CENTRALE COMMISSIE VOORTENTAMEN WISKUNDE

Program of the entrance exam Wiskunde A

Valid from December 2018

The entrance exam Wiskunde A is taken as a written examination with open questions. The exam time is 3 hours. Information about the exam dates and registration for these exams can be found on www.ccvx.nl.

The program of the entrance exam Wiskunde A of the CCVW is based on the program wiskunde A of the Dutch VWO for 2019 as published on www.examenblad.nl . Compared to the Central Exam of VWO there are two important differences:

1. **At the entrance exam Wiskunde A, graphing calculators** or any other ICT devices **may not be used**.
2. **The domain Statistics and Probability Theory is also tested at the entrance exam Wiskunde A.** In the Dutch VWO exam, this domain is only tested at the School Exam.

The further determination of the VWO examination program on www.examenblad.nl is therefore not applicable.

In this document you will find

- The exam program
- Exam supplies
- The formula list that is printed on the exam
- Elaboration of the exam program in a list of concepts, characteristics and skills
- Overview of algebraic skills
- Recommended learning materials

In the entrance exam all calculations must be performed algebraically, the use of a **graphing calculator** or a calculator with the possibility to calculate integrals is therefore **not allowed**.
The use of a standard calculator with exponential, logarithmic and trigonometric functions of a type similar to the Casio fx 82 series and the TI 30 series is permitted.

Exam program

This is a translation of the official program in Dutch. If there are any discrepancies between the text below and the Dutch version of this text, the Dutch version will prevail.

1 The candidate can analyse suitable problem situations in mathematical terms, solve them and translate the result back to the relevant context.

2 The candidate masters the mathematical skills appropriate to the examination program, including modelling and algebraizing, organizing and structuring, analytical thinking and problem solving, manipulating formulas, abstracting, and logical reasoning.

3 The candidate can perform calculations with numbers and variables, using arithmetic and algebraic basic operations and working with brackets.

4 The candidate can recognize and use the characteristics in graph, table and formula of first-degree functions, second-degree functions, power functions, exponential functions, logarithmic functions and sine functions.

5 The candidate can draw up and edit formulas and functional rules of combinations and assemblies of the types of functions mentioned in 4, draw the corresponding graphs, solve equations and inequalities with algebraic methods, thus without the use of a graphing calculator, and interpret the result in terms of a context.

6 The candidate can determine the derivative of first-degree functions, second-degree functions, power functions, exponential functions and logarithmic functions, use the rules for differentiation and describe the change behaviour of a function on the basis of the derivative. The use of the chain rule is limited to functions of the form $k(x) = f(g(x))$ in which f and g are single functions of the types mentioned in the previous sentence.

7 By means of the derived function, the candidate can calculate the position of the minima and the maxima of a graph by solving the associated equations algebraically and can determine the nature of these extremes by means of a sketch of the graph.

8 The candidate can recognize and describe the behaviour of a sequence and perform calculations on a sequence, especially for arithmetic and geometric sequences.

9 The candidate can structure counting problems and schematisation and use the result of this in calculations and reasoning.

10 The candidate can determine the mode and the median of a series of discrete numerical data and can use a simple calculator to calculate the mean and standard deviation of a population of limited size.

11 The candidate can use the concept of chance to determine the probability of a certain outcome or event in a random chance process by means of a probability (tree) diagram, of combinatorics and of laws of probabilities.

12 The candidate can set the probability distribution for random variables with a limited number of outcomes and calculate the expected value and the standard deviation.

13 The candidate can determine whether a binomial probability distribution is applicable in a given situation, indicate the parameters of this probability distribution and use the corresponding formulas to calculate probabilities, expected value and standard deviation.

14 The candidate can use the parameters of the normal distribution, i.e. the mean (or the expected value) and the standard deviation, and can use the rules of thumb for the location of 68% and 95% of the observations.

15 The candidate can determine the expected value and the standard deviation of the sum of two independent random variables and can determine the expected value and the standard deviation of the sum and the average of the results of n independent repetitions of the same random experiment.

