

Key

Name: _____ Student ID #: _____

CIRCLE YOUR RECITATION SECTION and T.A.:

- | | | | |
|-----|---------|-----|---------|
| 211 | Jessica | 221 | Aaron |
| 212 | Lance | 222 | Matthew |
| 213 | Tianyi | 223 | Ethan |
| 214 | Paula | 224 | Dylan |
| 215 | Brendan | 225 | Brendan |

Please read and sign the Honor Code statement below:

I pledge that on my honor, as a University of Colorado at Boulder student, I have neither given nor received unauthorized assistance on this exam.

Signature

General Instructions: There are 6 pages of questions. Be sure you have them all. Read each question carefully so that you know exactly what is being asked. Good luck!

1A 2A 3A 4A 5A 6A 7A 8A

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* Lanthanide series

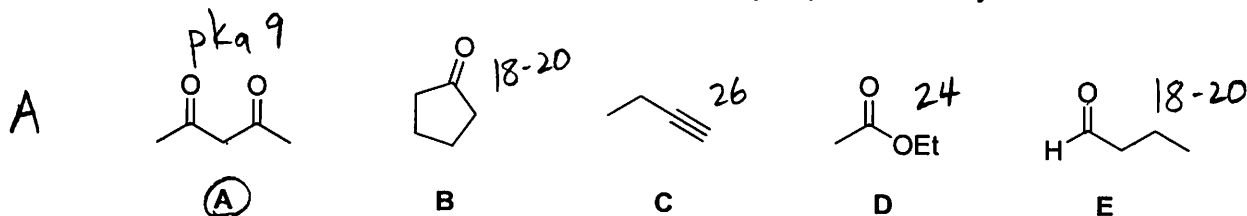
57	58	59	60	61	62	63	64	65	66	67	68	69	70
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
89	90	91	92	93	94	95	96	97	98	99	100	101	102
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No

** Actinide series

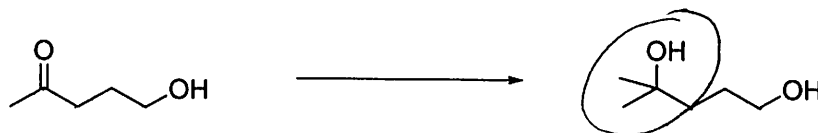
+3 each

Multiple choice. Select the single best answer to each of the following questions. (30 pts).

1. Which of these compounds will be quantitatively deprotonated by sodium ethoxide?



2. The transformation shown requires a multi-step synthesis. Which of the following reagents are you most likely to need for the most efficient synthesis?

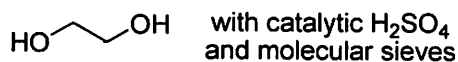


B a. Me_2CuLi , followed by aqueous workup

(b.)



c.

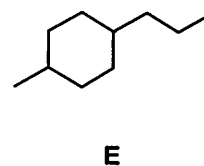
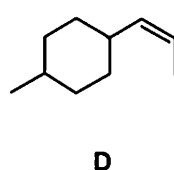
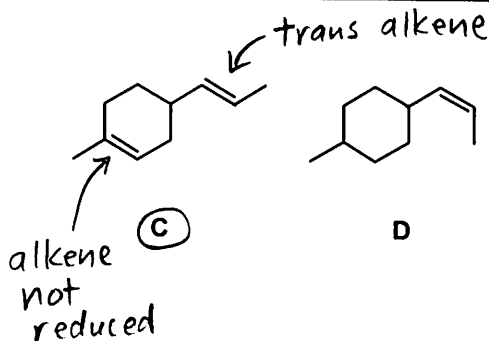
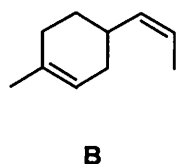
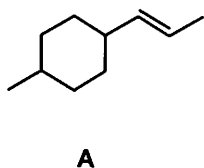
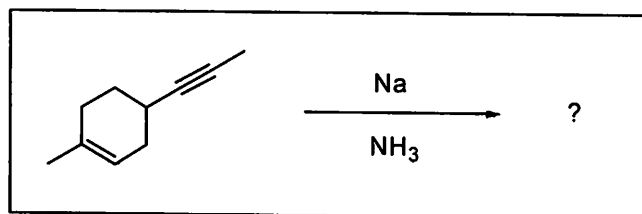


