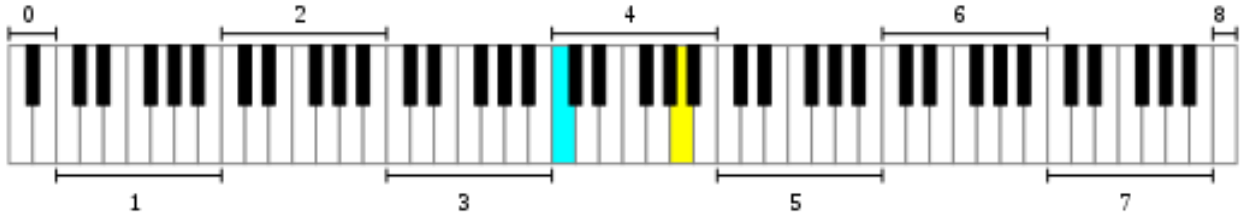


Piano Notes, Speakers & Headphones

[Pete Matthews Jr – https://3nt.xyz](https://3nt.xyz) – © December 8, 2021



The full piano keyboard has 88 keys, laid out as shown in this image from https://en.wikipedia.org/wiki/Piano_key_frequencies. The scientific name of the lowest note is A_0 . The seven full octaves start with C_1 , through C_7 ; the high note on the keyboard is C_8 . Middle C is C_4 . A_4 , known as A440, is the tuning note.

An arcane naming scheme that I'll omit is called Helmholtz. I also won't discuss the extra keys that can be available on the rare keyboards with more than 88 keys - few musicians would ever use them. These topics are discussed at the link above.

Keyboards with fewer than 88 keys are common:

76-key models have E_1 as their lowest note, omitting seven lower keys and five at the top of the keyboard.

61-key models have C_2 as their lowest note, omitting eight more lower keys and seven more at the top of the keyboard.

The 27 apparently optional keys don't add that much, especially for popular music. However, you cannot install them later! Also, I understand that pianists use the ends of the keyboard in judging jumps. Switching between keyboards of different lengths can mess this up. Expert wisdom is to get 88 keys unless there is a compelling reason otherwise.

The Issue

As indicated in my article, [A Comparison of Arranger Pianos](#), I acquired a Yamaha DGX-670 digital arranger piano. I have been working my way through [How to Play Piano](#) from The Great Courses, possibly an article of its own. In the process, I have discovered that lower chords and notes on the piano can sound unpleasant.

Investigation on the DGX-670

Summary. The speakers and headphones are clearly an issue. Moving down the keyboard, chords deteriorate first, then single notes. Avoid notes that don't rhyme and chords that are discordant. Chords starting at C_3 and single notes starting at C_2 can be counted on as good harmony for a song.

When I first got my piano, it was immediately obvious that I needed headphones. Nobody wants to hear me practice; furthermore, there are times when I need to shut out the TV or other activity. Since open-back headphones leak sound, both in and out, I needed closed backs. My old Bose headphones were too decrepit for daily use; after some research, I settled on Audio-Technica ATH-M20X over-the-ear headphones (\$50). These comfortable cans provide sound a bit better than the built-in speakers – at the same volume on the dial – a good match.

The DGX-670 does not have “line out” ports, a distinct shortcoming. However, I was able to connect the “line in 2” ports of my Swans D1090 powered desktop speakers to the headphone port of the piano. I had to turn the volume on the speakers up to the max, but I was able to demonstrate that the processor on the DGX-670 was putting better sound onto the wires than either the built-in speakers or the M20Xs were able to play. Specifically, some of the higher unpleasant notes and chords sounded better on the D1090s.

After researching better headphones, I ordered Sony MDR7506 (\$98) and Beyerdynamic DT 770 80 ohm (\$139) over-the-ear headphones. I tested the lower notes on the aDGX-670 with them, the ATH-M20X and the built-in speakers. I rated each note three ways, on a scale from 0 to 9:

Column	Description
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- | | |
|----------|--|
| 8 | Spanning the higher octave, playing the notes both together and back & forth, checking that they “rhyme”. Example: test C_2 with C_3 |
| I | The primary chord for the note. Example: test $C_2 - E_2 - G_2$ |
| V | The V_5^6 (inverted fifth) chord that has the tested note as its lowest note. Example: for C_2 , test $C_2 - F\#_2 - G\#_2$ (in the key of $C\#$, not C ; in practice, major chord $C\#_2 - F_2 - G\#_2$ transforms to the test keys) |

The results are in the chart below. I stopped testing chords below A_1 . When it became clear that the Sony MDR7506 headphones were hardly better than the ATH-M20Xs for my purposes, I boxed up the MDR7506s for return; thus I have no ratings for single notes below A_1 for them.

The DT 770s are definitely better than all the others. They are available in three resistances: 32, 80 and 250 ohms. A higher resistance requires more power, and the three resistance models are reported to sound differently. I had hoped the piano would drive the 80 ohm headphones, which are reputed to have better bass (relevant to my issue). Even when I turned the piano volume to max, the sound seemed distant. I measured, and the depth of those cans is at least a full inch ($\frac{3}{4}$ inch on the M20Xs). When I reduced the gap by pressing my hands onto the cans, the sound was louder. Since I don't want to buy an amplifier for these cans – or squeeze my head while I play – I also boxed up the DT 770s for return.

The ratings in the table are subjective and were hard to coordinate.