16 The candidate can set up a statistical testing procedure from a suitable problem situation and thereby
- indicate whether it concerns a test of the mean or a proportion test
- formulate the null hypothesis
- indicate whether the procedure must be carried out left-sided, right sided or two-sided
- indicate how a given sample result must be converted to a p-value
- interpret the given value of a p-value
calculate the boundaries of the rejection region (the critical region) with the table in the formula list and interpret the given sample result using these boundaries.

Aids required during the entrance exams

To take the exam you must take:

- Identity document. *Your identity document will be inspected during the entrance exam. You should always be able to identify yourself with a valid identity document (passport, Dutch driving licence, Dutch identity card, EU/EEA document, residence document model 2001 types I to IV).*
- Writing utensils*. A pen (not a red one) and a pencil. A pencil may only be used for drawing graphs.*
- A set square and protractor.
- calculator with exponential, logarithmic and goniometric functions. *A **graphic calculator** and\or a calculator with the ability to calculate integrals is **not permitted**; a list of formulae will be provided with the exam, as well as the necessary tables of the binominal and normal distribution of probability. Other aids, such as a formula sheet, BINAS and table book are NOT permitted.*
- Watch. *It might be a good idea to bring a watch (no smartwatch) to be able to divide your time over the different assignments. You are not allowed to use your mobile phone as a watch.*
- It may also be wise to bring spare batteries for your calculator

Make sure you take the correct calculator with you. If you only have a graphing calculator with you, you will have to take the exam without a calculator.

Formula list

This list will be printed on the last pages of the entrance exam Wiskunde A

Quadratic equations

The solutions of the equation $ax^2 + bx + c = 0$ with $a \neq 0$ and $b^2 - 4ac \geq 0$ are

$$x = \frac{-b + \sqrt{b^2 - 4ac}}{2a} \quad \text{and} \quad x = \frac{-b - \sqrt{b^2 - 4ac}}{2a}$$

Differentiation

Rule	**function**	**derivative function**
Sum rule	$s(x) = f(x) + g(x)$	$s'(x) = f'(x) + g'(x)$
Product rule	$p(x) = f(x) \cdot g(x)$	$p'(x) = f'(x) \cdot g(x) + f(x) \cdot g'(x)$
Quotient rule	$q(x) = \frac{f(x)}{g(x)}$	$q'(x) = \frac{f'(x) \cdot g(x) - f(x) \cdot g'(x)}{\big(g(x)\big)^2}$
Chain rule	$k(x) = f(g(x))$	$k'(x) = f'\big(g(x)\big) \cdot g'(x)$ or $\frac{dk}{dx} = \frac{df}{dg} \cdot \frac{dg}{dx}$

Logarithms

Rule	**conditions**
${}^g\log a + {}^g\log b = {}^g\log ab$	$g > 0, \quad g \neq 1, \quad a > 0, \quad b > 0$
${}^g\log a - {}^g\log b = {}^g\log \frac{a}{b}$	$g > 0, \quad g \neq 1, \quad a > 0, \quad b > 0$
${}^g\log a^p = p \cdot {}^g\log a$	$g > 0, \quad g \neq 1, \quad a > 0$
${}^g\log a = \frac{{}^p\log a}{{}^p\log g}$	$g > 0, \quad g \neq 1, \quad a > 0, \quad p > 0, \quad p \neq 1$

Arithmetic and geometric sequences

Arithmetic sequence:	$Sum = \frac{1}{2} \cdot number\ of\ terms \cdot (u_e + u_l)$
Geometric sequence:	$Sum = \frac{u_{l+1} - u_e}{r - 1} \quad (r \neq 1)$
In both formulas:	*e* =number first term of the sum; *l* = number last term of the sum

Probability

If *X* and *Y* are any random variables, then: $E(X+Y) = E(X) + E(Y)$
If furthermore *X* and *Y* are independent, then: $\sigma(X+Y) = \sqrt{\sigma^2(X) + \sigma^2(Y)}$

$\sqrt{n}$-law:
For *n* independent repetitions of the same experiment where the result of each experiment is a random variable *X*, the sum of the results is a random variable *S* and the mean of the results is a random variable $\overline{X}$.

