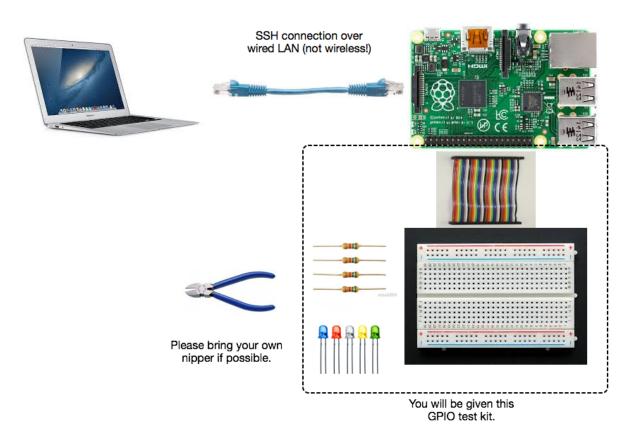
email: ysjoo@cs.kookmin.ac.kr

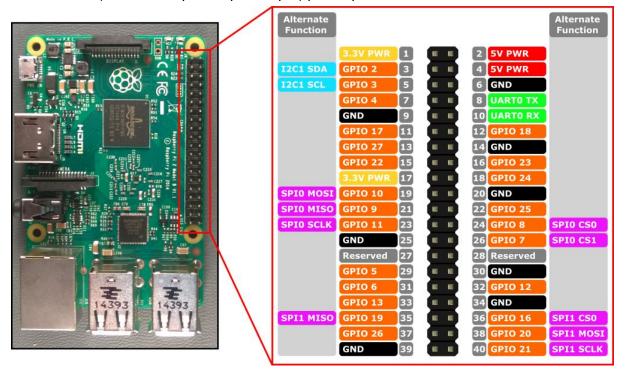
LED circuit & GPIO test

NOTE:

- Be sure to take off your watches, rings, and any metal accessories before practice.
- When power is ON, changing wiring or inserting & removing components to the breadboard is strongly prohibited.
- 1. Experimental setup.

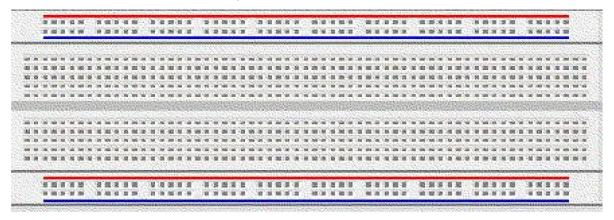


• GPIO (General Purpose Input/Output) pin map

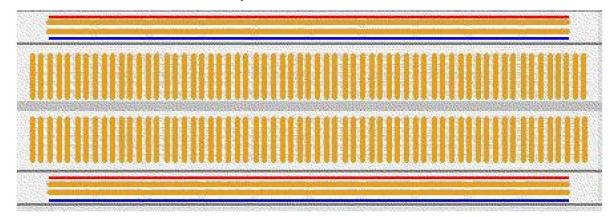


2. How to use breadboard?

 A breadboard is used to build and test circuits quickly before finalizing any circuit design. The breadboard has many holes into which circuit components like ICs and resistors can be inserted. A typical breadboard is shown below:



 The bread board has strips of metal which run underneath the board and connect the holes on the top of the board. The metal strips are laid out as shown below. Note that the top and bottom rows of holes are connected horizontally while the remaining holes are connected vertically.



Reference: http://hibp.ecse.rpi.edu/~connor/education/breadboard.pdf

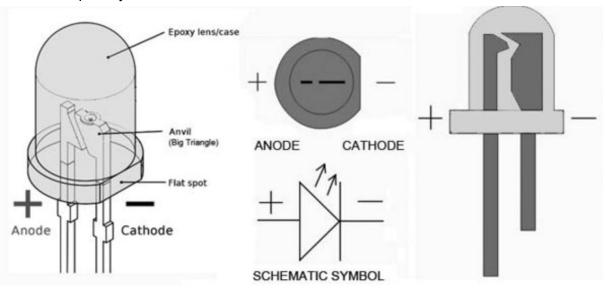
• Breadboard simulation tool

https://123d.circuits.io/circuits/1255805-the-unnamed-circuit#breadboard

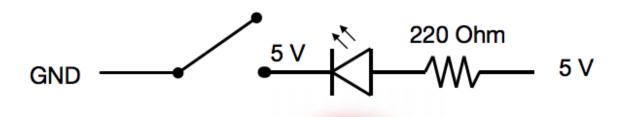
3. How to use LEDs?

