

## How to solve quantitative problems

*It is a mistake to think that solving problems is a purely intellectual exercise; determination and emotions can play an important role. You must summon up a real desire for solving the problem before you begin. The real secret of success is to throw your whole personality into its solution.*

George Polya, in *How to Solve It*

### **FIRST – Understand the problem**

- Read the question carefully. Do you understand all the concepts or technical terms referred to in the problem?
- What do you need to find? What data is given? Is there any information implied though not explicitly mentioned?
- Introduce conventional notation. Regard this as an exercise in *translation* - from ordinary language into mathematical language. Choose suitable signs if more than one direction is involved. Change the data to consistent (SI?) units if appropriate.
- Try to visualise the problem. Draw a labelled diagram or sketch graph. Diagrams from different points of view, or at different times, may be helpful.

### **SECOND - Plan the steps in your solution**

- Concentrate on the unknown. Can you re-state the problem?
- What major principle or concepts are involved? Go back to definitions.
- Is all the data relevant to the problem? Are the data linked? Can you write down an equation?
- Use your knowledge and experience. Have you seen this problem, or a similar problem, before? Or have you seen the same problem in a slightly different form?
- Do you know a related problem? Should you introduce one or more 'stepping stones', in order to solve the problem set? Try working backward from the solution, to discover intermediate steps.
- Explore incomplete ideas to see where they lead. Can you see 'light at the end of the tunnel'? 'Brainwaves' come from knowledge of concepts, a proper understanding of the problem, and intuition. Intuition improves with practise.

### **THIRD – Carry out your plan**

- Work patiently, quickly and carefully. Leave a trail. Your procedural steps should be clear to another person reading your work later (it may even be you!).
- Keep a lookout for signs of progress.
- If you feel you are not making progress, go back to the first two steps – review your understanding of the problem and your plan of attack. Ask yourself 'what am I missing or what do I need to know to make progress here?' and 'Am I stuck because of lack of knowledge or because of an inability to apply a principle or concept?'

### **FOURTH – Look back and check your solution**

- Do you really believe the answer you got? Are numerical values and units sensible?
- Check each step. Can you see clearly that each step is correct?
- Can you derive the result differently? Can you see it 'at a glance'?
- Afterwards it is sometimes useful to ask yourself, 'what did I learn that was new by solving this problem?'