How to Keep a Scientific Notebook

by George E. Hrabovsky, President, MAST

Introduction

One of the great mysteries in amateur science is how to maintain a scientifically correct notebook. Such a notebook is your single best tool for doing significant science. This is what separates the true amateur scientist from the mere dabbler.

Maintaining a Scientific Notebook

The notebook must be bound.

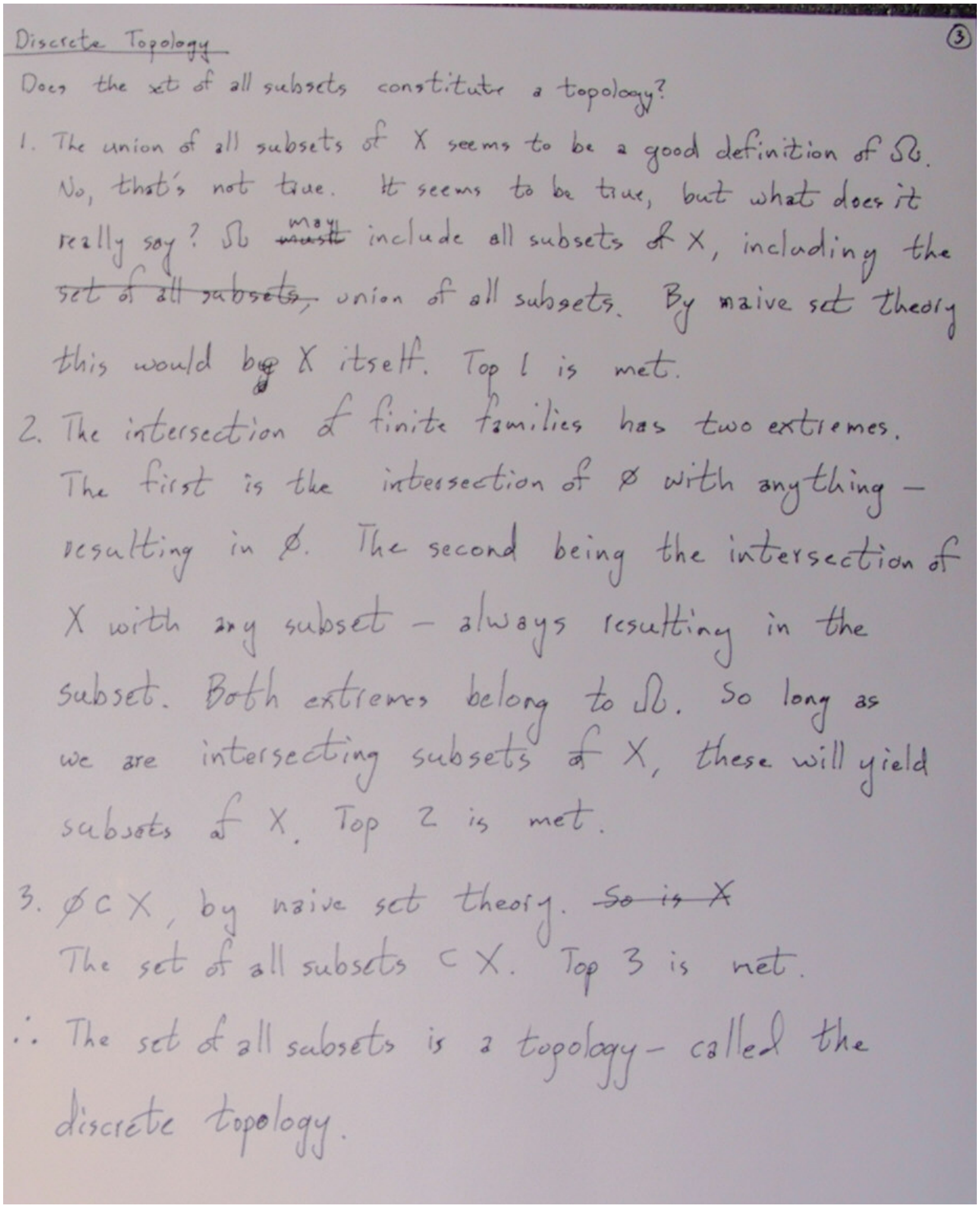
The pages must be prenumbered, or you may number them as you go.

