* More Aromaticity + Intro to Phenols
Warm-Up + Application Answers

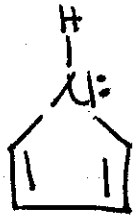
① If it has continuous conjugation, is cyclic, is planar, + has $4n+2$ π e^-, charge doesn't matter.

② Same as #1

③ False: There are many heterocyclic molecules that are classified as aromatic.

④

Pyridine

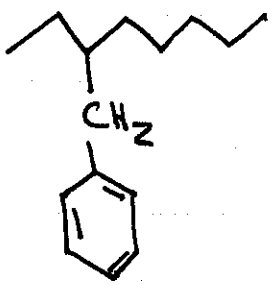


Pyrrole

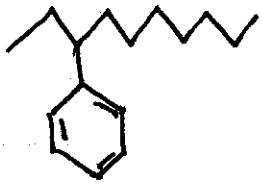
Pyridine is more basic. The lone pair e^- on N in pyridine are in an sp^2 orbital + therefore, not part of aromaticity. Pyridine can act like a base + not break aromaticity.

The lone pair e^- on N in pyrrole are in a p orbital + therefore, part of aromaticity. If pyrrole acts like a base, aromaticity will be broken.

⑤.

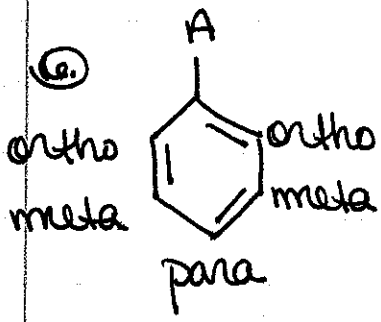


Benzyl



Phenyl

⑥.

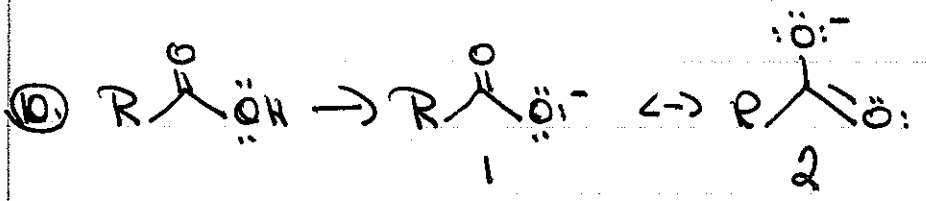


⑦.

Carbolic Acids

⑧ True

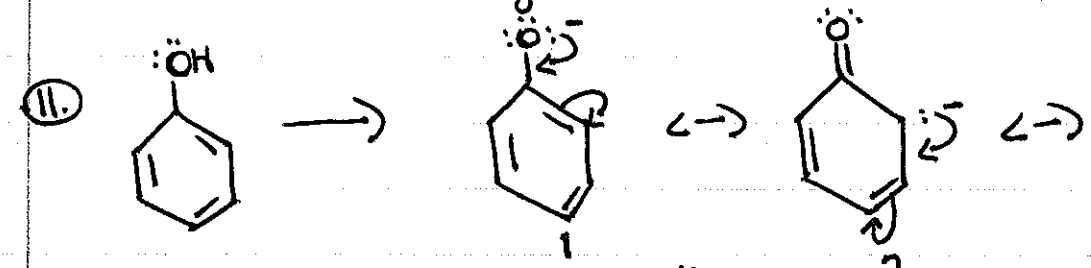
⑨ Acidic : H_2O Soluble : Higher Boiling Points : Phenols have high boiling points due to H bonding. Phenols are H_2O soluble b/c they can H bond w/ H_2O.

(10) 

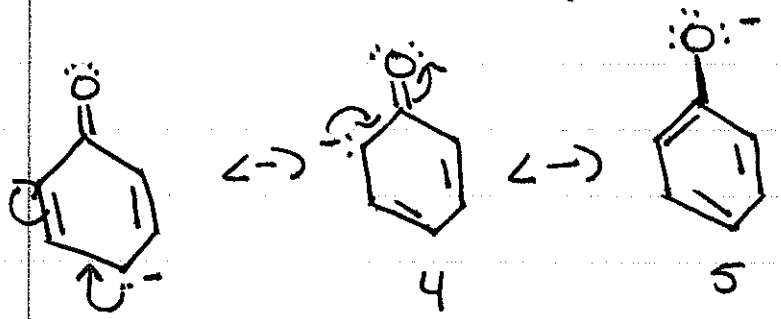
1 2

$RCH_2\ddot{O}H \rightarrow RCH_2\ddot{O}:^-$

The conjugate base of a carboxylic acid is resonance stabilized.

(11.) 

