How to Build the Dementia Friendly Music Player

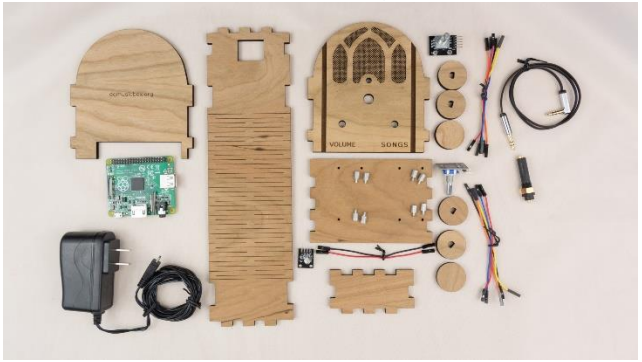
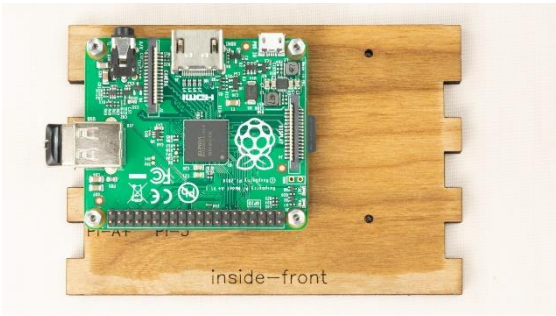
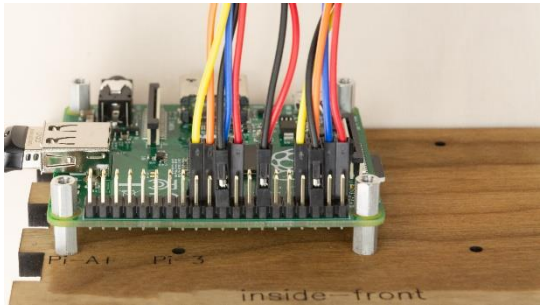
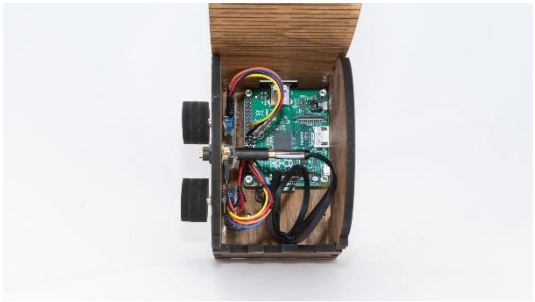
26 October 2019, http://DementiaMusicPlayer.org, Ross Porter rosswesleyporter@gmail.com

My Dad could not operate normal music players. But he could operate this music player because it operates like a familiar two-knob radio. My son & I were inspired to design this by the documentary Alive Inside which shows the profound joy felt by some people with dementia when listening to their favorite music.

It's easier than you think to make one. Everything I did (e.g. software, wood case design) is open source. This document contains all the information you need. You can order the parts online. Good project for kids. A 13 year old can do this with minimal assistance. Younger kids with more assistance.

Parts cost	~$100 + tax + shipping
Music cost	Minimal as you should use the recipient's existing music collection
Build time	About three hours, once you have the parts & music
Parts source	All parts can be mail ordered, links below
Soldering?	No
Woodworking?	No
Laser cutter needed?	No, you can mail order the pre-cut pieces for the wood case
With a friend?	Good idea, especially if your friend has the basic tools required
Beverage?	I recommend a hoppy IPA while you are assembling

Preview of the steps

STEP 1: Order parts 	STEP 2: Assemble recipient's favorite music 	STEP 3: Copy software to micro SD card 
STEP 4: Stain it 	STEP 5: Add the Pi 	STEP 6: Wire it 
STEP 7: Glue it 	STEP 8: Add audio cable 	STEP 9: Enjoy! 

No warranty

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Acknowledgements

People were very generous with their time, and I really enjoyed the experience. This is certainly an incomplete list: Alex & Mike & others at Ada's, the super smart staff at Metrix, neighbor Randy, Stephen Christopher Phillips, Bob Rathbone, Stephen Rusk, Graham Hill, support at Ponoko, Florian Festi, and my son.

What DQMusicBox does

For the person with dementia

Name	Description & implementation
Start song	Turning either of the knobs will start music playing.
Change song	Turn the songs knob.
Change volume	Turn the volume knob.
Pause	Tap the volume knob. Note that this also happens automatically – music pauses if there are no knob events in one hour.

For you

Name	Description & implementation
Shut down	Pull the power plug or long hold (15-30 seconds) on the volume knob.
Reboot	Pull the power plug and re-insert or long hold (15-30 seconds) on the songs knob.
Add/remove music	By adding/removing files on the USB memory stick.

STEP 1: Order the parts

Create a Ponoko account (optional but convenient)

Ponoko is a company that laser cuts wood and sends you the precisely cut pieces. You don't need to use Ponoko – you are welcome to download my case design files (from Ponoko or github) and go to your local maker space and use the laser cutter there. Or buy yourself a laser cutter (if you do, will you be my friend?). In other words, Ponoko is convenient but not necessary. I have no affiliation with them, other than being a happy customer. To create a Ponoko account:

1. Go to https://www.ponoko.com/
2. Choose "Get Making"

Order from Ponoko

1. Go to https://github.com/rosswesleyporter/dqmusicbox/tree/master/case/laser_cut/cherry_cathedral_style
2. Right-click on DQMusicBox_cathedral_5point7mm_cherry.svg, choose to "Save link as…"
3. Verify that you chose the correct file – has 5poin7mm in the name and is a .svg file.
4. Go to https://www.ponoko.com/
5. Login
6. If prompted in blue at the top of the screen, choose to switch to Ponoko 5.0
7. Click on "Reorder" and/or click on "Make your first product"
8. Choose material = Cherry Veneer MDF
9. Choose "Upload your design" and upload the file that you downloaded just above
10. Wait while Ponoko validates the design
11. Click "Confirm design size & colors"
12. Click "Add to Cart"

Order the remaining parts

Item	Supplier	Cost	Notes & alternatives
Cherry case	Ponoko	$31.39	See instructions above.
Raspberry Pi 1 A+ single board computer	Newark	$20.00	Tested with a Raspberry Pi 1A+, 2B, 3A+, 3B, 3B+. Do not use Pi Zero.
Power supply	Newark	$3.62	This is the US model. Any micro USB 2A or better supply will do.
Female-female jumper wires	Newark	$3.95	Or buy Amazon B01L5ULRUA
Panel mount 3.5mm headphone jack	Newark	$2.69	Or buy Amazon B004JX64FE
M2.5 standoffs (screws) – 8 of them	Newark	$4.32	Or by Amazon B06XXV8RTR
Micro SD card	Amazon	$7.49	Any brand name micro SD card that is 8GB or larger will do.
USB thumb drive	Amazon	$5.79	This one is helpfully physically small, but many USB drives will work
Audio cable	Amazon	$5.79	Or find a short audio cable with a right angle bend.
KY-016 indicator LED	Amazon	$6.99	
KY-040 rotary encoders (knobs)	Amazon	$7.99	Or buy Amazon B06XQTHDRR.
TOTAL		**$100.02**	Prices will vary. Does not include tax, shipping.

About headphones

Item	Cost	Notes and alternatives
The recipient's existing headphone	$0.00	The best headphones are the headphones that the recipient is already used to.
Monoprice On-Ear headphones	$10.99	Very good sound.
Monoprice Over-the-Ear headphones	$15.99	Amazing sound. My musician son rates the sound as better than the ever-popular Sony MDR7506 headphones.
Other		Look for high sensitivity headphones, as the Pi's output is a bit weak.

