CENTRALE COMMISSIE VOORTENTAMEN WISKUNDE

Entrance Exam Wiskunde A

Date: 15 December 2025
Time: 13.30 – 16.30
Questions: 6

Please read the instructions below carefully before answering the questions. Failing to comply with these instructions may result in deduction of points.

Make sure your name is clearly written on every answer sheet.

Take a new answer sheet for every question.

Show all your calculations clearly. Illegible answers and answers without a calculation or an explanation of the use of your calculator are invalid (*see also question 1)*.

Write your answers in ink. Do not use a pencil, except when drawing graphs. Do not use correction fluid.

You can use a basic scientific calculator. **Other equipment, like a graphing calculator, a calculator with the option of computing integrals, a formula chart, BINAS or a book with tables, is NOT permitted.**

On the last two pages of this exam you will find a list of formulas.

You can use a dictionary if it is approved by the invigilator.

Please **switch off your mobile telephone** and put it in your bag.

Points that can be scored for each item:						
Question	1	2	3	4	5	6
a b c d	6 6 4	7 6	4 4 2 6	3 4 3 3	2 3 5	5 6 2
Total	16	13	16	13	10	13
$\text{Grade} = \frac{\text{total points scored}}{9} + 1$ You will pass the exam if your grade is at least 5.5 .						

Question 1 – Algebraic computations

Take a new answer sheet for every question!

*When you are asked to perform a computation **algebraically**, your computation should be fully worked out on paper. Reading function values from a table (including tables produced by a calculator) is not allowed in algebraic calculations. You can use a calculator for simple calculations and for approximations of numbers like* $\sqrt{2}$ *and* $\log(3)$.
Unless stated otherwise, all computations in this exam have to be performed algebraically.

The function f is given by $f(x) = (x-2)(x^2+5x-35)$.

6pt a Compute algebraically the *x*-coordinates of the points on the graph of f at which the tangent line to this graph is horizontal.

The function g is given by $g(x) = \sqrt{12-2x^2}$

6pt b Compute algebraically the value(s) of x for which the slope of the graph of g in the point $A\big(x, g(x)\big)$ is equal to 2.

4pt c Compute algebraically the sum of the odd numbers between 100 and 1000, that is $101 + 103 + \cdots + 997 + 999$.

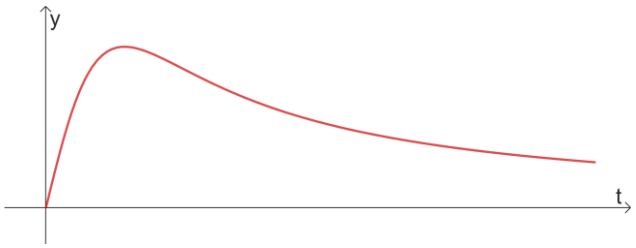
Question 2 – Advertising on social media

Take a new answer sheet for every question!

A worldwide operating online shop launches a campaign with ads on social media.
The number of current visitors of the website of the shop who reached this website by clicking these ads, is given by the formula

$$V = \frac{1000t}{16t^2 + 49}$$

In this formula, V is the number of visitors in thousands and t is the time in days with $t = 0$ at the start of the campaign.
The figure below shows the graph that represents the relation between V and t.



7pt a Use the derivative $\frac{dV}{dt}$ to compute algebraically the maximal number of visitors to this website that reached the website by clicking these ads.

The campaign is stopped when the number of visitors to this website that reached the website by clicking these drops below 5000.

6pt b Compute algebraically the time at which the campaign is stopped.

Question 3 – The length of Dutch and Belgian men

Take a new answer sheet for every question!

The length of the Dutch men born in 1980 is normally distributed with a mean of $\mu = 184$ cm and a standard deviation of $\sigma = 10$ cm.

4pt a Use the figure on the bottom of this page to compute the percentage of these men that have a length between 164 cm and 199 cm.

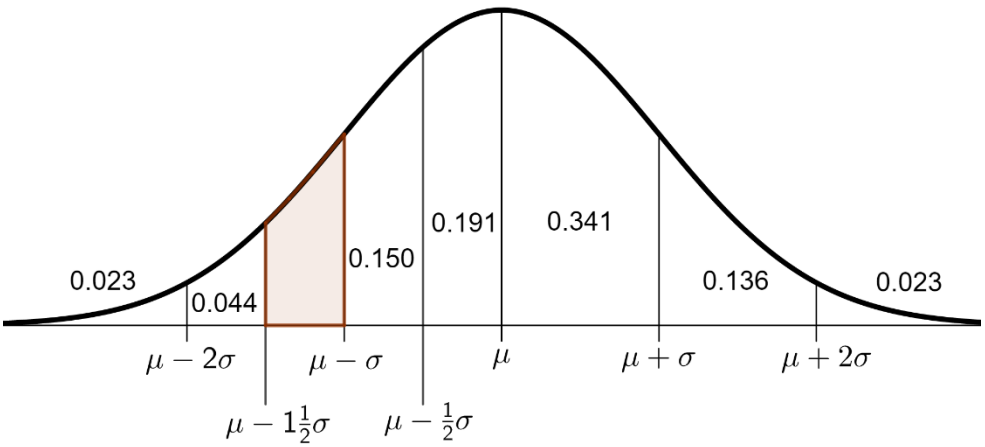
The length of the Belgian men born in 1980 is normally distributed with a mean of $\mu = 176$ cm and a standard deviation of $\sigma = 9$ cm.