You must have at least one page for the title of the notebook (for example, "Projects for 2004," "Chemistry," "Building a Tornado Machine," etc.), include your name here. You need not number the title page.

You must reserve at least one page (and I recommend at least two) for a table of contents. As you add relevant sections to your notebook, write down the section title and page into your table of contents so you can find it later.

When you attend discussions, talks, or seminars note the title, date, and speaker as the Section Heading. You might want to take your notes on a pad during the talk, and then add them to the notebook later. This gives you a chance to think about the notes as you add them to the notebook.

When you read source material, note the question you are attempting to answer, the author of the book/paper/article, the date of publication, the title, and the publisher/magazine/journal. Again, you might want to take the notes on a pad as you read and then transfer them to your notebook later on.



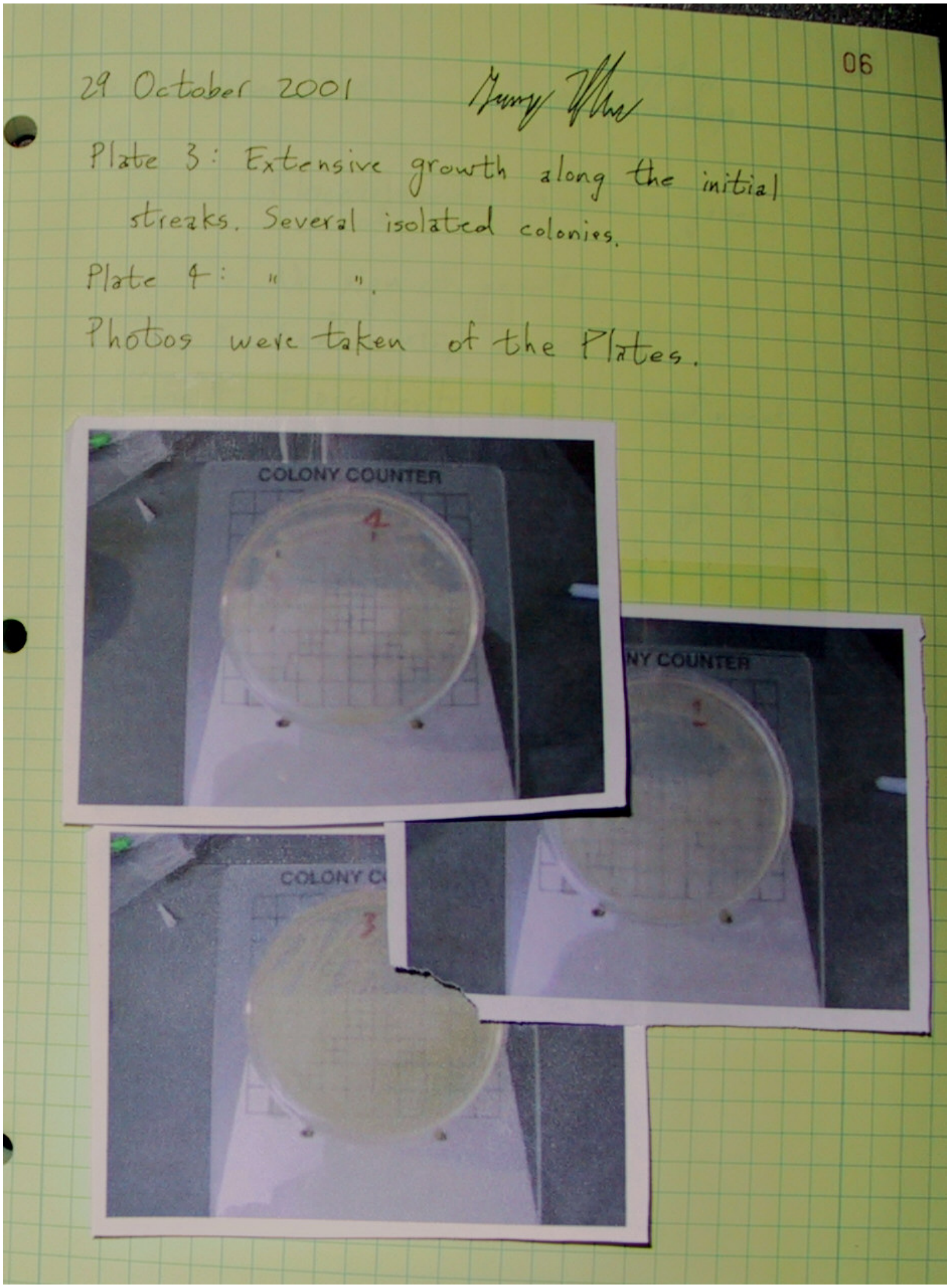
Discrete Topology ③

Does the set of all subsets constitute a topology?

1. The union of all subsets of X seems to be a good definition of Ω. No, that's not true. It seems to be true, but what does it really say? Ω ~~must~~ may include all subsets of X, including the ~~set of all subsets,~~ union of all subsets. By naive set theory this would be X itself. Top 1 is met.
