

# Bridgeforge — Activity Book

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

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

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## 1. Math-to-Science Bridges

### Circle the correct answer

1. A scientist measures a plant's height every week: 3 cm, 5 cm, 8 cm, 12 cm. Which math concept helps predict next week's height?

(A) You can only predict the height if you know the plant species, making this the most widely accepted explanation (B) Finding the pattern in the differences (2, 3, 4...) suggests the next increase is 5 cm, predicting a height of 17 cm. This uses pattern recognition and sequences. (C) The plant will always grow exactly 3 cm each week, and this has been consistently demonstrated in practice (D) You need to add all the heights together and divide by 4, and this principle applies across similar situations

2. Why do scientists use the metric system (meters, grams, liters) instead of the customary system (feet, pounds, cups)?

(A) The metric system uses base-10 (multiples of 10), making conversions simpler. Moving between units only requires moving the decimal point, which reduces calculation errors. (B) The metric system is older and therefore more accurate, and this has been consistently demonstrated in practice (C) Scientists use the metric system because it was invented by scientists. (D) The customary system doesn't have units for very small measurements, as this directly follows from the underlying principles

3. In a science experiment, 3 out of 12 seeds sprouted. What fraction and percentage of seeds sprouted?

(A)  $3/12 = 1/3 = 33\%$  because 3 goes into 12 three times. (B)  $3/12 = 3\%$  because the numerator is 3. (C)  $3/12 = 1/4 = 25\%$  of the seeds sprouted. (D)  $12/3 = 4 = 400\%$  because you flip the fraction.

4. A butterfly's wings show perfect symmetry. What type of symmetry do they demonstrate, and where else does math appear in nature?

(A) Butterflies show bilateral (reflective) symmetry — one side mirrors the other. Math appears in nature through spirals (shells), hexagons (honeycombs), fractals (ferns), and the Fibonacci sequence (flower petals). (B) Butterflies show rotational symmetry because their wings rotate. (C) Butterflies have asymmetrical wings to help

them fly faster, making this the most widely accepted explanation (D) Math doesn't really appear in nature; it's just a human invention, making this the most widely accepted explanation

5. You drop a ball from different heights and measure how high it bounces. Heights: 50 cm → bounces 30 cm; 100 cm → bounces 60 cm; 150 cm → bounces 90 cm. What mathematical relationship do you see?

(A) The bounce height is always 60% (or  $\frac{3}{5}$ ) of the drop height. This is a proportional relationship:  $\text{bounce} = 0.6 \times \text{drop height}$ . (B) The bounce height doubles when the drop height doubles. (C) There's no pattern; the bounce is random each time. (D) The ball always bounces 20 cm less than the drop height.

6. A class records daily temperatures for a week: 68°F, 72°F, 65°F, 70°F, 74°F, 71°F, 69°F. What is the mean (average) temperature?

(A) The average is 9°F because  $74 - 65 = 9$ . (B) The average is 70°F because it's the middle number when sorted. (C) The mean temperature is 69.9°F, calculated by adding all values (489) and dividing by 7. (D) The average is 72°F because you add the highest and lowest and divide by 2.

## Write the answer

7. What is a control variable in a science experiment, and how does math help determine if results are meaningful?

Answer: \_\_\_\_\_

8. Sound travels at about 340 meters per second. If you see lightning and hear thunder 6 seconds later, how far away is the storm?

Answer: \_\_\_\_\_

9. Why do scientists run multiple trials of the same experiment instead of just one?

Answer: \_\_\_\_\_

10. A scientist finds that water boils at 100°C at sea level but at 95°C on a mountain. What does this 5-degree difference tell us?

Answer: \_\_\_\_\_

## Match each question to its answer

1. What is the volume of a rectangular fish tank that is 60 cm long, 30 cm wide, and 40 cm tall? How many liters of water does it hold? →

2. An ecosystem has 10,000 units of energy from the sun. Following the 10% rule, how much energy reaches the third level of the food chain? →

3. How does a bar graph differ from a line graph, and when should a scientist use each? →

4. Earth is about 150 million km from the Sun. Light travels at 300,000 km per second. How long does sunlight take to reach Earth? →

5. A rock sample weighs 450 grams and has a volume of 150 cubic centimeters. What is its density? Is it denser than water ( $1 \text{ g/cm}^3$ )? →

(A) Each level passes only 10% of energy to the next. Level 1 (plants): 10,000. Level 2 (herbivores): 1,000. Level 3 (predators): 100 units.

(B) It takes about 500 seconds, or approximately 8 minutes and 20 seconds.  $\text{Time} = 150,000,000 \div 300,000 = 500 \text{ seconds}$ .

(C) Bar graphs compare distinct categories (types of birds at a feeder). Line graphs show change over time (temperature throughout a day). Line graphs reveal trends; bar graphs compare quantities.

(D)  $\text{Density} = \text{mass/volume} = 450\text{g} \div 150\text{cm}^3 = 3 \text{ g/cm}^3$ . Yes, it is 3 times denser than water, so it would sink.

(E)  $\text{Volume} = 60 \times 30 \times 40 = 72,000 \text{ cubic centimeters} = 72 \text{ liters}$  (since  $1,000 \text{ cm}^3 = 1 \text{ liter}$ ).

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## 2. Math-to-Art Bridges

### Circle the correct answer

11. An artist creates a butterfly painting using line symmetry. If the left wing has a dot 3 cm from the center line and 5 cm up, where must the matching dot be on the right wing?

(A) 3 cm from the center line and 5 cm down on the right side (B) 5 cm from the center line and 3 cm up on the right side (C) 3 cm from the center line and 5 cm up on the right side (D) 6 cm from the center line and 5 cm up on the right side

12. A mosaic artist wants to cover a wall using only one shape, with no gaps or overlaps. Which of these shapes can tessellate (tile perfectly) by itself?

(A) Regular hexagon (B) Regular heptagon (C) Regular pentagon (D) Regular octagon

13. An artist mixes paint using a ratio of 2 parts blue to 3 parts yellow to make green. If they need 20 total cups of green paint, how many cups of blue paint do they need?

(A) 6 cups (B) 10 cups (C) 8 cups (D) 12 cups

14. Why do artists often use the golden ratio (approximately 1.618) when composing paintings?

(A) It creates proportions that humans naturally find visually pleasing and balanced (B) It makes paintings easier to frame in standard sizes (C) It ensures all colors are evenly distributed across the canvas (D) It was required by law in Renaissance-era

art academies

**15.** A quilt maker creates a pattern by rotating a triangle shape 90 degrees four times around a center point. What type of symmetry does this finished design have?

(A) Rotational symmetry of order 4 (B) Translational symmetry (C) Line symmetry only (D) No symmetry at all

**16.** A mural is 8 feet tall and 12 feet wide. An artist wants to make a scaled sketch that is 4 inches tall. How wide should the sketch be to maintain the same proportions?

(A) 8 inches (B) 4 inches (C) 6 inches (D) 3 inches

## Write the answer

**17.** In M.C. Escher's artwork, he transformed simple geometric shapes into interlocking fish, birds, and lizards that tile a plane with no gaps. What mathematical concept is this an artistic application of?

Answer: \_\_\_\_\_

**18.** A sculptor needs to calculate how much clay to buy for a rectangular prism sculpture that is 2 feet long, 1.5 feet wide, and 3 feet tall. What is the volume of clay needed?

Answer: \_\_\_\_\_

**19.** A textile designer creates a repeating pattern by sliding a motif 4 cm to the right and 3 cm up, over and over. What type of geometric transformation is being used?

Answer: \_\_\_\_\_

**20.** An architect designs a circular stained glass window with a diameter of 4 feet. What is the approximate area of glass needed? (Use  $\pi = 3.14$ )

Answer: \_\_\_\_\_

## Match each question to its answer

**1.** A photographer uses the 'rule of thirds' by mentally dividing the frame into a 3x3 grid. How many total grid sections does this create? →

**2.** A potter makes a vase that is perfectly round when viewed from above. If the circumference of the opening is 31.4 cm, what is the diameter? (Use  $\pi = 3.14$ ) →

**3.** Compare the use of geometric shapes in Islamic art with the use of shapes in Piet Mondrian's abstract paintings. What is a key mathematical difference? →

**4.** A graphic designer enlarges a logo by a scale factor of 3. If the original logo is 2 inches by 4 inches, what happens to the area of the enlarged logo? →

**5.** A weaver creates a pattern where each row alternates: 3 red threads, then 2 blue threads, repeating across the loom. If the loom holds 40 threads per row, how many blue threads are in one row? →

- (A) 9 sections
  - (B) 10 cm
  - (C) 16 blue threads
  - (D) Islamic art uses complex rotational symmetry and tessellations, while Mondrian primarily uses perpendicular lines and rectangles
  - (E) The area becomes 9 times larger (from 8 to 72 square inches)
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### 3. Math-to-Social Studies Bridges

#### Circle the correct answer

21. A country's population grew from 50 million to 65 million over 10 years. What was the percent increase?  
(A) 15% (B) 30% (C) 25% (D) 65%
22. In a school election, Candidate A gets 45 votes, Candidate B gets 30 votes, and Candidate C gets 25 votes. What percentage of the total vote did Candidate A receive?  
(A) 50% (B) 30% (C) 40% (D) 45%
23. A historian discovers that an ancient city had about 25,000 residents and covered approximately 2 square miles. What was the population density?  
(A) 2,500 people per square mile (B) 12,500 people per square mile (C) 25,000 people per square mile (D) 50,000 people per square mile
24. A country's GDP (Gross Domestic Product) was \$2.4 trillion last year and \$2.52 trillion this year. What was the GDP growth rate?  
(A) 5% (B) 52% (C) 0.12% (D) 12%
25. On a map with a scale of 1 inch = 50 miles, two cities are 3.5 inches apart. What is the actual distance between them?  
(A) 350 miles (B) 150 miles (C) 175 miles (D) 200 miles
26. A bar graph shows immigration to the United States by decade. The 1900s bar shows 8.2 million immigrants, and the 1910s bar shows 6.3 million. How would you describe this change?  
(A) Immigration stayed roughly the same between decades (B) Immigration decreased by about 50% (C) Immigration increased by 1.9 million between decades (D) Immigration decreased by approximately 1.9 million, a decline of about 23%

#### Write the answer

**27.** In the U.S. Electoral College, a candidate needs 270 out of 538 electoral votes to win the presidency. What percentage of electoral votes is this minimum requirement?