Tools & supplies

You probably have some of these supplies. If you don't, you have a friend that does. This is exactly the sort of project that a friend would be happy to help you with.

Link to order item	Notes & alternatives
Elmer's wood glue	Any wood glue will do
3/16th nut driver	Or wrench. Or needle-nosed pliers. Or really strong fingers
SD card reader/writer	Your computer may have an SD card reader/writer. If not, you probably have a friend that does. Or order a USB SD-card reader.
Painter's tape	Any tape that comes off easily will do. Painter's tape is great. Regular masking tape is probably fine too.
Light blocking tape	The LED is bright, so I prefer to block some light. You can use the tape above. Or light blocking stickers e.g. Amazon B009WSJNCW.
Wood stain or oil	If you have a friend that does woodworking, ask them for advice and they'll probably give you the little bit of product that you need. I used Tried & True Varnish Oil (linseed oil) because I like the result, it's easy, and non-toxic.

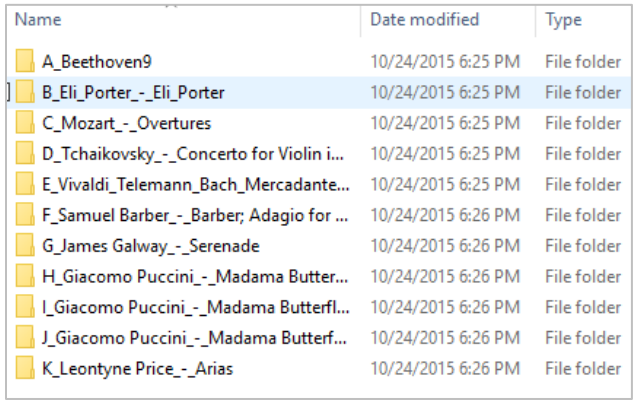
STEP 2: Assemble the personalized collection of music

Choosing the music – go for familiar favorites

This is the most important step. The personalized (familiar) music is the fundamental magic. You don't need much music, perhaps 6-10 albums. But only familiar favorites. In my case, my Mom mailed me my Dad's favorite CDs. It will take two weeks for the parts above to arrive, so you have time to do this well. Though it is easy to change the set of music later.

Put the music on the USB memory stick

Organize the digitized music into folders on the USB memory stick, one folder per album. MP3, iTunes, and FLAC files are supported i.e. files with extensions .mp3, .m4a, .flac. In the end, you should have a set of folders that looks something like this:



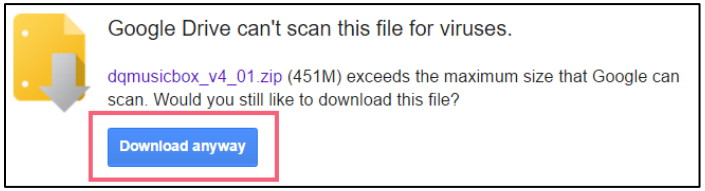
STEP 3: Copy software to the micro-SD memory card

I prepared a disk image for you. It has all the required software. Your job is to download this disk image and then write it to the micro-SD card. The steps:

1. Install Etcher on your PC or Mac or Linux computer. Win32 Disk Imager also works.

2. Download the Dementia Friendly Music Player disk image.

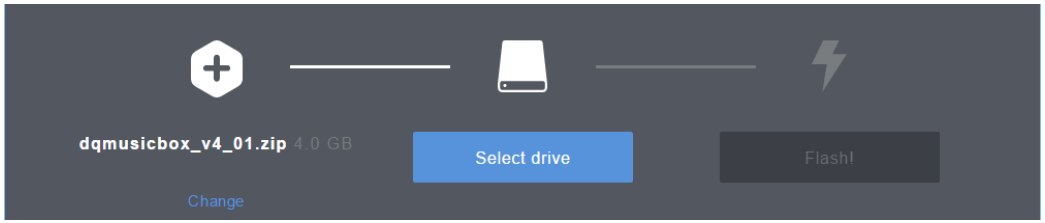
3. Confirm download – "Download anyway"



4. Put the micro-SD memory card into the SD card adapter that it came with i.e. put the tiny card into the larger card.

5. Put the SD card adapter into the SD reader/writer in your computer.

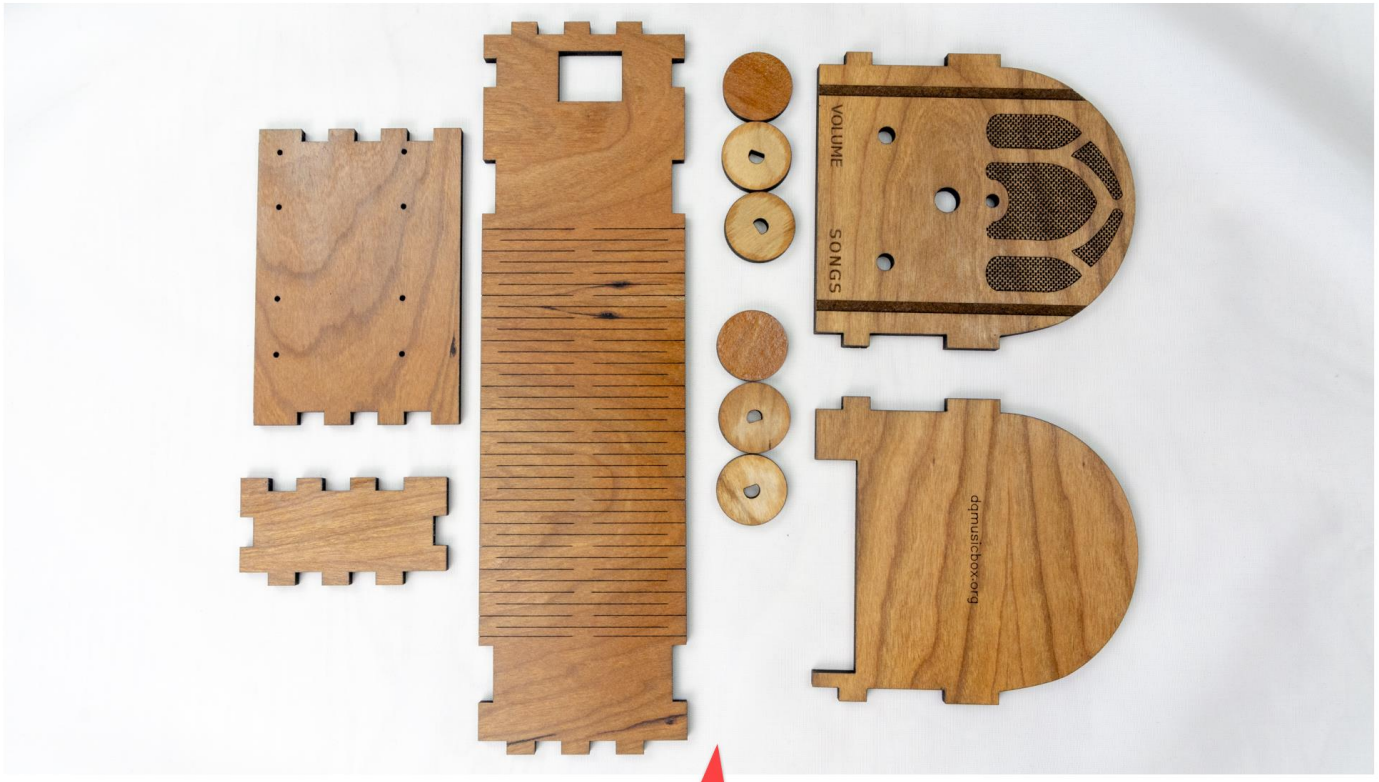
6. Start Etcher, instruct it to write the image file to the SD card:



7. Wait for the writing to complete, ~10 minutes. This would be a good time to make a sandwich.

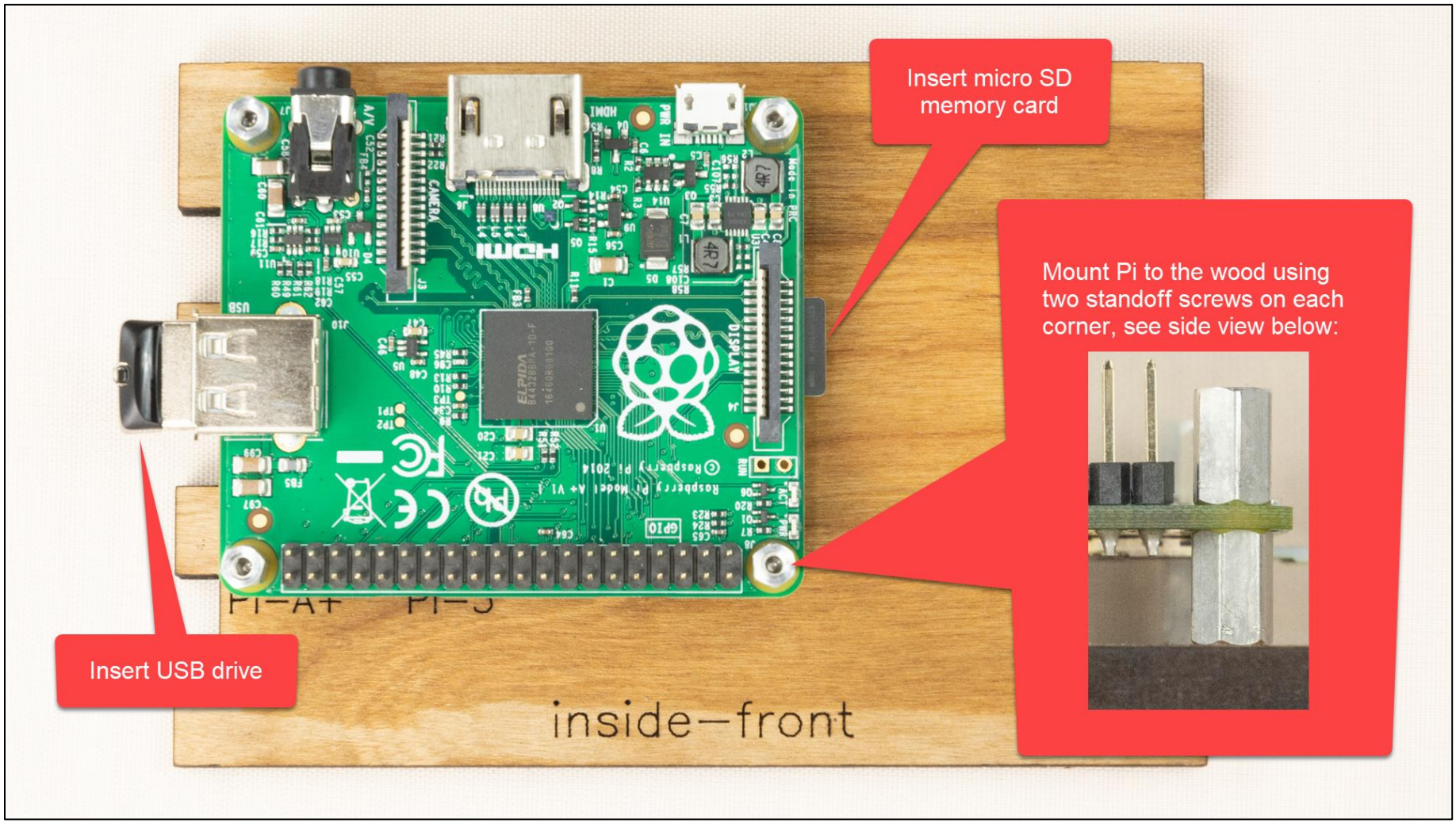
STEP 4: Stain it or oil it

Ask a woodworking friend for help. They probably have everything you need.

