The following is an example of how a section in your lab notebook might be formatted, and the information it should contain. Compare this with the example of a formal lab write-up.

**Note:** All of the following would go on the right-hand pages in your notebook. You can put notes and scratch work on the left-hand pages.

### Title Page

Kinetic & Static Friction  
Date  
Your name  
Your partner’s name

You should have a title page for each laboratory. Its page number should be referenced in the table of contents. No other information goes on the title page.

### Experiment page(s):

**Experiment 1: Kinetic Friction on a Sliding Wood Block**

**Objective:** Determine the kinetic friction force on a sliding wood block, and the coefficient of kinetic friction.

**Set up & Theory**

For each experiment in the laboratory:

- Title of experiment  
- Statement of objective(s)  
- Diagram of experiment set-up  

Label the diagram with the variables you will use.
Free body diagrams for $M_1$ and $M_2$:

- $T - f = M_1a$
- $W_2 - T = M_2a$
- $W_2 - f = (M_1 + M_2)a$
- $M_2g - f = (M_1 + M_2)a$

**Result:**

- $f = M_2g - (M_1 + M_2)a$
- If $a = 0$, then $f = M_2g$

- To find the coefficient of kinetic friction:

$$
\mu_k = \frac{\text{frictional force}}{\text{Normal force}} = \frac{M_2g}{M_1g} = \frac{M_2}{M_1}
$$

**Note:** You will likely make mistakes as you work through derivations or calculations. This is normal. Cross out what you want to discard, and begin again.

Your notebook records your work *in progress*. Your report will show your work in *final form*. 
Data & Calculations: Kinetic Friction

Mass of block: 253 grams
Weight of block: 2.48 N

<table>
<thead>
<tr>
<th>Trial</th>
<th>( M_1 )</th>
<th>( W_1 )</th>
<th>( M_2 )</th>
<th>( W_2 )</th>
<th>( \mu_k )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(grams)</td>
<td>(Newtons)</td>
<td>(grams)</td>
<td>(Newtons)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>253</td>
<td>2.48</td>
<td>66.0</td>
<td>.657</td>
<td>.261</td>
</tr>
<tr>
<td>2</td>
<td>303</td>
<td>2.97</td>
<td>82.0</td>
<td>.808</td>
<td>.271</td>
</tr>
<tr>
<td>3</td>
<td>353</td>
<td>3.46</td>
<td>96.0</td>
<td>.941</td>
<td>.272</td>
</tr>
<tr>
<td>4</td>
<td>403</td>
<td>3.95</td>
<td>103</td>
<td>1.01</td>
<td>.256</td>
</tr>
<tr>
<td>5</td>
<td>453</td>
<td>4.44</td>
<td>125</td>
<td>1.23</td>
<td>.277</td>
</tr>
</tbody>
</table>

Average coefficient: .267

Graphs and other analysis

Tape graphs into your notebook after the relevant data. Graphs should be ½ page in size and should be annotated with:

- a title
- labeled axes
- units of measurement

Do not leave graphs loose-leaf in the notebook, and cut graphs to fit on the notebook pages.

Note:

- Data are the measurements you made in-lab.
- Calculations are part of your analysis of that data to determine your results.
Conclusions: The friction force is always about \( \frac{1}{4} \) the weight of the load on the block. It appears to increase in proportion to the increasing weight on the block. The coefficient is roughly the same for all loads.

Summarize what you found in your calculations, graphs, and analysis in a brief concluding statement.

Experiment 2: The Effect of Surface Area

Objective: How much does the friction force change if we change the area of contact?

Set up & Theory

We use the same set-up as in experiment 1, but we set the block on its narrow face. We expect the friction force to be less in this case.