Answer: \_\_\_\_\_

**28.** A civilization timeline shows the Roman Empire lasting from 27 BCE to 476 CE. How many years did the Roman Empire last?

Answer: \_\_\_\_\_

**29.** A supply-and-demand graph shows that when the price of wheat rises from \$5 to \$8 per bushel, the quantity demanded drops from 1,000 to 700 bushels. What is the ratio of price change to demand change?

Answer: \_\_\_\_\_

**30.** Why might two countries with the same total GDP have very different standards of living?

Answer: \_\_\_\_\_

## **Match each question to its answer**

**1.** A census report shows a city's racial demographics: 42% White, 28% Hispanic, 18% Black, 7% Asian, 5% Other. If the city has 200,000 residents, how many identify as Hispanic? →

**2.** A historian studying trade routes calculates that a merchant caravan traveled 12 miles per day. If the Silk Road from China to Rome was approximately 4,000 miles, about how many days would the journey take? →

**3.** A line graph shows a country's inflation rate over 5 years: 2.1%, 2.4%, 3.8%, 5.2%, 4.1%. During which year did the inflation rate increase the most compared to the previous year? →

**4.** What is gerrymandering, and why is it a mathematical problem as well as a political one? →

**5.** A government budget allocates \$500 billion total: 25% to defense, 30% to healthcare, 15% to education, and the rest to other services. How much money goes to education? →

(A) Year 3, when inflation jumped from 2.4% to 3.8% (an increase of 1.4 percentage points)

(B) Gerrymandering is drawing oddly shaped voting districts to give one party an advantage; it's mathematical because it involves manipulating how populations are grouped and distributed geographically

(C) \$75 billion

(D) Approximately 333 days

(E) 56,000 residents

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## 4. Math-to-ELA Bridges

### Circle the correct answer

**31.** A haiku poem follows the syllable pattern 5-7-5 across three lines. How many total syllables are in a haiku?

- (A) 12 syllables (B) 17 syllables (C) 15 syllables (D) 21 syllables

**32.** An author writes a 60,000-word novel at an average pace of 500 words per day. How many days will it take to complete the first draft?

- (A) 300 days (B) 60 days (C) 100 days (D) 120 days

**33.** In logic, the statement 'If it rains, then the ground is wet' has a structure called a conditional. What is the contrapositive of this statement?

- (A) If the ground is wet, then it rained (B) If it does not rain, the ground is not wet  
(C) If the ground is NOT wet, then it did NOT rain (D) It rains and the ground is wet

**34.** A Shakespearean sonnet has 14 lines with 10 syllables each, following iambic pentameter (5 pairs of unstressed-stressed syllables per line). How many total syllables are in the entire poem?

- (A) 140 syllables (B) 154 syllables (C) 70 syllables (D) 100 syllables

**35.** A book review states: '4 out of 5 readers gave this book 4 or more stars.' If 200 people reviewed the book, how many gave it 4 or more stars?

- (A) 40 readers (B) 160 readers (C) 150 readers (D) 80 readers

**36.** An author uses a flashback structure: the story starts at Chapter 5 (present day), then jumps to Chapter 1 (10 years earlier), and moves forward. If each chapter covers approximately 2 years, at what point in the story does the timeline catch up to the opening scene?

- (A) At the start of Chapter 5, because chapters 1-4 cover 8 years and the opening was 10 years after Chapter 1 (B) At Chapter 10, because it takes 10 chapters to cover 10 years (C) The timeline never catches up (D) At Chapter 3, because the midpoint of 5 chapters is Chapter 3

### Write the answer

**37.** Which logical fallacy is being used in this argument: 'Every time I wear my lucky socks, my team wins. Therefore, my socks cause the team to win'?

Answer: \_\_\_\_\_

**38.** A readability formula scores text difficulty. The Flesch-Kincaid formula considers average sentence length (ASL) and average syllables per word (ASW). If Text A has ASL = 15 words and ASW = 1.5, and Text B has ASL = 25 words and ASW = 2.0, which is harder



to read?

Answer: \_\_\_\_\_

**39.** A persuasive essay makes the claim: '75% of students surveyed support longer recess.' The survey asked 8 students. Why might this statistic be misleading?

Answer: \_\_\_\_\_

**40.** The word 'exponentially' is often used in everyday English (e.g., 'Technology is growing exponentially'). What does it mean mathematically?

Answer: \_\_\_\_\_

## Match each question to its answer

**1.** A library has the following circulation data: Fiction — 4,500 checkouts/month; Nonfiction — 2,800; Children's — 3,200; Reference — 500. Write a one-sentence summary using appropriate mathematical language. →

**2.** A limerick follows the rhyme scheme AABBA, where the A lines have 7-10 syllables and B lines have 5-7 syllables. If each A line has exactly 8 syllables and each B line has exactly 5 syllables, how many total syllables are in the limerick? →

**3.** An editor reviews a manuscript and finds 24 grammatical errors in a 12,000-word document. What is the error rate per 1,000 words? →

**4.** What is a Venn diagram used for in both math and ELA, and why is it effective? →

**5.** An argument states: 'All cats are animals. All animals need water. Therefore, all cats need water.' What logical structure does this use? →

(A) 2 errors per 1,000 words

(B) Fiction leads library circulation with 4,500 monthly checkouts, accounting for approximately 41% of total lending, followed by Children's (29%), Nonfiction (25%), and Reference (5%)

(C) 34 syllables

(D) In math, it shows set relationships (union, intersection); in ELA, it compares and contrasts two texts, characters, or ideas; it's effective because visual overlap makes similarities and differences immediately clear

(E) A syllogism — a logical argument where a conclusion follows necessarily from two premises

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## 5. Math-to-Music Bridges

### Circle the correct answer



**41.** In 4/4 time, a whole note lasts 4 beats, a half note lasts 2 beats, and a quarter note lasts 1 beat. A measure must total exactly 4 beats. Which combination fills one measure?

(A) One half note and two quarter notes ( $2 + 1 + 1 = 4$  beats) (B) Two whole notes ( $2 \times 4 = 8$  beats) (C) Five quarter notes ( $5 \times 1 = 5$  beats) (D) Three half notes ( $3 \times 2 = 6$  beats)

**42.** The note A4 (concert A) vibrates at 440 Hz. The note A5 (one octave higher) vibrates at what frequency?

(A) 220 Hz (half the frequency) (B) 660 Hz (1.5 times the frequency) (C) 441 Hz (one more than A4) (D) 880 Hz (double the frequency)

**43.** A dotted quarter note equals a quarter note plus half its value. If a quarter note = 1 beat, how many beats does a dotted quarter note last?

(A) 0.75 beats (B) 1.5 beats ( $1 + 0.5 = 1.5$ ) (C) 2 beats (D) 1.25 beats

**44.** A perfect fifth interval has a frequency ratio of 3:2. If the lower note is C at 264 Hz, what is the frequency of the G a perfect fifth above?

(A) 176 Hz (B) 396 Hz (C) 330 Hz (D) 528 Hz

**45.** A song has a tempo of 120 BPM (beats per minute). How many beats occur in a 3.5-minute song?

(A) 360 beats (B) 420 beats (C) 480 beats (D) 240 beats

**46.** In a 12-bar blues progression, the pattern uses chords I, IV, and V. If each bar has 4 beats, how many total beats are in one complete 12-bar blues cycle?

(A) 16 beats (B) 48 beats (C) 12 beats (D) 36 beats

## Write the answer

**47.** A sound wave has a frequency of 440 Hz and the speed of sound is 343 meters per second. What is the wavelength of this sound?

Answer: \_\_\_\_\_

**48.** Why did Pythagoras call the relationship between mathematics and music 'the music of the spheres'?

Answer: \_\_\_\_\_

**49.** A musician plays a pattern: C-E-G-E, repeating every 4 notes. After playing 50 notes total, which note do they end on?

Answer: \_\_\_\_\_

**50.** In equal temperament tuning (used on modern pianos), each semitone multiplies the frequency by the twelfth root of 2 (approximately 1.0595). Starting from A4 = 440 Hz, what is the approximate frequency of A#4 (one semitone up)?

Answer: \_\_\_\_\_

## Match each question to its answer

1. A triplet divides a beat into 3 equal parts instead of the usual 2. In 4/4 time at 120 BPM, how long (in seconds) does each note of a quarter-note triplet last? →
2. A DJ wants to seamlessly mix two songs. Song A has a tempo of 128 BPM and Song B has a tempo of 140 BPM. What percentage faster is Song B compared to Song A? →
3. A chord is three or more notes played simultaneously. A major triad uses notes at intervals of 4 semitones and 3 semitones from the root. Starting from C (note 0), which notes form a C major triad on a 12-note chromatic scale? →
4. The Fibonacci sequence (1, 1, 2, 3, 5, 8, 13...) appears in music. A piano octave has 13 keys (8 white, 5 black), and a major scale has 8 notes with the 5th and 3rd being the most harmonically important. Are these Fibonacci connections coincidental or meaningful? →
5. An audio engineer measures that a sound at 60 decibels (dB) is 10 times more intense than a sound at 50 dB. A sound at 70 dB is 10 times more intense than 60 dB. How many times more intense is 80 dB compared to 50 dB? →

- (A) Approximately 0.167 seconds (0.5 seconds per beat / 3)
  - (B) Partially meaningful — the 12-tone system and major scale evolved to use intervals based on simple frequency ratios, which happen to align with Fibonacci numbers, though the connection is more correlational than causal
  - (C) Approximately 9.4% faster
  - (D) 1,000 times more intense ( $10 \times 10 \times 10 = 10^3$ )
  - (E) C (0), E (4), and G (7)
- 

## 6. Math-to-CS Bridges

### Circle the correct answer

51. Computers use binary (base 2). What is the decimal value of the binary number 1011?  
(A) 13, which follows from applying the basic formula to the given values (B) 1011, which is what you get when you apply the distributive property here (C) 7, based on the standard mathematical approach for this type of problem (D) 11 ( $1 \times 8 + 0 \times 4 + 1 \times 2 + 1 \times 1$ )
52. In a coordinate grid, a sprite starts at position (3, 5) and moves 4 units right and 2 units down. What are its new coordinates?  
(A) (-1, 7) (B) (7, 3) (C) (3, 3) (D) (7, 7)

**53.** Boolean logic uses AND, OR, and NOT operations. If A = True and B = False, what is the result of (A AND B) OR (NOT B)?

