American Chemical Society's

Record Keeping Fact Sheet

The American Chemical Society's Committee on Patents and Related Matters has prepared this fact sheet as a guideline for maintaining complete research records. Such records are crucial to the advancement of invention and to the protection of intellectual property rights.

1. **Do** keep the record factual.
   Do record novel concepts and ideas relating to the work project.
   Don't editorialize.

2. **Do** use a record book with a permanent binding.
   Don't use a loose-leaf, spiral bound or otherwise temporarily bound book that provides for page deletion and insertions.

3. **Do** enter data and information including formulas and/or drawings directly into the record book promptly as generated.
   Do sign and date each page of the record book at the time the page was completed.
   Don't rely on memory or use informal loose sheets for entries with the intention of later putting these into the bound record book.
   Don't leave any completed page unsigned and undated.
   Don't postpone signing and dating all completed pages.

4. **Do** use permanent ink, preferably black, which will reproduce well when photocopied in black and white.
   Don't use pencil or non-permanent inks.
   Don't use colored ink.

5. **Do** write legibly.
   Don't make entries in handwriting that later on can be subject to interpretation, translation or wrong meaning.

6. **Do** identify errors and mistakes and explain them.
   Don't ignore errors and mistakes.
   Don't obliterate, delete or otherwise render errors unreadable.

7. **Do** completely fill each page.
   Do sign and date each page immediately after the last entry.
   Do draw vertical lines through unused portions of the page where an experiment takes less than a full page.
   Don't leave part of a page blank.

8. **Do** attach support records to the record book where practical; where volume and size prohibit this action, store such records, after properly referencing and cross-indexing, in an orderly form in a readily retrievable manner.

Don't file supporting records in a haphazard, helter-skelter manner without any record of their relationship or connection to the research reported in the record book.

9. **Do** use standard accepted terms; avoid abbreviations, code names, trademarks, trade names, or numbers if possible; if abbreviations or code names, trademarks, trade names or numbers are used, make certain these are defined at least once in every record book.
   Don't use any abbreviations, code names, trademarks, trade names, or numbers without giving its meaning or definition, or identifying the compound or the trademark and/or trade name and source.

10. **Do** keep the record book clean; avoid spills and stains.
    Don't subject the pages of the research notebook to chemical or physical destruction from spills.

11. **Do** see that the record is promptly witnessed by a knowledgeable person who understands what is being reported and, preferably, who assisted in or witnessed the work, but who is not a contributor to the research being conducted.
    Don't postpone having notebooks witnessed.
    Don't have notebooks witnessed by someone who is not technically skilled in the art being reported and who does not understand the contents of the record.
    Don't use a witness someone who has contributed professionally, conceptually, or technically to the work being reported.

12. **Do** maintain the confidentiality of the record until properly released.
    Don't treat the record book as a publication that is freely available to the public.

13. **Do** maintain control of an assigned record book at all times, keeping it in a fireproof safe, file or vault when not in use.
    Don't let the book lie open around the laboratory when not in use.
    Don't remove the record book from the company's or institution's premises.

14. **Do** index and close out the record book as soon as it is filled or a project is completed and check it back in for filing and storage to the person who issued it.
    Do reference the location where the book is being stored to assure ready retrieval.
    Don't keep a closed out and completed record book in the possession of the author.
    Don't file or store a book without referencing its location.

15. **Do** remember the record book is a legal document and should b3e treated as such and made available to your legal and patent counsel if needed.
    Don't keep a record book beyond the company's or institution's established record retention policy for such a record.

Darby & Darby

Proper Maintenance of a Laboratory Notebook

The United States laws implementing the general agreement on tariffs and trade (GATT) came into force on June 8, 1995. As a result, as of January 1, 1996, it has been possible for foreign inventors to establish a date of invention in a U.S. patent application by reference to knowledge or use of the invention in a foreign country which is a member of the World Trade Organization (WTO), or activity with respect to it in a foreign country which is a member of the WTO. Since United States patents are awarded to the first person to invent, not the first applicant, an applicant's ability to obtain a patent for his invention may often depend upon how well he documents inventive foreign activity with respect to his invention. This applies, not only to the situation in which an inventor becomes involved in an interference, but also when he wishes to avoid or "swear behind" a reference applied against an application by proving a prior date of invention.

Under the new law, it therefore becomes essential for foreign inventors to maintain an accurate and well-documented laboratory notebook.

The following guidelines should be followed with respect to all laboratory notebooks.

1. The notebook should have permanently bound pages which are consecutively numbered and should be used by a single engineer or scientist.
2. Ideas, calculations and experimental results should be entered into the notebook as soon as possible, preferably the same date they occur, so that the laboratory notebook becomes a daily record of the inventor's activities.
3. All entries should be made in the notebook in permanent black ink and should be as legible and complete as possible. Do not use abbreviations, code names or product codes without defining them clearly.
4. Draw a line through all errors. *Do not erase!*
5. Entries should always be made in the notebook without skipping pages or leaving empty spaces at the bottom of a page. If you wish to start an entry on a new page, draw a line through any unused portion of the previous page.
6. Never tear out or remove a page from the notebook.
7. Each page should be signed with the inventor's full name and dated. No entry should be changed or added to after signature. If the inventor has any additional information or corrections, a new entry should be made.
8. Each page of the notebook should be witnessed, signed and dated by a colleague who understands the inventor's work. This should preferably occur daily and certainly no less frequently than weekly. The witness should not be a direct contributor to the work being reported.
9. If an additional entry is made between the initial and final pages recording an experiment, the entry should identify the page on which the previous entry for that experiment occurs.

10. When the laboratory notebook is completely filled and is no longer required for reference, it should be indexed and stored in a safe location and, thereafter, handled in accordance with the company's established record retention and destruction policy for such documents.

