# GCSE TO A LEVEL MATHS TRANSITION BOOKLET

# FULFORD SCHOOL

*You must have made notes for all "My Turn" questions, and attempted and marked all "Your Turn" questions by your first A Level Maths lesson in September*

NAME:

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# Simplifying surds

## Getting ready for A-Level Maths...

*"The most important investment you can make is in **yourself**."*

# Simplifying surds

## What is a surd?

A **surd** is the answer to a root (square root, cube root etc) which is an **irrational** number (i.e. it is a non-terminating, non-recurring decimal).

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# Simplifying surds

## Important rules

$$\sqrt{a} \times \sqrt{b} = \sqrt{a \times b}$$

$$\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}}$$

## Be careful...

$$\sqrt{a} + \sqrt{b} \neq \sqrt{a + b}$$

$$\sqrt{a} - \sqrt{b} \neq \sqrt{a - b}$$

## Learn by heart...

| | | |
|---|---|---|
| $1^2$ | $= 1 \times 1$ | $= \mathbf{1}$ |
| $2^2$ | $= 2 \times 2$ | $= \mathbf{4}$ |
| $3^2$ | $= 3 \times 3$ | $= \mathbf{9}$ |
| $4^2$ | $= 4 \times 4$ | $= \mathbf{16}$ |
| $5^2$ | $= 5 \times 5$ | $= \mathbf{25}$ |
| $6^2$ | $= 6 \times 6$ | $= \mathbf{36}$ |
| $7^2$ | $= 7 \times 7$ | $= \mathbf{49}$ |
| $8^2$ | $= 8 \times 8$ | $= \mathbf{64}$ |
| $9^2$ | $= 9 \times 9$ | $= \mathbf{81}$ |
| $10^2$ | $= 10 \times 10$ | $= \mathbf{100}$ |
| $11^2$ | $= 11 \times 11$ | $= \mathbf{121}$ |
| $12^2$ | $= 12 \times 12$ | $= \mathbf{144}$ |
| $13^2$ | $= 13 \times 13$ | $= \mathbf{169}$ |
| $14^2$ | $= 14 \times 14$ | $= \mathbf{196}$ |
| $15^2$ | $= 15 \times 15$ | $= \mathbf{225}$ |

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# Simplifying surds

## How to simplify a surd

$\sqrt{20}$

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# Simplifying surds

## My turn

Simplify $\sqrt{50}$ by writing it in the form $a\sqrt{b}$ where $b$ is prime. State the values of $a$ and $b$.

$1^2 = 1$
$2^2 = 4$
$3^2 = 9$
$4^2 = 16$
$5^2 = 25$
$6^2 = 36$
$7^2 = 49$
$8^2 = 64$
$9^2 = 81$
$10^2 = 100$
$11^2 = 121$
$12^2 = 144$
$13^2 = 169$
$14^2 = 196$
$15^2 = 225$

## Your turn

Simplify $\sqrt{32}$ by writing it in the form $a\sqrt{b}$ where $b$ is prime. State the values of $a$ and $b$.

# Simplifying surds

## My turn

Simplify $6\sqrt{45}$ by writing it in the form $a\sqrt{b}$ where $b$ is prime. State the values of $a$ and $b$.

| | |
|---|---|
| $1^2$ | = **1** |
| $2^2$ | = **4** |
| $3^2$ | = **9** |
| $4^2$ | = **16** |
| $5^2$ | = **25** |
| $6^2$ | = **36** |
| $7^2$ | = **49** |
| $8^2$ | = **64** |
| $9^2$ | = **81** |
| $10^2$ | = **100** |
| $11^2$ | = **121** |
| $12^2$ | = **144** |
| $13^2$ | = **169** |
| $14^2$ | = **196** |
| $15^2$ | = **225** |

## Your turn

Simplify $7\sqrt{99}$ by writing it in the form $a\sqrt{b}$ where $b$ is prime. State the values of $a$ and $b$.

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# Simplifying surds

## My turn

Simplify $\frac{\sqrt{450}}{3}$ by writing it in the form $a\sqrt{b}$ where $b$ is prime. State the values of $a$ and $b$.

| | |
|---|---|
| $1^2$ | = **1** |
| $2^2$ | = **4** |
| $3^2$ | = **9** |
| $4^2$ | = **16** |
| $5^2$ | = **25** |
| $6^2$ | = **36** |
| $7^2$ | = **49** |
| $8^2$ | = **64** |
| $9^2$ | = **81** |
| $10^2$ | = **100** |
| $11^2$ | = **121** |
| $12^2$ | = **144** |
| $13^2$ | = **169** |
| $14^2$ | = **196** |
| $15^2$ | = **225** |

## Your turn

Simplify $\frac{\sqrt{288}}{4}$ by writing it in the form $a\sqrt{b}$ where $b$ is prime. State the values of $a$ and $b$.

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# Simplifying surds

## My turn

Show that $\sqrt{27}+\sqrt{192}= a\sqrt{b}$. State the values of $a$ and $b$.

## Your turn

Show that $\sqrt{28}+\sqrt{63}= a\sqrt{b}$. State the values of $a$ and $b$.

| | |
|---|---|
| $1^2$ | = **1** |
| $2^2$ | = **4** |
| $3^2$ | = **9** |
| $4^2$ | = **16** |
| $5^2$ | = **25** |
| $6^2$ | = **36** |
| $7^2$ | = **49** |
| $8^2$ | = **64** |
| $9^2$ | = **81** |
| $10^2$ | = **100** |
| $11^2$ | = **121** |
| $12^2$ | = **144** |
| $13^2$ | = **169** |
| $14^2$ | = **196** |
| $15^2$ | = **225** |

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# Simplifying surds

## Review Exercise

**1.** Write down the first 15 square numbers from memory.

**2.** Simplify $\sqrt{72}$ by writing it in the form $a\sqrt{b}$ where $b$ is prime.
State the values of $a$ and $b$.

**3.** Simplify $5\sqrt{63}$ by writing it in the form $a\sqrt{b}$ where $b$ is prime.
State the values of $a$ and $b$.

**4.** Simplify $\frac{\sqrt{392}}{2}$ by writing it in the form $a\sqrt{b}$ where $b$ is prime.
State the values of $a$ and $b$.

**5.** Show that $\sqrt{32}+\sqrt{128}= a\sqrt{b}$. State the values of $a$ and $b$.

# Simplifying surds

## Review Exercise (Answers)

**1.** Write down the first 15 square numbers from memory
1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, 169, 196, 225

**2.** Simplify $\sqrt{72}$ by writing it in the form $a\sqrt{b}$ where $b$ is prime.
State the values of $a$ and $b$. $6\sqrt{2}$

**3.** Simplify $5\sqrt{63}$ by writing it in the form $a\sqrt{b}$ where $b$ is prime.
State the values of $a$ and $b$. $15\sqrt{7}$

**4.** Simplify $\frac{\sqrt{392}}{2}$ by writing it in the form $a\sqrt{b}$ where $b$ is prime.
State the values of $a$ and $b$. $7\sqrt{2}$

**5.** Show that $\sqrt{32}+\sqrt{128}= a\sqrt{b}$ where $b$ is prime.

State the values of $a$ and $b$. $12\sqrt{2}$

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# Expanding brackets with surds

## Getting ready for A-Level Maths...

*"The most important investment you can make is in **yourself**."*

# Expanding brackets with surds

## Important rules

$$\sqrt{a} \times \sqrt{b} = \sqrt{a \times b}$$

$$\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}}$$

## Be careful...

$$\sqrt{a} + \sqrt{b} \neq \sqrt{a + b}$$

$$\sqrt{a} - \sqrt{b} \neq \sqrt{a - b}$$

## Learn by heart...

| | | |
|---|---|---|
| $1^2$ | $= 1 \times 1$ | $= \mathbf{1}$ |
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| $3^2$ | $= 3 \times 3$ | $= \mathbf{9}$ |
| $4^2$ | $= 4 \times 4$ | $= \mathbf{16}$ |
| $5^2$ | $= 5 \times 5$ | $= \mathbf{25}$ |
| $6^2$ | $= 6 \times 6$ | $= \mathbf{36}$ |
| $7^2$ | $= 7 \times 7$ | $= \mathbf{49}$ |
| $8^2$ | $= 8 \times 8$ | $= \mathbf{64}$ |
| $9^2$ | $= 9 \times 9$ | $= \mathbf{81}$ |
| $10^2$ | $= 10 \times 10$ | $= \mathbf{100}$ |
| $11^2$ | $= 11 \times 11$ | $= \mathbf{121}$ |
| $12^2$ | $= 12 \times 12$ | $= \mathbf{144}$ |
| $13^2$ | $= 13 \times 13$ | $= \mathbf{169}$ |
| $14^2$ | $= 14 \times 14$ | $= \mathbf{196}$ |
| $15^2$ | $= 15 \times 15$ | $= \mathbf{225}$ |

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# Expanding brackets with surds

## Question

$$\sqrt{a} \times \sqrt{b} = \sqrt{a \times b}$$

What's the answer

$$\sqrt{2} \times \sqrt{2} =$$

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# Expanding brackets with surds

## Question

$$\sqrt{a} \times \sqrt{b} = \sqrt{a \times b}$$

What's the answer

$$\sqrt{7} \times \sqrt{7} =$$

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# Expanding brackets with surds

## Question

$\sqrt{a} \times \sqrt{b} = \sqrt{a \times b}$

What's the answer

$$\sqrt{919} \times \sqrt{919} =$$

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# Expanding brackets with surds

## Expanding brackets

Expand and simplify

$2(x + 4)$

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# Expanding brackets with surds

## Expanding brackets

Expand and simplify

$$(x + 2)(x + 4)$$

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# Expanding brackets with surds

## My turn

Evaluate without a calculator

$\sqrt{2}(\sqrt{8} + \sqrt{50})$

## Your turn

Evaluate without a calculator

$\sqrt{3}(\sqrt{12} + \sqrt{27})$

# Expanding brackets with surds

## My turn

Express in the form $a + b\sqrt{3}$

$$(4 + \sqrt{3})(1 + 2\sqrt{3})$$

State the values of $a$ and $b$.

## Your turn

Express in the form $a + b\sqrt{5}$

$$(2 + \sqrt{5})(3 + 4\sqrt{5})$$

State the values of $a$ and $b$.

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# Expanding brackets with surds

## My turn

Express in the form $a + b\sqrt{3}$

$$(5 + 3\sqrt{3})^2$$

State the values of $a$ and $b$.

## Your turn

Express in the form $a + b\sqrt{5}$

$$(7 + 2\sqrt{5})^2$$

State the values of $a$ and $b$.

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# Expanding brackets with surds

## My turn

Express in the form $a + b\sqrt{3}$

$$(2\sqrt{3} - 1)^2$$

State the values of $a$ and $b$.

## Your turn

Express in the form $a + b\sqrt{5}$

$$(3\sqrt{5} - 2)^2$$

State the values of $a$ and $b$.

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# Expanding brackets with surds

## My turn

Simplify

$(\sqrt{7} - 1)(\sqrt{7} + 1)$

## Your turn

Simplify

$(\sqrt{11} - 2)(\sqrt{11} + 2)$

# Expanding brackets with surds

## Difference of two squares

$$(a + b)(a - b) = a^2 - b^2$$

$$(a - b)(a + b) = a^2 - b^2$$

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# Expanding brackets with surds

## My turn

Simplify

$$(2 + \sqrt{5})(2 - \sqrt{5})$$

## Your turn

Simplify

$$(8 + \sqrt{7})(8 - \sqrt{7})$$

# Expanding brackets with surds

## My turn

Simplify

$$(6 - 4\sqrt{2})(6 + 4\sqrt{2})$$

## Your turn

Simplify

$$(10 - 3\sqrt{5})(10 + 3\sqrt{5})$$

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# Expanding brackets with surds

## Review Exercise

1. Evaluate without a calculator.
   $\sqrt{5}(\sqrt{20} + \sqrt{45})$

2. Express in the form $a + b\sqrt{2}$.
   $(5 + \sqrt{2})(6 + 3\sqrt{2})$
   State the values of $a$ and $b$.

3. Express in the form $a + b\sqrt{6}$.
   $(4 + 2\sqrt{6})^2$
   State the values of $a$ and $b$.

4. Express in the form $a + b\sqrt{7}$.
   $(2\sqrt{7} - 3)^2$
   State the values of $a$ and $b$.

5. Simplify $(\sqrt{13} - 2)(\sqrt{13} + 2)$

6. Simplify $(7 + \sqrt{6})(7 - \sqrt{6})$

7. Simplify $(9 - 5\sqrt{3})(9 + 5\sqrt{3})$

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# Expanding brackets with surds

## Review Exercise (Answers)

1. Evaluate without a calculator. 25
   $\sqrt{5}(\sqrt{20} + \sqrt{45})$

2. Express in the form $a + b\sqrt{2}$. $36 + 21\sqrt{2}$
   $(5 + \sqrt{2})(6 + 3\sqrt{2})$ $a = 36$
   State the values of $a$ and $b$. $b = 21$

3. Express in the form $a + b\sqrt{6}$. $40 + 16\sqrt{6}$
   $(4 + 2\sqrt{6})^2$ $a = 40$
   State the values of $a$ and $b$. $b = 16$

4. Express in the form $a + b\sqrt{7}$. $37 - 12\sqrt{7}$
   $(2\sqrt{7} - 3)^2$ $a = 37$
   State the values of $a$ and $b$. $b = -12$

5. Simplify $(\sqrt{13} - 2)(\sqrt{13} + 2)$ 9

6. Simplify $(7 + \sqrt{6})(7 - \sqrt{6})$ 43

7. Simplify $(9 - 5\sqrt{3})(9 + 5\sqrt{3})$ 6

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# Rationalising surds (1)

## Getting ready for A-Level Maths...

*"The most important investment you can make is in **yourself**."*

# Rationalising surds (1)

## Making life simpler...

$$\frac{8}{0.1}$$

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# Rationalising surds (1)

## Making life simpler...

$$\frac{8}{\sqrt{2}}$$

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# Rationalising surds (1)

## My turn

Rationalise $\frac{1}{\sqrt{2}}$

## Your turn

Rationalise $\frac{1}{\sqrt{7}}$

# Rationalising surds (1)

## My turn

Rationalise $\frac{4}{\sqrt{2}}$

Give your answer in the form $a\sqrt{b}$ where $b$ is prime and state $a$ and $b$.

## Your turn

Rationalise $\frac{21}{\sqrt{7}}$

Give your answer in the form $a\sqrt{b}$ where $b$ is prime and state $a$ and $b$.

# Rationalising surds (1)

## My turn

Rationalise $\dfrac{15}{2\sqrt{5}}$

Give your answer in the form $a\sqrt{b}$ where $a$ is in simplest form and $b$ is prime. State $a$ and $b$.

## Your turn

Rationalise $\dfrac{14}{5\sqrt{7}}$

Give your answer in the form $a\sqrt{b}$ where $a$ is in simplest form and $b$ is prime. State $a$ and $b$.

# Rationalising surds (1)

## My turn

Simplify the following, giving your answer in the form $a\sqrt{b}$. State $a$ and $b$.

$$\frac{\sqrt{54}}{3} + \frac{12}{\sqrt{6}}$$

## Your turn

Simplify the following, giving your answer in the form $a\sqrt{b}$. State $a$ and $b$.

$$\frac{\sqrt{63}}{3} + \frac{21}{\sqrt{7}}$$

# Rationalising surds (1)

## My turn

A rectangle has an area of 60 $cm^2$ and a width of $\sqrt{12}$ *cm.* Find the length and state your answer in the form $a\sqrt{b}$ where $b$ is prime.

## Your turn

A rectangle has an area of 64 $cm^2$ and a width of $\sqrt{32}$ *cm.* Find the length and state your answer in the form $a\sqrt{b}$ where $b$ is prime.

# Rationalising surds (1)

## Review Exercise

1. Rationalise $\frac{1}{\sqrt{3}}$

2. Rationalise $\frac{35}{\sqrt{5}}$ . Give your answer in the form $a\sqrt{b}$ where $b$ is prime and state $a$ and $b$.

3. Rationalise $\frac{30}{4\sqrt{3}}$ . Give your answer in the form $a\sqrt{b}$ where $a$ is in simplest form and $b$ is prime. State $a$ and $b$.

4. Simplify the following, giving your answer in the form $a\sqrt{b}$ . State $a$ and $b$. $\frac{\sqrt{50}}{5} + \frac{26}{\sqrt{2}}$

5. A rectangle has an area of 80 $cm^2$ and a width of $\sqrt{20}$ $cm$. Find the length and state your answer in the form $a\sqrt{b}$ where $b$ is prime.

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# Rationalising surds (1)

## Review Exercise (Answers)

1. Rationalise $\frac{1}{\sqrt{3}}$

   $\frac{\sqrt{3}}{3}$

2. Rationalise $\frac{35}{\sqrt{5}}$ . Give your answer in the form $a\sqrt{b}$ where $b$ is prime and state $a$ and $b$.

   $7\sqrt{5}$

   $a=7$, $b=5$

3. Rationalise $\frac{30}{4\sqrt{3}}$ . Give your answer in the form $a\sqrt{b}$ where $a$ is in simplest form and $b$ is prime. State $a$ and $b$.

   $\frac{5}{2}\sqrt{3}$

   $a=\frac{5}{2}$, $b=3$

4. Simplify the following, giving your answer in the form $a\sqrt{b}$. State $a$ and $b$. $\frac{\sqrt{50}}{5}+\frac{26}{\sqrt{2}}$

   $14\sqrt{2}$

   $a=14$, $b=2$

5. A rectangle has an area of 80 $cm^2$ and a width of $\sqrt{20}$ $cm$. Find the length and state your answer in the form $a\sqrt{b}$ where $b$ is prime.

   $8\sqrt{5}$

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# Rationalising surds (2)

## Getting ready for A-Level Maths...

*"The most important investment you can make is in **yourself**."*

# Rationalising surds (2)

## Difference of two squares

$$(a + b)(a - b) = a^2 - b^2$$

$$(2 + \sqrt{5})(2 - \sqrt{5})$$

$$(6 - 4\sqrt{2})(6 + 4\sqrt{2})$$

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# Rationalising surds (2)

## My turn

Rationalise the following giving your answer in the form $a + b\sqrt{3}$. State $a$ and $b$.

$$\frac{4}{1+\sqrt{3}}$$

## Your turn

Rationalise the following giving your answer in the form $a + b\sqrt{7}$. State $a$ and $b$.

$$\frac{18}{1+\sqrt{7}}$$

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# Rationalising surds (2)

## My turn

Rationalise the following giving your answer in the form $a + b\sqrt{2}$. State $a$ and $b$.

$$\frac{2}{3-\sqrt{2}}$$

## Your turn

Rationalise the following giving your answer in the form $a + b\sqrt{5}$. State $a$ and $b$.

$$\frac{2}{4-\sqrt{5}}$$

# Rationalising surds (2)

## My turn

Rationalise the following giving your answer in the form $a + b\sqrt{5}$. State $a$ and $b$.

$$\frac{12}{-1+\sqrt{5}}$$

## Your turn

Rationalise the following giving your answer in the form $a + b\sqrt{11}$. State $a$ and $b$.

$$\frac{20}{-3+\sqrt{11}}$$

# Rationalising surds (2)

## My turn

A rectangle has an area $(2+\sqrt{2})cm^2$ and a width of $(3\sqrt{2}-4)$ *cm.* Find the length and state your answer in the form $a+b\sqrt{2}$ where $a$ and $b$ are integers.

## Your turn

A rectangle has an area $(15-6\sqrt{3})cm^2$ and a width of $(2\sqrt{3}-3)$ *cm.* Find the length and state your answer in the form $a+b\sqrt{3}$ where $a$ and $b$ are integers.

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# Rationalising surds (2)

## Review Exercise

1. Rationalise the following giving your answer in the form $a + b\sqrt{5}$.
   State $a$ and $b$. $\dfrac{24}{1+\sqrt{5}}$

2. Rationalise the following giving your answer in the form $a + b\sqrt{6}$.
   State $a$ and $b$. $\dfrac{2}{5-\sqrt{6}}$

3. Rationalise the following giving your answer in the form $a + b\sqrt{7}$.
   State $a$ and $b$. $\dfrac{18}{-2+\sqrt{7}}$

4. A rectangle has an area $(10 + 4\sqrt{3})$ $cm^2$ and a width of $(3\sqrt{3} - 5)$ $cm$.
   Find the length and state your answer in the form $a + b\sqrt{3}$ where
   $a$ and $b$ are integers.

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# Rationalising surds (2)

## Review Exercise (Answers)

1. Rationalise the following giving your answer in the form $a + b\sqrt{5}$.
   State $a$ and $b$. $\dfrac{24}{1+\sqrt{5}}$

   $-6+6\sqrt{5}$

   $a=-6$, $b=6$

2. Rationalise the following giving your answer in the form $a + b\sqrt{6}$.
   State $a$ and $b$. $\dfrac{2}{5-\sqrt{6}}$

   $\dfrac{10}{19}+\dfrac{2}{19}\sqrt{6}$

   $a=\dfrac{10}{19}$, $b=\dfrac{2}{19}$

3. Rationalise the following giving your answer in the form $a + b\sqrt{7}$.
   State $a$ and $b$. $\dfrac{18}{-2+\sqrt{7}}$

   $12+6\sqrt{7}$

   $a=12$, $b=6$

4. A rectangle has an area $(10 + 4\sqrt{3})$ $cm^2$ and a width of $(3\sqrt{3} - 5)$ $cm$.
   Find the length and state your answer in the form $a + b\sqrt{3}$ where
   $a$ and $b$ are integers.

   $43+25\sqrt{3}$

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# YouTube Live Lessons

## Getting ready for A-Level Maths...

*"We are what we repeatedly do.*

*Excellence is not an act, but a habit."*

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# Laws of indices (1)

## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A device to watch connected to internet
- A pen and paper
- Can do attitude

# Laws of indices (1)

## Important rules

$$a^1 = a$$

$$a^0 = 1$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ka^m)^n = k^n a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{m}} = \sqrt[m]{a}$$

$$a^{\frac{n}{m}} = \sqrt[m]{a^n}$$

$$a^{-\frac{1}{m}} = \frac{1}{\sqrt[m]{a}}$$

$$a^{-\frac{n}{m}} = \frac{1}{\sqrt[m]{a^n}} = \frac{1}{(\sqrt[m]{a})^n}$$

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# Laws of indices (1)

## My turn

Evaluate:

$3^{-4}$

## Your turn

Evaluate:

$2^{-4}$

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# Laws of indices (1)

## My turn

Write as a fraction.

$t^{-9}$

## Your turn

Write as a fraction.

$t^{-12}$

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# Laws of indices (1)

## My turn

Write as a fraction.

$7r^{-4}$

## Your turn

Write as a fraction.

$10r^{-9}$

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# Laws of indices (1)

## My turn

Simplify the following, leaving your answer in index form:

$(r^{-6})^4$

## Your turn

Simplify the following, leaving your answer in index form:

$(r^8)^{-4}$

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# Laws of indices (1)

## My turn

Simplify the following, writing your answer as a fraction:

$(3r^{-6})^4$

## Your turn

Simplify the following, writing your answer as a fraction:

$(4r^{-8})^3$

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# Laws of indices (1)

## My turn

Simplify the following, writing your answer as a fraction:

$$(3r^{-6})^{-4}$$

## Your turn

Simplify the following, writing your answer as a fraction:

$$(4r^{-8})^{-3}$$

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# Laws of indices (1)

## My turn

Simplify the following, writing your answer as a fraction:

$$(2r^4t^{-5})^7$$

## Your turn

Simplify the following, writing your answer as a fraction:

$$(3rt^{-8})^4$$

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# Laws of indices (1)

## My turn

Simplify the following:

$5t^2 \times 7t^{-3} \times t$

## Your turn

Simplify the following:

$4t^6 \times 9t^{-5} \times t$

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# Laws of indices (1)

## My turn

Simplify the following, leaving your answer in index form:

$$\frac{18r^{-8}}{6r^{-2}}$$

## Your turn

Simplify the following, leaving your answer in index form:

$$\frac{36r^{-12}}{9r^{-16}}$$

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# Laws of indices (1)

## My turn

Simplify.

$$\left(\frac{a^{-2}b^{3}}{c^{4}}\right)^{3}$$

## Your turn

Simplify.

$$\left(\frac{a^{-5}b^{2}}{c^{6}}\right)^{4}$$

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# Laws of indices (1)

## Review Exercise

**1.** Evaluate $4^{-3}$.

**2.** Write as a fraction: $t^{-7}$

**3.** Write as a fraction: $6r^{-5}$

**4.** Simplify the following, leaving your answer in index form:
$(r^{-7})^{6}$

**5.** Simplify the following, writing your answer as a fraction:
$(5r^{-9})^{3}$

**6.** Simplify the following, writing your answer as a fraction:
$(6r^{-8})^{-3}$

**7.** Simplify the following, writing your answer as a fraction:
$(2r^{5}t^{-7})^{6}$

**8.** Simplify the following, leaving your answer in index form:
$3t^{6} \times 8t^{-4} \times t$

**9.** Simplify the following, leaving your answer in index form:

$$\frac{24r^{-14}}{4r^{-5}}$$

**10.** Simplify.

$$\left(\frac{a^{-3}b^{4}}{c^{6}}\right)^{5}$$

# Laws of indices (1)

## Review Exercise (Answers)

**1.** Evaluate $4^{-3}$.

$\frac{1}{64}$

**2.** Write as a fraction: $t^{-7}$

$\frac{1}{t^7}$

**3.** Write as a fraction: $6r^{-5}$

$\frac{6}{r^5}$

**4.** Simplify the following, leaving your answer in index form:
$(r^{-7})^6$

$r^{-42}$

**5.** Simplify the following, writing your answer as a fraction:
$(5r^{-9})^3$

$\frac{125}{r^{27}}$

**6.** Simplify the following, writing your answer as a fraction:
$(6r^{-8})^{-3}$

$\frac{r^{24}}{216}$

**7.** Simplify the following, writing your answer as a fraction:
$(2r^5t^{-7})^6$

$\frac{64r^{30}}{t^{42}}$

**8.** Simplify the following, leaving your answer in index form:
$3t^6 \times 8t^{-4} \times t$

$24t^3$

**9.** Simplify the following, leaving your answer in index form:

$$\frac{24r^{-14}}{4r^{-5}}$$

$6r^{-9}$

**10.** Simplify.

$$\left(\frac{a^{-3}b^4}{c^6}\right)^5$$

$\frac{b^{20}}{a^{15}c^{30}}$

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# Laws of indices (2)

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What you need...

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# Laws of indices (2)

## Important rules

$$a^1 = a$$

$$a^0 = 1$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ka^m)^n = k^n a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{m}} = \sqrt[m]{a}$$

$$a^{\frac{n}{m}} = \sqrt[m]{a^n}$$

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# Laws of indices (2)

## My turn

Evaluate:

$64^{\frac{1}{3}}$

## Your turn

Evaluate:

$169^{\frac{1}{2}}$

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# Laws of indices (2)

## My turn

Evaluate:

$16^{\frac{5}{4}}$

## Your turn

Evaluate:

$27^{\frac{2}{3}}$

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# Laws of indices (2)

## My turn

Evaluate:

$81^{-\frac{3}{4}}$

## Your turn

Evaluate:

$36^{-\frac{3}{2}}$

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# Laws of indices (2)

## My turn

Evaluate:

$$\left(\frac{64}{125}\right)^{-\frac{2}{3}}$$

## Your turn

Evaluate:

$$\left(\frac{32}{243}\right)^{-\frac{3}{5}}$$

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# Laws of indices (2)

## My turn

Express the following in the form $x^n$.

$\sqrt[3]{x^5}$

## Your turn

Express the following in the form $x^n$.

$\sqrt[6]{x^7}$

# Laws of indices (2)

## My turn

Express the following in the form $x^n$.

$$\frac{\sqrt[5]{x}}{x}$$

## Your turn

Express the following in the form $x^n$.

$$\frac{\sqrt[3]{x}}{x^2}$$

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# Laws of indices (2)

## My turn

Exam Q

Express the following in the form $ax^n$, where $a$ is an integer.

$$\left(\frac{2}{\sqrt[7]{x}}\right)^5$$

## Your turn

Exam Q

Express the following in the form $ax^n$, where $a$ is an integer.

$$\left(\frac{3}{\sqrt[9]{x}}\right)^4$$

# Laws of indices (2)

## My turn

**Exam Q**

Express $7^{\frac{5}{2}}$ in the form $a\sqrt{b}$, where $a$ is an integer and $b$ is a prime number.

## Your turn

**Exam Q**

Express $5^{\frac{9}{2}}$ in the form $a\sqrt{b}$, where $a$ is an integer and $b$ is a prime number.

# Laws of indices (2)

## My turn

Exam Q

Simplify fully.

$(8y^9)^{\frac{5}{3}}$

## Your turn

Exam Q

Simplify fully.

$(81y^8)^{\frac{3}{4}}$

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# Laws of indices (2)

## Review Exercise

**1.** Evaluate:

$81^{\frac{1}{4}}$

**2.** Evaluate:

$36^{\frac{3}{2}}$

**3.** Evaluate:

$64^{-\frac{2}{3}}$

**4.** Evaluate:

$$\left(\frac{81}{256}\right)^{-\frac{3}{4}}$$

**5.** Express the following in the form $x^n$.

$\sqrt[7]{x^3}$

**6.** Express the following in the form $x^n$.

$$\frac{\sqrt[4]{x}}{x}$$

**7.** Express the following in the form $ax^n$, where $a$ is an integer.

$$\left(\frac{4}{\sqrt[5]{x}}\right)^3$$

**8.** Express $5^{\frac{7}{2}}$ in the form $a\sqrt{b}$, where $a$ is an integer and $b$ is a prime number.

**9.** Simplify fully.

$(32y^{10})^{\frac{6}{5}}$

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# Laws of indices (2)

## Review Exercise (Answers)

**1.** Evaluate:

$81^{\frac{1}{4}}$

3

**2.** Evaluate:

$36^{\frac{3}{2}}$

216

**3.** Evaluate:

$64^{-\frac{2}{3}}$

$\frac{1}{16}$

**4.** Evaluate:

$\left(\frac{81}{256}\right)^{-\frac{3}{4}}$

$\frac{64}{27}$ or $2\frac{10}{27}$

**5.** Express the following in the form $x^n$.

$\sqrt[7]{x^3}$

$x^{\frac{3}{7}}$

**6.** Express the following in the form $x^n$.

$\frac{\sqrt[4]{x}}{x}$

$x^{-\frac{3}{4}}$

**7.** Express the following in the form $ax^n$, where $a$ is an integer.

$\left(\frac{4}{\sqrt[5]{x}}\right)^3$

$64x^{-\frac{3}{5}}$

**8.** Express $5^{\frac{7}{2}}$ in the form $a\sqrt{b}$, where $a$ is an integer and $b$ is a prime number.

$125\sqrt{5}$

**9.** Simplify fully.

$(32y^{10})^{\frac{6}{5}}$

$64y^{12}$

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# Laws of indices (3)

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# Laws of indices (3)

## Important rules

$$a^1 = a$$

$$a^0 = 1$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ka^m)^n = k^n a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{m}} = \sqrt[m]{a}$$

$$a^{\frac{n}{m}} = \sqrt[m]{a^n}$$

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# Laws of indices (3)

## My turn

Evaluate the following.

$3^{-\frac{1}{5}} \times 3^{3} \times 3^{\frac{6}{5}}$

## Your turn

Evaluate the following.