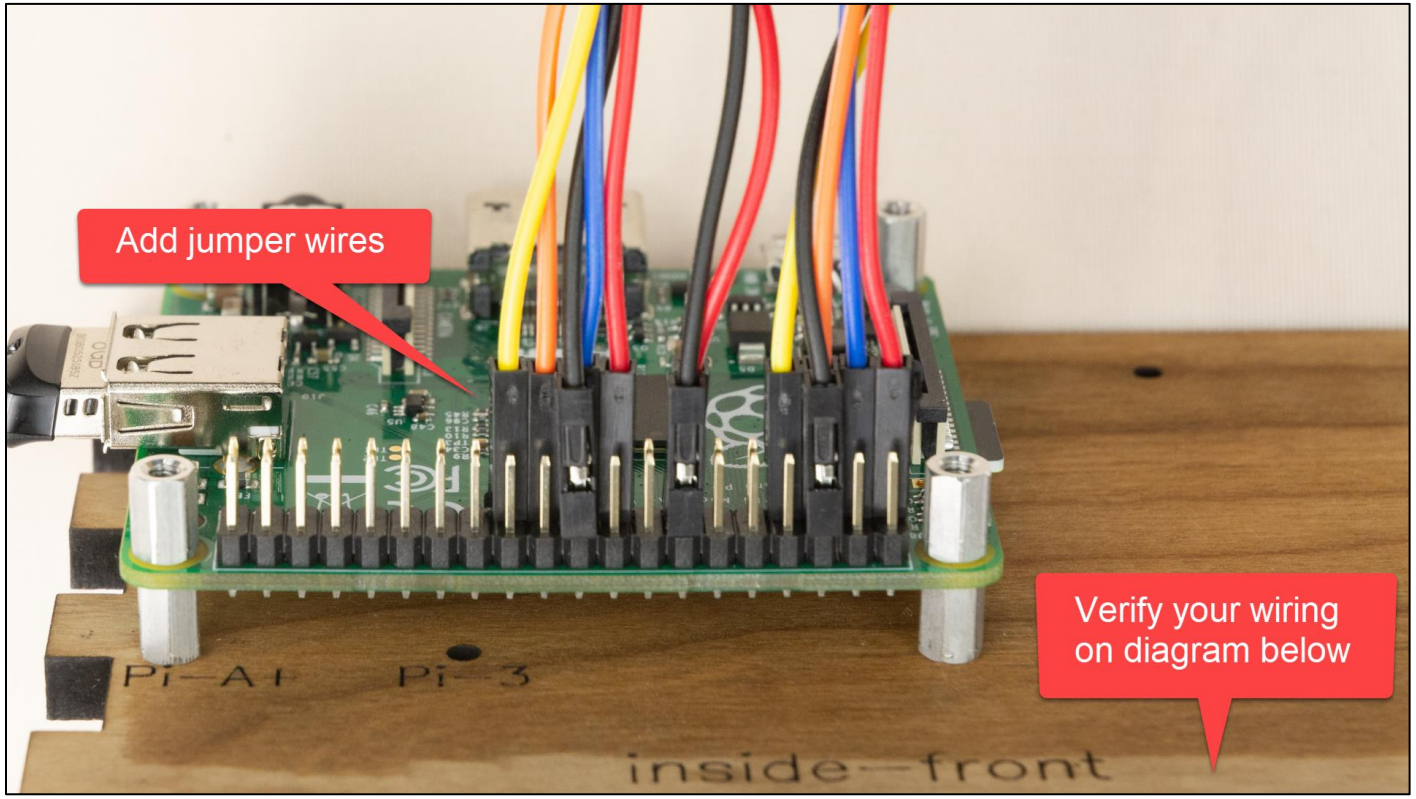


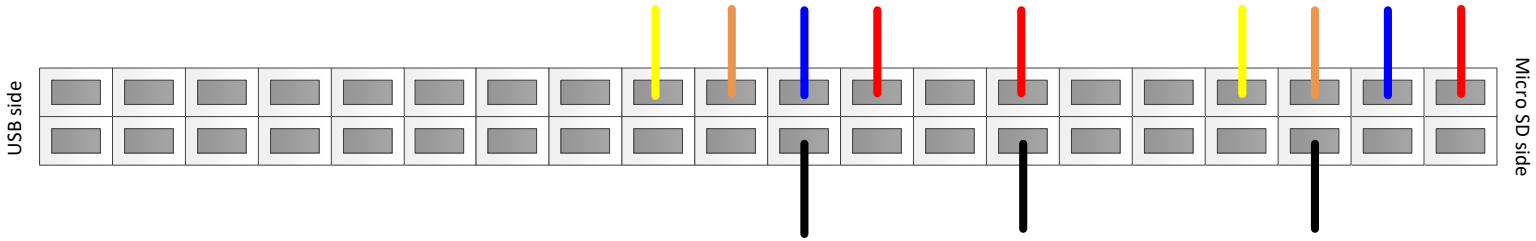
I used the non-toxic Tried & True Danish Oil i.e. flax seed oil. Three thin coats (three days) for outside surfaces. One thin coat for inside surfaces. Follow directions on the can.