Some factors which reduce the value or credibility of your laboratory notebook:

- Illegible entries are totally worthless;
- Unsigned or undated pages are almost totally worthless;
- Notebook pages which have not been witnessed are almost as bad as unsigned and undated pages;
- A long delay between the signing of the page by the inventor and the witness raises question;
- Consecutive note book pages which are not dated in chronological order raise questions;
- Missing notebook pages raise questions;
- Erasures and deletions raise questions – instead, any later discovered mistakes should be corrected and explained on the next available blank page, referencing the page with the mistake.

In modern laboratories it is often the habit of engineers to maintain records of their work in computer files. We don not believe that computer files can provide sufficient evidence of invention. The reason for having invention records is to be able to prove the earliest date of invention. Since computer records can be updated and changed at will, and their dates are subject to tampering, they cannot serve as evidence that their content was created at a particular time. With a bound notebook, it is clear that the work occurred in a particular sequence and was witnessed by others. Also, scientific experiments can be conducted on the ink and paper in a notebook to prove their age.

Laboratory Notebook Rubric

	Beginning (0)	Developing (2.6)	Adequate (3)	Accomplished (3.4)	Exemplary (4)
Organization	No organization at all, random incomplete entries unidentifiable with specific experiments. Poor handwriting so that what is written is difficult to read.	Some organization. Entries appear broken into individual experiments. No clear organization of data within experiments. Difficult to asses completeness of record.	Entries clearly broken into individual experiments. Data complete and grouped together, but randomly arranged on the page. Entries are often messy or too tightly spaced to read easily.	Clear Organization. Data complete and grouped together. Good space between lines, however handwriting occasionally difficult to read.	Clear organization. Entries are easy to read with good space between lines. Entries clear and concise with good handwriting. Clear indication of where experiment starts and stops.
Heading	Heading non existent. Simple non-descriptive title - exp. 51. No date/chemical equation/purpose/procedure.	Heading missing one or more of the crucial elements of date/title/chemical equation/purpose/procedure. Title/purpose/procedure ambiguous or inaccurate or insufficient.	Heading complete with date/title/chemical equation/purpose/procedure. Only one of the title/purpose/procedure ambiguous or inaccurate or insufficient.	Heading complete with date/title/chemical equation/purpose/procedure. Title/purpose/procedure may be too brief or too lengthy.	Heading complete with date/title/chemical equation/purpose/procedure. Title/purpose/procedure clear concise and accurate.
Data	Values listed haphazardly. Little if any description of what the value is. Values frequently recorded without units. Values frequently overwritten in attempt to correct error making data unreadable. Data incomplete and/or inaccurate	Writing sloppy or tightly crammed together making data hard to read. Some values recorded without units. Some values or symbols ill-formed or illegible. Data complete but with some inaccuracies.	Writing clear and easy to read. All values recorded with proper units. Data preceded by somewhat ambiguous or lengthy descriptors. Few, if any, ill-formed or illegible symbols. Data complete and accurate.	Writing clear with appropriate space between data. All values recorded with proper units. Data preceded by clear descriptors. Data complete and accurate. No ill-formed or illegible symbols.	Data organized into clear data table format. Writing clear easy to read. Data descriptors clear and concise. All data complete and accurate with no ill-formed or illegible symbols.
Legal	Pages not numbered. Entries not dated. Entries in colored ink or pencil. Abbreviations used but not defined. Blank pages between entries. Frequent obliterations of data. Completed pages not signed or witnessed.	Only pages containing entries numbered. Many pages not dated. Colored ink or pencil frequently used. Abbreviations used but often not defined. Portions of pages left blank but not struck. Occasional obliterations of data. Completed pages signed but not witnessed.	All pages numbered consecutively. Most entries dated. Colored ink or pencil occasionally used. Abbreviations clearly defined. Portions of pages left blank usually, but not always, struck. Few obliterations of data. Completed pages signed but not timely witnessed.	All pages numbered consecutively. All entries dated. Colored ink occasionally used (no pencil). Abbreviations clearly defined. Portions of pages left blank intentionally struck. Zero obliterations of data. Completed pages signed but not timely witnessed.	All pages consecutively numbered and entries dated. Black ink used exclusively. Abbreviations clearly defined. No blank pages between entries. Portions of pages left blank intentionally struck. Zero obliterations of data. Completed pages signed and timely witnessed.