$5^{\frac{1}{3}} \times 5^{4} \times 5^{-\frac{7}{3}}$

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# Laws of indices (3)

## My turn

Simplify the following, leaving your answer in index form.

$$3^{-\frac{1}{5}} \times 3^{4} \times 3^{\frac{9}{5}}$$

## Your turn

Simplify the following, leaving your answer in index form.

$$5^{-\frac{1}{3}} \times 5^{2} \times 5^{\frac{8}{3}}$$

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# Laws of indices (3)

## My turn

Simplify fully.

$$a^{\frac{2}{3}}b^{\frac{2}{5}} \times a^{\frac{4}{3}}b^{\frac{-12}{5}}$$

## Your turn

Simplify fully.

$$a^{\frac{9}{2}}b^{\frac{3}{4}} \times a^{\frac{7}{2}}b^{\frac{-27}{4}}$$

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# Laws of indices (3)

## My turn

Exam Q

Simplify fully.

$\sqrt[3]{a^4} \times \sqrt[3]{27a^2}$

## Your turn

Exam Q

Simplify fully.

$\sqrt{a^5} \times \sqrt{36a}$

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# Laws of indices (3)

## My turn

Exam Q

Simplify fully.

$$\sqrt{a^{\frac{2}{3}} \times a^{\frac{2}{7}}}$$

## Your turn

Exam Q

Simplify fully.

$$\sqrt[3]{a^{\frac{3}{4}} \times a^{\frac{3}{5}}}$$

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# Laws of indices (3)

## Review Exercise

**1.** Evaluate the following.

$2^{-\frac{1}{4}} \times 2^{5} \times 2^{\frac{13}{4}}$

**2.** Simplify the following, leaving your answer in index form.

$2^{-\frac{1}{3}} \times 2^{4} \times 2^{\frac{11}{3}}$

**3.** Simplify fully.

$a^{\frac{3}{4}} b^{\frac{2}{3}} \times a^{\frac{5}{4}} b^{\frac{-14}{3}}$

**4.** Simplify fully.

$\sqrt[4]{a^{7}} \times \sqrt[4]{625a^{5}}$

**5.** Simplify fully.

$\sqrt[4]{a^{\frac{4}{5}} \times a^{\frac{4}{7}}}$

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# Laws of indices (3)

## Review Exercise (Answers)

**1.** Evaluate the following.

$2^{-\frac{1}{4}} \times 2^{5} \times 2^{\frac{13}{4}}$

256

**2.** Simplify the following, leaving your answer in index form.

$2^{-\frac{1}{3}} \times 2^{4} \times 2^{\frac{11}{3}}$

$2^{\frac{22}{3}}$

**3.** Simplify fully.

$a^{\frac{3}{4}}b^{\frac{2}{3}} \times a^{\frac{5}{4}}b^{\frac{-14}{3}}$

$a^{2}b^{-4}$

**4.** Simplify fully.

$\sqrt[4]{a^{7}} \times \sqrt[4]{625a^{5}}$

$5a^{3}$

**5.** Simplify fully.

$\sqrt[4]{a^{\frac{4}{5}} \times a^{\frac{4}{7}}}$

$a^{\frac{12}{35}}$

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# Laws of indices (4)

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# Laws of indices (4)

## Important rules

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$$a^0 = 1$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ka^m)^n = k^n a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{m}} = \sqrt[m]{a}$$

$$a^{\frac{n}{m}} = \left(\sqrt[m]{a}\right)^n$$

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# Laws of indices (4)

## My turn

Simplify the following, leaving your answer in index form.

$$\frac{3^{-\frac{6}{5}} \times 3^{4} \times 3^{\frac{1}{5}}}{3^{7}}$$

## Your turn

Simplify the following, leaving your answer in index form.

$$\frac{5^{-\frac{1}{4}} \times 5^{3} \times 5^{\frac{9}{4}}}{5^{8}}$$

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# Laws of indices (4)

## My turn

Simplify the following, leaving your answer in index form.

$$\frac{(7^{\frac{4}{5}})^{15} \times (7^2)^{-3}}{(7^{-1})^{-8}}$$

## Your turn

Simplify the following, leaving your answer in index form.

$$\frac{(2^{\frac{2}{3}})^{18} \times (2^4)^{-5}}{(2^{-1})^{-2}}$$

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# Laws of indices (4)

## My turn

Simplify fully.

$$\frac{15yz^{-\frac{1}{4}}}{3yz^{\frac{3}{4}}}$$

## Your turn

Simplify fully.

$$\frac{24y^2z^{-\frac{4}{5}}}{6yz^{\frac{1}{5}}}$$

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# Laws of indices (4)

## My turn

Exam Q

Simplify fully.

$$\frac{(5x^{\frac{1}{4}})^3}{125x^2}$$

## Your turn

Exam Q

Simplify fully.

$$\frac{(4x^{\frac{1}{5}})^3}{64x^4}$$

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# Laws of indices (4)

## My turn

Exam Q

Simplify fully.

$$\frac{(a^6b)^{\frac{8}{3}}}{(a^3b^{\frac{1}{3}})^{-4}}$$

## Your turn

Exam Q

Simplify fully.

$$\frac{(a^6b)^{\frac{7}{2}}}{(a^4b^{\frac{1}{2}})^{-5}}$$

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# Laws of indices (4)

## My turn

Simplify fully.

$$\sqrt{\frac{32x^{-5}y^{2}}{4xy^{-4}}}$$

## Your turn

Simplify fully.

$$\sqrt{\frac{40x^{-9}y^{6}}{2xy^{-8}}}$$

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# Laws of indices (4)

## Review Exercise

**1.** Simplify the following, leaving your answer in index form.

$$\frac{3^{-\frac{13}{6}} \times 3^{5} \times 3^{\frac{1}{6}}}{3^{8}}$$

**2.** Simplify the following, leaving your answer in index form.

$$\frac{(5^{\frac{7}{2}})^{6} \times (5^{3})^{-4}}{(5^{-1})^{-12}}$$

**3.** Simplify fully.

$$\frac{20yz^{-\frac{1}{3}}}{5yz^{\frac{2}{3}}}$$

**4.** Simplify fully.

$$\frac{(3x^{\frac{1}{3}})^{4}}{81x^{4}}$$

**5.** Simplify fully.

$$\frac{(a^{8}b)^{\frac{3}{4}}}{(a^{2}b^{\frac{1}{4}})^{-5}}$$

**6.** Simplify fully.

$$\sqrt{\frac{48x^{-7}y^{2}}{4xy^{-8}}}$$

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# Laws of indices (4)

## Review Exercise (Answers)

**1.** Simplify the following, leaving your answer in index form.

$$\frac{3^{-\frac{13}{6}} \times 3^5 \times 3^{\frac{1}{6}}}{3^8}$$

$3^{-5}$

**2.** Simplify the following, leaving your answer in index form.

$$\frac{(5^{\frac{7}{2}})^6 \times (5^3)^{-4}}{(5^{-1})^{-12}}$$

$5^{-3}$

**3.** Simplify fully.

$$\frac{20yz^{-\frac{1}{3}}}{5yz^{\frac{2}{3}}}$$

$\frac{4}{z}$

**4.** Simplify fully.

$$\frac{(3x^{\frac{1}{3}})^4}{81x^4}$$

$\frac{1}{x^{\frac{8}{3}}}$

**5.** Simplify fully.

$$\frac{(a^8b)^{\frac{3}{4}}}{(a^2b^{\frac{1}{4}})^{-5}}$$

$a^{18}b^2$

**6.** Simplify fully.

$$\sqrt{\frac{48x^{-7}y^2}{4xy^{-8}}}$$

$\frac{2\sqrt{3}y^5}{x^4}$

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# Manipulating powers (1)

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# Manipulating powers (1)

## Important rules

$$a^1 = a$$

$$a^0 = 1$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ka^m)^n = k^n a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{m}} = \sqrt[m]{a}$$

$$a^{\frac{n}{m}} = \left(\sqrt[m]{a}\right)^n$$

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# Manipulating powers (1)

## My turn

Write 243 as a power of 3.

## Your turn

Write 256 as a power of 4.

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# Manipulating powers (1)

## My turn

Write $\frac{1}{243}$ as a power of 3.

## Your turn

Write $\frac{1}{625}$ as a power of 5.

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# Manipulating powers (1)

## My turn

Write 0.04 as a power of 5.

## Your turn

Write 0.25 as a power of 2.

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# Manipulating powers (1)

## My turn

Write 32 x 128 as a power of 2.

## Your turn

Write 27 x 81 as a power of 3.

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# Manipulating powers (1)

## My turn

Write $25^6$ as a power of 5.

## Your turn

Write $64^3$ as a power of 2.

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# Manipulating powers (1)

## My turn

Write $81^5 \times 27^2$ as a power of 3.

## Your turn

Write $64^2 \times 16^7$ as a power of 2.

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# Manipulating powers (1)

## My turn

Write $\frac{128^2}{32^5}$ as a power of 2.

## Your turn

Write $\frac{243^3}{27^6}$ as a power of 3.

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# Manipulating powers (1)

## My turn

Write $0.25^5 \times 0.5^4$ as a power of 2.

## Your turn

Write $0.04^4 \times 0.2^3$ as a power of 5.

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# Manipulating powers (1)

## Review Exercise

**1.** Write 216 as a power of 6.

**2.** Write $\frac{1}{128}$ as a power of 2.

**3.** Write 0.5 as a power of 2.

**4.** Write 25 x 625 as a power of 5.

**5.** Write $27^8$ as a power of 3.

**6.** Write $25^4 \times 125^3$ as a power of 5.

**7.** Write $\frac{64^3}{32^4}$ as a power of 2.

**8.** Write $0.125^3 \times 0.5^5$ as a power of 2.

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# Manipulating powers (1)

## Review Exercise (Answers)

**1.** Write 216 as a power of 6. $6^3$

**2.** Write $\frac{1}{128}$ as a power of 2. $2^{-7}$

**3.** Write 0.5 as a power of 2. $2^{-1}$

**4.** Write 25 x 625 as a power of 5. $5^6$

**5.** Write $27^8$ as a power of 3. $3^{24}$

**6.** Write $25^4 \times 125^3$ as a power of 5. $5^{17}$

**7.** Write $\frac{64^3}{32^4}$ as a power of 2. $2^{-2}$

**8.** Write $0.125^3 \times 0.5^5$ as a power of 2. $2^{-14}$

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# Manipulating powers (2)

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# Manipulating powers (2)

## Important rules

$$a^1 = a$$

$$a^0 = 1$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ka^m)^n = k^n a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{m}} = \sqrt[m]{a}$$

$$a^{\frac{n}{m}} = \left(\sqrt[m]{a}\right)^n$$

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# Manipulating powers (2)

## My turn

Write $\sqrt{128}$ as a power of 2.

## Your turn

Write $\sqrt{125}$ as a power of 5.

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# Manipulating powers (2)

## My turn

Write $\sqrt[3]{32}$ as a power of 2.

## Your turn

Write $\sqrt[3]{81}$ as a power of 3.

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# Manipulating powers (2)

## My turn

Write $\frac{1}{\sqrt[4]{27}}$ as a power of 3.

## Your turn

Write $\frac{1}{\sqrt[4]{128}}$ as a power of 2.

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# Manipulating powers (2)

## My turn

Write $64\sqrt{32}$ as a power of 2.

## Your turn

Write $9\sqrt{27}$ as a power of 3.

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# Manipulating powers (2)

## My turn

Write $\sqrt[3]{128} \div 8^2$ as a power of 2.

## Your turn

Write $\sqrt[3]{81} \div 9^4$ as a power of 3.

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# Manipulating powers (2)

## My turn

Express 243 as a power of 9.

## Your turn

Write 32 as a power of 4.

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# Manipulating powers (2)

## Review Exercise

**1.** Write $\sqrt{216}$ as a power of 6.

**2.** Write $\sqrt[3]{625}$ as a power of 5.

**3.** Write $\frac{1}{\sqrt[4]{32}}$ as a power of 2.

**4.** Write $3 \times \sqrt[4]{3}$ as a power of 3.

**5.** Write $32\sqrt{8}$ as a power of 2.

**6.** Write $\sqrt[3]{625} \div 25^2$ as a power of 5.

**7.** Write $\frac{27}{\sqrt[4]{3}}$ as a power of 3.

**8.** Express 128 as a power of 4.

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# Manipulating powers (2)

## Review Exercise (Answers)

**1.** Write $\sqrt{216}$ as a power of 6. $6^{\frac{3}{2}}$

**2.** Write $\sqrt[3]{625}$ as a power of 5. $5^{\frac{4}{3}}$

**3.** Write $\frac{1}{\sqrt[4]{32}}$ as a power of 2. $2^{-\frac{5}{4}}$

**4.** Write $3 \times \sqrt[4]{3}$ as a power of 3. $3^{\frac{5}{4}}$

**5.** Write $32\sqrt{8}$ as a power of 2. $2^{\frac{13}{2}}$

**6.** Write $\sqrt[3]{625} \div 25^2$ as a power of 5. $5^{-\frac{8}{3}}$

**7.** Write $\frac{27}{\sqrt[4]{3}}$ as a power of 3. $3^{\frac{11}{4}}$

**8.** Express 128 as a power of 4. $4^{\frac{7}{2}}$

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# Manipulating powers (3)

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# Manipulating powers (3)

## Important rules

$$a^1 = a$$

$$a^0 = 1$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ka^m)^n = k^n a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{m}} = \sqrt[m]{a}$$

$$a^{\frac{n}{m}} = \left(\sqrt[m]{a}\right)^n$$

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# Manipulating powers (3)

## My turn

Express $81^{3x}$ as a power of 3 in terms of $x$.

## Your turn

Express $64^{7x}$ as a power of 2 in terms of $x$.

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# Manipulating powers (3)

## My turn

Express $25 \times 125^{3x}$ as a power of 5 in terms of $x$.

## Your turn

Express $27 \times 243^{2x}$ as a power of 3 in terms of $x$.

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# Manipulating powers (3)

## My turn

Express 8 x $\frac{1}{32^{4x}}$ as a power of 2 in terms of $x$.

## Your turn

Express 25 x $\frac{1}{625^{2x}}$ as a power of 5 in terms of $x$.

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# Manipulating powers (3)

## My turn

Express $32 \times 16^{x-5}$ as a power of 2 in terms of $x$.

## Your turn

Express $81 \times 27^{x-4}$ as a power of 3 in terms of $x$.

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# Manipulating powers (3)

## My turn

$27^m \times 81^n$ can be written in the form $3^a$. Express $a$ in terms of $m$ and $n$.

## Your turn

$32^m \times 128^n$ can be written in the form $2^a$. Express $a$ in terms of $m$ and $n$.

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# Manipulating powers (3)

## My turn

Exam Q

$\frac{64}{\sqrt[6]{(8^n)}}$ can be written in the form $2^a$.

Express $a$ in terms of $n$.

## Your turn

Exam Q

$\frac{32}{\sqrt[4]{(4^n)}}$ can be written in the form $2^a$.

Express $a$ in terms of $n$.

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# Manipulating powers (3)

## Review Exercise

**1.** Express $25^{4x}$ as a power of 5 in terms of $x$.

**2.** Express $16 \times 128^{2x}$ as a power of 2 in terms of $x$.

**3.** Express $9 \times \frac{1}{81^{3x}}$ as a power of 3 in terms of $x$.

**4.** Express $64 \times 8^{x-4}$ as a power of 2 in terms of $x$.

**5.** $64^m \times 16^n$ can be written in the form $2^a$. Express $a$ in terms of $m$ and $n$.

**6.** $\frac{27}{\sqrt[6]{(9^n)}}$ can be written in the form $3^a$.
Express $a$ in terms of $n$.

### Extra Practice

**7.** $8^m \div 32^n$ can be written in the form $2^a$.
Express $a$ in terms of $m$ and $n$.

**8.** $(27^m)^{4n}$ can be written in the form $3^a$.
Express $a$ in terms of $m$ and $n$.

**9.** $\sqrt[3]{9} \times 81^n$ can be written in the form $3^a$.
Express $a$ in terms of $n$.

**10.** $\frac{\sqrt[3]{32}}{16^n}$ can be written in the form $2^a$.
Express $a$ in terms of $n$.

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# Manipulating powers (3)

## Review Exercise (Answers)

**1.** Express $25^{4x}$ as a power of 5 in terms of $x$. $5^{8x}$

**2.** Express $16 \times 128^{2x}$ as a power of 2 in terms of $x$. $2^{14x+4}$ or $2^{4+14x}$

**3.** Express $9 \times \frac{1}{81^{3x}}$ as a power of 3 in terms of $x$. $3^{-12x+2}$ or $3^{2-12x}$

**4.** Express $64 \times 8^{x-4}$ as a power of 2 in terms of $x$. $2^{3x-6}$ or $2^{-6+3x}$

**5.** $64^m \times 16^n$ can be written in the form $2^a$. Express $a$ in terms of $m$ and $n$. $a=6m+4n$ or $a=4n+6m$

**6.** $\frac{27}{\sqrt[6]{(9^n)}}$ can be written in the form $3^a$. Express $a$ in terms of $n$. $a=-\frac{n}{3}+3$ or $a=3-\frac{n}{3}$

### Extra Practice

**7.** $8^m \div 32^n$ can be written in the form $2^a$. Express $a$ in terms of $m$ and $n$. $a=3m-5n$ or $a=-5n+3m$

**8.** $(27^m)^{4n}$ can be written in the form $3^a$. Express $a$ in terms of $m$ and $n$. $a=12mn$ or $a=12nm$

**9.** $\sqrt[3]{9} \times 81^n$ can be written in the form $3^a$. Express $a$ in terms of $n$. $a=\frac{2}{3}+4n$ or $a=4n+\frac{2}{3}$

**10.** $\frac{\sqrt[3]{32}}{16^n}$ can be written in the form $2^a$. Express $a$ in terms of $n$. $a=\frac{5}{3}-4n$ or $a=-4n+\frac{5}{3}$

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# Manipulating powers (4)

## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A device to watch connected to internet
- A pen and paper
- Can do attitude

# Manipulating powers (4)

## Important rules

$$a^1 = a$$

$$a^0 = 1$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ka^m)^n = k^n a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{m}} = \sqrt[m]{a}$$

$$a^{\frac{n}{m}} = \left(\sqrt[m]{a}\right)^n$$

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# Manipulating powers (4)

## My turn

Given that $5^k = 2$, find the value of $5^{k+3}$.

## Your turn

Given that $4^k = 3$, find the value of $4^{k+2}$.

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# Manipulating powers (4)

## My turn

Given that $5^k = 125$, find the value of $5^{k-2}$.

## Your turn

Given that $4^k = 128$, find the value of $4^{k-3}$.

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# Manipulating powers (4)

## My turn

Given that $5^k = 4$, find the value of $5^{2k}$.

## Your turn

Given that $4^k = 3$, find the value of $4^{3k}$.

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# Manipulating powers (4)

## My turn

Given that $5^k = 4$, find the value of $5^{2k+1}$.

## Your turn

Given that $4^k = 3$, find the value of $4^{3k+2}$.

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# Manipulating powers (4)

## My turn

Given that $5^k = 2$, find the value of $5^{3k-4}$.

## Your turn

Given that $4^k = 3$, find the value of $4^{2k-3}$.

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# Manipulating powers (4)

## My turn

Exam Q

Given that $5^k = 6$, find the value of $5^{2-3k}$.

## Your turn

Exam Q

Given that $4^k = 3$, find the value of $4^{2-5k}$.

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# Manipulating powers (4)

## My turn

Exam Q

Given that $3^{-n} = 0.5$, find the value of $3^{5n-1}$.

## Your turn

Exam Q

Given that $4^{-n} = 0.2$, find the value of $4^{2n-1}$.

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# Manipulating powers (4)

## Review Exercise

**1.** Given that $3^k = 4$,
find the value of $3^{k+2}$.

**2.** Given that $2^k = 128$,
find the value of $2^{k-5}$.

**3.** Given that $3^k = 2$,
find the value of $3^{6k}$.

**4.** Given that $5^k = 3$,
find the value of $5^{4k+1}$.

**5.** Given that $4^k = 5$,
find the value of $4^{2k-3}$.

**6.** Given that $3^k = 4$,
find the value of $3^{3-4k}$.

**7.** Given that $3^{-n} = 0.125$,
find the value of $3^{2n-1}$.

### Extra Practice

**8.** Given that $4^m = 3$ and $4^n = 5$,
find the value of $4^{m+n}$.

**9.** Given that $8^m = 3$ and $8^n = 7$,
find the value of $8^{m-n}$.

**10.** Given that $7^m = 4$ and $7^n = 3$,
find the value of $7^{3m+2n}$.

**11.** Given that $3^m = 2$ and $243^n = 5$,
find the value of $3^{5n+4m}$.

**12.** Given that $4^m = 3$ and $64^n = 7$,
find the value of $4^{6n+2m}$.

**13.** Given that $4^n = 0.6$,
find the value of $4^{-2n}$.

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# Manipulating powers (4)

## Review Exercise (Answers)

**1.** Given that $3^k = 4$, find the value of $3^{k+2}$. — 36

**2.** Given that $2^k = 128$, find the value of $2^{k-5}$. — 4

**3.** Given that $3^k = 2$, find the value of $3^{6k}$. — 64

**4.** Given that $5^k = 3$, find the value of $5^{4k+1}$. — 405

**5.** Given that $4^k = 5$, find the value of $4^{2k-3}$. — $\frac{25}{64}$

**6.** Given that $3^k = 4$, find the value of $3^{3-4k}$. — $\frac{27}{256}$

**7.** Given that $3^{-n} = 0.125$, find the value of $3^{2n-1}$. — $\frac{64}{3}$

### Extra Practice

**8.** Given that $4^m = 3$ and $4^n = 5$, find the value of $4^{m+n}$. — 15

**9.** Given that $8^m = 3$ and $8^n = 7$, find the value of $8^{m-n}$. — $\frac{3}{7}$

**10.** Given that $7^m = 4$ and $7^n = 3$, find the value of $7^{3m+2n}$. — 576

**11.** Given that $3^m = 2$ and $243^n = 5$, find the value of $3^{5n+4m}$. — 80

**12.** Given that $4^m = 3$ and $64^n = 7$, find the value of $4^{6n+2m}$. — 441

**13.** Given that $4^n = 0.6$, find the value of $4^{-2n}$. — $\frac{25}{9}$

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# Manipulating powers (5)

## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A device to watch connected to internet
- A pen and paper
- Can do attitude

# Manipulating powers (5)

## Important rules

$$a^1 = a$$

$$a^0 = 1$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ka^m)^n = k^n a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{m}} = \sqrt[m]{a}$$

$$a^{\frac{n}{m}} = \left(\sqrt[m]{a}\right)^n$$

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# Manipulating powers (5)

## My turn

Exam Q

If $p = \frac{1}{25}q^2$, write the expression $p^{\frac{1}{2}}$ in terms of $q$.

## Your turn

Exam Q

If $p = \frac{1}{9}q^2$, write the expression $p^{\frac{1}{2}}$ in terms of $q$.

# Manipulating powers (5)

## My turn

**Exam Q**

If $p = \frac{1}{25}q^2$, write the expression $3p^{-1}$ in terms of $q$.

## Your turn

**Exam Q**

If $p = \frac{1}{9}q^2$, write the expression $4p^{-1}$ in terms of $q$.

# Manipulating powers (5)

## My turn

Exam Q

If $p = \frac{1}{25}q^2$, write the expression $p^2q$ in terms of $q$.

## Your turn

Exam Q

If $p = \frac{1}{9}q^2$, write the expression $p^2q$ in terms of $q$.

# Manipulating powers (5)

## My turn

**Exam Q**

Given that $y = 5^x$, express $5^{4x}$ in terms of $y$.

## Your turn

**Exam Q**

Given that $y = 6^x$, express $6^{3x}$ in terms of $y$.

# Manipulating powers (5)

## My turn

**Exam Q**

Given that $y = 3^x$, express $3^{4x-2}$ in terms of $y$.

## Your turn

**Exam Q**

Given that $y = 4^x$, express $4^{5x-3}$ in terms of $y$.

# Manipulating powers (5)

## My turn

**Exam Q**

Given that $y = 5^x$, express $\frac{1}{5^{x-3}}$ in terms of $y$.

## Your turn

**Exam Q**

Given that $y = 4^x$, express $\frac{1}{4^{x-2}}$ in terms of $y$.

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# Manipulating powers (5)

## My turn

**Exam Q**

Given that $y = 2^x$, express $\frac{64}{8^{2-3x}}$ in terms of $y$.

## Your turn

**Exam Q**

Given that $y = 4^x$, express $\frac{256}{16^{2-3x}}$ in terms of $y$.

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# Manipulating powers (5)

## Review Exercise

**1.** If $p = \frac{1}{36}q^2$, write the expression $p^{\frac{1}{2}}$ in terms of $q$.

**2.** If $p = \frac{1}{36}q^2$, write the expression $2p^{-1}$ in terms of $q$.

**3.** If $p = \frac{1}{36}q^2$, write the expression $p^2q$ in terms of $q$.

**4.** Given that $y = 4^x$, express $4^{3x}$ in terms of $y$.

**5.** Given that $y = 2^x$, express $2^{5x-3}$ in terms of $y$.

**6.** Given that $y = 3^x$, express $\frac{1}{3^{x-4}}$ in terms of $y$.

**7.** Given that $y = 3^x$, express $\frac{81}{9^{2-3x}}$ in terms of $y$.

### Extra Practice

**8.** If $p = \frac{1}{36}q^2$, write the expression $p^{\frac{1}{2}} \div 2p^{-1}$ in terms of $q$.

**9.** If $p = \frac{1}{36}q^2$, write the expression $\frac{4p}{q^3}$ in terms of $q$.

**10.** If $p = \frac{1}{36}q^2$, write the expression $\frac{q^2}{4p^2}$ in terms of $q$.

**11.** Given that $y = 2^x$, express $32^{4x-1}$ in terms of $y$.

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# Manipulating powers (5)

## Review Exercise (Answers)

**1.** If $p = \frac{1}{36}q^2$, write the expression $p^{\frac{1}{2}}$ in terms of $q$. $\frac{1}{6}q$ or $\frac{q}{6}$

**2.** If $p = \frac{1}{36}q^2$, write the expression $2p^{-1}$ in terms of $q$. $72q^{-2}$ or $\frac{72}{q^2}$

**3.** If $p = \frac{1}{36}q^2$, write the expression $p^2q$ in terms of $q$. $\frac{1}{1296}q^5$ or $\frac{q^5}{1296}$

**4.** Given that $y = 4^x$, express $4^{3x}$ in terms of $y$. $y^3$

**5.** Given that $y = 2^x$, express $2^{5x-3}$ in terms of $y$. $\frac{1}{8}y^5$ or $\frac{y^5}{8}$

**6.** Given that $y = 3^x$, express $\frac{1}{3^{x-4}}$ in terms of $y$. $81y^{-1}$ or $\frac{81}{y}$

**7.** Given that $y = 3^x$, express $\frac{81}{9^{2-3x}}$ in terms of $y$. $y^6$

### Extra Practice

**8.** If $p = \frac{1}{36}q^2$, write the expression $p^{\frac{1}{2}} \div 2p^{-1}$ in terms of $q$. $\frac{1}{432}q^3$ or $\frac{q^3}{432}$

**9.** If $p = \frac{1}{36}q^2$, write the expression $\frac{4p}{q^3}$ in terms of $q$. $\frac{1}{9}q^{-1}$ or $\frac{1}{9q}$

**10.** If $p = \frac{1}{36}q^2$, write the expression $\frac{q^2}{4p^2}$ in terms of $q$. $324q^{-2}$ or $\frac{324}{q^2}$

**11.** Given that $y = 2^x$, express $32^{4x-1}$ in terms of $y$. $\frac{1}{32}y^{20}$ or $\frac{y^{20}}{32}$

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# Exponential equations (1)

## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A device to watch connected to internet
- A pen and paper
- Can do attitude

# Exponential equations (1)

## Important rules

$$a^1 = a$$

$$a^0 = 1$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ka^m)^n = k^n a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{m}} = \sqrt[m]{a}$$

$$a^{\frac{n}{m}} = \left(\sqrt[m]{a}\right)^n$$

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# Exponential equations (1)

## My turn

Find the value of $x$ if $5^x = 125$.

## Your turn

Find the value of $x$ if $2^x = 64$.

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# Exponential equations (1)

## My turn

Find the value of $x$ if $2^{x+5} = 128$.

## Your turn

Find the value of $x$ if $3^{x+2} = 243$.

# Exponential equations (1)

## My turn

Find the value of $x$ if $2^{6x} = 32$.

## Your turn

Find the value of $x$ if $5^{3x} = 25$.

# Exponential equations (1)

## My turn

Find the value of $x$ if $16 = 2^{3x-2}$.

## Your turn

Find the value of $x$ if $81 = 3^{3x-5}$.

# Exponential equations (1)

## My turn

Exam Q

Find the value of $x$ if $3 = 27^x$.

## Your turn

Exam Q

Find the value of $x$ if $4 = 256^x$.

# Exponential equations (1)

## My turn

Exam Q

Find the value of $x$ if $\frac{1}{125} = 5^x$.

## Your turn

Exam Q

Find the value of $x$ if $\frac{1}{64} = 2^x$.

# Exponential equations (1)

## My turn

Exam Q

Find the value of $x$ if $216^x = \frac{1}{6}$.

Give your answer in its simplest form.

## Your turn

Exam Q

Find the value of $x$ if $243^x = \frac{1}{3}$.

Give your answer in its simplest form.

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# Exponential equations (1)

## My turn

Find the value of $x$ if $\frac{1}{64} = 2^{2x+3}$.

Give your answer in its simplest form.

## Your turn

Find the value of $x$ if $\frac{1}{81} = 3^{5x+2}$.

Give your answer in its simplest form.

# Exponential equations (1)

## My turn

Find the value of $x$ if $2^{4x-3} = \frac{4}{128}$.

Give your answer in its simplest form.

## Your turn

Find the value of $x$ if $5^{3x-1} = \frac{25}{625}$.

Give your answer in its simplest form.

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# Exponential equations (1)

## Review Exercise

**1.** Find the value of $x$ if $4^x = 64$.

**2.** Find the value of $x$ if $5^{x+3} = 625$.

**3.** Find the value of $x$ if $3^{4x} = 243$.

**4.** Find the value of $x$ if $32 = 2^{3x-7}$.

**5.** Find the value of $x$ if $2 = 64^x$.

**6.** Find the value of $x$ if $\frac{1}{81} = 3^x$.

**7.** Find the value of $x$ if $32^x = \frac{1}{2}$.

Give your answer in its simplest form.

**8.** Find the value of $x$ if $\frac{1}{64} = 4^{3x+4}$.

Give your answer in its simplest form.

**9.** Find the value of $x$ if $3^{6x-1} = \frac{9}{243}$.

Give your answer in its simplest form.

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# Exponential equations (1)

## Review Exercise (Answers)

**1.** Find the value of $x$ if $4^x = 64$.

$x=3$

**2.** Find the value of $x$ if $5^{x+3} = 625$.

$x=1$

**3.** Find the value of $x$ if $3^{4x} = 243$.

$x=\frac{5}{4}$

**4.** Find the value of $x$ if $32 = 2^{3x-7}$.

$x=4$

**5.** Find the value of $x$ if $2 = 64^x$.

$x=\frac{1}{6}$

**6.** Find the value of $x$ if $\frac{1}{81} = 3^x$.

$x=-4$

**7.** Find the value of $x$ if $32^x = \frac{1}{2}$.

Give your answer in its simplest form.

