**Time limit:** 30 minutes.
Instructions: For this test, you work in teams of five to solve 20 short answer questions. All answers must be expressed in simplest form unless specified otherwise. Submit a single answer sheet for grading. Only answers written inside the boxes on the answer sheet will be considered for grading.
**No calculators.**

1. Given that $2 \times 10 \times 101 = 2020$, compute $4 \times 5 \times 303$.

2. Ariel the Frog is on the top left square of a 8×10 grid of squares. Ariel can jump from any square on the grid to any adjacent square, including diagonally adjacent squares. What is the minimum number of jumps required for Ariel to reach the bottom right corner?

3. When Star tries to split his gold bars into groups of 4, he has 3 left over, and when he tries to split his gold bars into group of 5, he has 4 left over. What is the least number of gold bars Star could have?

4. As an afternoon activity, Emilia will either play exactly two of four games (Minecraft, Fortnite, Undertale, and Fire Emblem) or work on homework for exactly one of three classes (Physics 5A, Math 1B, and Anthropology 3). How many choices of afternoon activities does Emilia have?

5. Matthew wants to buy merchandise of his favorite sports team. He wants to buy posters of the players on the team, but he only has 30 dollars to spend. If he can buy 2 posters for 4 dollars and 5 posters for 8 dollars, what is the maximum number of posters that Matthew can buy?

6. Ada draws six lines in a plane such that no two lines are parallel and no three lines all intersect at the same point. What is the maximum number of regions she can divide the plane into? One line divides the plane into two regions.

7. Deepak the Dog is tied with a leash of 7 meters to a corner of his 4 meter by 6 meter rectangular shed such that Deepak is outside the shed. Deepak cannot go inside the shed, and the leash cannot go through the shed. Compute the area of the region that Deepak can travel to.
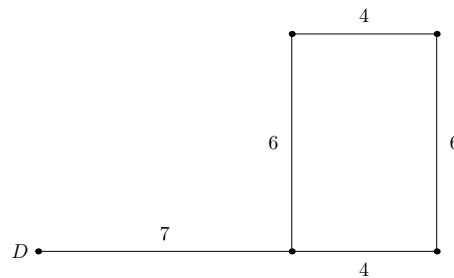

8. City A is 30 miles north and 40 miles east of city B. Alice leaves from city A and drives west at a constant speed of 35 miles per hour at the same time as Bob leaves from city B and drives east at 25 miles per hour. How many minutes will it take for them to be 34 miles apart for the first time?

9. The quadratic equation $a^2x^2 + 2ax - 3 = 0$ has two solutions for x that differ by a, where $a > 0$. What is the value of a?

10. Find the number of ways to color a 2×2 grid of squares with 4 colors such that no two (non-diagonally) adjacent squares have the same color. Each square should be colored entirely with one color. Colorings that are rotations or reflections of each other should be considered different.

11. Let x and y be real numbers such that $xy = 4$ and $x^2y + xy^2 = 25$. Find the value of $x^3y + x^2y^2 + xy^3$.

12. Right triangle ABC has $AB = 5$, $BC = 12$, and $CA = 13$. Point D lies on the angle bisector of $\angle BAC$ such that CD is parallel to AB. Compute the length of BD.
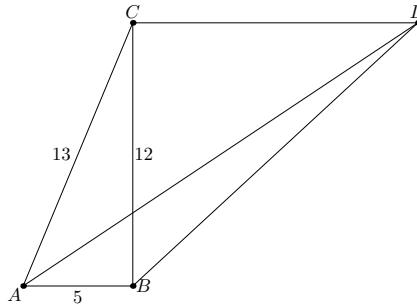
13. Let $\triangle ABC$ be a right triangle with $m\angle B = 90°$ such that AB and BC have integer side lengths. Squares $ABDE$ and $BCFG$ lie outside $\triangle ABC$. If the area of $\triangle ABC$ is 12, and the area of quadrilateral $DEFG$ is 38, compute the perimeter of $\triangle ABC$.
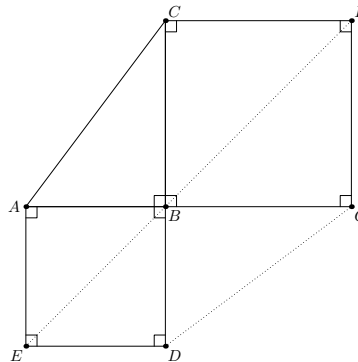
14. Shivani is planning a road trip in a car with special new tires made of solid rubber. Her tires are cylinders that have width 6 inches and have diameter 26 inches, but need to be replaced when the diameter is less than 22 inches. The tire manufacturer claims that 0.12π cubic inches of its tire will wear away with every single rotation. Assuming that the tire manufacturer is correct about the wear rate of its tires, and that the tire loses volume by reducing radius **ONLY**, how many revolutions can each tire make before Shivani needs to replace it?

15. Square $ABCD$ has side length 1 and square $EFGH$ has side length greater than 1. $ABCD$ and $EFGH$ share the same center, and ABE, BFC, CGD, and DHA are all equilateral triangles. If x is the length of AG, find x^2.

16. Rohith has a large equilateral triangle grid consisting of 9 equilateral triangles, where each small triangle has side length 3. He also has a circular coin with a diameter of $\frac{\sqrt{3}}{3}$. Given that he randomly throws the coin such that the center of the coin lies in the large triangular grid, find the probability that the coin lands completely inside a small equilateral triangle.
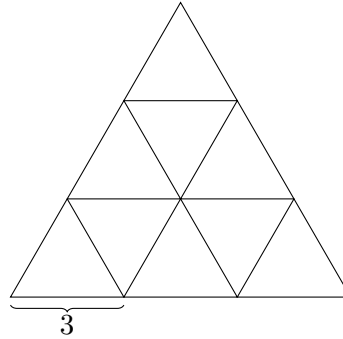
17. Let $\{a_i\}$ for $1 \le i \le 10$ be a finite sequence of 10 integers such that for all odd i, $a_i = 1$ or -1, and for all even i, $a_i = 1, -1$, or 0. How many sequences $\{a_i\}$ exist such that $a_1+a_2+a_3+\cdots+a_{10} = 0$?

18. What is the smallest positive integer x such that there exists an integer y with $\sqrt{x}+\sqrt{y} = \sqrt{1025}$?

19. Let
$$a = \underbrace{19191919\ldots 1919}_{\text{19 is repeated 3838 times}}.$$

What is the remainder when a is divided by 13?

20. James is watching a movie at the cinema. The screen is on a wall perpendicular to the floor and is 5 meters tall with the bottom edge of the screen 1.5 meters above the floor. James wants to find a seat which maximizes his vertical viewing angle (depicted below as θ in a two dimensional cross section), which is the angle subtended by the top and bottom edges of the screen. How far back from the screen in meters (measured along the floor) should he sit in order to maximize his vertical viewing angle?