**Notes on Investigation Report:**

Generally, it is not necessary for students to show *every* calculation that they do in a lab (for “Results” and “Discussion” sections), but they should show samples of each calculation for you to check. The remaining results they can present in a table or graph as appropriate.

The marking key for the “Results” section states that students should;

*Provide relevant measurements & calculations used to test the assumption of negligible rolling friction of the ramp (Part 1).*

The best way to do this would be for students to calculate a *theoretical* time for the cart to reach the bottom of the ramp and compare it to a *measured* time (with calculated uncertainties for one or both results). If the results match (within uncertainty), then friction is likely negligible and can be ignored. Otherwise, friction force of the ramp may need to be calculated and factored in to subsequent calculations.

The marking key for the “Discussion” section states that students should;

*State any potential sources for error and detail, with sample calculations, how they could have affected the result (or why they did not affect the result).*

Some students may literally just describe sources of error, without providing any evidence (i.e., sample calculations) of how these errors affect the final result. I would be inclined to give such a response 1 mark out of 3 at most, but really a sample calculation should be shown for full marks.

Ideally students should show some *attempt* at error propagation. More than one approach may be valid; adding relative errors is one approach, but for a lab like this calculating a max/min interval estimate for the measurement might make more sense. However, if the kids haven’t done that, don’t stress; I tend to find that, even in Year 12, many students don’t quite have the grip of it. If they’ve made a valid attempt at error propagation, *with supporting calculations*, I’d give them 3 marks out of 3 even if they have a made a few minor mistakes, or not quite completed the error propagation fully (maybe 2 out of 3 if they’ve made a glaring mistake or two) and provide feedback on how to improve; error propagation calculations are not likely to come up again for the remainder of the year (some past exam questions have involved the *interpretation* of error bars, but no actual error propagation), and including it here really is about extending the kids and pushing them towards a University standard. The kids could minimise the amount of error propagation required through stating a few assumptions i.e., that the velocity at the bottom of the ramp is independent of the mass of the cart (only true if ramp is truly frictionless).

Also, I would award the marks even if this appears in the “Results” section of the student report rather than the “Discussion” section of their report.

\*See “Sample Calcs” pdf for further detail. Note that this document provides more detail than I expect from students, unless their understanding of error propagation is top-notch, hence my suggestion above for some leniency in marking this dot-point.