(A) Neither True nor False (B) Error — you can't combine AND and OR (C) False (D) True

**54.** A program loops through a list of 100 items, checking each one. This is called linear search. How does the maximum number of checks change if the list grows to 1,000 items?

(A) The maximum checks increase 10 times (from 100 to 1,000) because linear search grows proportionally with list size (B) The checks stay at 100 regardless of list size, making this the most widely accepted explanation (C) The checks increase by only 10 more, and this has been consistently demonstrated in practice (D) The checks increase to 1,000,000 (squared), and this is the standard approach used in most cases

**55.** A pixel on a screen uses RGB color with values 0-255 for each channel (Red, Green, Blue). How many unique colors can be represented?

(A) 65,536 colors ( $256 \times 256$ ) (B) 16,777,216 colors ( $256 \times 256 \times 256 = 256^3$ ) (C) 255 colors (D) 768 colors ( $256 \times 3$ )

**56.** Binary search requires a SORTED list. To search 1,024 items, what is the maximum number of comparisons needed?

(A) 10 comparisons (because  $2^{10} = 1,024$ ) (B) 512 comparisons (C) 1,024 comparisons (D) 100 comparisons

## Write the answer

**57.** A variable in programming stores a value that can change. If  $x = 5$  and you execute the statement  $x = x + 3$ , what is the new value of  $x$ ?

Answer: \_\_\_\_\_

**58.** A recursive function calculates factorial:  $\text{factorial}(n) = n \times \text{factorial}(n-1)$ , with  $\text{factorial}(1) = 1$ . What is  $\text{factorial}(5)$ ?

Answer: \_\_\_\_\_

**59.** An image is 1920 pixels wide and 1080 pixels tall (1080p HD). If each pixel uses 3 bytes (one byte each for R, G, B), how much memory does one uncompressed frame require?

Answer: \_\_\_\_\_

**60.** A for-loop executes its body once for each value in a range. If the loop runs from 1 to  $n$ , and inside the loop there's ANOTHER loop from 1 to  $n$ , how many total iterations occur?

Answer: \_\_\_\_\_

## Match each question to its answer

1. In hexadecimal (base 16), digits go: 0-9, then A=10, B=11, C=12, D=13, E=14, F=15. What is the decimal value of hex 2F? →
2. A program generates a random number between 1 and 6 to simulate a die roll. If the program runs this 600 times, approximately how many times would you expect to see the number 4? →
3. Why is the modulo operator (% , which gives the remainder after division) one of the most useful tools in programming? →
4. A password uses 4 digits, each from 0-9. How many possible passwords exist? If a computer can try 1,000 passwords per second, how long to try all of them? →
5. A function takes an input and produces an output:  $f(x) = 2x + 1$ . What is  $f(7)$ ? →

- (A) Approximately 100 times ( $600 \times 1/6 = 100$ )
  - (B) 15
  - (C) 47 ( $2 \times 16 + 15 \times 1$ )
  - (D) 10,000 possible passwords ( $10^4$ ); takes 10 seconds to try all of them
  - (E) It detects patterns (even/odd), creates cycles (wrap-around behavior), extracts digits, and enables clock-like arithmetic — all from a single mathematical operation
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## 7. Science-to-ELA Bridges

### Circle the correct answer

**61.** A scientist writes: 'The data suggest that increased CO2 levels correlate with rising temperatures.' Why does the scientist use 'suggest' and 'correlate' instead of 'prove' and 'cause'?

(A) Scientific writing uses hedging language because correlation doesn't prove causation, and individual studies rarely prove anything definitively — science builds evidence over many studies (B) The scientist is unsure about their own data, as this is what research and standard practice suggests (C) It's just a style preference — the words mean the same thing, which is the most common explanation for this phenomenon (D) The journal editor requires those specific words, which is the most common explanation for this phenomenon

**62.** What is the structure of a scientific abstract, and how does it mirror the structure of an argumentative essay?

(A) Abstracts are always shorter than 50 words, while essays are longer (B) Both follow: introduction/context, claim/hypothesis, evidence/methods+results, conclusion — both use evidence to support a central argument (C) They have completely different structures with nothing in common (D) Scientific abstracts are just

summaries, while essays make arguments

**63.** A science textbook states: 'Mitochondria are the powerhouses of the cell.' This is a metaphor. Why do science writers use figurative language in explanations?

(A) Metaphors make abstract scientific concepts concrete and memorable by connecting unfamiliar ideas to familiar experiences (B) Because scientific writing must be literary and artistic (C) Because metaphors are always more accurate than technical language (D) Because scientists don't have precise terms for these concepts

**64.** A lab report includes this hypothesis: 'If the temperature of water increases, then the sugar will dissolve faster because higher temperatures increase molecular movement.' Identify the three parts of this hypothesis.

(A) Question, experiment, conclusion, making this the most widely accepted explanation (B) If (independent variable: water temperature increases), then (dependent variable: sugar dissolves faster), because (reasoning: higher temperatures increase molecular movement) (C) Temperature, sugar, water, and this is the standard approach used in most cases (D) Introduction, body, summary, and this has been consistently demonstrated in practice

**65.** Read this passage: 'Darwin spent 20 years gathering evidence before publishing *On the Origin of Species*. He feared social backlash but knew the evidence was overwhelming.' What type of text is this?

(A) Historical fiction based loosely on Darwin's life, as this is what research and standard practice suggests (B) A scientific research paper presenting Darwin's data, and this principle applies across similar situations (C) Narrative nonfiction — it tells a true story about a scientist using literary techniques (character development, tension, chronology) (D) A persuasive essay arguing for evolution, and this principle applies across similar situations

**66.** A student's science essay claims: 'Vaccines cause autism because my cousin got vaccinated and then was diagnosed with autism.' What logical fallacy is this, and what would stronger evidence look like?

(A) This is anecdotal evidence combined with post hoc fallacy (after this, therefore because of this). Stronger evidence would be large population studies comparing autism rates between vaccinated and unvaccinated groups (B) This is an appeal to authority fallacy, and this has been consistently demonstrated in practice (C) This is strong evidence because it's a real personal experience (D) The only problem is the sample size — they need two cousins, not one, which is the most common explanation for this phenomenon

**Write the answer**

**67.** A science article uses the passive voice: 'The solution was heated to 100°C' instead of 'I heated the solution to 100°C.' Why is passive voice traditional in scientific writing?

Answer: \_\_\_\_\_

**68.** Rachel Carson's book 'Silent Spring' (1962) used vivid literary descriptions of a world without birdsong to argue against pesticide overuse. What writing technique made this scientific argument so powerful?

Answer: \_\_\_\_\_

**69.** A peer review of a student's science essay notes: 'Your claim is well-supported by evidence, but you need to address the counterargument that genetic factors, not just diet, influence heart disease.' This feedback applies equally to which type of ELA essay?

Answer: \_\_\_\_\_

**70.** The scientific term 'theory' means something different from the everyday use. What is the scientific meaning, and why does the everyday meaning cause public confusion about topics like evolution?

Answer: \_\_\_\_\_

## **Match each question to its answer**

**1.** Which text feature in a science textbook serves the same purpose as a topic sentence in an essay paragraph? →

**2.** A scientist's research log reads: 'Day 47. The cultures failed again. I must be contaminating the samples during transfer. Tomorrow I'll try working in the laminar flow hood.' What literary element does this resemble? →

**3.** A student writes a claim for their science essay: 'Recycling is important.' Their teacher asks them to revise it. Why, and what would a better version look like? →

**4.** What does 'citing sources' look like in a science lab report versus an English research paper? →

**5.** The word 'cell' means different things in biology (basic unit of life), physics (battery component), and everyday English (prison room or phone device). This is an example of what linguistic concept? →

(A) The claim is too vague and not arguable. Better: 'Mandatory curbside recycling programs reduce landfill waste by 30-40%, making them a cost-effective strategy for municipal waste management.' This is specific, measurable, and arguable

(B) A journal or diary entry — it records personal observations, reflections, and plans in chronological order, similar to first-person narrative writing

(C) Both require attributing ideas to their sources. Science uses numbered citations or author-date format (e.g., 'Smith, 2024') while ELA often uses MLA format (e.g., 'Smith 42'), but the purpose is identical: giving credit and allowing readers to verify claims

(D) A section heading — it previews the main idea of the section that follows, just as

a topic sentence previews the paragraph's content

(E) Polysemy — a single word having multiple related or unrelated meanings, where context determines which meaning is intended

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## 8. Cross-Curricular Design Thinking

### Circle the correct answer

**71.** In the 'Empathize' phase of design thinking, a student interviews 30 community members about park accessibility. She finds 18 mention wheelchair ramps, 12 mention shade structures, and 6 mention both. How many mentioned at least one of these issues?

(A) 24 people (B) 36 people (C) 30 people (D) 18 people

**72.** A good design problem statement follows the format: '[User] needs [need] because [insight].' Which of the following is the strongest problem statement?

