

A Guide for Titration Coordinators

Including tips from teachers who trained Excellent Teams in 2021

If you are new to the competition

Prepare yourself by making sure your own techniques are correct, and that you are confident in demonstrating and explaining each step of the process. Practise using accurately weighed samples of primary standards so you can assess your own accuracy.

Use the resources provided by RACI – *A Guide to Titration* and the series of videos (*School Training videos* and *Tips to improve your titration skills*) that are on the Titration homepage of the RACI website at [RACI/Schools/Titration Competition](https://www.raci.org.au/Schools/TitrationCompetition). Be wary of other videos you may find on the internet as some demonstrate incorrect procedures and unsafe practices such as grasping the pipette near the bulb when inserting it into the pipette filler or filling the burette above eye level.

A suggested training pathway for students

Address safety concerns and insist on correct procedure. These points are all addressed in the RACI resources identified above.

Maintain vigilance when students are practising – correct errors in procedure before they become bad habits.

Use the RACI videos and documentation as teaching resources.

Make sure all glassware, especially pipettes and burettes, is scrupulously clean. Droplets of water should not cling to surfaces.

Break the process down in its individual steps.

Make it fun – students find it addictive!

- (1) Teach students how to rinse a pipette and burette correctly, and how to use each to deliver accurately known volumes of solution. Initially, practise with DI water only. If possible, use a balance to weigh the liquid delivered for multiple transfers and encourage replicability in delivery from both burette and pipette. Aim for mastery of the pipette before moving on to the burette.
- (2) Once mastery of pipette and burette is achieved, introduce the titration process, demonstrating and explaining it before having students start do their own. Have students watch the video of the whole process. Make sure they know the aim of the process – to reliably find an accurate value for the concentration of a solution. The intent of the processes used is to ensure that the solutions being analysed are the same concentration as those supplied, and that all volumes used in calculations are reliable and accurate. An analyst should be able to defend the procedures used.
- (3) Once you move on to doing actual titrations, progress gradually from just one or two per session to completing the whole analysis as competence and confidence develop. Give them the opportunity to practise. Encourage competition. Provide feedback as to their accuracy to encourage ongoing improvement. This may mean having to run the titrations yourself to establish the concentration.
- (4) Make sure they can do the calculations correctly and use significant figures correctly!

Pearls of wisdom from successful trainers

The following approaches have been generously shared by coaches who have had long-term success in the Competition.

- *Introduce Year 11s to the tools of the trade early – for example when teaching Measurement and Uncertainty, teach use of a burette and pipette and balance, and use these as a vehicle for teaching accuracy vs precision, uncertainty, significant figures, graphing, etc. This way, when titration competition rolls around, students have already developed some of the required skills and attitudes (EB from Qld).*
- *I generally start training the students in lunchtimes about a month from the competition and make the samples and analyse them so I can provide accurate feedback and then fine tune their accuracy. We always include titrations in senior chemistry experiments where we can (DP from Qld).*
- *My advice is simply to **teach it well** and **practise often**. I have either trained the students at lunchtime, after school or during their extracurricular time. Yr10 chemistry students are introduced to a basic acid base titration as part of their curriculum. Titrations is our main investigation in Year 12 (titration of wine) and every student leaves school knowing how to titrate well. We also complete redox titrations to give them extra practice (SM from WA).*
- *Students practise two lunch times per week. They are asked what days best suit them. For the regional competition they practise for 6 weeks. Consistency is the key: the more they practise the more consistent they become. For the National competition they practise twice a week; first session of the week is for making solutions, second session is titrating. Once again, it's about 6 weeks of practice. The students send their result to the teacher and the teacher tells them how far off they are. The teacher needs to be enthusiastic so it rubs off onto the Students (GH from Qld).*
- *Our Year 11s are introduced to titrations in Term Two. After learning how to use a volumetric pipette and burette (with water only), they do a series of practicals (at least 6) where they make up a standard solution to standardise other solutions which are used to determine the concentrations of various acids or bases in household materials such as cloudy ammonia, vinegar, etc. The nature of the titrations means they are required to use both phenolphthalein and methyl orange. Students are encouraged to see who can produce the faintest pink for their colour change with phenolphthalein (love a bit of competition). When the analysis competition draws closer, we practise with the chemicals involved in the competition for some familiarisation (MZ from SA).*
- *I start training at the beginning of Term 2 and run morning and lunch sessions. I stipulate that they need to attend at least two training sessions per week. The first couple of sessions are teaching them how to use the equipment and do calculations. Before they start the training sessions, I get them to watch two videos that explain titrations. As we get closer to the state competition date, I extend the training sessions to the afternoons and in the week before the competition I get them to do two full titrations under competition conditions. During the training sessions I have the students write their results on the whiteboard and we have discussions about the results. I get them to think about their technique and what things could have affected their results (LS from NSW).*
- *It usually requires about 20 hours of training to prepare a team to qualify for the Finals. And about as much to prepare the team to achieve in the top 10 of the nation (CP from Qld).*
- *In year 12, students perform titrations early in Semester 1 (building on the skills developed in year 11) which allows them to compete in the RACI Titration Competition. The focus is more on precision, accuracy, and the use of significant figures. By the time of the competition, students have done an acid base back titration and a few standard acid base titrations. We do not practise for the competition as such, but rather focus on titration skills which are then used by students to solve problems in class, e.g. determining ammonia content in household cleaner, ethanoic acid in vinegar, level of carbonation in drinks and pH, efficiencies of antacids on the market, etc. We focus on skill development which can then be applied in problem solving. This seems to set up our students with the technical and problem-solving skills to work and perform independently and individually. (ML from SA).*

