Student Name: ____________________________

Welcome to the Third Annual
Harrison Chen Memorial Math Competition!

Please observe the following information for the competition.

- Scoring. All problems will be worth one point. This means that the most difficult problems will be worth the same as the more straightforward problems. Your goal is to get as many correct as you can within the 60 minutes allowed.
- Answer Key. You **MUST** write the answer in the answer key provided. If you do not, no credit will be given, so make sure you write down your answer in the key as soon as you finish a problem!
- Work. You **MUST** show work in order to receive credit for a problem. Do not solve problems in your head! If you do not explain how you arrived at an answer, no credit will be given.

- Tiebreakers. In the event of a tie score ONLY, tiebreak points will be awarded. Question 1 will be worth 1 tiebreak point, Question 2 will be worth 2 tiebreak points, Question 3 will be worth 3 tiebreak points, and so on until Question 12, which will be worth 12 tiebreak points.
- Pencils. We have provided pencils for you to use. If you need additional pencils, ask.
- Erasers. Because you only have 60 minutes to solve these problems, we strongly recommend that you do not erase any work. If you try something and it doesn't lead to the correct answer, that's fine! Just leave the work on the page and keep going. Neatness does not count for this set of problems.

- Calculators. You may not use calculators of any kind for this contest. If you brought one to the contest, give it to the TA, who will return it to you when the contest is complete.
- Scratch Paper. You should have enough space to solve a problem directly where the question is written. If you still need more paper for your work, raise your hand and it will be provided.

- Food. No food in the contest room. All students will receive a snack ticket which can be used once the contest finishes.
- Bathroom. Because you have only 60 minutes for 12 problems, we strongly urge you to use the bathroom before or after – not during – the contest. If you must use the bathroom, raise your hand and inform the TA.

- Definitions. If you do not understand what a word means, raise your hand and ask the TA quietly. **You may not ask for any help/hints on how a problem should be solved.** You may only ask questions if you do not know a specific word. Part of the challenge is reading the problems and figuring out what method must be used to solve them.
- Suggestion. Read the questions CAREFULLY before you solve, because sometimes one word can change the entire solution!
- Time. You will be allowed 60 minutes for the competition. Do not open this booklet until time starts. Once time begins, if you finish early, you have two options: check your work (strongly suggested), or turn in the contest early and be dismissed for the remaining time. If you leave early, you may not return to change any answers, so don't leave early unless you know you are completely finished.

Thank you for participating! Remember to HAVE FUN with these challenging (and somewhat ridiculous) problems.

Answer Key (DO NOT DETACH THIS PAGE)

#1	#2	#3
#4	#5	#6
#7	#8	#9
#10	#11	#12

Nathaniel Satriya Genius Division

Remember: SHOW WORK to receive credit!

#1. Kavya has six quarters, while Kriti has five quarters. They flip all the coins. What is the probability that Kavya will get more heads than Kriti? Express your answer as a fraction in lowest terms.

#2. Each of the digits 1 through 9 is to be placed, 1 per box, in the figure below, replacing the nine letters such that all of the following statements are true:

- $A + B + C = 17$
- $T \div U - V = 1$
- $X \div Y - Z = 0$
- $A + T - X = 4$
- $B \div U \times Y = 12$
- $C \times V \div Z = 27$

A	B	C
T	U	V
X	Y	Z

What is the value of the product $Y \times A \times Z$?

#3. Express the following in lowest terms:

$$\frac{2^{16} \times 3^{27} \times 5^{5}}{30^{5} \times 18^{11}} \quad - \quad \frac{7^{5} \times 11^{4} \times 13^{3}}{1001 \times 91^{2}} \quad \times \quad \frac{7 \times 77^{2}}{11 \times 77^{4}}$$

#4. Mr. G. creates a probability game that starts with rolling a 6-sided die.

- If you roll a prime number on the 6-sided die, you flip a coin.
- If the coins shows heads, you lose.
- If it shows tails, you roll a 12-sided die. If that shows an even number, you win!

