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Reorganizing the universe: The development of a *Harmonic Table of the Elements* as a new paradigm toward an underlying musical template that can be utilized to discover useful inorganic compounds.

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Abstract

Assuming that element periodicity is correlated with musical harmony, we arranged the first 88 elements in 8 octaves, each octave consisting of 12 elements; corresponding to the twelve-tone equal temperament musical frequencies of the piano. We termed this arrangement as the Harmonic Table of the Elements (HTE). New inorganic compounds can be derived from existing ones using the HTE and using our 'harmonic paradigm'; i.e. that all elements constituting existing inorganic compounds have certain frequencies assigned to them; and that other frequencies (associated with proposed elements) that work in harmony with these frequencies of the original elements are likely those compounds that are functionally similar to those existing compounds. Such harmonious correlation is likely to manifest in the form of similar chords, similar notes (semitones) in different octaves or similar patterns of notes (semitones) across different octaves. Using our hypothesis, we have; *a priori*; proposed new semiconductors, perovskite compounds, superconductors, catalysts, thermionic emitters and piezoelectric compounds. This novel paradigm or its future derivatives has the potential to exponentially advance the field of inorganic chemistry.

Keywords

Harmonic Table of Elements, Harmonic paradigm, New periodic table, Octave, Note, Semiconductor, Superconductor, Perovskite, Catalyst, Piezoelectric

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Introduction

Inorganic compounds for use in specific applications are usually discovered by empirical means or by using compounds (or their derivatives) that already exist in nature that were historically being used for specific applications. For example, for the development of the Haber-Bosch process, it has been reported that 2500 different kinds of catalysts were tested in 6500 trials. For lack of any *a priori* alternative, this tedious and random iterative process of catalyst optimization still exists today. What is needed is an *a priori* process that will inform which combinations of elements are likely to be useful in specific applications. We therefore asked the question: can the twelve-tone equal temperament musical frequencies of the piano be used as a template for the identification and design of inorganic compounds consisting of different elements that would be generally or exquisitely suited for use in specific applications?

John Newlands proposed a predecessor of the modern periodic table based on his observation of octaves in music. His conceptualization was based on the solfegio scale; Do, Re, Mi, Fa, So, La, Ti, Do, so that the frequency after each 7th note was double that of the first note. The germ of his idea goes back to the 16th century physician/alchemist/free thinker Paracelsus, who is attributed with the idea of a connection between the musical octaves and the periodicity of the properties of the elements. Sparse publications indicate that superficial constructs of 'Atom Music' (1) or 'musical periodic tables' (2) have been occasionally visited, primarily for their appeal to novelty in art and music. To that effect, some enthusiasts have assigned a frequency to every element, or wavenumbers to musical notes, with a resulting 'sound of the elements' products as web pages or exhibits (3,4). Music has also been investigated as a medium to store molecular information (5,6). However, the idea that musically or harmonically similar compounds may have similar functionality; i.e. the existence of a 'harmonic paradigm' does not seem to have occurred to any of these investigators. The harmonic paradigm can be conjectured as being composed of the following propositions. 1] All elements constituting existing inorganic compounds are envisaged to correlate with certain frequencies that are based on the 12-tone equal temperament scale. 2] Other frequencies that work in harmony with these frequencies of the original elements (either as chords, as semitones in different octaves or calculated via matrix algebra operations) will be associated with other elements. 3] The compounds making up these elements (in proposition 2) are likely to be functionally similar to those in proposition 1.