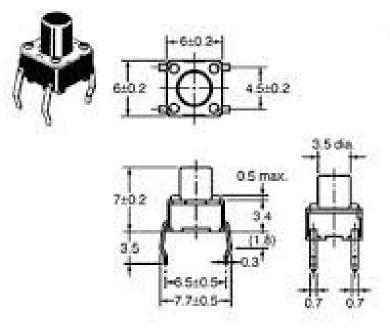
http://web.ece.ucdavis.edu/~bbaas/180a/lab/LabUsingLEDs.pdf

• LED polarity

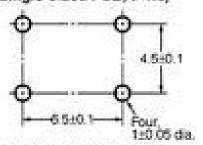


4. Make a prototype for the below circuit.

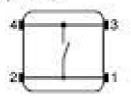




PCB Mounting (Top View) (Single-sided PCB, t=1.6)



Terminal Arrangement Anternal Connections (Top View)





E12 Range, Resistor 220Ω, 5% Tolerance, Carbon Film

www.iamtechnical.com

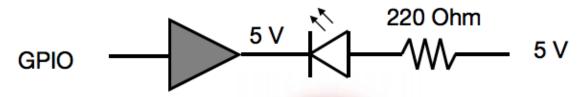
Red

Red

Brown

Gold

5. Make a prototype for the below circuit.



< Active low circuit: LED will be on with the GPIO output 0, off with GPIO output 1>

- 6. Use a set of Linux shell commands to turn on and off the LED through GPIO control.
 - Using "gpio" command
 - IMPORTANT: your GPIO extension board (T-shape PCB) uses BCM numbering. However, the gpio command uses the wPi numbering by default. In order to use the BCM numbering, you should add -g option, for example:
 - gpio -g mode 12 out == gpio mode 26 out

