Solving physics exercises

AIMS

Clarify: to help us understand the problem and picture the physical processes, we need

- a **clear, methodical, structured layout**, starting with
- a **diagram**

We may also sketch, or at least have in mind,

- a **flow diagram** of our strategy for solution.

Solve and test: we need the route to our answer to be reliable and testable. Crucially, the solution must be

- **logical**, so that we can examine every step to check its validity. Remember that physics was historically known as *Natural Philosophy*.
- **complete**, including dimensions (**units** and **vectors**), so that we can see what we're checking
- **honest** – because if we write down something untrue, or which doesn't follow logically, then it's probably wrong

Communicate and convince (ourselves and others) of the physics and our method of solution. We may need to look back on our working; certainly, others will need to be able to follow it. We should therefore

- give a **commentary**: explanatory phrases, stating (in English) the physical laws as they're introduced, and noting explicitly any assumptions (including specific values of constants and parameters, simplifications or limitations)
- indicate key points by underlining the solution, writing '$\Rightarrow$' or '$\therefore$', and noting 'QED', etc.

LAYOUT

Our solutions have four distinct components, which may indeed appear in the order below although they're usually distributed as fragments:

- a **diagram** — this establishes the problem, defines coordinates and dimensions, and forces us to think about what the question means
- **fundamental principles** — physical laws, which are *general* assumptions about the behaviour of the system
- **assumptions** — approximations, specific values and regime limitations, which are *particular* assumptions
- **mathematics** — a series of steps, which introduce no new physical information but allow us to view the original physical truths from a different perspective. (An origami swan is still a square piece of paper, although it looks quite different.)

For amusement, we could colour these components differently in our solution: at least try and think of each of these parts separately. In Wolfson, problem solving is described with the acronym IDEA (Interpret, Develop, Evaluate and Assess), which contain all of the above components. Read Chapter 1 for more tips and important advice.

There are plenty of examples of well-laid-out solutions, in text books, and lecture hand-outs. Students should expect to build a library of texts, and should be inspired by photographs of notorious scientists and researchers, almost always taken against a backdrop of books.

TIPS

DO:

- check logic, validity and dimensions (including vectors)
- work in an algebraic form until as late as possible
- check limiting regimes ($x = 0$, $x \to \infty$ etc)
- sketch graphs of solutions

DON'T:

- introduce equations without explanation: if you don't understand them, they're probably inappropriate
- make big steps: errors are more likely, and they're harder to check
- insert specific numerical values too early

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