d. Si_2BH , then H_2O_2 , $\text{HO}^-(\text{aq})$

e. PCC

MeLi or MeMgBr
followed by H_3O^+
Means we need to
protect the OH group
first

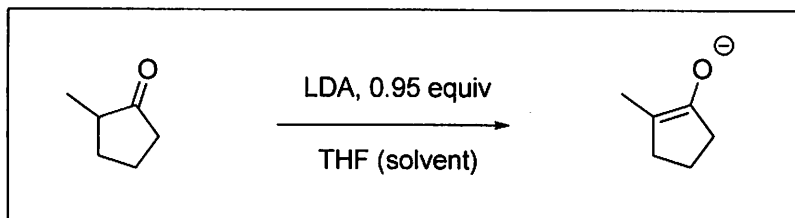
3. Which of these compounds is the major product of the reaction conditions shown?



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4. A thermodynamic enolate can be formed using the conditions shown. These conditions permit equilibration of the kinetic enolate to the more stable thermodynamic enolate.

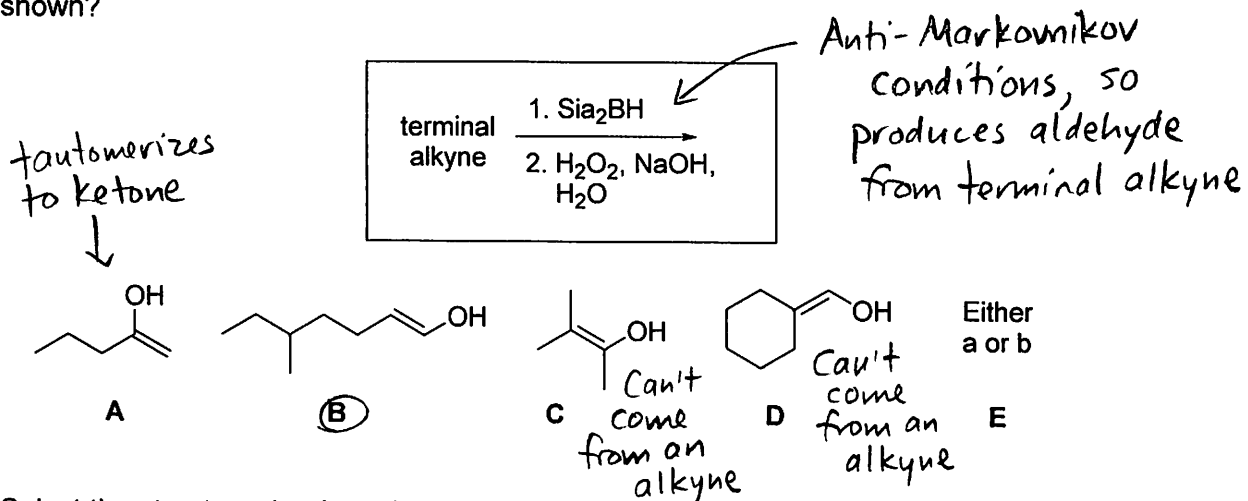
C



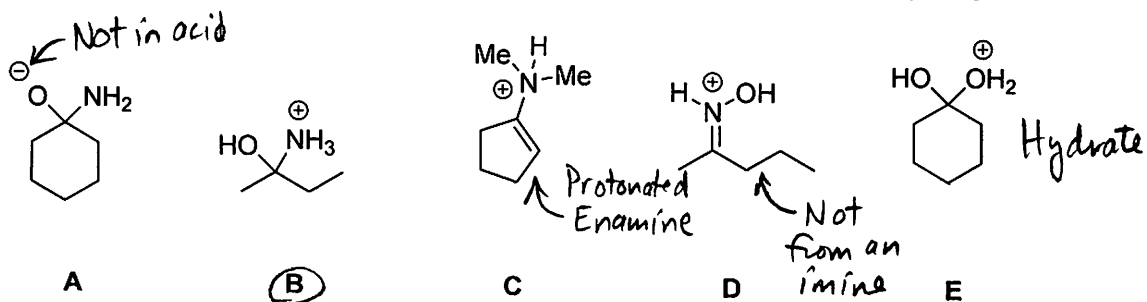
What is the proton source in this equilibrium?

