

## ***How to Calculate the Probabilities of Winning the Nine Mega Millions Prize Levels:***

**Mega Millions** numbers are drawn from two sets of numbers. Five numbers are drawn from one set of 70 numbered white balls and one **Mega Ball** number is drawn from a second set of 25 numbered gold balls. The odds of winning Mega Millions are calculated by combining the odds for both sets of numbers for all prize levels. The first, third, fifth, seventh, eighth and ninth prize level odds are determined by the chances of choosing a given number of white balls correctly as well as the gold **Mega Ball**. The second, fourth and sixth prize level odds are determined by the chances of choosing a given number of white balls correctly and the gold **Mega Ball** incorrectly. Since the order of the items chosen is irrelevant, the applicable probability rule is the formula to determine combinations.

Before calculating the odds for the different prize levels, calculate the total number of combinations possible for each portion of the Mega Millions draw.

- A. Calculate how many combinations of 5 numbers can be drawn from 70 unique numbers:

The formula is as follows:

$$\frac{70!}{5!(70-5)!} = \frac{70 * 69 * 68 * 67 * 66 * 65!}{5 * 4 * 3 * 2 * 1 * 65!} = \frac{70 * 69 * 68 * 67 * 66}{5 * 4 * 3 * 2 * 1} = \frac{1,452,361,680}{120} = 12,103,014$$

where ! indicates a factorial, i. e.,  $n! = n * (n - 1) * (n - 2) * \dots * 2 * 1$

Thus, there are 12,103,014 different ways in which 5 numbers can be chosen from a total of 70 unique numbers.

- B. Calculate how many combinations of 1 number can be drawn from 25 unique numbers:

$$\frac{25!}{1!(25-1)!} = \frac{25 * 24!}{1 * 24!} = 25$$

Thus, there are 25 different ways 1 number can be chosen from a total of 25 unique numbers.

**1. Top Prize Level: Match all five numbers plus the Mega Ball (1 in 302,575,350 odds)**

**Step 1:** Calculate the number of ways in which 5 numbers can be chosen correctly out of 5 numbers drawn from 70 unique numbers.

The formula is as follows:

$$\frac{5!}{5!(5-5)!} * \frac{(70-5)!}{((70-5)-(5-5))!(5-5)!} = \frac{1}{0!} * \frac{65!}{(65-0)! 0!} = \frac{65!}{65! 1} = 1$$

(note: 0!=1)

This means that there is only 1 way in which 5 numbers out of 5 numbers drawn from a field of 70 numbers can be chosen correctly.

Thus, there is only 1 chance in 12,103,014 of correctly choosing all five numbers drawn in the first portion of Mega Millions.

**Step 2:** Calculate how many ways the correct Mega Ball number can be chosen from 25 unique numbers.

The chance of correctly choosing the Mega Ball is simply 1 in 25.

**Step 3:** Determine the chance of choosing both correctly by multiplying these figures together:

$$\frac{1}{12,103,014} * \frac{1}{25} = \frac{1}{302,575,350} \text{ or 1 chance in 302,575,350.}$$

**2. Second Prize Level: Match all five numbers only (1 in 12,607,306.25 odds)**

**Step 1:** The chance of getting 5 numbers correct out of 5 numbers drawn from 70 unique numbers is 1 in 12,103,014 (see #1, Step 1 above.)

**Step 2:** The chance of correctly choosing the Mega Ball is 1 in 25. Therefore, the chances of incorrectly choosing the Mega Ball are, conversely, 24 in 25.

**Step 3:** Determine the chances of choosing 5 out of 5 of 70 correctly and getting the Mega Ball incorrect by multiplying these figures together:

$$\frac{1}{12,103,104} * \frac{24}{25} = \frac{24}{302,575,350} = \frac{1}{12,607,306.25} \text{ or 1 chance in 12,607,306.25.}$$

**3. Third Prize Level: Match four numbers plus the Mega Ball (1 in 931,001.08 odds)**

**Step 1:** Calculate the number of ways in which 4 numbers can be chosen correctly out of 5 numbers drawn from 70 unique numbers.