- Instead, if you roll a number with the 6-sided die that is not prime, you roll a 12-sided die.
- If the 12-sided die shows an odd number, you win!

What is the probability that Mr. G. will win at least once on one of his first three tries? Express your answer as a fraction in lowest terms.

#5. After finally winning his first game of Hearts, Bidipta celebrates by creating a pair of 739,940-sided dice. However, he is completely exhausted as a result of this effort, so instead of numbering the dice 1 through 739,940, he paints all sides of the dice blue or gold. On the first die, Bidipta paints all sides blue except for one side which is gold. Pratham (who still can't believe that Bidipta actually defeated him and Mr. G. in Hearts) comes over and tells Bidipta that from now on, whenever the two of them have a disagreement, they will settle it by rolling both of Bidipta's dice. Bidipta wins if both rolls have the same color, while Pratham wins if the rolls are different colors. Bidipta and Pratham have an equal chance of winning. "How many sides does the second die have to be painted gold for this to happen?" asks Bidipta. "You beat me in Hearts; figure it out yourself, and call that number G," snaps Pratham.

Immediately, the two get into a heated argument, and after 20 minutes, both begin to sound like Great Uncle Venkatesh. "Truce!" screams Bidipta, to which Pratham mercifully agrees. "Perhaps this is a sign that we need to use the dice to settle this," states Bidipta. "Agreed," replies Pratham, "provided you answer my original question." Bidipta hesitates. "Can you give me a clue?" he asks. "Very well. Let's use the first three letters of your last name – S, A, and R – and your first name's first letter, B. Let S, A, and R represent distinct prime numbers less than 20. If $S^4 + A^3 + R^2 + B = G$, what is the least possible value of B?"

"Hey, that's two questions!" groans Bidipta. "No, it's two steps to get one answer," counters Pratham. "I want the least possible value of B." (For those of you reading this problem, that's what you need to find, too).

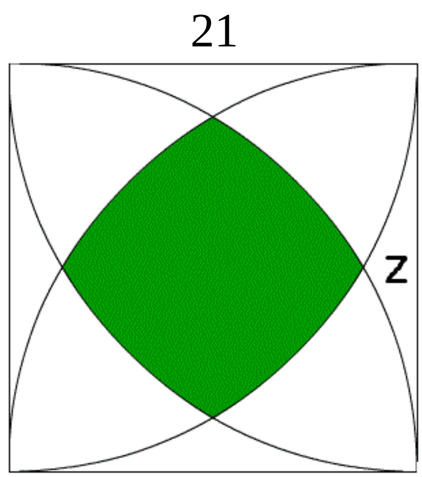
#6. At how many minutes after 12:30 will the hands of a clock displaying the correct time first form an acute angle 1/5 the size of the obtuse angle formed at 12:30? Express your answer as a mixed number in lowest terms.

#7. In the following cryptarithm, different letters represent different digits (repeated letters represent the same digit). If we wish to maximize the value of THAT, what is the greatest possible value of HOW?

$$
\begin{array}{r}
HOW \\
DID \\
YOU \\
+\quad DO \\
\hline
THAT
\end{array}
$$

#8. Four dogs – Johnny, Suzy, Rohnny, and Zoey – are tied up to 4 different corners of a 21-yard square lot. Their ropes are each 21 yards long, and each dog is permitted to roam inside the square lot as far as their rope allows. If each dog is randomly placed within their allowed area:

- Determine the probability that all four dogs are in the overlapping area where they can all stay (see shaded region in the diagram below).
- Using 22/7 for π, express your answer in the form $[(Az + B) / C]^{D}$ using z as shown in the diagram, in lowest terms, and with A, B, C, and D representing positive integers.
- Calculate the value of A + B + C + D and write that integer value in the answer key.