Table 1. Existing inorganic compounds with specific applications

Application	Compound(s)
Solar cells (perovskites)	$CaTiO_3$, $CH_3NH_3PbX_3$, $LaAlO_3$, $(LaAlO_3)_{0.3}(Sr_2TaAlO_6)_{0.7}$, $Pb(Sc_{0.5}Ta_{0.5})O_3$, $Pb(Zr_xTi_{(1-x)})O_3$, $La_{1-x}Sr_xMn)_3$, $LaYbO_3$
Catalysts	V_2O_5, Pt-Rh, $LiAlH_4$, $NaBH_4$, $KMnO_4$,
Superconductors	$YBa_2Cu_3O_7$, Fluorine doped LaOFeAs,
Semiconductors	CdS, GaAs, InP, PtSi, ZnSb, GaN, Cu_2O, Ag_2S, CdSe, ZnTe, ZnSe, ZnS, CuO, Cd_3As_2, PbTe, EuS, AlN, SnO_2, Zn_3As_2, TiO_2, MoS_2, BiI_3, ZnO, PbS, $BaTiO_3$, VO_2, HgI_2, Zn_3P_2, BN, $CrBr_3$, MnTe, HgSe, HgS
Phosphors in thermionic emission	$Ca_5(PO_4)_3(F, Cl)$:Sb^{3+}, Mn^{2+} A typical "cool white" fluorescent lamp utilizing two rare-earth-doped phosphors, Tb^{3+}, Ce^{3+}:$LaPO_4$ for green and blue emission and Eu:Y_2O_3 for red. Barium aluminate (BAM), $BaMg_2Al_{16}O_{27}$: Eu^{+2} at 450 nm, (Sr, Ca, Ba, Mg)$_5$ $(PO_4)_3$ Cd: Eu^{+2} at 453 nm, $Ca_{0.65}Tb_{0.35}MgAl_{11}O_{19}$ at 543 nm (CAT), $LaPO_4$: Ce^{+3} : Tb^{+3} at 544 nm (LAP), Y_2O_3: Eu^{+3} at 611 nm (YOX)
Piezoelectrics	Pb[ZrxTi1−x]O3 Lead Zirconate Titanate, Barium titanate, Lead titanate, Gallium nitride, Zinc oxide, $BaTiO_3$ [BT], $(Bi_{1/2}Na_{1/2})$ TiO_3 [BNT], $(Bi_{1/2}K_{1/2})$ TiO_3 [BKT], $KNbO_3$ [KN], (K, Na) NbO_3 [KNN]

Harmonic Table of the elements (HTE)

The octaves supercede periods and the notes (semitones) supercede groups in our rendition of the periodic table. The element Y, for example, has a frequency of 277.18 Hz associated with it since it occupies the 4th semitone note in the 4th Octave. Similarly, the elements C and Br have frequencies of 38.89 Hz and 207.65 Hz associated with them. A table of frequency and the corresponding element for the 88 elements studied, is provided in the supplementary file.

We used the modulo-12 arithmetic for the 12 distinct pitches and mapped each of those 12 distinct pitches to a number 0-11 as in the standard 12-tone matrix with the prime form (row). Since the first integer is a zero in this modulo system, we had to skip the first semitone of the first Octave (since there is no element with zero protons) and started with semitone C# corresponding to integer (proton #) 1. For the purposes of prediction, it would not necessarily matter if the semitones started with a C or with an A (as in a Grand Piano) because it would not make a difference to the numbers and they would remain unchanged.

Table 2. The Harmonic Table of the Elements (HTE)

Octaves	Notes (semitones)											
	^{1}C	^{2}C#	^{3}D	^{4}D#	^{5}E	^{6}F	^{7}F#	^{8}G	^{9}G#	^{10}A	^{11}A#	^{12}B
1		$_{1}$H	$_{2}$He	$_{3}$Li	$_{4}$Be	$_{5}$B	$_{6}$C	$_{7}$N	$_{8}$O	$_{9}$F	$_{10}$Ne	$_{11}$Na
2	$_{12}$Mg	$_{13}$Al	$_{14}$Si	$_{15}$P	$_{16}$S	$_{17}$Cl	$_{18}$Ar	$_{19}$K	$_{20}$Ca	$_{21}$Sc	$_{22}$Ti	$_{23}$V
3	$_{24}$Cr	$_{25}$Mn	$_{26}$Fe	$_{27}$Co	$_{28}$Ni	$_{29}$Cu	$_{30}$Zn	$_{31}$Ga	$_{32}$Ge	$_{33}$As	$_{34}$Se	$_{35}$Br
4	$_{36}$Kr	$_{37}$Rb	$_{38}$Sr	$_{39}$Y	$_{40}$Zn	$_{41}$Nb	$_{42}$Mo	$_{43}$Tc	$_{44}$Ru	$_{45}$Rh	$_{46}$Pd	$_{47}$Ag
5	$_{48}$Cd	$_{49}$In	$_{50}$Sn	$_{51}$Sb	$_{52}$Te	$_{53}$I	$_{54}$Xe	$_{55}$Cs	$_{56}$Ba	$_{57}$La	$_{58}$Ce	$_{59}$Pr
6	$_{60}$Nd	$_{61}$Pm	$_{62}$Sm	$_{63}$Eu	$_{64}$Gd	$_{65}$Tb	$_{66}$Dy	$_{67}$Ho	$_{68}$Er	$_{69}$Tm	$_{70}$Yb	$_{71}$Lu
7	$_{72}$Hf	$_{73}$Ta	$_{74}$W	$_{75}$Re	$_{76}$Os	$_{77}$Ir	$_{78}$Pt	$_{79}$Au	$_{80}$Hg	$_{81}$Tl	$_{82}$Pb	$_{83}$Bi
8	$_{84}$Po	$_{85}$At	$_{86}$Rn	$_{87}$Fr	$_{88}$Ra							