The formula is as follows:

$$\frac{5!}{4!(5-4)!} * \frac{(70-5)!}{((70-5)-(5-4))!(5-4)!} = \frac{5 * 4!}{4! 1!} * \frac{65!}{(65-1)! 1!} = \frac{5}{1} * \frac{65 * 64!}{64! 1} = 5 * 65 = 325$$

This means that there are 325 different ways in which 4 numbers out of 5 numbers drawn from a field of 70 numbers can be chosen correctly.

Thus, the chances are 325 in 12,103,014 of correctly choosing 4 out of 5 numbers in the first portion of Mega Millions.

**Step 2:** The chance of correctly choosing the Mega Ball is simply 1 in 25.

**Step 3:** Determine the chances of choosing 4 out of 5 of 70 correctly and getting the Mega Ball correct by multiplying these figures together:

$$\frac{325}{12,103,014} * \frac{1}{25} = \frac{325}{302,575,350} = \frac{1}{931,001.08} \text{ or 1 chance in 931,001.08.}$$

**4. Fourth Prize Level: Match four numbers only (1 in 38,791.71 odds)**

**Step 1:** The chances of getting 4 numbers correct out of 5 numbers drawn from 70 unique numbers are 325 in 12,103,104 (see #3, Step 1, above.)

**Step 2:** The chance of correctly choosing the Mega Ball is 1 in 25. Therefore, the chances of incorrectly choosing the Mega Ball are, conversely, 24 in 25.

**Step 3:** Determine the chances of choosing 4 out of 5 of 70 correctly and getting the Mega Ball incorrect by multiplying these figures together:

$$\frac{325}{12,103,014} * \frac{24}{25} = \frac{7,800}{302,575,350} = \frac{1}{38,791.71} \text{ or 1 chance in 38,791.71.}$$

**5. Fifth Prize Level: Match three numbers plus the Mega Ball (1 in 14,546.89 odds)**

**Step 1:** Calculate the number of ways in which 3 numbers can be chosen correctly out of 5 numbers drawn from 70 unique numbers.

The formula is as follows:

$$\frac{5!}{3!(5-3)!} * \frac{(70-5)!}{((70-5)-(5-3))!(5-3)!} = \frac{5 * 4 * 3!}{3! 2!} * \frac{65!}{(65-2)! 2!} = \frac{5 * 4}{2} * \frac{65 * 64 * 63!}{63! 2 * 1} = 5 * 65 * 64 = 20,800$$

This means that there are 20,800 different ways in which 3 numbers out of 5 numbers drawn from a field of 70 numbers can be chosen correctly.

Thus, the chances are 20,800 in 12,103,014 of correctly choosing 3 out of 5 numbers in the first portion of Mega Millions.

**Step 2:** The chance of correctly choosing the Mega Ball is simply 1 in 25.

**Step 3:** Determine the chances of choosing 3 out of 5 of 70 correctly and getting the Mega Ball correct by multiplying these figures together:

$$\frac{20,800}{12,103,014} * \frac{1}{25} = \frac{20,800}{302,575,350} = \frac{1}{14,546.89} \text{ or 1 chance in 14,546.89.}$$

**6. Sixth Prize Level: Match three numbers only (1 in 606.12 odds)**

**Step 1:** The chances of getting 3 numbers correct out of 5 numbers drawn from 70 unique numbers are 20,800 in 12,103,014 (see #5, Step 1, above.)

**Step 2:** The chance of correctly choosing the Mega Ball is 1 in 25. Therefore, the chances of incorrectly choosing the Mega Ball are, conversely, 24 in 25.

**Step 3:** Determine the chances of choosing 3 out of 5 of 70 correctly and getting the Mega Ball incorrect by multiplying these figures together:

$$\frac{20,800}{12,103,014} * \frac{24}{25} = \frac{499,200}{302,575,350} = \frac{1}{606.12} \text{ or 1 chance in 606.12.}$$

**7. Seventh Prize Level: Match two numbers plus the **Mega Ball** (1 in 692.71 odds)**

**Step 1:** Calculate the number of ways in which 2 numbers can be chosen correctly out of 5 numbers drawn from 70 unique numbers.