3.3v 1 2 5v 2 8 SDA.1 IN 1 3 4 5v 3 9 SCL.1 IN 1 5 6 0v 4 7 GPIO. 7 IN 1 7 8 0 IN TxD	1	
3 9 SCL.1 IN 1 5 6 0 0 4 7 GPIO. 7 IN 1 7 8 0 IN TXD 0 9 10 1 IN RXD 17 0 GPIO. 0 IN 0 11 12 0 IN GPIO. 17 2 GPIO. 2 IN 0 13 14 0 0 0 0 0 0 0 0 0		1
4 7 GPIO. 7 IN 1 7 8 0 IN TxD 0v 9 10 1 IN RxD 17 0 GPIO. 0 IN 0 11 12 0 IN GPIO. 17 2 GPIO. 2 IN 0 13 14 0v 0v 22 3 GPIO. 3 IN 0 15 16 0 IN GPIO. 18 10 12 MOSI IN 0 19 20 0v 0v 9 13 MISO IN 0 21 22 0 IN GPIO. 19 11 14 SCLK IN 0 23 24 1 IN CE0 0v 25 26 1 IN CE1 0 30 SDA.0 IN 1 27 28 1 IN SCL.0 5 21 GPIO.22 IN 1 31 32 0 IN GPIO.20	i	i
4 7 GPIO. 7 IN 1 7 8 0 IN TxD 0v 9 10 1 IN RxD 17 0 GPIO. 0 IN 0 11 12 0 IN GPIO. 17 2 GPIO. 2 IN 0 13 14 0v 0v 22 3 GPIO. 3 IN 0 15 16 0 IN GPIO. 18 10 12 MOSI IN 0 19 20 0v 0v 9 13 MISO IN 0 21 22 0 IN GPIO. 19 11 14 SCLK IN 0 23 24 1 IN CE0 0v 25 26 1 IN CE1 0 30 SDA.0 IN 1 27 28 1 IN SCL.0 5 21 GPIO.22 IN 1 31 32 0 IN GPIO.20	i	i
17 0 GPIO. 0 IN 0 11 12 0 IN GPIO. 1 27 2 GPIO. 2 IN 0 13 14	1 15	1 14
27 2 GPIO. 2 IN 0 13 14	1 16	1 15
22 3 GPIO. 3 IN 0 15 16 0 IN GPIO. 4 3.3v 17 18 0 IN GPIO. 5 10 12 MOSI IN 0 19 20 0v 9 13 MISO IN 0 21 22 0 IN GPIO. 6 11 14 SCLK IN 0 23 24 1 IN CE0 0 0v 25 26 1 IN CE1 0 30 SDA.0 IN 1 27 28 1 IN SCL.0 5 21 GPIO.21 IN 1 29 30 0v 6 22 GPIO.22 IN 1 31 32 0 IN GPIO.20	1 1	1 18
3.3v 17 18 0 IN GPIO. 9 10 12 MOSI IN 0 19 20 0v 9 13 MISO IN 0 21 22 0 IN GPIO. 0 11 14 SCLK IN 0 23 24 1 IN CE0 0v 25 26 1 IN CE1 0 30 SDA.0 IN 1 27 28 1 IN SCL.0 5 21 GPIO.21 IN 1 29 30 0v 6 22 GPIO.22 IN 1 31 32 0 IN GPIO.20	2000	j
10 12 MOSI IN 0 19 20 0v 9 13 MISO IN 0 21 22 0 IN GPIO. 0 11 14 SCLK IN 0 23 24 1 IN CE0 0v 25 26 1 IN CE1 0 30 SDA.0 IN 1 27 28 1 IN SCL.0 5 21 GPIO.21 IN 1 29 30 0v 6 22 GPIO.22 IN 1 31 32 0 IN GPIO.20	4 4	1 23
9 13 MISO IN 0 21 22 0 IN GPIO. 0 11 14 SCLK IN 0 23 24 1 IN CE0 0v 25 26 1 IN CE1 0 30 SDA.0 IN 1 27 28 1 IN SCL.0 5 21 GPIO.21 IN 1 29 30 0 0v 6 22 GPIO.22 IN 1 31 32 0 IN GPIO.20	5 5	1 24
11 14 SCLK IN 0 23 24 1 IN CE0	i	i
0v 25 26 1 IN CE1 0 30 SDA.0 IN 1 27 28 1 IN SCL.0 5 21 GPIO.21 IN 1 29 30 0v 6 22 GPIO.22 IN 1 31 32 0 IN GPIO.20	6 6	25
0 30 SDA.0 IN 1 27 28 1 IN SCL.0 5 21 GPIO.21 IN 1 29 30	1 10	1 8
5 21 GPIO.21 IN 1 29 30 0v 6 22 GPIO.22 IN 1 31 32 0 IN GPIO.20	1 11	17
6 22 GPIO.22 IN 1 31 32 0 IN GPIO.20	31	1 1
	(4080	j
	26 26	1 12
13 23 GPIO.23 IN 0 33 34 0v	i	i
19 24 GPIO.24 IN 0 35 36 0 IN GPIO.23	27 27	16
26 25 GPIO.25 IN 0 37 38 0 IN GPIO.20	28 28	20
0v 39 40 0 IN GPIO.29	29 29	21