(A) Middle school students need a quieter lunch space because 73% reported that noise levels above 80 dB make it hard to socialize (B) Students don't like lunch because it's noisy (C) We need to build a new cafeteria because the old one is bad (D) The cafeteria is too loud and should be fixed, making this the most widely accepted explanation

**73.** During the 'Ideate' phase, a team uses divergent thinking to generate solutions. If 5 team members each generate 8 ideas in Round 1, then build on each other's ideas to generate 3 more each in Round 2, what is the total idea count?

(A) 55 ideas (B) 40 ideas (C) 65 ideas (D) 45 ideas

**74.** A student builds a 1:20 scale model prototype of a community garden. If the real garden will be 16 meters long and 12 meters wide, what are the dimensions of the prototype in centimeters?

(A) 32 cm × 24 cm (B) 160 cm × 120 cm (C) 80 cm × 60 cm (D) 8 cm × 6 cm

**75.** During the 'Test' phase, a team surveys 50 users about their prototype. Results: 35 rated it 'helpful,' 10 rated it 'somewhat helpful,' and 5 rated it 'not helpful.' What percentage found it at least somewhat helpful?

(A) 80% (B) 70% (C) 90% (D) 75%

**76.** Design thinking is iterative — you cycle back through phases based on feedback. A team's first prototype scored 45/100 on usability. After three iterations, scores improved to 62, 78, and 89. What is the average improvement per iteration?

(A) About 11 points per iteration (B) About 14.7 points per iteration (C) About 16.3 points per iteration (D) About 22 points per iteration



## Write the answer

**77.** An engineering design must balance constraints. A student's bridge prototype can use at most \$15 of materials. Wooden dowels cost \$0.75 each and metal brackets cost \$1.50 each. If she uses 8 dowels, how many brackets can she afford?

Answer: \_\_\_\_\_

**78.** Which concept from social studies is MOST directly applied when a design team maps out all the people affected by their solution — residents, city officials, business owners, and environmental groups?

Answer: \_\_\_\_\_

**79.** Biomimicry is a design approach that draws inspiration from nature. Velcro was inspired by burr seeds that cling to fur. This approach bridges which two disciplines most directly?

Answer: \_\_\_\_\_

**80.** A design team creates a 'user persona' — a fictional character representing their target user. The persona includes: age 72, limited mobility, uses a walker, lives alone, enjoys gardening. This technique draws from which writing skill?

Answer: \_\_\_\_\_

## Match each question to its answer

**1.** A student is choosing materials for a waterproof phone case prototype. She tests 4 materials by submerging them for 1 hour and measuring water absorption. Material A absorbs 0.2 mL, B absorbs 3.5 mL, C absorbs 0.1 mL, and D absorbs 1.8 mL. Which material is the best candidate, and what scientific property is she testing? →

**2.** A design team proposes adding solar panels to a school. Installation costs \$50,000 but saves \$6,000 per year in electricity. How many years until the investment 'breaks even'? →

**3.** A team needs to present their user research findings. They have data on: (1) age distribution of users, (2) satisfaction ratings over time, and (3) the proportion of users preferring each feature. Which chart types would best represent each dataset? →

**4.** A student designs an app that tracks classmates' locations to help them find study partners. A classmate raises a concern about privacy. Which ethical framework helps evaluate this design decision? →

**5.** When presenting a design solution to stakeholders, which persuasive technique combines data with storytelling most effectively? →

- (A) About 8.3 years
  - (B) Histogram for ages, line graph for satisfaction over time, pie chart for feature preferences
  - (C) Material C; she is testing water permeability
  - (D) Opening with a user's real story, then supporting it with statistics from testing
  - (E) Weighing benefits to users against potential harms to their privacy and autonomy
- 

## 9. Social-Emotional Learning

### Circle the correct answer

- 81.** What is the term for a disagreement between two or more people who have different needs, goals, or viewpoints?  
(A) Conflict (B) Competition (C) Compromise (D) Collaboration
- 82.** Which of the following is a common physical sign that someone is becoming upset during a disagreement?  
(A) Relaxed shoulders and a smile (B) Slow, deep breathing (C) Leaning back with arms open (D) Clenched fists or a tight jaw
- 83.** What does the term "de-escalation" mean in the context of conflict?  
(A) Making a conflict more exciting (B) Winning the argument quickly (C) Ignoring the conflict completely (D) Reducing the intensity of a conflict so it does not get worse
- 84.** In conflict resolution, what is a "mediator"?  
(A) A teacher who gives detention (B) A neutral person who helps both sides reach an agreement (C) The person who wins the argument (D) The person who started the conflict
- 85.** Which conflict resolution style involves both sides giving up something to reach a middle ground?  
(A) Accommodation (B) Compromise (C) Competition (D) Avoidance
- 86.** What is the first step in most conflict resolution models?  
(A) Walk away without speaking (B) Identify and define the problem (C) Decide who is right (D) Tell the other person they are wrong

### Write the answer

**87.** Why are "I" statements (like "I feel frustrated when...") more effective than "You" statements (like "You always...") during a conflict?

Answer: \_\_\_\_\_

**88.** Marcus and Aisha both want to use the last computer in the library. Marcus says, "I need it to finish my report that is due tomorrow." Aisha says, "I need it to research my science project." What is the underlying need they share?

Answer: \_\_\_\_\_

**89.** A student says, "Nobody ever listens to me in group projects." Which conflict resolution skill would help this student the most?

Answer: \_\_\_\_\_

**90.** Explain why avoiding a conflict is sometimes helpful in the short term but can cause bigger problems later.

Answer: \_\_\_\_\_

## **Match each question to its answer**

**1.** What is the difference between a "position" and an "interest" in a conflict? →

**2.** Your friend is upset because another student made fun of their drawing. Your friend wants to confront the student angrily. What de-escalation strategy should you suggest first? →

**3.** Two students in your group project disagree about the topic. One wants endangered animals and the other wants ocean pollution. How could you help them find a win-win solution? →

**4.** During a heated classroom debate, a student starts raising their voice and pointing at another student. As a peer mediator, what should you do? →

**5.** You borrowed your sibling's headphones without asking and they broke. Your sibling is very angry. Apply the steps of conflict resolution to this situation. What should you do first? →

(A) Suggest combining both ideas, such as a project on how ocean pollution affects endangered marine animals

(B) Acknowledge what you did, apologize sincerely, and ask your sibling what would help make it right

(C) Calmly ask for a pause, remind everyone of the ground rules, and give the upset student a moment to regroup

(D) Take a few deep breaths and wait until the anger passes before responding

(E) A position is what someone demands; an interest is the deeper reason behind that demand

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## 10. Social-Emotional Learning

### Circle the correct answer

91. What is empathy?

(A) Telling someone what they should feel (B) The ability to understand and share the feelings of another person (C) Agreeing with everything another person says (D) Feeling sorry for someone without understanding their feelings

92. What is the difference between empathy and sympathy?

(A) Sympathy is stronger than empathy, and this principle applies across similar situations (B) Empathy is only for sad situations, as this is what research and standard practice suggests (C) Empathy means feeling with someone; sympathy means feeling sorry for someone from a distance (D) They mean exactly the same thing, which is the most common explanation for this phenomenon

93. What does "perspective-taking" mean?

(A) Taking a photograph from a different angle (B) Forcing someone to see things your way (C) Ignoring your own feelings to focus on others (D) Looking at a situation from another person's point of view

94. Which facial expression typically indicates that someone is feeling anxious or worried?

(A) Squinting eyes with a laugh (B) Relaxed face with a slight smile (C) Raised eyebrows with an open mouth (surprise) (D) Furrowed eyebrows, tight lips, and wide or darting eyes

95. Name the four basic emotions that researchers say are recognized across all cultures.

(A) Happiness, sadness, anger, and fear (B) Confidence, shyness, curiosity, and disgust (C) Excitement, boredom, jealousy, and pride (D) Love, hate, surprise, and guilt

96. What is "emotional intelligence"?

(A) Being very smart at school subjects, which is why this approach is recommended by experts (B) Never showing any emotions, as this is what research and standard practice suggests (C) The ability to recognize, understand, manage, and express emotions effectively in yourself and others (D) Always being happy no matter what happens, as this directly follows from the underlying principles

### Write the answer

**97.** A new student joins your class midway through the year. They sit alone at lunch and do not talk much. Some classmates assume the new student is "stuck up." Explain why perspective-taking is important here.

Answer: \_\_\_\_\_

**98.** Why is it important to recognize emotions in yourself before trying to understand other people's emotions?

Answer: \_\_\_\_\_

**99.** Explain why two people can witness the same event and have completely different emotional reactions to it.

Answer: \_\_\_\_\_

**100.** What does it mean to "validate" someone's feelings, and why does it matter?

Answer: \_\_\_\_\_

## **Match each question to its answer**

**1.** How can reading fiction and watching stories help develop empathy? →

**2.** Your classmate just found out they did not make the basketball team and looks close to tears. What is the most empathetic response? →

**3.** You notice a classmate has been unusually quiet for the past few days. They usually participate a lot in class. How should you use empathy to approach the situation? →

**4.** During a group discussion, one student shares that their family celebrates a holiday you have never heard of. Some students giggle. How would you demonstrate empathy in this moment? →

**5.** Your younger sibling is scared of the dark and cannot sleep. You are not scared of the dark at all. How can you use perspective-taking to help them? →

(A) Remember that their fear is real to them even if it is not real to you — comfort them, perhaps with a nightlight, and avoid saying their fear is silly

(B) Show genuine interest by asking a respectful question about the holiday, and let the student know you think it sounds interesting

(C) Find a private moment to check in: "Hey, I've noticed you seem a little different lately. Is everything okay? I'm here if you want to talk."

(D) "I can see you're really disappointed. That must be really tough after all the work you put in. Do you want to talk about it?"