The formula is as follows:

$$\frac{5!}{2!(5-2)!} * \frac{(70-5)!}{((70-5)-(5-2))!(5-2)!} = \frac{5 * 4 * 3!}{2! 3!} * \frac{65!}{(65-3)! 3!} = \frac{5 * 4}{2} * \frac{65 * 64 * 63 * 62!}{62! 3 * 2 * 1} = \frac{5 * 65 * 64 * 63}{3} = 436,800$$

This means that there are 436,800 different ways in which 2 numbers out of 5 numbers drawn from a field of 70 numbers can be chosen correctly.

Thus, the chances are 436,800 in 12,103,014 of correctly choosing 2 out of 5 numbers in the first portion of Mega Millions.

**Step 2:** The chance of correctly choosing the **Mega Ball** is simply 1 in 25.

**Step 3:** Determine the chances of choosing 2 out of 5 of 70 correctly and getting the **Mega Ball** correct by multiplying these figures together:

$$\frac{436,800}{12,103,014} * \frac{1}{25} = \frac{436,800}{302,575,350} = \frac{1}{692.71} \text{ or 1 chance in 692.71.}$$

**8. Eighth Prize Level: Match one number plus the **Mega Ball** (1 in 89.38 odds)**

**Step 1:** Calculate the number of ways in which 1 number can be chosen correctly out of 5 numbers drawn from 70 unique numbers.

The formula is as follows:

$$\frac{5!}{1!(5-1)!} * \frac{(70-5)!}{((70-5)-(5-1))!(5-1)!} = \frac{5 * 4!}{1! 4!} * \frac{65!}{(65-4)! 4!} = \frac{5}{1} * \frac{65 * 64 * 63 * 62 * 61!}{61! 4 * 3 * 2 * 1} = \frac{5 * 65 * 64 * 63 * 62}{24} = 3,385,200$$

This means that there are 3,385,200 different ways in which 1 number out of 5 numbers drawn from a field of 70 numbers can be chosen correctly.

Thus, the chances are 3,385,200 in 12,103,014 of correctly choosing 1 out of 5 numbers in the first portion of Mega Millions.

**Step 2:** The chance of correctly choosing the **Mega Ball** is simply 1 in 25.

**Step 3:** Determine the chances of choosing 1 out of 5 of 70 correctly and getting the **Mega Ball** correct by multiplying these figures together:

$$\frac{3,385,200}{12,103,014} * \frac{1}{25} = \frac{3,385,200}{302,575,350} = \frac{1}{89.38} \text{ or 1 chance in 89.38.}$$

**9. Ninth Prize Level: Match the **Mega Ball** only (1 in 36.63 odds)**

**Step 1:** Calculate the number of ways in which no numbers are chosen correctly out of 5 numbers drawn from 70 unique numbers.

The formula is as follows:

$$\frac{5!}{0!(5-0)!} * \frac{(70-5)!}{((70-5)-(5-0))!(5-0)!} = \frac{5!}{1*5!} * \frac{65!}{(65-5)!5!} = \frac{65 * 64 * 63 * 62 * 61 * 60!}{60!5 * 4 * 3 * 2 * 1} = \frac{65 * 64 * 63 * 62 * 61}{120} = 8,259,888$$

(Note: 0! = 1)

This means that there are 8,259,888 different ways in which no numbers out of 5 numbers drawn from a field of 70 numbers are chosen correctly.

Thus, the chances are 8,259,888 in 12,103,014 of correctly choosing 0 out of 5 numbers in the first portion of Mega Millions

**Step 2:** The chance of correctly choosing the **Mega Ball** is simply 1 in 25.

**Step 3:** Determine the chances of choosing 0 out of 5 of 70 correctly and getting the **Mega Ball** correct by multiplying these figures together:

$$\frac{8,259,888}{12,103,014} * \frac{1}{25} = \frac{8,259,888}{302,575,350} = \frac{1}{36.63} \text{ or 1 chance in 36.63.}$$