

Probability | Theory, solved examples and practice questions

By MBA Crystal Ball on July 3, 2015

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When MS and MBA applicants ask us – ‘*What are my chances of getting into Harvard?*’ or ‘*What’s my probability of getting scholarships from Oxford?*’ we get tongue-tied. There are so many variables at play, it’s difficult to give an accurate answer.

But when you get probability questions in your GRE and [GMAT exam syllabus](#), you don’t have to get flummoxed. Understanding the basic rules and formulas of probability will help you score high in the entrance exams.

Meaning and definition of Probability

As the Oxford dictionary states it, Probability means ‘The extent to which something is probable; the likelihood of something happening or being the case’.

In mathematics too, probability indicates the same – the likelihood of the occurrence of an event.

Examples of events can be :

- Tossing a coin with the head up
- Drawing a red pen from a pack of different coloured pens
- Drawing a card from a deck of 52 cards etc.

Either an event will occur for sure, or not occur at all. Or there are possibilities to different degrees the event may occur.

An event that occurs for sure is called a Certain event and its probability is 1.

An event that doesn’t occur at all is called an impossible event and its probability is 0.

This means that all other possibilities of an event occurrence lie between 0 and 1.

This is depicted as follows:

$$0 \leq P(A) \leq 1$$

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where A is an event and $P(A)$ is the probability of the occurrence of the event.

This also means that a probability value can never be negative.

Every event will have a set of possible outcomes. It is called the ‘sample space’.

Consider the example of tossing a coin.

When a coin is tossed, the possible outcomes are Head and Tail. So, the sample space is represented as {H, T}.

Similarly when two coins are tossed, the sample space is {(H,H), (H,T), (T,H), (T,T)}.

The probability of head each time you toss the coin is $1/2$. So is the probability of tail.

Basic formula of probability

As you might know from the list of [GMAT maths formulas](#), the Probability of the occurrence of an event A is defined as:

$$P(A) = (\text{No. of ways A can occur}) / (\text{Total no. of possible outcomes})$$

Another example is the rolling of dice. When a single die is rolled, the sample space is {1,2,3,4,5,6}.

What is the probability of rolling a 5 when a die is rolled?

No. of ways it can occur = 1

Total no. of possible outcomes = 6

So the probability of rolling a particular number when a die is rolled = $1/6$.

Compound probability

Compound probability is when the problem statement asks for the likelihood of the occurrence of more than one outcome.

Formula for compound probability

- $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$

where A and B are any two events.

$P(A \text{ or } B)$ is the probability of the occurrence of atleast one of the events.

$P(A \text{ and } B)$ is the probability of the occurrence of both A and B at the same time.

Mutually exclusive events:

Mutually exclusive events are those where the occurrence of one indicates the non-occurrence of the other

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When two events cannot occur at the same time, they are considered mutually exclusive.

Note: For a mutually exclusive event, $P(A \text{ and } B) = 0$.

Example 1: What is the probability of getting a 2 or a 5 when a die is rolled?

Solution:

Taking the individual probabilities of each number, getting a 2 is $1/6$ and so is getting a 5.

Applying the formula of compound probability,

Probability of getting a 2 **or** a 5,

$$P(2 \text{ or } 5) = P(2) + P(5) - P(2 \text{ and } 5)$$

$$\Rightarrow 1/6 + 1/6 - 0$$

$$\Rightarrow 2/6 = 1/3.$$

Example 2: Consider the example of finding the probability of selecting a black card or a 6 from a deck of 52 cards.

Solution:

We need to find out $P(B \text{ or } 6)$

Probability of selecting a black card = $26/52$

Probability of selecting a 6 = $4/52$

Probability of selecting both a black card and a 6 = $2/52$

$$P(B \text{ or } 6) = P(B) + P(6) - P(B \text{ and } 6)$$

$$= 26/52 + 4/52 - 2/52$$

$$= 28/52$$

$$= 7/13.$$

Independent and Dependent Events

Independent Event

When multiple events occur, if the outcome of one event DOES NOT affect the outcome of the other events, they are called independent events.