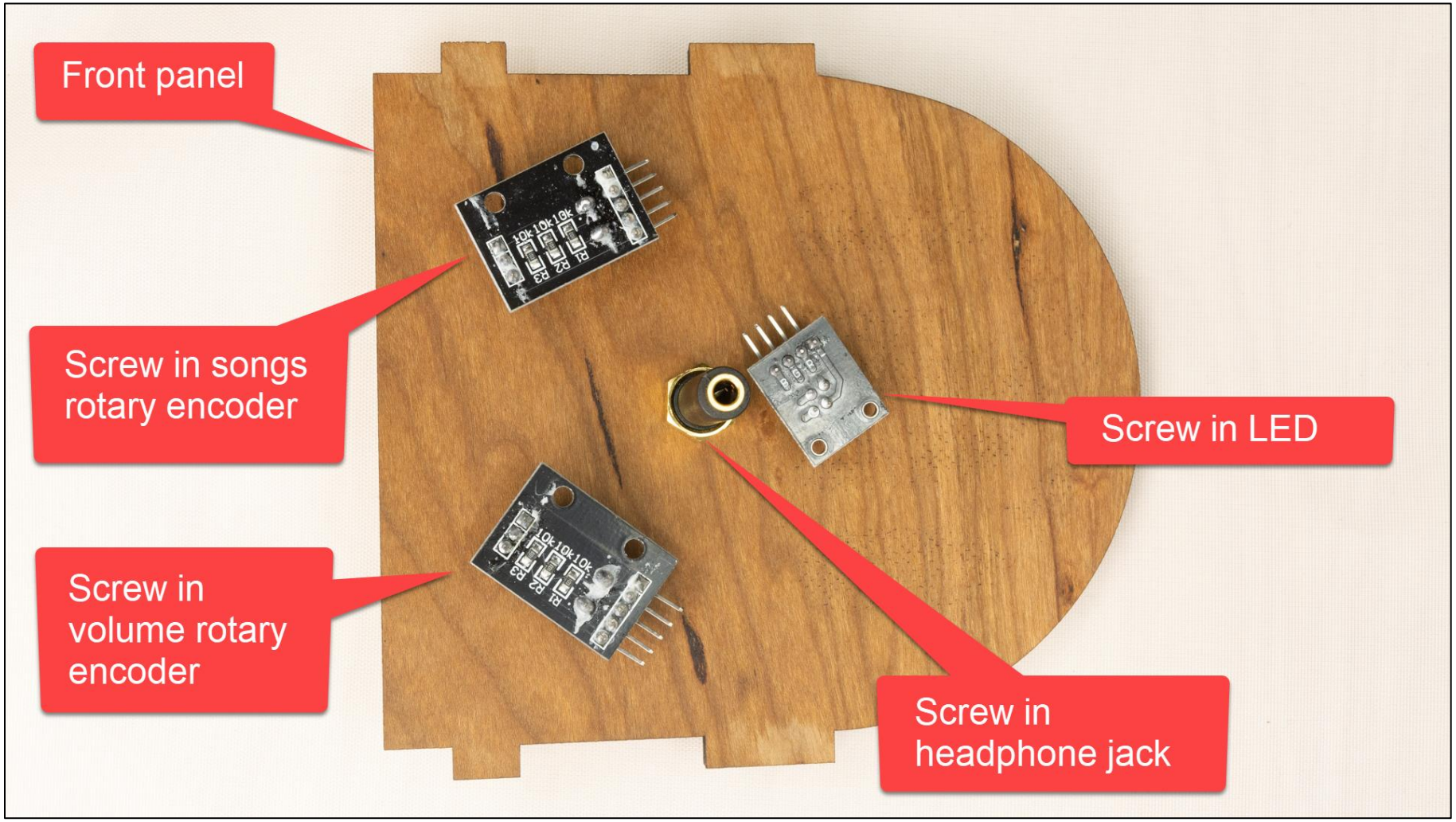
STEP 5: Add the Pi

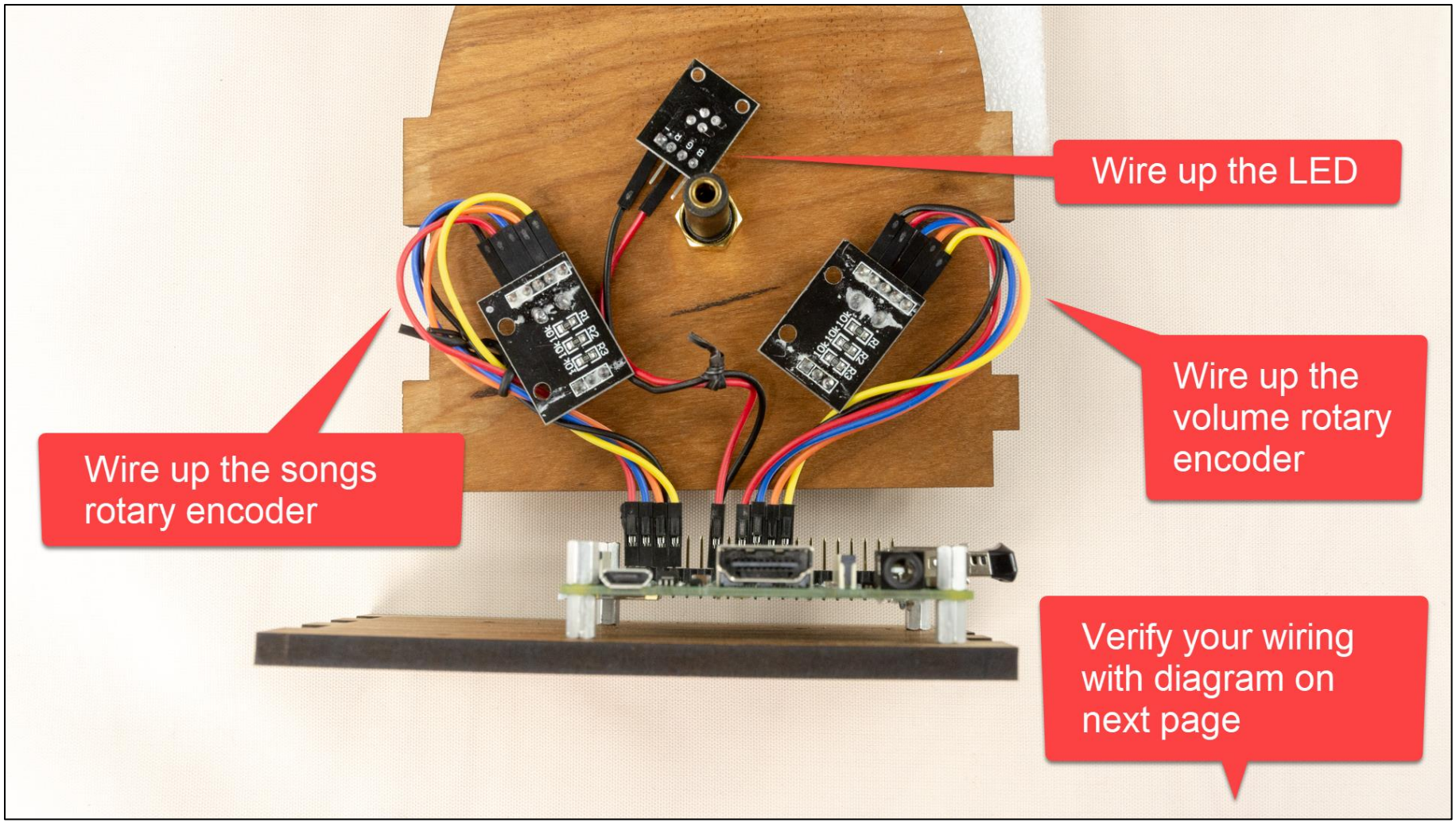


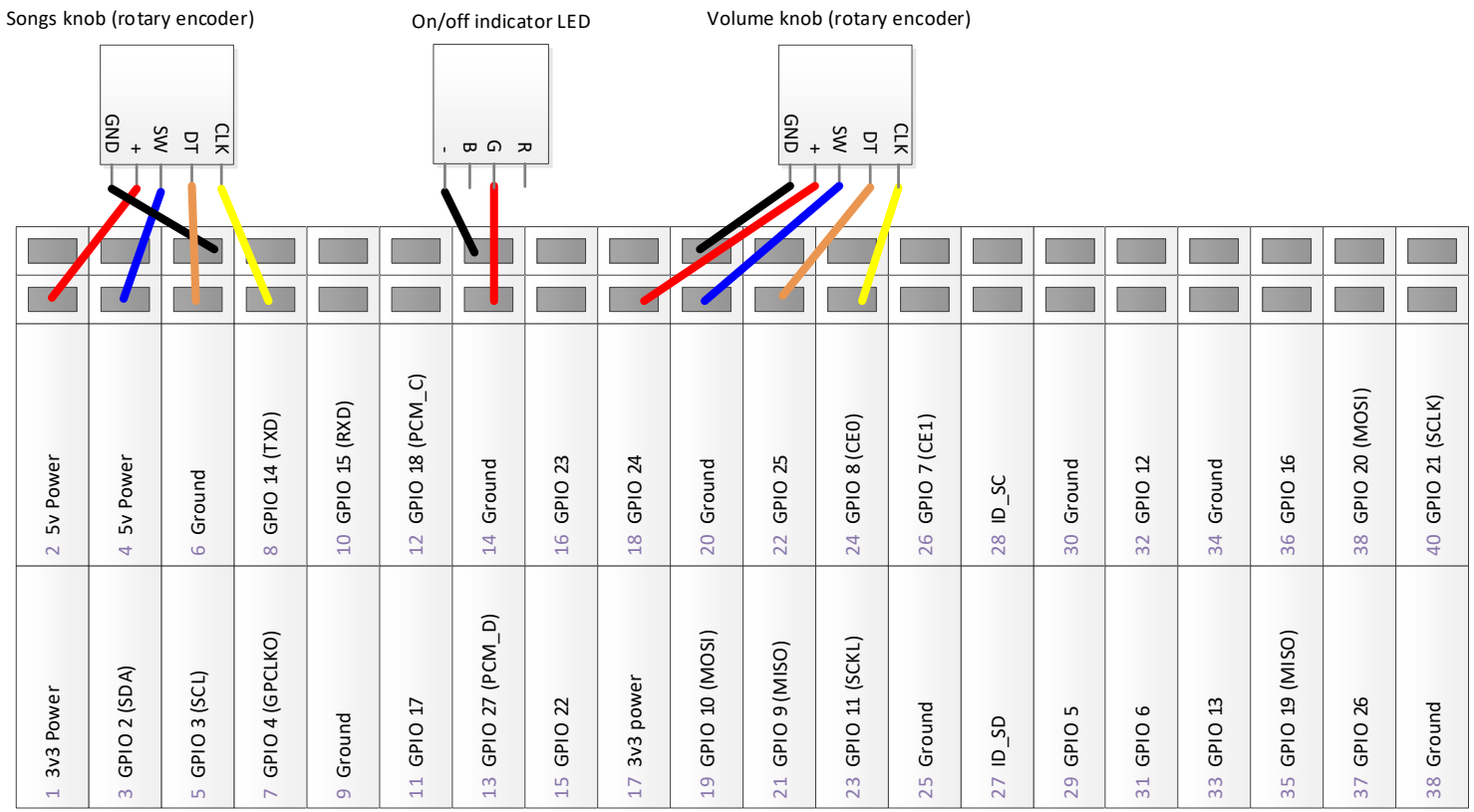
STEP 6: Wire it



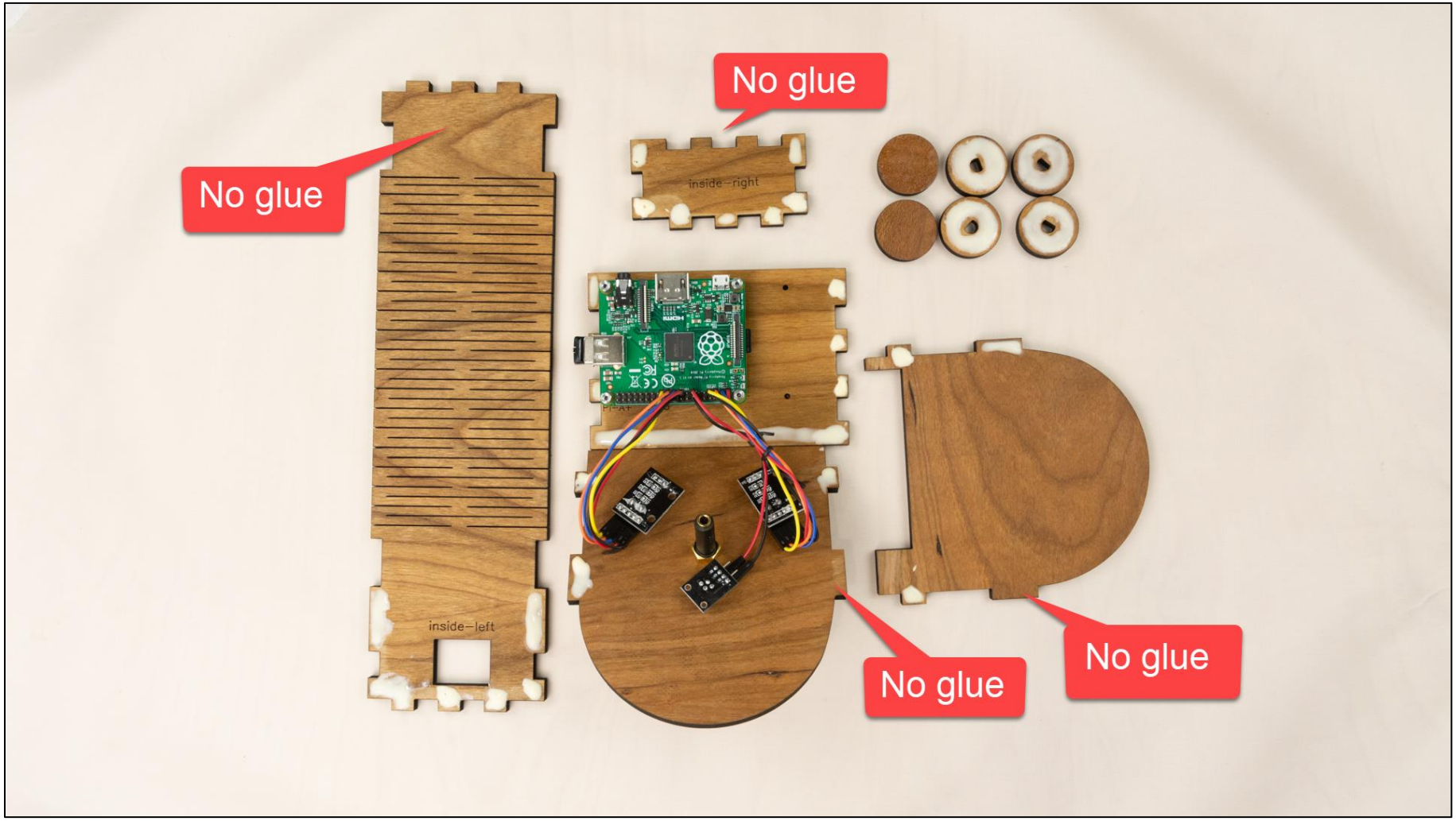


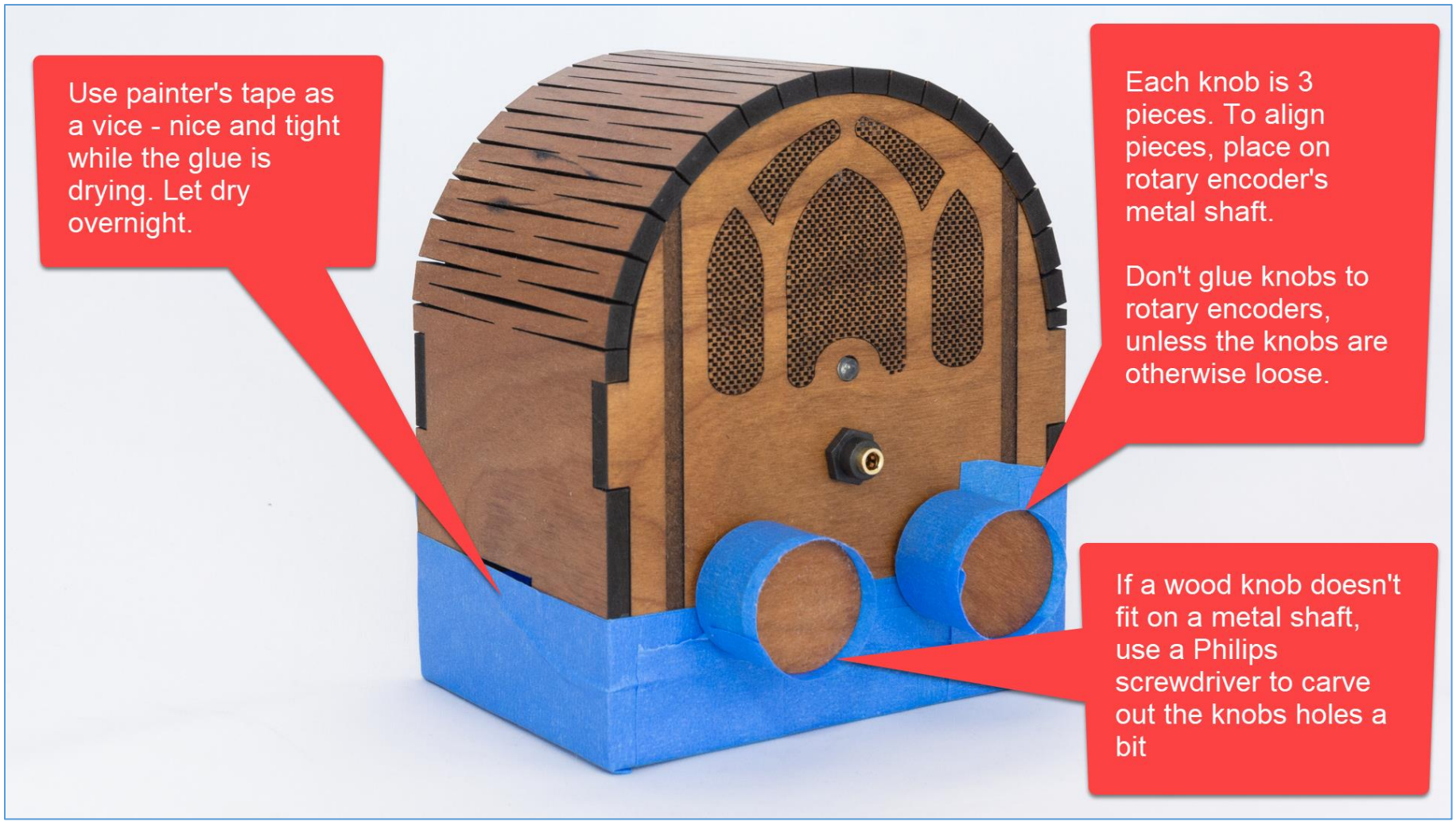

Front panel
Screw in songs rotary encoder
Screw in volume rotary encoder
Screw in LED
Screw in headphone jack


Wire up the LED
Wire up the volume rotary encoder
Wire up the songs rotary encoder
Verify your wiring with diagram on next page

