

Formula Sheet Explained

An annotated study companion to the VCAA General Mathematics formula sheet

What this guide adds

✓ Clear meaning of every formula	✓ Definitions for every variable
✓ When to use each formula	✓ Interpretation and exam traps
✓ Short worked examples	✓ Formula-sheet navigation by topic

HOW TO USE THIS PDF

Use the official formula sheet during practice, then use this annotated version whenever you need to understand what a formula means, which quantities go into it, and what a result tells you. The aim is not just to memorise formulas, but to recognise the question type quickly.

IMPORTANT

This is an independent KIS Academics study resource based on the VCAA VCE General Mathematics formula sheet. It is not an official VCAA publication and should not replace the official formula sheet or current VCAA examination instructions.

Topics covered

Data analysis — 5 formulas

Recursion and financial modelling — 2 formulas

Matrices — 4 formulas

Networks and decision mathematics — 1 formula

How to read the formula sheet

The official sheet is compact by design. Most exam errors happen not because the formula is unavailable, but because the wrong quantities are substituted, the result is misinterpreted, or the formula is used outside its conditions. For each formula below, focus on four questions:

1	What type of problem is this formula for?
2	What does each symbol represent in this question?
3	What does the calculated result mean in context?
4	What common mistake could change the answer?

Quick notation reminders

$\bar{x}$ or $\bar{y}$	A bar over a variable means the mean (average).
s_x or s_y	Standard deviation; a measure of spread.
Q1 and Q3	Lower and upper quartiles.
IQR	Interquartile range: $Q3 - Q1$.
$\hat{y}$	A predicted value of y from a model.
u_n, S_n	A value or state at time/step n .
A^{-1}	The inverse of matrix A .
$\det(A)$	The determinant of matrix A .

Data analysis

Annotated formulas from this section of the VCE General Mathematics formula sheet.

1. Standardised score (z-score)

Measures how far a value lies from the mean, expressed in standard deviations. It is useful because it puts values from different distributions onto the same scale.

$$z = (x - \bar{x}) / s_x$$

VARIABLES

z	standardised score (z-score)
x	the individual observation or data value
$\bar{x}$	mean of the data set
s_x	standard deviation of the x-values

WHEN TO USE IT

Use it to compare the relative position of observations, particularly when the values come from data sets with different means or spreads.

HOW TO INTERPRET IT

$z = 0$ means the value equals the mean. $z = 1.5$ means the value is 1.5 standard deviations above the mean. Negative z-values are below the mean.

EXAM TRAP

Do not compare raw scores from different distributions when the question is asking which result is relatively better. Standardise first.

MINI EXAMPLE

A score of 82 in a class with mean 70 and standard deviation 8 gives $z = (82 - 70)/8 = 1.5$, so the score is 1.5 standard deviations above the mean.

Data analysis

2. Lower and upper fences for a boxplot

Creates statistical boundaries used to flag potential outliers. The fences extend 1.5 interquartile ranges below Q1 and above Q3.

$$\begin{aligned}\text{Lower fence} &= Q1 - 1.5 \times IQR \\ \text{Upper fence} &= Q3 + 1.5 \times IQR\end{aligned}$$

VARIABLES

Q1	first (lower) quartile; 25% of observations lie at or below this value
Q3	third (upper) quartile; 75% of observations lie at or below this value
IQR	interquartile range = $Q3 - Q1$; spread of the middle 50% of the data

WHEN TO USE IT

Use it when a boxplot question asks you to identify, test or justify potential outliers.

HOW TO INTERPRET IT

Any observation below the lower fence or above the upper fence is treated as a potential outlier under the $1.5 \times IQR$ rule.

EXAM TRAP

Do not use the minimum and maximum to calculate IQR. Also remember that a value exactly on a fence is not beyond the fence.

MINI EXAMPLE

If $Q1 = 12$ and $Q3 = 20$, then $IQR = 8$. The fences are $12 - 12 = 0$ and $20 + 12 = 32$. Values below 0 or above 32 are potential outliers.

Data analysis

3. Least-squares line of best fit

Defines the regression line used to model a linear association between an explanatory variable x and a response variable y .

$$\hat{y} = a + bx, \quad \text{where} \quad b = r(s_y/s_x) \quad \text{and} \quad a = \bar{y} - b\bar{x}$$

VARIABLES

$\hat{y}$	predicted value of the response variable y
x	value of the explanatory variable
a	y -intercept of the regression line
b	slope/gradient of the regression line
r	Pearson correlation coefficient
s_x, s_y	standard deviations of x and y
$\bar{x}, \bar{y}$	means of x and y

WHEN TO USE IT

Use the regression equation to predict y from a known x , or to interpret the strength/direction and practical meaning of a linear relationship.