Say, a die is rolled twice. The outcome of the first roll doesn't affect the second outcome. These two are independent events.

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Example 1: Say, a coin is tossed twice. What is the probability of getting two consecutive tails ?

Probability of getting a tail in one toss = $1/2$

The coin is tossed twice. So $1/2 * 1/2 = 1/4$ is the answer.

Here's the verification of the above answer with the help of sample space.

When a coin is tossed twice, the sample space is $\{(H,H), (H,T), (T,H), (T,T)\}$.

Our desired event is (T,T) whose occurrence is only once out of four possible outcomes and hence, our answer is $1/4$.

Example 2: Consider another example where a pack contains 4 blue, 2 red and 3 black pens. If a pen is drawn at random from the pack, replaced and the process repeated 2 more times, What is the probability of drawing 2 blue pens and 1 black pen?

Solution

Here, total number of pens = 9

Probability of drawing 1 blue pen = $4/9$

Probability of drawing another blue pen = $4/9$

Probability of drawing 1 black pen = $3/9$

Probability of drawing 2 blue pens and 1 black pen = $4/9 * 4/9 * 3/9 = 48/729 = 16/243$

Dependent Events

When two events occur, if the outcome of one event affects the outcome of the other, they are called dependent events.

Consider the aforementioned example of drawing a pen from a pack, with a slight difference.

Example 1: A pack contains 4 blue, 2 red and 3 black pens. If 2 pens are drawn at random from the pack, NOT replaced and then another pen is drawn. What is the probability of drawing 2 blue pens and 1 black pen?

Solution:

Probability of drawing 1 blue pen = $4/9$

Probability of drawing another blue pen = $3/8$

Probability of drawing 1 black pen = $3/7$

Probability of drawing 2 blue pens and 1 black pen = $4/9 * 3/8 * 3/7 = 1/14$

Let's consider another example:

Example 2: What is the probability of drawing a king and a queen consecutively from a deck of 52 cards, without replacement.

Probability of drawing a king = $4/52 = 1/13$

After drawing one card, the number of cards are 51.

Probability of drawing a queen = $4/51$.

Now, the probability of drawing a king and queen consecutively is $1/13 * 4/51 = 4/663$

Conditional probability

Conditional probability is calculating the probability of an event given that another event has already occurred .

The formula for conditional probability $P(A|B)$, read as P(A given B) is

$$P(A|B) = P(A \text{ and } B) / P(B)$$

Consider the following example:

Example: In a class, 40% of the students study math and science. 60% of the students study math. What is the probability of a student studying science given he/she is already studying math?

Solution

$$P(M \text{ and } S) = 0.40$$

$$P(M) = 0.60$$

$$P(S|M) = P(M \text{ and } S)/P(S) = 0.40/0.60 = 2/3 = 0.67$$

Complement of an event

A complement of an event A can be stated as that which does NOT contain the occurrence of A.

A complement of an event is denoted as $P(A^c)$ or $P(A')$.

$$P(A^c) = 1 - P(A)$$

$$\text{or it can be stated, } P(A) + P(A^c) = 1$$

For example,

if A is the event of getting a head in coin toss, A^c is not getting a head i.e., getting a tail.

if A is the event of getting an even number in a die roll, A^c is the event of NOT getting an even number i.e., getting an odd number.

if A is the event of randomly choosing a number in the range of -3 to 3, A^c is the event of choosing every number that is NOT negative i.e., 0,1,2 & 3 (0 is neither positive or negative).

Consider the following example:

Example: A single coin is tossed 5 times. What is the probability of getting at least one head?

Solution:

Consider solving this using complement.

Probability of getting no head = $P(\text{all tails}) = 1/32$

$P(\text{at least one head}) = 1 - P(\text{all tails}) = 1 - 1/32 = 31/32$.

Sample Probability questions with solutions

Probability Example 1

What is the probability of the occurrence of a number that is odd or less than 5 when a fair die is rolled.