$x=-\frac{1}{5}$

**8.** Find the value of $x$ if $\frac{1}{64} = 4^{3x+4}$.

Give your answer in its simplest form.

$x=-\frac{7}{3}$

**9.** Find the value of $x$ if $3^{6x-1} = \frac{9}{243}$.

Give your answer in its simplest form.

$x=-\frac{1}{3}$

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# Exponential equations (2)

## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A device to watch connected to internet
- A pen and paper
- Can do attitude

# Exponential equations (2)

## Important rules

$$a^1 = a$$

$$a^0 = 1$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ka^m)^n = k^n a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{m}} = \sqrt[m]{a}$$

$$a^{\frac{n}{m}} = \left(\sqrt[m]{a}\right)^n$$

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# Exponential equations (2)

## My turn

Exam Q

Find the value of $x$ if $3^x = \sqrt[3]{81}$.

## Your turn

Exam Q

Find the value of $x$ if $2^x = \sqrt[4]{32}$.

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# Exponential equations (2)

## My turn

Exam Q

Find the value of $x$ if $5^{2x} = \sqrt{125}$.

Give your answer in its simplest form.

## Your turn

Exam Q

Find the value of $x$ if $3^{4x} = \sqrt{27}$.

Give your answer in its simplest form.

# Exponential equations (2)

## My turn

Exam Q

Find the value of $x$ if $3^{2x} = \frac{1}{\sqrt{243}}$ .

Give your answer in its simplest form.

## Your turn

Exam Q

Find the value of $x$ if $2^{3x} = \frac{1}{\sqrt{32}}$ .

Give your answer in its simplest form.

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# Exponential equations (2)

## My turn

Exam Q

Find the value of $x$ if $\frac{1}{\sqrt[3]{128}} = 2^{3x-1}$.

Give your answer in its simplest form.

## Your turn

Exam Q

Find the value of $x$ if $\frac{1}{\sqrt[4]{32}} = 2^{4x-3}$.

Give your answer in its simplest form.

# Exponential equations (2)

## My turn

Exam Q

Find the value of $x$ if $3^{7x+4} = \frac{27}{\sqrt[3]{81}}$.

Give your answer in its simplest form.

## Your turn

Exam Q

Find the value of $x$ if $5^{3x+5} = \frac{25}{\sqrt[4]{125}}$.

Give your answer in its simplest form.

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# Exponential equations (2)

## My turn

Exam Q

Find the value of $x$ if $2^{3x} = 0.125^{2x+1}$.

Give your answer in its simplest form.

## Your turn

Exam Q

Find the value of $x$ if $5^{2x} = 0.04^{3x+2}$.

Give your answer in its simplest form.

# Exponential equations (2)

## Review Exercise

**1.** Find the value of $x$ if $2^x = \sqrt[3]{128}$.

**2.** Find the value of $x$ if $3^{4x} = \sqrt{243}$.
Give your answer in its simplest form.

**3.** Find the value of $x$ if $5^{2x} = \frac{1}{\sqrt{125}}$.
Give your answer in its simplest form.

**4.** Find the value of $x$ if $\frac{1}{\sqrt[3]{128}} = 2^{4x-1}$.
Give your answer in its simplest form.

**5.** Find the value of $x$ if $3^{3x+2} = \frac{9}{\sqrt[4]{27}}$.
Give your answer in its simplest form.

**6.** Find the value of $x$ if $2^{2x} = 0.25^{4x+1}$.
Give your answer in its simplest form.

### Extra Practice

**7.** Find the value of $x$ if $8^5 = 32^{4x}$.
Give your answer in its simplest form.

**8.** Find the value of $x$ if $9^x = 27^{\frac{6}{5}}$.
Give your answer in its simplest form.

**9.** Find the value of $x$ if $25^{3x-1} = 125^{\frac{4}{9}}$.
Give your answer in its simplest form.

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# Exponential equations (2)

## Review Exercise (Answers)

**1.** Find the value of $x$ if $2^x = \sqrt[3]{128}$.

$x = \frac{7}{3}$

**2.** Find the value of $x$ if $3^{4x} = \sqrt{243}$.
Give your answer in its simplest form.

$x = \frac{5}{8}$

**3.** Find the value of $x$ if $5^{2x} = \frac{1}{\sqrt{125}}$.
Give your answer in its simplest form.

$x = -\frac{3}{4}$

**4.** Find the value of $x$ if $\frac{1}{\sqrt[3]{128}} = 2^{4x-1}$.
Give your answer in its simplest form.

$x = -\frac{1}{3}$

**5.** Find the value of $x$ if $3^{3x+2} = \frac{9}{\sqrt[4]{27}}$.
Give your answer in its simplest form.

$x = -\frac{1}{4}$

**6.** Find the value of $x$ if $2^{2x} = 0.25^{4x+1}$.
Give your answer in its simplest form.

$x = -\frac{1}{5}$

### Extra Practice

**7.** Find the value of $x$ if $8^5 = 32^{4x}$.
Give your answer in its simplest form.

$x = \frac{3}{4}$

**8.** Find the value of $x$ if $9^x = 27^{\frac{6}{5}}$.
Give your answer in its simplest form.

$x = \frac{9}{5}$

**9.** Find the value of $x$ if $25^{3x-1} = 125^{\frac{4}{9}}$.
Give your answer in its simplest form.

$x = \frac{5}{9}$

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# Exponential equations (3)

## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A device to watch connected to internet
- A pen and paper
- Can do attitude

# Exponential equations (3)

## Important rules

$$a^1 = a$$

$$a^0 = 1$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ka^m)^n = k^n a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{m}} = \sqrt[m]{a}$$

$$a^{\frac{n}{m}} = \left(\sqrt[m]{a}\right)^n$$

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# Exponential equations (3)

## My turn

Exam Q

Find the value of $x$ if $16 \times 2^{6x-3} = 128$.

## Your turn

Exam Q

Find the value of $x$ if $27 \times 3^{3x-5} = 81$.

# Exponential equations (3)

## My turn

**Exam Q**

Find the value of $x$ if $9^{-4} \times 3^{2x-5} = \frac{1}{81}$ .

Give your answer in its simplest form.

## Your turn

**Exam Q**

Find the value of $x$ if $8^{-4} \times 2^{2x-5} = \frac{1}{64}$ .

Give your answer in its simplest form.

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# Exponential equations (3)

## My turn

Exam Q

Find the value of $x$ if $(27^x)^2 = \frac{1}{9}$.

Give your answer in its simplest form.

## Your turn

Exam Q

Find the value of $x$ if $(32^x)^3 = \frac{1}{8}$.

Give your answer in its simplest form.

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# Exponential equations (3)

## My turn

Exam Q

Find the value of $x$ if $\sqrt{3} \times 3^x = \frac{1}{27}$.

Give your answer in its simplest form.

## Your turn

Exam Q

Find the value of $x$ if $\sqrt{2} \times 2^x = \frac{1}{64}$.

Give your answer in its simplest form.

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# Exponential equations (3)

## My turn

Exam Q

Find the value of $x$ if $25^{\frac{2}{5}x} \div 5^{2x+3} = 0.2$.

Give your answer in its simplest form.

## Your turn

Exam Q

Find the value of $x$ if $16^{\frac{2}{3}x} \div 2^{4x+2} = 0.5$.

Give your answer in its simplest form.

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# Exponential equations (3)

## Review Exercise

**1.** Find the value of $x$ if $9 \times 3^{2x-4} = 81$.

**2.** Find the value of $x$ if $16^{-3} \times 2^{3x-4} = \frac{1}{32}$.
Give your answer in its simplest form.

**3.** Find the value of $x$ if $(64^{x})^{3} = \frac{1}{8}$.
Give your answer in its simplest form.

**4.** Find the value of $x$ if $\sqrt{3} \times 3^{x} = \frac{1}{81}$.
Give your answer in its simplest form.

**5.** Find the value of $x$ if
$64^{\frac{2}{5}x} \div 4^{2x+6} = 0.25$.
Give your answer in its simplest form.

### Extra Practice

**6.** Find the value of $x$ if $16 \times 2^{x} = 128$.

**7.** Find the value of $x$ if $64 \times 2^{x} = 16^{\frac{2}{3}}$.
Give your answer in its simplest form.

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# Exponential equations (3)

## Review Exercise (Answers)

**1.** Find the value of $x$ if $9 \times 3^{2x-4} = 81$.

$x=3$

**2.** Find the value of $x$ if $16^{-3} \times 2^{3x-4} = \frac{1}{32}$.
Give your answer in its simplest form.

$x= \frac{11}{3}$

**3.** Find the value of $x$ if $(64^{x})^{3} = \frac{1}{8}$.
Give your answer in its simplest form.

$x=-\frac{1}{6}$

**4.** Find the value of $x$ if $\sqrt{3} \times 3^{x} = \frac{1}{81}$.
Give your answer in its simplest form.

$x=-\frac{9}{2}$

**5.** Find the value of $x$ if
$64^{\frac{2}{5}x} \div 4^{2x+6} = 0.25$.
Give your answer in its simplest form.

$x=-\frac{25}{4}$

### Extra Practice

**6.** Find the value of $x$ if $16 \times 2^{x} = 128$.

$x=3$

**7.** Find the value of $x$ if $64 \times 2^{x} = 16^{\frac{2}{3}}$.
Give your answer in its simplest form.

$x=-\frac{10}{3}$

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# Exponential equations (4)

## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A device to watch connected to internet
- A pen and paper
- Can do attitude

# Exponential equations (4)

## Important rules

$$a^1 = a$$

$$a^0 = 1$$

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ka^m)^n = k^n a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{m}} = \sqrt[m]{a}$$

$$a^{\frac{n}{m}} = \left(\sqrt[m]{a}\right)^n$$

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# Exponential equations (4)

## My turn

Given $3^x \times 3^y = 3\sqrt{3}$, express $y$ in terms of $x$.

## Your turn

Given $5^x \times 5^y = 5\sqrt[3]{5}$, express $y$ in terms of $x$.

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# Exponential equations (4)

## My turn

**Exam Q**

Given $3^x \times 9^y = \frac{1}{3\sqrt{3}}$, express $y$ in terms of $x$.

## Your turn

**Exam Q**

Given $2^x \times 32^y = \frac{1}{2\sqrt{2}}$, express $y$ in terms of $x$.

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# Exponential equations (4)

## My turn

**Exam Q**

Given $\frac{5^x}{5^{3y}} = 25\sqrt{5}$, express $y$ in terms of $x$.

## Your turn

**Exam Q**

Given $\frac{2^x}{2^{5y}} = 16\sqrt{2}$, express $y$ in terms of $x$.

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# Exponential equations (4)

## My turn

**Exam Q**

Given $\frac{9^a}{3^{5b}} = 81\sqrt{3}$, express $a$ in terms of $b$.

## Your turn

**Exam Q**

Given $\frac{16^a}{2^{3b}} = 64\sqrt{2}$, express $a$ in terms of $b$.

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# Exponential equations (4)

## My turn

**Exam Q**

Given that $2^{-2.5} = a\sqrt{2}$, find the exact value of $a$.

## Your turn

**Exam Q**

Given that $5^{-1.5} = a\sqrt{5}$, find the exact value of $a$.

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# Exponential equations (4)

## Review Exercise

**1.** Given $2^x \times 2^y = 2\sqrt[4]{2}$, express $y$ in terms of $x$.

**2.** Given $5^x \times 625^y = \frac{1}{5\sqrt{5}}$, express $y$ in terms of $x$.

**3.** Given $\frac{3^x}{3^{4y}} = 81\sqrt{3}$, express $y$ in terms of $x$.

**4.** Given $\frac{27^a}{3^{4b}} = 243\sqrt{3}$, express $a$ in terms of $b$.

**5.** Given that $2^{-3.5} = a\sqrt{2}$, find the exact value of $a$.

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# Exponential equations (4)

## Review Exercise (Answers)

**1.** Given $2^x \times 2^y = 2\sqrt[4]{2}$, express $y$ in terms of $x$. $y = -x + \frac{5}{4}$ or $y = \frac{5}{4} - x$

**2.** Given $5^x \times 625^y = \frac{1}{5\sqrt{5}}$, express $y$ in terms of $x$. $y = -\frac{1}{4}x - \frac{3}{8}$ or $y = -\frac{3}{8} - \frac{1}{4}x$

**3.** Given $\frac{3^x}{3^{4y}} = 81\sqrt{3}$, express $y$ in terms of $x$. $y = \frac{1}{4}x - \frac{9}{8}$ or $y = -\frac{9}{8} + \frac{1}{4}x$

**4.** Given $\frac{27^a}{3^{4b}} = 243\sqrt{3}$, express $a$ in terms of $b$. $y = \frac{4}{3}x + \frac{11}{6}$ or $y = \frac{11}{6} + \frac{4}{3}x$

**5.** Given that $2^{-3.5} = a\sqrt{2}$, find the exact value of $a$. $a = \frac{1}{16}$

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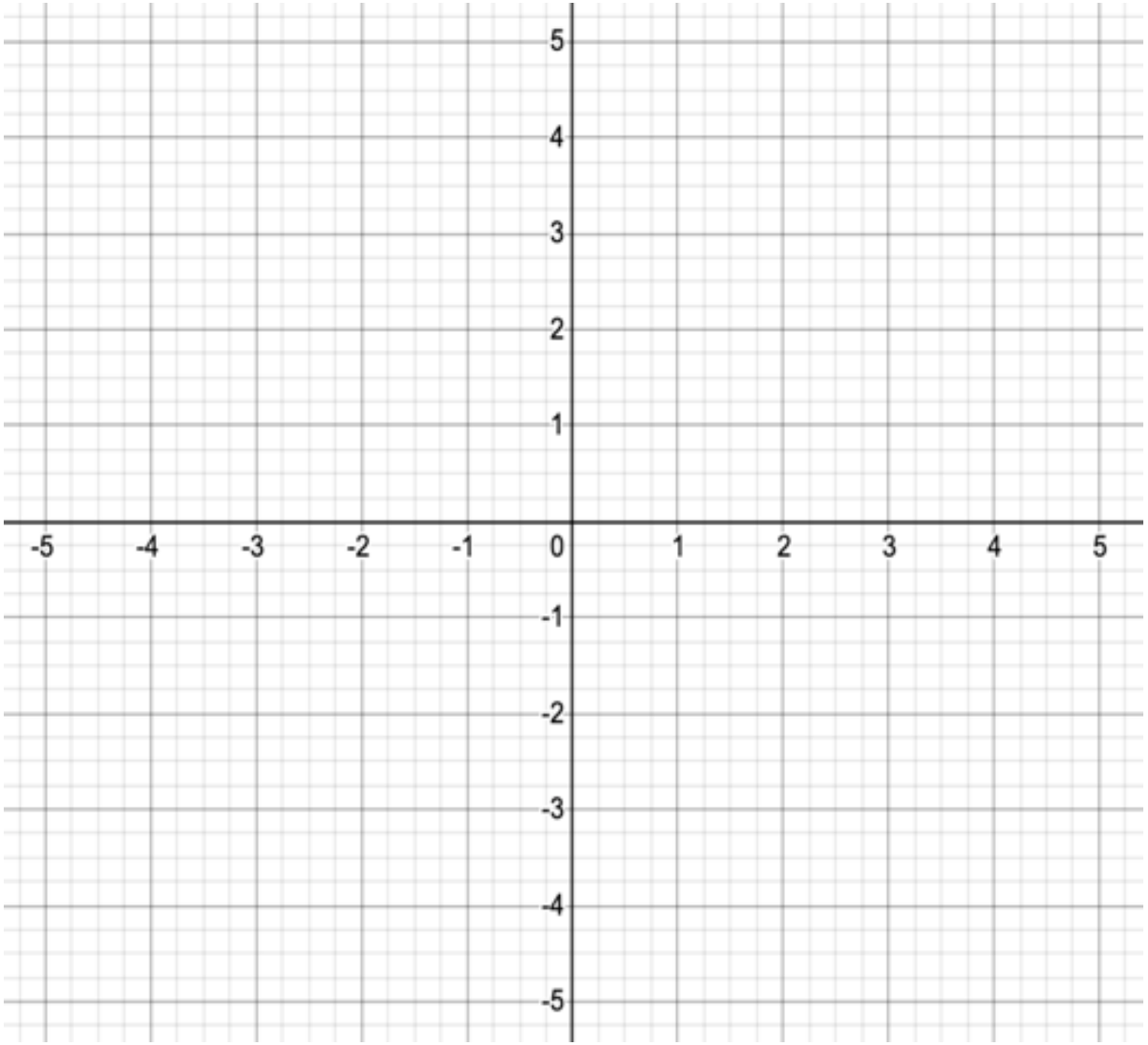
# Gradient of a line

## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A pen and paper
- Can do attitude

# Gradient of a line

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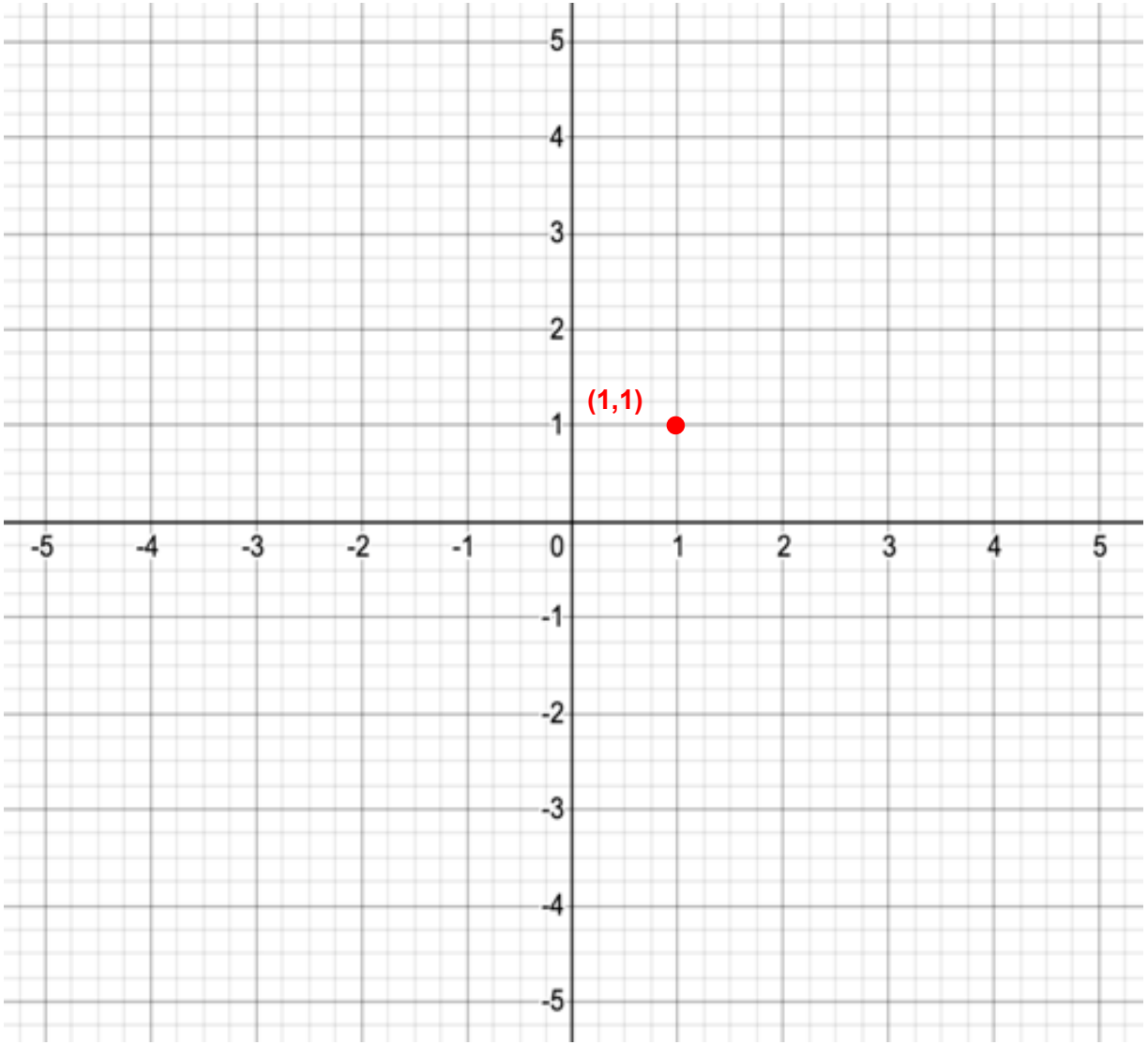
# Gradient of a line

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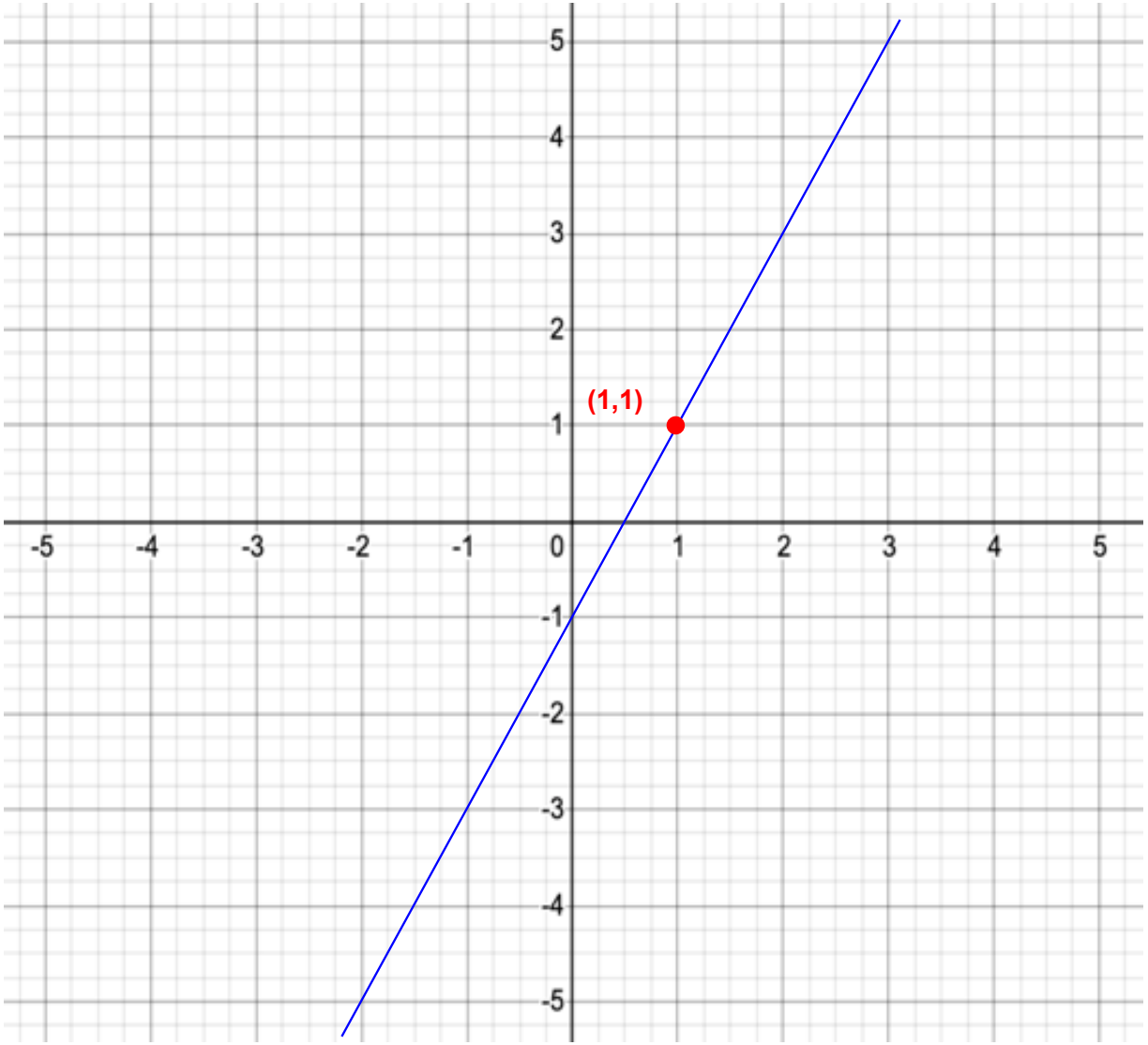
# Gradient of a line

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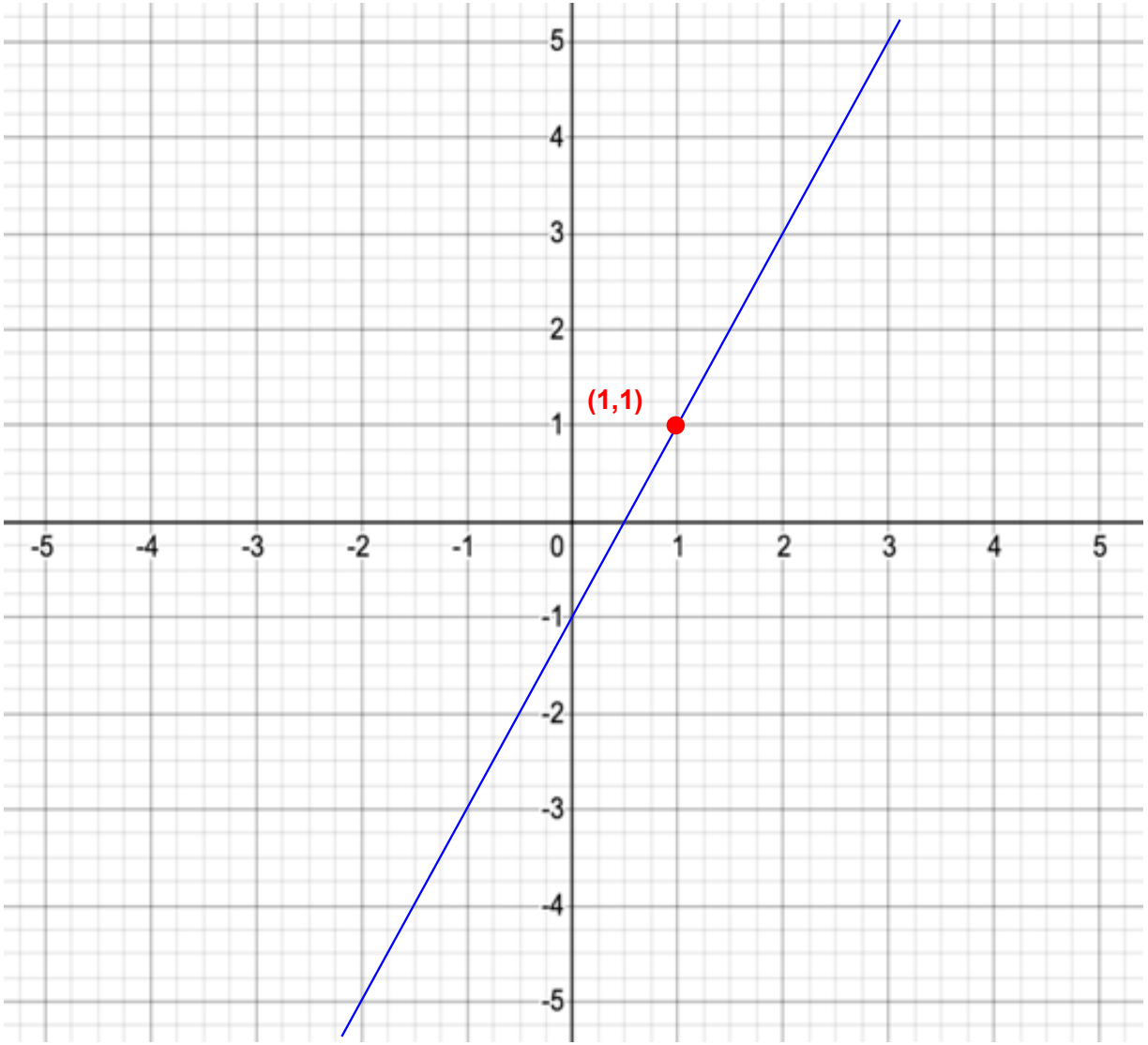
# Gradient of a line




## Gradient

The **gradient** measures the steepness of a line.

i.e. How far you go vertically for each 1 unit you go to the right.

