

# Linear Relations Review

Try each problem first. You don't need to finish everything.

Core path ~55 min · Full sheet ~1 h 50 min

**Recommended:** K1-K5, then one A and one T problem

K = Knowledge & Understanding · A = Application · T = Thinking · Boss = Challenge



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## QUICK REFERENCE

**Slope:**  $m = \frac{\text{rise}}{\text{run}} = \frac{y_2 - y_1}{x_2 - x_1}$ , with  $y$  on top. A horizontal line has  $m = 0$ ; a vertical line has an undefined slope.

$y = mx + b$ : isolate  $y$  first.  $m$  multiplies  $x$ ;  $b$  is the  $y$ -intercept (the value of  $y$  when  $x = 0$ ). Direct variation has  $b = 0$ .

**Inequalities:** dashed line for  $<$  or  $>$ , solid for  $\leq$  or  $\geq$ ; test a point to choose the side. Dividing by a negative flips the sign.

Show your work on separate paper.

## Core Skills (K)

First Differences · Slope ·  $y = mx + b$  · Equations of Lines · Parallel & Perpendicular

### K1 Linear or Not?

For each table, use first differences to decide whether the relation is linear. If it is linear, state whether it is a direct or a partial variation and write its equation.

a) Table (a)

|     |    |    |   |    |    |
|-----|----|----|---|----|----|
| $x$ | -2 | -1 | 0 | 1  | 2  |
| $y$ | 7  | 4  | 1 | -2 | -5 |

b) Table (b)

|     |   |   |   |    |    |
|-----|---|---|---|----|----|
| $x$ | 0 | 1 | 2 | 3  | 4  |
| $y$ | 1 | 2 | 5 | 10 | 17 |

c) Table (c)

|     |   |   |    |    |
|-----|---|---|----|----|
| $x$ | 0 | 3 | 6  | 9  |
| $y$ | 0 | 6 | 12 | 18 |

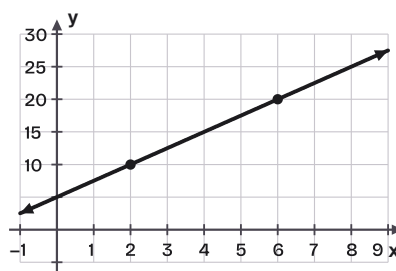
### K2 Find the Slope

- Find the slope of the line through  $(-3, 4)$  and  $(5, -2)$ .
- Find the slope of the line through  $(-2, 6)$  and  $(4, 6)$ , and of the line through  $(3, -1)$  and  $(3, 5)$ .

**Linear test:** first differences are constant when the  $x$ -values go up by the **same step**. Rate of change =  $\frac{\Delta y}{\Delta x}$ , not  $\Delta y$  alone.

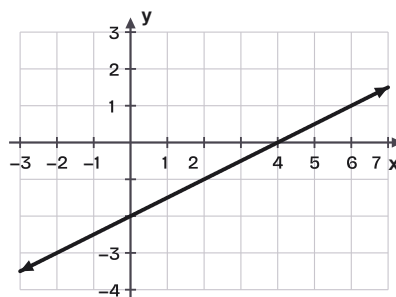
**Parallel:** equal slopes. **Perpendicular:** slopes multiply to  $-1$ , so flip and change the sign:  $4 \rightarrow -\frac{1}{4}$ .

- Find the slope of the line graphed below. Read both axis scales.



### K3 Slope and y-Intercept

- State the slope and  $y$ -intercept of  $y = 7 - 3x$ .
- State the slope and  $y$ -intercept of  $2y = x - 8$ .
- Write the equation of the line graphed below in the form  $y = mx + b$ . Each grid square is 1 unit.



### K4 Equation of a Line

- Determine the equation of the line with slope  $-3$  that passes through  $(3, -4)$ .
- Determine the equation of the line through  $(-2, 7)$  and  $(4, -2)$ .
- Write  $3x - 4y = 12$  in the form  $y = mx + b$ . Then state its slope and  $y$ -intercept.

**K5 Parallel & Perpendicular**

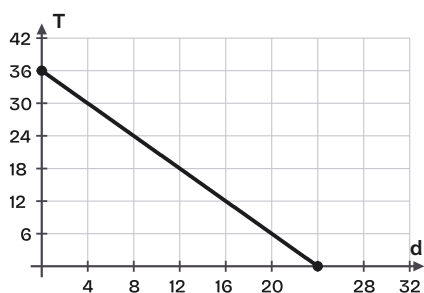
- a) State the slope of a line parallel to  $y = -\frac{2}{5}x + 1$ , and of a line perpendicular to it.
- b) Determine the equation of the line perpendicular to  $y = 4x - 3$  that passes through  $(8, 1)$ .
- c) Determine the equations of the lines through  $(-3, 2)$  that are parallel to and perpendicular to  $y = 5$ .

