Functionforge — Activity Book

A Spark & Anvil activity book — puzzles, questions, and fun from Functionforge.

Write in the book, circle your answers, and check the Answer Key at the back.

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1. Input-Output Machines: Understanding Functions

Circle the correct answer

1. A function machine takes an input and always gives exactly one output. If you put 3 into a machine and get 7, put 5 in and get 11, and put 8 in and get 17, what is the rule?
(A) Square the input and subtract 2 (B) Multiply by 3 and subtract 2 (C) Multiply by 2 and add 1 (output = 2 × input + 1) (D) Add 4 to the input

2. What makes something a 'function' in mathematics?
(A) It must use only whole numbers (B) Every input gives exactly one output — the same input always produces the same result (C) It must involve multiplication (D) The output must always be larger than the input

3. Which of the following is NOT a function?
(A) A machine that always outputs 5 regardless of input (B) A machine that doubles every input (C) A machine that adds the input to itself (D) A machine where you input 4 and sometimes get 8, sometimes get 10

4. A function table shows: Input 1 → Output 4, Input 2 → Output 7, Input 3 → Output 10, Input 4 → Output 13. What output would Input 6 give?
(A) 18 (B) 22 (C) 16 (D) 19

5. What is an 'input' in a function?
(A) The value you put into the function — the starting number that the rule acts on (B) The rule itself that changes numbers (C) The answer you get after applying the rule (D) The name of the function

6. Two function machines are connected in a chain. Machine A doubles the input. Machine B adds 3. If you put 5 into Machine A first, then feed the result into Machine B, what is the final output?
(A) 16 (B) 11 (C) 10 (D) 13

Write the answer

7. Is a constant function (a machine that always outputs 7 no matter what you input) still a function? Why or why not?
Answer: _____

8. Look at this function table: Input 2 → Output 6, Input 4 → Output 12, Input 7 → Output 21, Input 10 → Output 30. What is the function rule?
Answer: _____

9. What is the difference between a function rule and a pattern?
Answer: _____

10. A function has the rule: output = input + input. What is another way to write this rule?
Answer: _____

Match each question to its answer

1. In a function, if the output is always less than the input, which of these could be the rule? →
2. A 'reverse function' undoes what the original function does. If a function adds 5, what does its reverse function do? →
3. You have a mystery function machine. You input 0 and get 4. You input 1 and get 4. You input 100 and get 4. What is the rule? →
4. A function table has a gap: Input 2 → Output 8, Input 3 → Output 12, Input 5 → Output ?, Input 7 → Output 28. What is the missing output? →
5. Which real-world situation is BEST modeled by a function? →

(A) Subtract 5
(B) 20
(C) Subtract 3 from the input (output = input − 3)
(D) The output is always 4, regardless of the input (constant function: output = 4)
(E) The total cost of apples at $2 each — for any number of apples, there is exactly one total cost

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2. Function Tables and Growing Patterns

Circle the correct answer

11. A growing pattern uses square tiles. Step 1 has 3 tiles, Step 2 has 5 tiles, Step 3 has 7 tiles. How many tiles will Step 6 have?
(A) 11 (B) 12 (C) 15 (D) 13

12. What does it mean when we say a function table shows a 'constant rate of change'?
(A) The table has the same number of rows and columns (B) The output increases by the same amount each time the input increases by 1 (C) The input and output are always the same number (D) The output stays the same no matter what the input is

13. Complete this function table using the rule 'output = input × 2 + 3': Input 1 → ?, Input 4 → ?, Input 7 → ?, Input 10 → ?
(A) 5, 10, 15, 20 (B) 5, 11, 17, 23 (C) 5, 11, 14, 23 (D) 6, 12, 18, 24

14. A visual pattern shows triangles: Step 1 has 1 triangle, Step 2 has 3 triangles arranged in a row, Step 3 has 6 triangles in a triangular shape, Step 4 has 10 triangles. These are called triangular numbers. What is the 5th triangular number?
(A) 15 (B) 14 (C) 12 (D) 16

15. In a function table, the input goes: 0, 1, 2, 3, 4. The output goes: 2, 5, 8, 11, 14. What is the starting value and the rate of change?
(A) Starting value is 3 and rate of change is 2, as this is what research and standard practice suggests (B) Starting value is 5 and rate of change is 1, and this principle applies across similar situations (C) Starting value is 2 (output when input is 0) and the rate of change is 3 (output increases by 3 for each increase of 1 in input) (D) Starting value is 0 and rate of change is 2, and this principle applies across similar situations

16. A snail grows 2 centimeters per week. It was 5 cm long at the start. Make a function table for weeks 0-4 and state the rule.
(A) Week 0: 5cm, Week 1: 7cm, Week 2: 9cm, Week 3: 11cm, Week 4: 13cm. Rule: length = 2 × week + 5 (B) Week 0: 2cm, Week 1: 4cm, Week 2: 6cm, Week 3: 8cm, Week 4: 10cm (C) Week 0: 5cm, Week 1: 10cm, Week 2: 15cm, Week 3: 20cm, Week 4: 25cm (D) Week 0: 0cm, Week 1: 5cm, Week 2: 7cm, Week 3: 9cm, Week 4: 11cm

Write the answer

17. Two function tables are shown. Table A: inputs 1,2,3,4 → outputs 3,6,9,12. Table B: inputs 1,2,3,4 → outputs 3,5,7,9. Which table shows a rule that involves multiplication?
Answer: _____

18. A growing pattern uses toothpicks. 1 square needs 4 toothpicks. 2 squares in a row need 7 toothpicks. 3 squares need 10. How many toothpicks for 10 squares in a row?
Answer: _____

19. What happens to the outputs in a function table when you double all the inputs, if the rule is 'output = input + 5'?
Answer: _____

20. A function table has these pairs: (1, 1), (2, 4), (3, 9), (4, 16), (5, 25). How does the DIFFERENCE between consecutive outputs change?
Answer: _____

Match each question to its answer

1. If you know that a function's output is 20 when the input is 4, and the output is 30 when the input is 6, what is the rate of change? →
2. A visual pattern shows L-shaped figures. Step 1 has 3 squares, Step 2 has 5 squares, Step 3 has 7 squares. Which description matches how the pattern grows? →
3. You have two function tables with the SAME outputs but different inputs. Table X: input 1→5, 2→10, 3→15. Table Y: input 2→5, 4→10, 6→15. What can you conclude? →
4. A cafeteria charges $3 for a lunch tray plus $1 per extra item. Complete the function table for 0, 1, 2, 3 extra items and write the rule. →
5. In a function table, the output for input 3 is 15, and the output for input 8 is 15 also. Is this possible for a function? →

(A) 0 extras: $3, 1 extra: $4, 2 extras: $5, 3 extras: $6. Rule: cost = $3 + $1 × extras
(B) They are different functions with different rules: Table X is output = 5 × input, Table Y is output = 2.5 × input
(C) Yes — different inputs CAN have the same output in a function. The rule might be 'always output 15' or a more complex rule that produces 15 for both these inputs
(D) Each step adds 2 squares — one to the bottom and one to the right of the L-shape
(E) 5 per input unit (the output increases by 10 when the input increases by 2, so 10 ÷ 2 = 5)

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3. Variables, Expressions, and Simple Equations

Circle the correct answer

21. What does the variable 'n' represent in the expression n + 7?
(A) The number 14 specifically (B) An unknown number that can change (C) The letter after 'm' in the alphabet (D) A mistake in the math problem