- *We have to be flexible, working around time restraints on both ourselves and the students. We run our training sessions after school, usually running between 1-2 sessions a week, starting 5 weeks out from the competition. Sometimes, in the week before the competition, we'll even run a third session if the kids are up for it. This procedure is the same for both state and national competitions (BH from WA).*
- *Students volunteer to take part and select their own teams. They are required to attend a minimum of six 90 minute practices for the Regional competition, and at least another two 3 hour sessions to prepare for the final. Practices are held during lunch time and after school. Each student is allocated their own glassware (esp. burette and pipette), and is then responsible for its care during the training period, and is familiar with it for the competition. (EB from Qld).*
- *Without giving away any trade secrets, I'd say don't ignore the fact that the students will need to problem-solve as a team under time pressure. Early in training, they want to check everything with the teacher; "Is this the right colour?", "Is my pipette clean enough?", "Which result(s) should I keep/discard?". It is important to address these queries, as individuals or as a group, so that the students learn how to think and what to look for, with the benefit of teacher experience. However, as the competition draws near, I encourage them to make their own judgements, and to speak to their peers if they need further advice, because that's how it'll be on the night. If something goes wrong during training, instead of telling the student how to fix the problem, ask them how they'll fix it. Students are encouraged to make their own decisions and defend them; this builds their confidence in decision-making so that they are not paralysed by indecision on the night of the competition. It also makes them conscious of the fact that their teammates are a resource, and encourages collaboration in the form of sanity-checking (on calculations, procedures, etc.). In short, get them to model the behaviours that you expect on the night, not just the techniques. This experience also makes them feel more relaxed on the night of the competition. At the end of the training session, you can provide feedback, not just on results and technique, but on the decisions that they made and the behaviours that they demonstrated (BH from WA).*

Make the competition matter in your school community

- *Make the competition part of your school's culture – publicise results in school newsletters, on social media, and in the local press; present certificates, badges, etc. at whole school assemblies. Create an expectation among younger students that they will be given the opportunity to take part.*
- *In the last 3 schools I worked at I have made it my job to create a school culture which values this competition. Successes announced at assembly etc. I have also introduced the colour system for this skill. The students gain a lot out of learning how to titrate for their chemistry course and for the extracurricular aspect of their schooling (SM from WA)*
- *Our students take pride in their achievements which are celebrated during an assembly, in a newsletter article and by displaying trophies in the laboratory. Their golden individual badges are also worn with pride (ML from SA).*
- *Our school culture encourages and acknowledges student participation in extra-curricular activities. Students who compete are acknowledged on stage at whole of school assemblies, in the student bulletin, school newsletters and the school magazine. The "Excellent Team" plaques are all displayed in the Front Office along with the athletics, swimming, etc shields and pennants. I am looking at establishing a wall of fame in the Chem Lab to display the certificates of all our "Excellent Teams". As both the school phase and state final are held at our school, staff are encouraged to call in during the competition to appreciate what the students are doing (MZ from SA).*