2. The intersection of finite families has two extremes. The first is the intersection of $\emptyset$ with anything – resulting in $\emptyset$. The second being the intersection of X with any subset – always resulting in the subset. Both extremes belong to Ω. So long as we are intersecting subsets of X, these will yield subsets of X. Top 2 is met.
3. $\emptyset \subset X$, by naive set theory. ~~So is X~~
The set of all subsets $\subset X$. Top 3 is net.

$\therefore$ The set of all subsets is a topology – called the discrete topology.

When you make observations in the field or the laboratory, title the observation (for example, "Observing a thunderstorm video," note the date, the time, any relevant local conditions (temperature, light level, etc.) that might influence the observations. Note how the data is being recorded. Then record the data into your notebook as it is taken. You should sign each page as you record the time for each observation. This is to establish and maintain the integrity of your data.



When making a calculation you must first title it, note all relevant assumptions you are making, note all units and constants in use, and then record each step in the calculation and its results.

MATHIEU FUNCTIONS (Based on Matthews & Walker) (pp. 198 - 204) 10

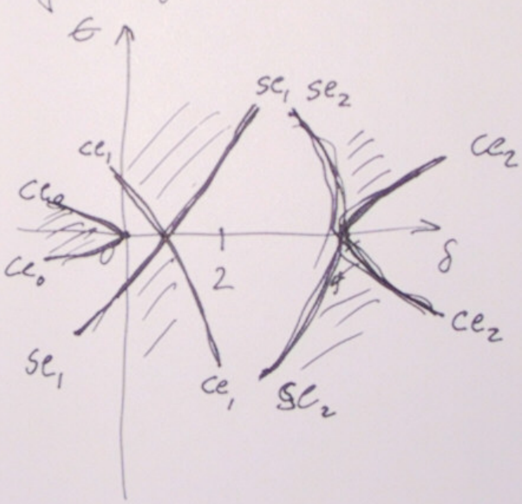
We have

$$\frac{d^2y}{d\tau^2} + (\delta + \epsilon \cos \tau) = 0$$

where we can always find a solution of the form

$$y(\tau) = e^{\mu\tau}\psi(\tau)$$

By Floquet's Theorem.

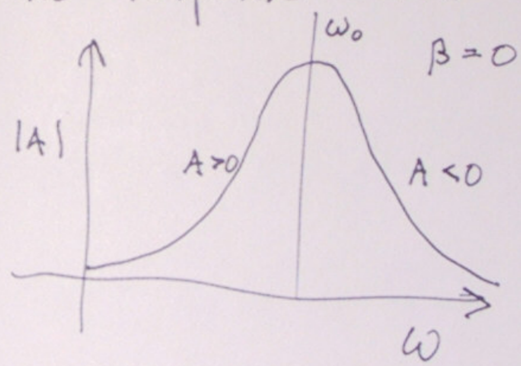


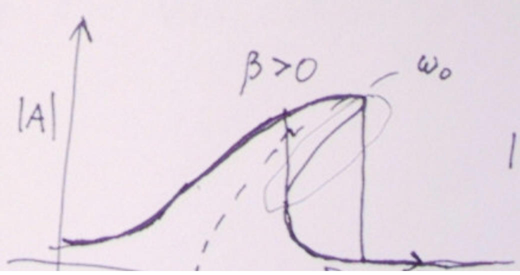
We determine the A-response curve with (11)