- Water
 - Diisopropylamine (the conjugate acid of LDA)
 - c.** Ketone
 - H_3O^+
 - The kinetic enolate
5. Which of these enols would be the expected intermediate under the reaction conditions shown?

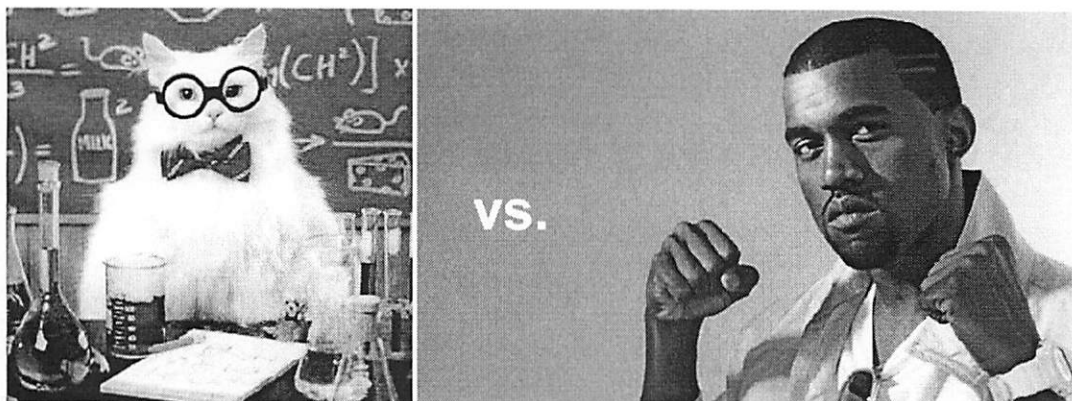
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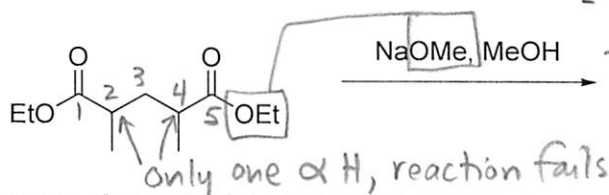
6. Select the structure that is an intermediate in an acid-catalyzed imine hydrolysis.



7. After challenging the Chemistry Cat to a Synthesis Showdown in 2015, Kanye West went down to a stunning defeat.



Kanye has been working hard in the lab (and unfortunately has written songs about it) and now wants to challenge the Cat to a rematch. As one of the first steps in his synthesis, he plans to perform a Dieckmann condensation using the following starting material and reagents:

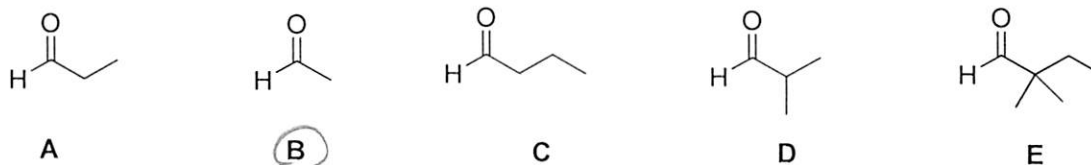


- Base doesn't match ester
- Would form a 4-membered ring - not observed with Dieckmann

What are Kanye's chances of success? (Read all answer choices carefully before deciding.)

- There is one flaw with the proposal and Kanye's reaction will fail.
- There are two flaws with the proposal and Kanye's reaction will fail.
- There are three flaws with the proposal and Kanye's reaction will fail.
- The reaction will work fine as proposed.
- It depends on what Kanye's target molecule is, so there's not enough information to answer the question.

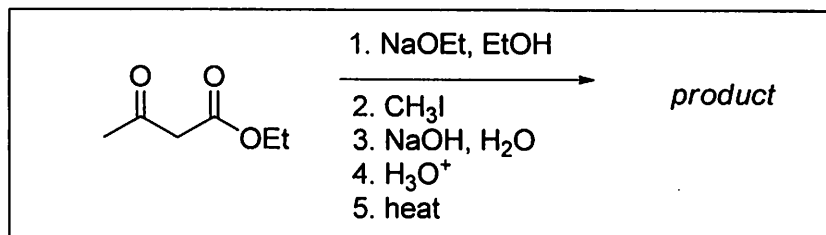
8. Which aldehyde has the largest value of $K_{\text{hydration}}$?



