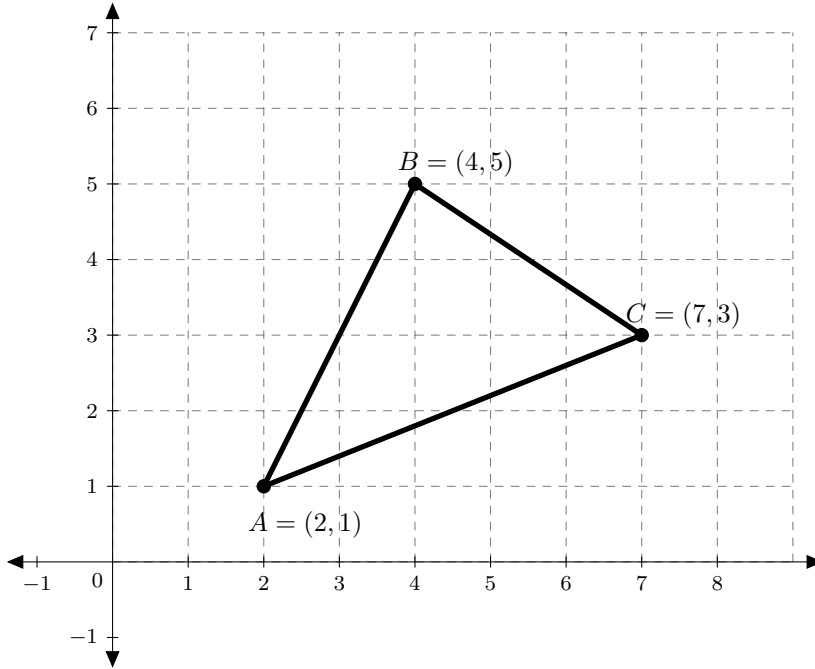


Grade 4

1. A prime number is a natural number greater than 1 that is divisible by only 1 and itself. Let a , b , and c be primes satisfying: $0 < a < b < c < 10$ and the average of a , b , and c is 4. What is b ?
(a) 2 (b) 3 (c) 5 (d) 7
2. A hockey practice consists of 10 minutes of stretching and two 45 minute long games with a 15 minute break between games. If the practice started at 3: 00 PM, what time would the practice end?
(a) 4: 10 PM (b) 4: 30 PM (c) 4: 45 PM (d) 4: 55 PM (e) 6: 05 PM
3. A gas tank is $\frac{1}{3}$ full. After putting 8 gallons of gas into it, the gas tank is $\frac{3}{5}$ full. How many gallons of gas can the entire tank hold?
4. Given the pattern
$$\frac{1}{19}, \frac{1}{4}, \frac{7}{13}, 1, \frac{13}{7}, 4, 19, -11, x$$
what is x ?

Grade 5

1. The sum of three consecutive whole numbers is 2016. What is the largest of the three numbers?
(a) 669 (b) 670 (c) 671 (d) 672 (e) 673
2. The digits 1, 2, 3, 4, and 5 are each used once to form the greatest possible five-digit even number. What is the digit in the ones place?
(a) 1 (b) 2 (c) 3 (d) 4 (e) 5
3. The sum of first 5 digits of 1.23123 is $1 + 2 + 3 + 1 + 2 = 9$. When $\frac{2014}{11}$ is written as a decimal number, what is the sum of its first 2014 digits?
4. In the xy -plane below, what is the area of the triangle with three vertices $A(2, 1)$, $B(4, 5)$, and $C(7, 3)$?



Grade 6

- If $20a - 16b = 240$, what is the value of $\frac{a}{4} - \frac{b}{5}$?
 (a) 1 (b) 3 (c) 12 (d) 24 (e) None of these
- Define an operation $\#$ as follows: $a\#b = a \cdot b - (a - b)$ for all integers a and b . Find the value of x satisfying the equation $(7\#x) - 8 = 57$.
 (a) 11 (b) 9 (c) 7 (d) 5 (e) 3
- It is known that

$$\begin{aligned}
 1 &= 1^2 \\
 1 + 3 &= 2^2 \\
 1 + 3 + 5 &= 3^2 \\
 1 + 3 + 5 + 7 &= 4^2 \\
 &\vdots
 \end{aligned}$$

Using this pattern, find k that satisfies

$$3 + 9 + 15 + 21 + 27 + 33 + 39 + \cdots + 153 + 159 = 3^k$$

- Find all ordered pairs (x, y) that satisfy the following two conditions:
 (a) x and y are non-zero numbers, and

- (b) three of the following four expressions are the same

$$x + y, x - y, xy, \text{ and } \frac{x}{y}.$$

Grade 7

1. If $x < 0$, which of the following must be always negative? (a) $x^3 - x$ (b) $x - x^3$ (c) $x^2 - x^3$ (d) $x^2 + x$
2. If Brian scores 95 on an upcoming math test, his average would be 92. However, if his grade is 80 on the test, the average would be 89. How many tests he already taken? (a) 2 (b) 3 (c) 4 (d) 5
3. If x is a number such that $x^2 - x + 1 = 0$, then find the numerical value of

$$x + x^2 + x^3 + \cdots + x^{2020} + \frac{1}{x} + \frac{1}{x^2} + \frac{1}{x^3} + \cdots + \frac{1}{x^{2020}}$$

4. An urn contains 4 red and 5 blue balls. Amy first withdraws a ball from the urn and then Brian withdraws a ball from the urn without replacement. They keep withdrawing a ball alternately until a red ball is selected. Find the probability that Brian selects the red ball. Provide your answer as a fraction.