Solution

Let the event of the occurrence of a number that is odd be 'A' and the event of the occurrence of a number that is less than 5 be 'B'. We need to find $P(A \text{ or } B)$.

$$P(A) = 3/6 \text{ (odd numbers = 1,3 and 5)}$$

$$P(B) = 4/6 \text{ (numbers less than 5 = 1,2,3 and 4)}$$

$$P(A \text{ and } B) = 2/6 \text{ (numbers that are both odd and less than 5 = 1 and 3)}$$

$$\text{Now, } P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$$

$$= 3/6 + 4/6 - 2/6$$

$$P(A \text{ or } B) = 5/6.$$

Probability Example 2

A box contains 4 chocobars and 4 ice creams. Tom eats 3 of them, by randomly choosing. What is the probability of choosing 2 chocobars and 1 icecream?

Solution

Probability of choosing 1 chocobar = $4/8 = 1/2$

After taking out 1 chocobar, the total number is 7.

Probability of choosing 2nd chocobar = $3/7$

Probability of choosing 1 icecream out of a total of 6 = $4/6 = 2/3$

So the final probability of choosing 2 chocobars and 1 icecream = $1/2 * 3/7 * 2/3 = 1/14$

Probability Example 3

When two dice are rolled, find the probability of getting a greater number on the first die than the one on the second, given that the sum should equal 8.

Solution

Let the event of getting a greater number on the first die be G.

There are 5 ways to get a sum of 8 when two dice are rolled = $\{(2,6), (3,5), (4,4), (5,3), (6,2)\}$.

And there are two ways where the number on the first die is greater than the one on the second given that the sum should equal 8, $G = \{(5,3), (6,2)\}$.

Therefore, $P(\text{Sum equals } 8) = 5/36$ and $P(G) = 2/36$.

$$\begin{aligned} \text{Now, } P(G|\text{sum equals } 8) &= P(G \text{ and sum equals } 8)/P(\text{sum equals } 8) \\ &= (2/36)/(5/36) \\ &= 2/5 \end{aligned}$$

Probability Quiz: Sample probability questions for practice

- Probability Problem 1

A bag contains blue and red balls. Two balls are drawn randomly without replacement. The probability of selecting a blue and then a red ball is 0.2. The probability of selecting a blue ball in the first draw is 0.5. What is the probability of drawing a red ball, given that the first ball drawn was blue?

- a) 0.4
- b) 0.2
- c) 0.1
- d) 0.5

+ Answer 1

**Problem 2****Answer 2**

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36 Comments

algia logan says:

[Reply](#)

November 20, 2016 at 3:40 am

a number of people gave a hat check girl one hat. suppose all the tickets got misplaced, so all the hat were given back randomly.

- a) if its 2 people determine the probability at least one person got their hat returned.
- b) if its 3 people determine the probability at least one person got their hat returned.
- c) if its 4 people determine the probability at least one person got their hat returned.

d) if its 5 people determine the probability at least one person got their hat returned.

Hi I'm Algia and I need help in solving this problem, can you help me please.

Sam Sam says:

[Reply](#)

November 12, 2017 at 6:02 pm

- a) $1-(0.5)=0.5$
- b) $1-(0.667 \cdot 0.5)=0.667$
- c) $1-(0.75 \cdot 0.667 \cdot 0.5)=0.75$
- d) $1-(0.8 \cdot 0.75 \cdot 0.667 \cdot 0.5)=0.8$

Really nice sequence.

$P(h')=1-P(h)$ etc. At least one hat is correctly returned is compliment that no hat is returned correctly.

$(n-1)/n$

Random says:

[Reply](#)

February 3, 2018 at 1:58 am

The math here is totally wrong

Sam Sam says:

[Reply](#)

March 18, 2018 at 9:48 pm

Feel free to enlighten!

abdullah says:

[Reply](#)

December 5, 2016 at 9:58 pm

Hi

Last question must be 212/216 right ?