HOW TO INTERPRET IT

The slope b is the predicted change in y for each one-unit increase in x . The intercept a is the predicted y -value when $x = 0$, although that interpretation may not always be meaningful.

EXAM TRAP

Identify x and y correctly: x is explanatory and y is response. Avoid extrapolating far outside the observed x -range unless the question explicitly asks you to discuss it.

MINI EXAMPLE

For $\hat{y} = 12 + 3.4x$, increasing x by 1 is associated with a predicted increase of 3.4 in y .

Data analysis

4. Residual value

Measures the prediction error for a data point by comparing the observed value with the value predicted by the regression model.

$$\text{Residual} = \text{actual value} - \text{predicted value}$$

VARIABLES

Actual value	observed response from the data
Predicted value	response estimated by the regression model
Residual	vertical difference between the observed point and the fitted line

WHEN TO USE IT

Use it to measure how well the regression line predicts an individual observation and when interpreting residual plots.

HOW TO INTERPRET IT

A positive residual means the actual value is above the prediction; a negative residual means it is below the prediction. A residual near 0 indicates a close prediction.

EXAM TRAP

The order matters: actual – predicted, not predicted – actual.

MINI EXAMPLE

If the actual value is 48 and the regression predicts 44.5, the residual is $48 - 44.5 = +3.5$.

Data analysis

5. Seasonal index

Measures the seasonal effect in a time series relative to its deseasonalised or trend value.

$$\text{Seasonal index} = \frac{\text{actual figure}}{\text{deseasonalised figure}}$$

VARIABLES

Actual figure observed time-series value including seasonal effects

Deseasonalised figure value after the seasonal effect has been removed; often a trend estimate

Seasonal index multiplicative factor representing the seasonal effect

WHEN TO USE IT

Use it when analysing seasonality, deseasonalising data, or reseasonalising forecasts.

HOW TO INTERPRET IT

An index of 1 means no seasonal effect. 1.20 means the period is typically 20% above the deseasonalised level; 0.80 means 20% below.

EXAM TRAP

A seasonal index is a multiplier, not automatically a percentage. To express the effect as a percentage, compare it with 1.

MINI EXAMPLE

If sales are 132 and the deseasonalised value is 120, the seasonal index is $132/120 = 1.10$, meaning about 10% above trend.

Recursion and financial modelling

Annotated formulas from this section of the VCE General Mathematics formula sheet.

6. First-order linear recurrence relation

Models a quantity that changes in repeated time steps through multiplication by a constant factor and then addition of a constant amount.

$$u_0 = a, \quad u_{n+1} = Ru_n + d$$

VARIABLES

u_0	initial value at time 0
u_n	value after n periods
u_{n+1}	value one period after u_n
R	multiplicative factor applied each period
d	constant amount added or subtracted each period
a	initial value

WHEN TO USE IT

Use it for repeated growth/decay processes, investments, loans, depreciation and other situations where the same rule is applied each period.

HOW TO INTERPRET IT

R controls proportional change. For example, 3% growth gives $R = 1.03$ and 3% depreciation gives $R = 0.97$. The d term represents a fixed deposit, withdrawal, payment or adjustment.

EXAM TRAP

Convert percentages to multipliers correctly and apply the operations in the stated order. Also distinguish u_0 from u_1 .

MINI EXAMPLE

A \$10,000 balance earning 4% per year with a \$500 deposit at year-end can be modelled by $u_0 = 10000$ and $u_{n+1} = 1.04u_n + 500$.

Recursion and financial modelling

7. Effective annual interest rate

Converts a nominal annual interest rate with multiple compounding periods into the equivalent percentage growth over one full year.

$$r_{\text{effective}} = [(1 + r/(100n))^n - 1] \times 100\%$$

VARIABLES

$r_{\text{effective}}$	effective annual interest rate, as a percentage
r	nominal annual interest rate, as a percentage
n	number of compounding periods per year

WHEN TO USE IT

Use it to compare loans or investments quoted with different compounding frequencies on an equivalent annual basis.

HOW TO INTERPRET IT

More frequent compounding usually makes the effective annual rate slightly larger than the nominal rate when interest is positive.

EXAM TRAP

Use $n = 12$ for monthly, 4 for quarterly, 2 for half-yearly and 1 for annual compounding. Keep r as a percentage in this version of the formula.

MINI EXAMPLE

For a nominal rate of 6% compounded monthly: $[(1 + 6/(100 \times 12))^{12} - 1] \times 100\% \approx 6.17\%$.

Matrices

Annotated formulas from this section of the VCE General Mathematics formula sheet.

8. Determinant of a 2×2 matrix

Calculates a single number associated with a square matrix. For VCE General Mathematics, it is especially important for deciding whether a 2×2 matrix has an inverse.

$$\text{If } A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}, \quad \det(A) = ad - bc$$

VARIABLES

A the 2×2 matrix

a, b, c, d entries of the matrix

$\det(A)$ determinant of A

WHEN TO USE IT

Use it when finding a determinant, checking whether an inverse exists, or as the first step in the 2×2 inverse formula.

