Exam Programme
VWO Mathematics C

The exam programme recognizes the following domains:

Domain A	Mathematical skills
Domain B	Algebra and combinatorics
Domain C	Formulas and graphs
Domain D	Change
Domain E	Probability and statistics
Domain F	Logic

The exam topics per domain.

Domain A: Mathematical skills

The candidate is able to think mathematically. This includes ordering and structuring data, translating a problem to an algebraic equivalent, problem solving and the ability to manipulate formulas.

Domain B: Algebra and combinatorics

Subdomain B1 Algebra

The candidate is able to perform calculations with numbers and variables. Furthermore, the candidate is able to work with brackets.

The candidate knows:

- the difference between absolute and relative data.

The candidate is able to:

1. perform calculations with (and without) variables in which certain algebraic rules are used, including those for exponents and roots;
2. perform calculations with ratios, percentages and fractions;
3. work with (and expand) brackets;
4. simplify algebraic expressions;
5. convert units.

Subdomain B2 Combinatorics

The candidate is able to structure and schematize counting problems and use the result in calculations.

The candidate knows:

- what a factorial is.

The candidate is able to:

1. draw a tree diagram;
2. calculate the number of permutations and combinations;
3. identify a given problem as a counting problem;
4. come up for a strategy for a counting problem and use this strategy to solve the problem.

Domain C: Formulas and graphs

The candidate is able to recognize and work with linear, quadratic, power, exponential and logarithmic relationships represented by a graph, a table or a formula. Furthermore, the candidate is able to describe periodic phenomena.

The candidate knows:

- the following relationships:
  - $y = ax + b$ (linear),
  - $y = ax^2 + bx + c$ (quadratic),
  - $y = a \cdot x^p$, where p is a rational number (power),
  - $y = b \cdot g^x$ (**not** $y = b \cdot \mathrm{e}^x$) (exponential)
    including the concepts exponent, initial value and growth factor,
  - $y = \log_g(x)$ (**not** $y = \ln(x)$) (logarithmic);
- the rule $\sqrt[p]{x} = x^{\frac{1}{p}}$;
- the following characteristics of the graphs of the abovementioned relationships:
  - points of intersection with the x-axis and y-axis,
  - maximum and minimum points,
  - asymptotic behaviour.

The candidate is able to:

1. make a table or graph of a formula;
2. recognize the graphs of the abovementioned relationships;
3. name the characteristics of the abovementioned relationships;
4. use and recognize relationships of the form $y = a \cdot x$ (directly proportional) and $y = \frac{a}{x}$ (inversely proportional);
5. use a table to determine whether a quantity grows linearly or exponentially;
6. express x in terms of y for formulas of the form:
   $y = a \cdot x + b$, $y = b \cdot g^x$, $y = a \cdot x^p$ and $y = \log_g(x)$;
7. use the rules for exponents and roots in calculations;
8. determine the period, the amplitude and the equilibrium of a periodic phenomenon;
9. find values using linear interpolation and linear extrapolation;
10. use a logarithmic scale;
11. determine a formula for exponential growth when given a table of values;
12. convert a growth factor to a growth percentage (and vice versa);
13. calculate the half-life or doubling time corresponding to a given growth factor;
14. use the different representations of a relationship (formula, table, graph, text) in a given problem situation.
15. describe a trend;
16. solve equations and inequalities using the graphing calculator.

Domain D: Change

The candidate is able to describe the change of the graphs of linear, quadratic, exponential and logarithmic relationships. Furthermore, the candidate is able to describe (and use) the pattern in a sequence of numbers.

The candidate knows:

- the notation for sequences: u_n, where n can start at 0 or 1.

The candidate is able to:

1. determine on which intervals a graph is constant, increasing or decreasing and indicate whether the growth rate is increasing or decreasing;
2. calculate the average rate of change on an interval and interpret what this number means in a given context;
3. compare the slope of graphs in different points with each other;
4. recognize, describe and interpret the change of the graphs of the abovementioned relationships;
5. calculate the terms of a sequence that is given by a recursive or a direct sequence;
6. determine a direct or recursive formula for an arithmetic (linear) and geometric (exponential) sequence.

Domain E: Probability and Statistics

Subdomain E2 Representation of data

The candidate is able to interpret data from a table or graph and evaluate these data on their merit.

Subdomain E3 Quantification of data

The candidate is able to summarize data using measures of central tendency (mean, median and mode) and measures of variability (standard deviation) and interpret these numbers within the given context. The candidate is able to calculate these numbers using the graphing calculator.

Subdomain E4 Probability

The candidate is able to determine probabilities using diagrams, by using combinatorics or by using the rules for probability (the sum rule and the product rule). The candidate is able to distinguish between sampling with replacement and sampling without replacement.

Subdomain E5 Probability distributions

The candidate knows what a random variable is and can determine the probability distribution, the expected value and the standard deviation of a random variable.
The candidate can use the graphing calculator to perform calculations for binomially and normally distributed random variables. The candidate knows the rules for random variables, e.g. the $\sqrt{n}$-law.

Domain F: Logic

The candidate is able to analyze logical arguments.

The candidate knows:

- what a proposition is;
- the logic symbols $\wedge$, $\vee$, $\Rightarrow$ and $\neg$;
- what premises are and what a conclusion is;
- what a contradiction and a paradox are.

The candidate is able to:

5. determine the structure of a logical argument;
6. verify whether a logical argument is correct;
7. use examples to illustrate that a proposition is true and use counterexamples to refute a proposition;
8. write a proposition using logic symbols (and vice versa);
9. draw and use a Venn diagram;
10. distinguish between necessary and sufficient conditions;
11. recognize and describe a contradiction or a paradox;
12. use different representations, e.g. a table, a (Venn) diagram and logic symbols to analyze and solve logic problems.

Exam VWO Math C

Formula sheet

Rules for random variables

For two random variables X and Y, we have:

$$\mathrm{E}(X+Y) = \mathrm{E}(X) + \mathrm{E}(Y)$$

For two independent random variables X and Y, we have:

$$\sigma(X+Y) = \sqrt{\left(\sigma(X)\right)^2 + \left(\sigma(Y)\right)^2}$$

If you have n independent random experiments, each with the same random variable X, then the following holds for the sum S and the mean $\bar{X}$:

$$\mathrm{E}(S) = n \cdot \mathrm{E}(X) \qquad \mathrm{E}(\bar{X}) = \mathrm{E}(X)$$

$$\sigma(S) = \sqrt{n} \cdot \sigma(X) \qquad \sigma(\bar{X}) = \frac{\sigma(X)}{\sqrt{n}}$$

Binomial distribution

For a binomially distributed random variable X, where n is the number of trials and p the probability of success, the probability of k successes is equal to:

$$\mathrm{P}(X = k) = \binom{n}{k} \cdot p^k \cdot (1-p)^{n-k}$$

Furthermore: $\mathrm{E}(X) = n \cdot p$ and $\sigma(X) = \sqrt{n \cdot p \cdot (1-p)}$

Normal distribution

If X is normally distributed with mean μ and standard deviation σ, then:

$Z = \dfrac{X - \mu}{\sigma}$ follows a standard normal distribution with: $\mathrm{P}(X \leq g) = \mathrm{P}\left(Z \leq \dfrac{g-\mu}{\sigma}\right)$