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

$E(\overline{X}) = E(X)$ $\qquad$ $\sigma(\overline{X}) = \frac{\sigma(X)}{\sqrt{n}}$

Binomial Distribution

If *X* has a binomial distribution with parameters *n* (number of experiments) and *p* (probability of success at each experiment), then

$P(X = k) = \binom{n}{k} \cdot p^k \cdot (1-p)^{n-k}$ $\quad$ with $\quad k = 0, 1, 2, \dots, n$

Expected value: $E(X) = np$ $\qquad$ Standard deviation: $\sigma(X) = \sqrt{n \cdot p \cdot (1-p)}$

n and *p* are the parameters of the binomial distribution

Normal Distribution

If *X* is a normally distributed random variable with mean μ and standard deviation σ, then

$Z = \frac{X-\mu}{\sigma}$ has a standard normal distribution and $P(X < g) = P\left(Z < \frac{g-\mu}{\sigma}\right)$

μ and σ are the parameters of the normal distribution.

Hypothesis testing

In a testing procedure where the test statistic *T* is normally distributed with mean μ_T standard deviation σ_T the boundaries of the rejection region (the critical region) are::

α	left sided	right sided	two sided
0.05	$g = \mu_T - 1.645\sigma_T$	$g = \mu_T + 1.645\sigma_T$	$g_l = \mu_T - 1.96\sigma_T$ $g_r = \mu_T + 1.96\sigma_T$
0.01	$g = \mu_T - 2.33\sigma_T$	$g = \mu_T + 2.33\sigma_T$	$g_l = \mu_T - 2.58\sigma_T$ $g_r = \mu_T + 2.58\sigma_T$

Elaboration of the exam program

Below, the exam program is further elaborated in a list of concepts, properties and skills. This list is intended as a support in preparing for the entrance exam, but not as a replacement for the exam program. Although this list has been compiled with the greatest possible care, it may therefore occur that an exam question is not dealt with in this list.

Concept / property / skill	Remark / explanation
Various calculations	
Computations with percentages; percentual change	$\frac{New - Old}{Old} \times 100\%$
Scientific notation	$0.0000123 = 1.23 \times 10^{-5}$
Computations with fractions	Addition, subtraction, multiplication Adding fractions with unlike denominators Simplifying fractions Dividing fractions
Ratios	In a table of ratios the cross products are equal
Computations with variables:	*For example:*
Eliminating parentheses	$(a+b)(c+d)-(e+f) = ac+ad+bc+bd-e-f$
Solve for a variable	$y = \frac{1}{x+1} \Leftrightarrow x = \frac{1}{y} - 1$
Computations with units	The train runs 12 km in 5 minutes. That is 2,4 km/minute Or 40 m/s Or 144 km/h

Powers, roots and radicals	
a^n is a power with base number a and exponent n	n is a rational number (a fraction)
$\sqrt[n]{a}$ is the number of which the *n*-the power equals a	$n = 2, 3, 4, 5, \ldots$ If n is even, then $a \geq 0$ and $\sqrt[n]{a} \geq 0$
Special exponents	
$a^2 = a \cdot a$; $a^3 = a \cdot a \cdot a$ etc.	
$a^1 = a$	
$a^0 = 1$	$a \neq 0$
$a^{-n} = \frac{1}{a^n} = \left(\frac{1}{a}\right)^n$	$a \neq 0$ $a^{-1} = \frac{1}{a^1} = \frac{1}{a}$
$a^{\frac{1}{n}} = \sqrt[n]{a}$	$n = 2, 3, 4, 5, \ldots$ If n is even, then $a \geq 0$ and $a^{\frac{1}{n}} \geq 0$ $a^{\frac{1}{2}} = \sqrt[2]{a} = \sqrt{a}$
Calculation rules for powers	
$a^m \cdot a^n = a^{m+n}$	
$\frac{a^m}{a^n} = a^{m-n}$	
$(a^m)^n = a^{m \cdot n}$	$a^{\frac{m}{n}} = a^{\frac{1}{n} \cdot m} = \left(a^{\frac{1}{n}}\right)^m = \left(\sqrt[n]{a}\right)^m$
$(a \cdot b)^n = a^n \cdot b^n$	$(a + b)^2 \neq a^2 + b^2$
$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$	