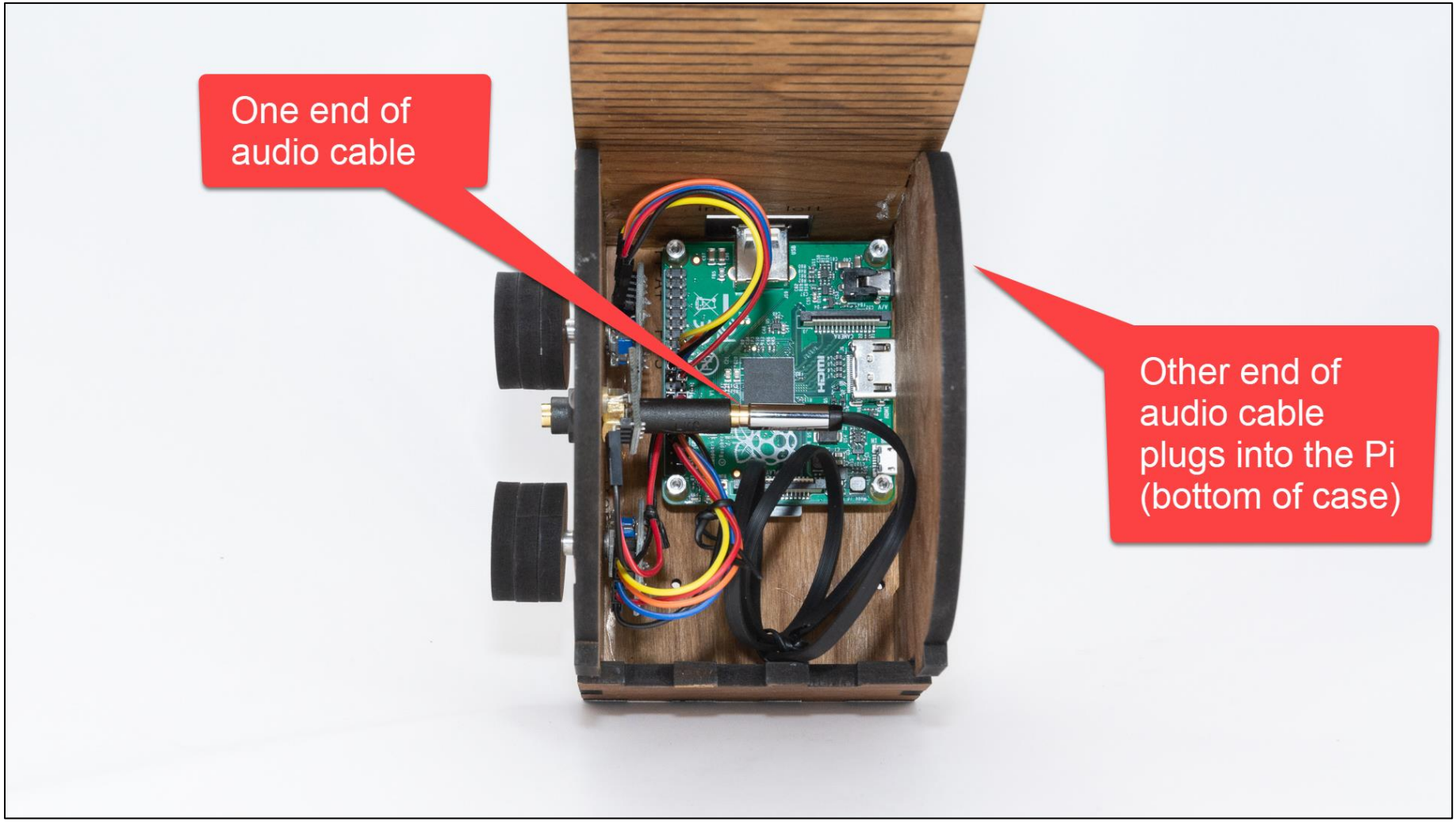

Songs knob (rotary encoder)
On/off indicator LED
Volume knob (rotary encoder)
GND
+
SW
DT
CLK
-
B
G
R
GND
+
SW
DT
CLK
1 3v3 Power
2 5v Power
3 GPIO 2 (SDA)
4 5v Power
5 GPIO 3 (SCL)
6 Ground
7 GPIO 4 (GPCLKO)
8 GPIO 14 (TXD)
9 Ground
10 GPIO 15 (RXD)
11 GPIO 17
12 GPIO 18 (PCM_C)
13 GPIO 27 (PCM_D)
14 Ground
15 GPIO 22
16 GPIO 23
17 3v3 power
18 GPIO 24
19 GPIO 10 (MOSI)
20 Ground
21 GPIO 9 (MISO)
22 GPIO 25
23 GPIO 11 (SCKL)
24 GPIO 8 (CE0)
25 Ground
26 GPIO 7 (CE1)
27 ID_SD
28 ID_SC
29 GPIO 5
30 Ground
31 GPIO 6
32 GPIO 12
33 GPIO 13
34 Ground
35 GPIO 19 (MISO)
36 GPIO 16
37 GPIO 26
38 GPIO 20 (MOSI)
38 Ground
40 GPIO 21 (SCLK)

STEP 7: Glue it




Use painter's tape as a vice - nice and tight while the glue is drying. Let dry overnight.
Each knob is 3 pieces. To align pieces, place on rotary encoder's metal shaft.
Don't glue knobs to rotary encoders, unless the knobs are otherwise loose.
If a wood knob doesn't fit on a metal shaft, use a Philips screwdriver to carve out the knobs holes a bit

STEP 8: Add audio cable

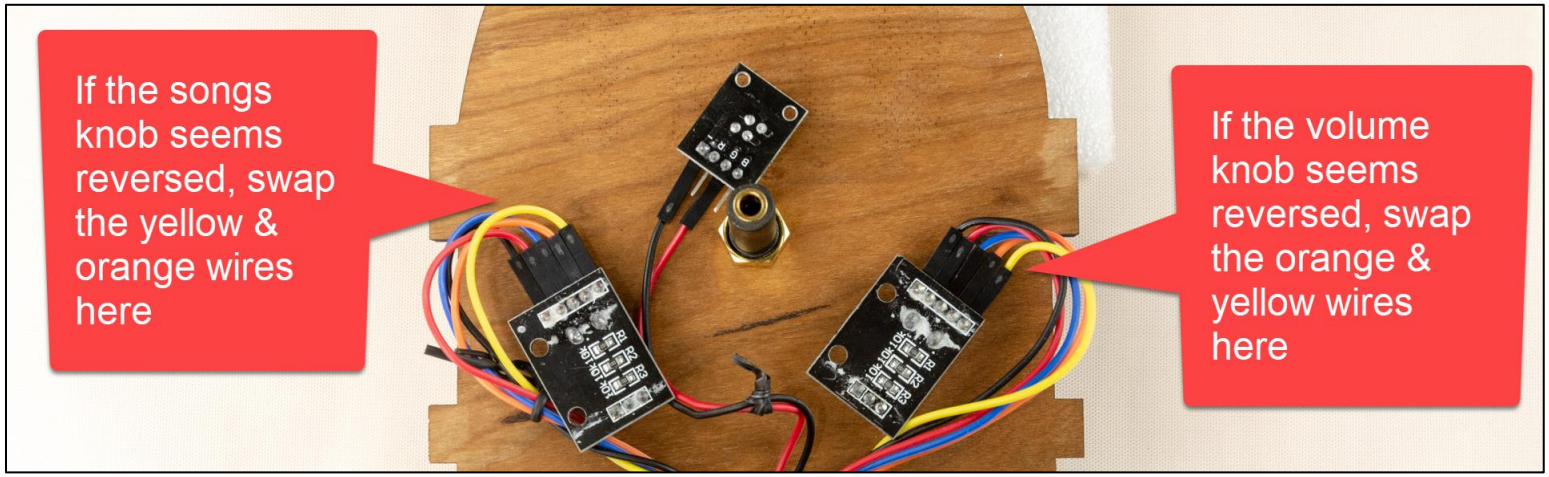


Test it

Test	Description & Expectation
Light 30sec after power on	The indicator LED turns on when DQMusicBox is ready to play music, which is generally 20-30 seconds after power on.
Start song	Turning either of the knobs will start music playing.
Change song	Turn the songs knob. If you go forward and backward through the song list as expected, then all is well.
Change volume	Turn the volume knob. If the volume goes up and down as expected, then all is well.
Pause	Tap the volume knob, song should pause. Tap the songs knob, this should also pause the song.
Unpause	Tap a knob

If one or both knows do the opposite of what you expect

Once assembled, you may find your knobs doing the opposite of what you expect e.g. a clockwise turn decreases the volume. This is because there are two kinds of rotary encoders out there. Happy, the fix is easy, just switch the orange and yellow wires on the misbehaving rotary encoders(s) (don't touch the Pi itself):

