Iodine Clock Experimental Design General Notes

This practical has formed a part of a module including experimental design elements.

In it, the students are not provided with a protocol or set of instructions. Instead, they are introduced to a simple clock reaction, told what equipment and reagents they will be using and asked to plan a set of experiments to achieve an objective.

It is hoped that because (albeit with some guidance) the students themselves will arrive at things like including replicates and using standard curves, as well as more abstract principles such as allowing for variation and avoiding bias in gathering and interpreting data, they will understand these aspects of scientific practice better.

The reaction itself can be framed in terms of reaction kinetics, redox reactions in chemistry or biochemistry (the I^-/I_3^- couple transfer electrons from ascorbic acid to hydrogen peroxide in a manner that could be said to be analogous to components of the electron transport chains in oxidative phosphorylation or the light dependent reactions of photosynthesis), or even as vitamin C acting as an anti-oxidant.

When we have run the practical, we have made the planning tutorial (or tutorials) compulsory to ensure that students do not arrive at the practical unprepared. We also give each group their random target times in the tutorial (these are actually one randomly generated time and another that is either 10 s higher or 10 s lower than the first). The second time was added to the practical later to make students focus more on the process of controlling the system than just hitting their target and could be given to the groups during the practical instead of in the tutorial.

The exercise is assessed by means of a report, to be written in the style of a short scientific paper. More marks than is perhaps usual are allocated to the Methods section because they will have been designed by the students themselves. However, we also award a proportion of the marks (20%) based on how close each group is to two “target” times (10 marks for each time). Each group’s times are recorded by demonstrators in the lab and the marks calculated by the module team. The students in each group tell the demonstrator what their target time is and when to start and stop the stopwatch, without being able to see it (or use a timer of their own). We have allocated these marks by starting at ten marks for each target time and reducing by one mark for each second they are off their objective for the first five seconds, then reducing by half a mark for each second for the next eight seconds, leaving a half mark for making an attempt however far off the group is*.

This may not be possible, but we have also allowed groups to pick up “bonus“ marks by designing additional experiments using the same experimental system. Some groups have used this to recover from failing to match their target times. For example, one group hypothesised that their times were off because (in a rush) they had used tap water instead of Milli-Q water and designed a nice set of experiments to test this (from which, they seemed to be correct).

* For example, for a target of 30 s, 30 s – 10 marks, 29 s or 31 s- 9 marks, 28 s or 32 s- 8 marks, 27 s or 33 s- 7 marks, 26 s or 34 s- 6 marks, 25 s or 35 s- 5 marks, 24 s or 36 s- 4.5 marks, 23 s or 37 s- 4 marks, 22 s or 38 s- 3.5 marks, 21 s or 39 s- 3 marks, 20 s or 40 s- 2.5 marks, 19 s or 41 s- 2 marks, 18 s or 42 s- 1.5 marks, 17 s or 43 s- 1 mark, ≤16 s or ≥ 32 s- 0.5 marks.