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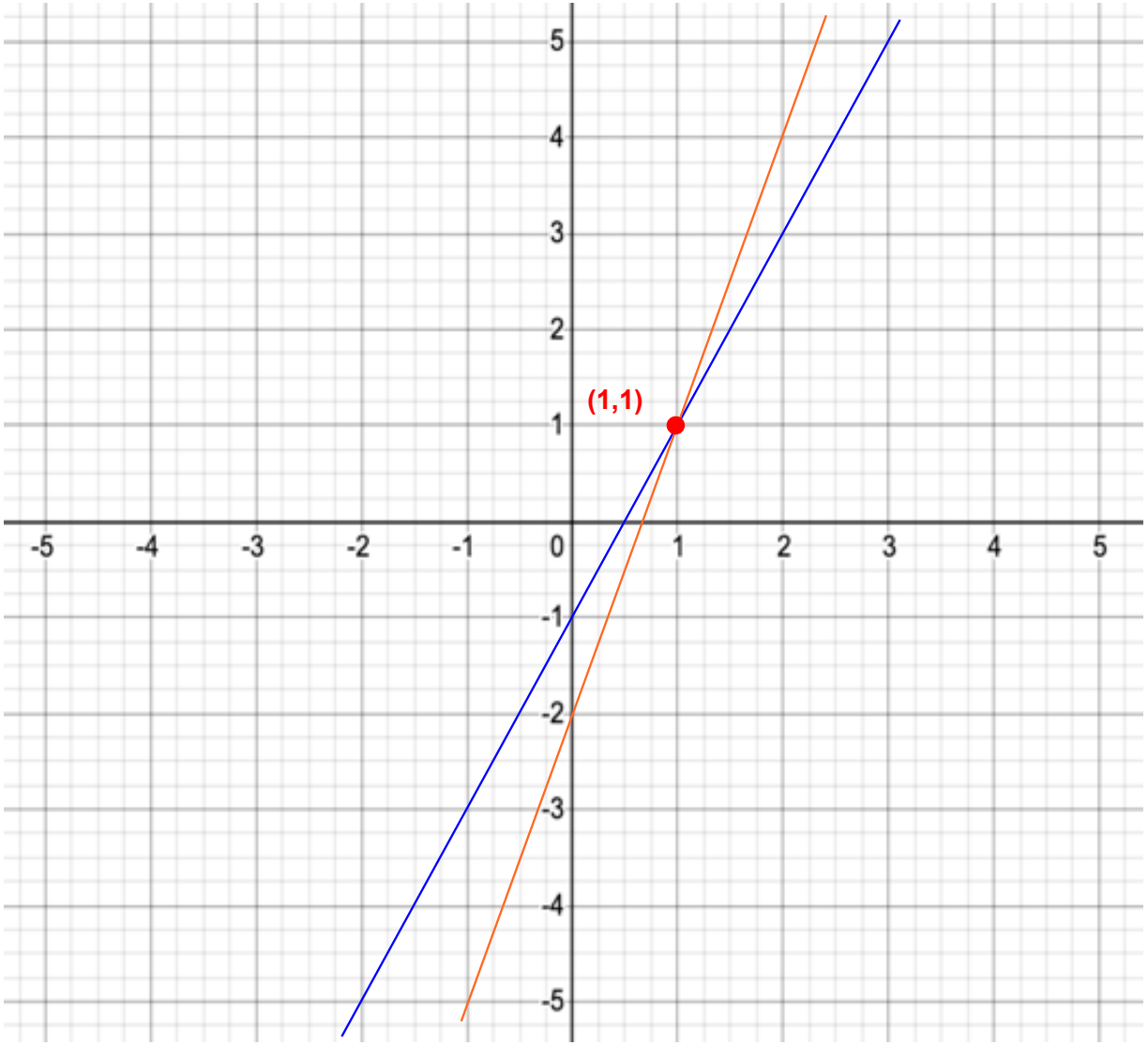
# Gradient of a line

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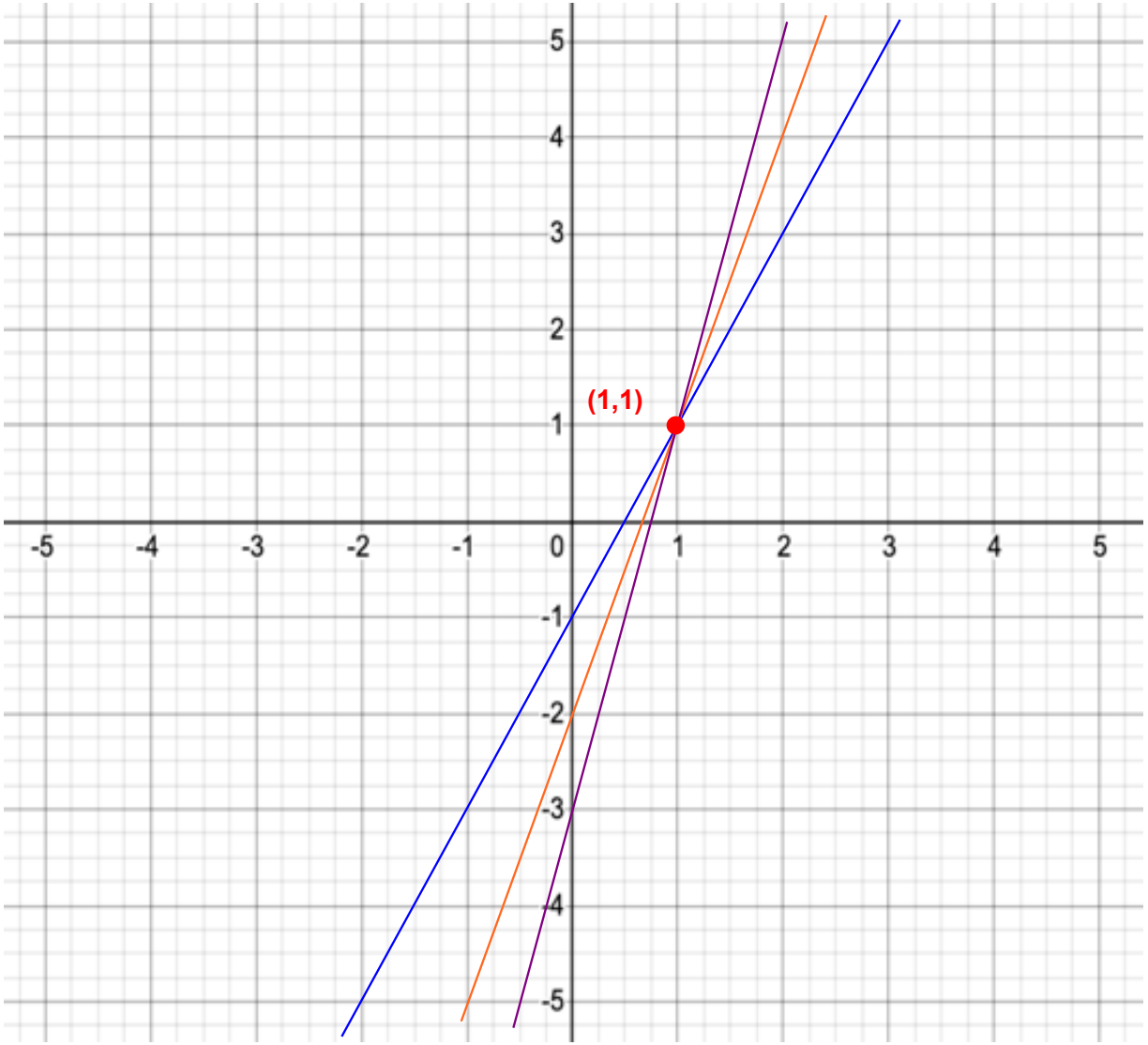


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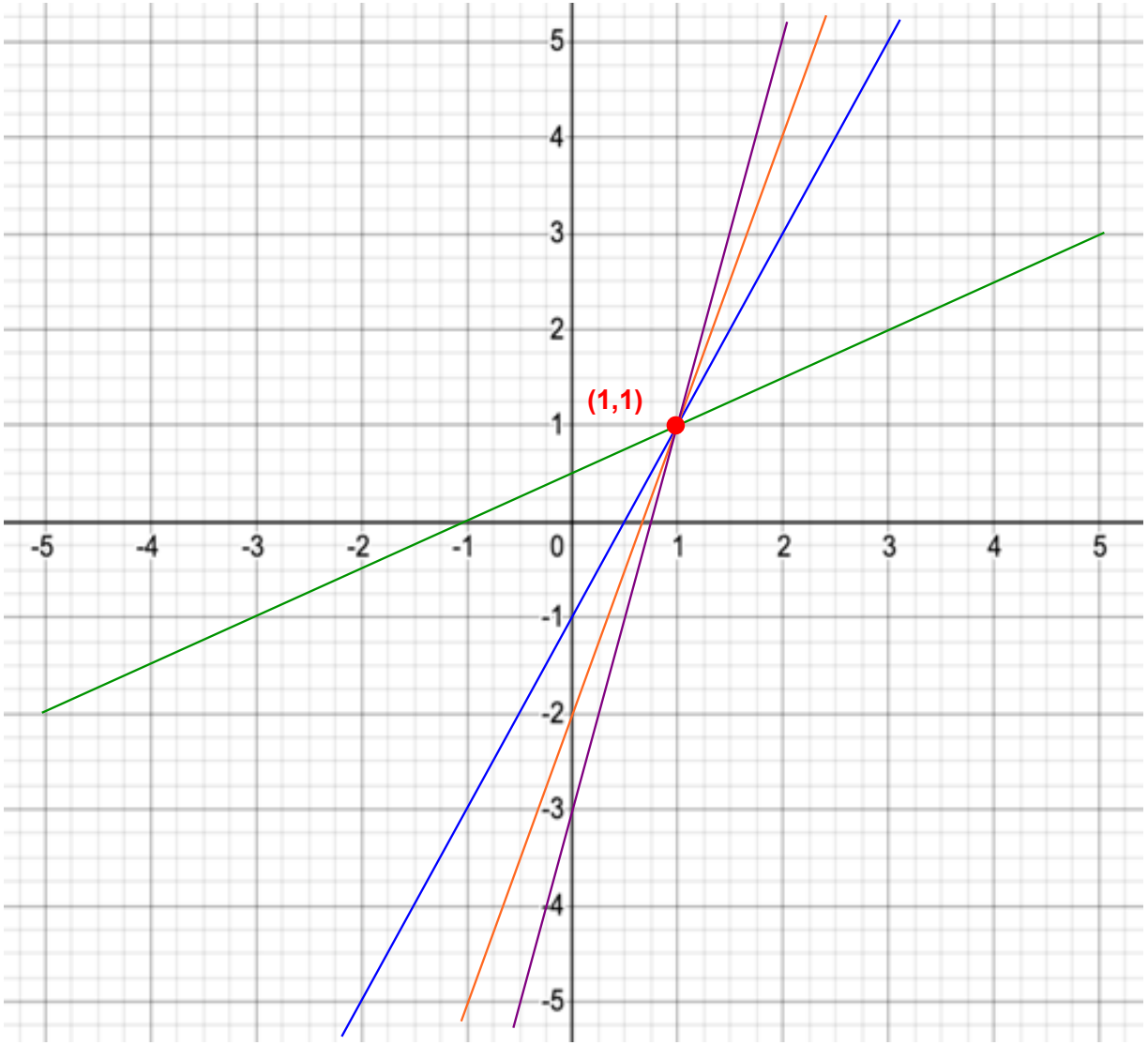


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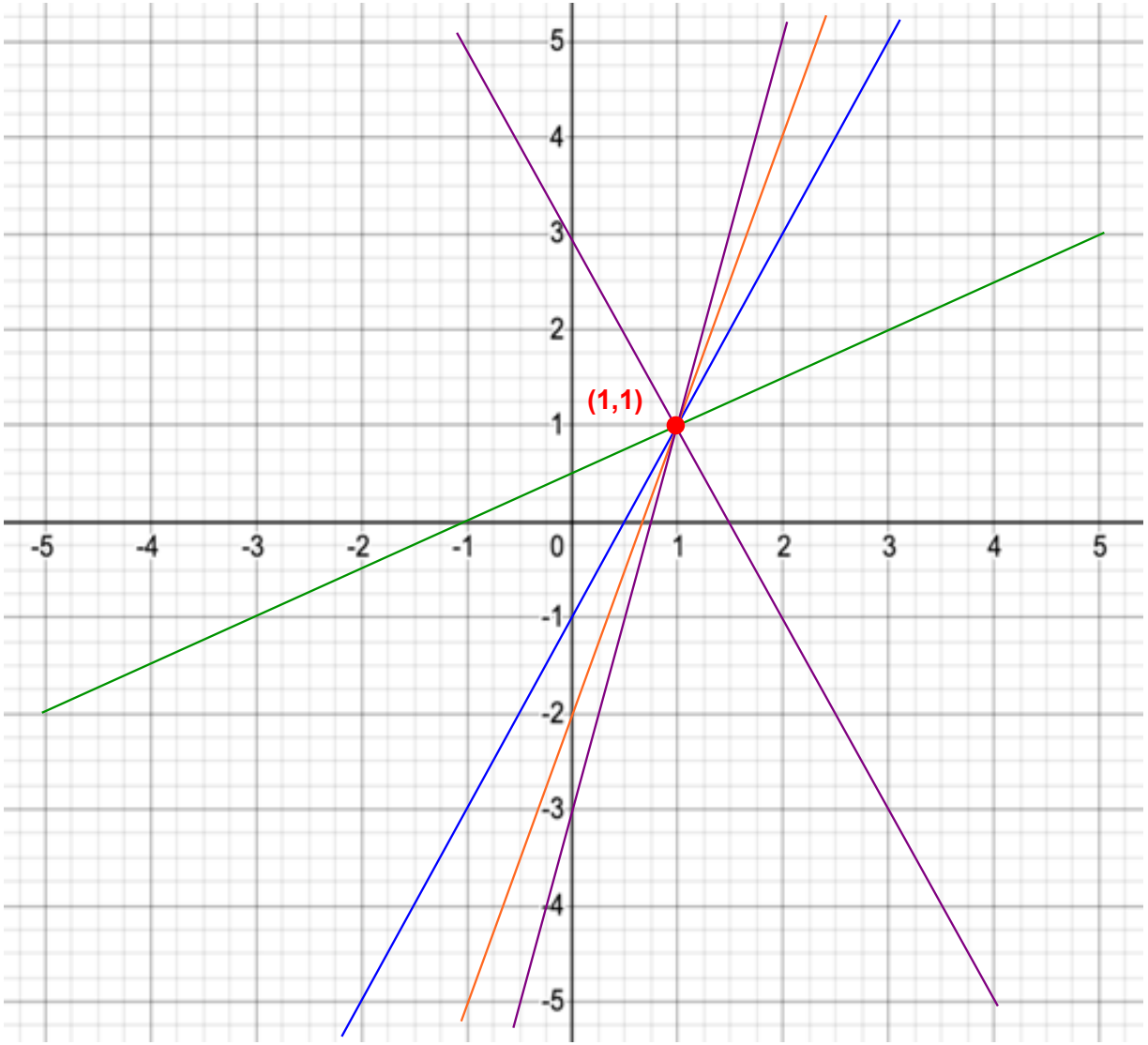


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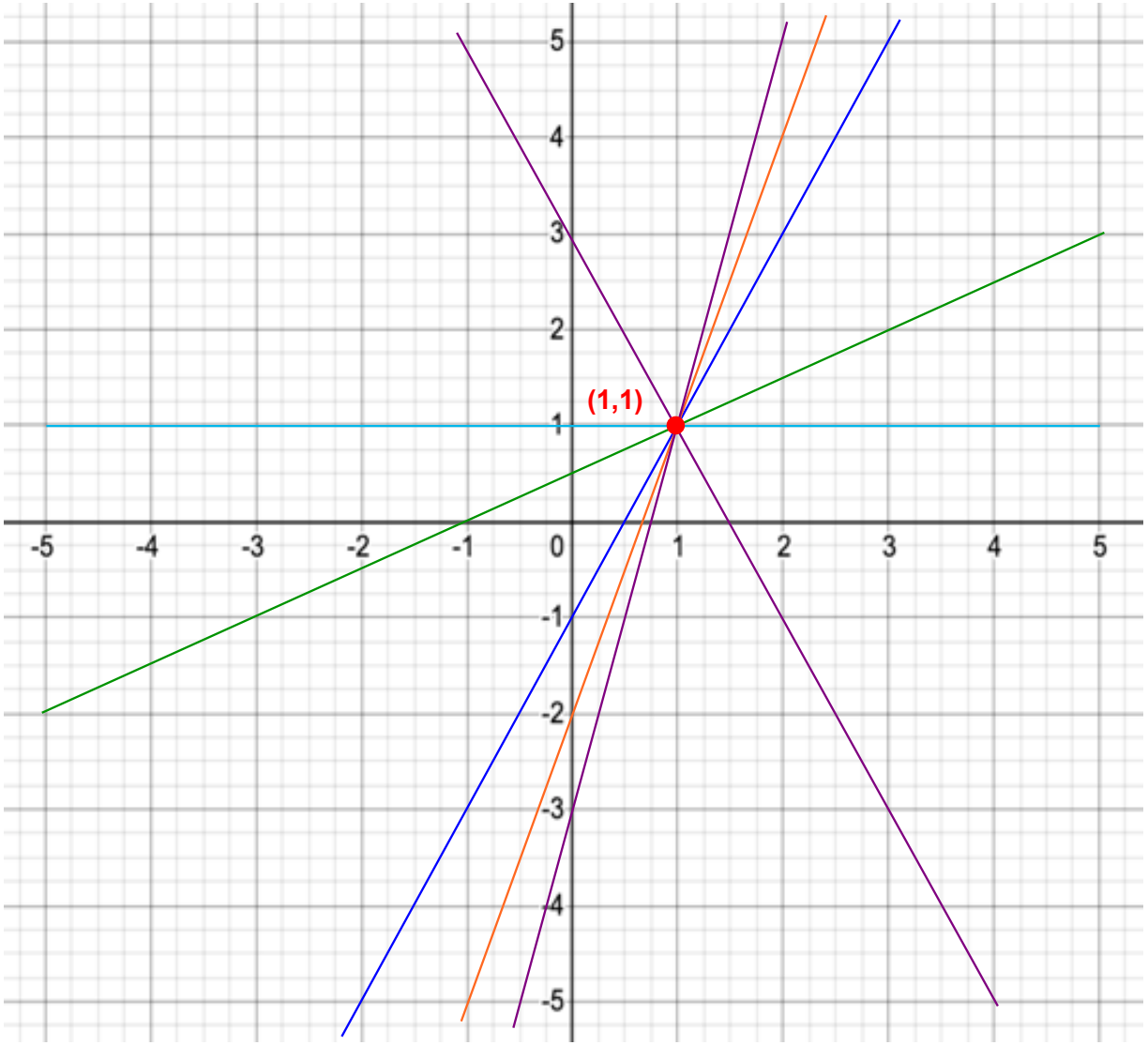


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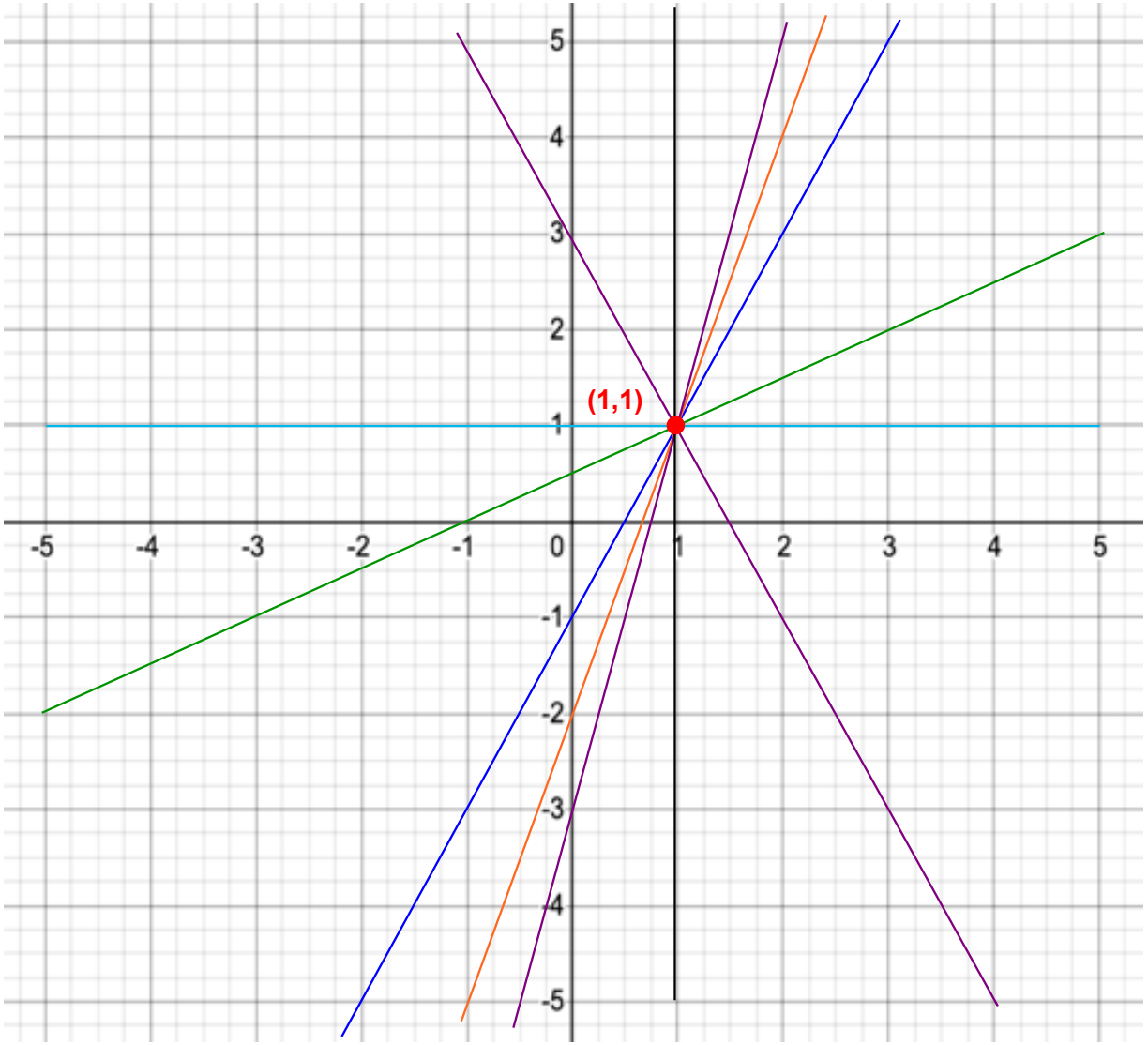


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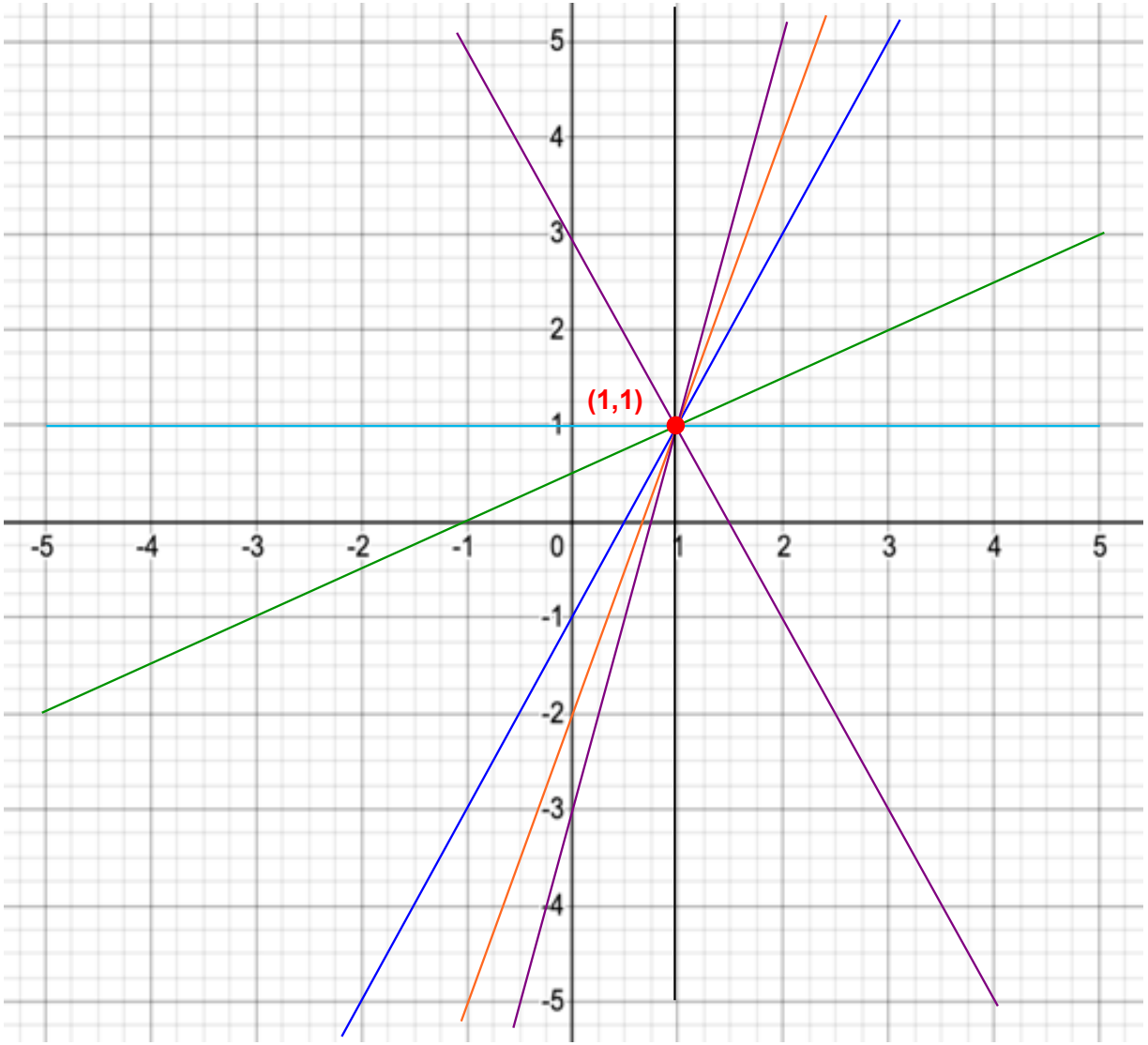


## Gradient

The **gradient** measures the steepness of a line.

i.e. How far you go vertically for each 1 unit you go to the right.

Gradients can be positive, negative, zero, or undefined.

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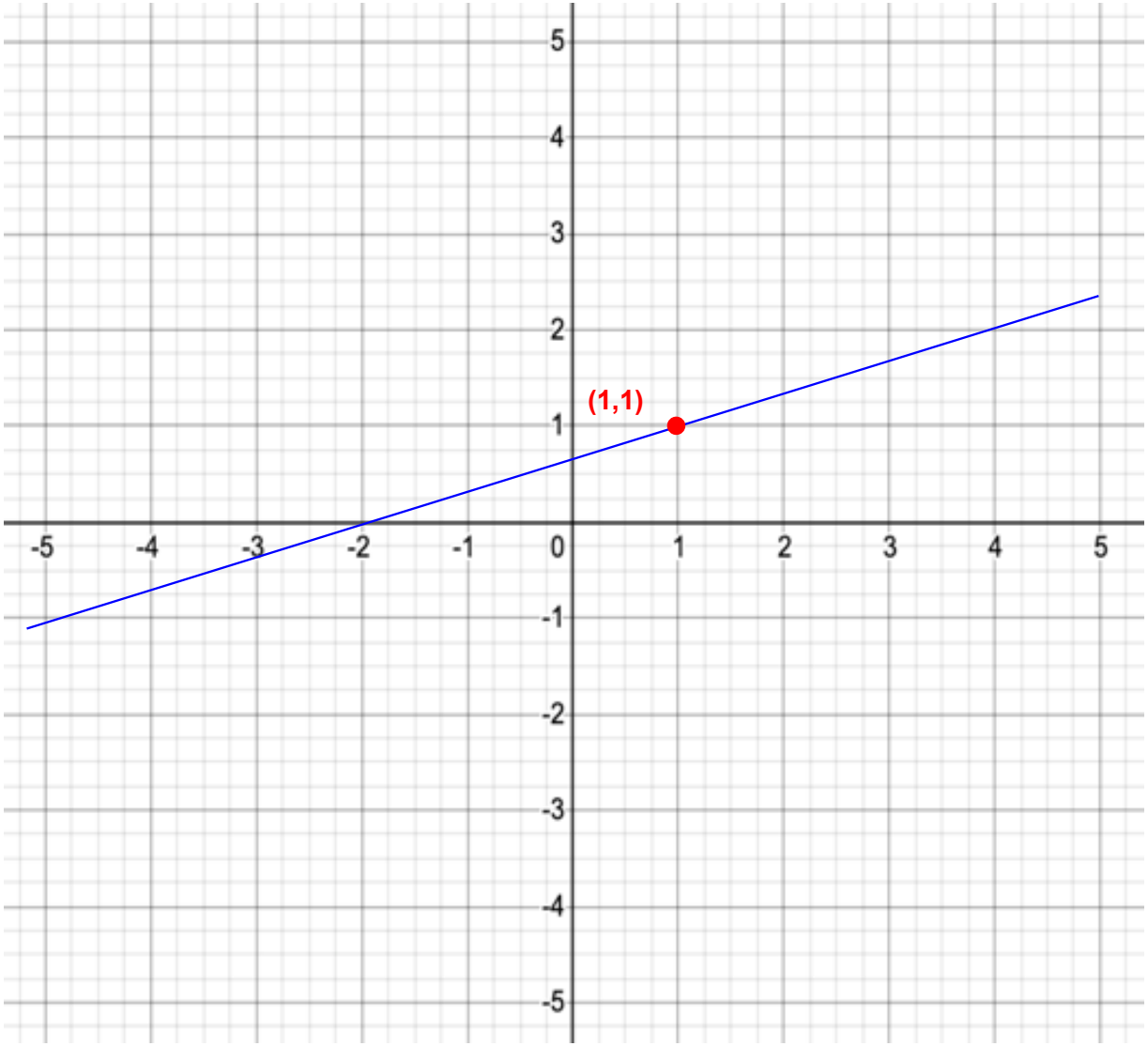
# Gradient of a line




## Gradient

The **gradient** measures the steepness of a line.

i.e. How far you go vertically for each 1 unit you go to the right.

Gradients can be positive, negative, zero, or undefined.

## Formula

Given two points $(x_1,y_1)$ and $(x_2,y_2)$, the gradient between them can be found using the formula:

$$\text{Gradient} = \frac{\text{change in } y}{\text{change in } x}$$

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

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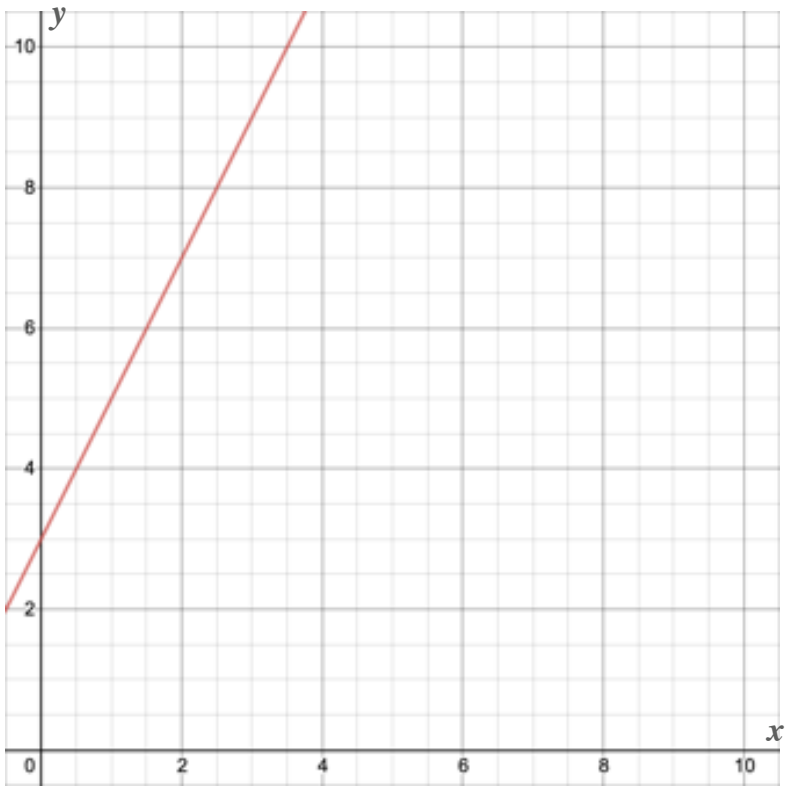
# Gradient of a line

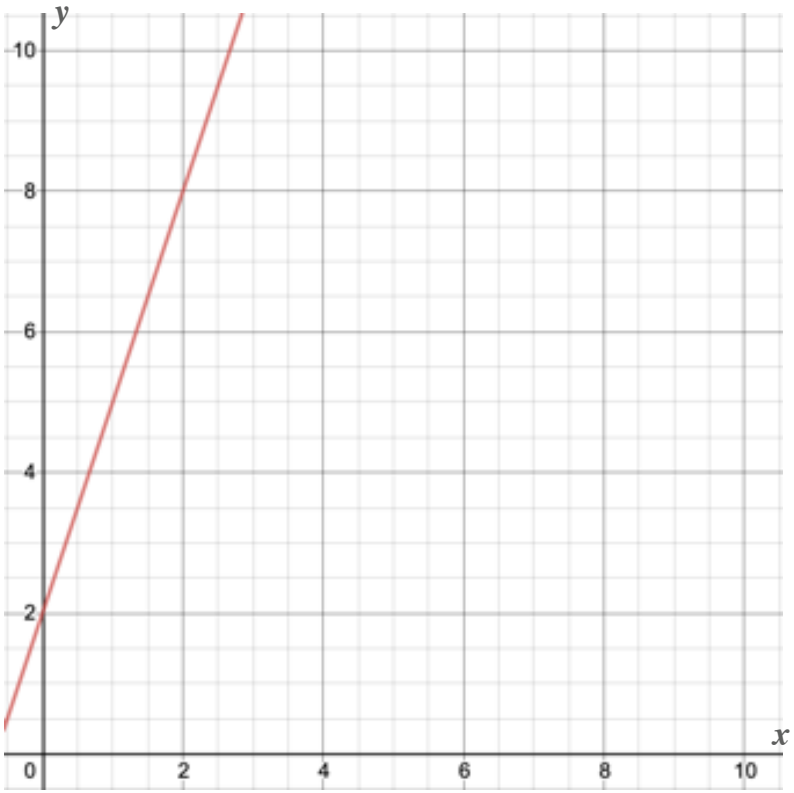
## My turn

Find the gradient, $m$, of the line shown on the graph below. Give your answer in its simplest form.