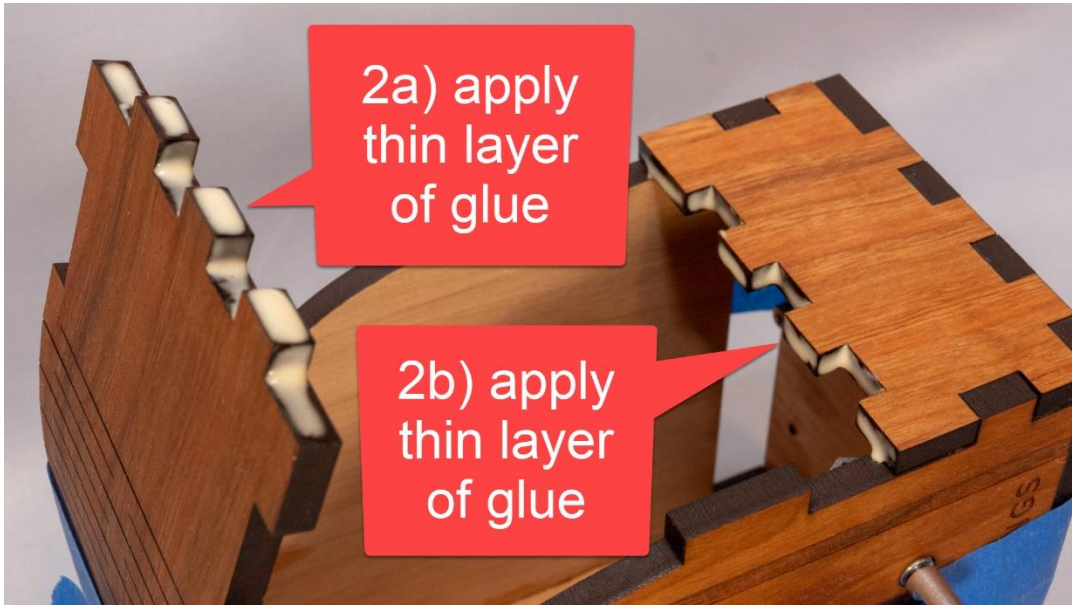


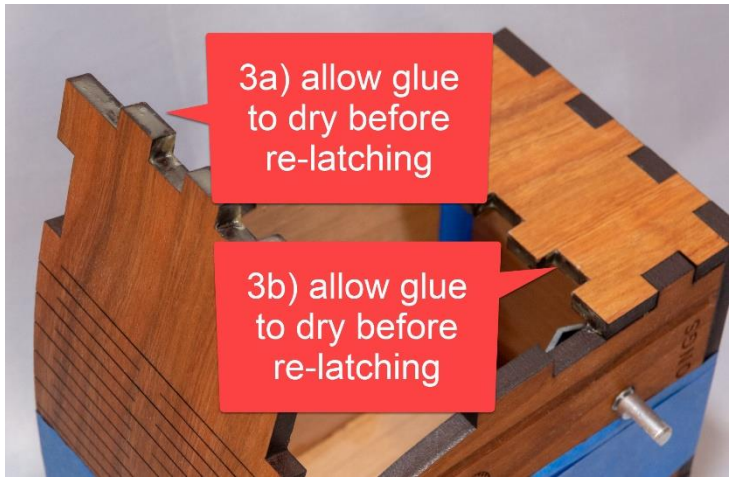
If the wood knobs are loose on the metal shafts

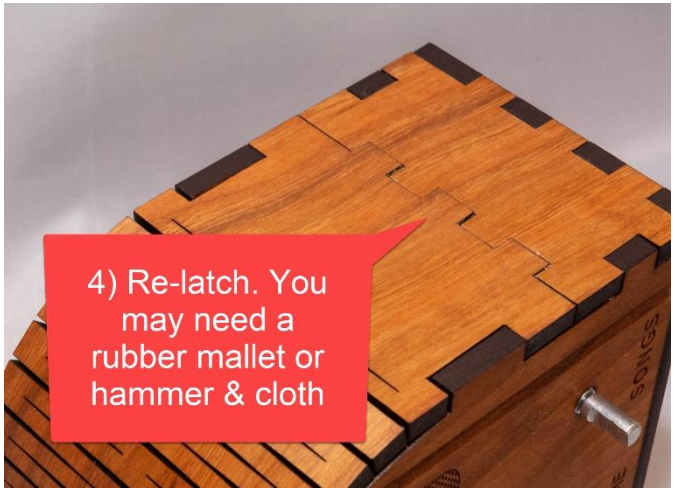
Just glue the wood knobs to the metal shafts. But only if it is really necessary. Once the knobs & shafts are glued, it's harder to dissemble the box to fix any problems.

If the top does not latch securely

To resolve, very slightly increase the size of the tabs by applying a thin layer of glue and allowing to dry before re-latching. It's a friction latch, so you are essentially adding more static friction – slightly thicker tabs can mean much more static friction.





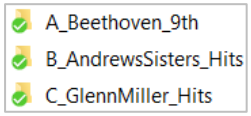


Tape instructions

Print this page and tape the instructions in the box below to the bottom of your new DQMusicBox:

To create personalized music

Organize the music on your computer



One folder per album. Use MP3 files, must have .mp3 file extension. Or iTunes files (.m4a). Or FLAC files (.flac). Optionally, use folder names prefixes to specify the play order e.g. A_, B_

Copy the music to the USB thumb drive

1. Unplug your DQMusicBox.
2. Remove the USB thumb drive and place in your computer.
3. Copy music files from your computer to the USB thumb drive.
4. Put the USB thumb drive back in the DQMusicBox.
5. Plug in your DQMusicBox.

Congratulations

Congratulations! You should have a fully functional DQMusicBox.

Appendix 1: Change log

v1, November 2015	Original release
v2, September 2016	• Changed music storage from a micro-SD memory card to a conventional USB memory stick. • Changed the base Operating System from full Raspbian to DietPi – much smaller, so faster to boot, and less to go wrong.
v3, January 2017	• Changed from USB audio to Pi built-in audio, including a firmware update for excellent audio quality.
v4, May 2017	• Switched to bamboo for durability and use of standoffs. • Switched to Pi A+ to lower cost. • Made USB thumb drive externally accessible, to make it easier for the caregiver to organize music.
v4.01, 25 June 2017	• Minor edits.
v4.01_1, 20 July 2017	• Minor edits.
v4.01_2, 11 August 2017	• Added links for ordering parts in the UK. • Added detailed instructions for write protecting a micro-SD card.
v4.01_3, 12 August 2017	• Minor edits
v4.01_4, 12 August 2017	• Minor edits
v4.01_5, 14 October 2017	• Edited text and updated photographs to reflect the change from an HDD-style LED to a KY-016 LED module.
v4.01_6, 26 February 2018	• Updated the links for purchasing the parts. No changes to the parts themselves, just the links. • Minor change to the instructions, noting how the build can be accomplished in one sitting, if desired.
v4.1, 7 April 2018	• Reflects that the software has been updated to support the new Raspberry Pi 3 B+. No new software features.
v4.1_1, 23 April 2018	• Updated to reflect the new bamboo case design.
v4.1_2, 22 July 2018	• Updated for the new cherry wood version
27 Jan 2019	• Updated to note support for the Raspberry Pi 3A+.
v4.2, 1 March 2019	• Switched to pmount for USB drive auto mounting.
v4.2, 7 April 2018	• Removed instructions for write protecting the SD card – rarely used and may cause certain rare problems
v4.2, 26 October 2019	• Updated the parts list • Updated the Ponoko instructions