Least hindered

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9. Which of the following structures is not a chemical species that would exist at some point in this synthesis?

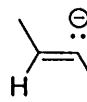
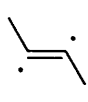
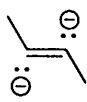
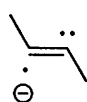
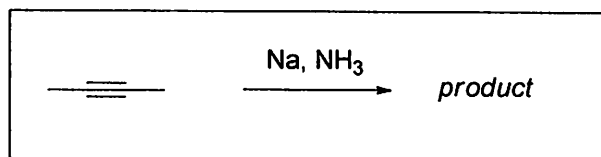


D

- a. Enol ✓
- b. Enolate ✓
- c. Carboxylic acid ✓
- ~~d. Conjugated enone~~
- e. All of these structures may exist at some point in the synthesis

10. Which of these structures is a mechanistic intermediate in the dissolving metal reduction of 2-butyne using sodium in liquid ammonia?

D



✓

None of these structures are intermediates

Negative charge is not on the C with the radical

A

B

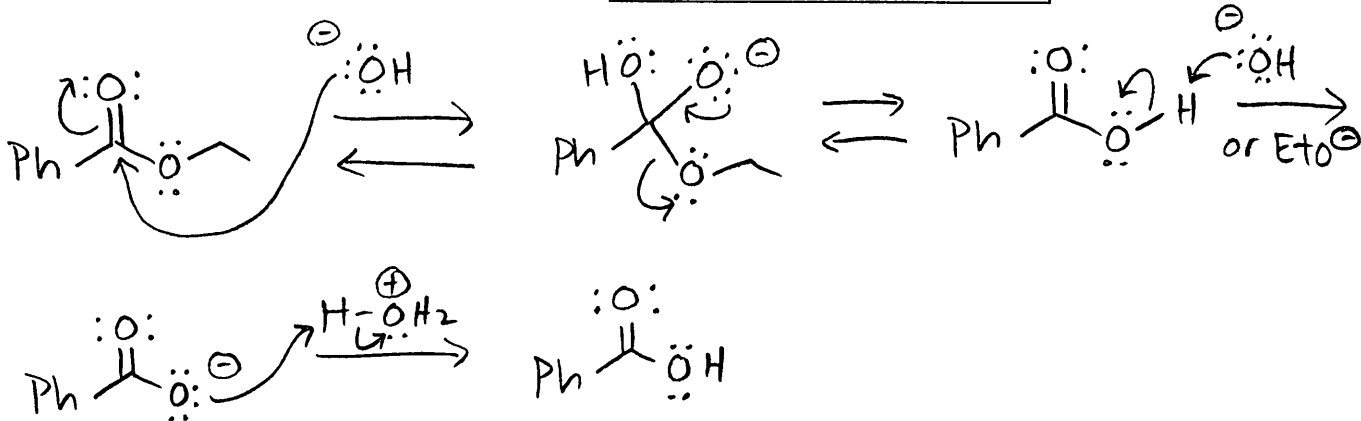
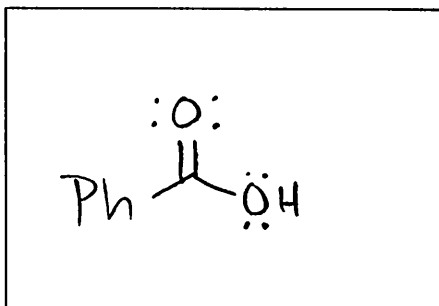
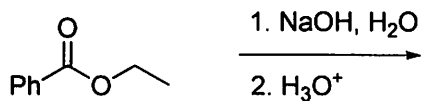
C

D

E

11. **Mechanism.** Predict the major organic product of this set of reaction conditions and draw a mechanism to show how it is formed. Include all necessary curved arrows, lone pairs, and nonzero formal charges. (20 pts)