Methods

An average sized piano has 88 keys, representing 8 octaves, from the lowest frequency of 27.5 Hz to the highest frequency of 4186 Hz. The periodic table consists of 92 elements, not counting the trans-Uranium elements, which are artificially made. It was therefore necessary to leave out the Actinide elements with proton numbers from 89 to 92 so as to assign every key of the piano to a specific element.

We used four criteria to find compounds (combination of elements) with similar functionality to existing compounds.

Criterion 1. The most obvious method was to determine if all of the elements constituting existing compounds populated the same group of the Harmonic Table of the Elements (HTE). This is akin to stating that all those elements constituted similar notes in different octaves. For example, the existing semiconductor material GaN, has two elements - Ga and N - and they constitute the same note (8th note) in the HTE. This also means that they constitute the same notes in other octaves; i.e. the harmonic note for Ga is exactly two octaves higher than the harmonic note for N. Using this template as an axiom, then enabled us to conclude that **a]** any two elements from different octaves with that note could act as a semiconductor material. For example, K and N, Ga and Tc, Cs and Ho, Au and Cs, etc. could all be investigated as potential semiconductors. However, the obvious flaw in this logic is that since there are 7 elements in group 8 of the HTE, there can be 21 unique combinations of a diad; which seems excessive. **b]** Therefore, we decided to impose another restriction that those elements be at least a period apart; or one octave apart (as exemplified by and similar to GaN, where N is in period (octave) 1 and Ga is in period (octave) 3).

Criterion 2. The two elements constituting the existing catalyst Pt, Rh populate the 7th note (group) of the 7th octave (period) and the 10th note (group) of the 4th octave (period) respectively. Using the same *modus operandi* as in 1 above, we propose that elemental notes that are 2 notes apart and octaves that are 2

octaves apart, and which specifically populate notes 7 and 10, should be investigated as potential specific catalyst replacements for [Pt, Rh], or general replacements for those reactions which can be catalyzed by [Pt, Rh].

If an existing compound consisted of two or more elements which populated the 1st and the 8th octave, or the 1st and the 6th through the 12th semitones of the 7th octave, then criterion 2 could not be used to propose new compounds. This is because no 'shifts' in pattern can occur. In this instance, we ignored the most electronegative element (usually the anion if monoatomic) and applied criterion 2 to the elements *sans* this element. As an example, see $Pb(Sc_{0.5}Ta_{0.5})O_3$ in Table 2, where criterion 2 was applied to the elements Pb, Sc and Ta.

The method of matching elements to perform specific functions from the HPT cannot propose the stoichiometric ratios in which those elements should be mixed to perform that function, unless the stoichiometric ratios of elements in existing compounds also fit a replicative pattern. For example, Ca_5Br_2 does not seem possible using a knowledge of conventional ionic structure. However, Ag_2Ge_5, Pr_2Ru_5, Lu_2Ba_5 and Bi_2Er_5 may be possible to various degrees depending on whether alloys behave the same as ionic compounds and if Bertholides which have elemental mole ratios near the Daltonide ratios proposed above are possible. Either way, it seems to us to be a stretch to propose stoichiometric ratios in addition to combinations of elements, and such may indeed impose too unfair of a burden on the HTE than can be reasonably called upon for it to bear. Therefore, this work is limited to proposing elemental combinations and permutations; not their stoichiometric ratios.

Criterion 3. The three elements constituting the existing Perovskite compound $LaYbO_3$ occur in octaves 5, 6 and 1 and in notes 10, 11 and 9 respectively. Using a similar analogy to 1, we propose that [Tm, Pb, Ca] may serve as a Perovskite material. However, it is evident that the existing compound is ionic, whereas the proposed elemental composition is metallic. Therefore, a third heuristic may be employed that conjectures that harmonious exchange of replicative octaves may keep the first octave as is. This is because elements in the first octave are more amenable to forming anions than those in any other octave in the HTE.