Santhosh says:

[Reply](#)

December 12, 2016 at 7:48 pm

Tell me the way u did that sol. Plzz...

shaily says:

[Reply](#)

April 25, 2017 at 1:05 pm

yes its must be 212/216

Sangin Pandey says:

[Reply](#)*November 1, 2017 at 12:21 pm*

I think it should be 212/216

Bcz we have 4 number of event to getting a number of sum less than 5

$\{(1,1,1),(1,1,2),(1,2,1),(2,1,1)\}$

It means $p(e) = 4/216$

Nd getting a number of sum at least 5

Is

$1-4/216=212/216$

John victor says:

[Reply](#)*February 23, 2017 at 11:03 am*

A woman bought 5 basket of tomatoes each costing 1250 naira, in her discovery she observed that 90% of the tomatoes were damaged resulting in a loss of 510 naira. (a) what is the probability of obtaining an average of 50 if the cost per bag is 50 above the cost? (b) what will be the actual price for selling the tomato at cost plus (+) 25%?

ramanan says:

[Reply](#)*April 26, 2017 at 4:22 pm*

The personal director of a company wishes to select applicants for advanced training without regard to sex. Let "W" denote women and "M" denote men and the pattern of arrival be M WWW MMM WW M WWW MMMM W M W MM WWW MM W MMMM WW M WW MMMM WW M WWWWW MM WW M W WW. Will you conclude that the applicants have arrived in a random fashion?

haval says:

[Reply](#)*May 9, 2017 at 12:24 am*

pavement. Before any 250 m length of a pavement is accepted by the state highway department, the thickness of a 30 m section is monitored by an ultrasonic to verify compliance to specification. Each section is rejected if a measurement thickness less than 10 cm; otherwise the all section is accepted. From past experiments, the state highway engineer

know the 85% of all section constructed by the contractor comply with specification . however the reliability of ultrasonic thickness testing is only 75 ,so that there is a 25 percent chance of erroneous conclusion based on the determination of thickness with ultrasonic . what is the probability that a poorly constructed section is accepted on the base of ultrasonic test?

diriba says:

Reply

May 26, 2017 at 5:09 pm

solution

the possible outcome of rolling die is =6 here in this case since it is rolled 3 our sample space is $6 \times 6 \times 6 = 216$

we have asked to solve the probability of sum which will be atleast 5 this means 5 and more is possible. so that we have to search the possibilities of less than five to ease our work this will be like[111][112] [121] = 3 outcomes only. So $P(S) = 3/216$ where $P(S)$ is probability of sum less than five or probability of sum greater than equal to five.

since the sum of $P(S)$ and $P(S^c) = 1$

$P(S) = 1 - P(S^c)$

$1 - 3/216 = 213/216$

Sunny says:

Reply

October 14, 2017 at 11:18 pm

what about 2,1,1?

Meychou says:

Reply

July 10, 2017 at 8:06 am

Two cards are drawn at random from an ordinary deck of 52 cards.

Find the probability P that

(a) Both are spade

(b) One is a spade and one is heart

Arjuna says:

Reply

August 19, 2017 at 6:52 am

Ans:

(a) Probability of getting spade 1st time is $13/52$ and

Probability of getting spade 2nd time is $12/51$

Total Probability is $13 \times 12 / (52 \times 51) = 156/2652$

(b) Probability of getting spade is $13/52$ and Probability of

getting Heart is 12/51

Total probability is $13^*13/(52^*51) = 169/2652$

Olasunkanmi Mayowa says:

[Reply](#)

August 10, 2017 at 11:58 pm

copying the solution offered by @ diriba

solution

the possible outcome of rolling die is =6 here in this case since it is rolled 3 our sample space is $6\times6\times6=216$

we have asked to solve the probability of sum which will be atleast 5 this means 5 and more is possible. so that we have to search the possibilities of less than five to easy our work this will be like[111][112] [121] = 3 out comes onlywso $p(s')=3/216$ when $p(s')$ is probability of sum less than five or probability of sum greater than equal to five.

since the sum of $p(s)$ and $p(s')=1$

$p(s)=1-p(s\sim)$

$1-3/216=213/216$

The above solution is good but a little faulty because it considered only the possibility of obtaining a '1' on the first die, it omitted the possibility of getting a '2' on the first die i.e (using the same notation) [211], this is the fourth possible outcome.

