

Merchant Venturers School of Engineering

Outreach Programme

Minecraft Redstone

Part 1 of 2: The Basics of Redstone

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Notes to Teachers & Helpers

- This workshop is intended to last 1 to $1\frac{1}{2}$ hours.
- This workshop is intended for ages 9+ (years 5+).
- The content is intended to be learnt through self-directed individual or pair game play, using this worksheet as a guide.
- The learning platform is Minecraft, the popular block-based building game.
- There are a number of versions of the Minecraft game, not all of which are compatible with this workshop:

Minecraft for Windows or Mac	This version is compatible . This is the normal version downloadable from the Minecraft website.
Minecraft for RaspberryPi	This version is not compatible . This version does not include the required Redstone features.
Minecraft Education Edition	This version is compatible . You may wish to set this up with your class before we arrive to run the workshop.

- Students should already be comfortable playing Minecraft.
This means they should be able to move easily, place and destroy blocks, use items, access the inventory (in Creative mode) and be familiar with the various block types available in the game.
- This workshop teaches the following skills:
Items marked with an asterisk are directly relatable to the National Curriculum.
 - Placing, destroying and designing basic circuits using Redstone in Minecraft
 - * Basic logic equations
 - * Logic gates: NOT, OR, NOR, AND
 - * Principles of digital design: Combining logic gates

1 Introduction

Hi! In this short workshop we're going to try to introduce some of the concepts that electronic engineers use every day to design everything from your mobile phone, to computers and laptops to the settings of a toaster.

Let's get started. Each section is made up of four parts:

Actions Stuff for you to do. They are highlighted in blue.

Notes Notes about important stuff you need to be aware of (and possibly remember!). They are highlighted in red.

Questions Questions you should try to answer. Sometimes you'll need to write things down; other times you'll need to build something in the game. They are highlighted in yellow.

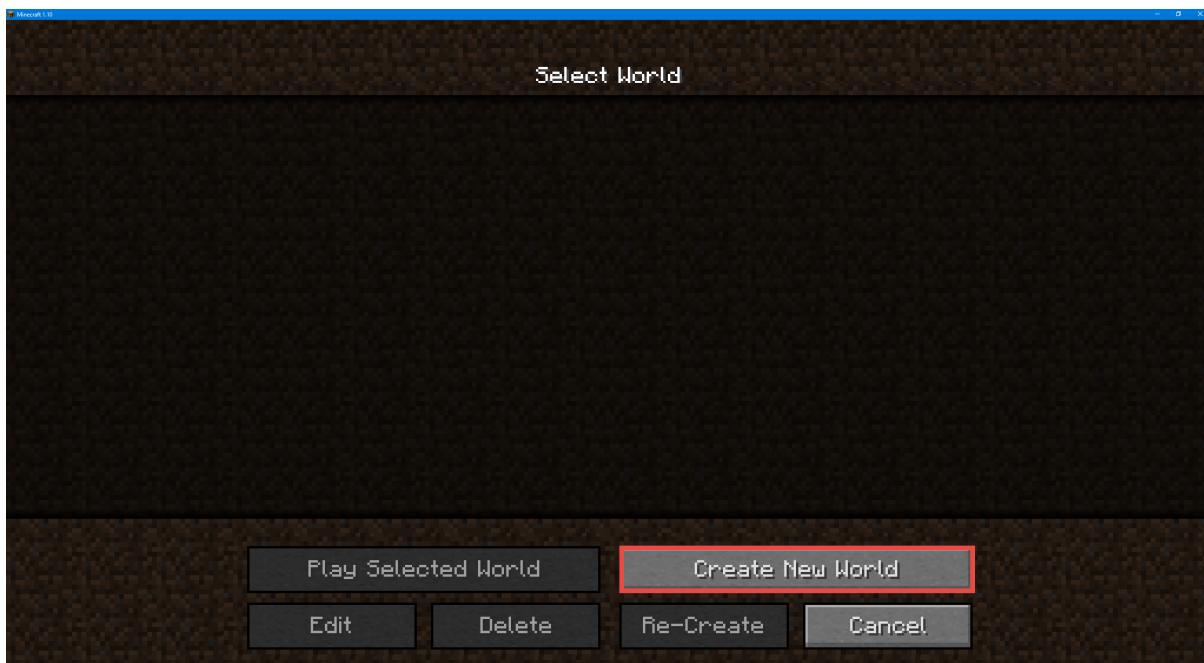
Ask a helper or the teacher to check your answers.

Goals Stuff you should have completed at the end of each section. They are highlighted in green.

We'll also write some information between parts and include plenty of screenshots to help you out.

Actions

1. Open Minecraft
2. Log in
3. Go to Single Player



The Minecraft Single Player World List

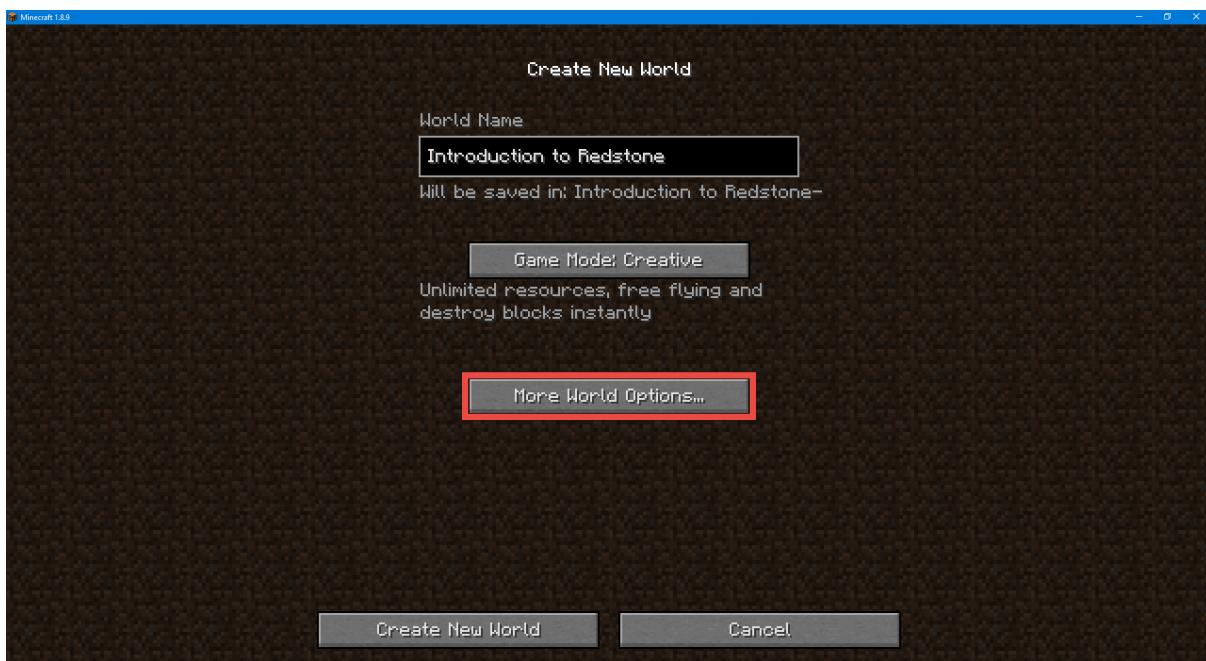
Notes

Click “Create New World”