Straight lines and linear relations	
General equation: $mx + ny = c$	The line with equation $3x + 4y = 12$ passes through (4,0) and (0,3)
$n = 0$ yields a vertical line	$3x + 0 \cdot y = 12$ yields $x = 4$
$m = 0$ yields a horizontal line	$0 \cdot x + 4y = 12$ yields $y = 3$
The equation of a non-vertical line can also be written in the form $y = ax + b$	$3x + 4y = 12$ yields $y = -\frac{3}{4}x + 3$
Slope of the line through the points $A(x_A, y_A)$ and $B(x_B, y_B)$: $\frac{\Delta y}{\Delta x} = \frac{y_B - y_A}{x_B - x_A}$	This is equal to a in the formula $y = ax + b$
Drawing up an equation with the slope	Substitute the slope and the coordinates of a point in the formula $y = ax + b$
Computing the intersection of two straight lines	Eliminate y from the system of two equations
Interpolation and extrapolation	
Direct proportionality and inverse proportionality	
Power relations	
$y = ax^n$ with *n* even	The graph has a vertex in (0,0)
$y = ax^n$ with *n* odd	(0,0) is the punt of symmetry of the graph
Horizontal shift Vertical shift Rescaling in vertical direction	$y = 3(x - 4)^2 + 5$ is obtained from the graph of $y = x^2$ by tripling the *y*-coordinates, followed by shifting the graph 4 units to the right and 5 units upwards. This results in an upwards opening parabola with vertex (4,5).

Growth formulas	
Exponential growth with initial value b and growth factor g	$N(t) = b \cdot g^t$
The graph of $N(t) = g^t$ is increasing for $g > 1$ and decreasing for $0 < g < 1$	En “ontaard” voor $g = 1$
Growth factor and growth percentage	
Converting a growth percentage to a different unit of time	Via the growth factor
Doubling time for $g > 1$	Also computing the growth factor for a certain unit of time from the doubling time / half-life
Half-life for $0 < g < 1$	
Other growth formulas	
$N(t) = a(1 - g^t)$	For $0 < g < 1$, for both formulas the graphs are increasing to a, the boundary (the saturation level)
$N(t) = \frac{a}{1 + c \cdot g^t}$	

Logarithms	
$y = {}^g\log(x)$ means $g^y = x$	$g > 0,\ g \neq 1;\ x > 0$
${}^g\log(1) = 0;\ \ {}^g\log(g) = 1;\ \ {}^g\log(g^n) = n$	
$\log(x) = {}^{10}\log(x)$	$\log(1) = 0;\ \log(10) = 1;\ \log(100) = 2$
The graph is increasing for $g > 1$ and decreasing for $0 < g < 1$	If *x* approaches 0, the graphs approach the *y*-axis
Calculation rules for logarithms	These follow from the calculation rules for powers
${}^g\log(a) + {}^g\log(b) = {}^g\log(a \cdot b)$	
${}^g\log(a) - {}^g\log(b) = {}^g\log\left(\frac{a}{b}\right)$	
${}^g\log(a^n) = n \cdot {}^g\log(a)$	This holds for all numbers n
${}^g\log(a) = \frac{{}^p\log(a)}{{}^p\log(g)}$	Often used with $p = 10$ to compute logarithms with the log key of a