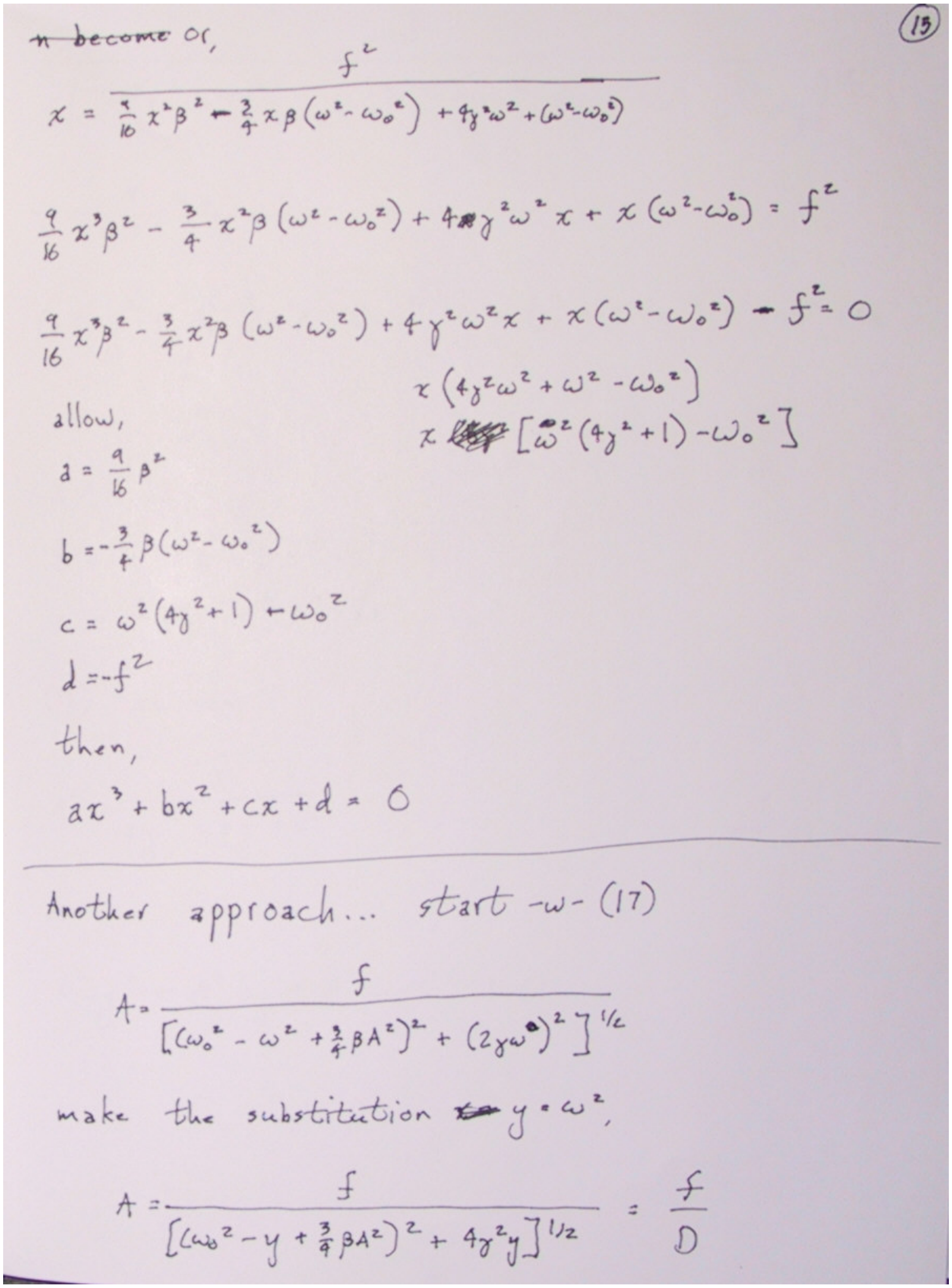
$A = A(\omega)$,

Horay! I just figured out how to do the Strutt diagram - thanks to Abramowitz & Stegun, with help from Matthews & Walker.