Actions

4. Create a new Creative world with the following setup:

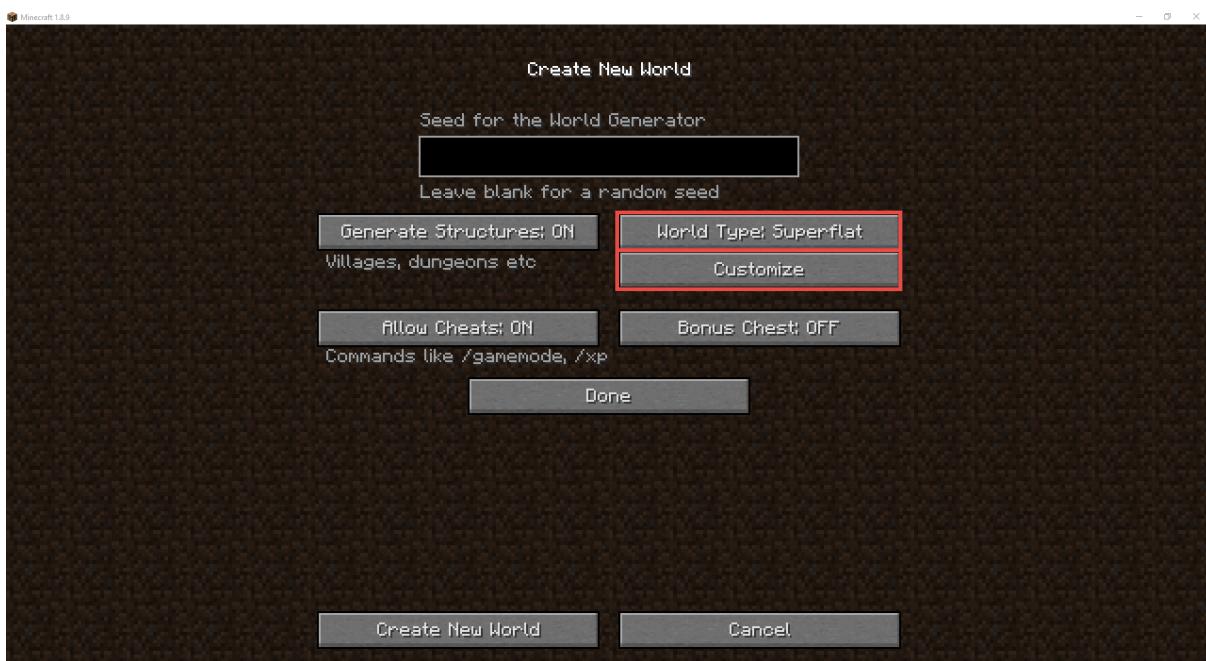
Game Mode	Creative
World Type	Superflat
Preset	Redstone Ready
Generate Structures	ON
Allow Cheats	ON



Create New World (Stage 1)

Notes

Click "More World Options..."

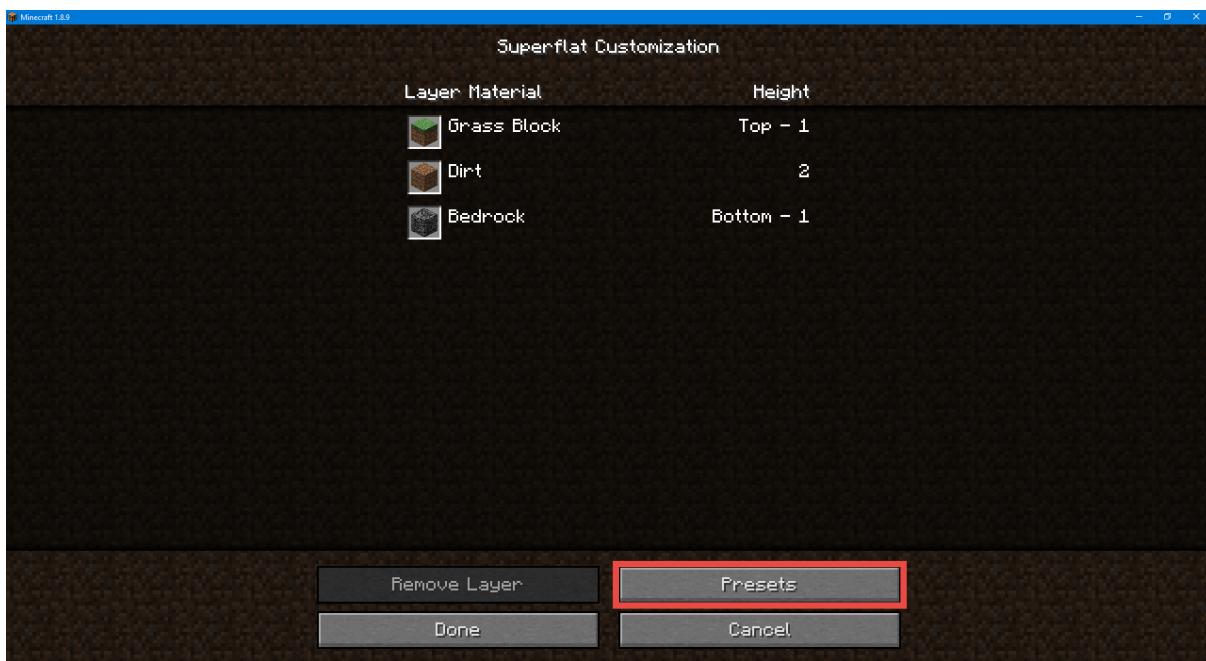


Create New World (Stage 2)

Notes

Set “World Type” to “Superflat” by repeat clicking it.

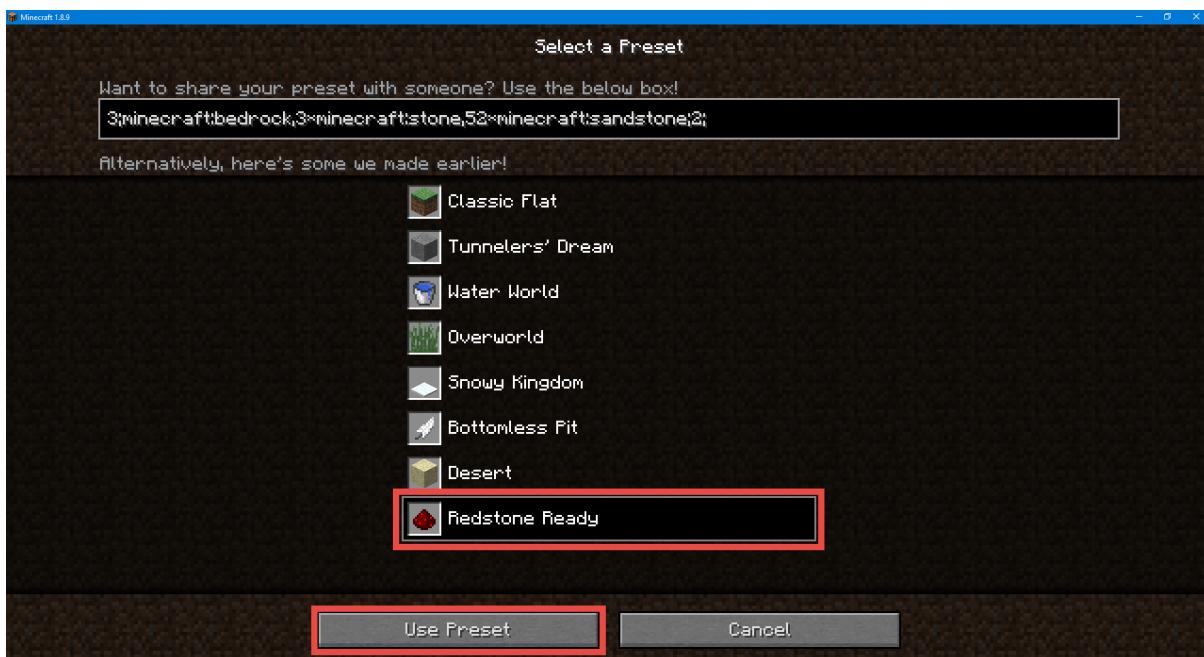
Then click “Customize”



Superflat Customisation

Notes

Click “Presets”



Select Redstone Ready preset (bottom of list)

Notes

Scroll to the bottom and click “Redstone Ready”

Finally, click “Use Preset” then “Done” then “Create New World”.

Wait for the world to load.

Goals

That's it for the introduction - you should now have created your new world ready for Redstone building.

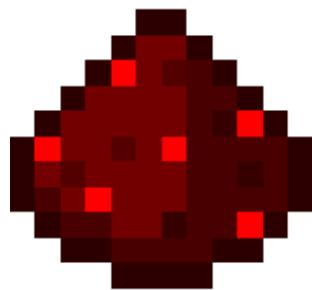
You can build Redstone in any type of world, but Redstone Ready worlds make it much easier.

Questions

1. What kind of block is the Redstone ready world made from?
2. How many blocks vertically downwards are there till you reach the bedrock?