Revised - 2/13/12

Total points = 16

TITLE Title

Project No. _____

Book No. _____

Confidential

From Page No. ___

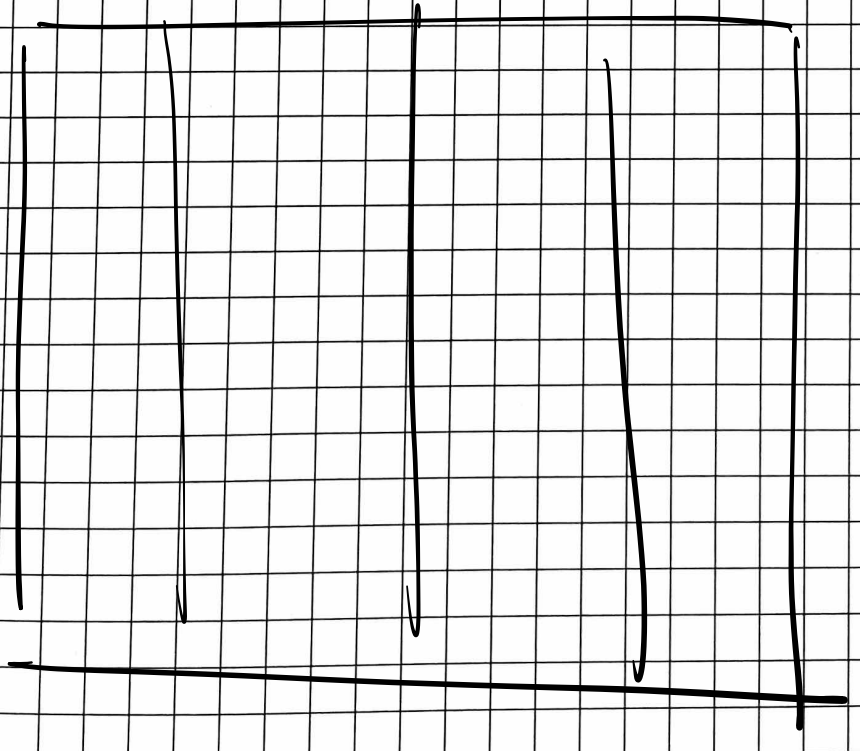
Date 1/26/22

Title

Purpose:

Procedure:

Data:



To Page No. ___

Witnessed & Understood by me,	Date	Invented by:	Date
	1/26/22	Recorded by:	1/26/22

TITLE Grignard Reaction

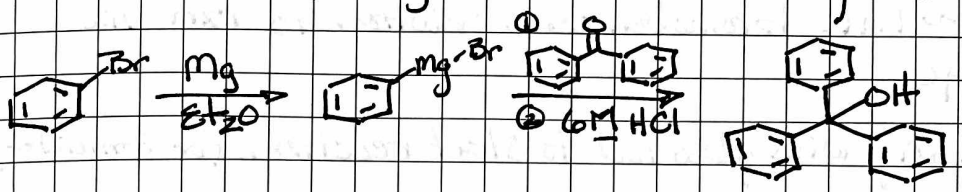
Project No. _____

Book No. _____

Confidential

From Page No. — ← Start of experiment

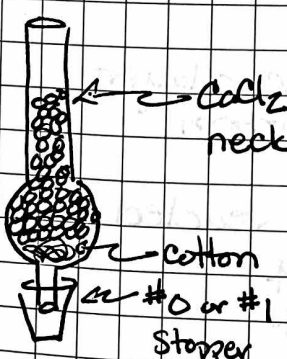
Formation of Triphenylmethanol via Grignard Reaction

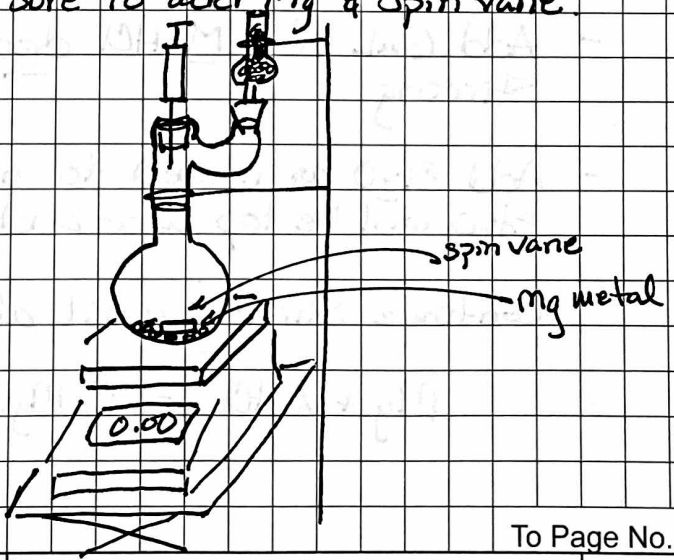


Purpose: Introduction to organometallic reactions and more sensitive organic laboratory techniques.

Procedure:

- Dry glassware in oven at 110°-115° for 24 hours, or flame dry glassware with bunsen burner. (25-mL Roundbottom flask, Claisen, drying tube, 5-mL Conical vial, 25-mL erlenmeyer flask)
- Add 0.70 mL bromobenzene (1.5g/mL, 157.0 g/mol, ~1.05g, 6.7mmol) to 4mL Conical vial with 4.0 mL Et_2O.
- Obtain 0.15g mg (6.2mmol)
- Assymbol aparatus making sure to add Mg & Spin vane. Start w/ drying tube





To Page No. 16

Witnessed & Understood by me, | Date | Invented by: | Date 2/1/21

Recorded by: J Camara

Project No. _____

Confidential Book No. _____ TITLE Grignard Rxn

From Page No. 15

Procedure Cont.

- Add ~1mL bromobenzene solution to rxn via syringe
- Crush Mg with glass rod to start reaction. (or sonicator)
- Add remaining 3 mL bromobenzene solution over 15 min at rate below boiling.
- Rinse conical vial with 2.0 mL Et_2O and add to rxn via syringe
- In same conical vial make 1.09 g benzophenone (6.0 mmol) solution with 2.0 mL Et_2O.
- After 30 min from start of Rxn, add benzophenone rapidly, but at rate below boiling
- When rxn solidifies & stir bar fails, open and stir w/ glass rod until homogeneous grey color.

