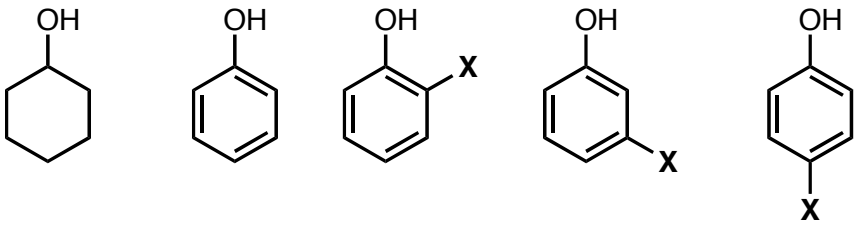
Q5. In the box below, you are given the pK_a values for a series of compounds, the least acidic is cyclohexanol (pK_a = 16.0). The pK_a value for phenol is 10.0, and two series of substituted phenols are given: 2-fluorophenol, 3-fluorophenol, and 4-fluorophenol have pK_a values of 8.7, 9.3, and 9.9, respectively; 2-nitrophenol, 3-nitrophenol, and 4-nitrophenol have pK_a values of 7.2, 8.4, and 7.2, respectively. Note: both –F and –NO_2 are strong electron withdrawing groups.



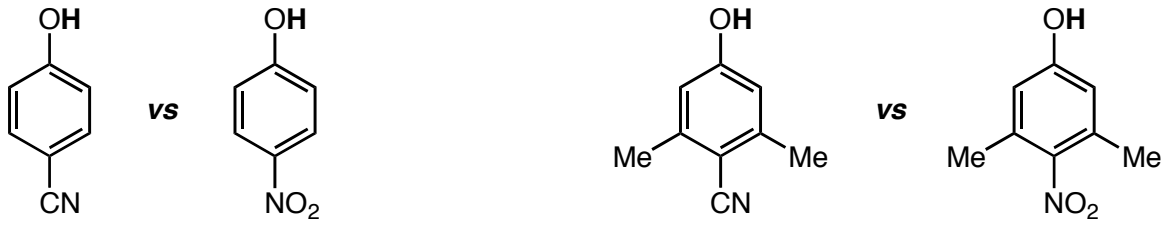
	cyclohexanol	*phenol*	*2-X-phenol*	*3-X-phenol*	*4-X-phenol*	
pK_a values	16.0	10.0				
			8.7	9.3	9.9	**X = F**
			7.2	8.4	7.2	**X = NO_2**

(a) Briefly explain (using words AND illustrations) why phenol is (literally and actually!) a million times more acidic than cyclohexanol (5 points).

(b) Briefly explain (using words and illustrations as you feel necessary) the trend observed in the acidity of 2-, 3-, and 4-fluorophenol (5 points).

(c) Briefly explain and illustrate why the trend observed in the acidity of 2-, 3-, and 4-nitrophenol is different to that observed for the analogous series of phenolic compounds containing fluorine (5 points).

EXTRA CREDIT. The pK_a values for 4-cyanophenol (**I**) and 4-nitrophenol (**II**) are approximately the same, i.e., the phenolic protons (**bold**) in each of these compounds are equally acidic. In contrast, however, the dimethyl-substituted compounds differ significantly in their acidity; the dimethyl-cyano compound (**III**) is much more acidic than the dimethyl-nitro compound (**IV**). Explain (using both words and drawings as you feel appropriate) this observation in the box below. (15 points) Hint: think resonance...



I **II** **III** **IV**