

## Self-assessment test with focus on SynCat subjects (1) (solutions)

### Part 1 – Organic Chemistry

1. Define the following terms and give one specific example for each term.

a) stereoisomers    b) diastereomers    c) enantiomers

a) stereoisomers: isomers with same connectivity between atoms but with different arrangement of substituents in space

b) diastereomers: stereoisomers which are no enantiomers (don't behave like image and mirror image)

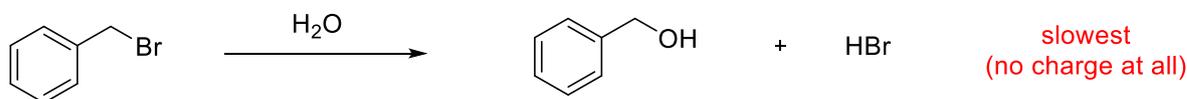
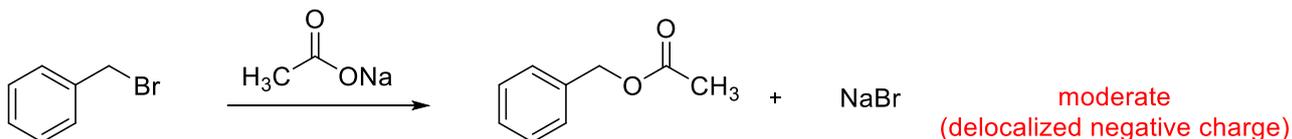
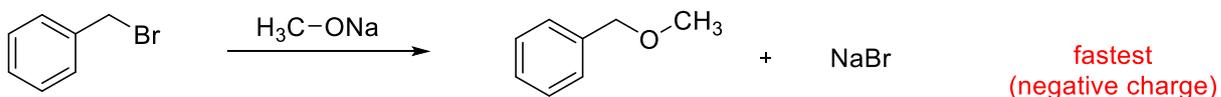
c) enantiomers: stereoisomers which behave like image and mirror image

2. How do diastereomers and enantiomers differ in their physical and chemical properties?

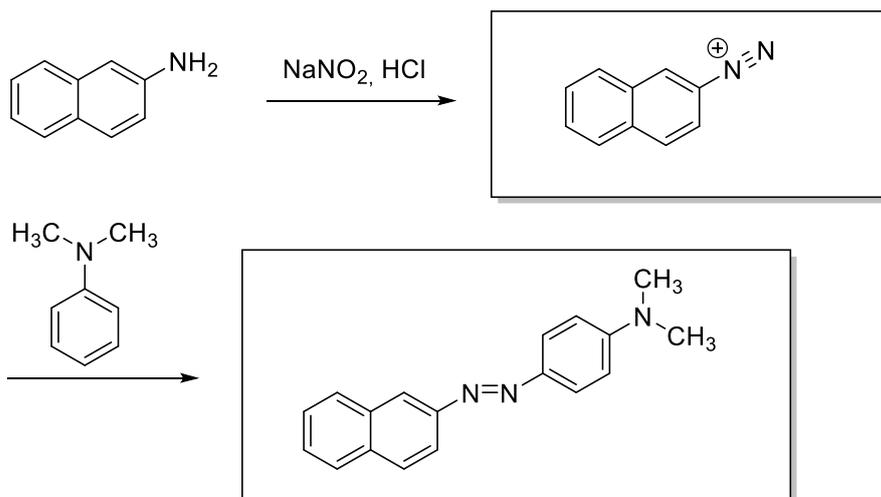
diastereomers: different in physical and chemical properties

enantiomers: equal in physical properties except in direction of rotation of linearly polarized light, equal in chemical reactions with achiral partners, different in chemical reactions with chiral partners

3. Give the products of the following transformation with benzyl bromide and a nucleophile as starting material. Which of these three reactions is the fastest one? All reaction conditions stay the same, the only difference is the nucleophile used. Hint: Identify the best and the worst nucleophile first!