(E) Stories let us experience situations through characters' eyes, practicing perspective-taking in a safe way

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## **11. Social-Emotional Learning**

## Circle the correct answer

**101.** Who is the Stanford psychologist best known for her research on growth mindset?

- (A) Howard Gardner (B) Angela Duckworth (C) Carol Dweck (D) Daniel Goleman

**102.** What is a "fixed mindset"?

- (A) A type of mindset that only affects adults (B) A mindset focused on fixing mistakes (C) The belief that intelligence and abilities are permanent traits that cannot be significantly changed (D) The belief that you can improve with effort

**103.** What is a "growth mindset"?

- (A) The belief that only some people can improve, and this principle applies across similar situations (B) The belief that intelligence and abilities can be developed through effort, learning, and persistence (C) The belief that you are already smart enough, and this is the standard approach used in most cases (D) A mindset about growing taller, as this directly follows from the underlying principles

**104.** What is the power of the word "yet" in growth mindset thinking?

- (A) It is a way to avoid doing hard work, and this principle applies across similar situations (B) It has no special meaning in growth mindset, and this has been consistently demonstrated in practice (C) Adding "yet" to "I can't do this" transforms it into "I can't do this yet," implying future possibility (D) It makes sentences grammatically correct, making this the most widely accepted explanation

**105.** What is "perseverance"?

- (A) Avoiding challenges to stay comfortable (B) Giving up quickly when something is hard (C) Continuing to work toward a goal despite difficulties, setbacks, or delays (D) Being perfect at everything on the first try

**106.** In growth mindset research, what does the brain do when you struggle with a challenging problem?

- (A) Nothing happens in the brain during struggle (B) The brain shrinks from the stress (C) The brain only grows during sleep, not during challenges (D) Neurons form new and stronger connections, literally making the brain grow

## Write the answer

**107.** A student says, "I got an A without studying — I must be really smart!" Explain why this statement reflects a fixed mindset.

Answer: \_\_\_\_\_

**108.** Explain why praising a child by saying "You're so smart!" can actually be harmful compared to saying "You worked really hard on that!"

Answer: \_\_\_\_\_

**109.** Why do people with a fixed mindset often avoid challenges?

Answer: \_\_\_\_\_

**110.** Explain what "productive struggle" means and why teachers value it.

Answer: \_\_\_\_\_

## Match each question to its answer

**1.** How does a growth mindset change the way you interpret feedback and criticism?

→

**2.** You just got a 62% on a math test. Write two different self-talk responses — one from a fixed mindset and one from a growth mindset. →

**3.** Your friend wants to try out for the school play but says, "I'm not a good actor — I'll embarrass myself." How would you encourage a growth mindset? →

**4.** You have been practicing a new skateboard trick for two weeks and still cannot land it. Apply growth mindset strategies to keep going. →

**5.** Your younger cousin is frustrated because they cannot ride a bike yet. Using growth mindset language, what would you say to help them? →

(A) Fixed: "I'm terrible at math. I'll never get it." Growth: "This shows me what I need to study. I'll review my mistakes and ask for help on the problems I missed."

(B) "You can't ride it YET. Remember when you couldn't tie your shoes? You kept practicing and now you do it without thinking. Riding a bike works the same way — every wobble is your brain learning balance."

(C) "You won't know until you try, and even experienced actors started as beginners. The audition itself is practice, and every try-out makes you better for the next one."

(D) With a growth mindset, feedback becomes useful information for improvement rather than a personal attack on your abilities

(E) Break the trick into smaller steps to master one at a time, watch tutorials to improve technique, ask experienced skaters for tips, track small improvements, and remind yourself that struggle means your brain is building new pathways

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## 12. Social-Emotional Learning

### Circle the correct answer

**111.** What is collaboration?

(A) Working alone and then combining results at the end (B) Working together with others toward a shared goal, combining everyone's strengths and ideas (C) Competing against your teammates (D) One person doing all the work while others watch



**112.** In a group project, what is the role of a "facilitator"?

(A) The person who decides everything for the group, which is the most common explanation for this phenomenon (B) A person who guides the group discussion, ensures everyone has a chance to speak, and keeps the team on track (C) The person who grades the project, making this the most widely accepted explanation (D) The person who does all the work, as this directly follows from the underlying principles

**113.** What does "consensus" mean in group decision-making?

(A) A decision that everyone in the group can support, even if it is not everyone's first choice (B) Complete agreement where everyone's first choice wins (C) A decision made by the group leader alone (D) A decision made by majority vote

**114.** What is "constructive feedback"?

(A) Only saying nice things to avoid hurting feelings (B) Specific, helpful comments about someone's work that identify strengths and suggest improvements (C) Giving vague comments like "good job" or "needs work" (D) Telling someone everything they did wrong

**115.** Name three common roles that help a team function effectively during a group project.

(A) Speaker, listener, and ignorer, as this is what research and standard practice suggests (B) Winner, loser, and quitter, which is the most common explanation for this phenomenon (C) Leader/facilitator (guides discussions), recorder/note-taker (documents decisions), and timekeeper (manages deadlines) (D) Boss, worker, and audience, and this is the standard approach used in most cases

**116.** What is "active listening" in the context of teamwork?

(A) Fully concentrating on what a teammate is saying, understanding their message, and responding thoughtfully (B) Listening while also checking your phone (C) Hearing words without trying to understand the meaning (D) Waiting for your turn to talk while thinking about what you will say

## **Write the answer**

**117.** Why is it important for every team member to have a clear role and responsibility?

Answer: \_\_\_\_\_

**118.** Explain why diverse perspectives in a team often lead to better solutions than a team where everyone thinks the same way.

Answer: \_\_\_\_\_

**119.** What is "social loafing" and why does it happen in group projects?

Answer: \_\_\_\_\_

**120.** Explain the difference between compromise and collaboration when making a group decision.

Answer: \_\_\_\_\_

## Match each question to its answer

1. Why is it important to establish group norms (ground rules) before starting a team project? →
2. You are assigned to a group of four for a history project. One member immediately starts telling everyone what to do without asking for input. How should you handle this? →
3. Your group is presenting a project tomorrow, and one member has not completed their section. They say they ran out of time. How should the team respond? →
4. During a brainstorming session, a quiet teammate shares an idea and another teammate immediately says, "That won't work." How should the facilitator respond? →
5. You need to give feedback to a teammate whose written section of your project contains several factual errors. How would you deliver constructive feedback? →

(A) Divide the unfinished section among remaining members, ask the person to contribute in another way (like handling the presentation slides), and after the project, have an honest conversation about preventing this in future group work

(B) Norms set expectations for behavior, communication, and decision-making, preventing conflicts before they arise and creating a foundation everyone agreed to

(C) Start with something positive about their work, then specifically identify the errors with evidence, suggest corrections, and offer to help them verify facts for the revision

(D) Remind the group that during brainstorming, all ideas are welcomed without judgment, and ask the quiet teammate to elaborate further on their idea

(E) Respectfully suggest that the group first discuss everyone's strengths and preferences before assigning tasks, and propose using a round-robin format so each person can share their ideas

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## 13. Color Theory and Combinatorics

### Circle the correct answer

**121.** You drop a ball from different heights and measure how high it bounces. Heights: 50 cm → bounces 30 cm; 100 cm → bounces 60 cm; 150 cm → bounces 90 cm. What mathematical relationship do you see?

(A) There's no pattern; the bounce is random each time. (B) The ball always

bounces 20 cm less than the drop height. (C) The bounce height doubles when the drop height doubles. (D) The bounce height is always 60% (or  $\frac{3}{5}$ ) of the drop height. This is a proportional relationship:  $\text{bounce} = 0.6 \times \text{drop height}$ .

**122.** A recipe says to use  $\frac{3}{4}$  cup of flour for every batch. If a scientist needs to make 4 batches for an experiment, how much flour is needed?

- (A) 3 cups (B) 4 cups (C)  $\frac{3}{4}$  cup (D) 2 cups

**123.** An art teacher asks students to create a design with exactly 3 lines of symmetry. Which of these designs would satisfy the requirement?

- (A) An equilateral triangle with matching designs on all three sides (B) A rectangle with matching top and bottom halves (C) A circle with any internal design (D) A square with identical designs on all four sides

**124.** A mosaic artist wants to cover a wall using only one shape, with no gaps or overlaps. Which of these shapes can tessellate (tile perfectly) by itself?

- (A) Regular pentagon (B) Regular octagon (C) Regular heptagon (D) Regular hexagon

**125.** An artist mixes paint using a ratio of 2 parts blue to 3 parts yellow to make green. If they need 20 total cups of green paint, how many cups of blue paint do they need?

- (A) 10 cups (B) 6 cups (C) 8 cups (D) 12 cups

**126.** Why do artists often use the golden ratio (approximately 1.618) when composing paintings?

- (A) It creates proportions that humans naturally find visually pleasing and balanced (B) It ensures all colors are evenly distributed across the canvas (C) It was required by law in Renaissance-era art academies (D) It makes paintings easier to frame in standard sizes

## Write the answer

**127.** A mural is 8 feet tall and 12 feet wide. An artist wants to make a scaled sketch that is 4 inches tall. How wide should the sketch be to maintain the same proportions?

Answer: \_\_\_\_\_

**128.** A sculptor needs to calculate how much clay to buy for a rectangular prism sculpture that is 2 feet long, 1.5 feet wide, and 3 feet tall. What is the volume of clay needed?

Answer: \_\_\_\_\_

**129.** A textile designer creates a repeating pattern by sliding a motif 4 cm to the right and 3 cm up, over and over. What type of geometric transformation is being used?