## Your turn

Find the gradient, $m$, of the line shown on the graph below. Give your answer in its simplest form.

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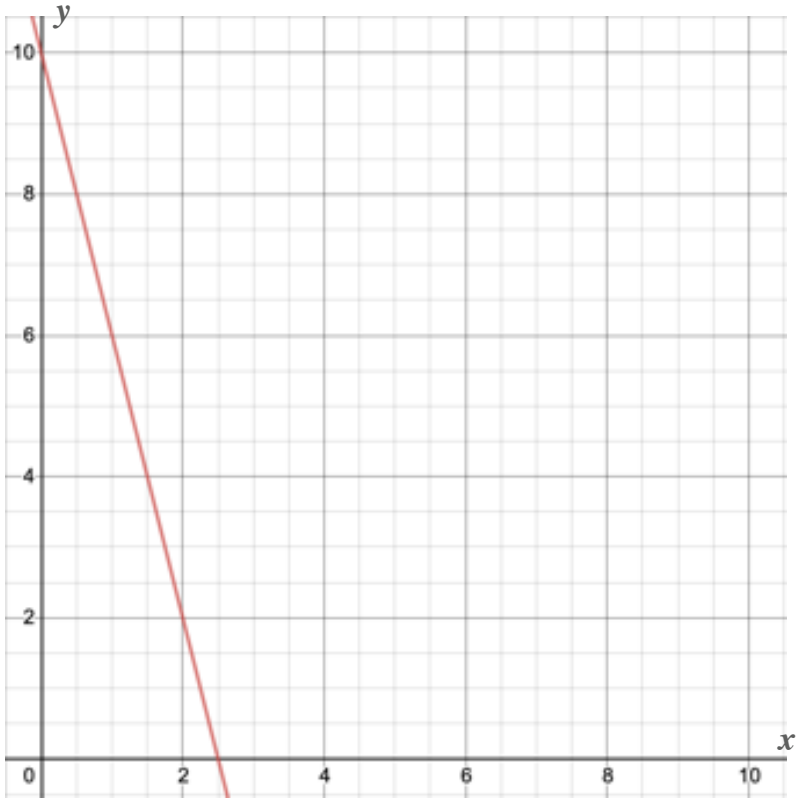
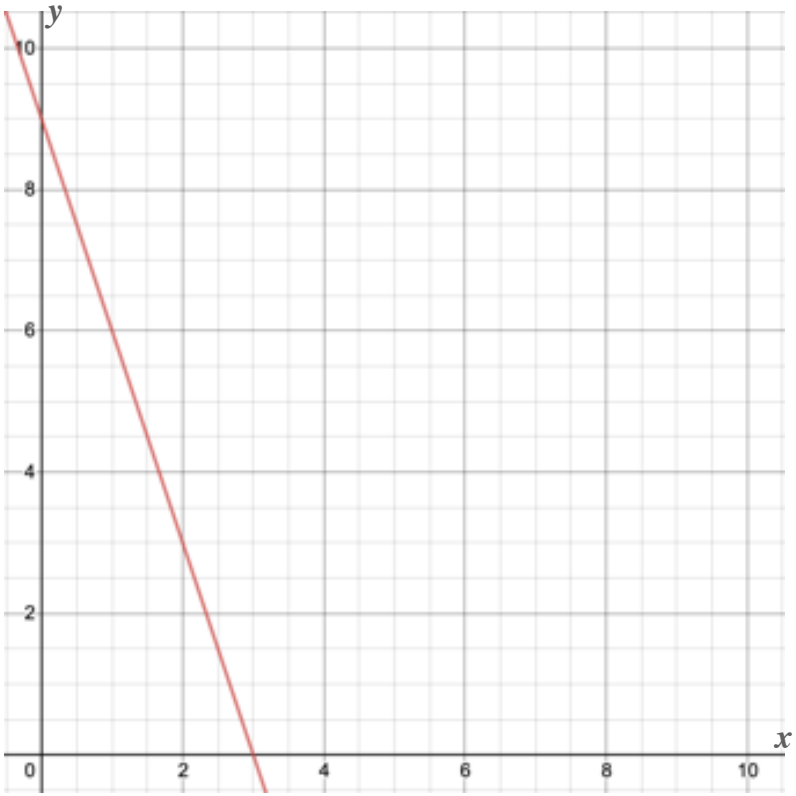



## Your turn

Find the gradient, $m$, of the line shown on the graph below. Give your answer in its simplest form.

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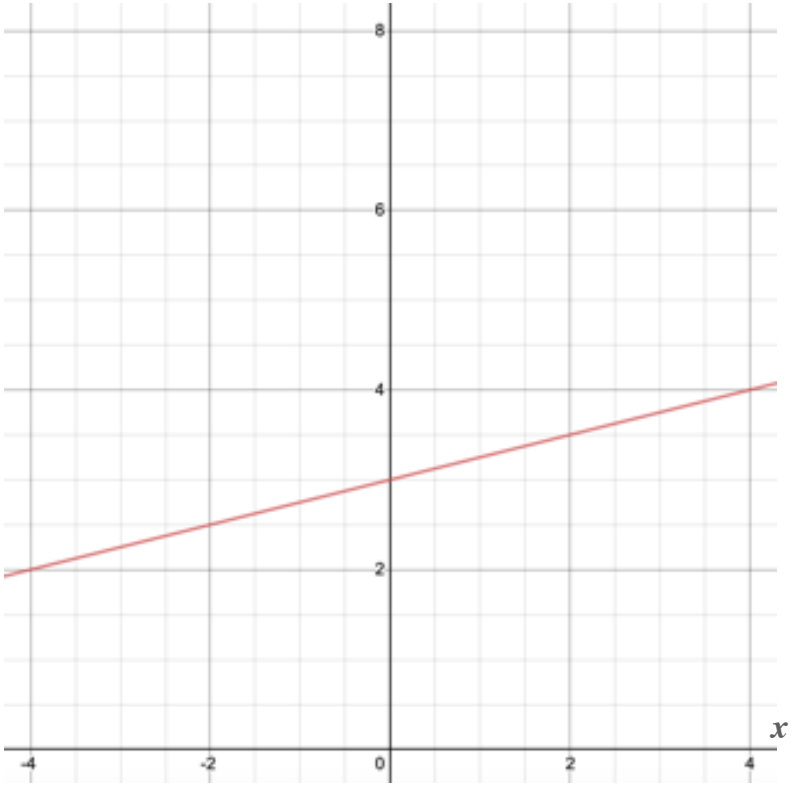
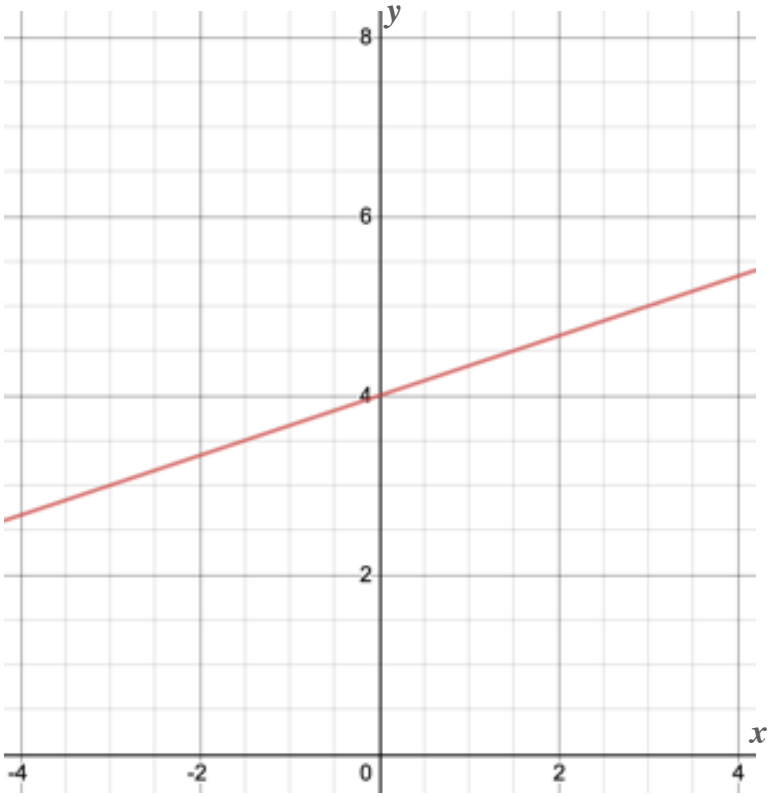
## My turn

Find the gradient, $m$, of the line shown on the graph below. Give your answer in its simplest form.




## Your turn

Find the gradient, $m$, of the line shown on the graph below. Give your answer in its simplest form.

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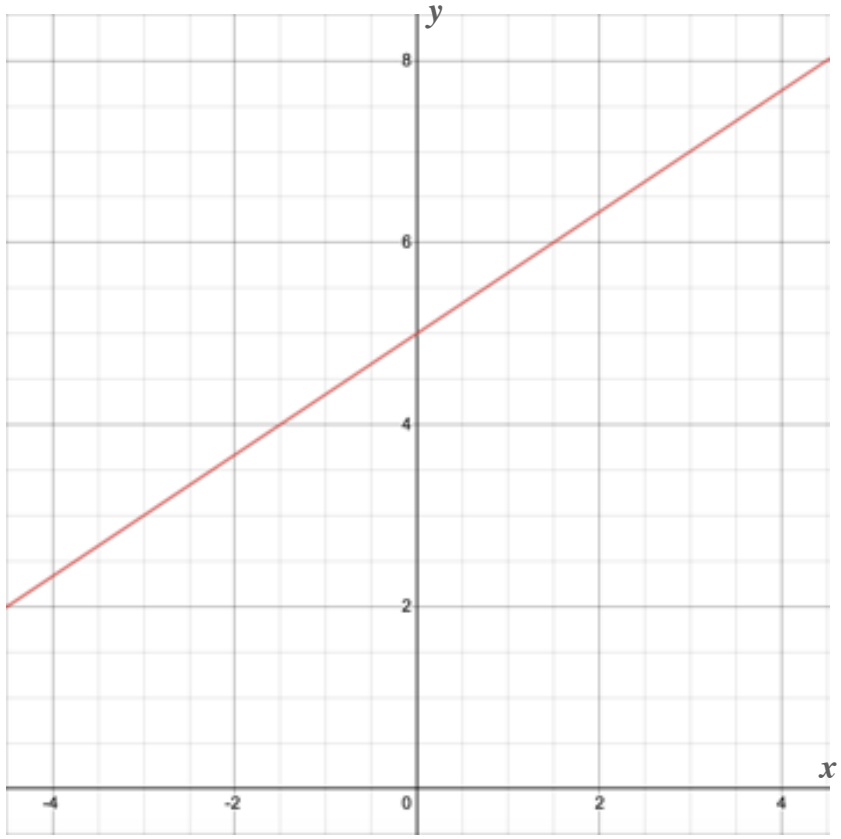
# Gradient of a line

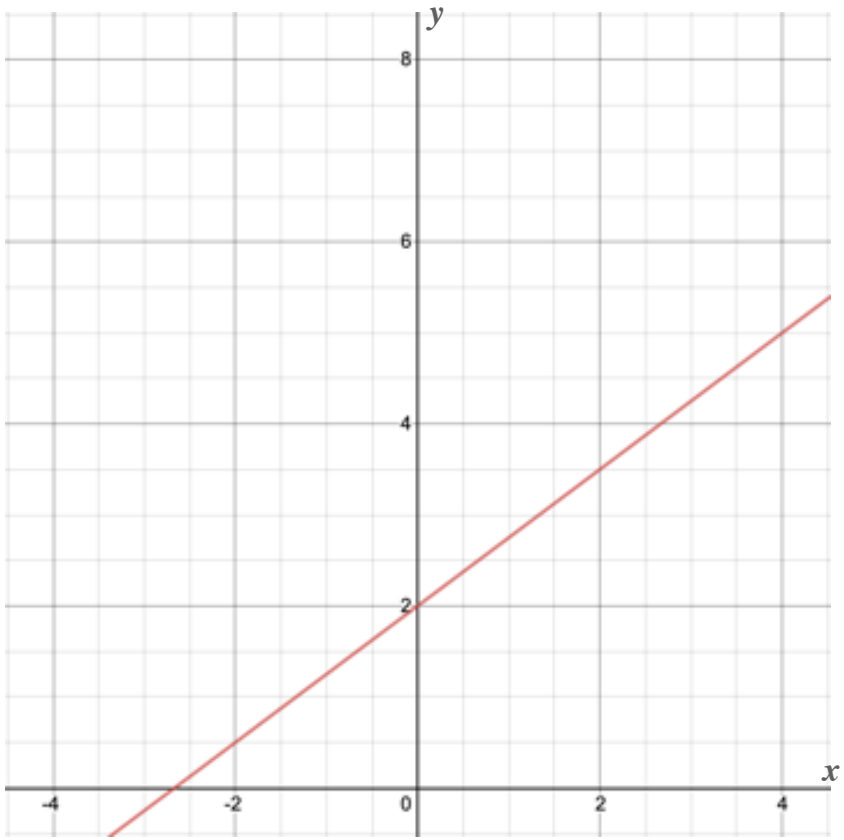
## My turn

Find the gradient, $m$, of the line shown on the graph below. Give your answer in its simplest form.




## Your turn

Find the gradient, $m$, of the line shown on the graph below. Give your answer in its simplest form.

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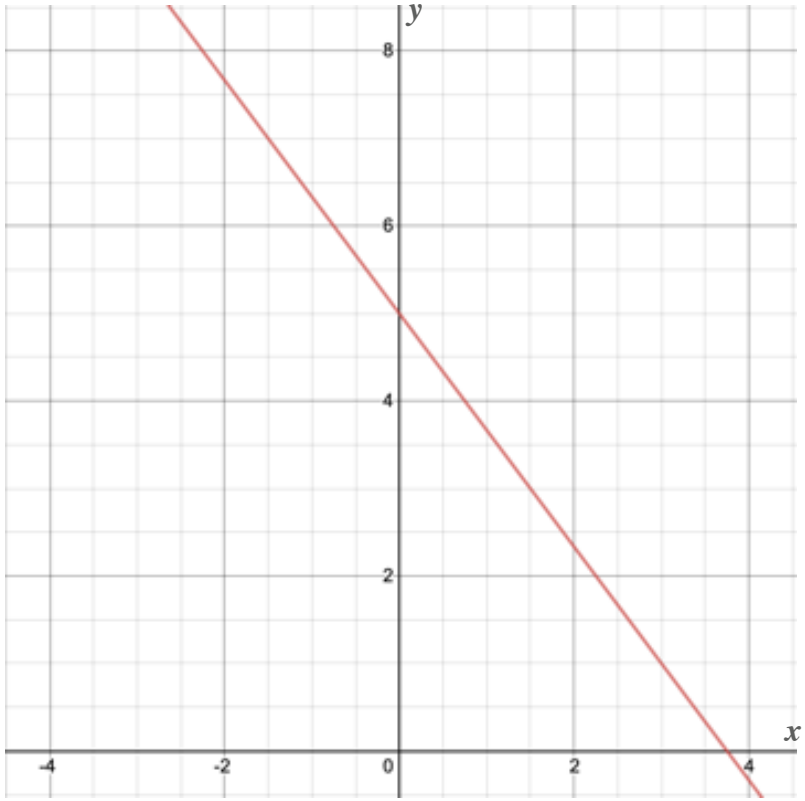
# Gradient of a line

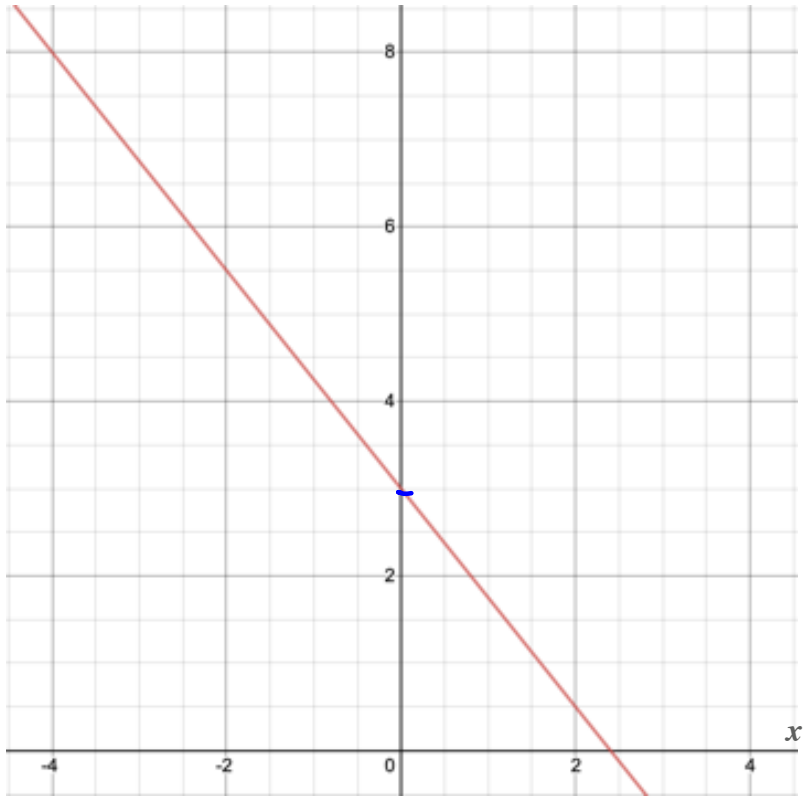
## My turn

Find the gradient, $m$, of the line shown on the graph below. Give your answer in its simplest form.




## Your turn

Find the gradient, $m$, of the line shown on the graph below. Give your answer in its simplest form.

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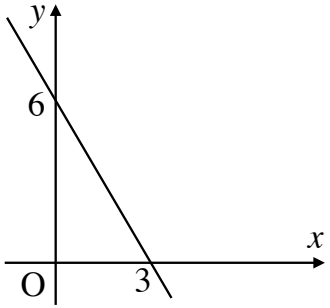
# Gradient of a line

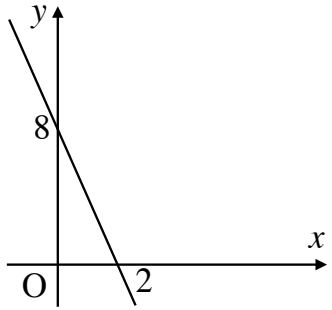
## My turn

Find the gradient, $m$, of the line shown on the graph below. Give your answer in its simplest form.




## Your turn

Find the gradient, $m$, of the line shown on the graph below. Give your answer in its simplest form.

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# Gradient of a line

## My turn

Find the gradient, $m$, of the line segments between the points (1,2) and (7,20).
Give your answer in its simplest form.

## Your turn

Find the gradient, $m$, of the line segments between the points (2,3) and (6,23).
Give your answer in its simplest form.

# Gradient of a line

## My turn

Find the gradient, $m$, of the line segments between the points (1,-8) and (3,-5).
Give your answer in its simplest form.

## Your turn

Find the gradient, $m$, of the line segments between the points (2,-6) and (5,7).
Give your answer in its simplest form.

# Gradient of a line

## My turn

Exam Q

$A(-3,6)$ and $P(a,2a)$ are two points, where $a$ is a constant. The gradient, $m$, of $AP$ is 4. Solve for $a$.

## Your turn

Exam Q

$A(-1,3)$ and $P(a,5a)$ are two points, where $a$ is a constant. The gradient, $m$, of $AP$ is 7. Solve for $a$.

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# Gradient of a line

## My turn

Exam Q

$A(-2,4)$ and $P(a,b)$ are two points, where $a$ and $b$ are constants. The gradient, $m$, of $AP$ is 3.

Find an expression for $b$ in terms of $a$.

## Your turn

Exam Q

$A(-1,6)$ and $P(a,b)$ are two points, where $a$ and $b$ are constants. The gradient, $m$, of $AP$ is 4.

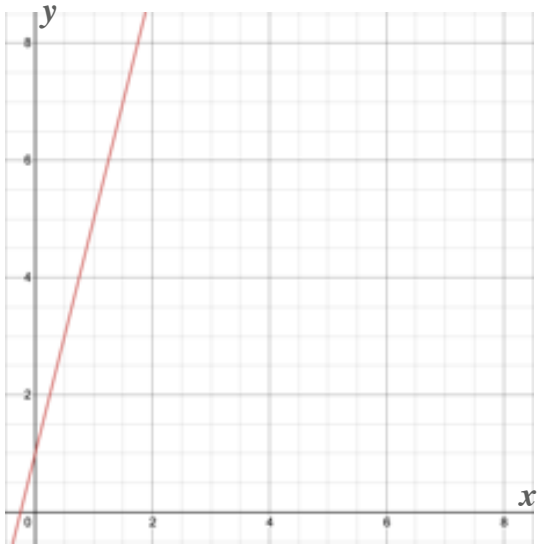
Find an expression for $b$ in terms of $a$.

# Gradient of a line

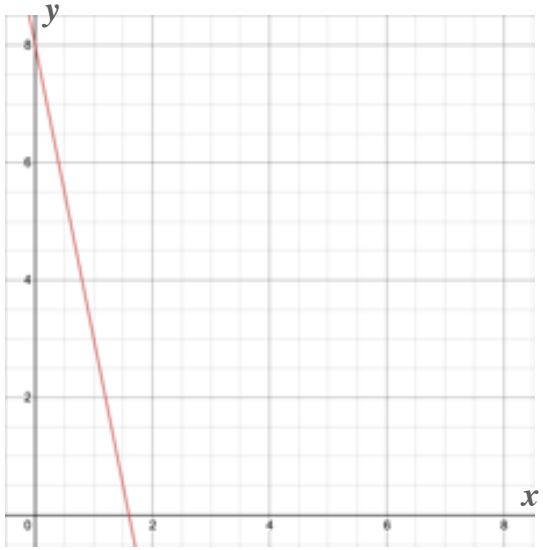
## Review Exercise Part 1

Find the gradient, $m$, of the lines shown on the following graphs.
Give your answers in their simplest form where appropriate.

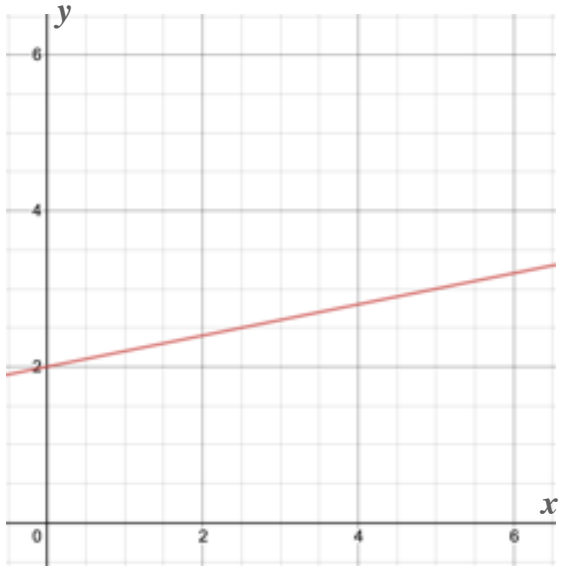
**1.**




**2.**




**3.**



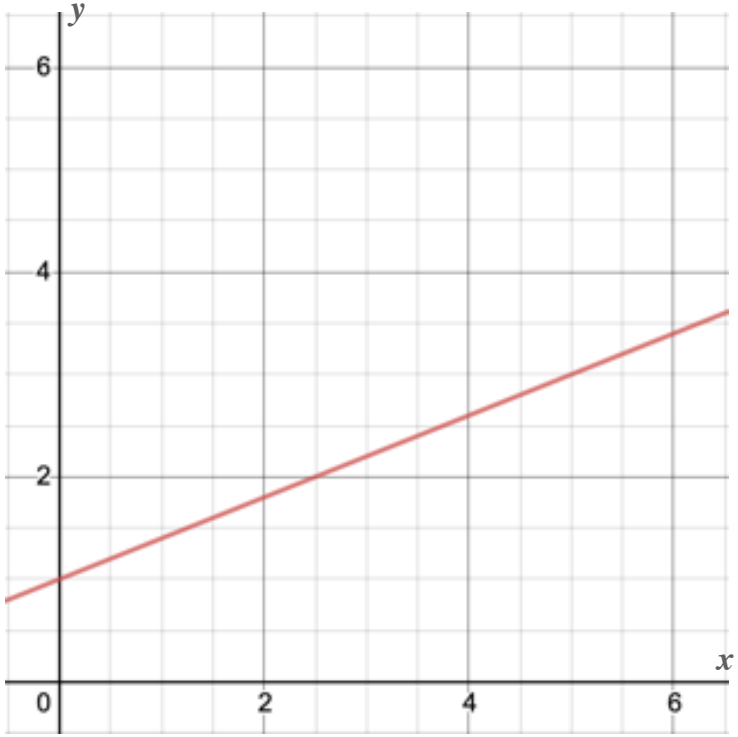
# Gradient of a line

## Review Exercise Part 2

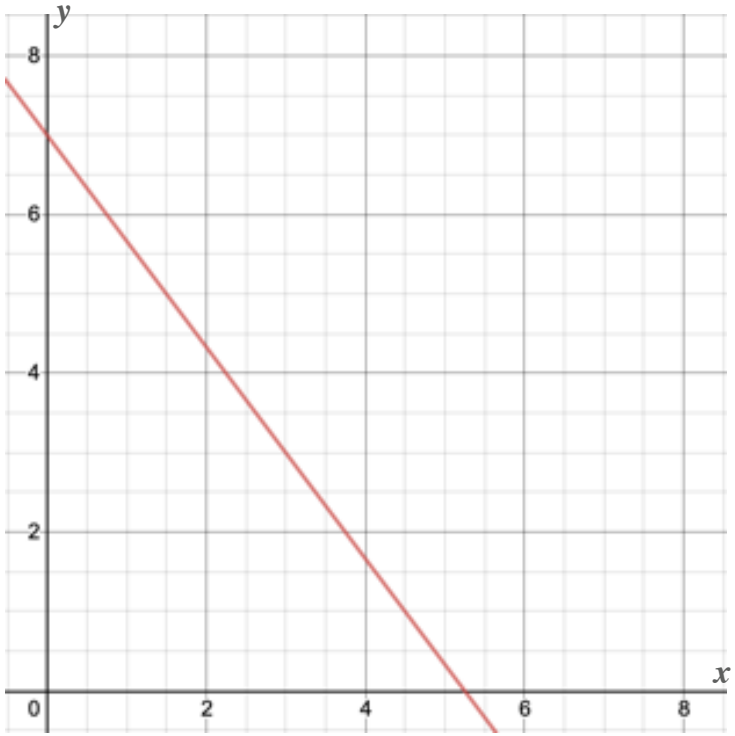
Find the gradient, $m$, of the lines shown on the following graphs.

Give your answers in their simplest form where appropriate.

**4.**




**5.**

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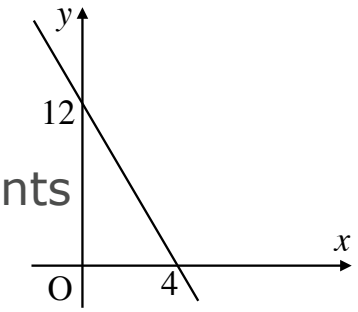
# Gradient of a line

## Review Exercise Part 3

**6.** Find the gradient, $m$, of the line shown on the graph. Give your answer in its simplest form.




**7.** Find the gradient, $m$, of the line segments between the points (1,4) and (5,28). Give your answer in its simplest form.

**8.** Find the gradient, $m$, of the line segments between the points (2,-9) and (5,-4). Give your answer in its simplest form.

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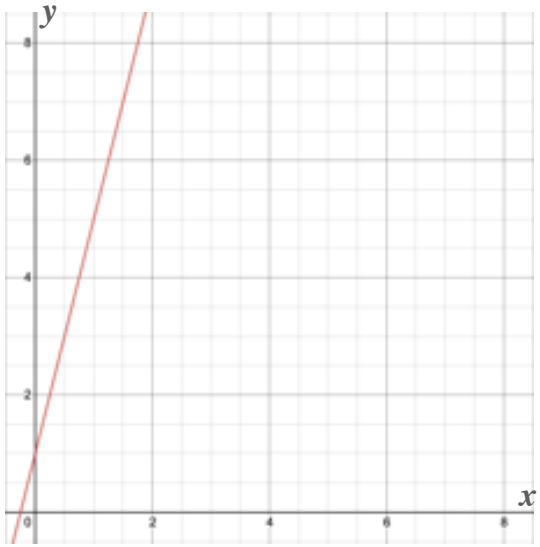
# Gradient of a line

## Review Exercise Part 1 (Answers)

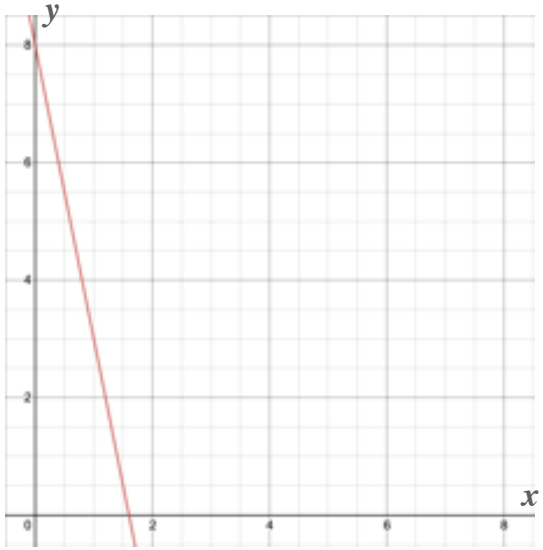
Find the gradient, $m$, of the lines shown on the following graphs.
Give your answers in their simplest form where appropriate.

**1.**



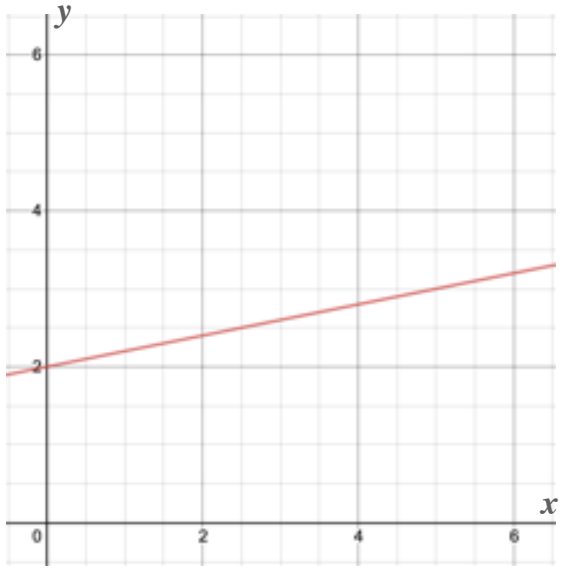

$m = 4$

**2.**




$m = 5$

**3.**




$m = \frac{1}{5}$

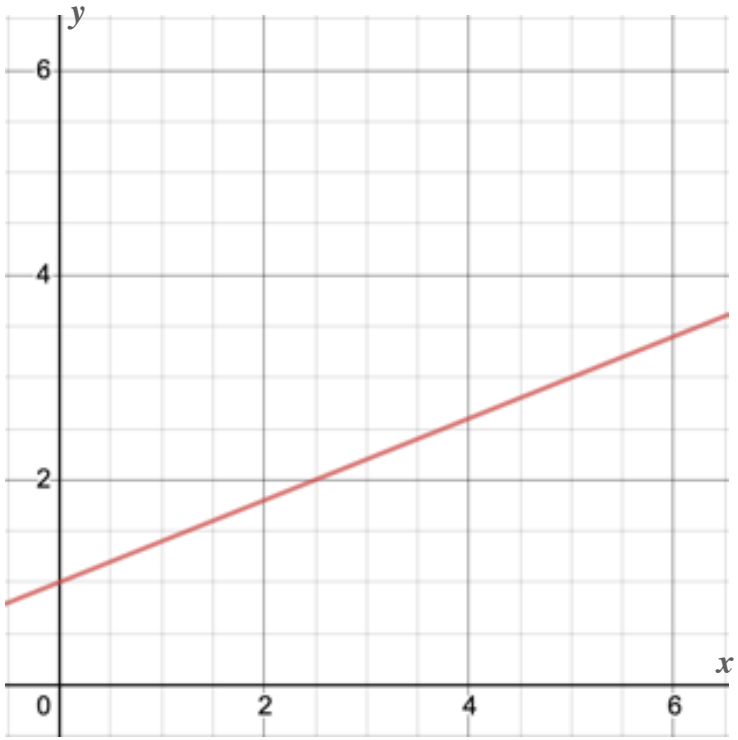
# Gradient of a line

## Review Exercise Part 2 (Answers)

Find the gradient, $m$, of the lines shown on the following graphs.