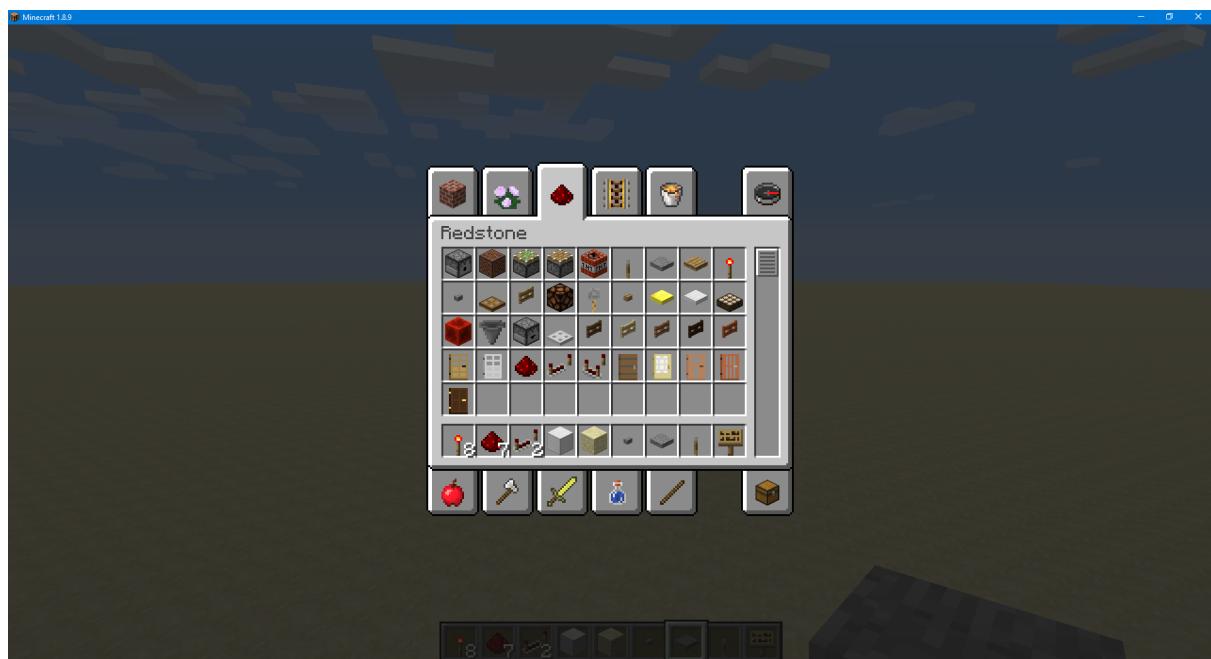
2 Placing and Powering Redstone

Let's get started with Redstone. It looks like this:



Redstone Dust

You can get it from the Redstone tab of the Inventory:



Redstone tab of the Inventory

Actions

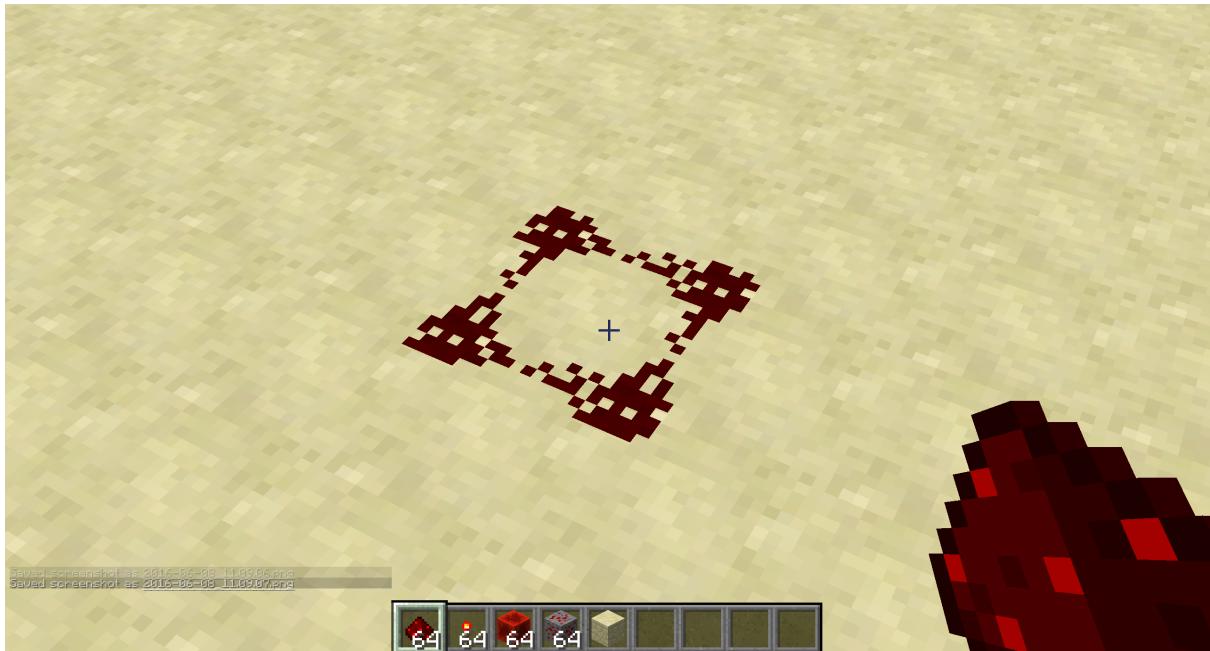
1. Open the inventory
2. Take some Redstone dust
3. Take a Redstone torch
4. Take a Redstone lamp
5. Take a Redstone repeater



Redstone Repeater

2.1 Powering a lamp

We can place Redstone dust on the ground to form wires. Wires move Redstone power around.



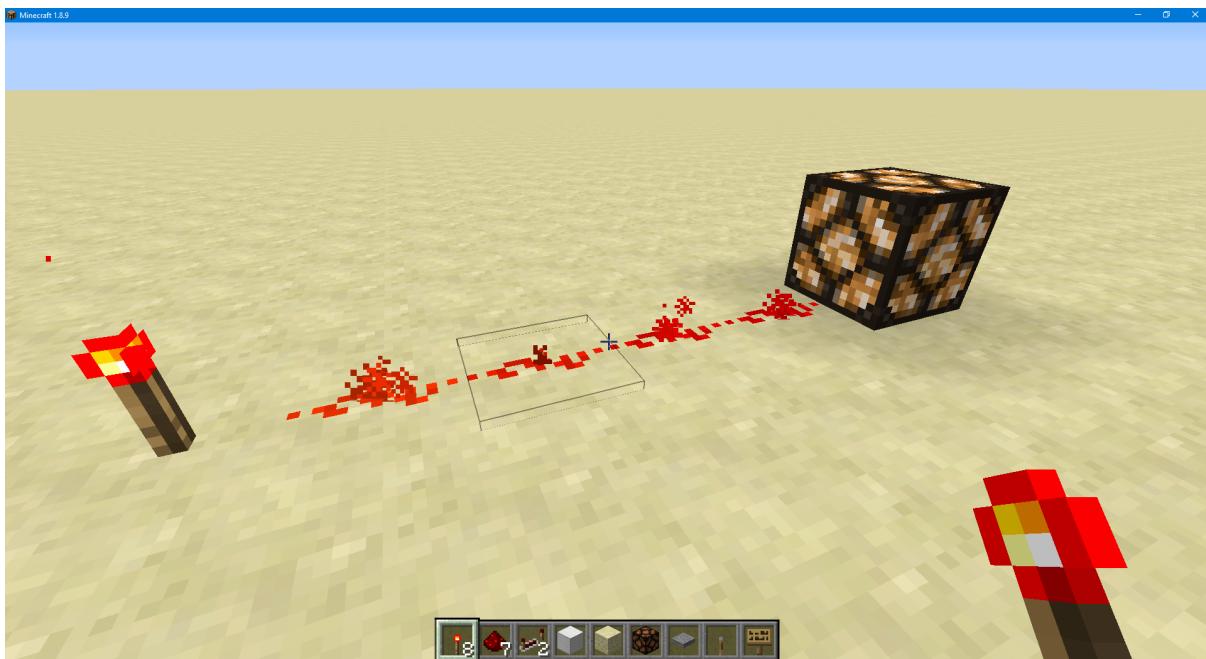
Four bits of Redstone dust placed on the ground

Actions

1. Place some Redstone dust on the ground
2. Place more Redstone dust to form a line
3. Place a Lamp at one end of the line (on the end, not next to it)
4. Place a Redstone torch at the other end of the line

Notes

Redstone torches look similar to normal torches - don't use the wrong one!