22. Evaluate the expression 3x + 2 when x = 4.
(A) 12 (B) 9 (C) 14 (D) 32

23. Which expression represents 'five more than twice a number'?
(A) 2(n + 5) (B) 5 × 2 + n (C) 2n + 5 (D) 5n + 2

24. What is a coefficient in the expression 7y + 3?
(A) The number 7, which multiplies the variable y (B) The constant 3 (C) The variable y (D) The plus sign between the terms

25. Solve for x: x + 9 = 15
(A) x = 15 (B) x = 24 (C) x = 6 (D) x = 9

26. Which of these is an equation rather than an expression?
(A) 3x + 1 (B) 3x + 1 = 10 (C) 4(n + 3) (D) 2y − 7

Write the answer

27. Simplify: 4a + 3a
Answer: _____

28. A pizza costs $12 and each topping costs $2. Which expression represents the total cost with t toppings?
Answer: _____

29. What does it mean to 'solve' an equation?
Answer: _____

30. Solve for y: 3y = 21
Answer: _____

Match each question to its answer

1. Are 5x and $5x^2$ like terms that can be combined? →
2. If the expression 2(n + 3) is expanded, what do you get? →
3. What is the constant term in the expression 4m + 9? →
4. A student writes the equation n − 5 = 12 and solves it by subtracting 5 from both sides, getting n = 7. What error did they make? →
5. Evaluate the expression 2a + b when a = 5 and b = 3. →

(A) 2n + 6
(B) They should have added 5 to both sides, not subtracted
(C) No, because the variables have different exponents
(D) 9
(E) 13

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4. Graphing Functions on the Coordinate Plane

Circle the correct answer

31. On a coordinate plane, which axis is horizontal (side to side)?
(A) The origin axis (B) The y-axis (C) The x-axis (D) The z-axis

32. What is the ordered pair for the origin of a coordinate plane?
(A) (1, 1) (B) (0, 1) (C) (0, 0) (D) (1, 0)

33. Plot the point (3, 5) on a coordinate plane. Which direction do you move first?
(A) Right 3 units along the x-axis (B) Up 5 units along the y-axis (C) Right 5 units along the x-axis (D) Up 3 units along the y-axis

34. A function rule is y = x + 2. What ordered pair does this give when x = 3?
(A) (5, 3) (B) (3, 2) (C) (2, 3) (D) (3, 5)

35. When you graph the function y = 2x using the points (0,0), (1,2), (2,4), (3,6), what shape does the graph form?
(A) A circle (B) A zigzag pattern (C) A straight line (D) A curve

36. A graph shows a line passing through (0, 3) and (1, 5). What is the function rule?
(A) y = 3x + 2 (B) y = x + 3 (C) y = 5x (D) y = 2x + 3

Write the answer

37. What does the point (4, 12) mean on the graph of y = 3x?
Answer: _____

38. Which quadrant contains the point (−3, 5)?
Answer: _____

39. Complete the table for y = x − 1:
| x | 0 | 1 | 2 | 3 |
| y | ? | ? | ? | ? |
Answer: _____

40. Two function graphs are shown. Function A passes through (0,1) and (3,7). Function B passes through (0,2) and (3,5). Which function has a greater rate of change?
Answer: _____

Match each question to its answer

1. If a graph of a function passes the 'vertical line test,' what does that tell you? →
2. What is the distance between points (2, 1) and (2, 7) on the coordinate plane? →
3. A function's graph starts at (0, 10) and goes down to (5, 0). What does this tell you about the relationship? →

4. A student plots the point (5, 3) but accidentally switches the coordinates and plots (3, 5). How far apart are the two points? →
5. Graph the function y = x + 3 for x = 0, 1, 2, 3, 4. Where does the line cross the y-axis? →

(A) At y = 3 (the point (0, 3))
(B) The output decreases as the input increases — it's a decreasing function
(C) 6 units
(D) Each input (x-value) has exactly one output (y-value)
(E) They are not on the same horizontal or vertical line, so you'd need the distance formula — but they're roughly 2.8 units apart

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5. Linear Functions and Rate of Change

Circle the correct answer

41. What does the 'm' represent in the equation y = mx + b?
(A) The slope (rate of change) of the line (B) The midpoint of the line (C) The x-coordinate of the starting point (D) The y-intercept

42. Calculate the slope between the points (1, 3) and (4, 12).
(A) 4 (B) 1/3 (C) 9 (D) 3

43. A function has a slope of 0. What does its graph look like?
(A) A single point (B) A line going up from left to right (C) A horizontal line (D) A vertical line

44. Write the equation of a line with slope 4 and y-intercept −2.
(A) y = −2x + 4 (B) y = −4x − 2 (C) y = 4x − 2 (D) y = 4x + 2

45. Which of these functions is NOT linear?
A: y = 3x + 1
B: y = x^2
C: y = −5x
D: y = 7
(A) B: y = x^2 (B) D: y = 7 (C) A: y = 3x + 1 (D) C: y = −5x

46. A phone plan charges $30/month plus $0.10 per text message. Identify the slope and y-intercept in this context.
(A) Slope = $30 per month; y-intercept = $0.10 (B) Slope = $30.10; y-intercept = 0 (C) Slope = 10; y-intercept = 30 (D) Slope = $0.10 per text (rate per message); y-intercept = $30 (monthly base cost)

Write the answer

47. What does a negative slope tell you about a linear function?
Answer: _____

48. Find the slope from this table:
| x | 0 | 2 | 4 | 6 |
| y | 1 | 5 | 9 | 13 |
Answer: _____

49. Is the relationship y = 3x proportional or non-proportional? How do you know?
Answer: _____

50. Two lines have equations y = 2x + 1 and y = 2x + 5. How do their graphs compare?
Answer: _____

Match each question to its answer

1. A line passes through (2, 7) and (5, 7). What is the slope? →
2. A candle is 12 inches tall and burns at 2 inches per hour. Write a function for the candle's height h after t hours. →
3. Is this table linear? Why or why not?
| x | 1 | 2 | 3 | 4 |
| y | 2 | 4 | 8 | 16 | →
4. What is the unit rate in the proportional relationship y = 7x? →
5. A line passes through (0, 4) and (3, 10). Write its equation in slope-intercept form. →

(A) y = 2x + 4
(B) No — the rate of change is not constant (differences are 2, 4, 8)
(C) 0
(D) 7 — for every 1 unit increase in x, y increases by 7
(E) h = −2t + 12

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6. Non-Linear Functions: Quadratics and Exponentials

Circle the correct answer

51. What shape does the graph of $y = x^2$ make?
(A) A straight line (B) A circle (C) A U-shaped curve called a parabola (D) A zigzag pattern

52. For the function $y = x^2$, what are the outputs when $x = -3$ and $x = 3$?
(A) $x = -3$ gives $y = -9$ and $x = 3$ gives $y = 9$ (B) Both give $y = 9$ (C) $x = -3$ gives $y = 6$ and $x = 3$ gives $y = 9$ (D) $x = -3$ gives $y = -6$ and $x = 3$ gives $y = 6$

53. How can you tell from a table whether a function is linear or quadratic?
| x | 0 | 1 | 2 | 3 | 4 |
| y | 0 | 1 | 4 | 9 | 16 |
(A) Because the table has 5 entries, it's quadratic (B) Check if y/x is constant — it isn't, so it's quadratic, which is the most common explanation for this phenomenon (C) The y-values are increasing, so it must be linear, making this the most widely accepted explanation (D) Check the differences: first differences (1,3,5,7) are NOT constant, but second differences (2,2,2) are — indicating quadratic

54. A ball is thrown upward. Its height after t seconds is $h = -16t^2 + 48t$. What is the maximum height?
(A) 36 feet (at t = 1.5 seconds) (B) 16 feet (at t = 2 seconds) (C) 48 feet (at t = 1 second) (D) 64 feet (at t = 3 seconds)