Saponification

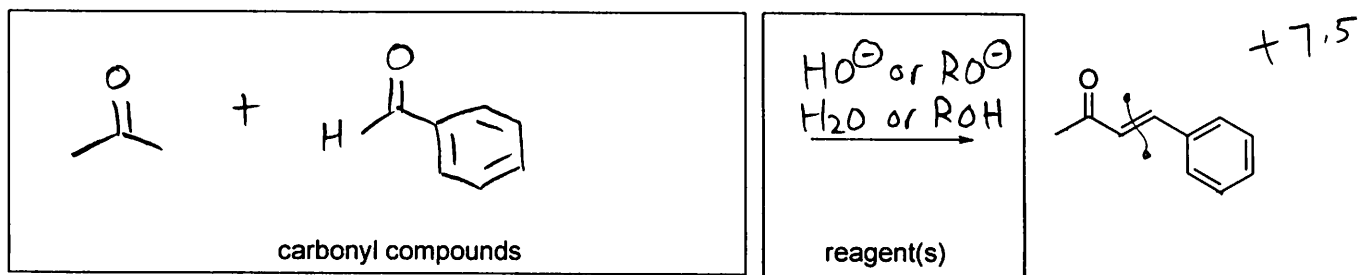


+ 5 each step
 (correct arrows, charges
 + product)

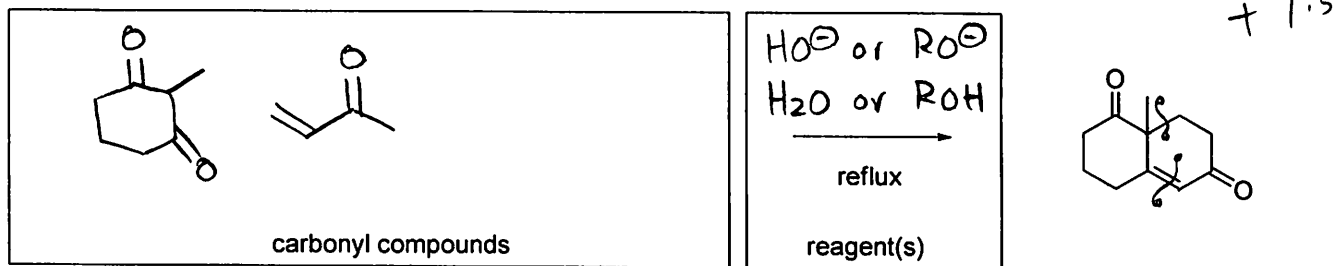
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12. **Retrosynthesis.** (20 pts)

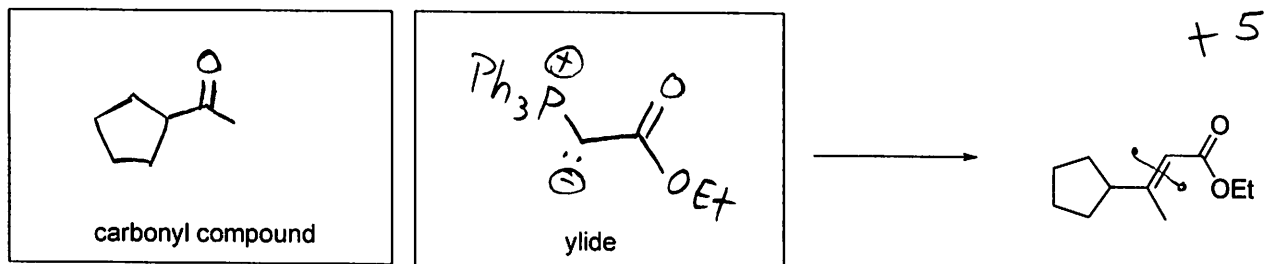
a. Draw the structures of the **carbonyl compounds and any reagents and solvent** you would use to prepare the following compound **using an aldol condensation**. (For this particular example, no heat is necessary; you just need to show reagents.) Do not show any mechanisms.



b. Draw the structures of the **carbonyl compounds and any reagents and solvent** you would use to prepare the target ketone **using a Robinson annulation**. (The reaction must be run at reflux and this has been noted.) Do not show any mechanisms.



c. Draw the structures of the **best combination of carbonyl compound and ylide** that you would use to prepare the following compound **using a Wittig reaction**. Do not show any mechanisms.



