**Choose the letter of the correct answer. In all cases, E) NOTA means “none of these answers”.**

1. As of the 2012 Olympics, the United States leads the world in number of medals in Olympic Shooting, with 107 medals won. If the US has 24 more gold medals than silver, and 4 more silver than bronze, how many silver medals does the United States have in shooting?

**A) 24 B) 29 C) 53 D) 83 E) NOTA**

2. Participants in shooting events are allowed to wear specialized clothing, which improves the stability of their shooting positions. Alberic’s score in the 10-meter air rifle event improves by when he puts on his specialized clothing, where is the coefficient of the term of the expansion of . If Alberic scores a 360 in the special clothing, what would he have scored if he was wearing normal clothing instead?

**A) 300 B) 340 C) 350 D) 432 E) NOTA**

3. The oldest Olympic medalist ever was the Swedish shooter Oscar Swahn, who barely missed the gold medal in his event and finished with silver. His age when he won the silver medal is equal to the sum of the integer solutions of . How old was Oscar?

**A) 24 B) 25 C) 49 D) 72 E) NOTA**

4. In the Paris Games in 1900, live pigeons were used as moving targets for shooting, but were thereafter replaced by clay pigeons and then synthetic targets, leaving the world’s pigeons free to do as they pleased. The pigeon friends Jamie, who lives in Paris, and Brandon, who lives in Rio, decide to fly straight toward each other to meet. It takes them 12.5 days, and Jamie is going 2 mph faster than Brandon. If there are 5700 miles between Paris and Rio, how fast was Brandon flying?

**A) 8.5 mph B) 9.5 mph C) 10.5 mph D) 12.5 mph E) NOTA**

5. London, United Kingdom, has hosted the Summer Olympics more times than any other city. In fact, the number of times it’s hosted the event is equal to the ordinate of the minimum value of How many times have the Summer Olympics been held in London?

**A) 1 B) 2 C) 3 D) 4 E) NOTA**

6. Some of the earliest recorded archery tournaments took place during the Zhou dynasty (1027- 280 BC) in China. Let’s suppose that one particular tournament took place every 4 years, the first in 1024 BC and the last in 280 BC, and another one took place every 7 years, the first in 1022 BC and the last also in 280 BC. In how many years did both tournaments take place?

**A) 26 B) 27 C) 38 D) 80 E) NOTA**

7. Karoly Takacs, who grew up right-handed, was part of Hungary’s world champion pistol-shooting team in 1938. Then his right hand was crippled when an army grenade exploded. Ten years later, having taught himself to shoot with his left hand, he won two gold medals in the rapid-fire class. You see, it’s good to have multiple perspectives in life! This equation in point-slope form, , becomes in slope-intercept form and in standard form. What is

**A) -20 B) 1 C) 22 D) 28 E) NOTA**

8. The most decorated archer in Olympic history is Hubert Van Innis of Belgium, who competed in 1900 and 1920, winning six gold and three silver medals total (two golds and one silver from 1900, the rest from 1920). If Hubert randomly picks a medal to wear each day, what is the probability that today he picks a gold medal from 1920 or any silver medal if he chooses from all of his medals each day?

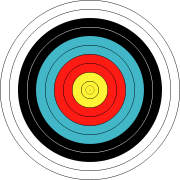
**A) B) C) D) E) NOTA**

9. According to the Rio 2016 website, “strength, flexibility, accuracy and a cool temperament are the main qualities needed by archers.” Since Jessica wants to be an archer, she practices math to try to gain those qualities. In particular, she simplifies the expression What does she get?

**A) B) C) D) E) NOTA**

10. Olympic Gold medals are required to be made from at least 92.5% silver, and must contain a minimum of 6 grams of gold. If Joanna’s gold medal is made up of only gold and silver, and has the minimum amount of gold, how much silver is in Joanna’s medal?

**A) 74 g B) 80 g C) 86.5 g D) 98.5 g E) NOTA**

11. The target in Olympic Archery is made up of ten concentric circles (see below). Scores on the archery target range from 10 for a bull’s eye

(the center circle), decreasing by one point for each ring as you

move out until you reach the outer ring which has a value of one

point. Alanna shoots two arrows. In how ways can she score

11 points? Note : A score of 6 on the first shot followed by a 5

on the second shot is considered different from a score of 5

followed by a score of 6.

**A) 0 B) 5 C) 10 D) 11 E) NOTA**

12. An archer has 40 seconds to shoot each of their six arrows at a target in the preliminary round. It’s a cloudy day; Cynthia has shot five of her six arrows and has 40 seconds to shoot the last one. But suddenly, everything goes wrong. The sun comes out, meaning there is a chance Cynthia will sneeze, rendering her incapable of shooting the arrow. Also, the #1 women’s archer in the world, Choi Mi-sun, appears, and there is a chance that Cynthia will be too star struck to shoot the final arrow. What is the probability Cynthia sneezes AND is star struck, failing to shoot the arrow and dashing her dreams of Olympic glory?