55. What does 'exponential growth' mean?
(A) The output increases by a constant amount each time (B) The output grows faster than any other function (C) The output multiplies by the same factor for each unit increase in input (D) The function has an exponent somewhere in it

56. Complete the table for $y = 2^x$:
| x | 0 | 1 | 2 | 3 | 4 | 5 |
| y | ? | ? | ? | ? | ? | ? |
(A) 1, 2, 4, 8, 16, 32 (B) 2, 4, 8, 16, 32, 64 (C) 1, 2, 4, 16, 256, 65536 (D) 0, 2, 4, 6, 8, 10

Write the answer

57. How does the graph of $y = x^2$ compare to the graph of $y = 2^x$ as x gets very large?
Answer: _____

58. A population of bacteria doubles every hour. If you start with 100 bacteria, which function models the population after h hours?
Answer: _____

59. What is the vertex of the parabola $y = x^2 - 4$?
Answer: _____

60. Classify each function as linear, quadratic, or exponential:
A: $y = 3x + 7$

B: $y = x^2 + 2x$
C: $y = 5 \times 3^x$
Answer: _____

Match each question to its answer

1. If a quadratic function opens downward, what does that tell you about the leading coefficient? →
2. A rumor spreads so that each person tells 3 others each day. Starting with 1 person, how many people know after 5 days? →
3. Is the function $y = 3^x$ increasing or decreasing? What about $y = (1/2)^x$? →
4. The area of a square with side length s is $A = s^2$. If you double the side length, what happens to the area? →
5. What value does every exponential function $y = a \times b^x$ equal when x = 0? →

(A) 243 people (3^5)
(B) The area quadruples (becomes 4 times as large)
(C) $y = 3^x$ is increasing (base > 1); $y = (1/2)^x$ is decreasing (base between 0 and 1)
(D) a (the initial value), because $b^0 = 1$
(E) The leading coefficient is negative

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7. Function Analysis: Domain, Range, and Transformations

Circle the correct answer

61. What is the domain of a function?
(A) The highest and lowest points on the graph (B) The set of all possible input values (x-values) (C) The set of all possible output values (D) The area under the curve

62. What is the range of $y = x^2$?
(A) All real numbers (B) $y \geq 0$ (all non-negative real numbers) (C) $y > 0$ (all positive numbers) (D) $0 \leq y \leq 100$

63. A movie theater can seat 200 people. Tickets cost $12 each. What are the domain and range of the revenue function $R = 12t$?
(A) Domain: $0 to $2400. Range: 0 to 200. (B) Domain: $0 \leq t \leq 200$ (whole numbers). Range: $0 to $2400 (multiples of $12). (C) Domain: all real numbers. Range: all real numbers. (D) Domain: 0 to infinity. Range: 0 to infinity.

64. How does the graph of $y = x^2 + 3$ differ from $y = x^2$?
(A) It opens downward instead of upward, which is why this approach is recommended by experts (B) It is shifted 3 units upward — same shape, vertex at (0, 3) instead of (0, 0) (C) It is 3 times wider, and this has been consistently demonstrated in practice (D) It is shifted 3 units to the right, and this principle applies across similar situations

65. Describe the transformation from $y = x^2$ to $y = (x - 4)^2$.
(A) The graph shifts 4 units upward (B) The graph shifts 4 units to the left (C) The graph stretches horizontally by a factor of 4 (D) The graph shifts 4 units to the right — vertex moves from (0,0) to (4,0)

66. What transformation does the negative sign perform in $y = -x^2$?
(A) It reflects the parabola across the y-axis (B) It shifts the parabola below the x-axis (C) It reflects the parabola across the x-axis — flipping it upside down (D) It makes the parabola narrower

Write the answer

67. A graph shows a function that is increasing for $x < 2$ and decreasing for $x > 2$. What can you conclude about $x = 2$?
Answer: _____

68. Given the function $y = |x|$ (absolute value), what is its range?
Answer: _____

69. How does the graph of $y = 3|x|$ compare to $y = |x|$?
Answer: _____

70. A function f is defined by the graph below:

- Starts at (0, 2)
- Goes to (3, 8)
- Then goes to (6, 8)
- Then goes to (9, 2)

Over what interval is the function constant?
Answer: _____

Match each question to its answer

1. What is the effect of the transformation $y = f(x) + 5$ on any function f? →
2. Determine the domain of the function $y = 1/x$. What value of x is NOT allowed? →
3. Match each transformation to its effect:

1. y = f(x) + k
2. y = f(x − h)
3. y = af(x) where a > 1
4. y = −f(x) →

4. A piecewise function is defined as:
f(x) = 2x when x < 0
f(x) = x² when x ≥ 0

What is f(−3) and f(3)? →
5. What is the range of y = −x² + 4? →

(A) f(−3) = −6 and f(3) = 9
(B) Every point on the graph moves up 5 units
(C) x ≠ 0 (you cannot divide by zero)
(D) 1: shift up k, 2: shift right h, 3: vertical stretch, 4: reflect over x-axis
(E) y ≤ 4

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8. Capstone: Real-World Modeling and Function Fluency

Circle the correct answer

71. A scientist records cell growth:
| Hours | 0 | 1 | 2 | 3 | 4 |
| Cells | 50 | 100 | 200 | 400 | 800 |

What type of function best models this data?
(A) Quadratic — the differences get larger (B) None — real data doesn't follow exact patterns (C) Linear — the number increases each hour (D) Exponential — the cells double each hour (constant ratio of 2)

72. A bridge has a parabolic arch described by h = −0.01x² + 4x, where h is height in feet and x is horizontal distance. What is the maximum height of the arch?
(A) 400 feet (B) 4 feet (C) 100 feet (D) 200 feet

73. Function notation: if f(x) = 3x − 7, what does f(5) mean and what is its value?
(A) It means 'evaluate the function f at input x = 5.' f(5) = 3(5) − 7 = 8. (B) It means the 5th value in a sequence. f(5) = 5. (C) It means multiply f times 5. f(5) = 5f. (D) It means f equals 5. So 3x − 7 = 5, x = 4.

74. Two hikers start at the same trailhead. Hiker A walks at $y = 3x$ (miles after x hours). Hiker B starts 2 hours later walking at $y = 4(x - 2)$ for $x \geq 2$. When does B catch A?
(A) At $x = 6$ hours (B) At $x = 2$ hours (when B starts) (C) B never catches A (D) At $x = 8$ hours (both at 24 miles)

75. A graph shows temperature over a 24-hour period. It starts at 60°F at midnight, rises to 85°F at 2pm, and falls back to 62°F at midnight. Is this situation best modeled by a linear, quadratic, or other type of function?
(A) A quadratic (or sinusoidal) function — it rises to a peak and then falls symmetrically (B) Exponential — temperature grows quickly in the morning (C) No function can model this because it goes up and down (D) Linear — temperature changes at a constant rate

76. If $f(x) = x^2 + 1$ and $g(x) = 2x$, find $f(g(3))$.
(A) 20 (B) 19 (C) 7 (D) 37

Write the answer

77. A car's value depreciates 15% per year. If it's worth $20,000 new, write a function for its value after t years and find its value after 5 years.
Answer: _____

78. Two functions are defined:
f: {(1,3), (2,5), (3,7), (4,9)}
g: {(1,2), (2,2), (3,4), (4,4)}

Which one is a function? Or are both functions?
Answer: _____

79. A water tank fills at 5 gallons per minute for the first 10 minutes, then a valve reduces the flow to 2 gallons per minute. Write a piecewise function for the total water W after t minutes.
Answer: _____

80. Explain the difference between $f(x) = 2x$ (linear) and $f(x) = 2^x$ (exponential) in terms of how they grow.
Answer: _____

Match each question to its answer

1. A company's profit P depends on the number of items sold n: $P = -2n^2 + 120n - 400$. How many items maximize profit, and what is the maximum profit? →
2. Given the table, determine if the relationship is a function and explain:
| Student | Math Grade | Science Grade |
| Ana | 92 | 88 |

| Ben | 85 | 92 |
| Ana | 92 | 90 | →

3. A savings account earns 3% interest compounded annually. Starting with $1,000, write the function and compare it to simple interest (3% of $1,000 = $30 added yearly) after 20 years. →

4. A graph shows a function that is:

- Decreasing on $(-\infty, -1)$
- Increasing on $(-1, 3)$
- Decreasing on $(3, \infty)$

How many local maxima and minima does this function have? →

5. If f(2) = 10 and f(5) = 10, does this mean f is not a function? →

(A) If Student→Science, it's NOT a function because Ana maps to both 88 and 90. If Student→Math, it IS a function because Ana always maps to 92.