Hence $P(s)=1-P(s')$

$=1-4/216$

$=212/216$

$=53/54$

Hema says:

[Reply](#)

August 15, 2017 at 5:02 pm

A bag contains blue and red balls. Two balls are drawn randomly without replacement. The

probability of selecting a blue and then a red ball is 0.2. The probability of selecting a blue ball in the first draw is 0.5. What is the probability of drawing a red ball, given that the first ball drawn was blue? Solution please

Sunny says:

[Reply](#)

October 14, 2017 at 11:23 pm

Lets assume probability of picking a red ball is X.

The probability of selecting a blue ball and then a red ball,

$P(B)*P(R)=.2$

.5*X=.2

x=.5/.2

x=.4

Pururaba swain says:

[Reply](#)

January 11, 2018 at 3:58 pm

$$\begin{aligned} P(R|B) &= P(R \text{ and } B)/P(B) \\ &= 0.2/0.5 = 0.4 \end{aligned}$$

Bharath says:

[Reply](#)

September 5, 2017 at 7:45 am

The personal director of a company wishes to select applicant for advanced

training without regard to sex. Let 'W' denote Women and 'M' Denotes men and

the pattern of arrival be M WWW MMM WW M WWW MMMM W M
W MM WWW

MM W MMMM WW M WW MMMM WW M WWWW MM WW M W
M WW. Will

you conclude that the applicants have arrived in a random fashion?

babar says:

[Reply](#)

September 6, 2017 at 10:53 pm

The probability of snow tomorrow is 0.6. And the probability that it will bi colder is 0.7. The probability that it will not snow and not bi colder is 0.1 .What is probability that it will not snow if it is colder tomorrow?

please solve it ... and tell me answer.. thanks ...

kaushik says:

[Reply](#)

September 18, 2017 at 12:17 pm

in a class 10 boys and 5 girls .three students are selected random one after the other.find the probability that

1)first two are boys and third is girl

2)first and third is of same gender and third is of opposite gender

please help me in solving this

Findme says:

[Reply](#)

June 9, 2018 at 12:00 pm

A) $10/15 * 9/14 * 5/13$

B) 1st case:

1st & 2nd are boys & 3rd is girl

$10/15 * 9/14 * 5/13$

2nd case:

1st & 2nd are girls & 3rd is boy

$5/15 * 4/14 * 10/13$

Lei says:

[Reply](#)

October 11, 2017 at 11:28 pm

There are three boxes, one of which contains a prize. A contestant is given two chances, such that if he chooses the wrong box in the first round, that box is removed from the selection and he then chooses between the two remaining boxes.

1. What is the probability that the contestant wins?
2. Does the contestant's probability of winning increases on the second round?

quark says:

[Reply](#)

October 24, 2017 at 11:23 pm

Hi Lei,

It's a Monty Hall problem. You can google it.

As for your question,

As the first box chosen if found empty is removed and you HAVE/Switch to pick from other two, the $P(W) = 2/3$.

Above answer can be explained as Prob. of winning on first box + Prob. of choosing wrong * Prob. of Choosing right between the two => $1/3 + 2/3 * 1/2 = 2/3$

The answer to the second: Yes probability increases as its a 50% chance to win as 1 wrong box is eliminated.

Jesse says:

[Reply](#)

December 1, 2017 at 2:11 pm

1) $10C2 * 5C1 / 15C3$?

2) $(10C1 * 5C1 * 9C1 / 15C3) + (5C1 * 10C1 * 4C1 / 15C3)$?

