The Laboratory Notebook

Your notebook will serve as a permanent record of your experimental work. It will contain the information you need to complete your work efficiently and safely, and you will use the information contained in your notebook to write laboratory reports explaining your results. For these reasons, it is important that your notebook be complete and accurate. As a general rule, a good notebook is one from which someone else can repeat your experimental work in the same way that you have done it.

I. General Guidelines:

1. Your notebook must be bound, the pages numbered, and have a carbon copy.
2. Write your name, the course name, and section # on the cover or front page.
3. Always use permanent ink, not pencil.
4. Write it down NOW. Your notebook is a log of what you do as you do it.
5. Use complete sentences.
6. Write everything in your notebook. Weights, temperatures, everything! When recording experimental data, always include units.
7. Do not erase! If you make an error, draw a single line through it, and continue. The original statement should still be legible.
8. Never remove original pages from your notebook. You may remove carbon copies.
9. Date every page as you use it.
10. Write legibly! If your notebook is illegible it will not be graded.

II. The Notebook:

Each experiment recorded in your notebook should contain the sections outlined below. A carbon copy of your notebook pages will be collected at the end of each laboratory period and will graded as a part of your lab report. Late notebook pages will not be accepted.

Sections A - E must be completed before you begin the experiment. This is the prelab. Your TA will verify that this section is complete. You will not be allowed to proceed with the experiment if you have not completed the prelab.

Section F, the Experimental, is recorded as you proceed each day.

→ Prelab: Completed before you arrive.

A. Title:

Give the experiment an accurate, descriptive title.

B. Purpose:

Discuss the general purpose of the experiment in two or three sentences. If the experiment is a synthesis (as opposed to a technique), write the chemical equation, including reagents and expected product(s). For multistep syntheses, write one equation for each transformation, including the preparation of reagents.
C. References:
Cite the reference upon which your experimental procedure is based. In most cases this will be your laboratory manual and/or a supplemental handout. Also cite the source(s) of the information found in the Chemical Properties & Safety table (part D).

D. Chemical Properties & Safety:
Make a table that lists the chemical properties of all reactants, reagents, and solvents that you will be using in the experiment as well as for the products you will make. This table should include the name of the compound, MW, density, mp, bp, etc. For each compound, also list the toxicity (if known), and any other important safety information (flammable, corrosive, irritant, etc.). Some useful references are provided at the end of this handout. A sample table is shown below:

E. Research Plan:
This section will include specific instructions on how to perform the lab. It must be complete before you arrive. In combination with the Experimental (Section F; completed during the experiment), any reader should be able to repeat the experiment as you did it based on what you have written here. To prepare this section:

- Split the notebook page in half vertically (this has been done for you in the notebook listed for this course).
- Briefly outline the procedure you will follow on the left hand side of the page. Leave the right hand side blank. You will use it later to record procedural modifications, data, and observations when you actually perform the experiment (section F).
- You do not need to use complete sentences when preparing the research plan, but your outline should provide enough detail that you can work directly from your notebook, using your lab manual only as a reference for clarification. Include the amounts of reagents you expect to use. As appropriate also record reagent purity and/or concentration.
- Incorporate any changes that were made in the lab lecture.
- Use your own words. Do not copy directly from the text or handout (this constitutes plagiarism!).
- If there are multiple parts to an experiment, you must provide an outline for each part.
- This is also the place to draw any specialized laboratory set-ups that you will use.

⇒ Experimental Section: Recorded as you proceed each day.

F. Experimental:
This section of your notebook is written during the course of a laboratory period, and should be recorded on the right hand side of the pages that contain the Research Plan (section E). An example follows. This portion of the notebook is a record of what you do as you do it. You do not need to rewrite the entire procedure, but you will need to note any deviations from the Research Plan. Record your data and observations completely and accurately. The information included here may help you understand later if your experiment was successful, or what went wrong. This section must be completed before you leave the lab for the day.

- Describe any changes to the procedure that you make during the course of the experiment.
- Record the actual amount of reactants, reagents and solvents that you use. Include units.
• Record your observations. Include any thoughts you have about what may be going on. Note any difficulties that you encounter.