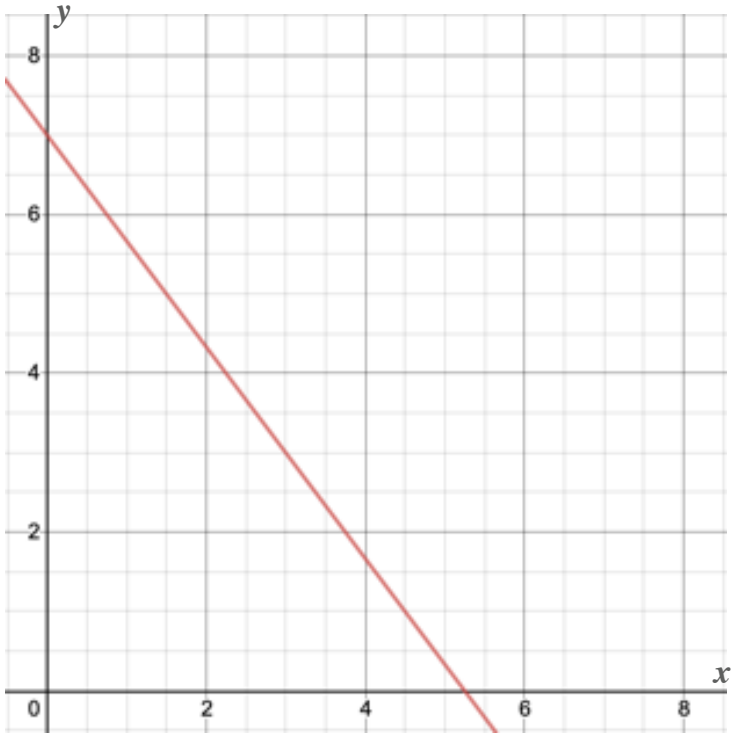
Give your answers in their simplest form where appropriate.

**4.**




$m = \frac{2}{5}$

**5.**




$m = -\frac{4}{3}$

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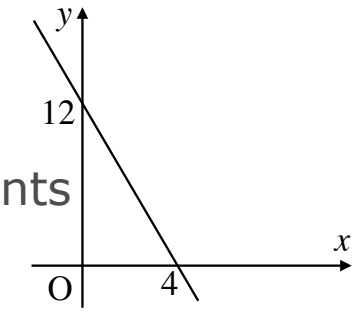
# Gradient of a line

## Review Exercise Part 3 (Answers)

**6.** Find the gradient, $m$, of the line shown on the graph. Give your answer in its simplest form. $m = -3$




**7.** Find the gradient, $m$, of the line segments between the points (1,4) and (5,28). Give your answer in its simplest form.

$m = 6$

**8.** Find the gradient, $m$, of the line segments between the points (2,-9) and (5,-4). Give your answer in its simplest form.

$m = \frac{5}{3}$

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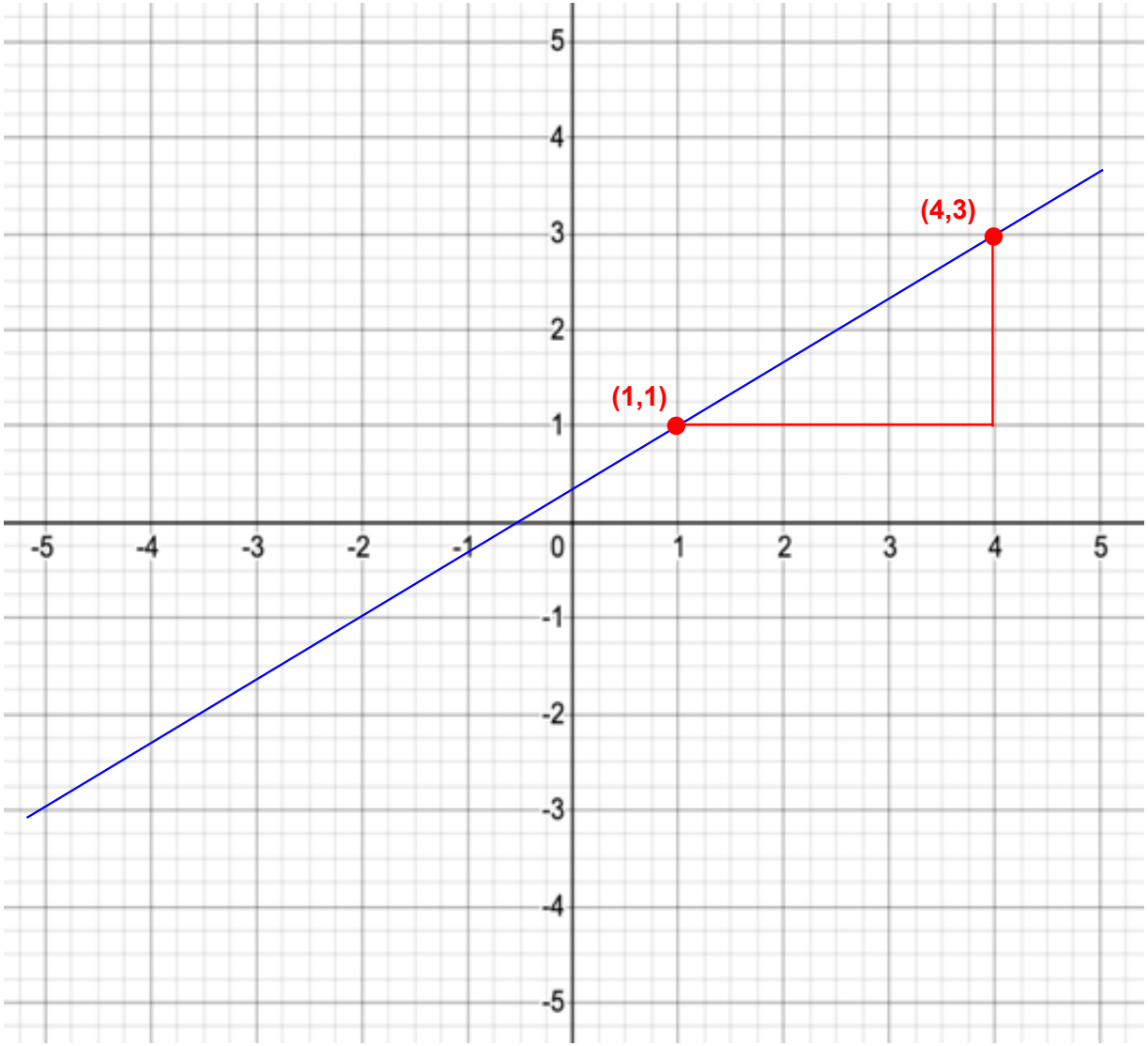
# Gradient of a line (2)

## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A pen and paper
- Can do attitude

# Gradient of a line (2)




## Gradient

Given two points $(x_1, y_1)$ and $(x_2, y_2)$, the gradient between them can be found using the formula:

$$\text{Gradient} = \frac{\text{change in } y}{\text{change in } x}$$

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

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# Gradient of a line (2)

## My turn

**Exam Q**

$A(7,9a)$ and $P(10,4a)$ are two points, where $a$ is a constant. Write the gradient, $m$, in terms of $a$. Give your answer in its simplest form.

## Your turn

**Exam Q**

$A(4,8a)$ and $P(11,2a)$ are two points, where $a$ is a constant. Write the gradient, $m$, in terms of $a$. Give your answer in its simplest form.

# Gradient of a line (2)

## My turn

Exam Q

$A(2a,5)$ and $P(7a,8)$ are two points, where $a$ is a constant. The gradient, $m$, of $AP$ is 6. Solve for $a$. Give your answer in its simplest form.

## Your turn

Exam Q

$A(3a,7)$ and $P(5a,12)$ are two points, where $a$ is a constant. The gradient, $m$, of $AP$ is 10. Solve for $a$. Give your answer in its simplest form.

# Gradient of a line (2)

## My turn

Exam Q

$A(-3,6)$ and $P(a,2a)$ are two points, where $a$ is a constant. The gradient, $m$, of $AP$ is 4. Solve for $a$.

## Your turn

Exam Q

$A(-1,3)$ and $P(a,5a)$ are two points, where $a$ is a constant. The gradient, $m$, of $AP$ is 7. Solve for $a$.

# Gradient of a line (2)

## My turn

Exam Q

$A(-2,4)$ and $P(a,b)$ are two points, where $a$ and $b$ are constants. The gradient, $m$, of $AP$ is 3.

Find an expression for $b$ in terms of $a$.

## Your turn

Exam Q

$A(-1,6)$ and $P(a,b)$ are two points, where $a$ and $b$ are constants. The gradient, $m$, of $AP$ is 4.

Find an expression for $b$ in terms of $a$.

# Gradient of a line (2)

## Review Exercise

**1.** $A(5,9a)$ and $P(14,7a)$ are two points, where $a$ is a constant.
Write the gradient, $m$, in terms of $a$.
Give your answer in its simplest form.

**2.** $A(3a,6)$ and $P(9a,10)$ are two points, where $a$ is a constant.
The gradient, $m$, of $AP$ is 8. Solve for $a$.
Give your answer in its simplest form.

**3.** $A(-2,5)$ and $P(a,5a)$ are two points, where $a$ is a constant.
The gradient, $m$, of $AP$ is 8. Solve for $a$.

**4.** $A(-3,8)$ and $P(a,b)$ are two points, where $a$ and $b$ are constants.
The gradient, $m$, of $AP$ is 2. Find an expression for $b$ in terms of $a$.

## Extra Practice

**5.** $A(9a,8a)$ and $P(6a,-7a)$ are two points, where $a$ is a constant.
Find the gradient, $m$. Give your answer in its simplest form.

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# Gradient of a line (2)

## Review Exercise (Answers)

**1.** $A(5,9a)$ and $P(14,7a)$ are two points, where $a$ is a constant.
Write the gradient, $m$, in terms of $a$.
Give your answer in its simplest form.

$m=-\frac{2}{9}a$

**2.** $A(3a,6)$ and $P(9a,10)$ are two points, where $a$ is a constant.
The gradient, $m$, of $AP$ is 8. Solve for $a$.
Give your answer in its simplest form.

$a=\frac{1}{12}$

**3.** $A(-2,5)$ and $P(a,5a)$ are two points, where $a$ is a constant.
The gradient, $m$, of $AP$ is 8. Solve for $a$.

$a=-7$

**4.** $A(-3,8)$ and $P(a,b)$ are two points, where $a$ and $b$ are constants.
The gradient, $m$, of $AP$ is 2. Find an expression for $b$ in terms of $a$.

$b=2a+14$

### Extra Practice

**5.** $A(9a,8a)$ and $P(6a,-7a)$ are two points, where $a$ is a constant.
Find the gradient, $m$. Give your answer in its simplest form.

$m=5$

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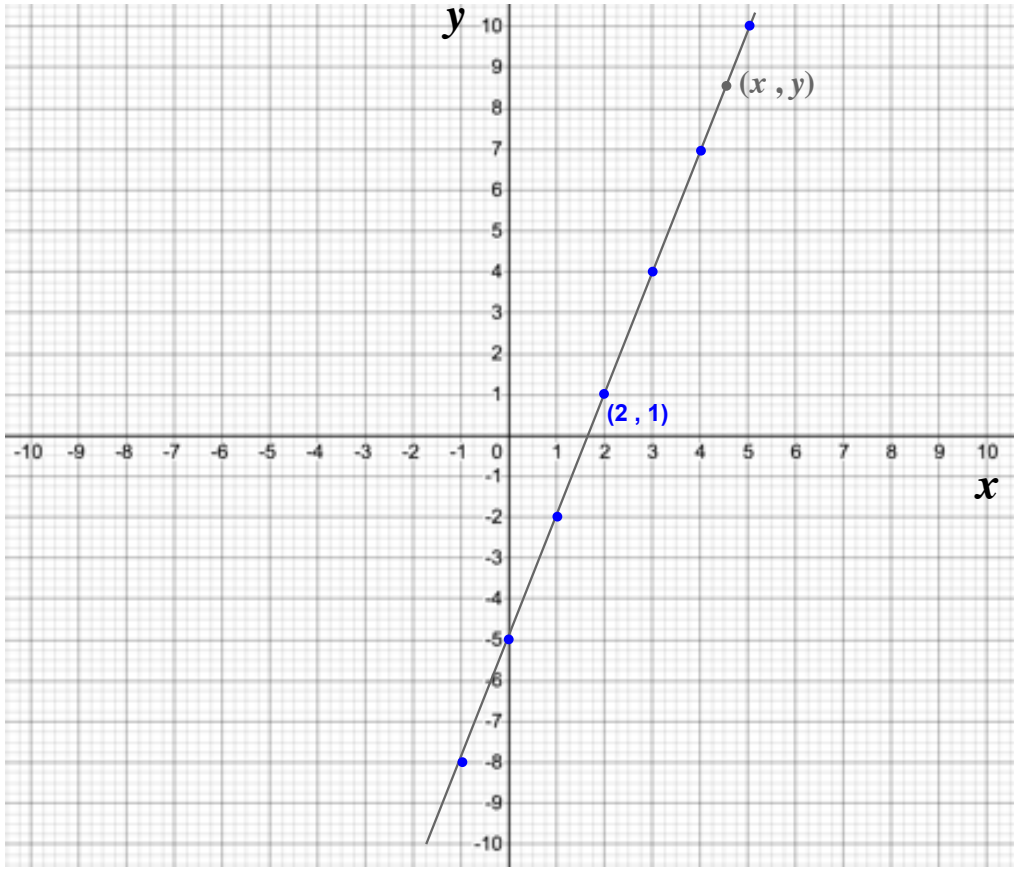
# Equation of a line (1)

## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A pen and paper
- Can do attitude

# Equation of a line (1)




$m = 3$

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# Equation of a line (1)

## Equation of lines

1. $y - y_1 = m(x - x_1)$ — $m$ is the gradient and $(x_1, y_1)$ is a point on the line.

2. $y = mx + c$ — $m$ is the gradient and $c$ is the $y$-intercept

3. $ax + by + c = 0$ — $a$, $b$ and $c$ are integers.

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# Equation of a line (1)

## My turn

Give the gradient and $y$-intercept of the following straight lines:

a) $y = 3x + 7$

b) $y = 10 - 2x$

c) $y = \frac{1}{2}x - \frac{5}{2}$

## Your turn

Give the gradient and $y$-intercept of the following straight lines:

a) $y = 5x + 11$

b) $y = 14 - 3x$

c) $y = \frac{1}{4}x - \frac{7}{4}$

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# Equation of a line (1)

## My turn

Exam Q

Find the gradient and $y$-intercept of the line with equation $4x+6y=11$.

## Your turn

Exam Q

Find the gradient and $y$-intercept of the line with equation $3x+6y=8$.

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# Equation of a line (1)

## My turn

Write the equation $y=6x-13$ in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

## Your turn

Write the equation $y=-5x+7$ in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

# Equation of a line (1)

## My turn

Exam Q

Write the equation $y=\frac{2}{3}x-\frac{4}{5}$ in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

## Your turn

Exam Q

Write the equation $y=\frac{3}{4}x-\frac{2}{5}$ in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

# Equation of a line (1)

## My turn

Exam Q

Write the equation $\frac{1}{2}(6x+5)=4(y-1)$ in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

## Your turn

Exam Q

Write the equation $\frac{1}{3}(9x+2)=5(y-1)$ in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

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# Equation of a line (1)

## Review Exercise

**1.** Give the gradient and $y$-intercept of the following straight lines:

a) $y=4x+13$

b) $y=16-5x$

c) $y=\frac{1}{3}x+\frac{8}{3}$

**2.** Find the gradient and $y$-intercept of the line with equation $2x+8y=13$. Simplify your answers fully.

**3.** Write the equation $y=7x-16$ in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

**4.** Write the equation $y=\frac{5}{3}x-\frac{3}{4}$ in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

**5.** Write the equation $\frac{1}{4}(8x+7)=3(y-1)$ in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

### Extra Practice

**6.** Find the gradient and $y$-intercept of the line with equation $4x+7y-15=0$.

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# Equation of a line (1)

## Review Exercise (Answers)

**1.** Give the gradient and $y$-intercept of the following straight lines:

a) $y=4x+13$ $m=4$ $c=13$

b) $y=16-5x$ $m=-5$ $c=16$

c) $y=\frac{1}{3}x+\frac{8}{3}$ $m=\frac{1}{3}$ $c=\frac{8}{3}$

**2.** Find the gradient and $y$-intercept of the line with equation $2x+8y=13$. Simplify your answers fully.

$m=-\frac{1}{4}$ $c=\frac{13}{8}$

**3.** Write the equation $y=7x-16$ in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

$7x-y-16=0$ or $-7x+y+16=0$

**4.** Write the equation $y=\frac{5}{3}x-\frac{3}{4}$ in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

$20x-12y-9=0$ or $-20x+12y+9=0$

**5.** Write the equation $\frac{1}{4}(8x+7)=3(y-1)$ in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

$8x-12y+19=0$ or $-8x+12y-19=0$

### Extra Practice

**6.** Find the gradient and $y$-intercept of the line with equation $4x+7y-15=0$.

$m=-\frac{4}{7}$ $c=\frac{15}{7}$

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# Equation of a line (2)

## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A pen and paper
- Can do attitude

# Equation of a line (2)

## Gradient

Given two points $(x_1,y_1)$ and $(x_2,y_2)$, the gradient between them can be found using the formula:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

## Equation of lines

1. $y - y_1 = m(x - x_1)$ — $m$ is the gradient and $(x_1,y_1)$ is a point on the line.

2. $y = mx + c$ — $m$ is the gradient and $c$ is the $y$-intercept

3. $ax + by + c = 0$ — $a$, $b$ and $c$ are integers.

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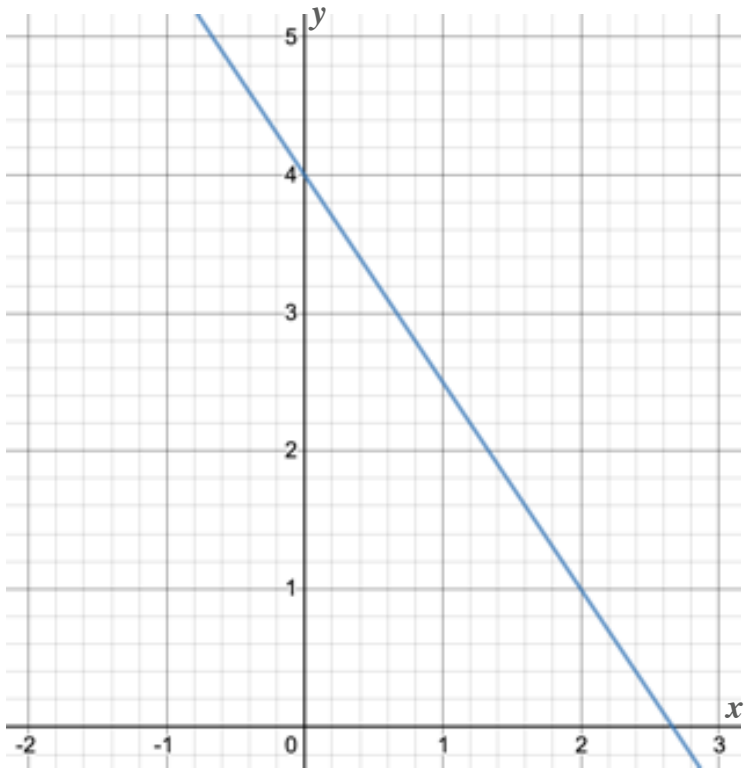
# Equation of a line (2)

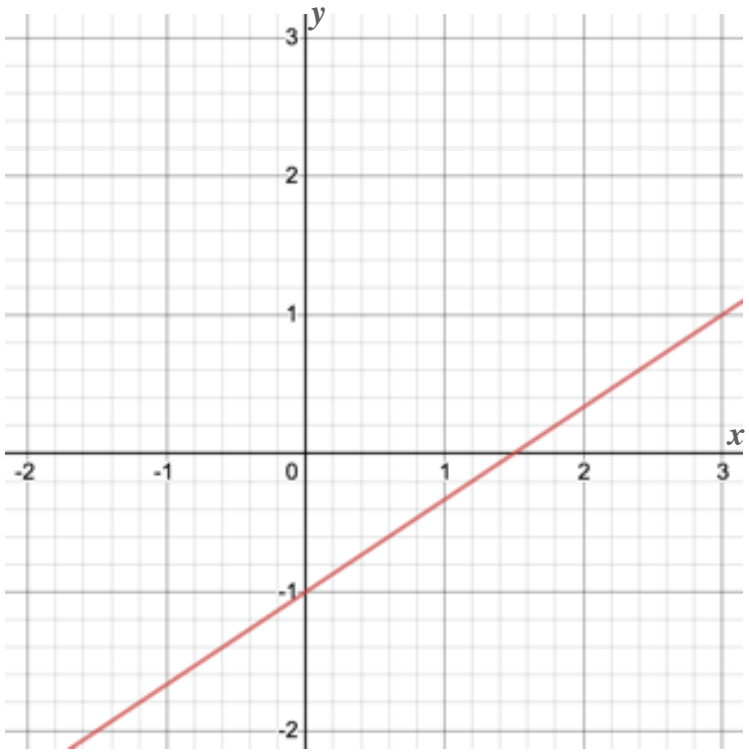
## My turn

Using the graph, find the equation of the line below. Give your answer in the form $y=mx+c$.




## Your turn

Using the graph, find the equation of the line below. Give your answer in the form $y=mx+c$.

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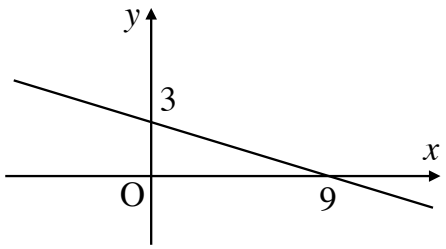
# Equation of a line (2)

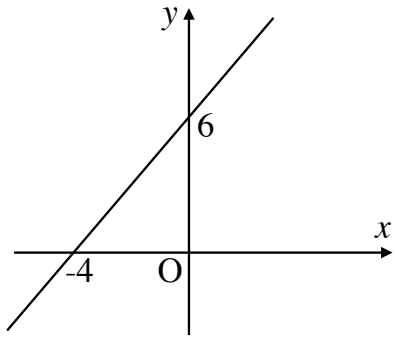
## My turn

Use the information in the diagram to find the equation of the straight line in the form $y=mx+c$.




## Your turn

Use the information in the diagram to find the equation of the straight line in the form $y=mx+c$.

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# Equation of a line (2)

## My turn

A straight line passes through the points (6,6) and (-2,30). Which of the following coordinates are also on the line?

a) (3,33)

b) (-22,90)

## Your turn

A straight line passes through the points (5,5) and (-4,23). Which of the following coordinates are also on the line?

a) (7,1)

b) (-8,11)

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# Equation of a line (2)

## My turn

Exam Q

Find an equation of the straight line passing through the points with coordinates (4,-5) and (-8,9), giving your answer in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

## Your turn

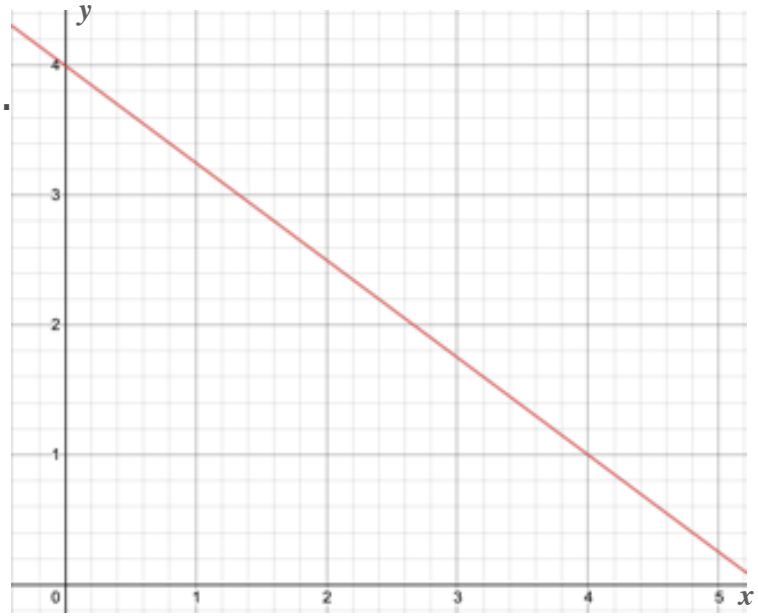
Exam Q

Find an equation of the straight line passing through the points with coordinates (3,-7) and (-6,5), giving your answer in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

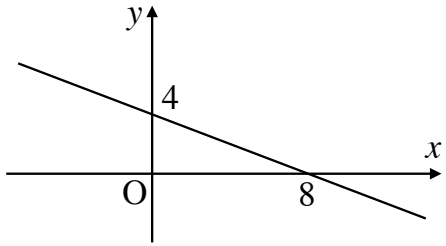
# Equation of a line (2)

## Review Exercise (Answers)

**1.** Using the graph to the right, find the equation of the line. Give your answer in the form $y=mx+c$.




**2.** Use the information in the diagram to find the equation of the straight line in the form $y=mx+c$.




**3.** A straight line passes through the points (5,2) and (-1,32). Which of the following coordinates are also on the line?

a) (2,19) b) (-11,82) c) $(\frac{3}{5},24)$

**4.** Find an equation of the straight line passing through the points with coordinates (2,-5) and (-6,9), giving your answer in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

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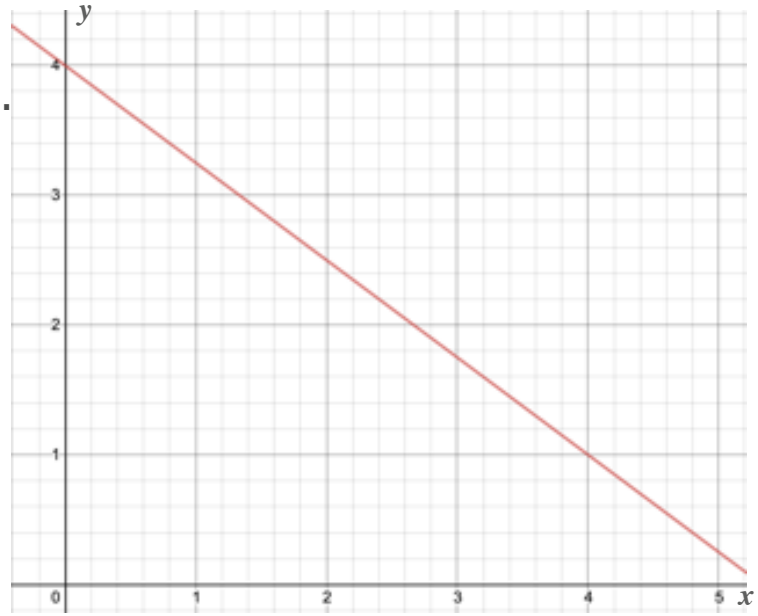
# Equation of a line (2)

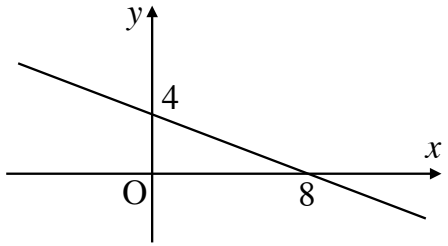
## Review Exercise (Answers)

**1.** Using the graph to the right, find the equation of the line. Give your answer in the form $y=mx+c$.

$y=-\frac{3}{4}x+4$




**2.** Use the information in the diagram to find the equation of the straight line in the form $y=mx+c$.




$y=-\frac{1}{2}x+4$

**3.** A straight line passes through the points (5,2) and (-1,32). Which of the following coordinates are also on the line?

a) (2,19) b) (-11,82) c) $(\frac{3}{5},24)$

**4.** Find an equation of the straight line passing through the points with coordinates (2,-5) and (-6,9), giving your answer in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

$7x+4y+6=0$

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# Midpoint

## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A pen and paper
- Can do attitude

# Midpoint

## Important formulae

Equation of a line

1. $y-y_1=m(x-x_1)$

   $m$ is the gradient

   $(x_1,y_1)$ is a point on the line

2. $y=mx+c$

   $m$ is the gradient

   $c$ is the $y$-intercept, $(0,c)$

3. $ax+by+c=0$

   $a$, $b$ and $c$ are integers

Given two points $(x_1,y_1)$ and $(x_2,y_2)$, the gradient between them can be found using the formula:

$$m = \frac{y_2-y_1}{x_2-x_1}$$

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# Midpoint

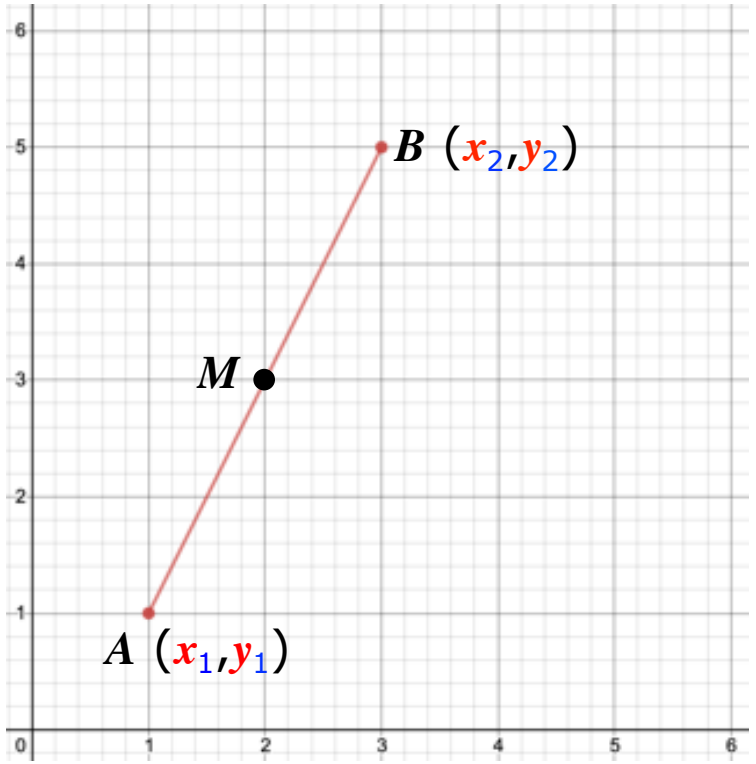
## What is the midpoint?

