2^{\frac{x}{2}}$. The year in which the number of transistors is estimated to be 1.1 million is represented by the value of x when $1.1 = 0.275 \cdot 2^{\frac{x}{2}}$. Dividing both sides of this equation by .275 yields $4 = 2^{\frac{x}{2}}$, which can be rewritten as $2^2 = 2^{\frac{x}{2}}$. Since the exponential equation has equal bases on each side, it follows that the exponents must also be equal: $2 = \frac{x}{2}$. Multiplying both sides of the equation $2 = \frac{x}{2}$ by 2 yields $x = 4$. Therefore, according to Moore's law, 4 years after 1985, or in 1989, the number of transistors included on microprocessors is estimated to reach 1.1 million.

Alternate approach: According to Moore's law, 2 years after 1985 (in 1987), the number of transistors included on a microprocessor is estimated to be $2 \cdot 275{,}000$, or 550,000, and 2 years after 1987 (in 1989), the number of transistors included on microprocessors is estimated to be $2 \cdot 550{,}000$, or 1,100,000. Therefore, the year that Moore's law estimates the number of transistors on microprocessors to reach 1.1 million is 1989.

Choices A, C, and D are incorrect. According to Moore's law, the number of transistors included on microprocessors is estimated to reach 550,000 in 1987, 2.2 million in 1991, and about 6.2 million in 1994.

Question Difficulty: Medium

Question ID 4209aefe

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 4209aefe

The function $f(x) = 206(1.034)^x$ models the value, in dollars, of a certain bank account by the end of each year from 1957 through 1972, where x is the number of years after 1957. Which of the following is the best interpretation of "$f(5)$ is approximately equal to 243" in this context?

A. The value of the bank account is estimated to be approximately 5 dollars greater in 1962 than in 1957.

B. The value of the bank account is estimated to be approximately 243 dollars in 1962.

C. The value, in dollars, of the bank account is estimated to be approximately 5 times greater in 1962 than in 1957.

D. The value of the bank account is estimated to increase by approximately 243 dollars every 5 years between 1957 and 1972.

ID: 4209aefe Answer

Correct Answer: B

Rationale

Choice B is correct. It's given that the function $fx = 2061.034^x$ models the value, in dollars, of a certain bank account by the end of each year from 1957 through 1972, where x is the number of years after 1957. It follows that fx represents the estimated value, in dollars, of the bank account x years after 1957. Since the value of $f5$ is the value of fx when $x = 5$, it follows that "$f5$ is approximately equal to 243" means that fx is approximately equal to 243 when $x = 5$. In the given context, this means that the value of the bank account is estimated to be approximately 243 dollars 5 years after 1957. Therefore, the best interpretation of the statement "$f5$ is approximately equal to 243" in this context is the value of the bank account is estimated to be approximately 243 dollars in 1962.

Choice A is incorrect and may result from conceptual errors.

Choice C is incorrect and may result from conceptual errors.

Choice D is incorrect and may result from conceptual errors.

Question Difficulty: Medium

Question ID 5bf0f84a

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 5bf0f84a

$h(t) = -16t^2 + 110t + 72$

The function above models the height h, in feet, of an object above ground t seconds after being launched straight up in the air. What does the number 72 represent in the function?

A. The initial height, in feet, of the object

B. The maximum height, in feet, of the object

C. The initial speed, in feet per second, of the object

D. The maximum speed, in feet per second, of the object

ID: 5bf0f84a Answer

Correct Answer: A

Rationale

Choice A is correct. The variable t represents the seconds after the object is launched. Since $h(0) = 72$, this means that the height, in feet, at 0 seconds, or the initial height, is 72 feet.

Choices B, C, and D are incorrect and may be the result of misinterpreting the function in context.

Question Difficulty: Medium

Question ID 70ebd3d0

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 70ebd3d0

$N(d) = 115(0.90)^d$

The function N defined above can be used to model the number of species of brachiopods at various ocean depths d, where d is in hundreds of meters. Which of the following does the model predict?

A. For every increase in depth by 1 meter, the number of brachiopod species decreases by 115.

B. For every increase in depth by 1 meter, the number of brachiopod species decreases by 10%.

C. For every increase in depth by 100 meters, the number of brachiopod species decreases by 115.

D. For every increase in depth by 100 meters, the number of brachiopod species decreases by 10%.

ID: 70ebd3d0 Answer

Correct Answer: D

Rationale

Choice D is correct. The function N is exponential, so it follows that $N(d)$ changes by a fixed percentage for each increase in d by 1. Since d is measured in hundreds of meters, it also follows that the number of brachiopod species changes by a fixed percentage for each increase in ocean depth by 100 meters. Since the base of the exponent in the model is 0.90, which is less than 1, the number of brachiopod species decreases as the ocean depth increases. Specifically, the number of brachiopod species at a depth of $d + 100$ meters is 90% of the number of brachiopod species at a depth of d meters. This means that for each increase in ocean depth by 100 meters, the number of brachiopod species decreases by 10%.

