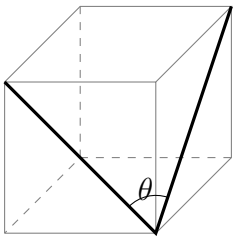
Problem 1. What is the angle, in degrees, between two face diagonals of a cube meeting at the same corner?



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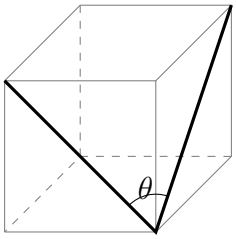

Problem 2. Suppose x is a single digit 0, 1, ..., 9. If the 8 digit number $23456x89$ is divisible by 9, what is x?

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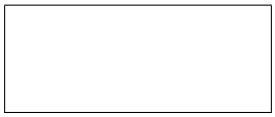

Problem 4. Suppose you have 10 distinct numbers. The average of the smallest 4 numbers is 20, while the average of the largest 6 numbers is 30. What is the average of all 10 numbers?

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Problem 5. Red stones weigh 1 pound while black stones weigh 2 pounds. How many different combinations of red and black stones weigh a total of 100 pounds? A combination must contain a minimum of one red stone and one black stone.

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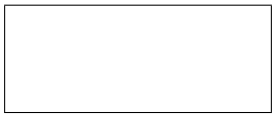
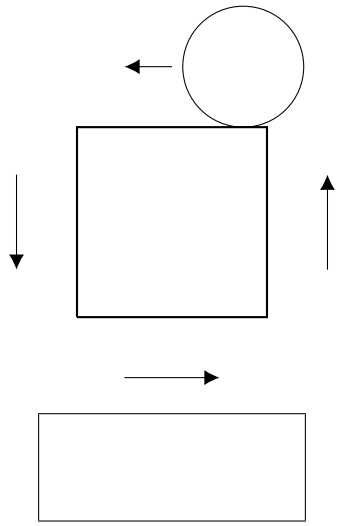


Problem 6. You have a square of sidelength π and a disk of radius 1. The disk rolls all the way around the outside of the square, and always remains tangent (or touching the square only at the corner). What is the area of the path traveled by the disk?



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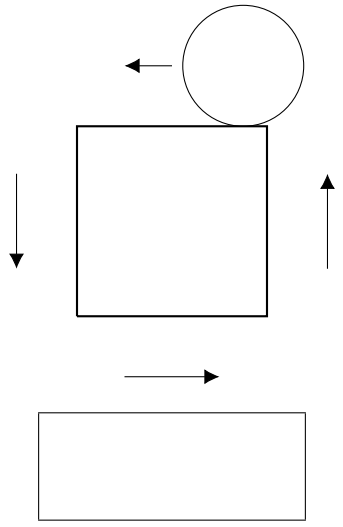
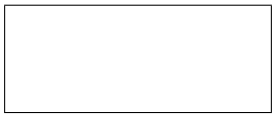


Problem 7. Find the maximum possible value of the function

$$1+\sin^2(x)+\sin^4(x)+\cdots+\sin^{2022}(x)+\cos^{2022}(x)+\cdots+\cos^4(x)+\cos^2(x)+1.$$

[Here the sum is over all the even powers of $\sin(x)$ and $\cos(x)$ from 0 to 2022.]



Problem 7. Find the maximum possible value of the function

$$1+\sin^2(x)+\sin^4(x)+\cdots+\sin^{2022}(x)+\cos^{2022}(x)+\cdots+\cos^4(x)+\cos^2(x)+1.$$

[Here the sum is over all the even powers of $\sin(x)$ and $\cos(x)$ from 0 to 2022.]

Problem 8. Fully simplify

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Problem 9. Suppose the nonzero real numbers a and b are the roots of $x^2 + ax + b$. Find a and b.

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Problem 10. How many equilateral triangles can be formed by joining the vertices of a cube?

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