1 2



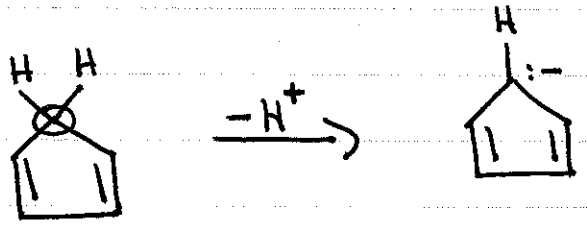
3 4 5

Carboxylate (#10) has 2 Resonance structures + phenoxide (above) has 5 resonance structures. Usually, more resonance = more stable. However, for phenoxide, 3 of the 5 resonance structures have the (-) charge on a less electronegative atom (C). Therefore, 3 of these structures are higher energy + contribute less to the actual hybrid structure.

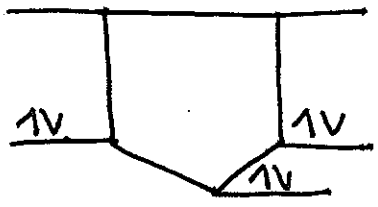
(12.) Resonance = the actual movement of lone pair e^- or πe^- from one atom to another
Induction = the momentary shift of e^- density through sigma bonds

(13.) Increase : Decrease: The conjugate base of phenol is (-) charged. e^- w/drawing substituents help to spread that (-) charge across the molecule + stabilize the conjugate base. More stable c.base = stronger acid

(14.) True

(1.) 

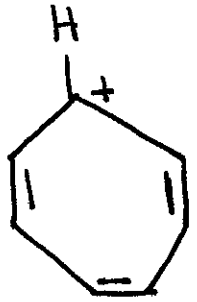
Non-aromatic



① Cyclic ✓
② Continuously Conjugated ✓
③ Planar ✓
④ $4n+2\ \pi e^-$ ✓

$4n+2 = 6$
$4n = 4$
$n = 1$

The conjugate base of cyclopentadiene is aromatic = extremely stable. Stable C.base = good acid

② 

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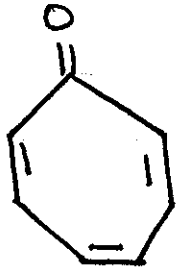
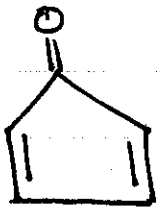
③ 

Aromatic



Anti-Aromatic

Both cyclic, both continuously conjugated, assuming both are planar:

$4n+2=6$
$4n=4$
$n=1$
aromatic #

$4n+2=4$
$4n=2$
$n=1/2$
antiaromatic #

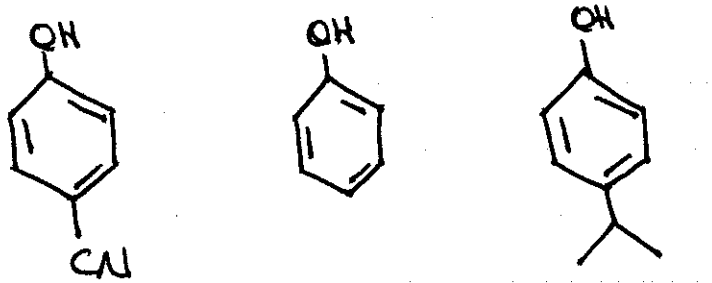
④ a.) Pyridine : Acetophenone : Thiophene :
Para-Hydroxyphenol or 1,4-dihydroxybenzene :
Indole : Meta-Iodonitrobenzene or 3-Iodonitrobenzene:
Pyrrole

b.) Meta-Fluorobenzaldehyde or 3-Fluorobenzaldehyde:
Imidazole : phenol : Styrene : Para-Bromoaniline or
4-Bromoaniline : Benzonitrile : Ortho-Xylene or
1,2-dimethylbenzene