										+	+
BCM	wPi	Name	Mode	V	Phys	ical	V	Mode	Name	wPi	BCM
	1	3.3v		1	1	1 2	1	I	5v	l	1
2	8	SDA.1	IN	1	3	4	1	1	5v	1	
3	9	SCL.1	IN	1	5	6	1	1	0v	garan (200
4	7	GPIO. 7	IN	1	7	8	10	IN	TxD	15	14
	1	0 v	1		9	10	1	IN	RxD	16	15
17	0	GPI0. 0	IN	0	11	12	0	IN	GPIO. 1	1	18
27	2	GPI0. 2	IN	0	13	14	1	1	0 v		
22	3	GPI0. 3	IN	0	15	16	0	IN	GPIO. 4	4	23
		3.3v			17	18	0	IN	GPIO. 5	5	24
10	12	MOSI	IN	0	19	20	1	İ	0 v		1
9	13	MISO	IN	0	21	22	10	IN	GPI0. 6	6	25
11	14	SCLK	IN	0	23	24	1	IN	CE0	10	8
		0 v			25	26	1	IN	CE1	11	7
0	30	SDA.0	IN	1	27	28	1 1	IN	SCL.0	31	1
5	21	GPI0.21	IN	1	29	30	1	2000	0v	1	
6	22	GPI0.22	OUT	0	31	32	10	IN	GPI0.26	26	12
13	23	GPI0.23	IN	0	33	34	1	İ	0 v	i i	ĺ
19	24	GPI0.24	IN	0	35	36	10	IN	GPI0.27	27	16
26	25	GPI0.25	IN	0	37	38	10	IN	GPI0.28	28	20
		0 v			39	1 40	10	IN	GPI0.29	29	21
всм	wPi	Name	Mode	V	Phys	ical	I V	l Mode	l Name	l wPi	BCM
		i:~ \$ gpio i:~ \$ gpio	write:	22 1 l		3	+	+	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		
rasp	berryp	i:~ \$ gpio	write : readal	22 1 l +	+Pj	3	+	+	+	+	+
rasp			write : readal	22 1 l +	+Pj	3	+	+	+	wPi	+ BCN
BCM	wPi	i:~ \$ gpio Name 3.3v	write readal	22 1 l + V +	+Pi Phys 	3 ical	+	+	Name	+ wPi 	+ BCN
BCM 2	wPi	i:~ \$ gpio Name 3.3v SDA.1	write readal	22 1 l + V + 	+Pi Phys 1	3 sical	+	+	Name	wPi	+ BCN
BCM 2 3	wPi wPi 8 9	i:~ \$ gpio Name 3.3v SDA.1 SCL.1	write readal Mode	22 1 \	+Pi Phys 1 3	3 sical 2 4 6	V	Mode	Name Sv 5v 5v	; 	
BCM 2	wPi	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7	write readal	22 1 l + V + 	+Pi Phys 1 3 5 7	3 sical 2 4 6 8	V V V V V V V V V V	Mode	Name Sv Sv Sv Øv TxD	 15	 14
BCM 2 3 4	wPi wPi 8 9 7	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7	write : readal Mode IN IN IN	22 1 \ \(\begin{array}{c c c c c c c c c c c c c c c c c c c	+Pj Phys 1 3 5 7 9	3 sical + 2 4 6 8 10	V	Mode	Name Sv Sv 0v TxD RxD	 15 16	 14 15
BCM 2 3 4 17	wPi wPi 8 9 7	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 0v GPIO. 0	write readal Mode IN IN IN IN IN IN IN IN IN IN IN IN IN	22 1 \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	+Pi Phys 1 3 5 7 9	3 ical + 2 4 6 8 10 12	V V V V V V V V V V	Mode	Name 5v 5v 0v TxD RxD GPIO. 1	 15	 14
2 3 4 17 27	wPi wPi 8 9 7 0	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 0v GPIO. 0 GPIO. 2	write readal Mode IN IN IN IN IN IN IN IN IN IN IN IN IN	22 1 \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	+Pi Phys 1 3 3 5 7 9 11	3 sical + 2 4 6 8 10 12 14	V	Mode IN IN IN	Name 5v 5v 0v TxD RxD GPIO. 1	 15 16 1	 14 15 18
BCM 2 3 4 17	wPi wPi 8 9 7	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 0v GPIO. 0 GPIO. 2 GPIO. 3	write readal Mode IN IN IN IN IN IN IN IN IN IN IN IN IN	22 1 \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	Physical Phy	3 ical + 2 4 6 8 10 12 14	V	Mode IN IN IN	Name 5v 5v 0v TxD RxD GPIO. 1	 15 16 1	 14 15 18 23
2 3 4 17 27 22	wPi 8 9 7 0 2 3	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 0v GPIO. 0 GPIO. 2 GPIO. 3 3.3v	write readal Mode	22 1 V V 1 1 1 0 0	Physical Phy	3 ical 2 4 6 8 10 12 14 16 18	V	Mode IN IN IN	Name 5v 5v 0v TxD RxD GPIO. 1 0v GPIO. 4 GPIO. 5	 15 16 1	 14 15 18
2 3 4 17 27 22	wPi 8 9 7 0 2 3 12	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 Øv GPIO. 0 GPIO. 2 GPIO. 3 3.3v MOSI	write readal Mode IN IN IN IN IN IN IN I	22 1 V V 1 1 1 0 0 0	Physical Phy	3 ical + 2 4 6 8 10 12 14 16 18 20	V	Mode IN IN IN IN	Name 5v 5v 0v TxD RxD GPIO. 1 0v GPIO. 4 GPIO. 5	 15 16 1 4 5	 14 15 18 23 24