Choices A and C are incorrect. These describe situations where the number of brachiopod species are decreasing linearly rather than exponentially. Choice B is incorrect and results from interpreting the decrease in the number of brachiopod species as 10% for every 1-meter increase in ocean depth rather than for every 100-meter increase in ocean depth.

Question Difficulty: Medium

Question ID 97158b3a

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 97158b3a

The area *A*, in square centimeters, of a rectangular painting can be represented by the expression $w(w+29)$, where w is the width, in centimeters, of the painting. Which expression represents the length, in centimeters, of the painting?

A. w

B. 29

C. $(w+29)$

D. $w(w+29)$

ID: 97158b3a Answer

Correct Answer: C

Rationale

Choice C is correct. It's given that the expression $ww+29$ represents the area, in square centimeters, of a rectangular painting, where w is the width, in centimeters, of the painting. The area of a rectangle can be calculated by multiplying its length by its width. It follows that the length, in centimeters, of the painting is represented by the expression $w+29$.

Choice A is incorrect. This expression represents the width, in centimeters, of the painting, not its length, in centimeters.

Choice B is incorrect. This is the difference between the length, in centimeters, and the width, in centimeters, of the painting, not its length, in centimeters.

Choice D is incorrect. This expression represents the area, in square centimeters, of the painting, not its length, in centimeters.

Question Difficulty: Medium

Question ID dba7432e

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: dba7432e

x	$f(x)$
0	5
1	$\frac{5}{2}$
2	$\frac{5}{4}$
3	$\frac{5}{8}$

The table above gives the values of the function f for some values of x. Which of the following equations could define f?

A. $f(x) = 5(2^{x+1})$

B. $f(x) = 5(2^{x})$

C. $f(x) = 5(2^{-(x+1)})$

D. $f(x) = 5(2^{-x})$

ID: dba7432e Answer

Correct Answer: D

Rationale

Choice D is correct. Each choice has a function with coefficient 5 and base 2, so the exponents must be analyzed. When the input value of x increases, the output value of f(x) decreases, so the exponent must be negative. An exponent of –x yields the values in the table: $5 = 5(2^{-0})$, $\frac{5}{2} = 5(2^{-1})$, $\frac{5}{4} = (2^{-2})$, and $\frac{5}{8} = 5(2^{-3})$.

Choices A and B are incorrect and may result from choosing equations that yield an increasing, rather than decreasing, output value of f(x) when the input value of x increases. Choice C is incorrect and may result from choosing an equation that doesn't yield the values in the table.

Question Difficulty: Medium

Question ID b7cd6ca6

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: b7cd6ca6

The equation $E(t) = 5(1.8)^t$ gives the estimated number of employees at a restaurant, where t is the number of years since the restaurant opened. Which of the following is the best interpretation of the number 5 in this context?

A. The estimated number of employees when the restaurant opened

B. The increase in the estimated number of employees each year

C. The number of years the restaurant has been open

D. The percent increase in the estimated number of employees each year

ID: b7cd6ca6 Answer

Correct Answer: A

Rationale

Choice A is correct. For an exponential function of the form $Et = ab^t$, where a and b are constants, the initial value of the function—that is, the value of the function when $t = 0$—is a and the value of the function increases by a factor of b each time t increases by 1. Since the function $Et = 51.8^t$ gives the estimated number of employees at a restaurant and t is the number of years since the restaurant opened, the best interpretation of the number 5 in this context is the estimated number of employees when $t = 0$, or when the restaurant opened.

Choice B is incorrect and may result from conceptual errors.

Choice C is incorrect and may result from conceptual errors.

Choice D is incorrect and may result from conceptual errors.

Question Difficulty: Medium

Question ID f5e8ccf1

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: f5e8ccf1

$f(x) = (x+4)(x-1)(2x-3)$

The function f is defined above. Which of the following is NOT an x-intercept of the graph of the function in the xy-plane?

A. $(-4, 0)$

B. $\left(-\frac{2}{3}, 0\right)$

C. $(1, 0)$

D. $\left(\frac{3}{2}, 0\right)$

ID: f5e8ccf1 Answer

Correct Answer: B

Rationale

Choice B is correct. The graph of the function f in the xy-plane has x-intercepts at the points (x,y), where $y = f(x) = 0$. Substituting 0 for $f(x)$ in the given equation yields $0 = (x+4)(x-1)(2x-3)$. By the zero product property, if $0 = (x+4)(x-1)(2x-3)$, then $x+4=0$, $x-1=0$, or $2x-3=0$. Solving each of these linear equations for x, it follows that $x=-4$, $x=1$, and $x=\frac{3}{2}$, respectively. This means that the graph of the function f in the xy-plane has three x-intercepts: $(-4,0)$, $(1,0)$, and $\left(\frac{3}{2},0\right)$. Therefore, $\left(-\frac{2}{3},0\right)$ isn't an x-intercept of the graph of the function f.