C.) Aniline : Bromobenzene : Nitrobenzene :
Furan : Benzaldehyde

D.) Benzoic Acid : Toulene : Ethylbenzene :
Isopropylbenzene

⑤

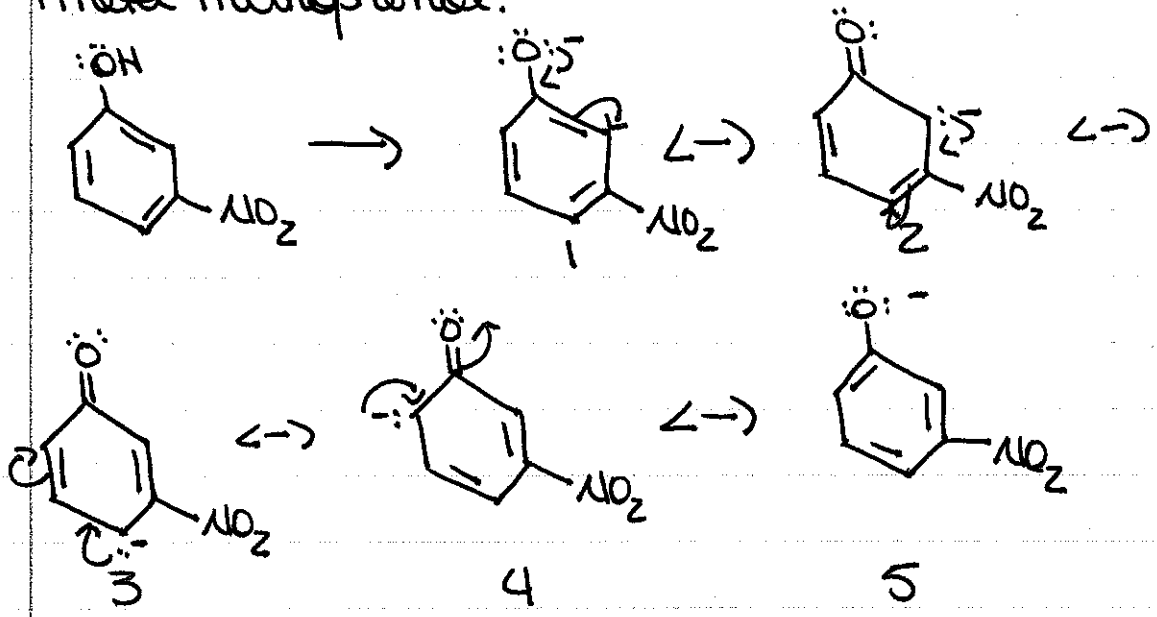


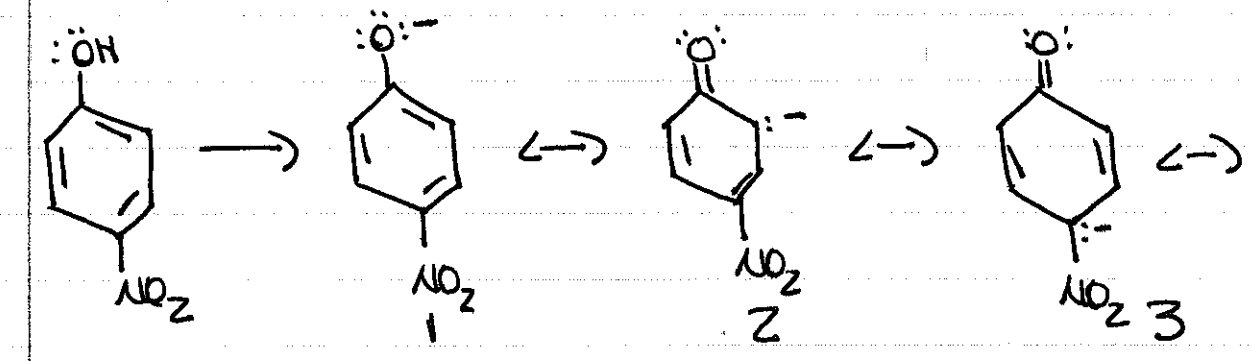
most acidic

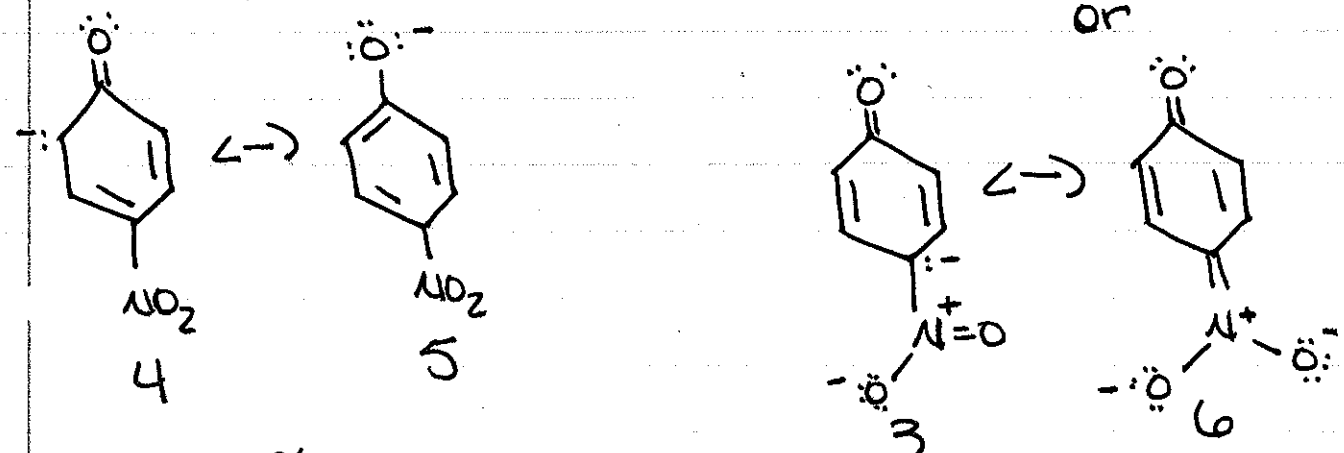
least acidic

CN = e- w/drawing
R = e- donating

⑥ Para-nitrophenol is more acidic than meta-nitrophenol.







If the e⁻ w/drawing group is ortho or para, there is an additional resonance structure where the (-) charge is on a more electronegative atom.