Powered wire going into lamp



Unpowered (left) and powered (right) Redstone wires

Goals

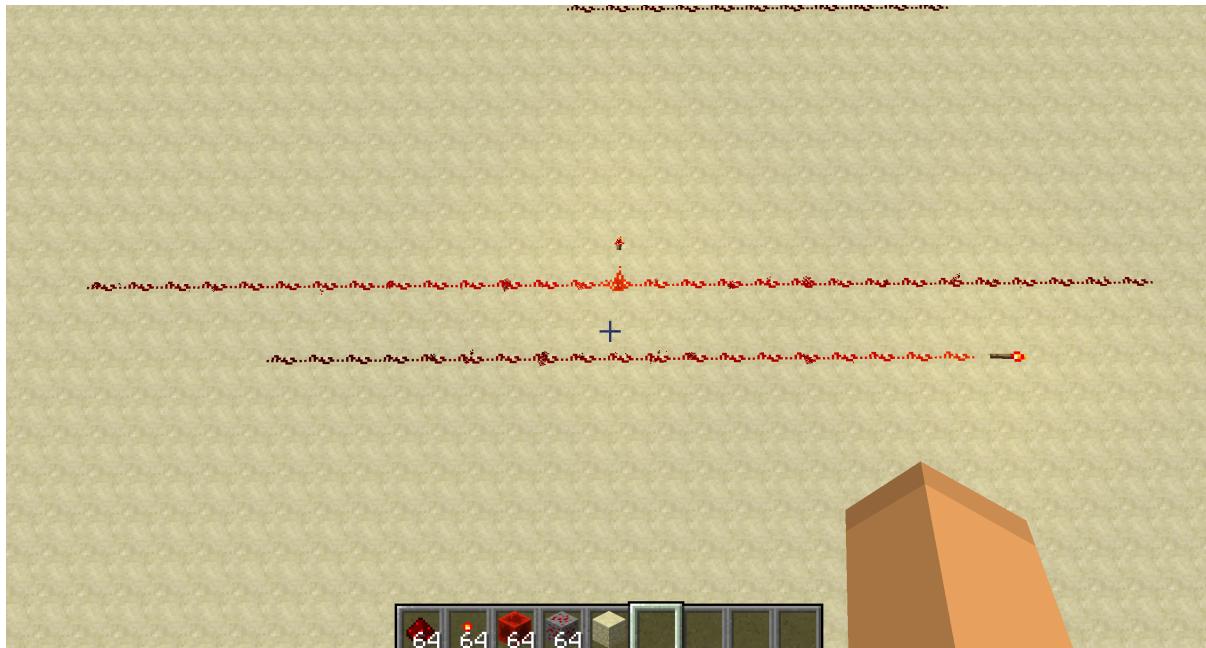
The torch should be supplying power to the wire. The power should be traveling down the wire into the lamp, so the lamp should light up.

2.2 Boosting power

Redstone power gets weaker the further it is from the source of power (i.e. the torch). A “Repeater” allows us to boost the power.

Notes

Redstone power runs out after 15 blocks.



2 wires where the power runs out

Notes

We can use a repeater to boost the power. A repeater is a power source, but it only transmits power when it is supplied with power!



A repeater (Right: input wire, Left: output wire)

Notes

A repeater only accepts power in on one side and only outputs power on the other side.



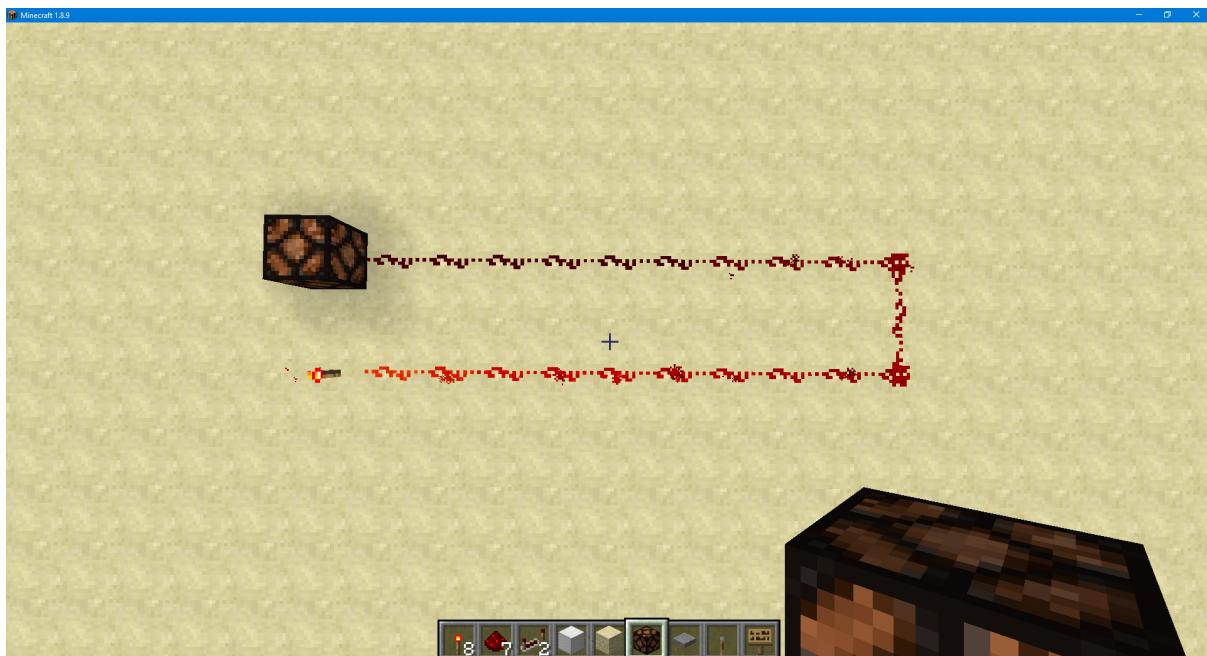
A repeater acts like a diode

Actions

1. Destroy the lamp you placed
2. Extend the wire so it is more than 15 blocks long (but less than 30!)
3. Place a lamp at the end of the new, longer wire

Goals

Notice how the Redstone power “runs out” after 15 blocks so the lamp doesn’t switch on.



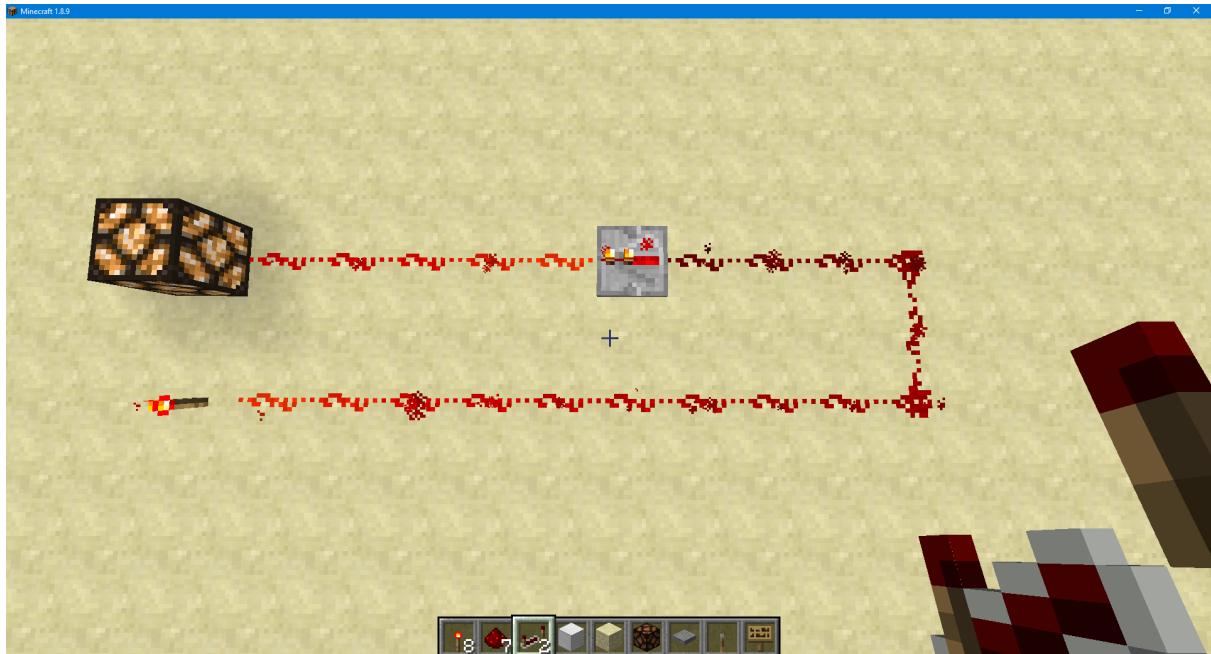
Redstone power decreases with each block

Actions

4. Find the block of Redstone dust where the power first runs out
5. Destroy the dust at this point
6. Place a repeater where the dust was

Notes

Make sure your repeater points in the right direction.