Criterion 4. We have thus far proposed elemental combinations that have similar harmonics (patterns to octaves and notes) to existing compounds. If that were all that was possible, it would not be necessary to examine the harmonics of melodies/songs/compositions in order to predict new compounds. However, we realized that it was possible to dissect the melody/song or composition if most, or all elements in existing compounds were also present in the composition. Using this insight could lead to a larger repertoire of predicted compounds than would be possible from extrapolation from the HTE alone. To that end, we considered if it was possible that notes immediately preceding or succeeding the elements in existing compounds in a particular tune/melody/song or composition - i.e. constituting a plausible chord - might also be capable of real world applications. As an example, we investigated the existing superconductor, $YBa_2Cu_3O_7$. The atomic numbers of these elements are 39, 56, 29 and 8 respectively. We searched each of our 65 compositions/tunes (see supplementary file 1) for some or all of those numbers; regardless of

what octaves they were associated with. For example, three of those four numbers; i.e. 8, 39 and 56 appeared in the 9th composition 'Fur Elise'. We then took each number and determined the two numbers on either side. For example, the number 8 appeared in the composition 4 times. The two numbers on either side of the number 8 were 4 and 13 for instance 1, 15 and 12 for instance 2, 16 and 20 for instance 3 and 4 and 13 for instance 4. Similarly, the number 56 appeared in the 9th composition 11 times, with adjacent numbers being 55 (instance 1), 54 and 55 (instance 2), 55 and 51 (instance 3), 63 and 60 (instance 4), 64 and 68 (instance 5), 44 and 55 (instance 6), 55 and 55 (instance 7), 55 and 51 (instance 8), 52 and 61 (instance 9), 63 and 56 (instance 10), and 56 and 64 (instance 11). The number 39 appeared in the 9th composition 5 times, with adjacent numbers being 44 and 42 (instance 1), 37 and 32 (instance 2), 44 and 42 (instance 3), 37 and 32 (instance 4), and 40 and 37 (instance 5). Using an algorithm written in Python (appendix 1), the same procedure was repeated for all the 65 compositions in the dataset. All the numbers corresponding to one semitone (say 8) from all the 65 compositions were then analyzed to find the mode (the most frequently occurring number). The mode for the numbers 29, 39 and 56 were found using a similar procedure. These modes were taken to be representative of the (alternative) elements that would have superconductor properties. This process was facilitated by an algorithm (Appendix 1 and also deposited in GitHub (https://github.com/coolcat-33/Musical-Template-Inorganic-Compounds/tree/main) that crawled through all the compositions and output the modes for each of the elements making up a particular compound. The modes represented alternative chord-associated sounds that would be harmonious with the existing semitone. Therefore, the new compounds suggested would be harmonious with the existing compound.

Results

For criterion 1, using the restriction presented in the methods section, yielded the possible combinations of [K,Tc], [Ga,Cs], [Tc,Ho] and [Cs,Au] which could be investigated as semiconductors.

Using criterion 2, [Dy, As], [Xe, Sc] and [Mo, F] are potential candidates for replacing the [Pt, Rh] catalyst. Similarly, potential candidates to replace V_2O_5 could be [Br, Ca], [Ag, Ge], [Pr, Ru], [Lu, Ba] and [Bi, Er]. Superconductors that we propose be investigated based on the harmonics of the elements are [Sb, Er, Nb, O], [Eu, Hg, I, O], and [Co, Ru, Cl, O], which are analogous to the existing superconductor $YBa_2Cu_3O_7$.

Using criterion 3, alternative Perovskite materials may be proposed to be composed of [Tm, Pb, Ca, O] or [Tm, Pb, O]. Similarly, the existing Perovskite compounds, $Pb(Sc_{0.5}Ta_{0.5})O$ and $(LaAlO_3)_{0.3}(Sr_2TaAlO_6)_{0.7}$ may be superseded with the proposed compounds [Yb,F,Pm,O] and $\{[Tm, Mn, O]_x$ [Sn, At, Mn, $O]_y\}$ respectively.

Table 3. Predicting different inorganic compounds that are harmonious with select existing compounds and may have similar functionality.