2 3 4 17 27 22 10 9	wPi 8 9 7 0 2 3 12 13	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 Øv GPIO. 0 GPIO. 2 GPIO. 3 3.3v MOSI MISO	write readal Mode IN IN IN IN IN IN IN IN IN IN IN IN IN	22 1 V V 1 1 1 0 0 0 0	Physical Phy	3 ical 2 4 6 8 10 12 14 16 18 20 22	V	Mode IN IN IN IN IN	Name 5v 5v 6v TxD RxD GPIO. 1 0v GPIO. 4 GPIO. 5 0v GPIO. 6	 15 16 1 4 5 6	 14 15 18 23 24 25
2 3 4 17 27 22	wPi 8 9 7 0 2 3 12	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 Øv GPIO. 0 GPIO. 2 GPIO. 3 3.3v MOSI MISO SCLK	write readal Mode IN IN IN IN IN IN IN I	22 1 V V 1 1 1 0 0 0	Physical Phy	3 ical 2 4 6 8 10 12 14 16 18 20 22 24	V	Mode IN IN IN IN IN IN	Name 5v 5v 0v TxD RxD GPIO. 1 0v GPIO. 4 GPIO. 5 0v GPIO. 6	 15 16 1 4 5 6 10	 14 15 18 23 24 25 8
2 3 4 17 27 22 10 9 11	wPi 8 9 7 0 2 3 12 13 14	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 Øv GPIO. 0 GPIO. 2 GPIO. 3 3.3v MOSI MISO SCLK Øv	write readal Mode IN IN IN IN IN IN IN IN IN IN IN IN IN	22 1 V V 1 1 1 0 0 0 0	Physical Phy	3 ical 2 4 6 8 10 12 14 16 18 20 22 24 26	V	Mode IN IN IN IN IN IN IN	Name 5v 5v 0v TxD RxD GPIO. 1 0v GPIO. 4 GPIO. 5 0v GPIO. 6 CE0 CE1	 15 16 1 4 5 6 10	 14 15 18 23 24 25 8
2 3 4 17 27 22 10 9 11	wPi 8 9 7 0 2 3 14 30	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 Øv GPIO. 0 GPIO. 2 GPIO. 3 3.3v MOSI MISO SCLK Øv SDA.0	write readal Mode IN IN IN IN IN IN IN IN IN IN IN IN IN	22 1 V V 1 1 1 0 0 0 0	Physical Phy	3 ical 2 4 6 8 10 12 14 16 18 20 22 24 26 28	V	Mode IN IN IN IN IN IN	Name 5v 5v 0v TxD RxD GPIO. 1 0v GPIO. 4 GPIO. 5 0v GPIO. 6	 15 16 1 4 5 6 10	 14 15 18 23 24 25 8
2 3 4 17 27 22 10 9 11	wPi 8 9 7 0 2 13 14 30 21	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 Øv GPIO. 0 GPIO. 2 GPIO. 3 3.3v MOSI MISO SCLK Øv SDA.0 GPIO.21	write readal Mode IN IN IN IN IN IN IN IN IN IN IN IN IN	222 1 1 V V V V V V V V V V V V V V V V	Physical Phy	3	V	Mode IN IN IN IN IN IN IN	Name 5v 5v 0v TxD RxD GPIO. 1 0v GPIO. 4 GPIO. 5 0v GPIO. 6 CE0 CE1 SCL.0	 15 16 1 4 5 6 10	 14 15 18 23 24 25 8 7
2 3 4 17 27 22 10 9 11	wPi 8 9 7 0 2 13 14 30 21 22	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 Øv GPIO. 0 GPIO. 2 GPIO. 3 3.3v MOSI MISO SCLK Øv SDA.0	write readal Mode IN IN IN IN IN IN IN IN IN IN IN IN IN	222 1 1 V V V V V V V V V V V V V V V V	Physical Phy	3 ical 2 4 6 8 10 12 14 16 18 20 22 24 26 28	V	Mode IN IN IN IN IN IN IN	Name 5v 5v 0v TxD RxD GPIO. 1 0v GPIO. 4 GPIO. 5 0v GPIO. 6 CE0 CE1 SCL.0	 15 16 1 4 5 6 10	 14 15 18 23 24 25 8
2 3 4 17 27 22 10 9 11	wPi 8 9 7 0 2 13 14 30 21	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 Øv GPIO. 0 GPIO. 2 GPIO. 3 3.3v MOSI MISO SCLK Øv SDA.0 GPIO.21	write readal Mode IN IN IN IN IN IN IN IN IN IN IN IN IN	222 1 1 V V V V V V V V V V V V V V V V	Physical Phy	3	V	Mode IN IN IN IN IN IN IN 	Name 5v 5v 0v TxD RxD GPIO. 1 0v GPIO. 4 GPIO. 5 0v GPIO. 6 CE0 CE1 SCL.0	15	 14 15 18 23 24 25 8 7
2 3 4 17 27 22 10 9 11	wPi 8 9 7 0 2 13 14 30 21 22	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 Øv GPIO. 0 GPIO. 2 GPIO. 3 3.3v MOSI MISO SCLK Øv SDA.0 GPIO.21 GPIO.22	write readal Mode IN IN IN IN IN IN IN IN IN IN IN IN IN	222 1 1 V V V V V V V V V V V V V V V V	Physical Phy	3	V	Mode IN IN IN IN IN IN IN 	Name 5v 5v 0v TxD RxD GPIO. 1 0v GPIO. 4 GPIO. 5 0v GPIO. 6 CE0 CE1 SCL.0 0v	15	 14 15 18 23 24 25 8 7
2 3 4 17 27 22 10 9 11 0 5 6	wPi 8 9 7 0 2 13 14 30 21 22 23	i:~ \$ gpio Name 3.3v SDA.1 SCL.1 GPIO. 7 0v GPIO. 0 GPIO. 2 GPIO. 3 3.3v MOSI MISO SCLK 0v SDA.0 GPIO.21 GPIO.22 GPIO.23	write readal Mode IN IN IN IN IN IN IN IN IN IN IN IN IN	222 1 1 V V V V V V V V V V V V V V V V	Physical Phy	3	V	Mode IN IN IN IN IN IN IN 	Name 5v 5v 0v TxD RxD GPIO. 1 0v GPIO. 5 0v GPIO. 6 CE0 CE1 SCL.0 0v	15	14 15 18 23 24 25 8 7 1