(B) No — a function CAN give the same output for different inputs. It just can't give different outputs for the same input.

(C) 30 items maximize profit at $1,400

(D) Compound: $A = 1000(1.03)^{20} \approx \$1{,}806$. Simple: $A = 1000 + 30(20) = \$1{,}600$. Compound earns $206 more.

(E) One local minimum at $x = -1$ and one local maximum at $x = 3$

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9. Foundational Concepts Review

Circle the correct answer

81. If a function's rule is 'add 10,' what input gives an output of 25?
(A) 35 (B) 25 (C) 15 (D) 10

82. What is the difference between a function rule and a pattern?
(A) Functions only work with large numbers while patterns work with small numbers, making this the most widely accepted explanation (B) There is no difference; they are the same thing, making this the most widely accepted explanation (C) Patterns use addition while functions use multiplication, as this directly follows from the underlying principles (D) A pattern describes a sequence of numbers, while a function rule describes the relationship between input and output — functions connect TWO quantities

83. A function table shows a negative rate of change: Input 0→20, Input 1→17, Input 2→14, Input 3→11. What does a negative rate of change mean in a real-world context?
(A) The function is broken because outputs should always increase (B) It means the input and output have different signs (C) Negative rate of change means the function goes backward in time (D) The output is DECREASING — like a candle getting shorter as it burns, losing 3 centimeters of height each hour

84. A visual pattern shows triangles: Step 1 has 1 triangle, Step 2 has 3 triangles arranged in a row, Step 3 has 6 triangles in a triangular shape, Step 4 has 10 triangles. These are called triangular numbers. What is the 5th triangular number?
(A) 16 (B) 15 (C) 12 (D) 14

85. What is the constant term in the expression $4m + 9$?
(A) 4 (B) 4m (C) m (D) 9

86. Which expression represents 'five more than twice a number'?
(A) $5 \times 2 + n$ (B) $5n + 2$ (C) $2n + 5$ (D) $2(n + 5)$

Write the answer

87. Solve the two-step equation: $2x + 3 = 11$
Answer: _____

88. Which quadrant contains the point $(-3, 5)$?
Answer: _____

89. Which table represents the function graphed as a line through (0, 0) and (2, 6)?
Answer: _____

90. Write the equation of a line with slope 4 and y-intercept −2.
Answer: _____

Match each question to its answer

1. For the function $y = x^2$, what are the outputs when $x = -3$ and $x = 3$? →
2. What does 'exponential growth' mean? →
3. Classify each function as linear, quadratic, or exponential:
A: $y = 3x + 7$
B: $y = x^2 + 2x$
C: $y = 5 \times 3^x$ →
4. How can you determine the domain and range of a function from its graph? →
5. Create a transformed function starting from $f(x) = |x|$ that has its vertex at $(-3, 2)$, opens downward, and is steeper than the original. Write the equation and describe each transformation. →

(A) The output multiplies by the same factor for each unit increase in input
(B) A = linear, B = quadratic, C = exponential
(C) Domain: look at the graph from left to right to see all x-values covered. Range: look from bottom to top to see all y-values reached.
(D) Both give y = 9
(E) y = −2|x + 3| + 2. Shift left 3, vertical stretch by 2, reflect over x-axis, shift up 2.

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10. Applied Problem Solving

Circle the correct answer

91. You have a mystery function machine. You input 0 and get 4. You input 1 and get 4. You input 100 and get 4. What is the rule?
(A) Output = input + 4, which is the most common explanation for this phenomenon (B) Output = 4 × input, and this principle applies across similar situations (C) The output is always 4, regardless of the input (constant function: output = 4) (D) There must be an error because the output should change

92. What makes something a 'function' in mathematics?
(A) Every input gives exactly one output — the same input always produces the same result (B) The output must always be larger than the input (C) It must involve multiplication (D) It must use only whole numbers

93. What is a 'function table'?
(A) An organized chart showing input-output pairs for a function, with inputs in one column and their corresponding outputs in another (B) A special desk used by mathematicians, making this the most widely accepted explanation (C) A table that can calculate any math problem, and this has been consistently demonstrated in practice (D) A multiplication table like the ones used in math class, and this principle applies across similar situations

94. Describe a real-world growing pattern that follows the rule 'output = 2 × step + 1' and explain what the 2 and the 1 represent in your example.
(A) A random sequence of numbers with no pattern, making this the most widely accepted explanation (B) Example: Building a fence — each section has 2 rails and 1 post is shared. Step 1: 2(1)+1=3 pieces. Step 2: 2(2)+1=5 pieces. The 2 represents rails per section, and the 1 represents the extra end post (C) Adding 2 to 1 repeatedly, giving 3, 3, 3, 3, which is the most common explanation for this phenomenon (D) Any situation involving the number 21, and this principle applies across similar situations

95. What does the variable 'n' represent in the expression n + 7?
(A) The letter after 'm' in the alphabet (B) An unknown number that can change (C) The number 14 specifically (D) A mistake in the math problem

96. How many terms are in the expression 2x + 5y − 3?
(A) 2 (B) 3 (C) 4 (D) 5

Write the answer

97. A rectangle has a perimeter of 30 cm. Its length is 9 cm. Which equation finds the width w?
Answer: _____

98. What is the reflection of the point (4, −2) across the x-axis?
Answer: _____

99. Complete the table for y = x − 1:
| x | 0 | 1 | 2 | 3 |
| y | ? | ? | ? | ? |
Answer: _____

100. Given the function y = −3x + 15, what is the x-intercept (where the line crosses the x-axis)?
Answer: _____

Match each question to its answer

1. The stopping distance of a car is approximately $d = 0.05v^2$ (where d is in feet and v is speed in mph). If you double your speed from 30 to 60 mph, what happens to the stopping distance? →
2. Is the function $y = 3^x$ increasing or decreasing? What about $y = (1/2)^x$? →
3. Explain the difference between f(x) = 2x (linear) and $f(x) = 2^x$ (exponential) in terms of how they grow. →
4. What is the range of $y = -x^2 + 4$? →
5. Write the equation of a parabola with vertex at (2, −1) that opens upward. →

(A) 2x adds 2 each step (constant addition). 2^x multiplies by 2 each step (constant multiplication). Exponential eventually far exceeds linear.
(B) $y = (x - 2)^2 - 1$
(C) $y \leq 4$
(D) $y = 3^x$ is increasing (base > 1); $y = (1/2)^x$ is decreasing (base between 0 and 1)
(E) It quadruples: from 45 feet to 180 feet

11. Critical Analysis & Evaluation

Circle the correct answer

101. Two function machines are connected in a chain. Machine A doubles the input. Machine B adds 3. If you put 5 into Machine A first, then feed the result into Machine B, what is the final output?
(A) 11 (B) 10 (C) 13 (D) 16