Existing compound	Proposed compound (combination of elements) using criterion			
	#1	#2	#3	#4
$LaYbO_3$	N/A	$(TmPbCa)_{abc}$	$(TmPbCa)_{abc}O_x$	$(CLaPr)_{abc}O_x$
$Pb(Sc_{0.5}Ta_{0.5})O_3$	N/A	$(YbPmF)_{abc}$	$(YbPmF)_{abc}O_x$	$(ReCLuSc)_{abc}O_x$
$LiAlH_4$	N/A	$(PMnAl)_{abc}$ $(CoRbMn)_{abc}$ $(YInRb)_{abc}$ $(SbPmIn)_{abc}$ $(EuTaPm)_{abc}$ $(ReAtTa)_{abc}$	$(PMnAl)_{abc}H_x$ $(CoRbMn)_{abc}H_x$ $(YInRb)_{abc}H_x$ $(SbPmIn)_{abc}H_x$ $(EuTaPm)_{abc}H_x$ $(ReAtTa)_{abc}H_x$	$(LiPNa)_{abc}H_x$
$YBa_2Cu_3O_7$	N/A	$(SbErNbCa)_{abcd}$ $(EuHgIGe)_{abcd}$	$(SbErNbCa)_{abcd}O_x$ $(EuHgIGe)_{abcd}O_x$	$(XeRbCY)_{abcd}$
(LaOFeAs)F	N/A	$(TmCaSrRh)_{abcd}$ $(TlGeSnLa)_{abcd}$	$(TmCaSrRh)_{abcd}F_x$ $(TlGeSnLa)_{abcd}F_x$	CNaAsLaF
CdS	N/A	$(NdNi)_{abc}$ $(HfZn)_{abc}$ $(PoTe)_{abc}$ $(KrBe)_{abc}$	$(NdNiS)_{abc}S_x$ $(HfZnS)_{abc}S_x$ $(PoTeS)_{abc}S_x$ $(KrBeS)_{abc}S_x$	ArS
Zn_3P_2	N/A	$(NiLi)_{ab}$ $(TeCo)_{ab}$ $(GdY)_{ab}$ $(OsSb)_{ab}$ $(RaEu)_{ab}$	$(NiLi)_{ab}P_x$ $(TeCo)_{ab}P_x$ $(GdY)_{ab}P_x$ $(OsSb)_{ab}P_x$ $(RaEu)_{ab}P_x$	MoAlP
$(BaMg_2Al_{16}O_{27})$ Eu^{+2}	N/A	$(ErCrMnCa)_{abcd}$ $(HgKrRbGe)_{abcd}$	$(ErCrMnCa)_{abcd}O_x$ $(HgKrRbGe)_{abcd}O_x$	NaPmCXePO
(K, Na) NbO_3	N/A	$(GaV)_{ab}$ $(TcBr)_{ab}$ $(CsAg)_{ab}$	$(GaV)_{ab}ICa_{xy}$ $(TcBr)_{ab}TbGe_{xy}$ $(CsAg)_{ab}IrRu_{xy}$	$(CAlFNe)_{abcd}O_x$

Discussion

Table 3 shows select representative compounds that were found using the different criteria (see Methods) applied to the 'harmonic paradigm'. Several attributes can be identified among the predicted compounds. The noble gasses seem to be over-represented in the predicted compounds that are found using criterion 4. Several of those are reminiscent of a musical chord; such as Xe predicted for the original Ba atom, Ne and O, while some are adjacent to one another such as Ne predicted for Na. Furthermore, chords can also be found among elements in the predicted compounds, such as Rb and Y, La and Pr and C and O. This musical chord pattern also appears in compounds proposed using criterion 3. Some examples are Co and Mn, Rb and Y, Sb and In, and Re and

Ta. A heuristic for a connection between superconductivity and the periodic table has been proposed; although not based on the 'harmonic paradigm' (7). Interestingly, noble gas ions contribute to superconductivity, especially under pressure (8).

The modern equal temperament scale has 12 notes to an octave because a collection of notes can be built using just one fixed ratio; i.e. the twelfth root of 2 ($2^{1/12}$). The advantage to doing so is that it allows a uniformity that makes modulating between octaves possible. The modern equal temperament piano therefore has 12 keys (semitones) per octave. To our knowledge, this is the first time a correlation has been ideated and attempted between the equal temperament octave and the properties of the compounds so formed from this arrangement of elements. Furthermore, we have envisaged using this paradigm to *a priori* propose new compounds with defined uses. We have proposed a new name; The Harmonic Table of the Elements (HTE); for our periodic table because it is based on the harmonic frequencies of the equal temperament. Our achievements are twofold; First, we have constructed an entirely new periodic table based on the harmonics of the equal temperament octave and Second, we are the first to propose that the functionality of compounds may be related to their harmony; i.e. that entirely new combinations of elements can be proposed *a priori* as compounds that will have similar - or indeed; better - functionality and properties to/than existing compounds. If harmonics do dictate - even if in part - the properties of compounds, the impact of our discovery in advancing inorganic chemical science would be incalculable. Since this idea has numerous ramifications and applications, this manuscript represents the first in a series. This particular work aimed to provide a general overview of the proposed harmonic architecture of the HTE as well as the general framework, importance, logic and utility of the compounds proposed using this architecture.