Work-Up

- Add 6mL of 6 M HCl dropwise to round bottom with stirring
- Add Et_2O as needed to make to clear layers. Et_2O will be top layer and aqueous bottom.
- Continue stirring until all Mg has reacted

$$Mg + 2\,HCl \longrightarrow MgCl_2 + H_{2(g)}\uparrow$$

To Page No. 17

Witnessed & Understood by me, | Date | Invented by: | Date 2/1/21

Recorded by: [signature]

Workup Continued

- Move into seperatory funnel
- Extract organic layer
- Re-extract aqueous layer with 5mL Et_2O
- Combine organic layers, discard aqueous
- Wash organic layer with 5mL brine (sat. aq. NaCl)
- Dry organic layer w/ $MgSO_4$
- Rotovap
- Weigh product
- Triturate w/ 3mL petroleum ether
- ~~Vacuum~~ Vacuum filter on Hirsch filter
- Weigh solid
- Recrystallize from iPrOH
- Mass, Mp, % Yield, FTIR (Lit 162°C)

Witnessed & Understood by me, | Date | Invented by: | Date

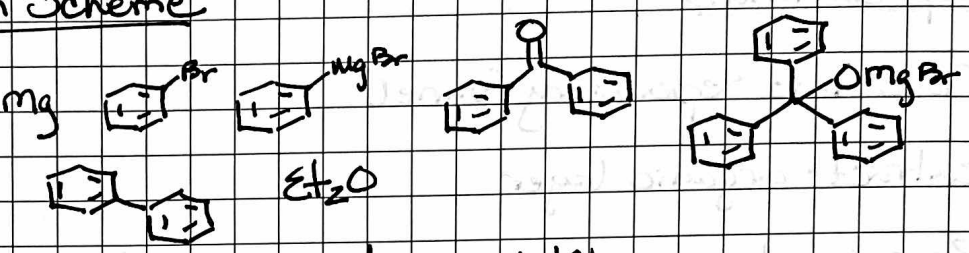
Recorded by: Tamara | 2/1/21

Project No. _____

Confidential Book No. _____ TITLE Grignard Rxn

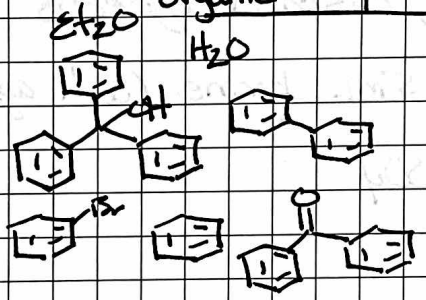
From Page No. 17

Seperation Scheme



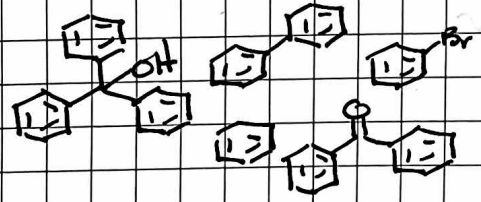
6M HCl

organic	aqueous	gas
Et_2O	H_2O	H_2
H_2O	HCl	
	$Mg^{2+}X_2$	



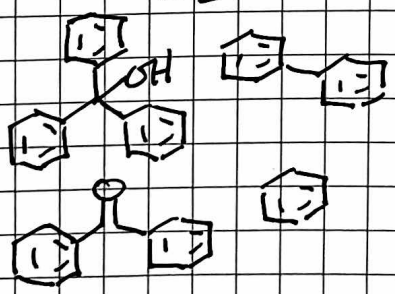
Sat NaCl aq

organic	aqueous
Et_2O	NaCl
Small H_2O	H_2O



$MgSO_4$

liquid	solid
Et_2O	$MgSO_4 \cdot 7H_2O$



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Witnessed & Understood by me,	Date	Invented by:	Date 2/1/21
		Recorded by: J Camara	

TITLE Grignard Rxn

Project No. _____

Book No. _____

Confidential

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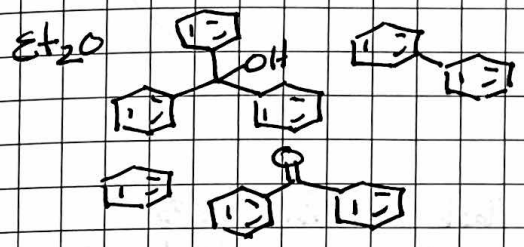
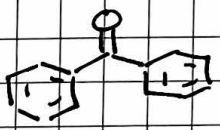
Seperation Scheme Cont.



Rotovap

solid — gas

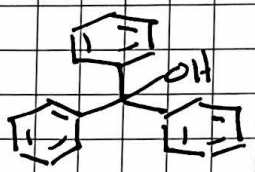
Et2O



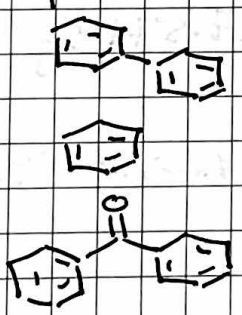
petroleum ether

solid — liquid

petroleum ether



impurities

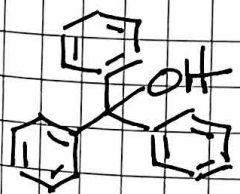


iPrOH

solid — liquid

iPrOH

Impurities



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Witnessed & Understood by me,	Date	Invented by:	Date
		Recorded by: Tamara	2/1/21

Project No. _____

Confidential Book No. _____ TITLE Grignard Rxn

From Page No. 19

Data

- Mass Mg metal 0.1565 g
- Mass Bromobenzene
  - Tare RB flask 26.7523
  - Mass Bromo Benzene & flask 27.6870
  - Mass Bromo Benzene 0.9347 g
- Volume Diethylether
- Mass Benzophenone
- Volume Diethylether
- Tare RB flask 26.3092 g
- RB w/ Crude product 27.5714 g
- Tare petri dish ~~89.89~~ 89.8922 g 88.8917 g
- Petri dish & Recrystallized product 89.7420 g

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Witnessed & Understood by me,	Date	Invented by:	Date 2/3/21
		Recorded by: Camara	