Redstone power is boosted by the repeater

Goals

The repeater boosts the power. Your lamp should now be switched on as power now reaches the end of the wire.

Questions

3. Which side of a repeater accepts power in?
4. Which side of a repeater outputs power?
5. How far (counted in blocks) does power travel out of a repeater?

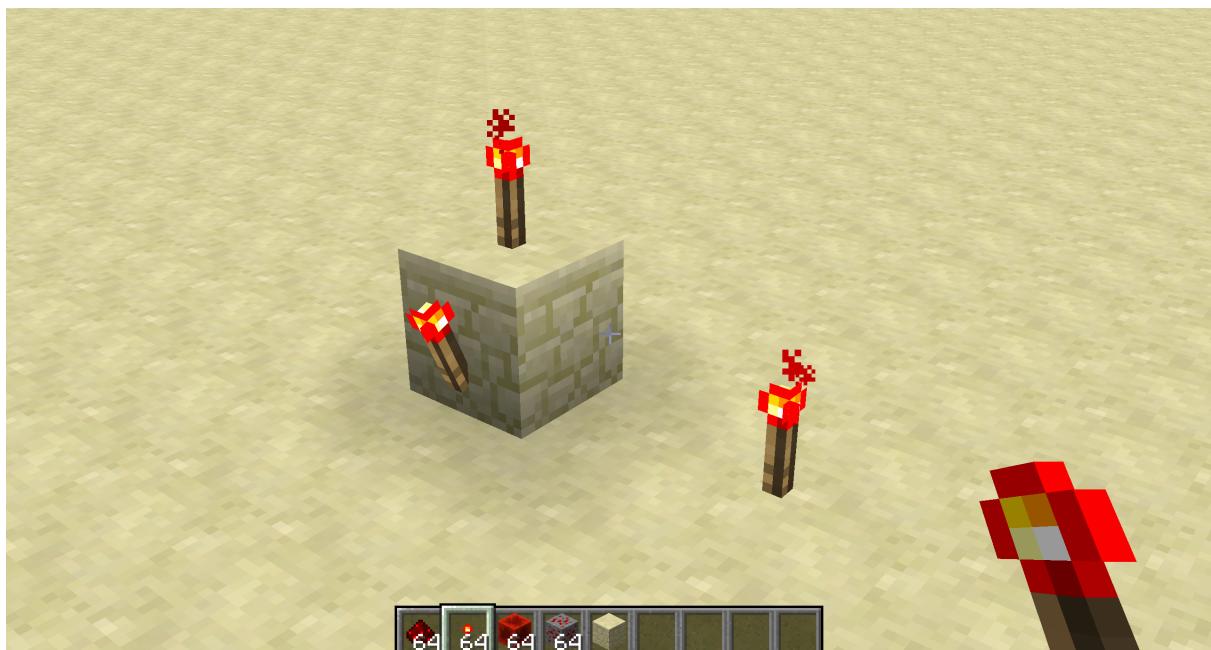
Goals

You should now know how to:

- Get Redstone from the inventory
- Place Redstone dust to form a wire
- Power and unpower Redstone wires using Redstone torches
- Boost Redstone power using a repeater

3 Redstone Torches

Redstone torches can be placed on top of or on the side of blocks.



Some Redstone torches

3.1 Flow of power from a torch

Redstone torches output power in all directions except diagonally and except to the block they are placed on.

Notes

Redstone torches **don't** output power to **either**:

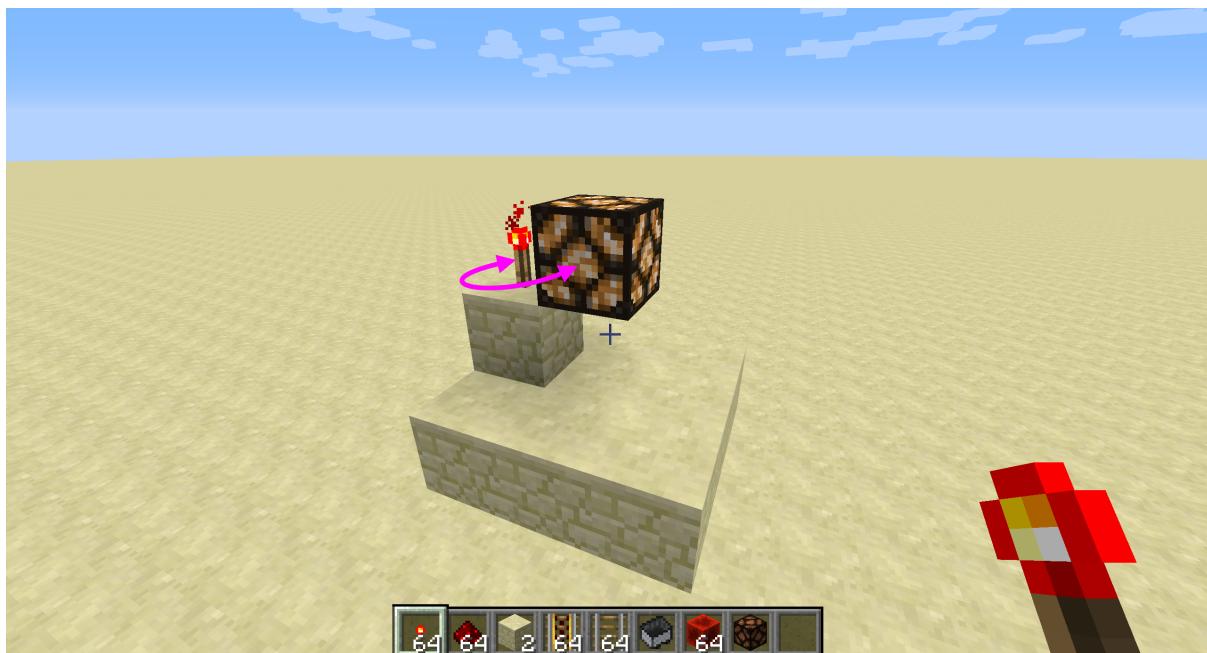
- the block they are hanging on the side of **or**,
- the block they are placed on top of.

Notes

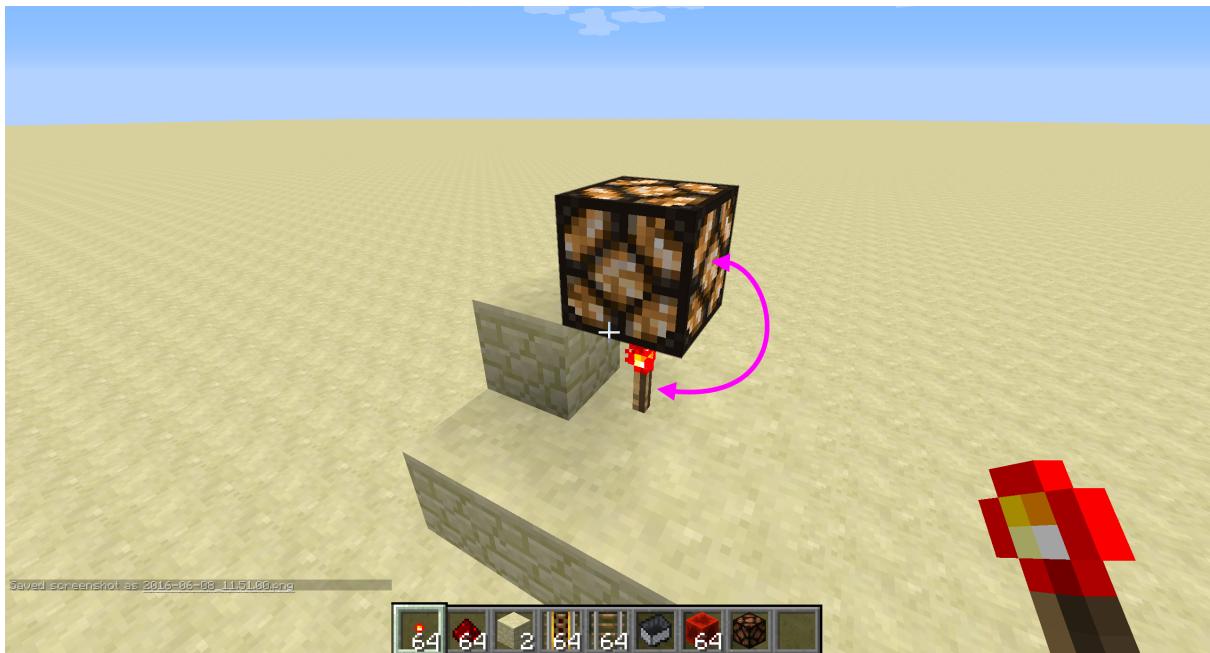
Redstone torches do not output power diagonally.

