How to use the « protocols of experiments » ?

What we call "protocols of experiments" are computer files that can help you to make good science.
These files are indeed tables, and you need an empty one. Then, for any experiment, the advice is to make a copy of this file, and then… it's easy, because you can just fill in the cells.
More generally, an empty cell is an invitation to fill it.
And be sure that, when all cells contain something, a publication can be done.

However, practice showed that some of us have questions about these documents, in the detailed formulation. Here is a description of the various cells, and how to fill them in.
Better write "nothing to say here" than leaving a cell empty.

Report of experiment (give a code and a number, so that the file can be easily recovered)	
Title	Title : no explanation should be needed… but do you know what a title is? And did you think that "beautiful words" are more pleasant to use than ugly ones?
Name of the scientist :	Name of the scientist: this is important, not only for you but also for the group, because we try to make a group, with friendship and cooperation, so that anybody can benefit from the work of others. Then it's frequent (daily!) that we exchange these "protocols of experiments", and then the name is useful.
Date of the creation of this file :	Date (first appearance of such a cell): it's always good to keep track of what one does, as it's also a possibility, later on, to evaluate the time that was really needed, so that a better prediction of times and a better planning can be made in the future.
Objective :	Objective, aim: an experiment has an objective. Which result do you want to reach?
Reasons for this	Reason of the experiment: of course, one does not make experiments

experiment (why one does it? References (bibliography) that justify the study (please, give as many of them as possible)	just for making experiments. There is certainly a reason. In other words, if you want to make an experiment, if you have an objective, it's because there is a reason for it. Which one(s)? This cell has another interest: remember that this "protocol of experiment" will be the basis for a scientific publication. Then the "reasons" are indeed the introduction of the paper. This is why in this cell it's good to discuss the reasons, using the bibliography. More precisely, the idea is to follow this way : initially, there is a question ; then a bibliographic survey (references should be give) is giving information ; then we can ask the question slightly differently, and the new question is…
Preliminary observations :	Preliminary observations: frequently, experiments are done because other experiments were done before, that indicate that there is a possibility of a discovery.
What is the theoretical assumption that is tested :	One asks if… Which theoretical assumption do you want to test: any experiment should be done to test some assumption because in science one has to refute old ideas, or previous theories, or models, which all are always wrong (because a reduced model of reality is obviously wrong, being reduced, and not the reality). Of course, this test should be done in view of a new possibility. And remember that if you are guessing wrongly, it's fortunate, because there is a possibility of a discovery (nothing is worse than a confirmation of deduced ideas, because it means that nothing new is in view).
Calculation on which the experiment is based on	Calculus on which the experiment is based: Of course, theories and models are not only ideas, but ideas corroborated by calculation. This is why some calculation should be done first.
General method to be used (only the general idea, i.e. methodology, not the method itself, as there is a cell below)	General method: this is not the place of explaining the method with steps, but rather to give a general idea of the experiment that is going to be done.
Scheme of the	Scheme : what one has to do is explained under "Scheme", i.e the

experimental method (Caution : one should not make pictures, but only to represent the steps, IN ORDER TO identify the main parameters and to introduce SYMBOLS, giving also numerical values expressed in IS units.	idea here is not to make a drawing of the system that you are going to use, because this is useless. The idea of this cell is only to invite you to describe the various parameters with letters, or symbols, so that you can use them later on, in "laws", relationships, models, etc. As it is good practice to always begin some calculation by introducing letters and symbols, instead of numerical values, and to use these symbols during calculation, instead of numerical values, this cell is a kind of place where you deposit the numerical data, translating them into IS units. For example, if one electrical current of 5 μA is used, or a mass of 250 mg, then this cell should get information such as I = 5E-6 A, m = 2.50E-4 kg.
Detailed method (you should be able to justify any step and any choice of particular parameters):	1. 2. 3. … Method: it's time, now, to define precisely, in details, the experimental method that you are going to use, i.e. to explain the experiment that you are going to make. The clearest way to explain is to use steps. Please, don't forget any step, and check that any hardware and products that you use during this experiment is indeed mentioned in the above cells, on reagents, products and hardware. This is not difficult: just read! If you read, weigh the mass, there should be a balance of particular specifications. If you read, record UV spectrum, there should be information on a particular UV-vis spectrometer that you are going to use. If you write "add 250 mL water", then in the reagent cell the kind of water has to be explained.
Reagents, including for each, name, physical and chemical characteristics, constants, security rules to be applied (the security file should be given now in annex), particular information, purity (did you check that	Reagents: this cell should give all information needed for publication, but also for the discussion of the experiment. Of course, you need the IUPAC name of solvents, but also their purity, grade, supplier… The main point is however the security question: generally physical and chemical constant are needed to judge the danger of these reagents, but this is not enough. If you use some reagent, you have to get the security file for it, and to read it, in order to decide for the security rules that you have to use. Please don't kill you (and us)!