HOW TO INTERPRET IT

If $\det(A) \neq 0$, the matrix is invertible. If $\det(A) = 0$, the matrix has no inverse.

EXAM TRAP

The subtraction order is $ad - bc$. A zero determinant means the inverse formula cannot be used.

MINI EXAMPLE

For $A = \begin{bmatrix} 2 & 3 \\ 1 & 4 \end{bmatrix}$, $\det(A) = (2 \times 4) - (3 \times 1) = 5$, so A has an inverse.

Matrices

9. Inverse of a 2×2 matrix

Produces the matrix that reverses the effect of A. It can be used to solve matrix equations when A is invertible.

$$\mathbf{A}^{-1} = \frac{1}{\det(\mathbf{A})} \times \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}, \quad \text{where } \det(\mathbf{A}) \neq 0$$

VARIABLES

A original 2×2 matrix

$\mathbf{A}^{-1}$ inverse matrix

a, b, c, d entries of A

$\det(\mathbf{A})$ determinant $ad - bc$

WHEN TO USE IT

Use it to find the inverse of a 2×2 matrix or to solve equations such as $\mathbf{AX} = \mathbf{B}$ by writing $\mathbf{X} = \mathbf{A}^{-1}\mathbf{B}$.

HOW TO INTERPRET IT

Multiplying a matrix by its inverse gives the identity matrix: $\mathbf{AA}^{-1} = \mathbf{I}$.

EXAM TRAP

Swap a and d, change the signs of b and c, then multiply the entire matrix by $1/\det(\mathbf{A})$. Matrix multiplication order also matters.

MINI EXAMPLE

If $\det(\mathbf{A}) = 5$ for $\mathbf{A} = \begin{bmatrix} 2 & 3 \\ 1 & 4 \end{bmatrix}$, then $\mathbf{A}^{-1} = (1/5)\begin{bmatrix} 4 & -3 \\ -1 & 2 \end{bmatrix}$.

Matrices

10. Matrix recurrence relation

Models a system whose state changes repeatedly according to the same matrix transformation, with an optional constant input each period.

$$S_0 = \text{initial state}, \quad S_{n+1} = TS_n + B$$

VARIABLES

S_n	state vector at time n
S_{n+1}	state vector one period later
T	transition matrix describing movement between states
B	constant vector added each period
S_0	initial state vector

WHEN TO USE IT

Use it when quantities repeatedly move between categories, locations or states, possibly with a fixed addition or removal each period.

HOW TO INTERPRET IT

T determines how the current state is redistributed into the next state. B represents an external addition such as new entrants, extra stock or a fixed inflow.

EXAM TRAP

Matrix dimensions must be compatible and multiplication order cannot be reversed. Keep the state categories in the same order throughout.

MINI EXAMPLE

If the state vector records customers in two plans, multiplying by T gives the expected distribution next period; adding B can represent new customers.

Matrices

11. Leslie matrix recurrence relation

A specialised matrix recurrence used to model age-structured populations using fertility and survival rates.

$$S_0 = \text{initial state}, \quad S_{n+1} = LS_n$$

VARIABLES

S_n	population vector at time n , grouped by age class
S_{n+1}	population vector in the next period
L	Leslie matrix
Top row of L	fertility rates for age groups
Subdiagonal of L	survival proportions from one age group to the next

WHEN TO USE IT

Use it for population models divided into age groups where births and survival determine the next population distribution.

HOW TO INTERPRET IT

The first row produces new births. The subdiagonal entries move surviving individuals into the next age class.

EXAM TRAP

Keep age groups in exactly the same order in the vector and matrix. Fertility and survival rates belong in specific positions in a Leslie matrix.

MINI EXAMPLE

For three age classes, the top row contains fertility rates, while entries directly below the main diagonal contain survival from class 1→2 and 2→3.

Networks and decision mathematics

Annotated formulas from this section of the VCE General Mathematics formula sheet.

12. Euler's formula for connected planar graphs

Relates the numbers of vertices, edges and faces in a connected planar graph.

$$v + f = e + 2$$

VARIABLES

v	number of vertices (nodes)
e	number of edges
f	number of faces/regions in the planar drawing, including the outside region

WHEN TO USE IT

Use it to find a missing number of vertices, edges or faces in a connected planar graph.

HOW TO INTERPRET IT

Once two of v, e and f are known, rearrange the equation to find the third.

EXAM TRAP

The unbounded outside region counts as one face. Euler's formula in this form assumes the graph is connected and planar.

MINI EXAMPLE

If a connected planar graph has 8 vertices and 12 edges, $f = e + 2 - v = 12 + 2 - 8 = 6$ faces.