MA99 EDUCATION

Focus area 2 Linear relationships: Summary

02

NSW MATHEMATICS STANDARD 11-12 SYLLABUS 2024 FOR HSC 2028 AND LATER

Linear relationships, in brief

The formulas

Result	Formula	Notes
Gradient from two points	$m = \dfrac{y_2 - y_1}{x_2 - x_1}$	Rise over run. Same point first on top and bottom
Equation of a straight line	$y = mx + c$	m gradient, c y-intercept
y-intercept	the value of y at $x = 0$	Read where the line crosses the y-axis
x-intercept	solve $mx + c = 0$	Where the quantity reaches zero
Direct variation	$y = kx$	Straight line through the origin, gradient k
Constant of variation	$k = \dfrac{y}{x}$	From any one pair of values with $x \neq 0$

None of these is on the HSC reference sheet. Learn them.

What the numbers mean in a model

In the model	It means	Write it as
c, the y-intercept	The starting value, when the input is zero	a $90 call-out fee; 4500 L at the start
m, the gradient	The rate of change	$80 **per** hour; decreases by 150 L **per** minute
$m > 0$ or $m < 0$	Increasing or decreasing	Put the sign into words: gains, loses
k in $y = kx$	The amount per one unit, with nothing fixed	$0.024 per gram; 0.62 euros per dollar
x-intercept	When the quantity runs out	the tank is empty after 30 minutes

The methods, as recipes

Task	Recipe
Equation from a graph	Read c at the y-axis. Pick two grid points, rise ÷ run for m. Check the sign by eye. Write $y = mx + c$.
Equation from two points	Gradient formula. Substitute one point into $y = mx + c$ to find c. Check with the other point.
m and c from an equation	Make y the subject, dividing **every** term. Read the coefficient of x and the constant, with signs.
Drawing by hand	Table of three or more values, or plot $(0, c)$ and step across 1, up m. Rule the line over the full range; label both axes.
Drawing with an application	Type it in x and y, restrict the domain, set the window to show the intercept, read points exactly.

Task	Recipe
Model from a description	Starting amount is c; rate is m, negative if decreasing. Two data points: use the gradient formula first.
Predicting	Substitute for y; or set the model equal to the value and solve for x. Then say interpolation (inside the data's range) or extrapolation (outside it).
Limitations	Name the domain; say what makes a value impossible; say why the rate may not stay constant.
Spreadsheet model	Parameters in their own cells; one formula with absolute references, such as =$B$1+$B$2*A5, filled down; a constant change column confirms linearity.
Direct variation	Check it is zero at zero. $k = y \div x$ from one pair. Write $y = kx$, then multiply forwards or divide backwards.

Linear, direct variation, or neither

Clue	Linear	Direct variation
Form	$y = mx + c$	$y = kx$
Graph	Straight line, any intercept	Straight line through $(0, 0)$
Table	Constant change for equal steps	Constant change **and** constant ratio $y \div x$
Words	A fixed charge plus a rate	A rate only: varies directly, proportional to
Doubling x	Does not double y (unless $c = 0$)	Doubles y

Common errors

1. Reading m before y is the subject: in $2y = 6x + 10$, $m = 3$, not 6.
2. Dropping the sign of the gradient: a line falling to the right has $m < 0$.
3. Counting grid squares instead of axis units when the scales differ.
4. Interpreting a gradient without units or without the word per.
5. Calling every prediction reliable. Say inside or outside the data, and name the range.
6. Reporting an impossible value (a negative volume, a 260 cm adult) without saying the model does not apply there.
7. Using $y = kx$ when there is a fixed charge.
8. Mixing units in direct variation: a formula built in grams needs grams.
9. Spreadsheet references that move when filled down: write $B$1, not B1.
10. Rounding a count the wrong way: with $50 and 22.5 cents each, you can afford 222, not 223.

Checklist

Ten minutes, no notes. Tick each one you get right. Answers below.

- ☐ **1.** Find the equation of the line with x-intercept -5 and y-intercept 3.
- ☐ **2.** State the gradient and y-intercept of $6x + 3y = 9$.
- ☐ **3.** An 8000 L tank drains at 25 L per minute. Write a model for the volume and find when it is empty.
- ☐ **4.** In $C = 35 + 4.5d$, interpret 35 and 4.5 if C is a monthly phone bill in dollars and d the gigabytes of extra data.
- ☐ **5.** Heights were measured from $t = 0$ to $t = 6$ hours. Is a prediction at $t = 1$ an interpolation or an extrapolation?
- ☐ **6.** y varies directly with x, and $y = 15$ when $x = 6$. Find k, then x when $y = 40$.
- ☐ **7.** Write a fill down formula for B5 for $C = 60 + 12n$, with 60 in B1, 12 in B2 and n in A5.
- ☐ **8.** Give one reason a linear model of a child's height fails for adults.

Answers. 1. $y = \frac{3}{5}x + 3$. 2. $m = -2$, $c = 3$. 3. $V = 8000 - 25t$, empty after 320 minutes. 4. A \$35 monthly charge; \$4.50 per extra gigabyte. 5. Interpolation. 6. $k = 2.5$, $x = 16$. 7. =\$B\$1+\$B\$2*A5. 8. Growth slows and stops, so the rate of change is not constant.

> Score 7 or 8: go to the Exam-style practice questions. Fewer: reread the sections of the notes your misses point to, then try again in two days.

Written to the NSW Mathematics Standard 11-12 Syllabus (2024), the syllabus Year 11 has studied since 2026, first examined in the 2027 HSC. Students in Year 11 in 2027 sit the HSC in 2028.

About this resource

MA99 EDUCATION

Scope

NSW Mathematics Standard, Year 11. Written to the NSW Mathematics Standard 11-12 Syllabus (2024), focus area 2, Linear relationships (MST-11-02), for students sitting the HSC in 2028 and later years. Every value, identity and solution was re-derived independently by computer algebra before printing. Contexts in the questions are invented unless a source is named.

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