The midpoint is the point on a line segment that divides the segment into two equal parts.

We can calculate the midpoint by finding the halfway point between the two $x$-coordinates, $x_1$ and $x_2$, and the halfway point between the two $y$-coordinates, $y_1$ and $y_2$.

Given two points $(x_1,y_1)$ and $(x_2,y_2)$, the midpoint can be found using the formula:

$$\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$$



# Midpoint

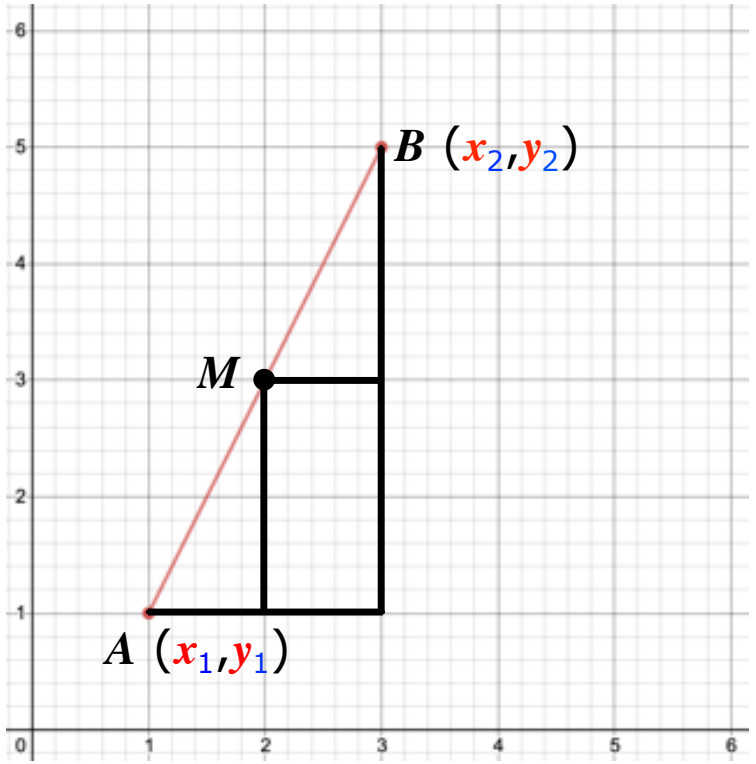
## What is the midpoint?

The midpoint is the point on a line segment that divides the segment into two equal parts.

We can calculate the midpoint by finding the halfway point between the two $x$-coordinates, $x_1$ and $x_2$, and the halfway point between the two $y$-coordinates, $y_1$ and $y_2$.

Given two points $(x_1,y_1)$ and $(x_2,y_2)$, the midpoint can be found using the formula:

$$\left( \frac{x_1+x_2}{2}, \frac{y_1+y_2}{2} \right)$$



# Midpoint

## My turn

Exam Q

The coordinates of two points $A$ and $B$ are (3,-6) and (7,-2) respectively and $D$ is the mid-point of $AB$.

State the coordinates of $D$.

## Your turn

Exam Q

The coordinates of two points $A$ and $B$ are (4,-5) and (8,-7) respectively and $D$ is the mid-point of $AB$.

State the coordinates of $D$.

# Midpoint

## My turn

A line $l$ has equation $y=3x+4$. Find the midpoint of the line segment between $x=2$ and $x=6$.

## Your turn

A line $l$ has equation $y=2x+8$. Find the midpoint of the line segment between $x=1$ and $x=3$.

# Midpoint

## My turn

Exam Q

A line $l$ has equation $-4x-y+10=0$.
Find the midpoint of the line segment between the points $A(a,6)$ and $B(3.5,b)$.

## Your turn

Exam Q

A line $l$ has equation $-6x-y+22=0$. Find the midpoint of the line segment between the points $A(a,4)$ and $B(2.5,b)$.

# Midpoint

## My turn

Exam Q

The point $M$ is the midpoint of the line joining the points (6,9) and (-4,3). Find the equation of the line through $M$ which has a gradient of $-\frac{2}{5}$. Give your answer in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

## Your turn

Exam Q

The point $M$ is the midpoint of the line joining the points (5,3) and (-1,7).
Find the equation of the line through $M$ which has a gradient of $-\frac{3}{5}$. Give your answer in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

# Midpoint

## My turn

**Exam Q**

Three points, $A$, $B$ and $C$, are such that $B$ is the midpoint of $AC$. The coordinates of $A$ are $(3,m)$ and the coordinates of $B$ are $(n, -8)$, where $m$ and $n$ are constants. Find the coordinates of $C$ in terms of $m$ and $n$.

## Your turn

**Exam Q**

Three points, $A$, $B$ and $C$, are such that $B$ is the midpoint of $AC$. The coordinates of $A$ are $(4,m)$ and the coordinates of $B$ are $(n, -3)$, where $m$ and $n$ are constants. Find the coordinates of $C$ in terms of $m$ and $n$.

# Midpoint

## Review Exercise

**1.** The coordinates of two points $A$ and $B$ are (3,-6) and (5,-8) respectively and $D$ is the mid-point of $AB$. State the coordinates of $D$.

**2.** A line $l$ has equation $y=4x+2$. Find the midpoint of the line segment between $x=3$ and $x=5$.

**3.** A line $l$ has equation $-2x-y+15=0$. Find the midpoint of the line segment between the points $A(a,3)$ and $B(3.5,b)$.

**4.** The point $M$ is the midpoint of the line joining the points (8,7) and (-2,1). Find the equation of the line through $M$ which has a gradient of $-\frac{3}{4}$. Give your answer in the form $ax+by+c$, where $a$, $b$ and $c$ are integers.

**5.** Three points, $A$, $B$ and $C$, are such that $B$ is the midpoint of $AC$. The coordinates of $A$ are $(2,m)$ and the coordinates of $B$ are $(n, -7)$, where $m$ and $n$ are constants. Find the coordinates of $C$ in terms of $m$ and $n$.

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# Midpoint

## Review Exercise (Answers)

**1.** The coordinates of two points $A$ and $B$ are (3,-6) and (5,-8) respectively and $D$ is the mid-point of $AB$. State the coordinates of $D$. (4,-7)

**2.** A line $l$ has equation $y=4x+2$. Find the midpoint of the line segment between $x=3$ and $x=5$. (4,18)

**3.** A line $l$ has equation $-2x-y+15=0$. Find the midpoint of the line segment between the points $A(a,3)$ and $B(3.5,b)$. (4.75,5.5)

**4.** The point $M$ is the midpoint of the line joining the points (8,7) and (-2,1). Find the equation of the line through $M$ which has a gradient of $-\frac{3}{4}$. Give your answer in the form $ax+by+c$, where $a$, $b$ and $c$ are integers.

$3x + 4y - 25=0$

**5.** Three points, $A$, $B$ and $C$, are such that $B$ is the midpoint of $AC$. The coordinates of $A$ are $(2,m)$ and the coordinates of $B$ are $(n, -7)$, where $m$ and $n$ are constants. Find the coordinates of $C$ in terms of $m$ and $n$.

$(2n-2,-m-14)$

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# Distance (1)

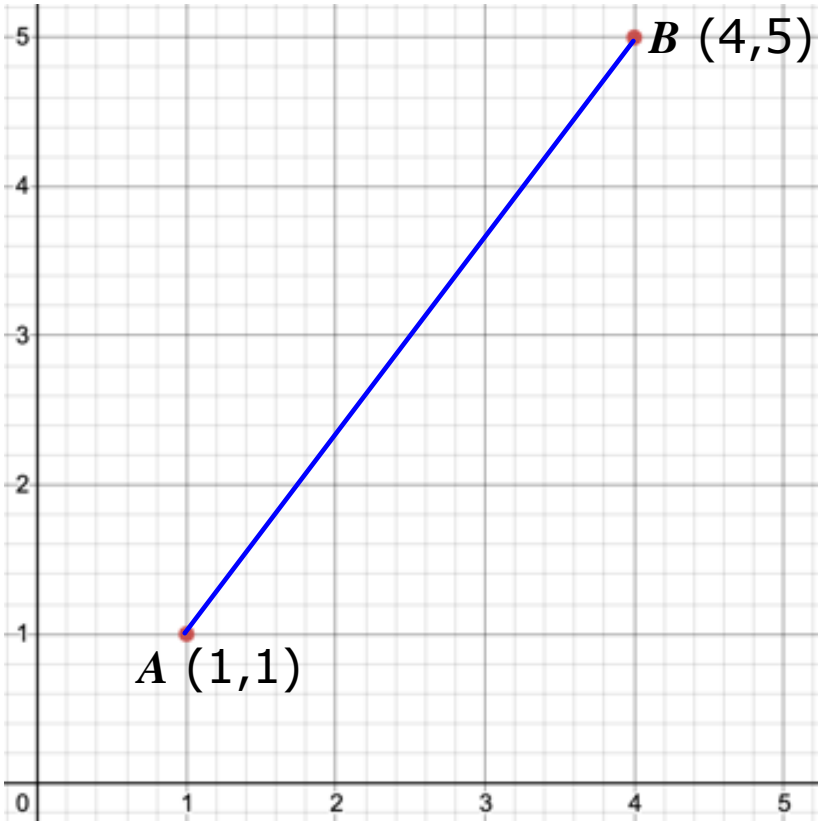
## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A pen and paper
- Can do attitude

# Distance (1)

## Distance

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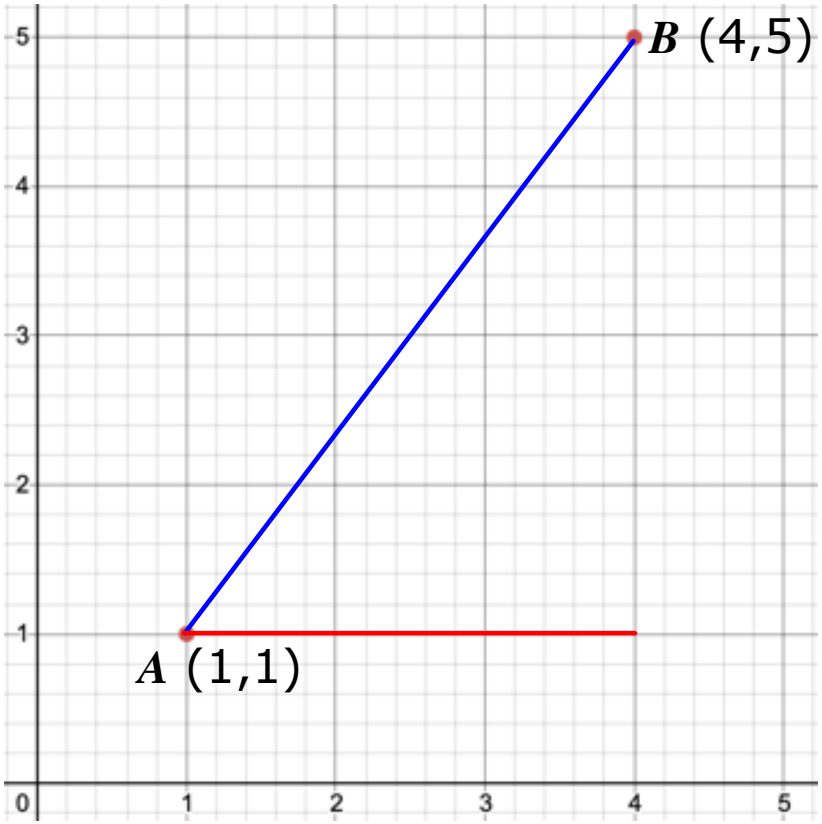
# Distance (1)

## Distance

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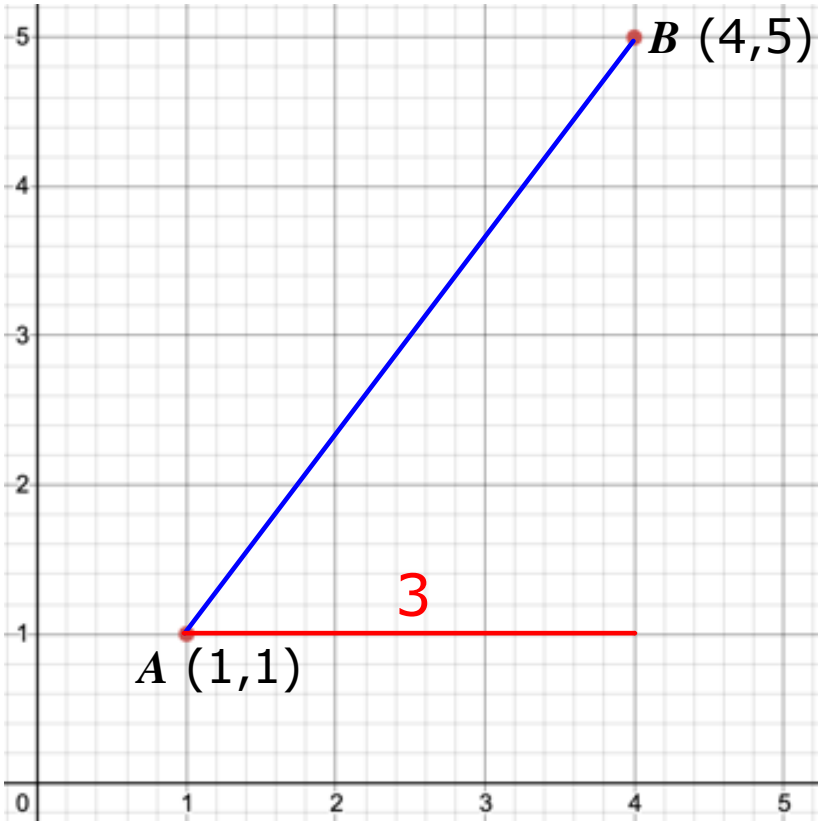
# Distance (1)

## Distance

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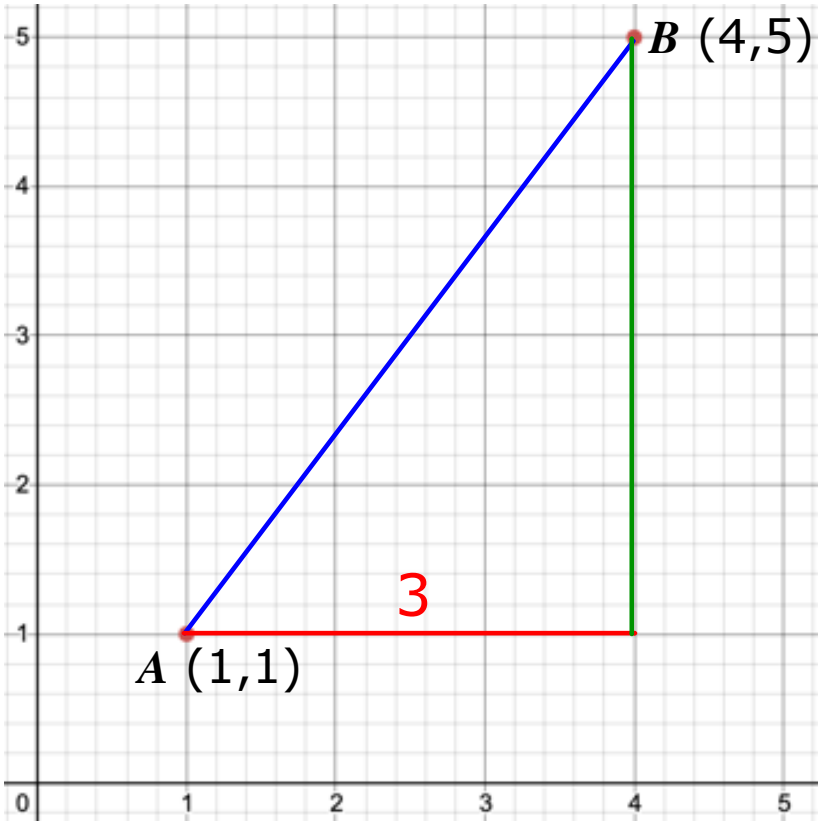
# Distance (1)

## Distance

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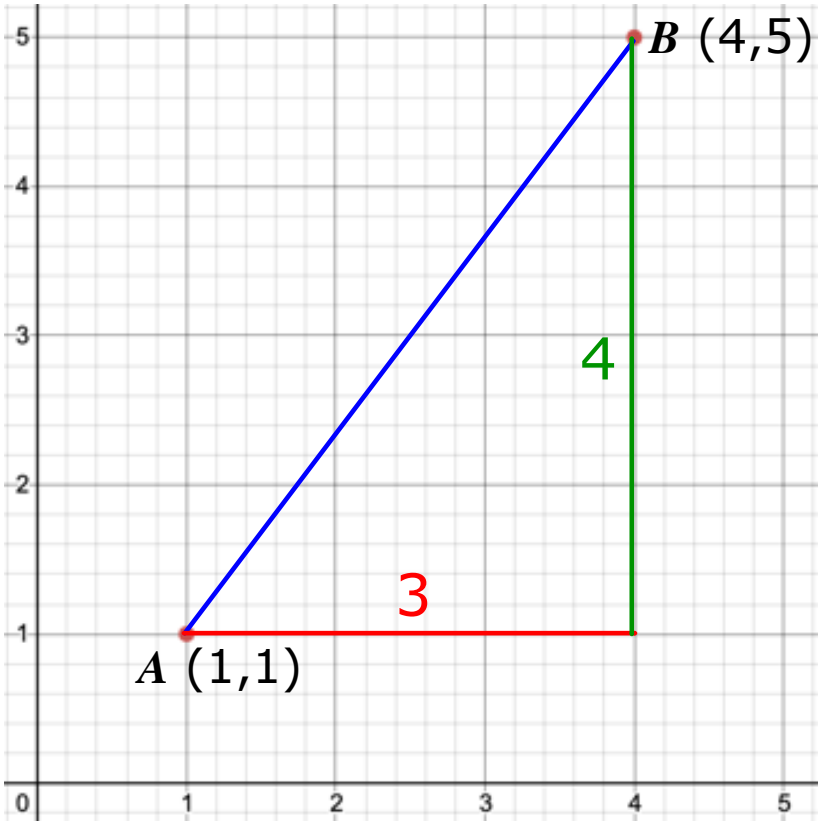
# Distance (1)

## Distance

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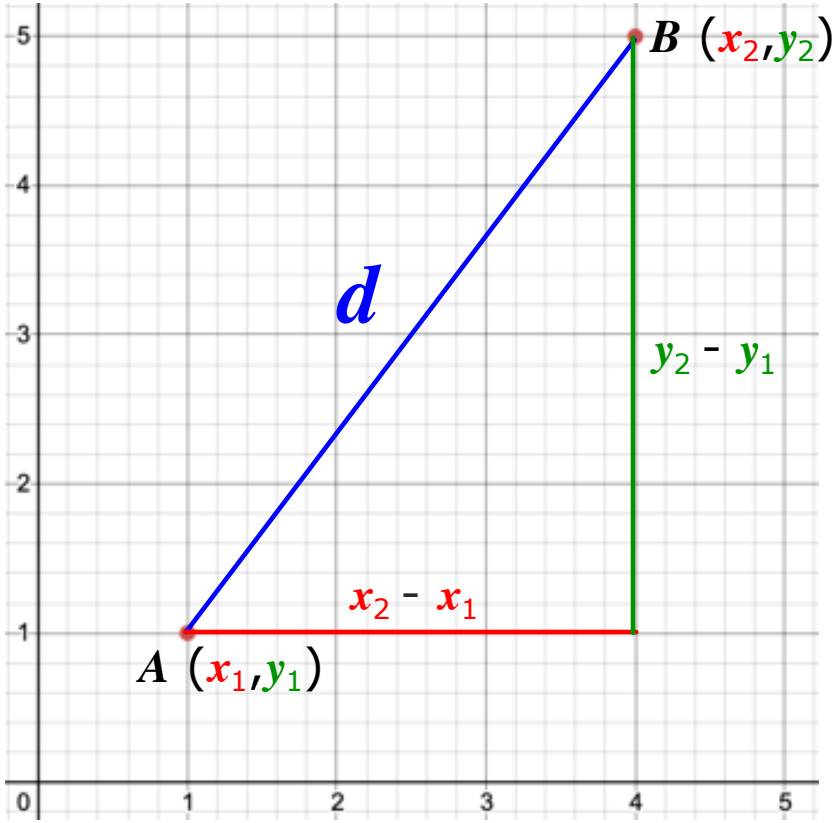
# Distance (1)

## Distance formula

Going forward, we no longer need to draw a triangle to find the distance; we can use the distance formula to find the distance between two points.

Given two points $(x_1,y_1)$ and $(x_2,y_2)$, the distance between them can be found using the formula:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

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# Distance (1)

## My turn

Exam Q

The coordinates of two points $A$ and $B$ are (3,-6) and (7,-2) respectively. Find the exact length of the line segment $AB$.

## Your turn

Exam Q

The coordinates of two points $A$ and $B$ are (4,-5) and (8,-7) respectively. Find the exact length of the line segment $AB$.

# Distance (1)

## My turn

A line $l$ has equation $y=3x+4$. Find the exact length of the line segment between $x=2$ and $x=6$.

## Your turn

A line $l$ has equation $y=2x+8$. Find the exact length of the line segment between $x=1$ and $x=3$.

# Distance (1)

## My turn

A line $l$ has equation $-4x-y+29=0$.
Find the length of the line segment between the points $A(a,5)$ and $B(3.5,b)$.
Give your answer to 3 significant figures.

## Your turn

A line $l$ has equation $-6x-y+34=0$.
Find the length of the line segment between the points $A(a,4)$ and $B(2.5,b)$.
Give your answer to 3 significant figures.

# Distance (1)

## My turn

Exam Q

Two points $A$ and $B$ have coordinates $(8a,-5a)$ and $(-a,7a)$ respectively, where $a$ is a positive constant. The length of the line $AB$ is $2\frac{1}{2}$ units. Find the value of $a$.

## Your turn

Exam Q

Two points $A$ and $B$ have coordinates $(7a,-2a)$ and $(-a,4a)$ respectively, where $a$ is a positive constant. The length of the line $AB$ is $7\frac{1}{3}$ units. Find the value of $a$.

# Distance (1)

## Review Exercise

**1.** The coordinates of two points $A$ and $B$ are (3,-6) and (5,-8) respectively. Find the exact length of the line segment $AB$.

**2.** A line $l$ has equation $y=4x+2$. Find the exact length of the line segment between $x=3$ and $x=5$.

**3.** A line $l$ has equation $-2x-y+15=0$. Find the length of the line segment between the points $A(a,3)$ and $B(3.5,b)$. Give your answer to 3 significant figures.

**4.** Two points $A$ and $B$ have coordinates $(4a,-3a)$ and $(-a,9a)$ respectively, where $a$ is a positive constant. The length of the line $AB$ is $3\frac{1}{4}$ units. Find the value of $a$.

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# Distance (1)

## Review Exercise (Answers)

**1.** The coordinates of two points $A$ and $B$ are (3,-6) and (5,-8) respectively. Find the exact length of the line segment $AB$.

$2\sqrt{2}$

**2.** A line $l$ has equation $y=4x+2$. Find the exact length of the line segment between $x=3$ and $x=5$.

$2\sqrt{17}$

**3.** A line $l$ has equation $-2x-y+15=0$. Find the length of the line segment between the points $A(a,3)$ and $B(3.5,b)$. Give your answer to 3 significant figures.

5.59 (3 sf)

**4.** Two points $A$ and $B$ have coordinates $(4a,-3a)$ and $(-a,9a)$ respectively, where $a$ is a positive constant. The length of the line $AB$ is $3\frac{1}{4}$ units. Find the value of $a$.

$a=\frac{1}{4}$

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# Distance (2)

## Getting ready for A-Level Maths...

What you need...

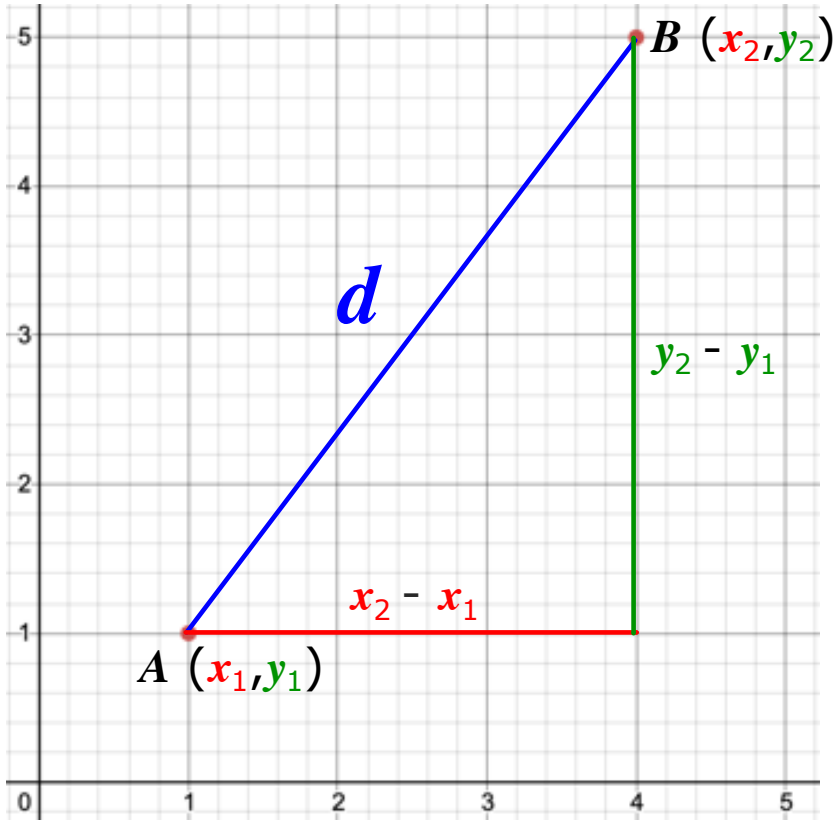
- Your brain and attention
- A pen and paper
- Can do attitude

# Distance (2)

## Distance formula

Given two points $(x_1,y_1)$ and $(x_2,y_2)$, the distance between them can be found using the formula:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

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# Distance (2)

## My turn

Exam Q

The line joining $A(4,-7)$ to $B(10,k)$ has gradient $\frac{7}{3}$. Find the exact length of $AB$.

## Your turn

Exam Q

The line joining $A(3,-8)$ to $B(13,k)$ has gradient $\frac{9}{5}$. Find the exact length of $AB$.

# Distance (2)

## My turn

Exam Q

The points $A(a,a)$ and $B(b,4)$ are joined by a line segment with a gradient of $-\frac{1}{5}$ .

Given that the midpoint of $AB$ is at $(c,1)$, find the exact distance between $A$ and $B$.

## Your turn

Exam Q

The points $A(a,a)$ and $B(b,5)$ are joined by a line segment with a gradient of $-\frac{1}{3}$ .

Given that the midpoint of $AB$ is at $(c,2)$, find the exact distance between $A$ and $B$.

# Distance (2)

## My turn

Exam Q

The coordinates of two points $A$ and $B$ are (1,2) and (10,-1) respectively. A point $C$ has coordinates $(x,y)$, where $x$ and $y$ are variables. It is given that $AC$ and $BC$ are equal in length. Find an equation relating $x$ and $y$. Write it in the format $y=ax-b$, where $a$ and $b$ are integers.

## Your turn

Exam Q

The coordinates of two points $A$ and $B$ are (2,3) and (7,-2) respectively. A point $C$ has coordinates $(x,y)$, where $x$ and $y$ are variables. It is given that $AC$ and $BC$ are equal in length. Find an equation relating $x$ and $y$. Write it in the format $y=ax-b$, where $a$ and $b$ are integers.

# Distance (2)

## Review Exercise

**1.** The line joining $A(3,-7)$ to $B(12,k)$ has gradient $\frac{5}{3}$.
Find the exact length of $AB$.

**2.** The points $A(a,a)$ and $B(b,6)$ are joined by a line segment with a gradient of $-\frac{1}{2}$. Given that the midpoint of $AB$ is at $(c,2)$, find the exact distance between $A$ and $B$.

**3.** The coordinates of two points $A$ and $B$ are (3,1) and (7,-1) respectively. A point $C$ has coordinates $(x,y)$, where $x$ and $y$ are variables. It is given that $AC$ and $BC$ are equal in length. Find an equation relating $x$ and $y$.
Write it in the format $y=ax-b$, where $a$ and $b$ are integers.

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# Distance (2)

## Review Exercise (Answers)

**1.** The line joining $A(3,-7)$ to $B(12,k)$ has gradient $\frac{5}{3}$.
Find the exact length of $AB$.

$3\sqrt{34}$

**2.** The points $A(a,a)$ and $B(b,6)$ are joined by a line segment with a gradient of $-\frac{1}{2}$. Given that the midpoint of $AB$ is at $(c,2)$, find the exact distance between $A$ and $B$.

$8\sqrt{5}$

**3.** The coordinates of two points $A$ and $B$ are (3,1) and (7,-1) respectively. A point $C$ has coordinates $(x,y)$, where $x$ and $y$ are variables. It is given that $AC$ and $BC$ are equal in length. Find an equation relating $x$ and $y$.
Write it in the format $y=ax-b$, where $a$ and $b$ are integers.

$y=2x-10$

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# Parallel lines

## Getting ready for A-Level Maths...

What you need...

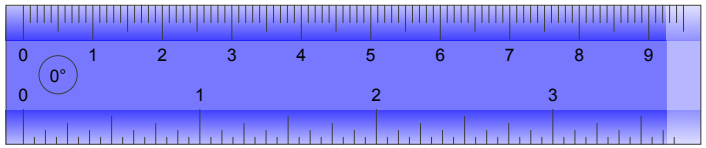
- Your brain and attention
- A pen and paper
- Can do attitude

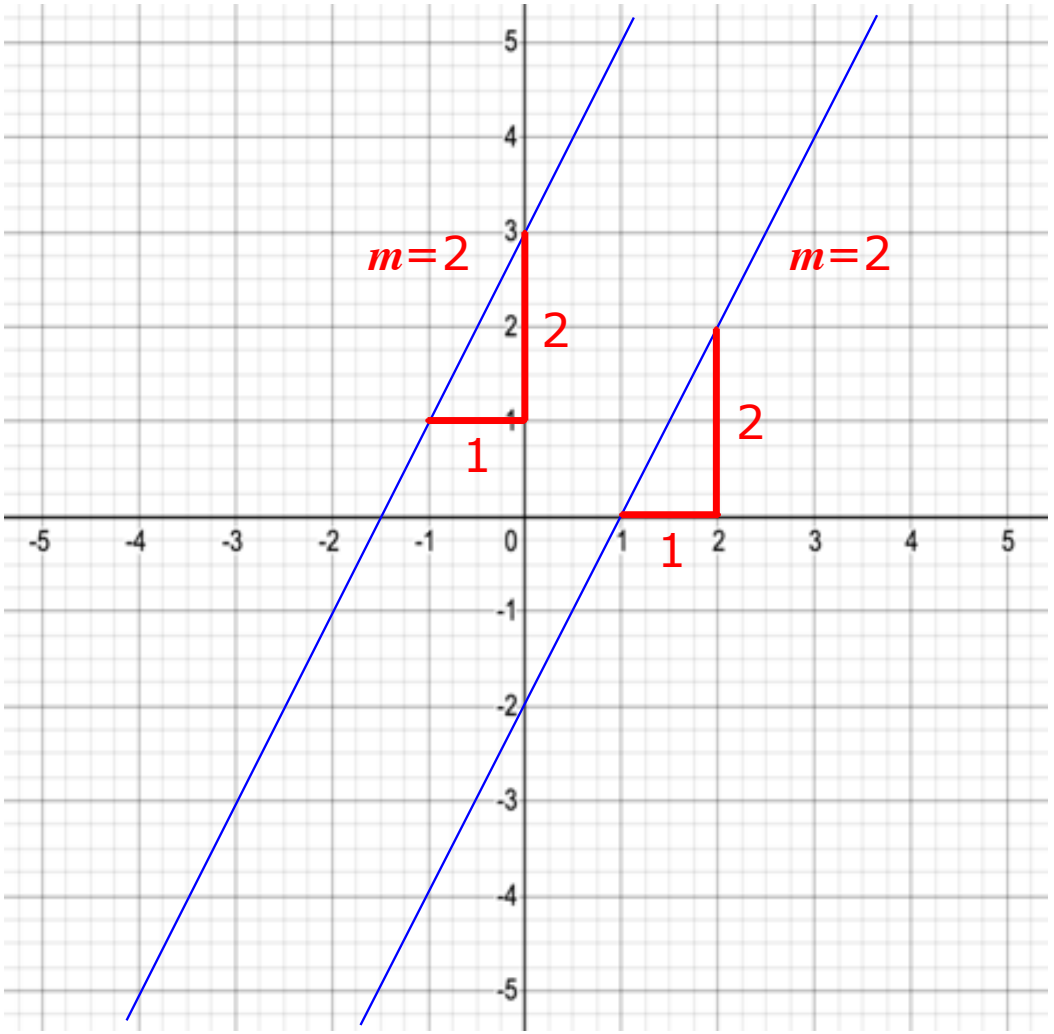
# Parallel lines

Lines are **parallel** if they are the same distance apart at every point.