Actions

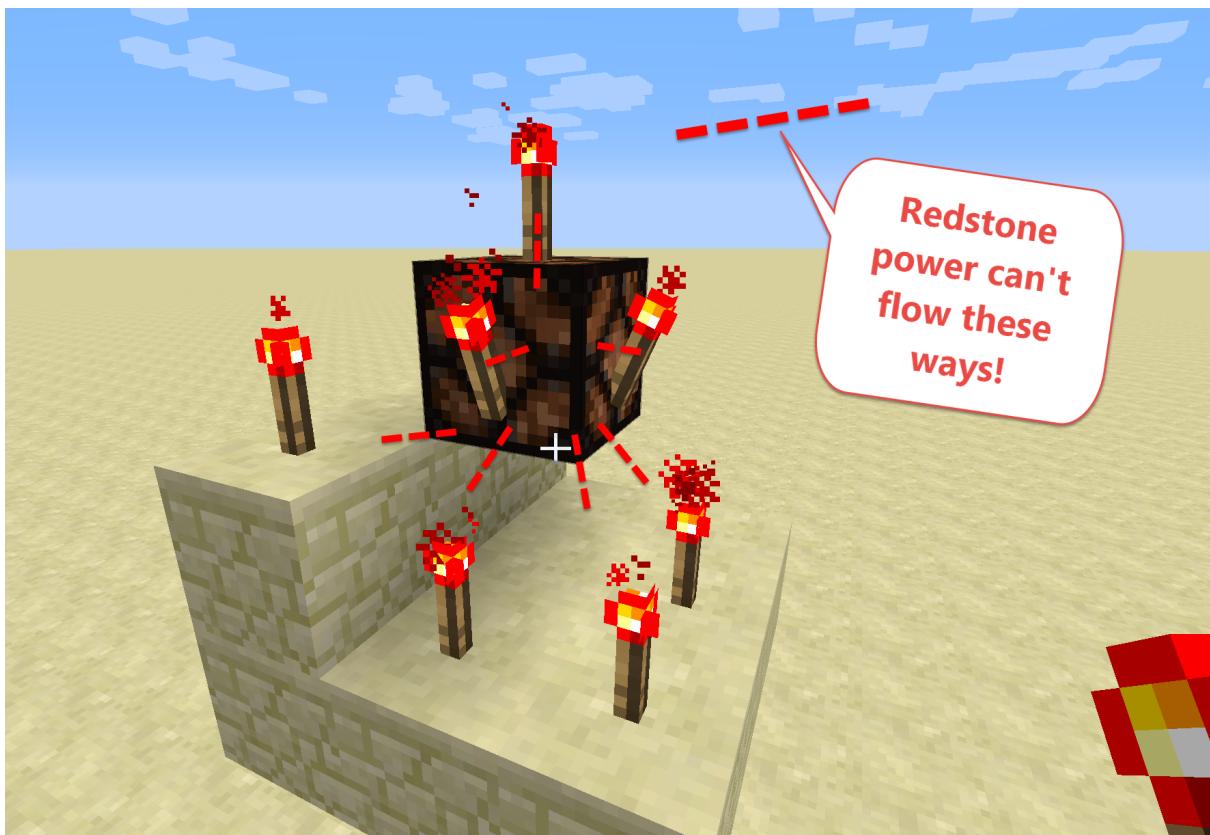
1. Place a block (of sandstone or anything else) on the ground
2. Place a lamp on top of the block
3. Destroy the block underneath the lamp
4. Using one torch at a time, place torches around, underneath, on top of and hanging on the lamp. Work out which do and which don't turn on the lamp.
5. Place a lamp on the ground
6. Using one torch at a time, place torches around the lamp (including diagonally). Work out which do and which don't turn on the lamp.



Lamp powered by torch to the side of it



Lamp powered by torch underneath it



Lamp not powered by torches placed on it or placed diagonally from it

Actions

7. Build a block on the ground
8. Place a block on top of the block you just built
9. Place a Redstone torch on the side of the upper block
10. Place a Redstone wire on the ground directly underneath the torch

Notes

This last exercise can be confusing as Redstone dust looks like it's lying on the ground - it doesn't look like a full block, but it does occupy a full block's space in the game. Thus the torch is directly above the Redstone dust and so it powers the dust.

Goals

The wire should be powered as the torch outputs power downwards to the block underneath it, which is the Redstone dust block in the wire.

Goals

You should now know which directions power flows from a Redstone torch.

3.2 Torch on a block

A Redstone torch placed on a block has a special feature. If a block is powered (just like we powered the lamp earlier) then any Redstone torch placed on the block will switch off!

Notes

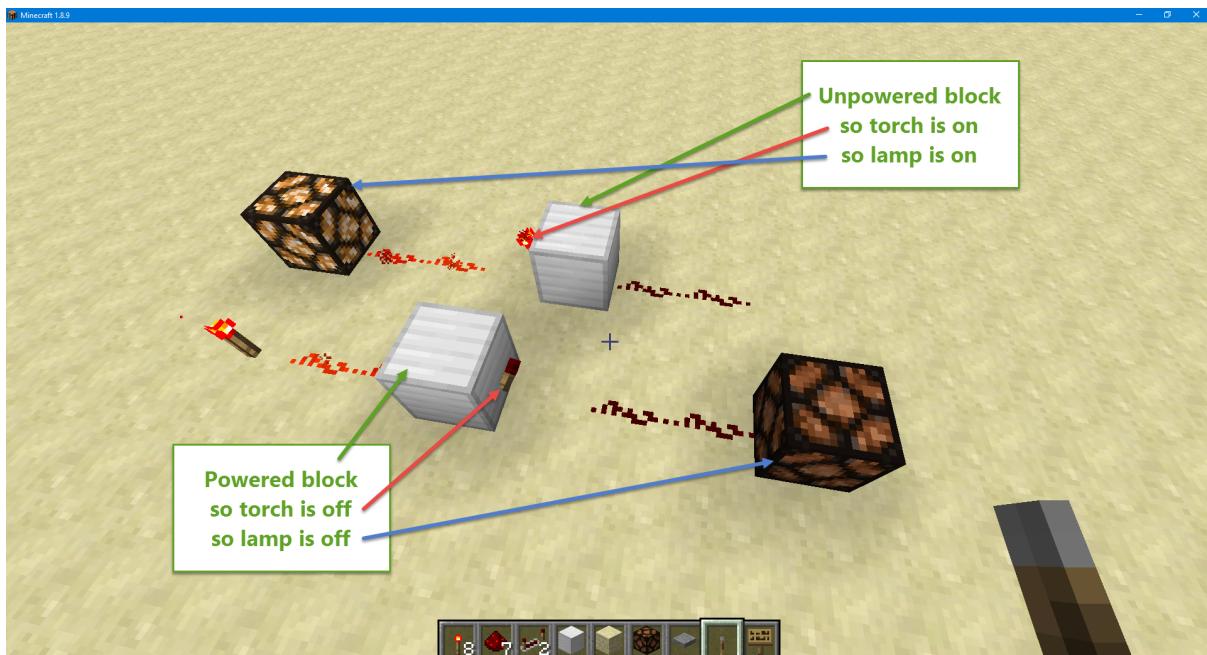
Redstone torches on unpowered blocks switch on. Redstone torches on powered blocks switch off.

Actions

1. Place a block on the ground
2. Place a torch on the side or top of the block you just made
3. Build a wire on the ground going into the block (just like the wire we built earlier going into the lamp)
4. Build a torch at the end of the wire
5. Destroy and remake the torch while looking at the torch on the block. Notice how the torch on the block switches off when power is put into the block.

Notes

Almost any block can be powered by passing power into it using a wire. Alternatively, you can power blocks by placing a torch underneath them or, for some blocks, next to them, as we saw with the lamp earlier.



Torches on unpowered and powered blocks

Goals

You should have seen the torch on the block switch off and on as you powered and unpowered the block.

Questions

6. What would happen if you powered a block using a wire from a torch placed on the same block?
7. When you power on the wire, is there a delay before the torch on the block switches off?

