






How Computers Work





In this worksheet, you can have a go at running some computer programs for yourself! Each program makes use of numbers stored in **memory**. Each value is accessed by a colour location, which we call an **address**. For example, the  location, or the  location.

Computers use memory to store and retrieve values they are working on. They use these during **instructions**, and multiple instructions are combined into a **program**. An instruction might look something like this:









$$\text{red} = \text{green} + \text{blue}$$





This instruction uses the + operation, and reads from two locations in memory,  and . The result is then **assigned** (written) into the  memory location.

These are the rules:

- Sometimes the right hand side is just a value with no operation. Like  = 5. You can write this straight into memory.
- You must calculate the right hand side *completely* before you write anything back into the left hand side.
- If you write into a memory address that already has a value, you **overwrite** it, you can cross it out and write a new number.
- Because you finish the right hand side first, the same memory can appear on both sides. Like  =  * . Here you read from yellow and blue to calculate the right hand side, and then write the answer back into yellow.
- You cannot read from an empty memory location, you must stop running your program if this happens.

Here is an example, and what your memory should look like once you've run the program.

Program	
	= 2
	= 4
	=  + 
	=  * 

Memory	
	2
	4
	6
	12

Programs

Here are some programs for you to try yourself, you could also try writing your own programs!

Program #1

$$\text{Red Circle} = 4$$

$$\text{Blue Circle} = 10$$

$$\text{Green Circle} = \text{Red Circle} + \text{Blue Circle}$$

$$\text{Yellow Circle} = \text{Green Circle} * \text{Red Circle}$$

Program #3

$$\text{Red Circle} = 2$$

$$\text{Blue Circle} = 4$$

$$\text{Yellow Circle} = \text{Red Circle} * \text{Blue Circle}$$

$$\text{Yellow Circle} = \text{Yellow Circle} * \text{Yellow Circle}$$

Program #2

$$\text{Red Circle} = 1$$

$$\text{Blue Circle} = 2$$

$$\text{Green Circle} = \text{Red Circle} + \text{Blue Circle}$$

$$\text{Yellow Circle} = \text{Blue Circle} * \text{Green Circle}$$

$$\text{Pink Circle} = \text{Yellow Circle} - \text{Blue Circle}$$

$$\text{Black Circle} = \text{Pink Circle} * \text{Green Circle}$$

Program #4

$$\text{Red Circle} = 1$$

$$\text{Blue Circle} = 3$$

$$\text{Green Circle} = \text{Red Circle} + \text{Blue Circle}$$

$$\text{Yellow Circle} = \text{Green Circle} * \text{Green Circle}$$

$$\text{Pink Circle} = \text{Yellow Circle} + \text{Blue Circle}$$

$$\text{Black Circle} = \text{Green Circle} + \text{Red Circle}$$

$$\text{Pink Circle} = \text{Pink Circle} + \text{Black Circle}$$

$$\text{Blue Circle} = \text{Blue Circle} * \text{Black Circle}$$

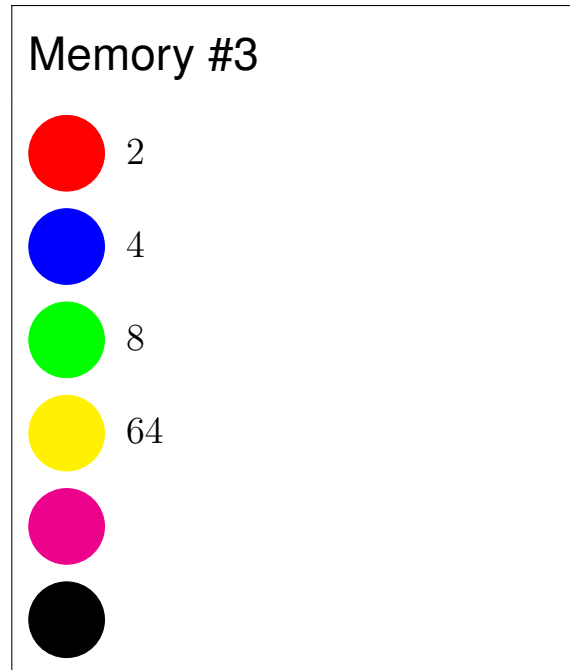
$$\text{Yellow Circle} = \text{Blue Circle} + \text{Pink Circle}$$

$$\text{Green Circle} = \text{Green Circle} - \text{Red Circle}$$

$$\text{Black Circle} = \text{Yellow Circle} \div \text{Green Circle}$$

Answers



These answers show you the memory you should see once you've finished running each program, assuming each program starts with nothing in the memory at all.




Writing Your Own Programs


In these puzzles you have some starting instructions and a goal. You need to add more instructions in order to reach the goal!


Program #1

 = 2
 = 3
...



Goal: Set  to 10


Program #3

 = 2
...



Goal: Set  to 64


Program #2

 = 2
 = 4
...

Goal: Set  to 18

Program #4

 = 1
 = 2
...

Goal: Set  to 37

Answers

Here are some answers to the coding challenge. As you might find out, there are actually many possible ways to solve these. This is true of most programs in real life, too. Sometimes a solution might be better than another for some reason, but in this case if you reached the goal, well done!

Program #1

$$\begin{aligned} \text{Red} &= 2 \\ \text{Blue} &= 3 \\ \text{Green} &= \text{Red} + \text{Blue} \\ \text{Black} &= \text{Green} * \text{Red} \end{aligned}$$

Program #3

$$\begin{aligned} \text{Red} &= 2 \\ \text{Red} &= \text{Red} * \text{Red} \\ \text{Yellow} &= \text{Red} * \text{Red} \\ \text{Black} &= \text{Red} * \text{Yellow} \end{aligned}$$

Program #2

$$\begin{aligned} \text{Red} &= 2 \\ \text{Green} &= 4 \\ \text{Blue} &= \text{Red} + \text{Green} \\ \text{Yellow} &= \text{Blue} \div \text{Red} \\ \text{Black} &= \text{Yellow} * \text{Blue} \end{aligned}$$

Program #4

$$\begin{aligned} \text{Red} &= 1 \\ \text{Blue} &= 2 \\ \text{Green} &= \text{Red} + \text{Blue} \\ \text{Yellow} &= \text{Green} * \text{Blue} \\ \text{Pink} &= \text{Yellow} * \text{Yellow} \\ \text{Black} &= \text{Pink} + \text{Red} \end{aligned}$$