Alternate approach: Substitution may be used. Since by definition an x-intercept of any graph is a point in the form $(k,0)$ where k is a constant, and since all points in the options are in this form, it need only be checked whether the points in the options lie on the graph of the function f. Substituting $-\frac{2}{3}$ for x and 0 for $f(x)$ in the given equation yields $0=\left(-\frac{2}{3}+4\right)\left(-\frac{2}{3}-1\right)\left(2\left(-\frac{2}{3}\right)-3\right)$, or $0=\frac{650}{27}$. Therefore, the point $\left(-\frac{2}{3},0\right)$ doesn't lie on the graph of the function f and can't be an x-intercept of the graph.

Choices A, C, and D are incorrect because each of these points is an x-intercept of the graph of the function f in the xy-plane. By definition, an x-intercept is a point on the graph of the form $(k,0)$, where k is a constant. Substituting -4 for x and 0 for $f(x)$ in the given equation yields $0=(-4+4)(-4-1)(2(-4)-3)$, or $0=0$. Since this is a true statement, the point

$(-4,0)$ lies on the graph of the function f and is an x-intercept of the graph. Performing similar substitution using the points $(1,0)$ and $\left(\frac{3}{2},0\right)$ also yields the true statement $0=0$, illustrating that these points also lie on the graph of the function f and are x-intercepts of the graph.

Question Difficulty: Medium

Question ID 981aca65

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 981aca65

$$f(x) = \frac{a-19}{x} + 5$$

In the given function f, a is a constant. The graph of function f in the *xy*-plane, where $y = f(x)$, is translated 3 units down and 4 units to the right to produce the graph of $y = g(x)$. Which equation defines function g?

A. $g(x) = \frac{a-19}{x+4} + 2$

B. $g(x) = \frac{a-19}{x-4} + 2$

C. $g(x) = \frac{a-22}{x+4} + 5$

D. $g(x) = \frac{a-22}{x-4} + 5$

ID: 981aca65 Answer

Correct Answer: B

Rationale

Choice B is correct. It's given that the graph of $y = gx$ is produced by translating the graph of $y = fx$ 3 units down and 4 units to the right in the *xy*-plane. Therefore, function g can be defined by an equation in the form $gx = fx$ - 4 - 3. Function f is defined by the equation $fx = \frac{a\text{ - }19}{x} + 5$, where a is a constant. Substituting x - 4 for x in the equation $fx = \frac{a\text{ - }19}{x} + 5$ yields fx - 4 $= \frac{a\text{ - }19}{x\text{ - }4} + 5$. Substituting $\frac{a\text{ - }19}{x\text{ - }4} + 5$ for fx - 4 in the equation $gx = fx$ - 4 - 3 yields $gx = \frac{a\text{ - }19}{x\text{ - }4} + 5$ - 3, or $gx = \frac{a\text{ - }19}{x\text{ - }4} + 2$. Therefore, the equation that defines function g is $gx = \frac{a\text{ - }19}{x\text{ - }4} + 2$.

Choice A is incorrect. This equation defines a function whose graph is produced by translating the graph of $y = fx$ 3 units down and 4 units to the left, not 3 units down and 4 units to the right.

Choice C is incorrect. This equation defines a function whose graph is produced by translating the graph of $y = fx$ 4 units to the left, not 3 units down and 4 units to the right.

Choice D is incorrect. This equation defines a function whose graph is produced by translating the graph of $y = fx$ 4 units to the right, not 3 units down and 4 units to the right.

Question Difficulty: Medium

Question ID 5c00c2c1

Assessment	Test	Domain	Skill	Difficulty
SAT	Math	Advanced Math	Nonlinear functions	■■□

ID: 5c00c2c1

There were no jackrabbits in Australia before 1788 when 24 jackrabbits were introduced. By 1920 the population of jackrabbits had reached 10 billion. If the population had grown exponentially, this would correspond to a 16.2% increase, on average, in the population each year. Which of the following functions best models the population $p(t)$ of jackrabbits t years after 1788?

A. $p(t) = 1.162(24)^t$

B. $p(t) = 24(2)^{1.162t}$

C. $p(t) = 24(1.162)^t$

D. $p(t) = (24 \cdot 1.162)^t$

ID: 5c00c2c1 Answer

Correct Answer: C

Rationale

Choice C is correct. This exponential growth model can be written in the form $p(t) = A(1 + r)^t$, where $p(t)$ is the population t years after 1788, A is the initial population, and r is the yearly growth rate, expressed as a decimal. Since there were 24 jackrabbits in Australia in 1788, $A = 24$. Since the number of jackrabbits increased by an average of 16.2% each year, $r = 0.162$. Therefore, the equation that best models this situation is $p(t) = 24(1.162)^t$.

Choices A, B, and D are incorrect and may result from misinterpreting the form of an exponential growth model.

Question Difficulty: Medium