the product in the bottle is indeed the real product that you intend to use, did you make a purification step before use, supplier, grade, etc.	
Various products used in the experiment (such as food products); give all detailed information: brand, date, origine, batch number, etc.	Products: some reagents are only solvent, or compounds that you use during experiments, but frequently one uses also food products, or raw material. In this case, one should write here where these products come from, and give as much information as possible. You have to know that in a publication, the choice of any particular detail should be explained. Then anticipate the questions of the referees, and indicate varieties, brands, batch number, etc. and more generally, try to give quantitative information about these products.
Hardware **Here again give all details: brand, model, specification, experimental conditions, date, time, temperature, hygrometry…):**	Hardware: if you use a particular balance, please indicate which one, i.e give his name, brand, origin, model, last checkout of the instrument (by the way, how do you know that it gives reliable results?)… Of course, all detailed information about precision, detection limit, etc. should be given here.
Estimation (order of magnitude) of the awaited result (i.e. is the experiment worth the effort to be done in such circumstances ?)	Estimation of the result (order of magnitude): this cell should contain a calculation that shows that in the particular conditions that you gave in the method section, you can get results precise enough to test the theoretical assumption given at the beginning of the file.
Estimation of the needed time to make the experiment:	Estimation of time needed for the experiment: this is only training! In order to improve one's practice, a key competence is the ability to determine in advance the time needed for various tasks, and to plan experiments and works. This information is important to make a realistic program.

Here stops the protocol file when you prepare the experiment. Below is first the part that you use during the experiment	
Date:	
Qualitative results (you can put here pictures or indications such as «lime becomes turbid while blowing», or "a color change is observed").	1. 2. 3. … Qualitative results: there are many things to be observed during an experiment, and all this information is very important either to be able to interpret the results later, or even to make new discoveries. The quality of a scientist is often linked to the ability to see what other don't see. Don't miss clues, important clues, and remember that in the past chemists were even smelling, tasting, hearing… If smelling and tasting can be dangerous, the idea remains.
Quantitative results given in tables or in files whose name are given here. These are raw data, but with three replicates at least:	Quantitative results given in tables or in files whose name are given here. These are raw data, but with three replicates at least. Of course, today some instruments give directly files with a lot of data (a spectrum for example), and it's useless to put them here. In this cell, only some synthesized information should be given. When all the information lies in a spectrum, a good idea is to give here the particular place where this file lies (did you make a backup? Where?) Remember that any data point should be given with a confidence interval, so that you need at least three replicates.
Estimation of uncertainties, confidence intervals (when needed; do you know when it's needed ?)	Estimation of uncertainties, confidence intervals (when needed; do you know when it's needed?). Of course, if you made replicates, this allows you to calculate an average value and a standard deviation. Sometimes, uncertainties are also needed, to estimate results. Indeed no curve (below) should be given without information on the quality of the results.
Results properly expressed : tables should now be translated into diagrams (but at this « Results » step, there should be no curve linking the data points) or into	Results properly expressed: tables should now be translated into diagrams (but at this « Results » step, there should be no curve linking the data points) or into histograms: As table with data are almost impossible to read, this is raw information that has to be translated into elaborated information (remember that elaboration is part of science). Curves and diagrams are a good way to express data in a very synthetic way. Any other graphic proposal is possible. But one has also to know that results are results, and that there is a main difference between results and interpretations. A main mistake

histograms :		would be to fit the data without having any reason to do it. Imagine a curve starting at zero, increasing rapidly in the beginning then slower, with an asymptote. Of course, you could fit with some exponential law, but also with some function using 1/x. As there is no reason here, at this step, without explanation, to use one fit rather than another, then no fit should be done now!
Description of the trends on curves and histograms (this description will be cut and pasted in the "Discussion" cell		Description of the trends on curves and histograms (this description will be cut and pasted in the "Discussion" cell): in order to interpret results, one has to see them. Of course, a curve is a curve, and all the information that you have to interpret is there, but practice shows that we generally have difficulty to make the "interpretation" step. This is why a method is proposed. Just describe your results with words, and make sentences. Any idea that you give (the curve starts at zero, the curve seems to increase linearly, there is an asymptote…) can be discussed later.
Other observations during the experiments		Other observations during the experiments: this is to remind you that many observations can be done, much more than are done effectively, in general. Please don't forget some useful piece of information, either a technical detail or a result.
Here stops the file after the experiment but before making science out of the results		
Date :		
Fittings (the same curves, but now data points have to be linked by particular curves based on theoretical assumptions, as remember that fitting a curve means interpreting, with is indeed discussion. If you fit, please don't forget to estimate quantatively the quality of the fitting		Fittings (the same curves, but now data points have to be linked by particular curves based on theoretical assumptions, as remember that fitting a curve means interpreting, with is indeed discussion. If you fit, please don't forget to estimate quantatively the quality of the fitting :
Calculati	**Formali**	

on (interpretations, modeling, etc.) THIS IS SCIENCE	**zation (new parameters are introduced)**	
	Look for relationship between parameters	
	Numerical applications	
Discussion (explanation of results, trying to answer the « why » question		1. 2. 3. … Here is the place where you paste the description of the results. Then, for each sentence, you try to use the bibliographic data in order to propose an explanation of the data you got with the experiment Indeed each "Result" sentence should become a question: why is it so and not differently? Of course, the proposals should be quantitative!
Interpretations :		Here you should try to find mechanisms in order to explain the laws that you find above (remember that any law is not science ; for example, U=RI is only a result, and science is there only when you propose a physical or chemical explanation, in terms of electrons)
Proposal for new concepts		Ech experiment has to be considered as a particular case of the general rule that has to be found)
Evaluation (did we reach the objective? etc.) :		

Please don't forget :	1. did you check the spelling ? 2. are they still adverbs or adjectives that you should translate into quantitative data ? 3. did you check the calculations (and how) ? 4. etc.
Conclusions :	
Proposals for the improvement of the technique and of the results:	
Signature (for priority questions, patents, etc.)	