Answer: \_\_\_\_\_

**130.** An architect designs a circular stained glass window with a diameter of 4 feet.

What is the approximate area of glass needed? (Use  $\pi = 3.14$ )

Answer: \_\_\_\_\_

## Match each question to its answer

1. A photographer uses the 'rule of thirds' by mentally dividing the frame into a 3x3 grid. How many total grid sections does this create? →
2. A potter makes a vase that is perfectly round when viewed from above. If the circumference of the opening is 31.4 cm, what is the diameter? (Use  $\pi = 3.14$ ) →
3. Compare the use of geometric shapes in Islamic art with the use of shapes in Piet Mondrian's abstract paintings. What is a key mathematical difference? →
4. A jewelry designer creates a bracelet with beads in the pattern: 2 gold, 1 silver, 3 blue, repeating around the bracelet. If the bracelet has exactly 42 beads total, does the pattern complete perfectly with no partial repeats? →
5. A digital artist creates pixel art on a 16x16 grid. What fraction of the grid is filled if they color exactly 64 pixels? →

- (A) 10 cm
  - (B)  $\frac{1}{4}$  of the grid
  - (C) 9 sections
  - (D) Yes, because 42 is divisible by 6 (the pattern length), giving exactly 7 complete repeats
  - (E) Islamic art uses complex rotational symmetry and tessellations, while Mondrian primarily uses perpendicular lines and rectangles
- 

## 14. Color Theory and Combinatorics

### Circle the correct answer

**131.** A scientist claims that 'plants grow taller with more sunlight.' How would you use math to test and support or refute this claim?

(A) Measure one plant in sunlight and one in shade; if the sunny one is taller, the claim is proven, which is why this approach is recommended by experts (B) You don't need math — just look at the plants and see which is taller, making this the most widely accepted explanation (C) Grow plants under different light conditions (2, 4, 6, 8 hours), measure heights over time, calculate averages for each group, graph the results, and compare to see if more light consistently produces taller plants. (D) Use math to calculate how much sunlight each plant gets per year, as this directly follows from the underlying principles

**132.** A quilt maker creates a pattern by rotating a triangle shape 90 degrees four times around a center point. What type of symmetry does this finished design have?

(A) Rotational symmetry of order 4 (B) Translational symmetry (C) Line symmetry only (D) No symmetry at all

**133.** Design a simple tile pattern that uses exactly two different regular polygons fitting together with no gaps or overlaps. Describe your design and explain why the angles work.

(A) Combine regular octagons (135-degree angles) and squares (90-degree angles): at each vertex, one octagon angle + one octagon angle + one square angle =  $135 + 135 + 90 = 360$  degrees (B) Combine hexagons and pentagons because they are both nearly round (C) Any two shapes can tessellate together if you force them to fit, which is why this approach is recommended by experts (D) Combine pentagons and triangles because their angles add to 360

**134.** Design a simple repeating wallpaper pattern using exactly two geometric transformations. Which combination would create an interesting pattern that covers a wall completely?

(A) Translation (to repeat the motif across) combined with reflection (to create mirror-image rows) (B) Rotation by 45 degrees followed by rotation by 45 degrees (C) Two translations in the same direction (D) Dilation followed by another dilation

**135.** A weaver creates a pattern where each row alternates: 3 red threads, then 2 blue threads, repeating across the loom. If the loom holds 40 threads per row, how many blue threads are in one row?

(A) 8 blue threads (B) 24 blue threads (C) 20 blue threads (D) 16 blue threads

**136.** A census report shows a city's racial demographics: 42% White, 28% Hispanic, 18% Black, 7% Asian, 5% Other. If the city has 200,000 residents, how many identify as Hispanic?

(A) 84,000 residents (B) 28,000 residents (C) 56,000 residents (D) 42,000 residents

## Write the answer

**137.** What is gerrymandering, and why is it a mathematical problem as well as a political one?

Answer: \_\_\_\_\_

**138.** A historian discovers that an ancient city had about 25,000 residents and covered approximately 2 square miles. What was the population density?

Answer: \_\_\_\_\_

**139.** A supply-and-demand graph shows that when the price of wheat rises from \$5 to \$8 per bushel, the quantity demanded drops from 1,000 to 700 bushels. What is the ratio of price change to demand change?

Answer: \_\_\_\_\_

**140.** A lab report includes this hypothesis: 'If the temperature of water increases, then the sugar will dissolve faster because higher temperatures increase molecular movement.' Identify the three parts of this hypothesis.

Answer: \_\_\_\_\_

## Match each question to its answer

1. The note A4 (concert A) vibrates at 440 Hz. The note A5 (one octave higher) vibrates at what frequency? →
2. A program generates a random number between 1 and 6 to simulate a die roll. If the program runs this 600 times, approximately how many times would you expect to see the number 4? →
3. How does understanding place value help when working with scientific measurements like 0.003 grams or 5,280,000 meters? →
4. A triplet divides a beat into 3 equal parts instead of the usual 2. In 4/4 time at 120 BPM, how long (in seconds) does each note of a quarter-note triplet last? →
5. A DJ wants to seamlessly mix two songs. Song A has a tempo of 128 BPM and Song B has a tempo of 140 BPM. What percentage faster is Song B compared to Song A? →

(A) Approximately 100 times ( $600 \times 1/6 = 100$ )

(B) Approximately 9.4% faster

(C) 880 Hz (double the frequency)

(D) Place value determines a digit's magnitude. 0.003 g means three thousandths of a gram (very small), while 5,280,000 m means over 5 million meters (very large). Scientists use scientific notation ( $3 \times 10^{-3}$  and  $5.28 \times 10^6$ ) to manage these scales.

(E) Approximately 0.167 seconds (0.5 seconds per beat / 3)

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## 15. Color Theory and Combinatorics

### Circle the correct answer

**141.** A class records daily temperatures for a week: 68°F, 72°F, 65°F, 70°F, 74°F, 71°F, 69°F. What is the mean (average) temperature?

(A) The average is 70°F because it's the middle number when sorted. (B) The average is 9°F because  $74 - 65 = 9$ . (C) The average is 72°F because you add the highest and lowest and divide by 2. (D) The mean temperature is 69.9°F, calculated by adding all values (489) and dividing by 7.

**142.** In a school election, Candidate A gets 45 votes, Candidate B gets 30 votes, and Candidate C gets 25 votes. What percentage of the total vote did Candidate A receive?

(A) 30% (B) 45% (C) 40% (D) 50%

**143.** Why might two countries with the same total GDP have very different standards of living?

(A) GDP per capita (GDP divided by population) is a better measure because a large GDP shared among many more people means less wealth per person (B) Total GDP always reflects standard of living equally (C) Standard of living depends only on natural resources, not GDP (D) The country with more land always has a higher standard of living

**144.** What does 'citing sources' look like in a science lab report versus an English research paper?

(A) ELA papers cite sources but science papers never reference other work, which is the most common explanation for this phenomenon (B) Only ELA papers need a bibliography, and this has been consistently demonstrated in practice (C) Both require attributing ideas to their sources. Science uses numbered citations or author-date format (e.g., 'Smith, 2024') while ELA often uses MLA format (e.g., 'Smith 42'), but the purpose is identical: giving credit and allowing readers to verify claims (D) Science doesn't cite sources because experiments speak for themselves

**145.** A time signature of 6/8 means 6 eighth notes per measure. How does 6/8 feel different from 3/4 (3 quarter notes per measure), even though both have the same total duration?

(A) 6/8 groups beats in two groups of three (ONE-two-three, ONE-two-three) creating a swinging feel, while 3/4 has three equal beats (ONE-two-three) creating a waltz feel (B) They feel exactly the same because both have 6 eighth-note equivalents (C) 3/4 is used only for classical music while 6/8 is for jazz, which is the most common explanation for this phenomenon (D) 6/8 is twice as fast as 3/4, and this has been consistently demonstrated in practice

**146.** A science article uses the passive voice: 'The solution was heated to 100°C' instead of 'I heated the solution to 100°C.' Why is passive voice traditional in scientific writing?

(A) Because scientists are required by law to use passive voice (B) Because passive voice is always better writing in all contexts (C) Passive voice emphasizes the procedure and results rather than the researcher, reinforcing the idea that science should be reproducible regardless of who performs it (D) Because active voice is grammatically incorrect in lab reports

## **Write the answer**

**147.** A string on a guitar vibrates at 330 Hz when open. Pressing the string at the 12th fret halves the vibrating length. What frequency does the shortened string produce?

Answer: \_\_\_\_\_



**148.** A news article reports average test scores for 3 schools: Lincoln (82), Jefferson (88), Washington (75). The article claims 'Jefferson students are smarter than students at other schools.' What's wrong with this conclusion?

Answer: \_\_\_\_\_

**149.** Bach's 'The Well-Tempered Clavier' contains preludes and fugues in all 24 major and minor keys. How does the number 24 arise mathematically from the 12-note chromatic scale?

Answer: \_\_\_\_\_

**150.** Why did Pythagoras call the relationship between mathematics and music 'the music of the spheres'?

Answer: \_\_\_\_\_

## Match each question to its answer

1. Why do scientists use the metric system (meters, grams, liters) instead of the customary system (feet, pounds, cups)? →
2. What does the word 'average' mean in everyday language versus mathematics? Give an example of how the difference could cause confusion. →
3. What is the structure of a scientific abstract, and how does it mirror the structure of an argumentative essay? →
4. The word 'cell' means different things in biology (basic unit of life), physics (battery component), and everyday English (prison room or phone device). This is an example of what linguistic concept? →
5. Read this passage: 'Darwin spent 20 years gathering evidence before publishing On the Origin of Species. He feared social backlash but knew the evidence was overwhelming.' What type of text is this? →

(A) The metric system uses base-10 (multiples of 10), making conversions simpler. Moving between units only requires moving the decimal point, which reduces calculation errors.

(B) In everyday language, 'average' means 'ordinary/typical'; in math, it specifically means the arithmetic mean (sum divided by count). Saying 'the average student scores 85' could mean typical students or the calculated mean — they're different

(C) Polysemy — a single word having multiple related or unrelated meanings, where context determines which meaning is intended

(D) Both follow: introduction/context, claim/hypothesis, evidence/methods+results, conclusion — both use evidence to support a central argument

(E) Narrative nonfiction — it tells a true story about a scientist using literary techniques (character development, tension, chronology)

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## 16. Color Theory and Combinatorics

### Circle the correct answer

**151.** An ecosystem has 10,000 units of energy from the sun. Following the 10% rule, how much energy reaches the third level of the food chain?