Key number	MIDI note	Scientific name	Frequency (Hz) (Equal temperament)	Tests with key as bottom of octave or chord												
				DGX-670			ATH-M20X			Sony 7506			BD DT 770			
				8	I	V	8	I	V	8	I	V	8	I	V	
40	60	C ₄ Middle C	261.6256													
39	59	B ₃	246.9417													
38	58	A ₃ /B _{b3}	233.0819													
37	57	A ₃	220.0000													
36	56	G ₃ /A _{b3}	207.6523													
35	55	G ₃	195.9977													
34	54	F ₃ /G _{b3}	184.9972													
33	53	F ₃	174.6141													
32	52	E ₃	164.8138													
31	51	D ₃ /E _{b3}	155.5635													
30	50	D ₃	146.8324	9	9	9	9	9	9	9	9	9	9	9	9	9
29	49	C ₃ /D _{b3}	138.5913	8	9	9	9	9	9	9	9	9	9	9	9	9
28	48	C ₃	130.8128	8	8	8	9	9	9	9	9	9	9	9	9	9
27	47	B ₂	123.4708	8	8	8	8	9	8	9	9	9	9	9	9	9
26	46	A ₂ /B _{b2}	116.5409	8	8	8	8	8	8	9	9	8	9	9	9	9
25	45	A ₂	110.0000	8	8	8	8	8	8	9	9	8	8	8	8	8
24	44	G ₂ /A _{b2}	103.8262	8	8	7	8	8	7	8	8	8	8	8	8	8
23	43	G ₂	97.99886	8	8	7	8	8	7	8	8	7	8	8	8	8
22	42	F ₂ /G _{b2}	92.49861	8	8	7	8	8	7	8	8	7	8	8	7	7
21	41	F ₂	87.30706	7	7	6	7	7	6	7	7	6	8	8	7	7
20	40	E ₂	82.40689	7	6	5	7	6	4	7	5	5	7	6	6	6
19	39	D ₂ /E _{b2}	77.78175	6	5	2	5	4	2	5	4	3	6	5	5	5
18	38	D ₂	73.41619	6	4	2	5	4	2	5	4	2	6	6	5	5
17	37	C ₂ /D _{b2}	69.29566	4	3	2	5	4	2	4	3	2	6	5	4	4
16	36	C ₂ Deep C	65.40639	4	3	1	4	4	2	4	4	2	6	5	4	4
15	35	B ₁	61.73541	4	3	0	4	4	1	4	3	1	5	4	2	2
14	34	A ₁ /B _{b1}	58.27047	3	2	0	3	2	1	3	2	1	4	3	1	1
13	33	A ₁	55.00000	2	1	0	3	2	0	2	2	1	4	2	1	1
12	32	G ₁ /A _{b1}	51.91309	2			3						3			
11	31	G ₁	48.99943	2			3						3			
10	30	F ₁ /G _{b1}	46.24930	1			2			Missing with 61 keys			3			
9	29	F ₁	43.65353	1			2						2			
8	28	E ₁	41.20344	1			1						2			
7	27	D ₁ /E _{b1}	38.89087	1			1						1			
6	26	D ₁	36.70810	1			1						1			
5	25	C ₁ /D _{b1}	34.64783	1			1			Missing with 61 or 76 keys			1			
4	24	C ₁ Pedal C	32.70320	0			0						0			
3	23	B ₀	30.86771	0			0						0			
2	22	A ₀ /B _{b0}	29.13524	0			0						0			
1	21	A ₀	27.50000	0			0						0			

Chart modified from https://en.wikipedia.org/wiki/Piano_key_frequencies

The solution is to avoid notes that don't rhyme and chords that are discordant. Headphones such as ATH-M70X (\$299) or Monolith M565C (\$200, the Wirecutter choice) might be superior, but the inadequate speakers would remain.

<https://pianoforall.com/> seems a fun way to start playing piano quickly (although the methods appear light on theory). Less than half way down that page is a section titled “200 Videos.” Play the second video, on the right, “The Amazing Broken Chord Ballad” (or go directly to <https://vimeo.com/577133383>). It shows you how to play broken chords of a single key, moving up the keyboard (an arpeggio) – then switch keys and do it again – to produce a pleasant tune.

Here’s the thing: there is no first chord, just a single note, for each key. That note is in the second octave, where lower chords may be discordant, but a single note should be fine. (The first verse is $C_2, C_3, E_3, G_3, C_4, E_4, G_4, C_5, E_5, G_5$.) The first (C_1) octave, where single notes do not rhyme well, is avoided altogether.

Investigations at a Piano Store

Lacking access to an acoustic piano in good condition, I went to Falcetti Pianos in Natick on a slow Monday afternoon and checked out half a dozen grand pianos (\$25,000 to \$50,000) and a Yamaha upright (under \$9,000). All did substantially better than the DGX-670 with built-in speakers, on the problem notes; they all played a primary chord at C_2 very well (7 or 8 rating); and the grand pianos were a joy to play and hear. A Schimmel piano had particularly pure notes.

After reviewing the chart, it appears the DGX-670 with the DT 770 cans begins to approach the performance of the acoustic pianos on the problem notes.

On all the acoustic pianos, an inverted fifth chord at C_2 was discordant. Connor, the salesman, said that low notes close together [as the upper two notes of the inverted fifth] tend to interact and produce greater dissonance. All the strings have overtones, but they are more insistent on lower notes. Amazingly enough, C_2 on the Schimmel and a low note on another grand piano, produced a very high, clear overtone, perhaps C_8 or higher

Conclusions

All pianos have problems with adjacent low notes. The Yamaha DGX-670 is hobbled on low notes by inadequate speakers; the lack of LINE OUT jacks means I cannot effectively take advantage of fine external speakers that I already have.

Headphones that address these issues cost \$140 to \$300, or more. My plan is to shelve all this for now, avoid the problem notes, and get back to learning to play my piano.