#9. José and Ricardo have a conversation after both talking to Matty separately. They try figuring out what Matty's favorite pizza is. Matty has given them a list of 13 possible options:

- Thin Crust with Veggies
- Thick Crust with Pepperoni
- Thin Crust with Cheese
- Gluten-Free Crust with Veggies
- Deep Dish Crust with Ham
- Thin Crust with Bacon
- Gluten-Free Crust with Cheese
- Thin Crust with Ham
- Thick Crust with Pineapple
- Deep Dish Crust with Cheese
- Thick Crust with Ham
- Thin Crust with Pineapple
- Gluten-Free Crust with Pineapple

José knows the type of crust, while Ricardo knows the type of topping, and that is all they know.
José states, "I don't know what Matty's favorite is, but I'm sure you don't know either."
Ricardo replies, "Really! I originally didn't know, but now I do!"
José comments, "Well then, so do I!"

What is Matty's favorite pizza?

#10. Mr. G. LOVES Jolly Ranchers. *(Note: this is extremely amusing as I dislike Jolly Ranchers.)* In a contest against the mathematical genius Carl Friedrich Gauss, both contestants will reach into a bag and pull out Jolly Ranchers with no replacement until the bag is emptied. If the Jolly Rancher is red (watermelon or cherry), it must be eaten with mustard. If it is a sad berry (blueberry), it must be eaten with ketchup. If it is a Granny Smith (green apple; Grandma Sinko is insulted that it isn't called Granny Sinko), it must be eaten alone. If the Jolly Rancher is any other color, it must be eaten with a mystery spice (clove, peppermint, spearmint, or licorice). The scoring is simple: for every Jolly Rancher consumed, the contestant scores one point; for every Jolly Rancher spit out or uneaten, they lose one point. Each contestant picks the same number of Jolly Ranchers from the bag. The highest score at the end of the game wins; in the event of a tie, whoever ate the first Jolly Rancher wins the contest.

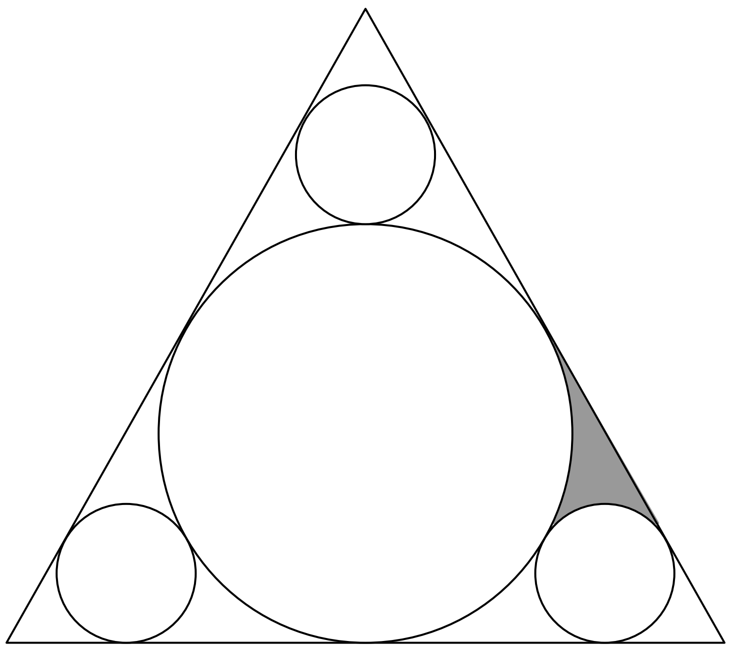
Because of his finicky tastes, Mr. G. refuses to eat anything that has to do with watermelon or ketchup. Nevertheless, he recognizes that Gauss presents a formidable challenge. Therefore, Mr. G. selects not only the first Jolly Rancher from the bag, but all of his Jolly Ranchers before Gauss picks his first one. The bag contains 29 blueberries, 33 cherries, 12 grapes, 21 watermelons, and 5 green apples. What is the probability that Mr. G. will guarantee a victory for himself before Gauss eats his first Jolly Rancher?