102. Which everyday device behaves MOST like a function machine?
(A) A dice — it gives a random number each time (B) A clock — its numbers go in a circle (C) A television — it shows many different channels (D) A calculator — you enter an input and press an operation, and it gives you exactly one result every time

103. Complete this function table using the rule 'output = input × 2 + 3': Input 1 → ?, Input 4 → ?, Input 7 → ?, Input 10 → ?
(A) 5, 10, 15, 20 (B) 5, 11, 14, 23 (C) 5, 11, 17, 23 (D) 6, 12, 18, 24

104. A growing pattern uses square tiles. Step 1 has 3 tiles, Step 2 has 5 tiles, Step 3 has 7 tiles. How many tiles will Step 6 have?
(A) 13 (B) 11 (C) 12 (D) 15

105. Why is it important to use inverse operations when solving equations?
(A) They eliminate the need for variables (B) They make the numbers larger (C) They undo the operation on the variable to isolate it (D) They always give you a positive answer

106. Are $5x$ and $5x^2$ like terms that can be combined?
(A) Yes, because they both contain x (B) No, because the variables have different exponents (C) Yes, because they both have the number 5 (D) No, because one has a coefficient and the other doesn't

Write the answer

107. Solve for x: $x + 9 = 15$
Answer: _____

108. Plot the point (3, 5) on a coordinate plane. Which direction do you move first?
Answer: _____

109. A function's graph starts at (0, 10) and goes down to (5, 0). What does this tell you about the relationship?
Answer: _____

110. A runner's distance function is d = 6t (miles after t hours). A cyclist's is d = 15t. Compare the rates and explain what happens if they start at the same time from the same place.

Answer: _____

Match each question to its answer

1. What are the x-intercepts (zeros) of the function $y = x^2 - 9$? →
2. Given the table:
| x | 0 | 1 | 2 | 3 |
| y | 5 | 15 | 45 | 135 |

Write the exponential function. →
3. Explain why the function $f(x) = 2^x$ can never equal zero or be negative, no matter what value of x you use. →
4. A function has domain [−3, 7] and range [0, 10]. If the function is shifted up 5 units, what is the new range? →
5. Why does the transformation y = f(x − 3) shift the graph RIGHT 3 units instead of left? This seems backwards. →

(A) [5, 15]
(B) Because x must be 3 units LARGER to produce the same y-value that f originally produced — the whole graph moves right to compensate
(C) x = 3 and x = −3
(D) Because 2 raised to any power is always positive — you're multiplying positive 2s together, which can never produce zero or a negative
(E) $y = 5 \times 3^x$

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12. Advanced Integration & Synthesis

Circle the correct answer

111. A function machine takes an input and always gives exactly one output. If you put 3 into a machine and get 7, put 5 in and get 11, and put 8 in and get 17, what is the rule?
(A) Multiply by 2 and add 1 (output = 2 × input + 1) (B) Multiply by 3 and subtract 2 (C) Square the input and subtract 2 (D) Add 4 to the input

112. A 'reverse function' undoes what the original function does. If a function adds 5, what does its reverse function do?
(A) Divide by 5 (B) Subtract 5 (C) Add 5 again (D) Multiply by 5

113. A snail grows 2 centimeters per week. It was 5 cm long at the start. Make a function table for weeks 0-4 and state the rule.
(A) Week 0: 5cm, Week 1: 10cm, Week 2: 15cm, Week 3: 20cm, Week 4: 25cm (B) Week 0: 2cm, Week 1: 4cm, Week 2: 6cm, Week 3: 8cm, Week 4: 10cm (C) Week 0: 5cm, Week 1: 7cm, Week 2: 9cm, Week 3: 11cm, Week 4: 13cm. Rule: length = 2 × week + 5 (D) Week 0: 0cm, Week 1: 5cm, Week 2: 7cm, Week 3: 9cm, Week 4: 11cm

114. A function table has these pairs: (1, 1), (2, 4), (3, 9), (4, 16), (5, 25). How does the DIFFERENCE between consecutive outputs change?
(A) The differences increase: 3, 5, 7, 9 — they grow by 2 each time (B) The differences are always the same: 3 (C) The differences decrease: 5, 4, 3, 2 (D) The differences alternate: 3, 5, 3, 5

115. Two hikers start at the same trailhead. Hiker A walks at $y = 3x$ (miles after x hours). Hiker B starts 2 hours later walking at $y = 4(x - 2)$ for $x \geq 2$. When does B catch A?
(A) At x = 8 hours (both at 24 miles) (B) At x = 6 hours (C) At x = 2 hours (when B starts) (D) B never catches A

116. Simplify: $4a + 3a$
(A) $7a$ (B) $7a^2$ (C) $43a$ (D) $12a$

Write the answer

117. Solve for m: $m/4 = 8$
Answer: _____

118. What is the distance between points (2, 1) and (2, 7) on the coordinate plane?
Answer: _____

119. A graph shows a line passing through (0, 3) and (1, 5). What is the function rule?
Answer: _____

120. A candle is 12 inches tall and burns at 2 inches per hour. Write a function for the candle's height h after t hours.
Answer: _____

Match each question to its answer

1. If a quadratic function opens downward, what does that tell you about the leading coefficient? →
2. Which table shows exponential growth?

Table A: x: 0,1,2,3 → y: 3,6,9,12
Table B: x: 0,1,2,3 → y: 3,6,12,24 →
3. Design a scenario where exponential growth is more realistic than linear growth. Explain your function and why it fits. →
4. Explain why a function like $f(x) = x^3$ has a domain and range of all real numbers, while $g(x) = x^2$ has all real numbers for domain but only $y \geq 0$ for range. →
5. How does the graph of $y = x^2 + 3$ differ from $y = x^2$? →

(A) Cubing preserves the sign (negative cubed is negative), so x^3 can produce any output. Squaring always gives a non-negative result, limiting the range.
(B) The leading coefficient is negative
(C) Social media followers doubling each week: $F = 10 \times 2^w$. This fits because each follower shares with friends, creating multiplicative growth, not additive.
(D) It is shifted 3 units upward — same shape, vertex at (0, 3) instead of (0, 0)
(E) Table B — each y-value is multiplied by 2 (constant ratio)

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13. Expressions

Circle the correct answer

121. Is a constant function (a machine that always outputs 7 no matter what you input) still a function? Why or why not?
(A) No, because it ignores the input completely (B) Yes, it is a function because every input still gives exactly one output — the rule is just 'always output 7' (C) No, because the output never changes (D) No, because a real function must use the input in its calculation

122. Solve for y: $3y = 21$
(A) $y = 63$ (B) $y = 7$ (C) $y = 18$ (D) $y = 24$

123. Explain how a table, an equation, and a graph are three different ways to show the same function. Use $y = x + 4$ as an example.
(A) The table is the most accurate, while the graph and equation are estimates, which is why this approach is recommended by experts (B) The table lists specific input-output pairs, the equation gives the general rule, and the graph visually shows all pairs as a line — all three describe the same relationship (C) They show different functions that look similar, and this has been consistently demonstrated in practice (D) Only the equation is the 'real' function; tables and graphs are just tools, and this principle applies across similar situations

124. What does the 'm' represent in the equation y = mx + b?
(A) The slope (rate of change) of the line (B) The x-coordinate of the starting point (C) The midpoint of the line (D) The y-intercept

125. A population of bacteria doubles every hour. If you start with 100 bacteria, which function models the population after h hours?
(A) $P = 100 \times 2^h$ (B) $P = 100h^2$ (C) $P = 2h + 100$ (D) $P = 200h$

126. Compare linear ($y = 5x$), quadratic ($y = x^2$), and exponential ($y = 2^x$) functions at $x = 10$ and explain which type eventually dominates.
(A) Linear dominates because it has the largest coefficient (5) (B) Quadratic always dominates because squaring is the most powerful operation (C) They all grow at the same rate for large x (D) At x=10: linear=50, quadratic=100, exponential=1024. Exponential always wins for large x, then quadratic, then linear.