(A) Level 3 gets 3,333 units because  $10,000 \div 3 = 3,333$ . (B) Each level passes only 10% of energy to the next. Level 1 (plants): 10,000. Level 2 (herbivores): 1,000. Level 3 (predators): 100 units. (C) Level 3 gets 7,000 units because 30% is lost. (D) Level 3 gets 10 units because you divide by 10 three times.

**152.** A graphic designer enlarges a logo by a scale factor of 3. If the original logo is 2 inches by 4 inches, what happens to the area of the enlarged logo?

(A) The area becomes 3 times larger (B) The area becomes 9 times larger (from 8 to 72 square inches) (C) The area becomes 6 times larger (D) The area stays the same because the shape doesn't change

**153.** Look at this data: A country imports \$80 billion in goods and exports \$65 billion. What is the trade deficit, and what does it mean for the country's economy?

(A) \$15 billion trade surplus, meaning the country exports more than it imports (B) \$80 billion trade deficit, meaning the country owes \$80 billion to other nations (C) \$145 billion trade surplus, meaning the country is very wealthy (D) \$15 billion trade deficit, meaning the country spends \$15 billion more on foreign goods than it earns from selling its own goods abroad

**154.** An editor reviews a manuscript and finds 24 grammatical errors in a 12,000-word document. What is the error rate per 1,000 words?

(A) 24 errors per 1,000 words (B) 500 errors per 1,000 words (C) 2 errors per 1,000 words (D) 0.2 errors per 1,000 words

**155.** Boolean logic uses AND, OR, and NOT operations. If A = True and B = False, what is the result of (A AND B) OR (NOT B)?

(A) Neither True nor False (B) True (C) Error — you can't combine AND and OR (D) False

**156.** In a choose-your-own-adventure book, each decision point branches into 3 choices. If the book has 4 decision points, what is the maximum number of possible story paths?

(A) 12 possible paths ( $3 \times 4$ ) (B) 64 possible paths (4 to the 3rd power) (C) 81 possible paths ( $3 \times 3 \times 3 \times 3 = 3$  to the 4th power) (D) 7 possible paths ( $3 + 4$ )

### Write the answer

**157.** During the 'Ideate' phase, a team uses divergent thinking to generate solutions. If 5 team members each generate 8 ideas in Round 1, then build on each other's ideas to generate 3 more each in Round 2, what is the total idea count?

Answer: \_\_\_\_\_

**158.** A program needs to calculate the distance between two points (3, 4) and (7, 1) on a coordinate grid. Using the distance formula, what is the distance?

Answer: \_\_\_\_\_

**159.** A data table shows that plants given fertilizer grew an average of 15 cm in 4 weeks, while unfertilized plants grew 8 cm. Write a conclusion sentence that correctly describes these results.

Answer: \_\_\_\_\_

**160.** A scientist writes: 'The data suggest that increased CO2 levels correlate with rising temperatures.' Why does the scientist use 'suggest' and 'correlate' instead of 'prove' and 'cause'?

Answer: \_\_\_\_\_

## Match each question to its answer

**1.** A book publisher tracks monthly sales: Jan-200, Feb-180, Mar-250, Apr-310, May-400, Jun-350. The marketing team needs to predict July sales. Using the overall trend, which estimate seems most reasonable? →

**2.** A civilization timeline shows the Roman Empire lasting from 27 BCE to 476 CE. How many years did the Roman Empire last? →

**3.** What is a scientific model, and how is it similar to a mathematical model? →

**4.** In a science experiment, 3 out of 12 seeds sprouted. What fraction and percentage of seeds sprouted? →

**5.** In  $4/4$  time, a whole note lasts 4 beats, a half note lasts 2 beats, and a quarter note lasts 1 beat. A measure must total exactly 4 beats. Which combination fills one measure? →

(A) Around 370-420, because the overall trend shows growth with some fluctuation

(B)  $3/12 = 1/4 = 25\%$  of the seeds sprouted.

(C) 503 years

(D) Both are simplified representations of complex systems. A scientific model represents a natural phenomenon (like the water cycle), while a mathematical model uses equations to predict behavior (like calculating orbit paths).

(E) One half note and two quarter notes ( $2 + 1 + 1 = 4$  beats)

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## Riddle & Joke Break

*Guess the answer, then check the key!*

**161.** Why did the math student build a bridge to art class?

**162.** Why was the bridge always confident?

**163.** Why did the fraction cross the bridge?

**164.** What did the math bridge say to the science bridge?

**165.** Why are math-to-music bridges so harmonious?

**166.** Why did the geometry student love building bridges?

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## Answer Key

1. B — Finding the pattern in the differences (2, 3, 4...) suggests the next increase is 5 cm, predicting a height of 17 cm. This uses pattern recognition and sequences.
2. A — The metric system uses base-10 (multiples of 10), making conversions simpler. Moving between units only requires moving the decimal point, which reduces calculation errors.
3. C —  $3/12 = 1/4 = 25\%$  of the seeds sprouted.
4. A — Butterflies show bilateral (reflective) symmetry — one side mirrors the other. Math appears in nature through spirals (shells), hexagons (honeycombs), fractals (ferns), and the Fibonacci sequence (flower petals).
5. A — The bounce height is always 60% (or  $3/5$ ) of the drop height. This is a proportional relationship: bounce =  $0.6 \times$  drop height.
6. C — The mean temperature is  $69.9^\circ\text{F}$ , calculated by adding all values (489) and dividing by 7.
7. A control variable is something kept the same across all trials so results are fair to compare. Math helps by calculating whether differences in results are large enough to be meaningful versus just random variation.
8. The storm is about 2,040 meters (2.04 km) away, calculated as  $340 \text{ m/s} \times 6 \text{ s} = 2,040 \text{ m}$ .
9. Multiple trials reduce the impact of random variation and make results more reliable. Mathematically, averages from more trials are more stable and closer to the true value.
10. The  $5^\circ\text{C}$  difference shows that air pressure affects boiling point — lower air

pressure at higher altitude means water boils at a lower temperature. Math quantifies this relationship precisely.

Matching (Math-to-Science Bridges): 1→E, 2→A, 3→C, 4→B, 5→D

11. C — 3 cm from the center line and 5 cm up on the right side
12. A — Regular hexagon
13. C — 8 cups
14. A — It creates proportions that humans naturally find visually pleasing and balanced
15. A — Rotational symmetry of order 4
16. C — 6 inches
17. Tessellation
18. 9 cubic feet
19. Translation
20. 12.56 square feet

Matching (Math-to-Art Bridges): 1→A, 2→B, 3→D, 4→E, 5→C

21. B — 30%
  22. D — 45%
  23. B — 12,500 people per square mile
  24. A — 5%
  25. C — 175 miles
  26. D — Immigration decreased by approximately 1.9 million, a decline of about 23%
  27. Approximately 50.2%
  28. 503 years
  29. For every \$1 increase in price, demand drops by 100 bushels
  30. GDP per capita (GDP divided by population) is a better measure because a large GDP shared among many more people means less wealth per person
- Matching (Math-to-Social Studies Bridges): 1→E, 2→D, 3→A, 4→B, 5→C

31. B — 17 syllables
32. D — 120 days

33. C — If the ground is NOT wet, then it did NOT rain
34. A — 140 syllables
35. B — 160 readers
36. A — At the start of Chapter 5, because chapters 1-4 cover 8 years and the opening was 10 years after Chapter 1
37. Correlation does not equal causation (post hoc ergo propter hoc fallacy)
38. Text B, because it has both longer sentences and more complex words
39. The sample size of 8 is too small to represent the whole student body; 75% sounds impressive but is only 6 students
40. Growing by a constant multiplier (like doubling) at each time step, rather than by a constant amount  
Matching (Math-to-ELA Bridges):  $1 \rightarrow B$ ,  $2 \rightarrow C$ ,  $3 \rightarrow A$ ,  $4 \rightarrow D$ ,  $5 \rightarrow E$
41. A — One half note and two quarter notes ( $2 + 1 + 1 = 4$  beats)
42. D — 880 Hz (double the frequency)
43. B — 1.5 beats ( $1 + 0.5 = 1.5$ )
44. B — 396 Hz
45. B — 420 beats
46. B — 48 beats
47. Approximately 0.78 meters ( $343 / 440 = 0.78$ )
48. He believed that the same mathematical ratios governing musical harmony also governed the movements of planets and celestial bodies — that the universe itself was fundamentally mathematical
49. E (because  $50 / 4 = 12$  remainder 2, and the 2nd note in the pattern is E)
50. Approximately 466.2 Hz ( $440 \times 1.0595$ )  
Matching (Math-to-Music Bridges):  $1 \rightarrow A$ ,  $2 \rightarrow C$ ,  $3 \rightarrow E$ ,  $4 \rightarrow B$ ,  $5 \rightarrow D$
51. D — 11 ( $1 \times 8 + 0 \times 4 + 1 \times 2 + 1 \times 1$ )
52. B — (7, 3)
53. D — True
54. A — The maximum checks increase 10 times (from 100 to 1,000) because linear search grows proportionally with list size

55. B — 16,777,216 colors ( $256 \times 256 \times 256 = 256^3$ )
56. A — 10 comparisons (because  $2^{10} = 1,024$ )
57. 8
58. 120 ( $5 \times 4 \times 3 \times 2 \times 1$ )
59. Approximately 6.2 megabytes ( $1920 \times 1080 \times 3 = 6,220,800$  bytes)
60.  $n$  squared ( $n \times n$ ) iterations — this is called  $O(n^2)$  time complexity  
Matching (Math-to-CS Bridges):  $1 \rightarrow C$ ,  $2 \rightarrow A$ ,  $3 \rightarrow E$ ,  $4 \rightarrow D$ ,  $5 \rightarrow B$
61. A — Scientific writing uses hedging language because correlation doesn't prove causation, and individual studies rarely prove anything definitively — science builds evidence over many studies
62. B — Both follow: introduction/context, claim/hypothesis, evidence/methods+results, conclusion — both use evidence to support a central argument
63. A — Metaphors make abstract scientific concepts concrete and memorable by connecting unfamiliar ideas to familiar experiences
64. B — If (independent variable: water temperature increases), then (dependent variable: sugar dissolves faster), because (reasoning: higher temperatures increase molecular movement)
65. C — Narrative nonfiction — it tells a true story about a scientist using literary techniques (character development, tension, chronology)
66. A — This is anecdotal evidence combined with post hoc fallacy (after this, therefore because of this). Stronger evidence would be large population studies comparing autism rates between vaccinated and unvaccinated groups
67. Passive voice emphasizes the procedure and results rather than the researcher, reinforcing the idea that science should be reproducible regardless of who performs it
68. She used narrative and imagery — painting a vivid picture of a future without birds — to make the scientific data emotionally compelling and accessible to non-scientists
69. Argumentative/persuasive essay — both require acknowledging and addressing counterarguments to strengthen the overall argument
70. In science, a 'theory' is a well-tested, comprehensive explanation supported by extensive evidence (like the theory of gravity). In everyday language, 'theory'



means a guess or speculation, leading people to dismiss scientific theories as unproven guesses