	calculator
Differentiation: the derivatives of standard functions $f(x) = a$ yields $f'(x) = 0$ $f(x) = ax$ yields $f'(x) = a$ $f(x) = ax^n$ yields $f'(x) = n \cdot x^{a-1}$ $f(x) = \mathrm{e}^x$ yields $f(x) = \mathrm{e}^x$ $f(x) = g^x$ yields $f'(x) = g^x \cdot \ln(g)$ $f(x) = \ln(x)$ yields $f'(x) = \frac{1}{x}$	The derivative is also noted as $\frac{\mathrm{d}y}{\mathrm{d}x}$ From the sum rule we get: $f(x) = ax + b$ yields $f'(x) = a$ This also holds when *n* is a fraction or a negative number. $\mathrm{e} \approx 2{,}71828$ $\ln(g) = {}^{\mathrm{e}}\log(g) \quad (g > 0)$ From the constant factor rule we get: $f(x) = {}^{g}\log(x)$ yields $f'(x) = \frac{1}{x \ln(g)}$
Rules for differentiation of combinations of functions Constant factor rule Sum rule Product rule Quotient rule Chain rule	$g(x) = c \cdot f(x)$ yields $g'(x) = c \cdot f'(x)$ *The other rules are in the formula list*
Applications of the derivative $f'(a)$ is the slope of the (tangent to the) graph of f in point $(a, f(a))$ The graph is increasing if $f'(x) > 0$ and decreasing if $f'(x) < 0$ In a minimum or a maximum, $f'(x) = 0$ Minima and maxima together are called extremes The points where the graph has a minimum or a maximum are called the vertices of the graph. Minimal and maximal rate of growth	The points where f could have a maximum or a minimum are determined by solving $f'(x) = 0$. In principle you further have to check in which of these points the graph has a minimum and in which point the graph has a maximum. *This often follows from the wording of the question.* The derivative (the rate of growth) can be differentiated as well

Sequences	
Direct formula	Computes a term based on its number
Recursive formula	Computes a term based on the previous term
Arithmetic sequence	Recursive formula: $u_{n+1} = u_n + a$ Direct formula: $u_n = u_0 + a \cdot n$ Or: $u_n = u_1 + a \cdot (n-1)$
Geometric sequence	Recursive formula: $u_{n+1} = r \cdot u_n$ Direct formula: $u_n = r^n \cdot u_0$ Or: $u_n = r^{n-1} \cdot u_1$
Sum formula of an arithmetic sequence Sum formula of a geometric sequence	*See the formula list*
Computing the number of a term	This is done by putting the direct formula equal to the value of the term.

Sinus functions	
General formula: $f(x) = A + B \cdot \sin\big(C \cdot (x - D)\big)$	$A =$ equilibrium $\lvert B \rvert =$ amplitude
The graph is a sinusoid	$C = \dfrac{2\pi}{\text{period}}$
Read the equilibrium, the amplitude, the period and a starting point from the graph	If $B > 0$ the graph passes the equilibrium increasing in point (D, A) (a starting point)
Determine the equilibrium, the amplitude, the period and a starting point from the formula	
Use the period and the symmetry around the minimum and the maximum	

Descriptive Statistics *This subject is only dealt with superficially in the entrance Wiskunde A*	
Mode, median, mean and standard deviation for a series of discrete numerical data Mean and standard deviation for a frequency distribution	Mean and standard deviation may be computed with the statistic functions of an ordinary calculator

Counting systematically *A.k.a. combinatorics*	
Visualisation	E.g. tree diagram, contingency table, venn diagram
Multiplication rule	I AND II
Addition rule	I OR II (exclusive)
With or without repetition	
Permutations, factorials	The order of the objects matters
Combinations	The order of the objects does not matter
Pascal's triangle	The number of codes with 5 A's and 3 B's is on the 8th row of Pascal's triangle and is equal to $\binom{8}{3} = \binom{8}{5} = \frac{8!}{3! \cdot 5!} = 56$
Combination of techniques	The number of codes with 3 A's, 4 B's and 5 C's is given by $\binom{12}{3} \cdot \binom{9}{4}$ (and by $\binom{12}{5} \cdot \binom{7}{4}$)

Probability

An event is a part of all possible outcomes of a random experiment

Is often indicated with a capital letter, such as G, A and B.