**A) B) C) D) E) NOTA**

13. Alanna, in a fit of anger, snapped her bow in half. Now she must buy a new one for the upcoming competition. At her favorite archery store, the owner always gives her a 15% discount. Also, the shop is having a storewide clearance where everything is an additional 40% off. What percentage of the original price of her new bow will Alanna pay?

**A) 45% B) 49% C) 51% D) 55% E) NOTA**

14. Odessa is going to archery practice 3600 miles away on her tricycle. If she has two extra wheels, and she wants to use each of her wheels equally, how many miles should each wheel be used for?

**A) 720 B) 1200 C) 1800 D) 2160 E) NOTA**

15. Since Odessa has to ride 3600 miles on a tricycle, she has plenty of time on the road to ponder things other than archery. One of her favorite things to do is to tell herself jokes and then laugh hysterically at them. The number of jokes she tells herself is equal to the number under the radical once this is simplified: . What is the sum of the digits of the number of jokes Odessa tells herself?

**A) 2 B) 11 C) 16 D) 17 E) NOTA**

16. A particular gun shoots a bullet at 2070 feet per second towards a target that is 30 yards away. How many seconds after the gun is shot will the bullet hit the target? (Assume the speed of the bullet does not change and gravity is negligible).

**A) seconds B)seconds C) seconds D) 1 second**

**E) NOTA**

17. Jessica’s bow has the curvature of a parabola! The equation of the bow is

for, and the bow string is represented by the y-axis. Jessica wants to know how far she must pull back the string with the arrow in order for the entire length of the 2 unit long arrow to be completely behind the bow and the tip of the arrow at the bow. After stringing her arrow in the center of the bow, how many units must she pull back for the tip of the arrow to be right at the arc bow?

**A) 0.25 B) 0.75 C) 2 D) 2.75 E) NOTA**

18. In the individual archery competition, archers have twenty seconds to shoot each of their arrows, and each archer shoots fives series of three arrows. The archers with the first, second, and third highest scores will get the gold, silver, and bronze medals, respectively. If ten archers are competing, and archers go one after the other with no time in between, how many minutes will it take for all archers to finish shooting all of their arrows, assuming they take the full twenty seconds to shoot each arrow?

**A) 50 B) 300 C) 600 D) 3000 E) NOTA**

19. George wants to choose a shooting event to compete in. There are three choices for weapons: rifle, pistol, and shotgun; and there are three distances: 10, 25, and 50 meters. If George randomly selects a weapon and one distance, what is the probability that he selects pistol and a distance greater than 25 meters?

**A) B) C) D)**

**E) NOTA**

20. What is the greatest number of total medals any country has won in archery for all the years archery has been an Olympic sport? (Hint: if is factored into , then the answer to this question is ).

**A) 21 B) 34 C) 182 D) 1638 E) NOTA**

21. In all combined shooting events in the Olympics, 43 countries have won at least one gold, 51 countries at least one silver, and 59 countries have won at least one gold or at least one silver. How many countries have won at least one gold but no silvers?

**A) 8 B) 15 C) 19 D) 22 E) NOTA**

22. Brandon and Jamie are shooting rifles (and following all safety precautions) on a coordinate plane. Brandon shoots his and the bullet follows the trajectory . Jamie shoots his rifle as well following the trajectory . Suddenly there is a flash. The bullets collided! At what point did this happen?

**A) B) C) D) Cannot be solved E) NOTA**

23. Professional marksmen need to be very steady in order to hit the target. They accomplish this steadiness by relaxing and slowing their heart rate up to half its normal speed. Also, they only shoot between heartbeats. Joanna aspires to be a master marksman. However, she is not yet up to par with the true masters, and she gets tired very easily. Therefore, her first two shots follow a single heartbeat, her third shot follows two heartbeats, her fourth shot follows three heartbeats, her fifth shot follows five heartbeats, and the number of heartbeats that succeed her shot continue to follow this pattern. How many heartbeats does it take to fire ten times?

**A) 67 B) 89 C) 113 D) 143 E) NOTA**

24. An archer’s score is determined by how close they shoot to the bullseye of the target. Ashley scored an average of 8.4 with her first ten arrows. What must she average with her next two arrows in order to have a total average of 8.5?

**A) 8.0 B) 8.5 C) 9.0 D) 9.5 E) NOTA**

25. Alanna isn’t angry anymore. She snaps an arrow in two, this time just for fun. One of the two fragments is three-fifths the length of the other one. If the arrow was five-sixths of a foot long before she snapped it, how long is the shorter fragment in inches?

**A) in. B)in. C) in. D) in. E) NOTA**

26. In the ranking round of the 2004 Olympics in Athens for archery, first and second seed were Im Dong-hyun of South Korea and Magnus Petersson of Sweden with scores of 687 and 673, respectively. What is ?

**A) 196 B) 1360 C) 17370 D) 19020 E) NOTA**

27. Julia and Odessa are practicing with their new pistols. Julia shoots and her bullet travels along a path defined by , and Odessa shoots hers along the path of . What is the sum of the y-intercepts of these two functions?