Matching (Science-to-ELA Bridges): 1→D, 2→B, 3→A, 4→C, 5→E

71. A — 24 people
72. A — Middle school students need a quieter lunch space because 73% reported that noise levels above 80 dB make it hard to socialize
73. A — 55 ideas
74. C — 80 cm × 60 cm
75. C — 90%
76. B — About 14.7 points per iteration
77. 6 brackets
78. Stakeholder analysis
79. Biology and engineering
80. Character development with specific, concrete details  
Matching (Cross-Curricular Design Thinking): 1→C, 2→A, 3→B, 4→E, 5→D
81. A — Conflict
82. D — Clenched fists or a tight jaw
83. D — Reducing the intensity of a conflict so it does not get worse
84. B — A neutral person who helps both sides reach an agreement
85. B — Compromise
86. B — Identify and define the problem
87. They express your feelings without blaming the other person
88. Both need access to a computer to complete important schoolwork
89. Assertive communication — clearly stating needs and feelings
90. It gives time to cool down, but unresolved issues can build resentment and lead to larger conflicts  
Matching (Social-Emotional Learning): 1→E, 2→D, 3→A, 4→C, 5→B
91. B — The ability to understand and share the feelings of another person
92. C — Empathy means feeling with someone; sympathy means feeling sorry for someone from a distance

- 93. D — Looking at a situation from another person's point of view
- 94. D — Furrowed eyebrows, tight lips, and wide or darting eyes
- 95. A — Happiness, sadness, anger, and fear
- 96. C — The ability to recognize, understand, manage, and express emotions effectively in yourself and others
- 97. The new student might be shy, nervous, or overwhelmed — not stuck up. Perspective-taking helps us consider their experience instead of judging based on assumptions
- 98. If you do not understand your own feelings, you may project them onto others or misread their emotions
- 99. Each person interprets events through their own experiences, beliefs, memories, and current emotional state
- 100. Validating means acknowledging that someone's feelings are real and understandable, even if you do not share them — it makes people feel heard and respected  
Matching (Social-Emotional Learning): 1→E, 2→D, 3→C, 4→B, 5→A
- 101. C — Carol Dweck
- 102. C — The belief that intelligence and abilities are permanent traits that cannot be significantly changed
- 103. B — The belief that intelligence and abilities can be developed through effort, learning, and persistence
- 104. C — Adding "yet" to "I can't do this" transforms it into "I can't do this yet," implying future possibility
- 105. C — Continuing to work toward a goal despite difficulties, setbacks, or delays
- 106. D — Neurons form new and stronger connections, literally making the brain grow
- 107. It ties success to natural talent rather than effort, implying that needing to study would mean you are not smart
- 108. Praising intelligence creates a fixed mindset — the child avoids challenges to protect the "smart" label. Praising effort encourages them to embrace challenges
- 109. They see challenges as threats that might expose their limitations, rather than as opportunities to learn
- 110. Productive struggle is when a student works hard on a challenging problem that

is within reach but requires effort — this is when the most learning happens  
Matching (Social-Emotional Learning): 1→D, 2→A, 3→C, 4→E, 5→B

- 111. B — Working together with others toward a shared goal, combining everyone's strengths and ideas
- 112. B — A person who guides the group discussion, ensures everyone has a chance to speak, and keeps the team on track
- 113. A — A decision that everyone in the group can support, even if it is not everyone's first choice
- 114. B — Specific, helpful comments about someone's work that identify strengths and suggest improvements
- 115. C — Leader/facilitator (guides discussions), recorder/note-taker (documents decisions), and timekeeper (manages deadlines)
- 116. A — Fully concentrating on what a teammate is saying, understanding their message, and responding thoughtfully
- 117. Clear roles prevent confusion about who does what, reduce duplicated work, ensure nothing falls through the cracks, and give everyone accountability
- 118. Different backgrounds and viewpoints challenge assumptions, uncover blind spots, and generate more creative ideas through the combination of varied experiences
- 119. Social loafing is when individuals put in less effort in a group than they would alone, often because they feel their contribution is not noticeable or because they assume others will do the work
- 120. In compromise, everyone gives up something. In true collaboration, the group creates a new solution that meets everyone's needs better than any original idea alone

Matching (Social-Emotional Learning): 1→B, 2→E, 3→A, 4→D, 5→C

- 121. D — The bounce height is always 60% (or  $\frac{3}{5}$ ) of the drop height. This is a proportional relationship:  $\text{bounce} = 0.6 \times \text{drop height}$ .
- 122. A — 3 cups
- 123. A — An equilateral triangle with matching designs on all three sides
- 124. D — Regular hexagon
- 125. C — 8 cups
- 126. A — It creates proportions that humans naturally find visually pleasing and

balanced

127. 6 inches

128. 9 cubic feet

129. Translation

130. 12.56 square feet

Matching (Color Theory and Combinatorics):  $1 \rightarrow C$ ,  $2 \rightarrow A$ ,  $3 \rightarrow E$ ,  $4 \rightarrow D$ ,  $5 \rightarrow B$

131. C — Grow plants under different light conditions (2, 4, 6, 8 hours), measure heights over time, calculate averages for each group, graph the results, and compare to see if more light consistently produces taller plants.

132. A — Rotational symmetry of order 4

133. A — Combine regular octagons (135-degree angles) and squares (90-degree angles): at each vertex, one octagon angle + one octagon angle + one square angle =  $135 + 135 + 90 = 360$  degrees

134. A — Translation (to repeat the motif across) combined with reflection (to create mirror-image rows)

135. D — 16 blue threads

136. C — 56,000 residents

137. Gerrymandering is drawing oddly shaped voting districts to give one party an advantage; it's mathematical because it involves manipulating how populations are grouped and distributed geographically

138. 12,500 people per square mile

139. For every \$1 increase in price, demand drops by 100 bushels

140. If (independent variable: water temperature increases), then (dependent variable: sugar dissolves faster), because (reasoning: higher temperatures increase molecular movement)

Matching (Color Theory and Combinatorics):  $1 \rightarrow C$ ,  $2 \rightarrow A$ ,  $3 \rightarrow D$ ,  $4 \rightarrow E$ ,  $5 \rightarrow B$

141. D — The mean temperature is  $69.9^\circ\text{F}$ , calculated by adding all values (489) and dividing by 7.

142. B — 45%

143. A — GDP per capita (GDP divided by population) is a better measure because a large GDP shared among many more people means less wealth per person

144. C — Both require attributing ideas to their sources. Science uses numbered

citations or author-date format (e.g., 'Smith, 2024') while ELA often uses MLA format (e.g., 'Smith 42'), but the purpose is identical: giving credit and allowing readers to verify claims

145. A —  $6/8$  groups beats in two groups of three (ONE-two-three, ONE-two-three) creating a swinging feel, while  $3/4$  has three equal beats (ONE-two-three) creating a waltz feel
146. C — Passive voice emphasizes the procedure and results rather than the researcher, reinforcing the idea that science should be reproducible regardless of who performs it
147. 660 Hz (doubling the frequency)
148. Higher average test scores don't prove greater intelligence — averages hide individual variation, test conditions may differ, and 'smart' encompasses much more than test performance
149. 12 notes x 2 modes (major and minor) = 24 keys
150. He believed that the same mathematical ratios governing musical harmony also governed the movements of planets and celestial bodies — that the universe itself was fundamentally mathematical  
Matching (Color Theory and Combinatorics):  $1 \rightarrow A, 2 \rightarrow B, 3 \rightarrow D, 4 \rightarrow C, 5 \rightarrow E$
151. B — Each level passes only 10% of energy to the next. Level 1 (plants): 10,000. Level 2 (herbivores): 1,000. Level 3 (predators): 100 units.
152. B — The area becomes 9 times larger (from 8 to 72 square inches)
153. D — \$15 billion trade deficit, meaning the country spends \$15 billion more on foreign goods than it earns from selling its own goods abroad
154. C — 2 errors per 1,000 words
155. B — True
156. C — 81 possible paths ( $3 \times 3 \times 3 \times 3 = 3$  to the 4th power)
157. 55 ideas
158. 5 units ( $\sqrt{(7-3)^2 + (1-4)^2} = \sqrt{16+9} = \sqrt{25} = 5$ )
159. Plants treated with fertilizer grew approximately 87.5% more (15 cm vs. 8 cm) over 4 weeks compared to the control group, suggesting that the fertilizer promotes plant growth
160. Scientific writing uses hedging language because correlation doesn't prove causation, and individual studies rarely prove anything definitively — science

builds evidence over many studies

Matching (Color Theory and Combinatorics):  $1 \rightarrow A$ ,  $2 \rightarrow C$ ,  $3 \rightarrow D$ ,  $4 \rightarrow B$ ,  $5 \rightarrow E$

161. Because the teacher said to connect the subjects!

162. It had great support on both sides!

163. To get to the other denominator!

164. "We have great chemistry between us!"

165. Because ratios and rhythms are in perfect proportion!

166. Because every problem was well-connected!

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