Laplace's definition of probability for random experiments with equally likely outcomes

$$P(G) = \frac{number\ of\ outcomes\ satisfying\ G}{total\ number\ of\ outcomes}$$

Empiric probabilities are determined with relative frequencies

Theoretical probabilities are often determined by counting systematically

Conditional probabilities

Are often determined with a contingency table

Independent events

$P(A \mid B) = P(A)$

Multiplication rule for independent events

$P(G_1\ and\ G_2) = P(G_1) \cdot P(G_2)$

Addition law for mutually exclusive events

$P(G_1\ or\ G_2) = P(G_1) + P(G_2)$

Complement rule

Application of these laws and rules for combined random experiments

Random variables

If the results of a random experiment are numbers, you can write down the corresponding probabilities using a random variable.

If X is the number of eyes on a roll with a die, then we note the probability of 4 eyes with $P(X = 4)$

The probability distribution is a list of all possible outcomes of a random variable with the associated probabilities

The probability distribution is often noted in a table, for example

x	1	2	3	4	5	6
$P(X = x)$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$

Expected value (or expectation); Expected value of a sum = sum of the expected values

$E(X) = 1 \cdot \frac{1}{6} + 2 \cdot \frac{1}{6} + \cdots + 6 \cdot \frac{1}{6}$
$E(X + Y) = E(X) + E(Y)$

Standard deviation

May be computed with the statistical functions of a calculator

Standard deviation of the sum and the mean of independent random variables; $\sqrt{n}$-law

See the formula list

The binomial distribution	
Bernoulli trial	Outcome: “success” or “failure”
Binomial random experiment	Parameters: $n =$ number of Bernoulli trials $p = P(success)$ at each trial
Single probabilities (probability of *k* successes)	$P(X = k) = \binom{n}{k} \cdot p^k \cdot (1-p)^{n-k}$
Cumulative probabilities	$P(X \leq k)$; $P(X \geq k)$; $P(k \leq X \leq l)$ Only for a sum of at most 3 simple probabilities
Expected value	$E(X) = np$
Standard deviation	$\sigma_X = \sqrt{np(1-p)}$
The normal distribution	
The normal distribution and the Gaussian curve as an approximation of a frequency distribution	Parameters: μ or $\mu_X =$ mean (expected value) σ or $\sigma_X =$ standard deviation 50% of the observations are below the mean
Rules of thumb	68% of the observations are between $\mu - \sigma$ en $\mu + \sigma$; 95% of the observations are between $\mu - 2\sigma$ en $\mu + 2\sigma$
Computing μ and/or σ using the rules of thumb	E.g. given that 84% of a population weighs more than 80 kg and 2.5 of this population weighs more than 110 kg.
Normal approximation	
A discretely distributed random variable can often be approached with a normal distribution	For a binomially distributed random variable, this is the case when $np \geq 5$
The mean and standard deviation of the normal approach are the expected value and the standard deviation of the discrete random variable.	Thus, for the normal approximation *Y* of a binomially distributed random variable with parameters *n* and *p*, we get: $\mu_Y = np$ and $\sigma_y = \sqrt{np(1-p)}$
Continuity correction	$P(X \leq k) = P\left(X < k + \frac{1}{2}\right)$

Hypothesis testing	
Deriving the type of test procedure and the accompanying null hypothesis from a description	Proportion test (binomial test) with null hypothesis $H_0\colon\ p = p_0$ or mean test (normal test) with null hypotheses $H_0\colon\ \mu = \mu_0$
Deriving the alternative hypothesis	Left sided, right sided or two sided
Deriving the test statistic and its parameters	The parameters for a binomial test are n and p_0, the parameters for a normal test are μ_0 and σ, use the $\sqrt{n}$-law to compute σ
Level of significance	Usually $\alpha = 0.05$, sometimes $\alpha = 0.01$
Decision based on a p-value	Since the use of graphing calculators and tables is forbidden, the p-value usually will be given at the entrance exam Wiskunde A
Decision by comparing the sample result with the boundary of the rejection region (the critical region)	The boundaries for a normal test can be calculated with the formulas from the formula list. If $np_0 \geq 5$, you can also use these formulas with a binomial test. In this situation, you do not have to use the continuity correction