4pt b Is the percentage of the Belgian men born in 1980 that have a length between 158 cm and 190 cm higher or lower than the percentage of the Dutch men born in 1980 that have a length between 164 cm and 199 cm? Explain your answer with a computation!

A university professor wants to test whether the average length of his current male students (all born after 2000) is the same as the length of the Dutch males born in 1980. To test this, he measures the length of 25 of his current students.
In this test procedure, he assumes that the length of his students is normally distributed with a standard deviation of $\sigma = 10$ cm.
The significance level of this test procedure is $\alpha = 0.05$.

2pt c State the null hypothesis and the alternative hypothesis for this test procedure.

6pt d What is the conclusion of this test procedure if the average length of these 25 students is 180.5 cm ?



A normal probability distribution X
The area of the shaded region represents $P\left(\mu - 1\frac{1}{2}\sigma < X < \mu - \sigma\right) = 0.092$

Question 4 – Club night

Take a new answer sheet for every question!

During a student club night, a few gambling games can be played.
One of these games involves rolling five special dice. Each die has three different images: a heart, a club, and a diamond, evenly distributed across the die (two sides with a heart, two sides with a club, and two sides with a diamond).

A participant is allowed one roll of these five dice.

A Yahtzee is rolled if the same symbol appears five times on a single roll. The probability of this is approximately 0.01.

3pt a Compute the probability of a Yahtzee rounded to four digits behind the decimal dot.

A Full House is thrown if, within a single roll, two different suits are thrown, with 3 of the first suit and 2 of the second suit. For example: 3 diamonds and 2 clubs, or 3 clubs and 2 diamonds.

Let's first consider the following option: 3 hearts and 2 clubs.
The probability of this outcome is $\frac{10}{243}$.

4pt b Show this.

The probability of a Full House is approximately 0.25.

3pt c Compute the probability of a Full House rounded to four digits behind the decimal dot.

The student club pays out the following amounts per roll:
for Yahtzee – €10, for Full House – €2, and for other outcomes – €0.

3pt d Compute the expected payout per roll.

Question 5 – The Ferris wheel on the Scheveningen pier

Take a new answer sheet for every question!

Scheveningen used to be a fishing village on the coast near The Hague, but nowadays it is a thriving seaside resort with a famous pier. Recently, a Ferris wheel was constructed on this pier.
Passengers enter the cabins at their lowest point, which is at 10 meters above sea level. The highest point of a cabin is at 60 meters above sea level.

When all passengers have entered the cabins, the Ferris wheel makes two complete turns at a constant speed. The height of one of the cabins is then given by a formula of the form

$$H = a + b\sin(ct)$$

In this formula, H is the height of this cabin in meters and t is the time in minutes.

On a quiet day, the Ferris wheel turns with a moderate speed at which it takes 5 minutes to complete the two turns.

2pt a Compute algebraically the height of this cabin at $t = 0$.

3pt b Compute algebraically values of a, b and c in the formula that match the description given above.

On a busy day, the Ferris wheel turns at a higher speed. The height of another cabin is then given by the formula

$$H = a + b\sin\left(\pi\left(t - \tfrac{1}{3}\right)\right)$$

In this formula, H is again the height of this cabin in meters and t is again the time in minutes. The values of a and b are the same as before, so you do not have to compute these again.

5pt c Compute algebraically the times in the two complete turns at which this cabin is at its highest point.

Question 6 – The population of a new town

Take a new answer sheet for every question!

To accommodate the need for more housing of a city, a nearby rural area is developed into a new town. At the official start of the project, on 1 January 2022, this area had 1000 inhabitants. Three years later, on 1 January 2025, this area had 10 000 inhabitants. In this period, the number of inhabitants of this area grew exponentially.

5pt a Compute algebraically the number of inhabitants of this area on both 1 January 2023 and 1 January 2024.

The growth of the population of this new town after 1 January 2025 is modelled by the formula

$$N = \frac{250\,000}{4 + 21 \cdot \mathrm{e}^{-t}}$$

In this formula, N is the number of inhabitants of this new town and *t* is the time in years with $t = 0$ on 1 January 2025.

6pt b Compute algebraically the time (year and month) at which this new town will have 60 000 inhabitants according to the given formula.

According to the given formula, he number of inhabitants will eventually approach a certain maximum value.

2pt c Compute this maximum value algebraically.

End of the exam.

*When you have finished the exam, check whether your **name** and the **question number** are on every answer sheet.*

Place the answer sheets in the correct order in the plastic folder and place the sheet with your data in the front in this folder.

*What should **not** be in the folder:*
- empty sheets, please leave them on your table;
- sheets with only your name on it, please take them with you;
- scrap paper;
- these questions.

This is the only way we can ensure a smooth correction of your exam work.

Remain seated until one of the invigilators collects your folder (or calls you).

Formula list 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

More formulas on the next page.

Formula list wiskunde A (continued)

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 $\overline{X}$.

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

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

Binomial Distribution

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

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

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	$g = \mu_T - 2.33\sigma_T$	$g = \mu_T + 2.33\sigma_T$	$g_l = \mu_T - 2.58\sigma_T$ $g_r = \mu_T + 2.58\sigma_T$