Rizwan shah says:[Reply](#)*November 10, 2017 at 9:28 pm*

Plz solve it

XYZ company wants to start a food outlet in pakistan. There is a 40% and 60% chance of stating in hyderabad and karachi respectively. If he start the outlet in hyderabad there is 30% chance that it will be in saddar and 70% chance that it will be in defence area. If they start the outlet in karachi there is 50% chance that it will be in defence, 30% in clifton and 20% in pechs. Determine probability of starting the outlet in: (a) saddar (b) defence area of any city (c) clifton given that the outlet is started in karachi

Sam Sam says:[Reply](#)*November 12, 2017 at 9:02 pm*

- a) $P(H,S) = 40\% \times 30\% = 0.4 \times 0.3 = 0.12 = 12\%$
- b) $P(H, D) + P(K, D) = 40\% \times 70\% + 60\% \times 50\% = 0.4 \times 0.7 + 0.6 \times 0.5 = 0.28 + 0.3 = 0.58 = 58\%$
- c) $P(C|K) = 30\%$

solomon says:[Reply](#)*November 30, 2017 at 7:48 pm*

please solve these questions. 1. The probability that a randomly chosen sales prospect will make a purchase is 0.20. if a sales man calls an 6 prospects, what is the probability that he will make a) exactly 4 sales b) 4 or more sales c) no sales

Sam Sam says:[Reply](#)*April 8, 2018 at 2:48 pm*

- a) $15^*(0.2)^4^*(0.8)^2 = 0.01536$
- b) $0.01536 + 6^*(0.2)^5^*(0.8)^1 + 1^*(0.2)^6^*(0.8)^0 = 0.01696$
- c) $(0.8)^6 = 0.262144$

abu almostafa says:[Reply](#)*December 15, 2017 at 11:16 pm*

please solve this problem : Suppose 100 new born in a maternity clinic , 55 were females and 45 males . What is the probability of the next three deliveries are females ?

Pururaba swain says:

[Reply](#)

January 11, 2018 at 4:12 pm

In maternity clinic the probability of new born was females is
 $55\% = 0.55$

So, the probabilitt of the next three deliveries are females is
 $0.55 \times 0.55 \times 0.55 = 0.166$ or 16.6%

Jaime says:

[Reply](#)

January 26, 2018 at 8:23 am

Pls. Answer. Thanks. Five hundred raffle tickets are sold at P25 each for 3 pieces of P4,000, P250 and P1,000. After each price drawing, the winner is then returned to the collection of tickets. What is the expected value if the person purchases four (4) tickets?

mubashir azeem says:

[Reply](#)

January 30, 2018 at 10:35 pm

a major urban hospital has gathered data on the number of heart attack victims seen. The given table indicates the probabilities of different numbers of heart attack victims being treated in the emergency room on a typical day. Number of victims treated (n) & their probabilities: n=5, p(n)=0.08; n=6, p(n)=0.16; n=7, p(n)=0.30; n=8, p(n)=0.26; n=9, p(n)=0.20

Geoffrey says:

[Reply](#)

February 23, 2018 at 3:35 pm

I have a question. It goes a manufacturing firm produces units of products in 4 plants A, B, C and D. From the first records of proportion of defectives produced at each plant, following conditional probabilities are set: A=0.5, B=0.1, C=0.15, D=0.02. The first plant produces 30% of the units of the output. The 2nd plant produces 25%, the 3rd produces 40% and the 4th 5%. A unit of the products meant at one of these plants is tested and it is found to be defective. What's the probability that the unit was produced in plant C?

Sheila M says:

[Reply](#)

February 26, 2018 at 12:18 am

I am kindly asking for help with the below question

There are three routes from a person's home to her place of work. There are four parking lots where she works, three entrances into her building, two elevators to her floor and one route from each elevator to her office door.

1. How many ways can she go from her home to her office?
2. If she makes her various choices at random, what is the probability that she will take morning-side drive, park in lot A, use the south entrance and take elevator 1.
3. As she starts her car one morning, she recalls parking lot A and B are closed for repair. What is the probability that she will take industrial avenue, park in lot D, use the north entrance and take elevator 2.

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