Write the answer

127. A student measures the height of a plant weekly:
| Week | 0 | 1 | 2 | 3 | 4 |
| cm | 5 | 8 | 11| 14| 17|

Another student's plant:
| Week | 0 | 1 | 2 | 3 | 4 |
| cm | 3 | 6 | 12| 24| 48|

Compare the growth patterns and predict each plant's height at week 8.
Answer: _____

128. A function has the rule: output = input + input. What is another way to write this rule?
Answer: _____

129. If you know that a function's output is 20 when the input is 4, and the output is 30 when the input is 6, what is the rate of change?
Answer: _____

130. What is the unit rate in the proportional relationship $y = 7x$?
Answer: _____

Match each question to its answer

1. A rumor spreads so that each person tells 3 others each day. Starting with 1 person, how many people know after 5 days? →
2. Complete the table for $y = 2^x$:
| x | 0 | 1 | 2 | 3 | 4 | 5 |

| y | ? | ? | ? | ? | ? | ? | →
3. Given the function y = |x| (absolute value), what is its range? →
4. Which of these functions is NOT linear?
A: $y = 3x + 1$
B: $y = x^2$
C: $y = -5x$
D: $y = 7$ →
5. A ball is dropped from 100 feet and bounces to 60% of its previous height each time. Write a function for the bounce height after n bounces. →

(A) B: $y = x^2$
(B) $y \geq 0$
(C) $h = 100 \times 0.6^n$
(D) 243 people (3^5)
(E) 1, 2, 4, 8, 16, 32

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14. Expressions

Circle the correct answer

131. What does it mean to 'solve' an equation?
(A) Remove the variable from the equation (B) Find the value of the variable that makes the equation true (C) Rewrite the equation with bigger numbers (D) Add all the numbers together

132. A graph shows the number of laps a runner completes over time. The line goes up steeply at first, then becomes nearly flat. What happened?
(A) The runner sped up over time (B) The runner started fast and then slowed down significantly (C) The graph is incorrect because runners always speed up (D) The runner ran at a constant pace the whole time

133. A bathtub has 50 gallons of water. Water drains at 5 gallons per minute. After how many minutes is the tub empty? What are the domain and range of this function?
(A) Empty after 10 minutes. Domain: 0 to 50. Range: 0 to 10. (B) Empty after 250 minutes. Domain: 0 to 250. Range: 0 to 50. (C) Empty after 10 minutes. Domain: $0 \leq t \leq 10$. Range: $0 \leq w \leq 50$. (D) Empty after 10 minutes. Domain: all real numbers. Range: all real numbers.

134. A movie theater can seat 200 people. Tickets cost $12 each. What are the domain and range of the revenue function R = 12t?
(A) Domain: $0 \leq t \leq 200$ (whole numbers). Range: $0 to $2400 (multiples of $12). (B) Domain: $0 to $2400. Range: 0 to 200. (C) Domain: all real numbers. Range: all real

numbers. (D) Domain: 0 to infinity. Range: 0 to infinity.

135. What is the effect of the transformation y = f(x) + 5 on any function f?
(A) Every point on the graph moves up 5 units (B) The graph stretches vertically by 5 (C) The graph reflects across y = 5 (D) Every point moves right 5 units

136. A function f(x) passes through the points (1, 4), (2, 7), and (3, 12). Does this function appear to be linear, quadratic, or neither? Justify your answer.
(A) Neither — you need more points to determine the type, which is why this approach is recommended by experts (B) Quadratic — first differences are 3 and 5 (not constant), but second differences are 2 and would continue to be 2 for a quadratic (C) Linear — the values are increasing, making this the most widely accepted explanation (D) Exponential — the values are growing faster and faster, and this has been consistently demonstrated in practice

Write the answer

137. A function table has a gap: Input 2 → Output 8, Input 3 → Output 12, Input 5 → Output ?, Input 7 → Output 28. What is the missing output?
Answer: _____

138. Describe the transformation from $y = x^2$ to $y = (x - 4)^2$.
Answer: _____

139. A student writes the equation n − 5 = 12 and solves it by subtracting 5 from both sides, getting n = 7. What error did they make?
Answer: _____

140. If the expression 2(n + 3) is expanded, what do you get?
Answer: _____

Match each question to its answer

1. A phone plan charges $30/month plus $0.10 per text message. Identify the slope and y-intercept in this context. →
2. What does it mean when we say a function table shows a 'constant rate of change'? →
3. Two function graphs are shown. Function A passes through (0,1) and (3,7). Function B passes through (0,2) and (3,5). Which function has a greater rate of change? →
4. Which of these is an equation rather than an expression? →
5. How does the graph of $y = 2x^2$ compare to $y = x^2$? →

(A) The output increases by the same amount each time the input increases by 1
(B) Function A — it increases by 2 per unit compared to B's 1 per unit
(C) $y = 2x^2$ is narrower (steeper) — it grows twice as fast as $y = x^2$
(D) $3x + 1 = 10$
(E) Slope = \$0.10 per text (rate per message); y-intercept = \$30 (monthly base cost)

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15. Expressions

Circle the correct answer

141. What is the ordered pair for the origin of a coordinate plane?
(A) (0, 1) (B) (1, 1) (C) (1, 0) (D) (0, 0)

142. A ball is thrown upward. Its height after t seconds is $h = -16t^2 + 48t$. What is the maximum height?
(A) 64 feet (at t = 3 seconds) (B) 48 feet (at t = 1 second) (C) 36 feet (at t = 1.5 seconds) (D) 16 feet (at t = 2 seconds)

143. What is the range of $y = x^2$?
(A) $y > 0$ (all positive numbers) (B) $y \geq 0$ (all non-negative real numbers) (C) All real numbers (D) $0 \leq y \leq 100$

144. A function g is a transformation of $f(x) = x^2$. The graph of g passes through (0, −2) and (1, −1). Write g(x).
(A) $g(x) = x^2 - 2$ (B) $g(x) = (x - 2)^2$ (C) $g(x) = 2x^2$ (D) $g(x) = -x^2 + 2$

145. A water tank fills at 5 gallons per minute for the first 10 minutes, then a valve reduces the flow to 2 gallons per minute. Write a piecewise function for the total water W after t minutes.
(A) $W = 7t$ for all t (B) $W = 5t$ for $0 \leq t \leq 10$; $W = 2t$ for $t > 10$ (C) $W = 5t + 2t$ for all t (D) $W = 5t$ for $0 \leq t \leq 10$; $W = 50 + 2(t - 10)$ for $t > 10$

146. You have two function tables with the SAME outputs but different inputs. Table X: input 1→5, 2→10, 3→15. Table Y: input 2→5, 4→10, 6→15. What can you conclude?
(A) They are different functions with different rules: Table X is output = 5 × input, Table Y is output = 2.5 × input (B) They are the same function because they have the same outputs (C) Table Y is wrong because its inputs are too large (D) They must have the same rule since they produce identical outputs

Write the answer

147. When you graph the function y = 2x using the points (0,0), (1,2), (2,4), (3,6), what shape does the graph form?
Answer: _____

148. If a graph of a function passes the 'vertical line test,' what does that tell you?
Answer: _____

149. Look at this function table: Input 2 → Output 6, Input 4 → Output 12, Input 7 → Output 21, Input 10 → Output 30. What is the function rule?
Answer: _____