	!	!	+		1000			+	!	!	+
BCM	wPi	Name	Mode	V	V Physical		V	Mode	Name	wPi	BCM
		3.3v		1	1 1	1 2			5v	1	1
2	8	SDA.1	IN	1	i 3 i	1 4	i	i	5v	i	i
3	9	SCL.1	IN	1	j 5 j	16	i	i	0v	i	i
4	7	GPIO. 7	IN	1	7 i	18	0	IN	TxD	15	14
	i	0 v	1		9 j	1 10	1	IN	RxD	16	15
17	0	GPIO. 0	IN	0	11	1 12	0	IN	GPI0. 1	1	18
27	2	GPI0. 2	IN	0	13	1 14	1		0v	İ	İ
22	3	GPI0. 3	IN	0	15	1 16	0	IN	GPI0. 4	1 4	23
	İ	3.3v			17	1 18	0	IN	GPIO. 5	5	24
10	12	MOSI	IN	0	19	20			0v	İ	
9	13	MISO	IN	0	21	22	0	IN	GPIO. 6	6	25
11	14	SCLK	IN	0	23	1 24	1	IN	CE0	10	8
	İ	0 v			25	26	1	IN	CE1	11	7
0	30	SDA.0	IN	1	27	28	1	IN	SCL.0	31	1
5	21	GPI0.21	IN	1	29	30	İ	İ	0v	İ	İ
6	22	GPI0.22	OUT	0	31	32	0	IN	GPI0.26	26	1 12
13	23	GPI0.23	IN	0	33	34		i	0v	i	i
19	24	GPI0.24	IN	0	35	36	0	IN	GPI0.27	27	16
26	25	GPI0.25	IN	0	37	38	0	IN	GPI0.28	28	20
	1	0 v	l	l	39	1 40	0	IN	GPI0.29	29	21
всм	wPi	l Name	Mode	V	Phys	ical	V	Mode	Name	l wPi	I BCM

Alternative way

\$ sudo su

Connect an LED using a resistor between GPIO22 and GND.

Creating a File access to GPIO using console commands:

If you write to the ./export file in the /sys/class/gpio/ subdirectory, the system creates a file with a GPIO structure according to the input. In this case we want to create an access to write directly to GPIO22 in order to handle an LED.

Create a GPIO file access:

\$ echo 22 > /sys/class/gpio/export

Configure the Pin Direction (In/Out):

\$ echo out > /sys/class/gpio/gpio22/direction

Write a value to turn on the LED using the GPIO22:

\$ echo 1 > /sys/class/gpio/gpio22/value

Now your led should be ON!!!

Write a value to clear the LED using the GPIO22

\$ echo 0 > /sys/class/gpio/gpio22/value

Now your led should be OFF!!!

Delete the created GPIO (22) \$ echo 22 > /sys/class/gpio/unexport

Reference: https://sites.google.com/site/semilleroadt/raspberry-pi-tutorials/gpio