TITLE Grignard Rxn

Project No. _____

Book No. _____

Confidential

From Page No. 20

Data

Mass Mg metal 0.15164g

Mass Conical Vial (Tare) 28.39845g

Mass Vial & Bromobenzene 29.57512g

Mass Bromobenzene 1.10953g

Volume diethylether _____

Mass Benzophenone 1.10953g

Volume diethylether _____

Tare RB flask for Rotovap 18.02218g

Mass flask & Crude product 19.54g

Tare petri dish ~~80.81768g~~ 80.81753g

Mass petri dish & triturated triphenylmethanol 81.88003g

2nd weighing 81.87610g

Mass ~~triphenphy~~ triphenylmethanol for Recryst 0.52062g

Mass triphenylmethanol after Recrystallization tare 88.3514g 3692g

Final 88.7207g

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Witnessed & Understood by me,	Date	Invented by:	Date
		Recorded by: Kamara	2/3/21

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Confidential Book No. _____ TITLE Grignard Rxn

From Page No. 21

Magnesium Metal

$0.15764\,g \times \frac{1\,mole}{24.305\,g} \times \frac{1000\,mmol}{1\,mol} = 6.2390\,mmol\ Mg$

Bromobenzene

$1.10953\,g \times \frac{1\,mol}{157.01\,g} \times \frac{1000\,mmol}{1\,mol} = 7.0666\,mmol\ bromobenzene$

Benzophenone

$1.10953\,g \times \frac{1\,mole}{182.22\,g} \times \frac{1000\,mmol}{1\,mol} = 6.0890\,mmol\ Benzophenone$ ~~Bromobenzene~~

Limiting Reagent ⇒ Benzophenone

Theoretical Yield

$6.0890\,mmol\ Benzophenone \times \frac{1\,mol\ triphenyl}{1\,mol\ Benzo} \times \frac{1\,mol}{1000\,mmol} \times \frac{260.34\,g}{1\,mol\ triphenyl}$

$= 1.5852\,g$ triphenylmethanol

Mass triphenylmethanol Isolated 1.05857 g

$\%\ yield = \frac{1.05857\,g}{1.5852\,g} \times 100 = \boxed{66.778\,\%}$

Recovery on recrystallization

$\frac{0.4153\,g}{0.520628\,g} \times 100 = 79.77\,\%$

Overall Isolated yield after Recrystallization $= 0.66778 \times 0.7977 \times 100 = \boxed{53.269\,\%}$

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Witnessed & Understood by me, | Date | Invented by: | Date 2/8/21

Recorded by: Kamara

TITLE Grignard Rxn

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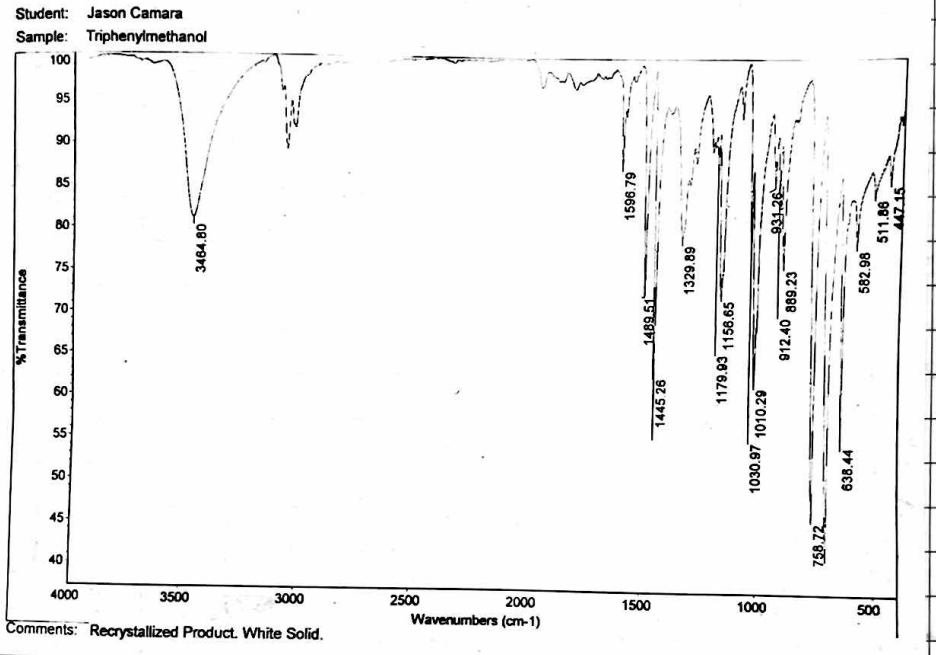
From Page No. 22

