

How to use this sheet. Conditional probability restricts attention to outcomes where the given event already happened. Bayes' theorem reverses the direction, finding the probability of a cause given an observed effect. A binomial setup needs a fixed number of independent trials, exactly two outcomes each, and a constant probability of success.

Quick reference — $P(A|B) = P(A \text{ and } B)/P(B)$ · Independent: $P(A \text{ and } B) = P(A) \times P(B)$ · Binomial $P(X=k) = {}^nC_k p^k (1-p)^{(n-k)}$, mean = np, variance = np(1-p)

Section A · Level 1

Seven questions. None should take more than twenty seconds.

1. The conditional probability $P(A|B)$ is defined as:

(1) $P(A) \times P(B)$ (2) $P(A \cap B) / P(A)$ (3) $P(A \cap B) / P(B)$, provided $P(B) \neq 0$ (4) $P(A) + P(B)$

2. Two events A and B are said to be independent when:

(1) $P(A \cap B) = P(A) + P(B)$ (2) $P(A \cap B) = P(A) \times P(B)$ (3) $P(A|B) = 0$ (4) $P(A) = P(B)$

3. The multiplication theorem of probability states that:

(1) $P(A \cap B) = P(A) + P(B) - P(A \cap B)$ (2) $P(A \cap B) = P(A) \times P(B|A)$ (3) $P(A \cap B) = P(A|B) \times P(B)$ (4) $P(A \cap B) = P(A) - P(B)$

4. If $P(A) = 0.5$, $P(B) = 0.3$, and $P(A \cap B) = 0.15$, then A and B are:

(1) Dependent (2) Independent, since $P(A \cap B) = P(A) \times P(B)$ (3) Mutually exclusive (4) Impossible to classify

5. Two events are mutually exclusive when:

(1) $P(A \cap B) = P(A) \times P(B)$ (2) $P(A \cap B) = 0$, meaning they cannot both occur at once (3) $P(A|B) = P(A)$ (4) They are always independent

6. If $P(A) = 0.6$ and $P(B|A) = 0.5$, then $P(A \cap B)$ equals:

(1) 1.1 (2) 0.3 (3) 0.6 (4) 0.083

7. A card is drawn from a standard deck of 52 cards. The probability that it is a king, given that it is a red card, is:

(1) $1/26$ (2) $1/13$ (3) $1/52$ (4) $2/13$

Section B · Level 2

Six questions. Identify what is being asked for: a cause, or an expected value.

8. Bayes' theorem is used to find:

(1) The probability of an event occurring twice (2) The probability of a cause given that an observed effect has occurred, using the known probabilities of the effect given each possible cause (3) The sum of all probabilities in a sample space (4) The variance of a random variable

9. In Bayes' theorem, the events $A_1, A_2, \dots, A_m$ representing all the possible causes must satisfy:

(1) They must all have equal probability (2) They must be mutually exclusive and exhaustive, together covering the entire sample space (3) They must be independent of the observed event E (4) There must be exactly two of them

10. A random variable is:

(1) A variable that can only take the value 0 or 1 (2) A function that assigns a real number to each outcome of a random experiment (3) Always the mean of a distribution (4) A fixed constant

11. For a random variable X with a probability distribution, the sum of all the probabilities $P(X = x_i)$ over every possible value must equal:

(1) 0 (2) 0.5 (3) 1 (4) The mean of X

12. The mean (expected value) of a random variable X , with values x_i and probabilities p_i , is given by:

(1) $\sum x_i$ (2) $\sum p_i$ (3) $\sum x_i p_i$ (4) $\sum x_i^2 p_i$

13. A random variable X takes the values 0, 1 and 2 with probabilities 0.2, 0.5 and 0.3 respectively. The mean $E(X)$ is:

(1) 1 (2) 1.1 (3) 1.5 (4) 2

Section C · Level 3

Nine questions. Confirm the setup is genuinely binomial before applying the formula.

14. A binomial distribution arises when an experiment consists of:

(1) A single trial only (2) A fixed number of independent trials, each with only two possible outcomes and the same probability of success (3) Infinitely many trials (4) Trials with changing probabilities each time

15. For a binomial distribution with parameters n and p , the probability of exactly k successes is given by:

(1) $p^D(1-p)^{n-D}$ (2) ${}^nC^D p^D(1-p)^{n-D}$ (3) np (4) $np(1-p)$

16. For a binomial distribution with $n = 3$ and $p = 1/2$, the probability of exactly 2 successes is:

(1) $1/8$ (2) $1/4$ (3) $3/8$ (4) $1/2$

17. For a binomial distribution with $n = 3$ and $p = 1/2$, the mean number of successes is:

(1) 1 (2) 1.5 (3) 2 (4) 3

18. For a binomial distribution with $n = 10$ and $p = 1/5$, the variance is:

(1) 2 (2) 1.6 (3) 8 (4) 0.16

19. A fair coin is tossed 3 times. Let X be the number of heads obtained. The probability that $X = 0$ (no heads at all) is:

(1) $1/2$ (2) $1/4$ (3) $1/8$ (4) $3/8$

20. Two dice are thrown. Let A be the event that the sum is greater than 9, and B be the event that at least one die shows a 5. Given that B has occurred, the probability that A also occurs, $P(A|B)$, requires:

(1) Counting the outcomes in A alone (2) Counting the outcomes common to both A and B , divided by the outcomes in B (3) Multiplying $P(A)$ and $P(B)$ directly (4) Adding $P(A)$ and $P(B)$

21. A bag contains balls, and a red ball is drawn. To find the probability that it came from a particular source bag among several possible source bags, given the observed colour, the correct tool is:

(1) The multiplication theorem alone (2) Bayes' theorem (3) The binomial distribution (4) Simple addition of probabilities

22. If events A and B are independent, then A and the complement of B (written B') are:

(1) Always dependent (2) Also independent (3) Always mutually exclusive (4) Impossible to determine

Answer key: 1. (3) 2. (2) 3. (2) 4. (2) 5. (2) 6. (2) 7. (2) 8. (2) 9. (2) 10. (2) 11. (3) 12. (3) 13. (2) 14. (2) 15. (2) 16. (3) 17. (2) 18. (2) 19. (3) 20. (2) 21. (2) 22. (2)

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