**A) B)-7 C) 6 D) 13 E) NOTA**

28. How many positive integral factors does 5400 have?

**A) 18 B) 24 C) 48 D) 56 E) NOTA**

29. Rationalize the denominator:

**A) B) C) 13 D) E) NOTA**

30.

Of the functions above, some of them cross the y-axis at some point. Let z = the number of functions that cross the x-axis. The United States has won a total of medals in Olympic archery. How many total medals has the United States won in Olympic archery?

**A) 16 B) 32 C) 48 D) 64 E) NOTA**

**SOLUTIONS**

1. B. Let the number of gold medals won be . Then, . Solving this, we find that . Since there are 24 more gold medals than silver, the number of silver medals is .

2. A. First, expand to become The coefficient of the x term is 20, so Alberic’s score increases by 20% when wearing the specialized clothing. If we say is his original score, Solve to get as his original score.

3. D. Solve the conjunction by adding 2 and dividing by 3 to all parts, yielding . The integers that satisfy the inequalities are 23, 24, and 25; Oscar was 72 years old.

4. A. Convert 12.5 days into hours; Now use the formula distance = rate x time. If is Brandon’s speed,

5. C. First, find the x-coordinate of the parabola’s vertex (where the minimum occurs) with the formula Then plug this into the equation to find the y-coordinate, which is the minimum of the function. .

6. B. Let’s think of this as finding the number of multiples of both 4 and 7, aka the multiples of 28, from 280 to 1024 inclusive. The lowest multiple of 28 in this range is 280, and the highest is 1008, so we go from to . There are multiples of 28. So in total, we have 27 years in which both archery tournaments taking place during the Zhou dynasty.

7. C. To get to slope-intercept form, distribute the and add to both sides to get . Thus, . To find standard form from here, multiply both sides by , subtract from both sides, and then subtract from both sides to get to the format. We find that , so . .

8. D. The number of gold medals won in 1920 is , so the probability of Hubert randomly picking one is . The number of silver medals won in all is 3, so the probability of Hubert randomly picking one is . “Or” means add, so , D.

9. D. , D.

10. A. Since there are only 6 grams of gold and the rest is silver, of the medal must be gold. . Now set up a proportion. If is the amount of silver, . Solving, we find that .

11. C. Possible ways to score 11 points : 1-10, 2-9, 3-8, 4-7, 5-6, 6-5, 7-4, 8-3, 9-2, and 10-1. Ten ways.

12. B. The probability Cynthia both sneezes AND is starstruck is the probability of those two events multiplied together. .

13. C. It is easiest to think of this as the percent she is paying after each discount, so

14. D. The total miles driven with the tires will be . miles per wheel.

15. A. The prime factorization of is . We can take 2 and 7 out from under the square root, so divide 2156 by This leaves beneath the radical; the simplified radical is , A.

16. C.

17. B. The distance from the y-axis (the string) to the vertex of the parabola (the center of the bow) is 1.25, which is found from the equation . If the 2 unit long arrow were strung, 0.75 units of it would be in front of the bow, so she must pull the arrow back 0.75 for it to be behind the bow.

18. A. , however, since the question asked for minutes, the answer is

19. A. There is a chance of choosing a pistol and a chance of choosing a distance **greater than** 25 meters.

20. B. , so the answer is .

21. A. , where is the number of countries that have won at least one or both medals. Solving for we get that it equals 35. Now we subtract this number from countries that have won at least one gold and get .

22. B. If we set the equations equal to one another, we get This can then be rearranged to get 2x = 6, meaning . By plugging the x value into either equation, we get that , giving us the ordered pair (3, 4).

23. D. The pattern is Fibonacci’s sequence, so the answer is 1+1+2+3+5+8+13+21+34+55=143.

24. C. The total sum of all 12 shots is . Her total after 10 shots is Therefore, the sum of her last two shots is , so their average is .

25. A. The whole arrow was inches long. If is the length of the longer fragment, Thus the length of the shorter fragment is inches.

26. E. can be rewritten as , so

27. B. The y-intercepts are the constant terms of the two functions, so .

28. C. The prime factorization of 5400 is , so the number of positive integral factors is

29. B. To rationalize the denominator, we must multiply the numerator and denominator by √13/√13. This gives us (26√13)/13, which can be simplified to 2√13.

30. E. A function crosses the y-axis when .

, so this function does not cross the y-axis

, so this function never crosses the y-axis

, since the absolute value makes it positive, this can never be true, so this function never crosses the y-axis

Two of the functions crossed the y-axis, so 16(2)=32

**ANSWERS**

1) B

2) A

3) D

4) A

5) C

6) B

7) C

8) D

9) D

10) A

11) C

12) B

13) C

14) D

15) A

16) C

17) B

18) A

19) A

20) B

21) A

22) B

23) D

24) C

25) A

26) E (19,040)

27) B

28) C

29) B

30) E