• Make sure to record any melting points, boiling points, weights, etc. before you leave the lab whether you think you need them or not. Chances are that you will. Drawings of TLC plates should also be included here. Be sure your data is clearly labelled such that someone else would be able to figure out what it represents.

• Don’t forget to record the physical characteristics of any compounds you isolate (e.g. solid, liquid, shape of crystals, color, etc.). Has purification resulted in any physical change?

• Other things you might wish to record: the formation and identification of layers, the evolution of heat or gas, the formation and characteristics of a precipitate, reaction time, unknown number if applicable, or your partners name (if any) - for most experiments you will work independantly.

• At the end of each day initial and date what you have written.

• Submit a carbon copy of your notebook pages to your TA before you leave each day. These pages will be graded as part of your laboratory report (Appendix D). Late notebook pages will not be accepted.

Below is an example of the research plan, with experimental details, data, and observations filled in as they would be during the laboratory period.

### III. References:

The following references will be helpful as you complete your prelab. You will find all of these sources in the reference section (room 103) of the Science and Technology Library or on the web. Please familiarize yourself with them as you will use them frequently throughout the semester.

**General Chemical Properties & Safety:**

1. Aldrich Catalog of Fine Chemicals. TP 202.A43
2. CRC Handbook of Chemistry and Physics QD 65.H231
3. The Merck Index RS 356.M524
5. Lange's Handbook of Chemistry QD 65.L362
6. Hazardous Chemicals Desk Reference T55.3.H3 L49 2002
7. Sax's Dangerous Properties of Industrial Materials T55.3.H3 L494 2000

**Resources on the Web:**

1. SIRI MSDS Index * http://hazard.com/msds/index.php
2. Sigma-Aldrich Home Page http://www.sigmaaldrich.com
3. Reaxys www.reaxys.com (on campus only); cite primary lit.

* The Materials Safety Data Sheet (MSDS) is the best source for safety information. Many chemical properties can also be found here.
Synthesis of Isoborneol

**Purpose:** To synthesize isoborneol from camphor. To learn the technique of gas chromatography and use it to evaluate the ratio of reduction products.

\[
\text{CH}_3\text{OH} \quad \text{NaBH}_4 \quad \text{C} \quad \text{OH} \quad + \quad \text{H} \quad \text{OH}
\]

SIRI MSDS Index [link](http://hazard.com/msds/index.php)

**Properties & Safety:**

<table>
<thead>
<tr>
<th>Compound</th>
<th>MW (g/mol)</th>
<th>mp (°C)</th>
<th>bp (°C)</th>
<th>Density (g/mL)</th>
<th>Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>camphor</td>
<td>152.24</td>
<td>179-180</td>
<td>---</td>
<td>---</td>
<td>harmful if swallowed</td>
</tr>
<tr>
<td>NaBH₄</td>
<td>37.8</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>severe irritant, may cause burns, keep away from water</td>
</tr>
<tr>
<td>methanol</td>
<td>32</td>
<td>---</td>
<td>64</td>
<td>miscible</td>
<td>toxic</td>
</tr>
<tr>
<td>ethyl ether</td>
<td>74</td>
<td>---</td>
<td>35</td>
<td>0.71</td>
<td>flammable</td>
</tr>
<tr>
<td>isoborneol</td>
<td>154.25</td>
<td>212-214</td>
<td>---</td>
<td>---</td>
<td>flammable, irritant</td>
</tr>
</tbody>
</table>

**Research Plan**

1. Obtain about 0.1g of camphor
2. Combine with 0.5mL methanol in a small test tube
3. Add 0.060g sodium borohydride in portions
4. Warm to reflux in a sand bath; heat 2 min
5. Analyze reaction mixture by TLC. Develop plate in 25% ethyl acetate in hexanes; visualize with iodine.

**Experimental**

- camphor used: 0.106g (white solid)
- NaBH₄ used: 0.059g 0.064g
- used ethanol as solvent instead of methanol
- some gas evolution observed (bubbles)