FTIR - KBr pellet



Melting points

Trial 1 155.4 - 157.2 °C

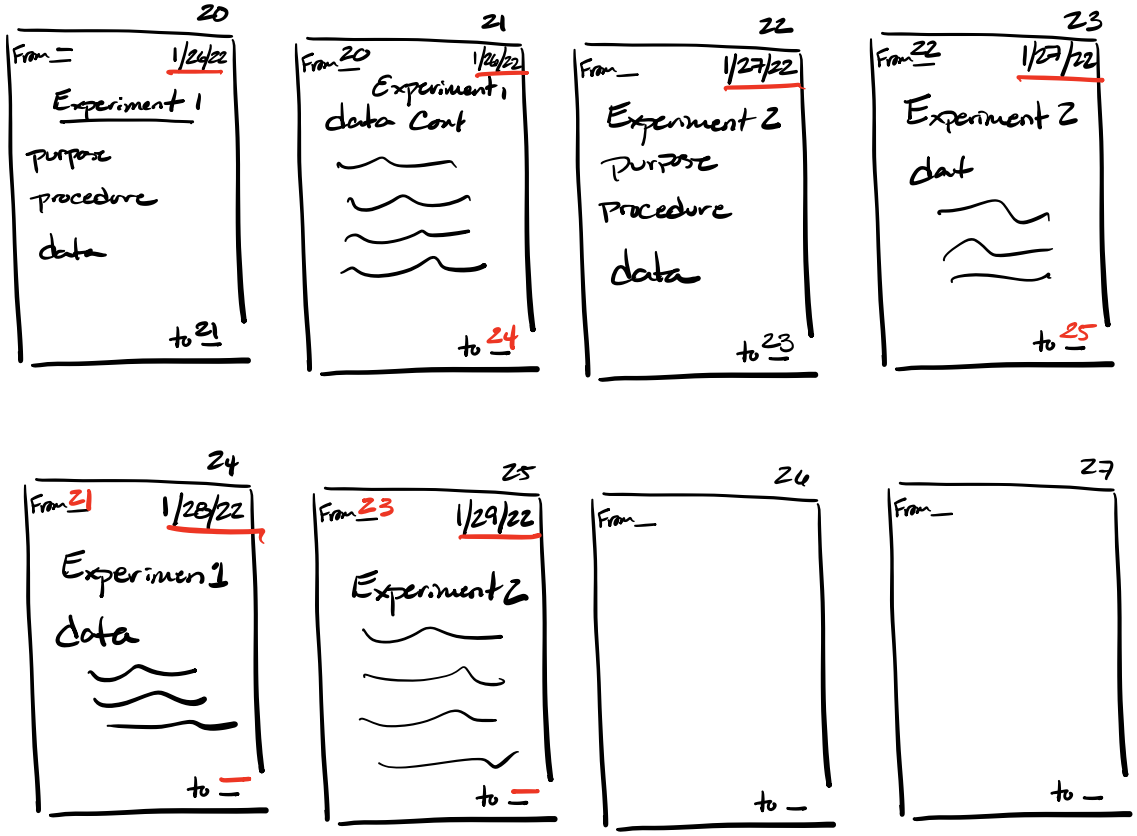
Trial 2 155.4 - 157.4 °C

likely still wet with 2-propanol

Reaction yield not bad for Grignard after storm storm. Hard to move fast enough while filtering. Percent recovery after recryst. likely high. Melting point depressed & broad likely wet with 2-Propanol.

To Page No. ____

Witnessed & Understood by me,	Date	Invented by:	Date
		Recorded by: J Camara	2/8/21



Laboratory Notebook

Soft Cover

Black

Scientific Notebook Company

www.SNCO.com

Organic Chemistry Formal Written Laboratory Reports

Cabrillo College Chemistry Department

Document Formatting

Document should be standard 8.5" x 11" with margins of 1", 1", 0.5", 1" (left, right, top, bottom) and 0.5" header and 0.6" footer. Type face should be an easily readable font such as 12 pt Helvetica, Times, Times New Roman, or Palatino. Double space everything to allow for comments.

Title

It is recommended that the title be written after the experiment. It should be brief and grammatically correct but accurate and complete enough to stand alone. The title should include keywords that might engage the reader. Avoid phrases such as "on the", "a study of", "report on" and "use of." Don't try to be tricky or fancy, just keep it simple.

Abstract

This section is a complete summary of what was done and what was found. It includes an overview of the general methods and results. It does not include experimental details (e.g., "1 M $NaOH_{(aq)}$ was used"). It is written in the past tense and is a "stand alone" description of your work.

Introduction

The purpose of this section is to stimulate interest and prepare the reader. It should describe the motivation and focus of experiment, why it is significant. It may contain theoretical background, chemical names, formulas, equations or structures. All information in this section should include references to the literature where the material was found. Wikipedia is not the best source of information, and should not be used as a primary source. This section contains a minimum of two paragraphs. The last paragraph is always a non-technical overview of the experiment.

The non-technical overview is an overview of what was done, in more detail than the abstract, but excluding things like temperatures, solvents, reaction times and the like. The non-technical overview does not include results.

Methods and Materials

All reagents used should be listed and sources cited (Chemical 1, Chemical 2, Chemical 3 were obtained from the stockroom and used without modification). The make and model of instrumentation used for characterization should be reported here, including software for analysis. The procedure for the experiment is then given in condensed format. If the procedure was followed unmodified you may simply cite your lab manual, specifying sections that were performed (The

procedure in Pavia et. al.[ref #] was followed without modification). Any deviations, additions or omissions to the reference procedure must be clearly stated here. The experiments designed by individual students must be described in a separate paragraph.

Your Mel-Temps are Mel-Temp II by Barnstead/Thermolyne model 1001 with a Fluke 51 K/J digital thermometer. The IR instrument is a Nicolet Avatar 360 FTIR ESP with Omnic 8 software by Thermo Fisher Scientific.

An example of what this section should look like is given below. We do not have all of this instrumentation, this is only for example.

Bromobenzene, magnesium turnings, anhydrous diethyl ether, 6 M $HCl_{(aq)}$, and petroleum ether were obtained from the chemistry stockroom and used without modification. Melting points were determined using a Barnstead/Thermolyne Mel-Temp II model 1001 equipped with a Fluke 51 K/J digital thermometer. Infrared spectra were obtained on a Perkin-Elmer 1600 Series FTIR. ^{1}H-NMR and ^{13}C-NMR were obtained on a Bruker AC250 250 MHz NMR equipped with a quad nucleus probe, and in some cases on a Varian Unity500+ 500 MHz NMR. Chemical shifts are reported relative to tetramethylsilane in δ ppm. ^{11}B-NMR spectra were obtained on a Bruker AC250 250 MHz NMR equipped with a quad nucleus probe. ^{11}B-NMR chemical shifts are reported relative to BF_3-OEt_2 in δ ppm. Purity of the materials synthesized, unless noted otherwise, was assessed solely through ^{1}H-NMR.