Algebraic skills

Below an overview of algebraic skills that the candidates for the examination mathematics A of the CCVW must master. Though this list has been compiled with the utmost care too, it may occur that a skill that is included the exam program, is not included in this list

Skill	Remark / explanation
Solving standard equations	
First degree	$ax + b = px + q$
Quadratic *With the quadratic formula*	$ax^2 + bx + c = 0$ *If possible, factorising can be used as well*
Power equations with positive even exponents	$x^n = a \Leftrightarrow x = \pm\sqrt[n]{a} \quad (a \geq 0)$
Power equations with positive odd exponents	$x^n = a \Leftrightarrow x = \sqrt[n]{a}$
Other power equations	$x^n = a \Leftrightarrow x = a^{\frac{1}{n}} \quad (a \geq 0)$
Equations with roots	$\sqrt{x} = a \Leftrightarrow x = a^2 \quad (x \geq 0;\ a \geq 0)$
Solving suitable exponential and logarithmic equations exactly	${}^g\log(g^n) = a \Leftrightarrow g^n = g^a \Leftrightarrow n = a$
Solving exponential equations using logarithms	$g^x = a \Leftrightarrow x = {}^g\log(a)$
Solving inequalities	When solving inequalities graphically, the intersections of the graphs have to be computed algebraically
Solving systems of equations	By elimination and/or substitution
Setting the equation of a straight line	Determine the slope and substitute this together with to coordinates of one point into one of the standard formula

Rewriting equations and formulas	*E.g. to rewrite an equation into a standard equation*
Splitting an equation	$A \cdot B = 0 \Leftrightarrow A = 0 \vee B = 0$ $A^2 = B^2 \Leftrightarrow A = \pm B$ $A \cdot B = A \cdot C \Leftrightarrow A = 0 \vee B = C$
Factorising using a common factor	$A \cdot B + A \cdot C = A(B + C)$
Expanding parentheses	$(A + B)(C + D) = AC + AD + BC + BD$
Operations with fractions	Addition (also of fractions with unlike denominators) Multiplication and division Crosswise multiplication: $\frac{A}{B} = \frac{C}{D} \Leftrightarrow AD = BC \wedge BD \neq 0$
Operations with roots	$\sqrt{A} = B \Leftrightarrow A = B^2 \wedge A \geq 0$
Applying calculation rules	Like those for powers and logarithms
Combining formulas	If e.g. the price per piece *p* and the cost *c* both depend on the quantity *q*, then you can derive formulas for the revenue: $r = pq$ and for the profit:: $\pi = r - c = pq - c$ Take care of the right use of parentheses when substituting formulas for *p* and *c*.
Rewriting formulas with logarithms	
Change of base	Use the fourth calculation rule
Solving an exponential or logarithmic equation for a variable	Use $Y = {}^{g}\log(X) \Leftrightarrow g^Y = X$
Converting ${}^{g}\log(N) = at + b$ into a formula of the form $N = B \cdot G^t$ and vice versa	$B = g^b;\ G = g^a$
Converting ${}^{g}\log(N) = a + b \cdot {}^{g}\log(t)$ into a formula of the form $N = A \cdot t^b$ and vice versa	$A = g^a$

Recommended learning materials

Unfortunately, as far as we know there are no textbooks in English covering the full program of the Dutch VWO exam wiskunde A. However, there is a textbook that covers most of the calculus topics (functions and derivatives):

Mathematics that works volume 1 (De Gee, ISBN 978-90-5041-167-7)
From this book you can skip the sections that cover antidifferentiation and integrals.

The topics Combinatorics, Statistics and Probability theory are covered in many textbooks on basic statistics. Be sure that the topics indicated in this document are covered in a book before you buy it!

There is also a wide range of materials available online, for instance the Kahn academy. You can use Google to find more information on a certain topic.

And last but not least, check the example exams on www.ccvx.nl