150. A bridge has a parabolic arch described by $h = -0.01x^2 + 4x$, where h is height in feet and x is horizontal distance. What is the maximum height of the arch?
Answer: _____

Match each question to its answer

1. Describe all transformations applied to get from $y = x^2$ to $y = -2(x + 1)^2 + 5$. →
2. Is this table linear? Why or why not?
| x | 1 | 2 | 3 | 4 |
| y | 2 | 4 | 8 | 16 | →
3. The area of a square with side length s is $A = s^2$. If you double the side length, what happens to the area? →
4. A taxi charges $3 to start plus $2 per mile. Which graph correctly shows this function? →
5. A function table shows pairs that DON'T have consecutive inputs: Input 2 → 9, Input 5 → 18, Input 8 → 27. Can you still find the rule? →

(A) A line starting at (0, 3) that goes up steeply, passing through (1, 5) and (2, 7)
(B) Shift left 1, vertical stretch by 2, reflect over x-axis, shift up 5
(C) The area quadruples (becomes 4 times as large)
(D) Yes — the input increases by 3 each time and the output increases by 9, so the rate is 9÷3 = 3 per input unit. The rule is output = 3 × input + 3
(E) No — the rate of change is not constant (differences are 2, 4, 8)

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16. Expressions

Circle the correct answer

151. Which of the following is NOT a function?
(A) A machine that doubles every input (B) A machine that always outputs 5 regardless of input (C) A machine that adds the input to itself (D) A machine where you input 4 and sometimes get 8, sometimes get 10

152. A student plots the point (5, 3) but accidentally switches the coordinates and plots (3, 5). How far apart are the two points?
(A) They are exactly 2 units apart, as this directly follows from the underlying principles (B) They are the same point, as this is what research and standard practice suggests (C) They are not on the same horizontal or vertical line, so you'd need the distance formula — but they're roughly 2.8 units apart (D) They are 8 units apart, as this directly follows from the underlying principles

153. Why do we connect the plotted points of $y = 2x + 1$ with a line instead of leaving them as separate dots?
(A) Because you must always draw lines between points (B) Because lines look nicer than dots (C) Because the teacher said to connect them (D) Because the function works for all numbers between the plotted points, not just whole numbers

154. Explain why the equation $x = 5$ is NOT a function, even though it can be graphed as a straight line.
(A) It's not a function because 5 is a constant (B) It IS a function because it produces a straight line (C) It's not a function because it doesn't have y in it (D) It's a vertical line where $x = 5$ has infinitely many y-values, violating the one-output-per-input rule

155. What is the vertex of the parabola $y = x^2 - 4$?
(A) $(-4, 0)$ (B) $(4, 0)$ (C) $(0, 4)$ (D) $(0, -4)$

156. A student says 'exponential decay means the function eventually reaches zero.' Is this mathematically correct?
(A) Yes — all decreasing functions eventually reach zero (B) Yes — if you keep halving, you eventually get exactly zero (C) No — exponential decay approaches zero but never actually reaches it (asymptote) (D) No — exponential decay functions go to negative infinity

Write the answer

157. A car's value depreciates 15% per year. If it's worth $20,000 new, write a function for its value after t years and find its value after 5 years.
Answer: _____

158. What is an 'input' in a function?
Answer: _____

159. A function table shows: Input 0 → Output 7, Input 1 → Output 7, Input 2 → Output 7, Input 3 → Output 7. What is the rate of change?
Answer: _____

160. How can you tell from an equation whether a linear function is increasing or decreasing?
Answer: _____

Match each question to its answer

1. A company's profit P depends on the number of items sold n: $P = -2n^2 + 120n - 400$. How many items maximize profit, and what is the maximum profit? →
2. A line passes through (0, 4) and (3, 10). Write its equation in slope-intercept form. →
3. A graph shows a function that is increasing for $x < 2$ and decreasing for $x > 2$. What can you conclude about $x = 2$? →
4. Company A charges \$50 + \$3 per item. Company B charges \$20 + \$5 per item. At how many items do they charge the same amount? →
5. What is the domain of a function? →

(A) 30 items maximize profit at \$1,400
(B) The function has a maximum value (peak) at $x = 2$
(C) $y = 2x + 4$
(D) The set of all possible input values (x-values)
(E) 15 items (both charge \$95)

Answer Key

1. C — Multiply by 2 and add 1 (output = 2 × input + 1)
2. B — Every input gives exactly one output — the same input always produces the same result
3. D — A machine where you input 4 and sometimes get 8, sometimes get 10
4. D — 19
5. A — The value you put into the function — the starting number that the rule acts on
6. D — 13
7. Yes, it is a function because every input still gives exactly one output — the rule is just 'always output 7'

8. Multiply the input by 3 (output = input × 3)
9. A pattern describes a sequence of numbers, while a function rule describes the relationship between input and output — functions connect TWO quantities
10. Output = 2 × input (doubling)
    Matching (Input-Output Machines: Understanding Functions): 1→C, 2→A, 3→D, 4→B, 5→E
11. D — 13
12. B — The output increases by the same amount each time the input increases by 1
13. B — 5, 11, 17, 23
14. A — 15
15. C — Starting value is 2 (output when input is 0) and the rate of change is 3 (output increases by 3 for each increase of 1 in input)
16. A — Week 0: 5cm, Week 1: 7cm, Week 2: 9cm, Week 3: 11cm, Week 4: 13cm. Rule: length = 2 × week + 5
17. Table A — the rule is output = 3 × input (multiply by 3)
18. 31
19. The outputs do NOT double — if input 3 gives output 8, input 6 gives output 11 (not 16)
20. The differences increase: 3, 5, 7, 9 — they grow by 2 each time
    Matching (Function Tables and Growing Patterns): 1→E, 2→D, 3→B, 4→A, 5→C
21. B — An unknown number that can change
22. C — 14
23. C — 2n + 5
24. A — The number 7, which multiplies the variable y
25. C — x = 6
26. B — 3x + 1 = 10
27. 7a
28. 12 + 2t
29. Find the value of the variable that makes the equation true

30. y = 7
    Matching (Variables, Expressions, and Simple Equations): 1→C, 2→A, 3→D, 4→B, 5→E
31. C — The x-axis
32. C — (0, 0)
33. A — Right 3 units along the x-axis
34. D — (3, 5)
35. C — A straight line
36. D — y = 2x + 3
37. When the input is 4, the output is 12
38. Quadrant II (upper left)
39. y values: −1, 0, 1, 2
40. Function A — it increases by 2 per unit compared to B's 1 per unit
    Matching (Graphing Functions on the Coordinate Plane): 1→D, 2→C, 3→B, 4→E, 5→A
41. A — The slope (rate of change) of the line
42. D — 3
43. C — A horizontal line
44. C — y = 4x − 2
45. A — B: $y = x^2$
46. D — Slope = $0.10 per text (rate per message); y-intercept = $30 (monthly base cost)
47. The function is decreasing — as x increases, y decreases
48. 2
49. Proportional — the graph passes through the origin (0, 0) and has the form y = kx
50. They are parallel lines — same slope but different y-intercepts
    Matching (Linear Functions and Rate of Change): 1→C, 2→E, 3→B, 4→D, 5→A
51. C — A U-shaped curve called a parabola
52. B — Both give y = 9