Fifteen milligrams of magnesium turnings (6.43 mmols) were placed into a 20-mL round bottom flask. The flask was fitted with a magnetic stir bar, a Claisen head with rubber septa, and drying tube. A solution of Bromobenzene (1.01 g, 6.43 mmols) in anhydrous diethyl ether (4.0 mL) was added to the stirred reaction flask via syringe dropwise. Addition of bromobenzene/diethyl ether solution was maintained at a rate to produce a steady reflux of the reaction mixture. After addition of bromobenzene/diethyl ether solution, the reaction was allowed to cool to room temp. A solution of benzophenone (1.09 g, 5.98 mmols) in anhydrous diethyl ether (2 mL) was added rapidly via syringe. The reaction was allowed to stir for 20 min. The reaction mixture was quenched with $HCl_{(aq)}$ (6.0 mL). The resulting biphasic system was separated using a separatory funnel, and the aqueous phase extracted with 10 ml diethyl ether. The ether layers were combined and evaporated to yield a yellow solid/oil mix. The solid was triturated with petroleum ether and filtered to yield the crude triphenylmethanol (1.25 g, 4.80 mmols) as a white powder. The crude material was recrystalized from isopropanol to afford the pure triphenyl-

methanol. Yield: 1.04 g, 4.00 mmols (67%). Mp. 160.5 – 161.0 ^{o}C. FT-IR (Solid, KBr pellet, cm^{-1}): xxxxx, xxxxx, xxxxx, xxxxx (where xxxxx are the important wavelengths for characterization).

Results

This section includes data tables, graphs and sample calculations. All tables and graphs will have appropriate titles and be a half page in size. The axes of the graphs will be properly labeled including units. Results should be summarized in text as well as tables. I know it's redundant, but that's only because our data sets are rather small.

Discussion/Conclusion - These may be treated as one or two separate sections

For organic papers, the first part of the discussion should be about the reaction mechanism. This is not a hard rule. If the mechanism is very small it can be placed in the introduction section. Likewise if there are topics to discuss that could come before the mechanism it is fine to do so.

The mechanism should be broken down into individual reaction steps. Each step should be proceeded by a figure and caption illustrating the step. The text should then explain what is taking place. The figures can be hand drawn, as can the caption headings. Computer drawn images are really nice but take a long time to master. There are a number of free applications for Macs and PC's that will allow you to draw molecules, however I would rather have you focus on other areas of the report and simply draw the reaction diagrams by hand. Just leave space for the figures in the text and add them afterwards.

In addition to the mechanism the discussion section is generally where the results section is thoroughly integrated to produce sound conclusions. Critical thinking is employed to analyze the results and deduce valid conclusions. In organic chemistry this section should include a discussion of any experimental difficulties, errors, or questions. It may also include answers to lab manual questions. In fact I would recommend looking at the lab manual questions and using them as an outline with which to construct this part of the discussion.

The Conclusion section is very brief, usually a single paragraph. Most often I think of this as a restatement of the abstract. Don't just copy the abstract however. The conclusion should reaffirm what was done and what was found. Sometimes, comments regarding future experiments may be appropriate.

Language and Format

In general, the report is written in the third person, impersonal observer voice. For example, "Ten grams of NaOH was weighed", **not** "I weighed 10 g of NaOH."

Using “we” or “I” in a lab report is very rare, it only pertains to comparison with others’ results.

Reports should be typed. Equations, calculations and structures can be written by hand even in a type written report. If chemical formulas and equations are not handwritten they must be formatted correctly using the appropriate sub- and superscripts.

Figures, Charts, Schemes and Tables

Graphical images fall into several types: figures, charts, schemes, and tables. Each graphical element should be referred to properly and most often addressed with a caption.

Captions are titled as “Figure 1.”, “Chart 5.”, “Scheme 7.”, or “Table 2.” followed by a period and then a description of the item. The caption is generally 2 pt smaller than the body text and indented both left and right of the body paragraph. Each caption is numbered sequentially within that graphical image type. For instance, you may have figures 1 through 8 and then wish to place two tables, which would be table 1 and table 2. The next figure would be figure 9.

A single structure or formula does not need a caption. This is often used when a single molecule is desired to be shown.

Figures are single structures, apparatus illustrations or graphs of reaction data for which the caption is placed below. Single mechanistic steps can be either figures or schemes, however most journals generally refer to them as figures.

Charts are collections of structures for which the caption is placed below.

Schemes show action such as full reaction mechanism or flow chart for which the caption is placed below.

Tables are collections of data or results for which the caption is placed at the top of the table.

References

References can be done either as footnotes or endnotes. References are cited within the text differently depending on the specific Journal. We will use a superscripted number directly following the information cited. This can be mid-sentence[1] or at the end of the sentence.[2] The references should be sequential in order of use, however a reference can be used more than once. For instance, after using a reference in the introduction as reference 3, it is okay to invoke reference 3 again in the discussion even though the next unique reference may be 9. Reference formats depend on the type of information referenced as illustrated below.

Books[1] - Author Last Name, Middle Initial. First Initial.; Second Author Last Name, Middle Initial. First Initial. Chapter Title. *Book Title;* Publisher: Publisher location City, Country, **Year**; pages.

Journals[2a-c] - Author Last Name, Middle Initial. First Initial.; Second Author Last Name, Middle Initial. First Initial. Article Title. *Journal Title*. **Year**, *Volume*, Pages.

Patents[3] - Author Last Name, Middle Initial. First Initial.; Second Author Last Name, Middle Initial. First Initial. Patent Title. Country and Patent Number, **Year**.

Web Pages[4] - Title of Web Page. http://address (date accessed - Month, **Year**), Navigational Submenus utilized.