**Real World (A)**

Rate of Change · Linear Models · Inequalities in Context

**A1 Spring Ice**

In spring, the ice on a lake in Muskoka thins at a steady rate. The graph shows the ice thickness  $T$ , in centimetres,  $d$  days after March 15.



- a) Find the rate of change of the ice thickness. Include units, and say what the sign means.
- b) Write an equation for  $T$  in terms of  $d$ . How many days after March 15 is the ice 15 cm thick?
- c) The equation gives  $T = -9$  when  $d = 30$ . What does this tell you about the ice on that day?

**A2 Parcel Pricing**

A Winnipeg courier charges by mass. The table shows the cost  $C$ , in dollars, to ship a parcel of mass  $m$ , in kilograms.

|          |    |    |    |    |
|----------|----|----|----|----|
| $m$ (kg) | 2  | 4  | 7  | 10 |
| $C$ (\$) | 13 | 17 | 23 | 29 |

- a) Show that the relation is linear, and write an equation for  $C$  in terms of  $m$ .
- b) What do the 2 and the 9 in your equation mean? Find the cost to ship a 15 kg parcel.
- c) The courier does not ship parcels over 30 kg. A customer has \$75 for one parcel. What is the heaviest parcel they can ship?

**A3 Trip Fundraiser**

A Grade 9 class in Thunder Bay sells pizza slices for \$3 each and drinks for \$2 each. They need to raise at least \$600 for a trip. Let  $p$  be the number of slices and  $d$  the number of drinks sold.

- a) Write an inequality for the class's goal. Is its boundary line drawn solid or dashed?
- b) Do 150 slices and 70 drinks reach the goal? Do 120 slices and 120 drinks?
- c) The point  $(220, -30)$  satisfies your inequality. Does it describe a possible result? State the extra conditions  $p$  and  $d$  must meet.

**Think It Through (T)**

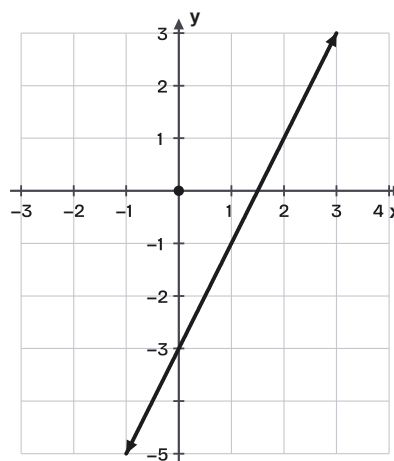
Error Analysis · Building a Rectangle

**T1 Spot the Flaw**

A student graphs  $4x - 2y > 6$ :

" $-2y > -4x + 6$ , so  $y > 2x - 3$ . I draw a solid line through  $(0, -3)$  with slope 2 and shade above it."

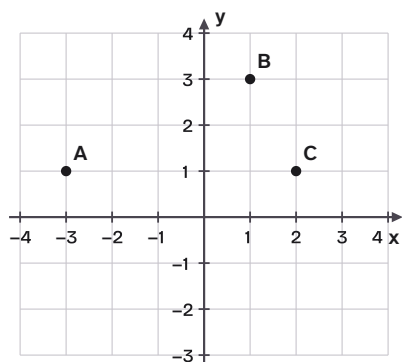
The student's boundary line is shown. Each grid square is 1 unit.



- a) Test the point  $(0, 0)$  in the original inequality. Is it a solution? Is it in the student's shaded region?
- b) Identify the student's two errors. Give the correct inequality in the form  $y \dots$  and describe the correct graph.
- c) Is  $(2, 1)$  a solution of  $4x - 2y > 6$ ? Explain using the graph.

**T2 Build the Rectangle**

Points  $A(-3, 1)$ ,  $B(1, 3)$  and  $C(2, 1)$  are plotted below.  
Each grid square is 1 unit.



- Show that  $\angle ABC$  is a right angle.
- Find point  $D$  so that  $ABCD$  is a rectangle. Then write the equation of line  $CD$ .
- A student claims: "Two lines whose slopes have opposite signs are perpendicular." Give a counterexample using a line through  $B$ .

**Boss Level**

Optional challenge

**Three in a Row**

The points  $A(1, 1)$ ,  $B(3, k)$  and  $C(k, 9)$  lie on one straight line.

- Find all possible values of  $k$ .
- For each value of  $k$ , write the equation of the line in the form  $y = mx + b$ .
- The two lines from (b) and the  $x$ -axis enclose a triangle. Find its area.

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