Grade 8

1. Triangle $\triangle ABC$ is isosceles with $\angle B = \angle C$. The measure of $\angle A$ is three times the measure of $\angle B$. What is the measure of $\angle A$ in degrees?
(a) 87° (b) 90° (c) 108° (d) 120° (e) 120° (e) 126°
2. How many distinct four-digit positive integers are there such that the product of their digits equal to 18?
(a) 60 (b) 48 (c) 36 (d) 30 (e) 24
3. Find the smallest natural number whose remainders are 2, 3, 4 and 5 when it is divided by 4, 5, 6 and 7, respectively.
4. Find the value of

$$\left(\frac{1}{2}\right) - \left(\frac{1}{3} + \frac{2}{3}\right) + \left(\frac{1}{4} + \frac{2}{4} + \frac{3}{4}\right) - \cdots - \left(\frac{1}{99} + \frac{2}{99} + \cdots + \frac{98}{99}\right) + \left(\frac{1}{100} + \frac{2}{100} + \cdots + \frac{99}{100}\right)$$

Grade 9

- In the arithmetic series $6, 13, 20, 27, \dots$, the fifth term is 34. Which term is 2015?
 (a) 285th (b) 286th (c) 287th (d) 288th (e) 289th
- The area of triangle ABC is 6. If the coordinates of A and B are $(0, 0)$ and $(3, 4)$ respectively, what is the locus of point C ? (Note: The locus of point C is the set of points (x, y) satisfying the condition for C . It may be a curve or a line.)
 (a) $(3, 8)$ or $(6, 4)$ (b) $y = \pm 4$
 (c) $4y = 3x + 24$ or $4y = 3x - 24$ (d) $3y - 4x - 12 = 0$ or $3y - 4x + 12 = 0$
 (e) None of these
- A balanced standard die is tossed six times, and the number on the uppermost face is recorded each time. What is the probability that the numbers recorded are 1, 2, 3, 4, 5, and 6 in any order. (Provide your answer as a fraction.)
- Evaluate the sum of the first 7 values of $\frac{1}{\sqrt{5n+1} + \sqrt{5n-4}}$ starting from $n = 1$ (up to $n = 7$): that is the value

$$\frac{1}{\sqrt{6} + \sqrt{1}} + \frac{1}{\sqrt{11} + \sqrt{6}} + \dots + \frac{1}{\sqrt{36} + \sqrt{31}}$$

Grade 10

- Suppose that $f(3-x) = 2x^2 - 6x + 3$ and $f(x) = ax^2 + bx + c$. What is $a + b + c$?
 (a) -1 (b) 0 (c) 1 (d) 2 (e) 3
- How many real solutions are there to the equation $|4-x| + |x-2| = 2$?
 (a) 0 (b) 1 (c) 2 (d) 3 (e) more than 3
- A rectangle of perimeter 24cm is inscribed in a circle of area $25\pi\text{cm}^2$. What is the area of the rectangle?
- Let z and w be nonzero complex numbers such that

$$|z| = |w| = |z + w|$$

Find the sum of all possible values of $\frac{z}{w}$.

Grade 11

- Evaluate $\left(\frac{1 + \sqrt{3}i}{2}\right)^{2019}$
 (a) -1 (b) $\frac{1 + \sqrt{3}i}{2}$ (c) $\frac{1+i}{2}$ (d) $\frac{1 - \sqrt{3}i}{2}$ (e) 0

2. A speedboat cruises at 20 miles per hour in still water, and the stream flow rate of a river is 8 miles per hour. For what values of x does the boat take x hour (s) longer to go 10 miles up the river than to return?

(a) $\frac{2}{5}$ hours (b) $\frac{10}{21}$ hours (c) $\frac{17}{33}$ hours (d) $\frac{32}{41}$ hours (e) 1 hours

3. Find $f(2016)$ when f satisfies the following condition:

$$f(xy) = f(x) - f(y) \text{ for all real numbers } x, y.$$

4. Let $f(x) = p(x)/x$ be a rational function such that $p(x)$ is a polynomial of degree 100 with the leading coefficient 1, i.e., $p(x) = x^{100} +$ (lower degree terms). If $f(k) = k + \frac{1}{k}$ for all $k = 1, 2, 3, \dots, 100$, then, what is the value of $f(101)$? (DO NOT simplify your final answer.)