The response curve is







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~~n become~~ or,

$$x = \frac{f^2}{\frac{9}{16}x^2\beta^2 - \frac{3}{4}x\beta(\omega^2-\omega_0^2) + 4\gamma^2\omega^2 + (\omega^2-\omega_0^2)}$$

$$\frac{9}{16}x^3\beta^2 - \frac{3}{4}x^2\beta(\omega^2-\omega_0^2) + 4\gamma^2\omega^2 x + x(\omega^2-\omega_0^2) = f^2$$

$$\frac{9}{16}x^3\beta^2 - \frac{3}{4}x^2\beta(\omega^2-\omega_0^2) + 4\gamma^2\omega^2 x + x(\omega^2-\omega_0^2) - f^2 = 0$$

$$x(4\gamma^2\omega^2 + \omega^2 - \omega_0^2)$$

$$x[\omega^2(4\gamma^2+1) - \omega_0^2]$$

allow,

$a = \frac{9}{16}\beta^2$

$b = -\frac{3}{4}\beta(\omega^2-\omega_0^2)$

$c = \omega^2(4\gamma^2+1) - \omega_0^2$

$d = -f^2$

then,

$$ax^3 + bx^2 + cx + d = 0$$

Another approach... start -w- (17)

$$A = \frac{f}{\left[(\omega_0^2 - \omega^2 + \frac{3}{4}\beta A^2)^2 + (2\gamma\omega)^2\right]^{1/2}}$$

make the substitution $y = \omega^2$,

$$A = \frac{f}{\left[(\omega_0^2 - y + \frac{3}{4}\beta A^2)^2 + 4\gamma^2 y\right]^{1/2}} = \frac{f}{D}$$

When setting up an experimental apparatus record the title of the experimental set-up, the date, time, local conditions that could influence the experiment, list all of the materials used, then list each step in the set-up as you perform it. If something unexpected happens be sure to record that, too. Sign each page as you perform the set-up.

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Experiment #1: Isolation of Bacteria from Soil. 28 Sept. '01

Objectives:

1. Practice growth & isolation of bacteria from soil.
2. Isolate & produce a stock of bacteria for future study.

Background:

(Drawn from [1] Ted R. Johnson, Christine L. Case, 2001, Laboratory Experiments in Microbiology, Benjamin Cummings).

1. There are many strains of bacteria in the soil.
2. These can be cultured using the proper medium.
3. Such media shall be (for this experiment) Nutrient Broth, and Nutrient Agar.

Nutrient Broth:

a. ~~Glucose~~ Pancreatic Digest of Gelatin (5.0gm/l)
b. Beef Extract (3.0g/l).

Nutrient Agar:

