Groups' Responses to Discussion Questions: Connected Bodies

Question 1: Suggest some scenarios of two body problems and connected bodies.

- Trains, Blocks connected by string, Abseiler falling off cliff with person at top being dragged, Two blocks on inclined planes, Vehicle towing object, Elevators, Pulleys, Trains of locomotive plus several wagons, Water skiing, 4WD pulling a caravan, Inclined plane with frictional forces, Small mass pushing a larger mass, Tugboat, Sleds.
- Big problem with scenarios relating to modern students, particularly girls.
- Variations of experiment, i.e. i) two different masses hanging vertically over a pulley, ii) one mass hanging off a table pulling another on the table, iii) two masses both on a table, one being pulled.
- Do a variation of the Prac demo to show that tension is present and acting on both masses.
  Equipment: Two masses, one hanging, the other a glider on an air track or a dynamics trolley on the bench. A string connects the two masses over a pulley. The ends of the string are connected to each mass via a short length of elastic cord, with the lengths of cord the same.
  Method: When the hanging mass is released, the masses will accelerate and the cords stretch.

Question 2: What mistakes do your students make?

- Students don't realise that both bodies accelerate at the same rate and that acceleration does not = g.
- Not considering the whole system to calculate acceleration. Forgetting combined mass leading to incorrect acceleration and tension value. Not identifying forces acting on each body within the system; confusing whether F or a is common; don't include 2^{nd} mass in acceleration calculations.
- Assume falling block is falling at g. Consider both masses as being accelerated by g.
- Not reading the whole question. Losing track of what they are trying to find. Partially answering, incorrect diagrams.
- Students misunderstand frictionless surfaces. Students forget about friction. Assume frictionless means mass on table is irrelevant.
- Assuming string tension only acts on one mass and not on the other. Misunderstanding tension as an internal force, that is, tension force acting in both directions and equal in strength. Direction of T incorrect. Students consider it a free fall problem, but is not, forget the tension.
- Not being able to deal with translation of force around a pulley.
- Similarity of hanging mass situation and pulled mass situation.

Question 3: How would you modify the strategy and also the exam technique.

- Lost of pracs to cement understanding that it falls at a slower rate than they often think it will.
- Considering mass of the system as well as the driving force.
- More practical experiments to start maybe measure all components of experiment then calculate to compare actual with theoretical. Repeat experiments at the end. Form standard process. 1. Draw, 2. Analyse and write down knowns and unknowns, 3. write formula(e), 4. Substitute and solve. 5. Check does it make sense
- i) FBD: Masses - system, individual, ii) Label all forces, iii) Direction, iv) Write force equations.
- Focus on falling mass as the driving force. Emphasise same acceleration. Tension from N3 Law. Total mass is not falling mass. .
- Suggest adding 'Consider 3rd law for interaction between bodies'
- Provide multiple contexts with similar / different examples. Use a POE when presenting the concept, ask students to predict, then observe and record with tracker. Then explain and evaluate with mathematical modelling to show how the systems works with Newton's laws.
- Use video for analysis, if no access to photogates.
- FBDs, use of tensiometer / spring balance; ticker timer, sensor gates, compare measurements with calculations.
- Understanding steps from horizontal problem to gravity 90^0 problem to pulley problem. Use visual and experimental demos.
- Isolate the objects in a system; include a vector (direction); revisit practical in Year 12, add friction, incline; include motion analysis with tracker; Predict – Observe – Explain.
- Is the system accelerating? If so, there must be a net force?