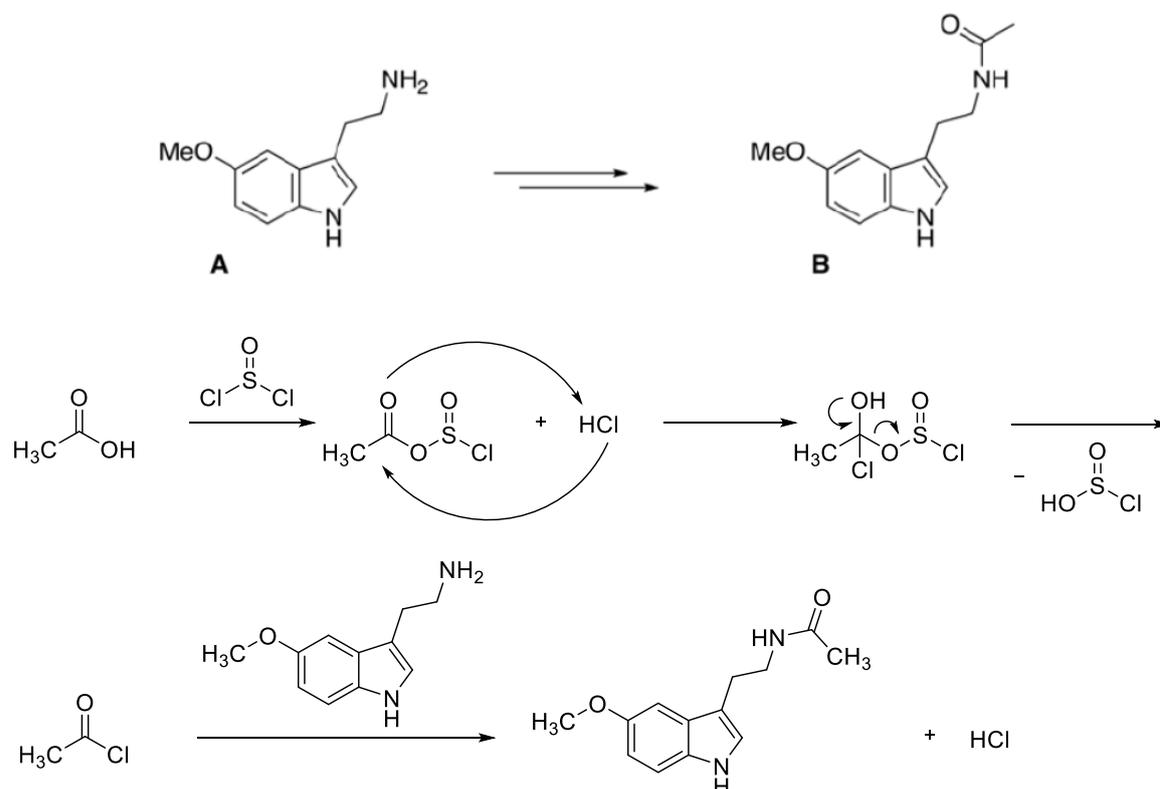
4. Draw the intermediate and the product of the following transformation.



5. You want to transform compound **A** into compound **B** with the help of acetic acid. Why won't this reaction work if you simply apply acetic acid to **A**? Come up with an alternative pathway to accomplish the transformation.

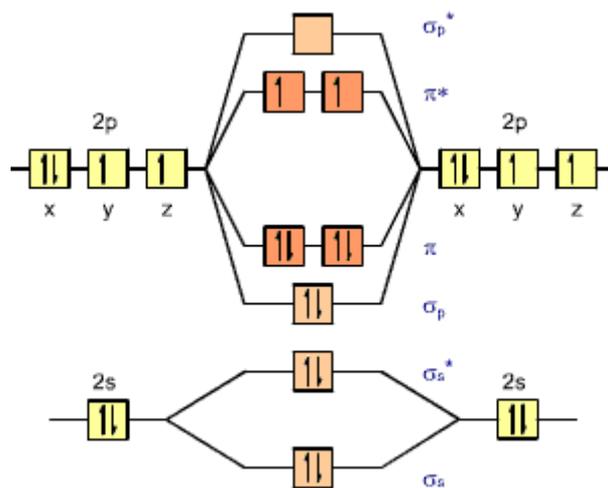
Application of acetic acid to a basic compound such as an amine leads to (de-)protonation and thus to ammonium salt formation rather than a nucleophilic attack.

Usage of a better electrophile is required. Transform acetic acid to its acid chloride with  $\text{SOCl}_2$ .



Part 2 – Inorganic Chemistry

6. Draw the complete molecular orbital scheme for O<sub>2</sub>. What is the chemical bond order in this molecule?  $BO = \frac{1}{2}(8 - 4) = 2$



7. Potassium's second ionization energy (IE<sub>2</sub> = 3051 kJ/mol) is seven-times higher than its first ionization energy (IE<sub>1</sub> = 419 kJ/mol). If you compare this to calcium, the second ionization energy (IE<sub>2</sub> = 1145 kJ/mol) is only twice as high as its first one (IE<sub>1</sub> = 590 kJ/mol). Why is there such a big difference between K and Ca?

After removal of a single electron K has reached its noble gas electron configuration. Further removal of electrons would mean taking electrons out of inner shells which is energetically unfavorable. Ca reaches noble gas configuration with the removal of two electrons from its outer shell, thus the ionization energies are lower there.

8. Give the suitable quantum numbers  $n$  and  $l$  for the following orbitals.

a) 3d-orbital:  $n = 3$   $l = 2$       b) 4s-orbital:  $n = 4$   $l = 0$

9. Which bond angle and which hybridization do the central atoms show in the following molecules?

a) BeF <sub>2</sub> (gas phase)	b) BeF <sub>3</sub> <sup>-</sup>	c) BeF <sub>4</sub> <sup>2-</sup>	d) azide ion, N <sub>3</sub> <sup>-</sup>
a) 180°, linear		c) 104.5°, tetrahedral	
b) 60°, trigonal planar		d) 180°, linear	