Goals

You should now be able to work out whether a torch on a block will be on by seeing if there is any power flowing into the block the torch is placed on.

We can describe what is going here like this:

A torch on a powered block is not on.

A torch on an unpowered block is not off.

In other words, if we call the power (or lack of power) going into the block the “input”, and the power supplied by the torch the “output”, then “the input is not the output”.

Notes

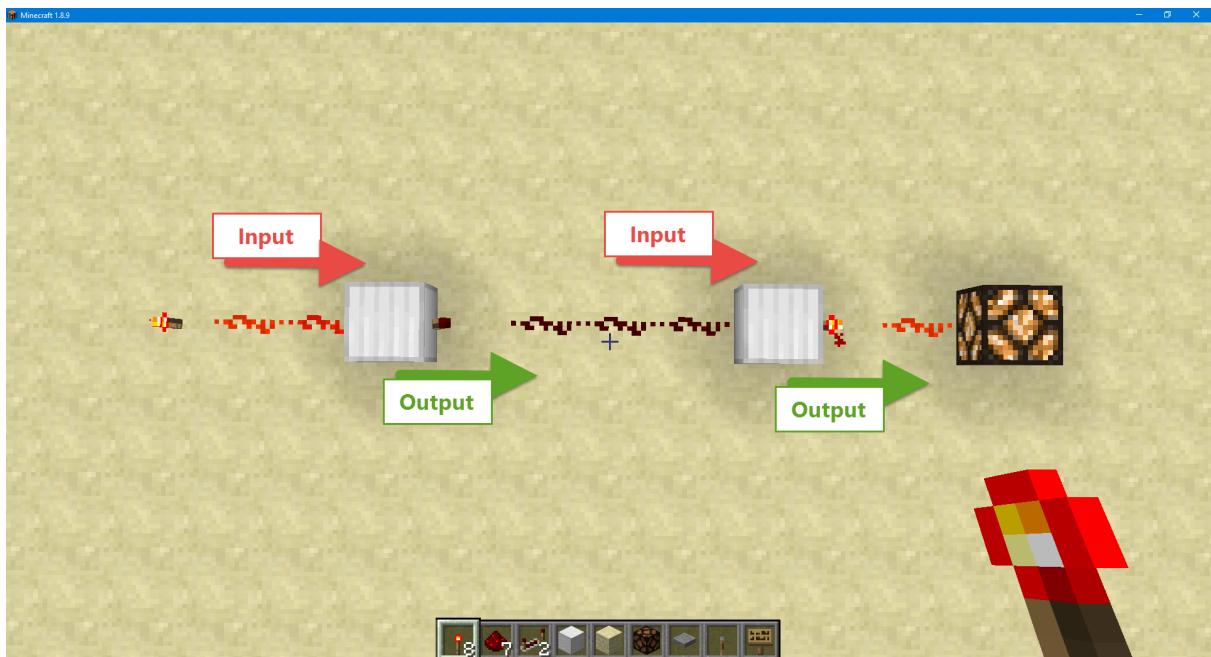
A torch on a block is called a **NOT gate**.

- Power going into block is called the “input”.
- Power going out from the torch on the block is called the “output”.
- If the torch is on, we say the output of the gate is on.
- If the torch is off, we say the output of the gate is off.
- For a NOT gate (which is a torch on a block), the output is the opposite of any inputs.
- We call this a NOR gate when there is more than one input
- We write the names of gates in CAPITAL LETTERS to distinguish them from ordinary English words.

3.3 NOT and NOR gates

Actions

1. Build a NOT gate
2. Build a second NOT gate, three blocks in front of the first one
3. Connect the output of the first NOT gate to the input of the second using a wire



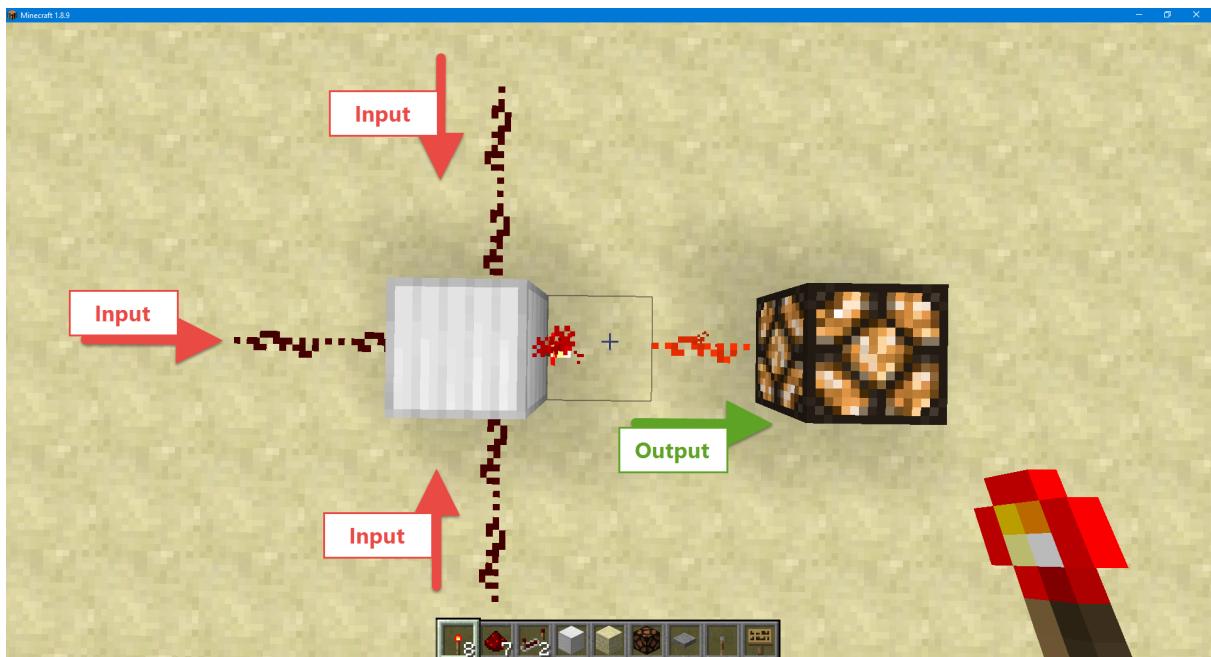
Two NOT gates chained together

Questions

8. What happens when you power the input of the first NOT gate?
9. Is two NOT gates in a row like this, the same as a repeater?

Actions

4. Build a NOT gate on the ground
5. Build three wires - one going into each side of the block of the NOT gate
This makes it a **NOR gate**.
6. Build a wire from the output of the NOR gate (the torch on the block) going into a lamp
7. Power and unpower the three inputs, one at a time and then multiple at once. Observe what happens to the output (by looking at the lamp).



A 3-input NOR gate with the output wired to a lamp

Questions

10. What combination of inputs makes the lamp switch on?
11. What combinations of inputs makes the lamp switch off?
12. If you wire all three inputs together, then put them into the block, is it the same thing?

Notes

Any point where two wires join is called an **OR gate** because the power coming out of the join is on if either of the inputs is on.

Notes

A NOR gate is an OR gate followed by a NOT gate, hence the name “NOR” meaning “NOT-OR”.

Goals

You should now be able to build NOT and NOR gates using torches on blocks and predict the output of a NOT or NOR gate given a set of inputs.

Questions

13. What is the output of a NOT gate if its input is on?
14. What is the output of a NOR gate, if it has three inputs of which two are on and one is off?

4 Using NOR gates

NOR gates are the most basic building block for all electronic circuits - including Redstone circuits. Amazingly, we can combine NOR gates to form anything from a simple lock to an entire computer or mobile phone!