For this problem, the probability must be expressed as a fraction in the form 1/P, in which P represents the non-calculated product of all applicable prime numbers. Once you have determined P, give the sum of the total number of <u>powers</u> as your answer. Example: if you determine that the probability is $1 / (2^6 \times 3^1 \times 7^3)$, your answer would be 10 (that is, 6+1+3).

#11. To celebrate having survived another year of HCMMC, Mr. G. resolves to bake a cake for himself. But because he is so tired from all of the organizing and problem-writing he has done in the past week, Mr. G. messes up while following the recipe and accidentally makes the cake in the shape of an equilateral triangle. “Oh, man,” Mr. G. sighs to his pet iguana Chocolate, finally realizing his mistake. “What should I do?” In response, Chocolate smiles at Mr. G. “The solution is simple,” he utters wisely. “If normal circular cakes are cut into triangular pieces to serve, then you should cut this triangular cake into circular slices instead!”

Too tired to consider the absurdity of his situation, Mr. G. obeys Chocolate’s advice without question and proceeds to cut the largest possible circular slice out of the middle of the cake, soon devouring it in record time. (After all, he has not had any meals the entire day. It’s Mr. G! What do you expect?) He decides that he is still not full, and so cuts out three more circular slices, each as large as now possible, from the corners of the cake. After also eating all of those pieces, Mr. G. feeds the leftover three corners of the cake to Chocolate. He is left with six very odd-looking sections of cake, each of which has the same area and shape (see shaded region in the diagram below). “Now what should I do?” asks a very confused Mr. G to Chocolate. “I can’t get rid of all of this cake!” “Yes you can,” Chocolate replies. “Just give one piece each to six lucky TA’s!”

If Mr. G. decides to follow Chocolate’s guidance again, and each side of the triangular cake originally had a length of 9 centimeters, how much cake will each lucky TA get, in square centimeters?



#12. After winning the California Lottery for a second consecutive year, Mr. G. flies to UCLA to celebrate with Cousin Noah. "Look, Cousin Noah! Money!" screams Mr. G. hysterically. Noah calms down Mr. G. by offering him some herbal tea. "That's wonderful, dear," states Cousin Noah. "And I have some added great news: Christin and I are going to be having a third child – a girl!"

The effects of the herbal tea are quickly lost as Mr. G. jumps in the air like a maniac. "WOW!" he yells. "Cousin Noah, I'd like to make you an offer. If you allow me to name this child, I will set aside $1,000,000 for her trust fund." Cousin Noah isn't so sure about this generous but strange offer, so he checks with Christin. "Let me hear the options for the name first," states Christin (a wise idea given Mr. G's love of exciting names).

Mr. G. explains that the child will have four options for her name. "When your husband and I were growing up, we knew two girls that we named Vardetta and Vardiga. (Those weren't their actual names, but we liked calling them that for reasons that we will not reveal.) It would be appropriate to name your child after either of them. But since I want to give you some options, we can also consider Vardisha and Vardiqua." To Cousin Noah's great surprise, Christin agrees to allow Mr. G. to choose one of these four names – but only if he can solve a related math problem.

"Listen carefully, Mr. G," begins Christin. "The four names – Vardetta, Vardiga, Vardisha, and Vardiqua – are arranged in ascending order by total value, calculated by the sum of all letters. Each vowel is worth 10, 20, 30, or 40, while each consonant is worth a prime number less than 20. Different letters represent different values. For example, if D = 2, then no other letter can be 2.

"Furthermore, an A in one name is worth the same as an A in another name. So if A = 20 in Vardetta, then A = 20 in Vardiga, Vardisha, and Vardiqua. This is true for all letters: the value of a letter in one name is the same as the value of that identical letter in any other name.

"The total value of the name Vardetta is 100 (thus, V+A+R+D+E+T+T+A = 100). The total value of the name Vardiga is 3 more than the total value of Vardetta, while the total value of Vardiqua is S more than the total value of Vardisha. If A > E, what is the 2nd highest possible value of VARDISHA + VARDIQUA?"