Additional Information

Additional information on general formatting, references, correct usage of chemical symbols, contents of scientific papers, scientific writing tips and more can be found in the ACS Style Guide, Second Edition[5], and in A Short Guide to Writing About Chemistry by Davis, Tyson, and Pechenik.[6]

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1. Collins, P.; Ferrier, R. Preliminary Matters – Structures, Shapes and Sources. *Monosaccharides: Their Chemistry and Their Roles in Natural Products*; John Wiley & Sons: Chichester, U.K., **1995**; pp. 40-44.

2. a) James, T. D.; Sandanayake, S.; Shinkai, S. Saccharide Sensing with molecular receptors based on boronic acid. *Angew. Chem. Int. Ed. Engl.* **1996**, *35*, 1911-1922. b) James, T. D.; Linnane, P.; Shinkai, S. Fluorescent saccharide receptors: a sweet solution to the design, assembly and evaluation of boronic acid derived PET sensors. *Chem. Commun.* **1996**, 281-288. c) James, T. D.; Shinkai, S. Artificial receptors as chemosensors for carbohydrates. *Top. Curr. Chem.* **2002**, *218*, 159-200. d) Hartley, J. H.; James, T. D.; Ward, C. J. Synthetic receptors. *J. Chem. Soc., Perkin Trans. I* **2000**, 3155-3184.

3. Sundrehagen, E. (Axis Research AS, Oslo, Norway) Glycosylated haemoglobin assay. U.S. Patent 5,242,842, **1993**.

4. American Diabetes Association Home Page. http://www.diabetes.org (Aug **2002**), Basic Diabetes Information, Facts & Figures, Impact of Diabetes.

5. Dodd, S. J.- editor. *The ACS Style Guide: A Manual For Authors and Editors, Second Edition*; American Chemical Society: U.S., **1997**.

6. Davis, H. B.; Tyson, J. F.; Pechenik, J. A. *A Short Guide To Writing About Chemistry;* Pearson: New York, U.S., **2010**.

Formal Written Laboratory Report Rubric

	Beginning (0)	Developing (2.6)	Adequate (3)	Accomplished (3.4)	Exemplary (4)
Abstract	Scope of work not sufficiently described or too lengthy. Experimental details included. Results not stated. Written in wrong tense. Many unneeded sentences.	Scope of work not sufficiently described or too lengthy. Experimental details included. Some critical results missing. Written in wrong tense. Few unneeded sentences.	Scope of work not sufficiently described or too lengthy. Not completely in past tense. Some critical results missing.	Between 80 - 200 words. Scope of work incomplete or too detailed. Written in past tense. Describes the work that was done and results found without using experimental details.	Between 80 - 200 words. Written in past tense. Describes the work that was done and results found without using experimental details.
Introduction	Little or no motivation or theoretical background given. Non-technical overview missing in last paragraph.	Motivation/focus miss directed. Theoretical background missing or riddled with errors. Non-technical overview incomplete or too technical.	Describes the motivation and focus of the experiment. Theoretical background incomplete or containing errors. Non-technical overview incomplete or too technical.	Describes the motivation and focus of the experiment. Contains appropriate theoretical background with minor errors. Non-technical overview too technical.	Describes the motivation and focus of the experiment. Contains appropriate theoretical background without errors. Last paragraph is non-technical overview of the experiment.
Methods/ Materials	No citations given. Deviations/ additions/omissions not discussed.	Some materials cited. Citations incorrect or incorrectly formatted. Deviations/additions/ omissions not discussed.	Materials cited. Some citations incorrect or incorrectly formatted. Deviations/additions/ omissions expressed but sometimes vague or unclear.	Lab manual and other materials properly cited. Deviations/ additions/omissions are expressed in paragraph format, but too brief or too lengthy.	Lab manual and other materials properly cited. Deviations/ additions/omissions are clearly expressed in paragraph format.
Results	Result data table not present, but discussed in paragraph format, or the reverse. Critical results missing or incorrect.	Result data presented in table format and discussed in paragraph format. Critical results missing or incorrect. Tables/ graphs incorrectly formatted. Captions missing.	Result data presented in table format, some data missing or incorrect. Data incompletely discussed in paragraph. Tables/graphs incorrectly formatted. Captions could be improved.	Result data presented in table format and discussed in paragraph format. Minor disagreements found between table and text. All data tables, graphs half page with correct captions.	Result data presented in table format and discussed in paragraph format. All data tables, graphs half page with correct captions.
Discussion / Conclusion	Results not analyzed. Experimental difficulties/errors/ questions not discussed. Conclusion not present.	Results analyzed producing some incorrect conclusions. Experimental difficulties/errors discussed incompletely, some questions answered incorrectly. Conclusion not well developed, too lengthy or short and missing the bottom line.	Results analyzed. Experimental difficulties, errors, questions discussed, some answered incorrectly. Conclusion too small or lengthy and missing the bottom line.	Results analyzed to produce sound conclusions. All experimental difficulties/errors/ questions discussed, with some minor error. Last paragraph is conclusion, expressing briefly the bottom line of the experiment.	Results analyzed to produce sound conclusions. All experimental difficulties, errors, questions discussed correctly. Last paragraph is conclusion, expressing briefly the bottom line of the experiment.
Language/ Grammar/ Formatting	First person used throughout. Incomplete sentences. Many grammatical errors. Complete lack of formatting.	Occasional lapses into first person. Sentence structure weak, many grammatical errors. Inconsistent formatting.	Third person used throughout. Sentence structure weak, many grammatical errors. Inconsistent formatting.	Third person used throughout. Well formed sentence structure, few grammatical errors. Few formatting errors.	Third person used throughout. Well formed sentence structure, grammatically correct. Excellent and consistent formatting.

Revised - 2/13/12

Total points = 24