This means their gradients are equal.

e.g. $y = 2x + 3$ and $y = 2x - 2$
both have a gradient of 2, so they are parallel.





# Parallel lines

## My turn

**Exam Q**

The line $l_1$ has equation $5x-2y+12=0$. The line $l_2$ cuts the $x$-axis at $R(6,0)$ and is parallel to $l_1$. Find the equation of $l_2$, writing your answer in the form $ax+by+c=0$, where $a$, $b$, and $c$ are integers to be found.

## Your turn

**Exam Q**

The line $l_1$ has equation $4x-5y+20=0$. The line $l_2$ cuts the $x$-axis at $R(10,0)$ and is parallel to $l_1$. Find the equation of $l_2$, writing your answer in the form $ax+by+c=0$, where $a$, $b$, and $c$ are integers to be found.

# Parallel lines

## My turn

Exam Q

Find the equation of the line parallel to $2x-5y+7=0$ that passes through the point (3,4). Give your answer in the form $y=ax+b$ where $a$ and $b$ are rational numbers.

## Your turn

Exam Q

Find the equation of the line parallel to $3x-4y+9=0$ that passes through the point (1,5). Give your answer in the form $y=ax+b$ where $a$ and $b$ are rational numbers.

# Parallel lines

## My turn

**Exam Q**

Two points $A$ and $B$ have coordinates $(4a, -a)$ and $(-a, 3a)$ respectively, where $a$ is a positive constant. Find the equation of the line through the origin parallel to $AB$.

## Your turn

**Exam Q**

Two points $A$ and $B$ have coordinates $(4a, -2a)$ and $(-2a, 3a)$ respectively, where $a$ is a positive constant. Find the equation of the line through the origin parallel to $AB$.

# Parallel lines

## My turn

Exam Q

The point $M$ is the midpoint of the line joining the points (7,5) and (-1,3). Find the equation of the line through $M$ which is parallel to the line $\frac{x}{2} + \frac{y}{5} = 1$.

## Your turn

Exam Q

The point $M$ is the midpoint of the line joining the points (5,8) and (-3,2). Find the equation of the line through $M$ which is parallel to the line $\frac{x}{3} + \frac{y}{4} = 2$.

# Parallel lines

## Review Exercise

**1.** The line $l_1$ has equation $2x-3y+15=0$. The line $l_2$ cuts the $x$-axis at $R(12,0)$ and is parallel to $l_1$. Find the equation of $l_2$, writing your answer in the form $ax+by+c=0$, where $a$, $b$, and $c$ are integers to be found.

**2.** Find the equation of the line parallel to $4x-5y+11=0$ that passes through the point (3,4). Give your answer in the form $y=ax+b$ where $a$ and $b$ are rational numbers.

**3.** Two points $A$ and $B$ have coordinates $(2a, -a)$ and $(-3a,a)$ respectively, where $a$ is a positive constant. Find the equation of the line through the origin parallel to $AB$.

**4.** The point $M$ is the midpoint of the line joining the points (10,7) and (-2,3). Find the equation of the line through $M$ which is parallel to the line $\frac{x}{5} + \frac{y}{2} = 1$.

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# Parallel lines

## Review Exercise (Answers)

**1.** The line $l_1$ has equation $2x-3y+15=0$. The line $l_2$ cuts the $x$-axis at $R(12,0)$ and is parallel to $l_1$. Find the equation of $l_2$, writing your answer in the form $ax+by+c=0$, where $a$, $b$, and $c$ are integers to be found.

$2x-3y-24=0$

**2.** Find the equation of the line parallel to $4x-5y+11=0$ that passes through the point (3,4). Give your answer in the form $y=ax+b$ where $a$ and $b$ are rational numbers.

$y=\frac{4}{5}x+\frac{8}{5}$

**3.** Two points $A$ and $B$ have coordinates $(2a, -a)$ and $(-3a,a)$ respectively, where $a$ is a positive constant. Find the equation of the line through the origin parallel to $AB$.

$y=-\frac{2}{5}x$

**4.** The point $M$ is the midpoint of the line joining the points (10,7) and (-2,3). Find the equation of the line through $M$ which is parallel to the line $\frac{x}{5}+\frac{y}{2}=1$.

$2x+5y-33=0$ or $y=-\frac{2}{5}x+\frac{33}{5}$

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# Perpendicular lines

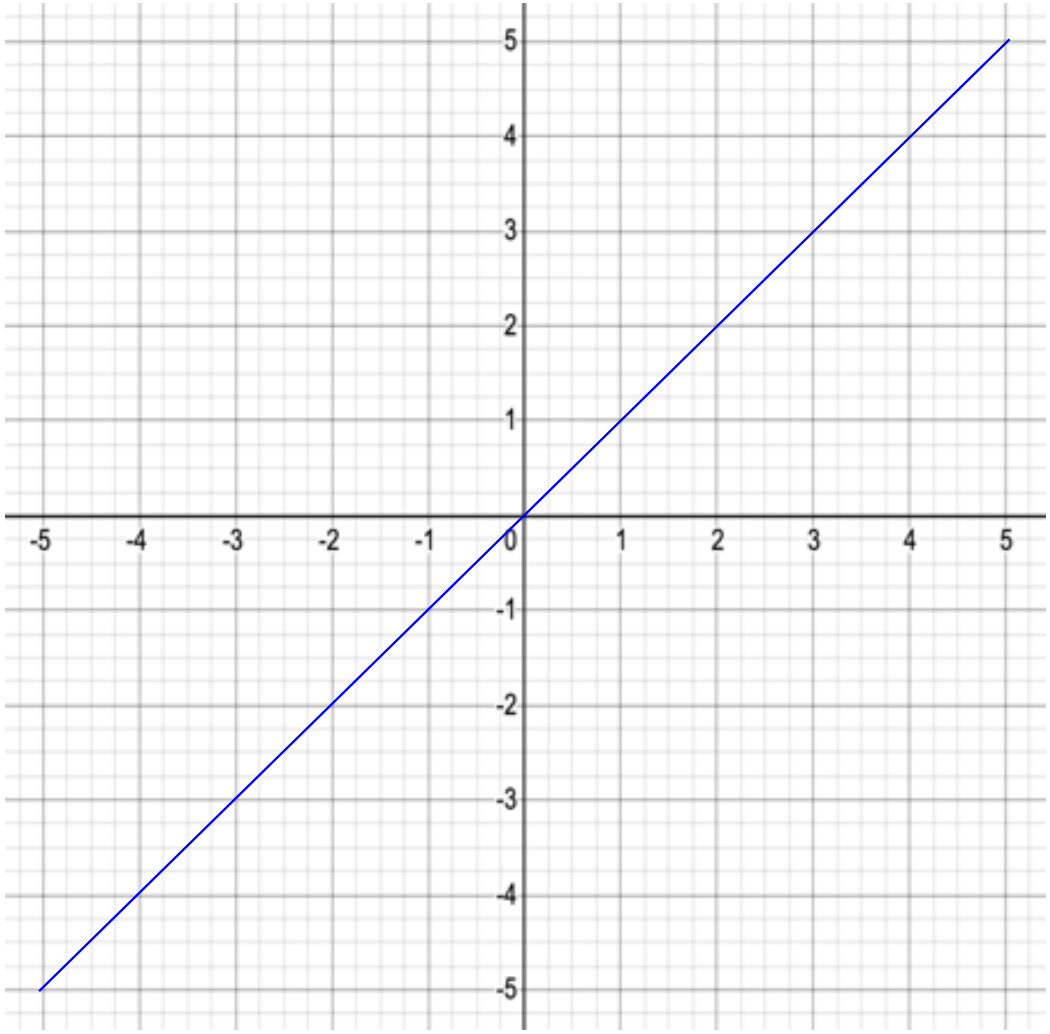
## Getting ready for A-Level Maths...

What you need...

- Your brain and attention
- A pen and paper
- Can do attitude

# Perpendicular lines

## Perpendicular lines

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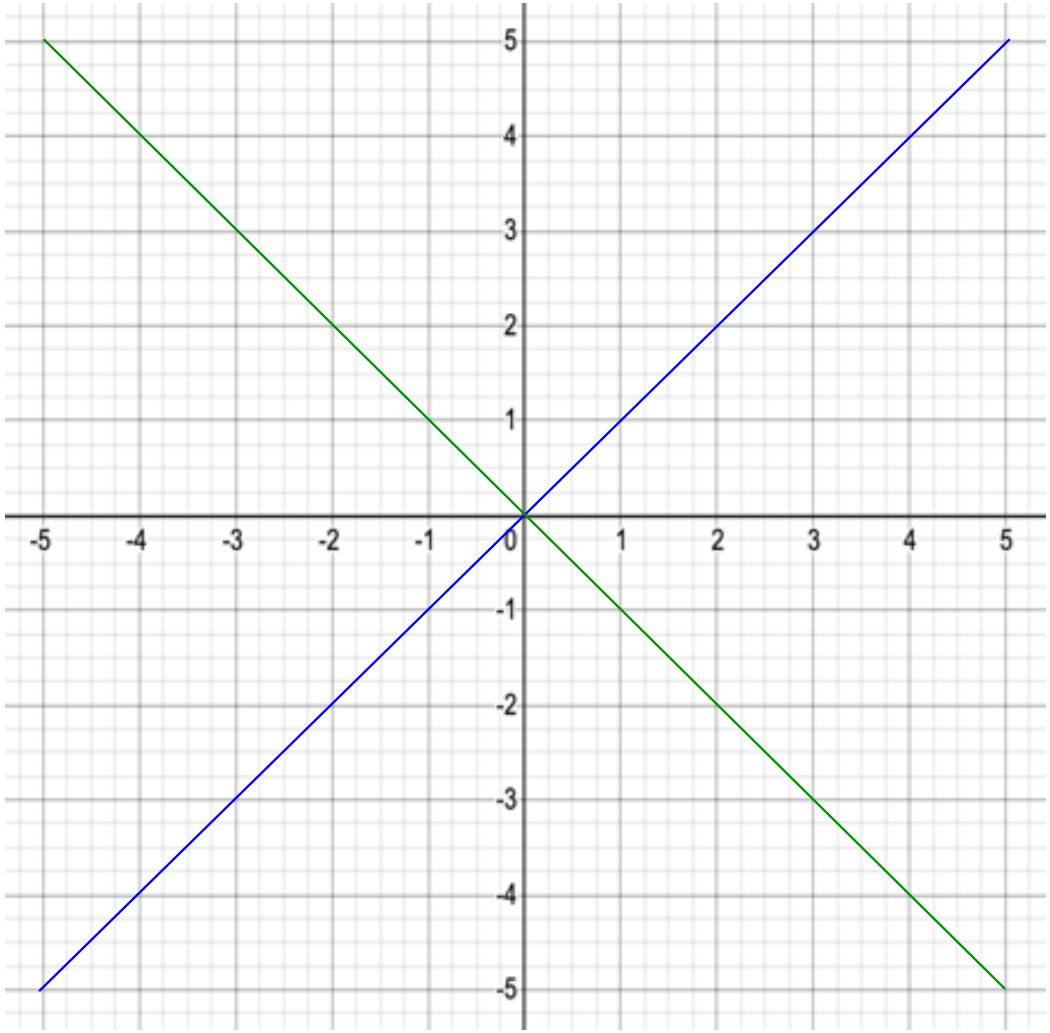
# Perpendicular lines

## Perpendicular lines

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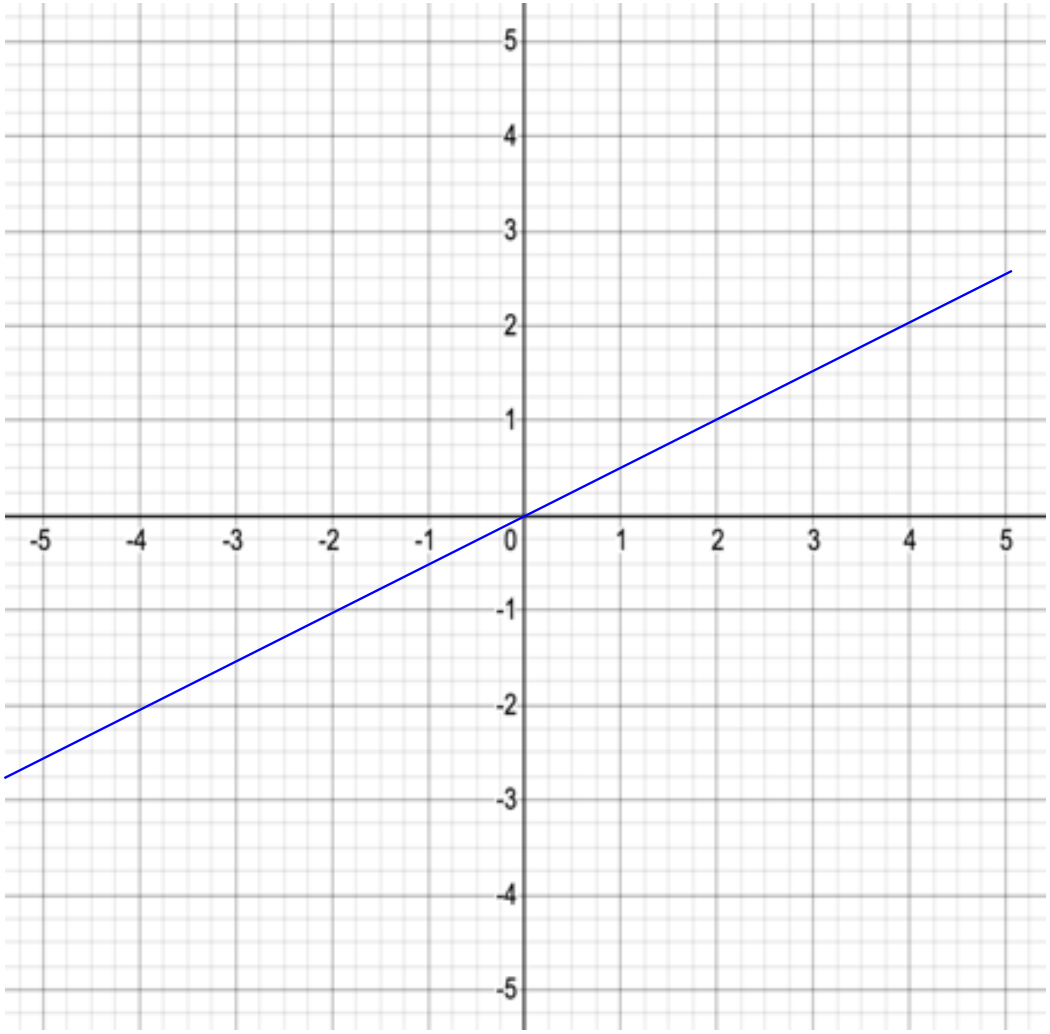
# Perpendicular lines

## Perpendicular lines

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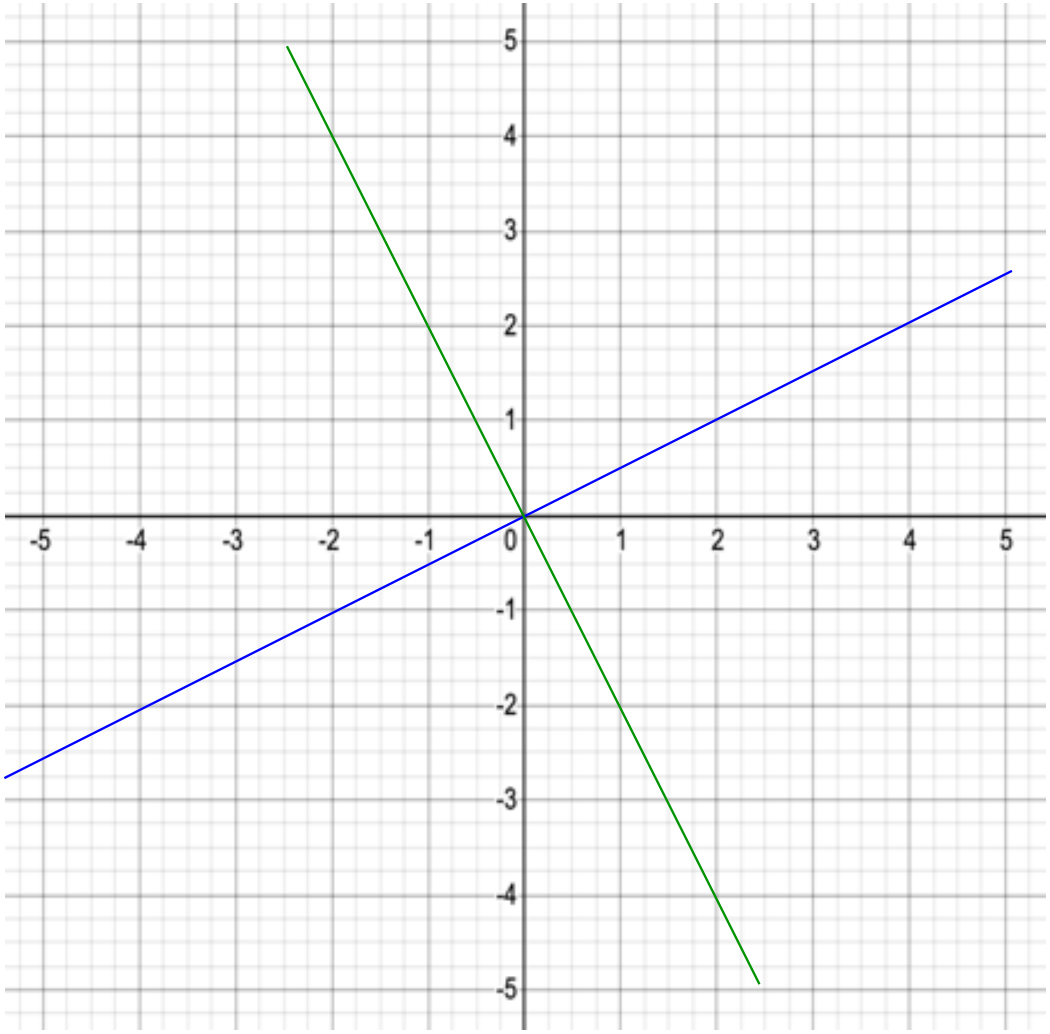
# Perpendicular lines

## Perpendicular lines

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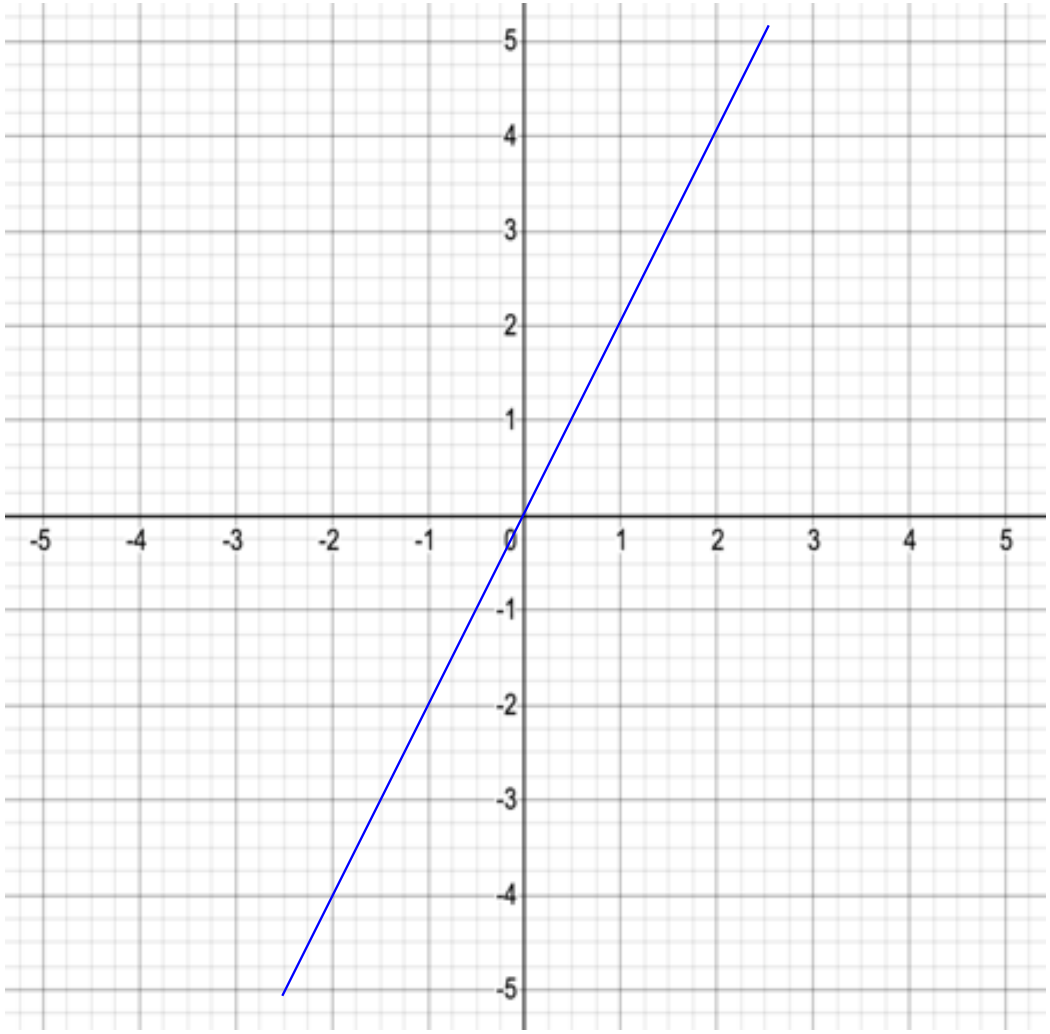
# Perpendicular lines

## Perpendicular lines

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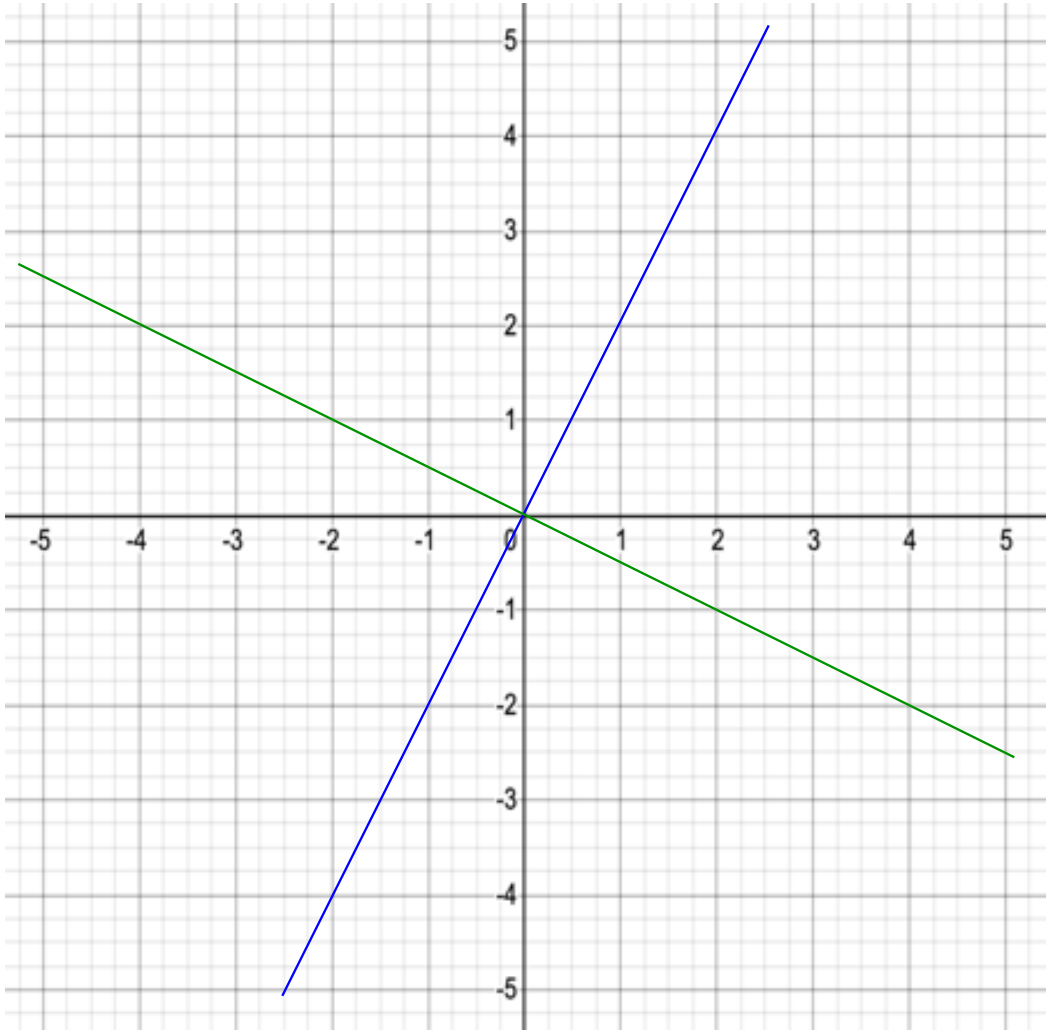
# Perpendicular lines

## Perpendicular lines

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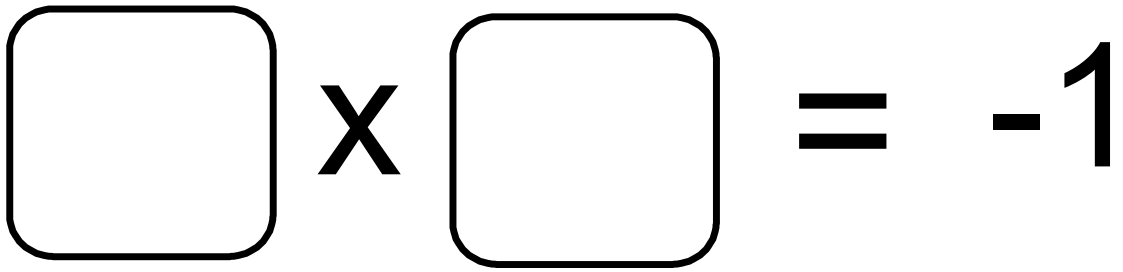
# Perpendicular lines

## Perpendicular lines

The gradients of perpendicular line multiply to give -1.



# Perpendicular lines

## My turn

Exam Q

The line $l_1$ has equation $3x+5y=21$. The line $l_2$ passes through the origin $O$ and is perpendicular to $l_1$. Find the equation for the line $l_2$.

## Your turn

Exam Q

The line $l_1$ has equation $4x+7y=10$. The line $l_2$ passes through the origin $O$ and is perpendicular to $l_1$. Find the equation for the line $l_2$.

# Perpendicular lines

## My turn

**Exam Q**

The line $l_1$ has equation $2x+5y-9=0$. The line $l_2$ is perpendicular to $l_1$ and passes through the point (8,-3). Find the equation of $l_2$ in the form $y=mx+c$ where $m$ and $c$ are constants.

## Your turn

**Exam Q**

The line $l_1$ has equation $3x+4y-7=0$. The line $l_2$ is perpendicular to $l_1$ and passes through the point (9,-5). Find the equation of $l_2$ in the form $y=mx+c$ where $m$ and $c$ are constants.

# Perpendicular lines

## My turn

Exam Q

The points $A$ and $B$ have coordinates (1,3) and (5,15) respectively. Find the equation of the straight line which passes through the point (3,7) and is perpendicular to $AB$. Give your answer in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

## Your turn

Exam Q

The points $A$ and $B$ have coordinates (1,4) and (3,18) respectively. Find the equation of the straight line which passes through the point (2,5) and is perpendicular to $AB$. Give your answer in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

# Perpendicular lines

## My turn

**Exam Q**

The lines $y = \frac{a}{5}x - 6$ and $y = 2 - \frac{b}{6}x$ are perpendicular. Find the value of $ab$.

## Your turn

**Exam Q**

The lines $y = \frac{a}{7}x - 3$ and $y = 5 - \frac{b}{4}x$ are perpendicular. Find the value of $ab$.

# Perpendicular lines

## Review Exercise

**1.** The line $l_1$ has equation $5x+6y=19$. The line $l_2$ passes through the origin $O$ and is perpendicular to $l_1$. Find the equation for the line $l_2$.

**2.** The line $l_1$ has equation $4x+7y-10=0$. The line $l_2$ is perpendicular to $l_1$ and passes through the point (8,-1). Find the equation of $l_2$ in the form $y=mx+c$ where $m$ and $c$ are constants.

**3.** The points $A$ and $B$ have coordinates (1,6) and (4,21) respectively. Find the equation of the straight line which passes through the point (4,9) and is perpendicular to $AB$. Give your answer in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

**4.** The lines $y = \frac{a}{3}x - 8$ and $y = 4 - \frac{b}{5}x$ are perpendicular. Find the value of $ab$.

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# Perpendicular lines

## Review Exercise (Answers)

**1.** The line $l_1$ has equation $5x+6y=19$. The line $l_2$ passes through the origin $O$ and is perpendicular to $l_1$. Find the equation for the line $l_2$.

$y=\frac{6}{5}x$

**2.** The line $l_1$ has equation $4x+7y-10=0$. The line $l_2$ is perpendicular to $l_1$ and passes through the point (8,-1). Find the equation of $l_2$ in the form $y=mx+c$ where $m$ and $c$ are constants.

$y=\frac{7}{4}x-15$

**3.** The points $A$ and $B$ have coordinates (1,6) and (4,21) respectively. Find the equation of the straight line which passes through the point (4,9) and is perpendicular to $AB$. Give your answer in the form $ax+by+c=0$, where $a$, $b$ and $c$ are integers.

$x+5y-49=0$

**4.** The lines $y=\frac{a}{3}x-8$ and $y=4-\frac{b}{5}x$ are perpendicular. Find the value of $ab$.

$ab=15$

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