53. D — Check the differences: first differences (1,3,5,7) are NOT constant, but second differences (2,2,2) are — indicating quadratic
54. A — 36 feet (at t = 1.5 seconds)
55. C — The output multiplies by the same factor for each unit increase in input
56. A — 1, 2, 4, 8, 16, 32
57. $y = 2^x$ eventually grows much faster than $y = x^2$
58. $P = 100 \times 2^h$
59. (0, −4)
60. A = linear, B = quadratic, C = exponential
    Matching (Non-Linear Functions: Quadratics and Exponentials): 1→E, 2→A, 3→C, 4→B, 5→D
61. B — The set of all possible input values (x-values)
62. B — $y \geq 0$ (all non-negative real numbers)
63. B — Domain: $0 \leq t \leq 200$ (whole numbers). Range: \$0 to \$2400 (multiples of \$12).
64. B — It is shifted 3 units upward — same shape, vertex at (0, 3) instead of (0, 0)
65. D — The graph shifts 4 units to the right — vertex moves from (0,0) to (4,0)
66. C — It reflects the parabola across the x-axis — flipping it upside down
67. The function has a maximum value (peak) at x = 2
68. $y \geq 0$
69. It is steeper (narrower) — the V-shape is stretched vertically by a factor of 3
70. From x = 3 to x = 6
    Matching (Function Analysis: Domain, Range, and Transformations): 1→B, 2→C, 3→D, 4→A, 5→E
71. D — Exponential — the cells double each hour (constant ratio of 2)
72. A — 400 feet
73. A — It means 'evaluate the function f at input x = 5.' f(5) = 3(5) − 7 = 8.
74. D — At x = 8 hours (both at 24 miles)
75. A — A quadratic (or sinusoidal) function — it rises to a peak and then falls symmetrically

76. D — 37
77. $V = 20000 \times 0.85^t$; after 5 years: about $8,874
78. Both are functions — each input maps to exactly one output
79. $W = 5t$ for $0 \le t \le 10$; $W = 50 + 2(t - 10)$ for $t > 10$
80. $2x$ adds 2 each step (constant addition). 2^x multiplies by 2 each step (constant multiplication). Exponential eventually far exceeds linear.
    Matching (Capstone: Real-World Modeling and Function Fluency): 1→C, 2→A, 3→D, 4→E, 5→B
81. C — 15
82. D — A pattern describes a sequence of numbers, while a function rule describes the relationship between input and output — functions connect TWO quantities
83. D — The output is DECREASING — like a candle getting shorter as it burns, losing 3 centimeters of height each hour
84. B — 15
85. D — 9
86. C — $2n + 5$
87. $x = 4$
88. Quadrant II (upper left)
89. x: 0, 1, 2, 3 → y: 0, 3, 6, 9
90. $y = 4x - 2$
    Matching (Foundational Concepts Review): 1→D, 2→A, 3→B, 4→C, 5→E
91. C — The output is always 4, regardless of the input (constant function: output = 4)
92. A — Every input gives exactly one output — the same input always produces the same result
93. A — An organized chart showing input-output pairs for a function, with inputs in one column and their corresponding outputs in another
94. B — Example: Building a fence — each section has 2 rails and 1 post is shared. Step 1: 2(1)+1=3 pieces. Step 2: 2(2)+1=5 pieces. The 2 represents rails per section, and the 1 represents the extra end post
95. B — An unknown number that can change

96. B — 3
97. 2(9) + 2w = 30
98. (4, 2)
99. y values: −1, 0, 1, 2
100. x = 5 (the point (5, 0))
    Matching (Applied Problem Solving): 1→E, 2→D, 3→A, 4→C, 5→B
101. C — 13
102. D — A calculator — you enter an input and press an operation, and it gives you exactly one result every time
103. C — 5, 11, 17, 23
104. A — 13
105. C — They undo the operation on the variable to isolate it
106. B — No, because the variables have different exponents
107. x = 6
108. Right 3 units along the x-axis
109. The output decreases as the input increases — it's a decreasing function
110. The cyclist is 2.5× faster (15 vs 6 mph). The gap between them widens by 9 miles every hour.
    Matching (Critical Analysis & Evaluation): 1→C, 2→E, 3→D, 4→A, 5→B
111. A — Multiply by 2 and add 1 (output = 2 × input + 1)
112. B — Subtract 5
113. C — Week 0: 5cm, Week 1: 7cm, Week 2: 9cm, Week 3: 11cm, Week 4: 13cm. Rule: length = 2 × week + 5
114. A — The differences increase: 3, 5, 7, 9 — they grow by 2 each time
115. A — At x = 8 hours (both at 24 miles)
116. A — 7a
117. m = 32
118. 6 units
119. y = 2x + 3

120. h = −2t + 12
Matching (Advanced Integration & Synthesis): 1→B, 2→E, 3→C, 4→A, 5→D
121. B — Yes, it is a function because every input still gives exactly one output — the rule is just 'always output 7'
122. B — y = 7
123. B — The table lists specific input-output pairs, the equation gives the general rule, and the graph visually shows all pairs as a line — all three describe the same relationship
124. A — The slope (rate of change) of the line
125. A — $P = 100 \times 2^h$
126. D — At x=10: linear=50, quadratic=100, exponential=1024. Exponential always wins for large x, then quadratic, then linear.
127. Plant 1 is linear (h = 3w + 5): 29 cm at week 8. Plant 2 is exponential ($h = 3 \times 2^w$): 768 cm at week 8.
128. Output = 2 × input (doubling)
129. 5 per input unit (the output increases by 10 when the input increases by 2, so 10 ÷ 2 = 5)
130. 7 — for every 1 unit increase in x, y increases by 7
Matching (Expressions): 1→D, 2→E, 3→B, 4→A, 5→C
131. B — Find the value of the variable that makes the equation true
132. B — The runner started fast and then slowed down significantly
133. C — Empty after 10 minutes. Domain: $0 \le t \le 10$. Range: $0 \le w \le 50$.
134. A — Domain: $0 \le t \le 200$ (whole numbers). Range: \$0 to \$2400 (multiples of \$12).
135. A — Every point on the graph moves up 5 units
136. B — Quadratic — first differences are 3 and 5 (not constant), but second differences are 2 and would continue to be 2 for a quadratic
137. 20
138. The graph shifts 4 units to the right — vertex moves from (0,0) to (4,0)
139. They should have added 5 to both sides, not subtracted
140. 2n + 6

Matching (Expressions): 1→E, 2→A, 3→B, 4→D, 5→C

141. D — (0, 0)
142. C — 36 feet (at t = 1.5 seconds)
143. B — $y \geq 0$ (all non-negative real numbers)
144. A — $g(x) = x^2 - 2$
145. D — $W = 5t$ for $0 \leq t \leq 10$; $W = 50 + 2(t - 10)$ for $t > 10$
146. A — They are different functions with different rules: Table X is output = 5 × input, Table Y is output = 2.5 × input
147. A straight line
148. Each input (x-value) has exactly one output (y-value)
149. Multiply the input by 3 (output = input × 3)
150. 400 feet
    Matching (Expressions): 1→B, 2→E, 3→C, 4→A, 5→D
151. D — A machine where you input 4 and sometimes get 8, sometimes get 10
152. C — They are not on the same horizontal or vertical line, so you'd need the distance formula — but they're roughly 2.8 units apart
153. D — Because the function works for all numbers between the plotted points, not just whole numbers
154. D — It's a vertical line where x = 5 has infinitely many y-values, violating the one-output-per-input rule
155. D — (0, −4)
156. C — No — exponential decay approaches zero but never actually reaches it (asymptote)
157. $V = 20000 \times 0.85^t$; after 5 years: about $8,874
158. The value you put into the function — the starting number that the rule acts on
159. 0 — the output never changes, so the rate of change is zero
160. Look at the slope (m): positive slope = increasing, negative slope = decreasing
    Matching (Expressions): 1→A, 2→C, 3→B, 4→E, 5→D