Data & Calculations:

<table>
<thead>
<tr>
<th>Trial</th>
<th>( M_1 ) (grams)</th>
<th>( W_1 ) (Newtons)</th>
<th>( M_2 ) (grams)</th>
<th>( W_2 ) (Newtons)</th>
<th>( \mu_k )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>253</td>
<td>2.48</td>
<td>65.0</td>
<td>.637</td>
<td>.257</td>
</tr>
<tr>
<td>2</td>
<td>303</td>
<td>2.97</td>
<td>78.0</td>
<td>.764</td>
<td>.257</td>
</tr>
<tr>
<td>3</td>
<td>353</td>
<td>3.46</td>
<td>94.0</td>
<td>.921</td>
<td>.272</td>
</tr>
<tr>
<td>4</td>
<td>403</td>
<td>3.95</td>
<td>105</td>
<td>1.03</td>
<td>.266</td>
</tr>
<tr>
<td>5</td>
<td>453</td>
<td>4.44</td>
<td>130</td>
<td>1.27</td>
<td>.287</td>
</tr>
</tbody>
</table>

Average coefficient: \( .268 \)

Conclusions: Surprisingly, the friction forces are essentially as in Experiment 1.
Experiment 3: Static Friction on an incline.

Objectives:

- Find the maximum strength of the static friction force for wood on wood.
- Find how the coefficient of static friction varies with load.
- Compare the coefficients of different materials.

Set up & Theory

Free body diagram for the block:

\[
\begin{align*}
W &= \text{weight of block and any added mass} = Mg \\
N &= \text{normal force on block (}= \text{load}) \\
F_s &= \text{static friction force on M}_1
\end{align*}
\]

Forces parallel to incline:

\[Mg\sin\theta = f_s\]

Forces perpendicular to incline:

\[Mg\cos\theta = N (= \text{load})\]

The coefficient of static friction is then:

\[\mu_s = \frac{f}{N} = \frac{Mg\sin\theta}{Mg\cos\theta} = \tan\theta\]
Data & Calculations: Static Friction

• Limiting Angle for Wood Block

<table>
<thead>
<tr>
<th>Trial</th>
<th>Limiting Angle (deg.)</th>
<th>( \mu_s )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22.8</td>
<td>.420</td>
</tr>
<tr>
<td>2</td>
<td>26.2</td>
<td>.492</td>
</tr>
<tr>
<td>3</td>
<td>21.2</td>
<td>.388</td>
</tr>
<tr>
<td>4</td>
<td>22.3</td>
<td>.410</td>
</tr>
<tr>
<td>5</td>
<td>23.5</td>
<td>.435</td>
</tr>
<tr>
<td>Averages:</td>
<td>23.2</td>
<td>.429</td>
</tr>
</tbody>
</table>

Average maximum force of static friction = \( 2.48 \text{N} \times \sin(23.2) = .977 \text{N} \).
This is about 43% of the load, or about 39% of the weight of the block.

• Coefficient vs. Load: Wood on Wood

<table>
<thead>
<tr>
<th>Mass (grams)</th>
<th>Limiting Angle (degrees)</th>
<th>( \mu_s )</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>21.6</td>
<td>.396</td>
</tr>
<tr>
<td>20</td>
<td>19.0</td>
<td>.344</td>
</tr>
<tr>
<td>50</td>
<td>25.0</td>
<td>.466</td>
</tr>
<tr>
<td>100</td>
<td>23.6</td>
<td>.437</td>
</tr>
<tr>
<td>200</td>
<td>17.8</td>
<td>.321</td>
</tr>
</tbody>
</table>

There are variations, but no trend is apparent.

• Coefficient for various materials on wood

<table>
<thead>
<tr>
<th>Material</th>
<th>Limiting Angle (deg)</th>
<th>( \mu_s )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>23.2</td>
<td>.429</td>
</tr>
<tr>
<td>Glass</td>
<td>28.0</td>
<td>.532</td>
</tr>
<tr>
<td>Aluminum</td>
<td>14.9</td>
<td>.266</td>
</tr>
<tr>
<td>Brass</td>
<td>15.1</td>
<td>.270</td>
</tr>
<tr>
<td>Iron</td>
<td>15.2</td>
<td>.272</td>
</tr>
<tr>
<td>Lead</td>
<td>16.8</td>
<td>.302</td>
</tr>
</tbody>
</table>

Metals seem to have the smallest coefficients. Surprisingly, the glass slab has the greatest coefficient.
**Lab Report:**

The objectives, set-up, theory, data, calculations, analysis and conclusions from your *lab notebook* can be compiled into your *lab report*.

Your report should focus on:

- The purpose of each experiment
- The method by which the purpose was accomplished
- The results of your calculations & analysis
- Your conclusions.

See the document:  *Example Lab Report*