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The new AP Physics exams: Integrating qualitative and quantitative reasoning

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When physics instructors and education researchers emphasize the importance of integrating qualitative and quantitative reasoning in problem solving, they usually mean using those types of reasoning serially and separately: first students should analyze the physical situation qualitatively/conceptually to figure out the relevant equations, then they should process those equations quantitatively to generate a solution, and finally they should use qualitative reasoning to check that answer for plausibility (Heller, Keith, & Anderson, 1992). The new AP Physics 1 and 2 exams will, of course, reward this approach to problem solving. But one kind of free response question will demand and reward a further integration of qualitative and quantitative reasoning, namely mathematical modeling and sense-making— inventing new equations to capture a physical situation and focusing on proportionalities, inverse proportionalities, and other functional relations to infer what the equation "says" about the physical world. In this talk, I discuss examples of these *qualitative-quantitative translation* questions, highlighting how they differ from both standard quantitative and standard qualitative questions. I then discuss the kinds of modeling activities that can help AP and college students develop these skills and habits of mind.