Notes

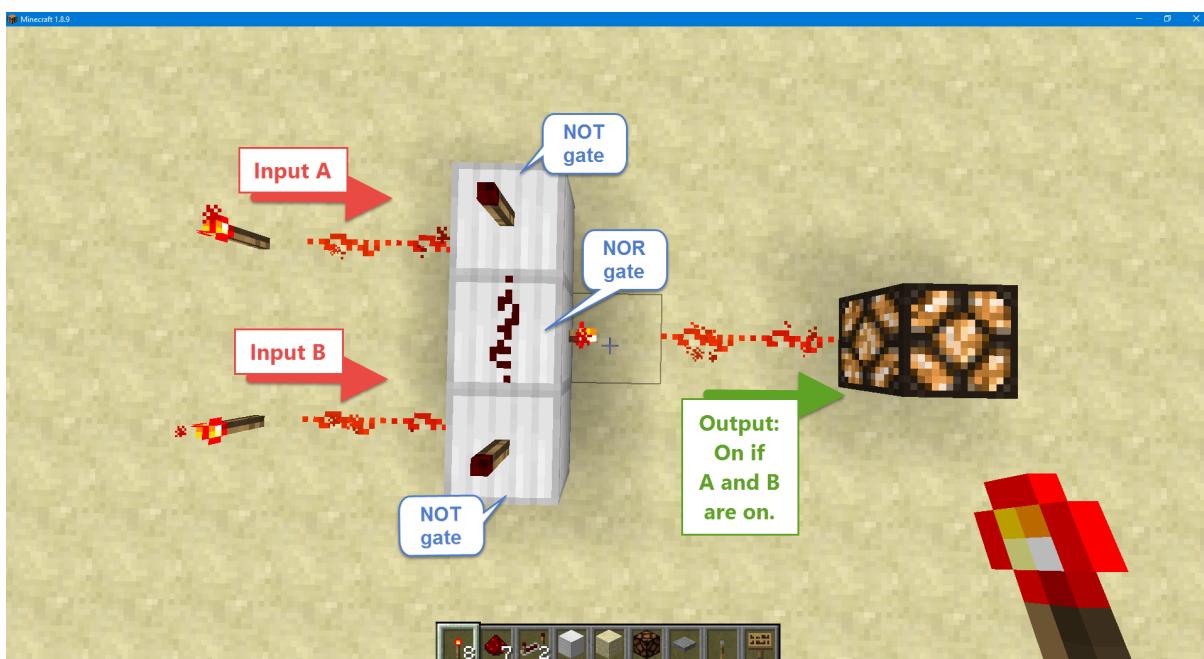
NOR gates for the building block of all circuits.

We can build other kinds of gate from a NOR gate. Let's suppose we wanted to build a locked door. Our locked door might require 4 levers to be put into the correct positions for the door to open.

Let's call the four levers of our lock inputs A, B, C and D. We want our door to open if A and B and C and not D are switched on. It sounds like we're going to need an AND gate!

4.1 AND gates

An AND gate is easy to make. We have two inputs. We NOT each of them separately, and then NOR the outputs of the NOT gates together. It looks like this:



A 2-input AND gate with the output wired to a lamp

Notes

AND gate: NOT the inputs, NOR the results together

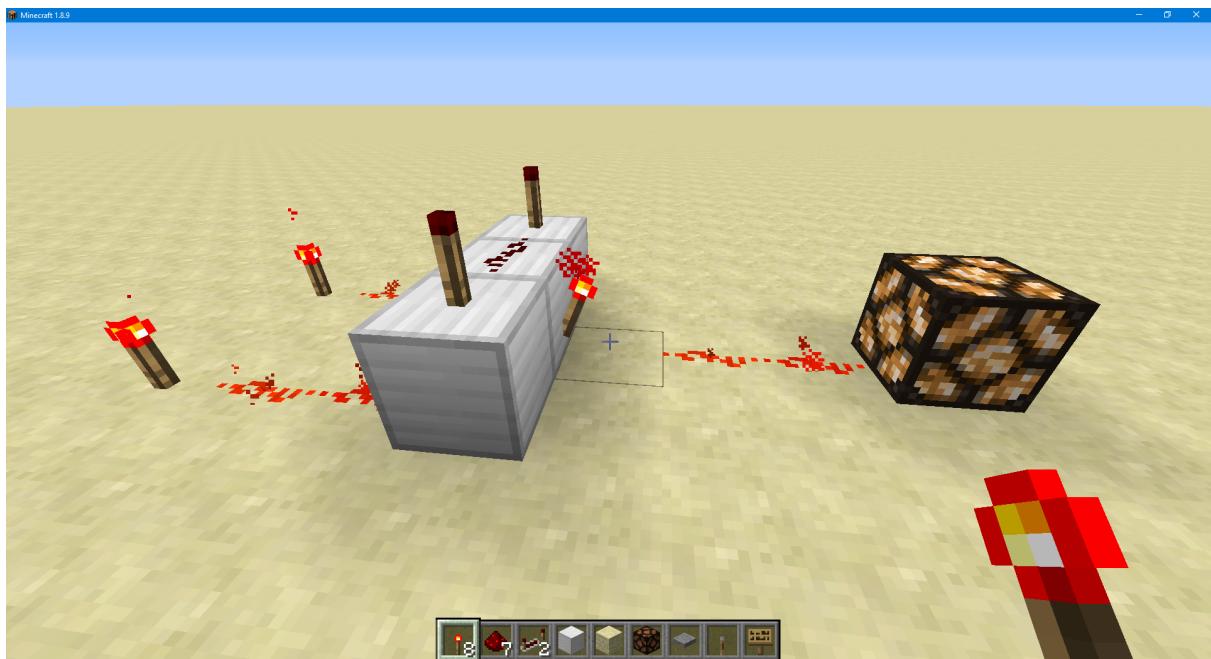
The output of an AND gate is on only if both of its inputs are on.

Actions

1. Build a NOT gate (placing the torch on top of the block not on the side)
2. Build a NOT gate next to this (this time, place the torch on the side of the block not on the top)
3. Build a third NOT gate, like the first - torch on top, next to the second gate
4. Place a piece of Redstone dust on top of the NOT gate (i.e. the block) in the middle
5. Build separate wires going into the back of the two NOT gates (i.e. the blocks) on either side. These are the input wires.
6. Build a wire from the torch in the middle to a lamp. This is the output.
7. Power both of the input wires - notice how the lamp switches on.

Notes

This can be tricky to build. Look at the screenshot above or the one below if you get stuck or it doesn't work!



A 2-input AND gate with the output wired to a lamp

Questions

15. Which inputs to an AND gate have to be on to make the output (i.e. the lamp) switch on?
16. Which inputs to an AND gate can be off to make the output (i.e. the lamp) switch off?

Goals

You should now be able to build an AND gate and predict the output of an AND gate from a given set of inputs.

4.2 Locked doors

Let's build a mini project! We're going to build the locked door we were talking about before. It'll use four levers to select a specific code to open the door.

For this example, we're going to make the code: On, Off Off, On - but you can use a different pattern. You'll need to change the positions of the NOT gates we use to make a different code.

Actions

1. Build a wall of iron blocks that is 10 long, 1 wide and 3 high
2. Place a lever one block in from the edge of the left hand end, in the middle
3. Destroy the block in the bottom right corner of your wall
4. Build a door at the end of the wall (as shown below)
5. Extend the wall over and around your door

Notes

Your wall should now look like the screenshot below



In front of the wall

Actions

6. Behind the wall, build four blocks as shown in the screenshot below.
7. Place a piece of Redstone dust on top of each block, as shown



Behind the wall (stage 1)

Actions

8. Place torches on any of the blocks which are behind levers that you want to be OFF in your lock code
9. Build two AND gates, one in front of each pair of blocks with Redstone (or torches) on them
10. Connect the AND gate inputs to the outputs of the blocks with wires
11. Build a third AND gate in 4 blocks in front of the other two
12. Connect the outputs of the first two AND gate to the inputs of the third AND gate
13. Connect the output of the AND gate through the hole in the wall to the door

Notes

You might need a repeater in the wire from the third AND gate to the door to boost the power.

Notes

The circuit behind your wall should look something like the screenshot below.



Behind the wall (stage 2)

Goals

Hopefully you now have a locked door, which only opens when the four levers are in the right positions!

Questions

17. What is the delay between switching the levers and the door opening and closing?
18. Can you work out what is causing this delay?
19. Here's a tricky one for you: Can you make the circuit smaller?
20. Lastly: Does making the circuit smaller reduce the open/close delay?

5 Wrap-up

We hope you enjoyed this workshop! This workshop also has a second part where we teach you how to build more complex circuits like a Minecart Wave Machine and a Locked Corridor. Ask your teacher about it!

Goals

Hopefully you now understand all of this stuff:

- Redstone wires
- Redstone torches
- Redstone repeaters
- Lamps, levers and doors
- Torches on blocks : NOT-gates / NOR-gates
- AND-gates
- How to combine NOT/NOR/AND gates to form more complex circuits (like a locked door combination circuit!)

That's an impressive amount for just an hour and a half!

6 Extra Resources

Here's a few extra resources to help you along with this worksheet and some stuff to try at home.

- Minecraft website : <http://www.minecraft.net>