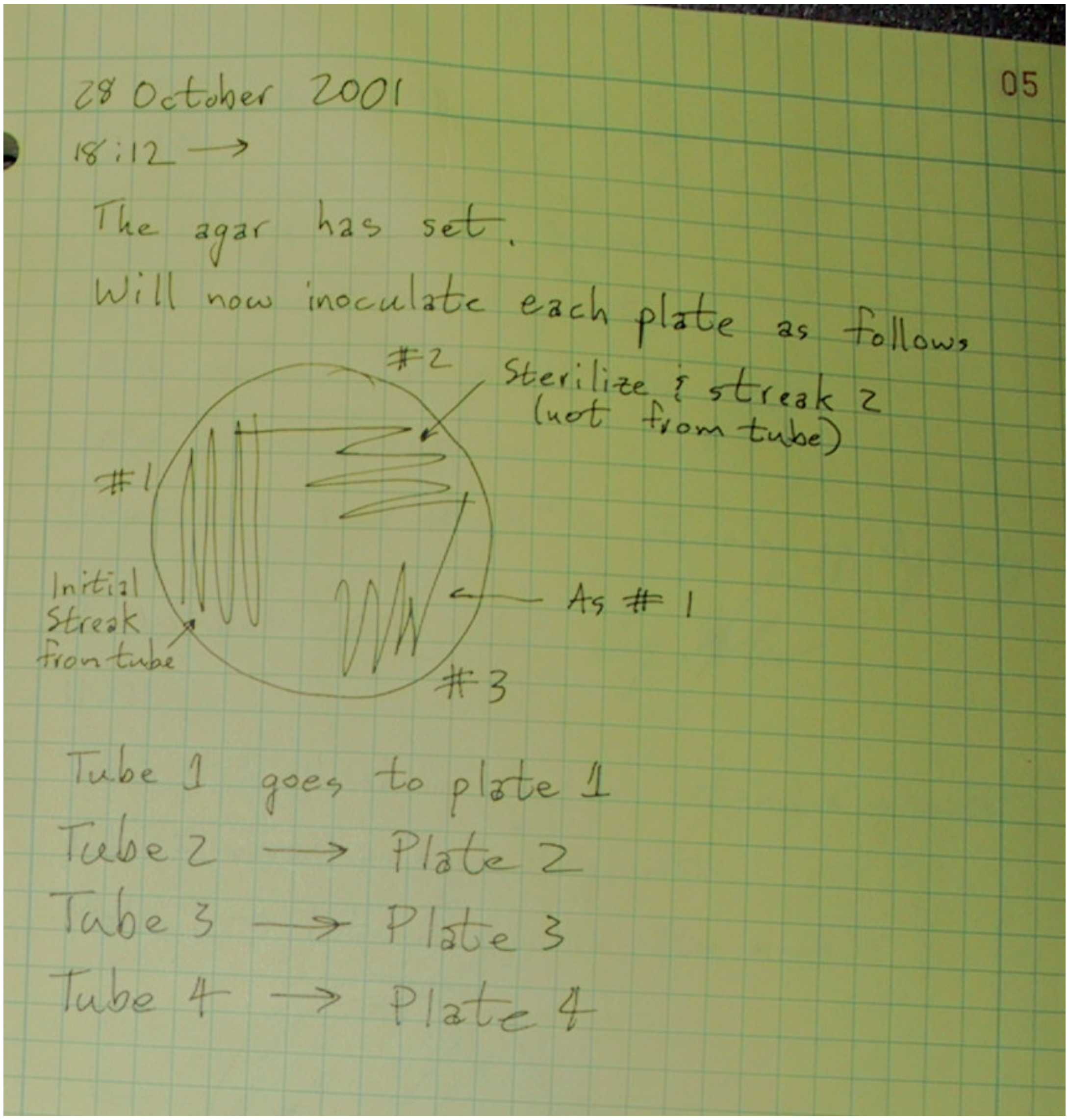
a. Beef Extract (3.0 gm/l)
b. Pancreatic Digest of Gelatin (5.0gm/l)
c. NaCl (8.0 gm/l)
d. Agar (15.0 gm/l).

4. After preparation the media are sterilized in an autoclave.

Materials & Equipment

250 ml Erlenmeyer Flask
100 ml Graduated Cylinder
Distilled H_2O
Nutrient Broth Powder
Nutrient Agar
Glass Stirring Rod
12 ml Serological Pipette
10 ml Pipette Pump
2 Test Tubes -w- Caps
4 Sterile Petrie Dishes
Balance
2 Weighing Pans

Autoclave
Autoclave Gloves
Hot Plate



When calibrating an apparatus or instrument record the title of it, the date, the time, all relevant local conditions, list all of the materials used and how you intend to perform the calibration and why you chose the method being used. Then record each step as you perform it. Record all data you collect as you collect it.

When analyzing data from an experiment or observation, record the title of the experiment/observation the data was drawn from, the method of analysis and its justification, the results of the analysis, and your estimate of the error in your analysis.

When making a model (physical, mathematical, or on a computer) record the title of the model, all assumptions that you are using, the method of modeling and its justification, and then record each step as your make in your model and its results.

When performing a derivation or proof record the title of the work, all assumptions being used, all definitions, all theorems, all conjectures, and then each step and its justification and results.

When entering a practice problem and its solution, be sure sure to name the problem (Problem Calculus - 1, for example), write the problem clearly, begin the solution process by explaining what you intend to do and why before you do it, then record each step in the solution along with full justifications for the methods you use, verify your answer, and then think about how the answer to the problem will influence the remainder of your work, can you think of applications for the answer? Can you think of other ways to asnwer the same problem? Does this answer shed light on other problems you are working on? (More than one research project has been started in this way).