If an underlying harmony pervades the periodicity of the elements, then there should be a function that describes the relationship between the element frequency and the element intrinsic properties such as electronegativity, ionization energy or atomic size. In our work, we have arranged the elements in ascending order based on their atomic numbers in the 8 octaves (see Table 2), thereby assigning frequencies from 27.5 Hz through 4186.0 Hz for elements H through Ra. The element and their assigned frequencies are shown in the supplementary file. In future work, we will investigate if such a function exists and if its arguments can provide 'first principles' information about the harmonic architecture of the elements.

We realize that there may be other ways to devise or use templates to predict new compounds from the frequencies of existing ones. Eigenvalues for simple models of musical instruments can be plotted as a single graph on a complex plane (9). Elements of a note set can be mapped using a polynomial function to create another note set (10). This suggests that square matrices can be constructed using repeating (different) octaves for existing compounds. The eigenvectors or the eigenvalues of such matrices can then be construed as harmonically similar compounds; as can relevant matrix operations such as finding the inverse or transpose of the matrix.

These methods still utilize the harmonic paradigm. We hope to investigate these methods in future work.

Limitations

We could not test our hypothesis because we do not have - and are not likely to have - the resources, equipment, funding, time or materials to do so. We hope that the scientific community will undertake this endeavor. Our testing dataset was limited to 65 compositions and may not have captured the entirety - and therefore may not be representative - of harmonic permutations and combinations of notes or semitones. This is of particular concern because of the adoption of atonality (11) since the early 20th century that superseded the tonal hierarchical triad of western classical music. As mentioned before, this work was limited to proposing elemental combinations and permutations; not their stoichiometric ratios.

Conclusion

We have proposed a new periodic table based on the 12 semitones of the equal temperament scale. New inorganic compounds can be derived from existing ones using this table and using our 'harmonic paradigm'; i.e. that all elements constituting existing inorganic compounds have certain frequencies assigned to them; and that other frequencies (associated with proposed elements) that work in harmony with these frequencies of the original elements are likely those compounds that are functionally similar to those existing compounds. Such harmonious collaboration is likely to manifest in the form of similar chords, similar notes (semitones) in different octaves or similar patterns of notes (semitones) across different octaves. Using our hypothesis, we have; *a priori*; proposed new semiconductors, perovskite compounds, superconductors, catalysts, thermionic emitters and piezoelectric compounds. This novel paradigm or its future derivatives has the potential to exponentially advance the field of inorganic chemistry.

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Appendix 1. Python code to search for adjacent semitones in the song database for an input of a known compound

```
choice = input("1. Run on one particular song OR 2. Run on all songs? Enter 1 or 2: ")
if (choice == "1"):
    filePath = input("Enter the file path of the particular song: ")
elif (choice == "2"):
    filePath = "Songs/Copy of music-elements-spreadsheet.xlsx - clustered notes.csv"
else:
    quit(print("Invalid choice. Quitting..."))
```

```
numbers = input("\n\nEnter the numbers of the elements you want to run on SEPARATED BY
SPACES: ")

lines = open(filePath).readlines()
newFile = open("newFile.txt", "a")
tables = {}
table = []
title = None
for line in lines:
    if "." in line:
        if table:
            tables[title] = table
        title = line.replace(",","")
        table = []
    else:
        a = line.split(",")
        if a[0]:
            table.extend(a)

if table and title:
     tables[title] = table
# Enter the numbers of elements
b = numbers.split(" ")

count = {}

for table, a in tables.items():
    i = 0
    while i < (len(a) - 1):
        if (a[i] in b) :
            adj_char = a[i+1]
            if adj_char in count:
              count[adj_char] += 1
            else:
              count[adj_char] = 1
            if i > 1:
                adj_char = a[i-1]
                if adj_char in count:
                    count[adj_char] += 1
                else:
                    count[adj_char] = 1
            i += 1
        i += 1
```

```
output = sorted(((times, number) for number, times in count.items()), reverse=True)
```