or

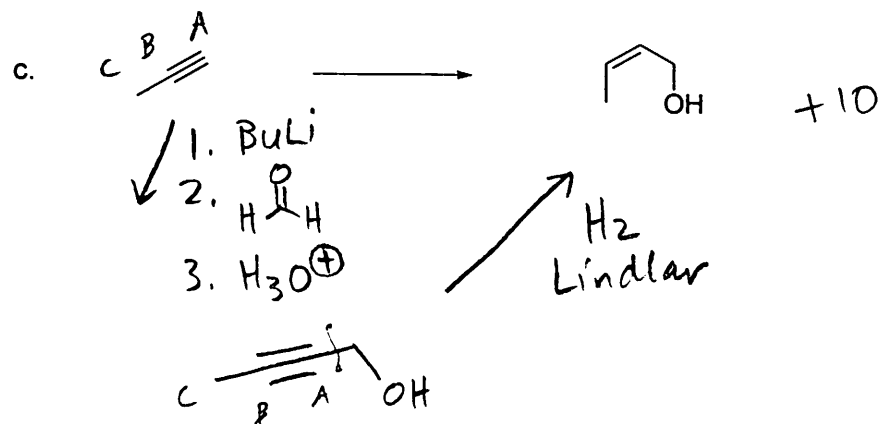
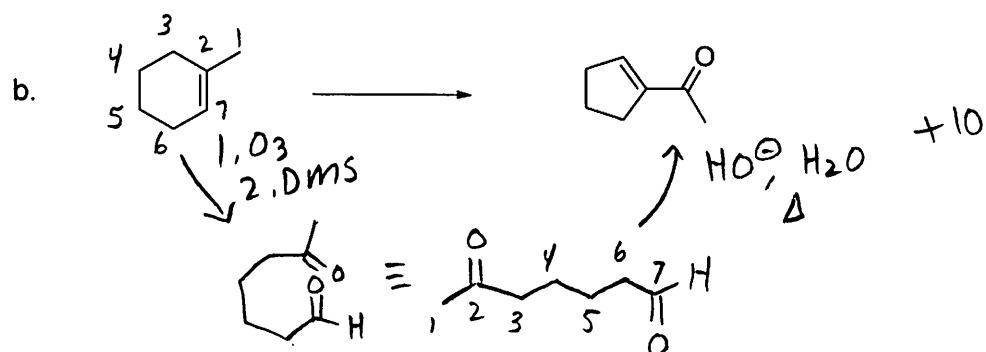
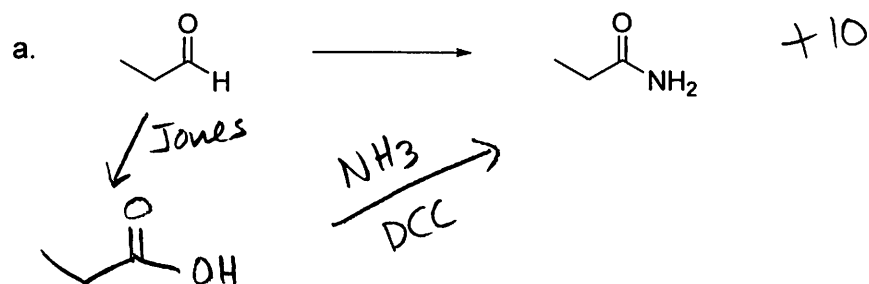
$\text{Ph}_3\text{P}=\text{CHCO}_2\text{Et}$
 (phosphorane)

13. **Multistep synthesis.** (30 pts) For each of the following transformations, propose a synthesis of the target molecule from the given starting material.

For full credit,

Don't show any mechanisms.

Show reagents needed for each step and the product of each step. This means you should write your answer like this example (the exact number of steps may vary):



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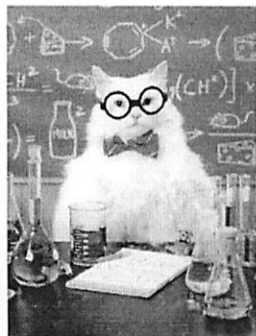
14. **Extra credit.** (Secret number of pts) Circle the name of the chemist who is credited with inventing the curved arrows we use in mechanisms to show electron movement.



Rainer Claisen



Sir Robert
Robinson



The Chemistry Cat



Georg Wittig



Victor Grignard

↪ This guy