Grading Guide for the Matter & Energy Unit

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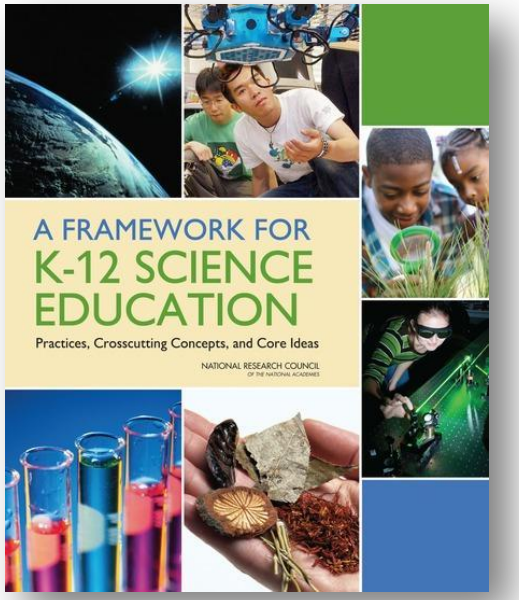
Grading for Sophistication

- **In our biology courses, we require more than just correct answers.**
  - To receive full credit on a test question, a student's answer needs to be both correct and sufficiently sophisticated.
- **By sophisticated, we mean the following:**
  - Accurate – their answer is conceptually accurate without any factual errors.
  - Precise – their answer uses all appropriate terminology to convey their ideas in a specific, exact, and thorough manner.
  - Complete – their answer explicitly addresses all relevant details (e.g., they specifically note what happens to all energy and matter in the reaction).

Why do we do this?

- **This approach to biology instruction may seem different from more traditional science courses.**
  - Admittedly, we are expecting much more from student performances in comparison to options like a multiple-choice test.
- **This approach is in response to recommendations from the consensus of research in science education (NRC, 2012).**
  - We now better recognize that to develop scientifically literate students, we cannot simply ask students to memorize facts.
  - Instead, we now prepare students to systematically utilize knowledge and practice to make informed decisions using credible evidence & logic.
  - This requires a research-based approach to teaching and assessment.



Examples of Student Responses

- **In the following slides, you will see examples of different student responses.**
  - Each writing sample provides insights into the different levels of sophistication we can expect from student responses.
  - Each of these examples are paraphrased.
- **These writing samples provide examples of the following levels of sophistication:**
  - Level 1: Student's comprehension of core ideas is still in progress. More time and instruction is required prior to advancing to the next unit.
  - Level 2: While the student understands some of the core ideas in this unit, they are struggling to accurately describe these concepts. They may need additional instruction.
  - Level 3: The student clearly understands the core ideas and can accurately and precisely describe these ideas in writing.

Example of a Level 1 Response

- **Q: What do you think happens to the atoms in fuel when it is combusted?**
- A: *It releases energy*
- **Q: What do you think happens to the chemical energy in fuel when it is combusted?**
- A: *It is used to make new substances.*

- **Accuracy**
  - *The atoms themselves do not release energy. They are rearranged to form new molecules.*
  - *High energy bonds (C-C, C-H) are transformed into heat and light energy.*
- **Precision**
  - *There is no use of specific terms from the unit, such as atoms, molecules, or high energy bonds.*
- **Completion**
  - *It is not clear what happens to the atoms in ethanol and oxygen molecules. It also does not address which kinds of energy have been transformed.*

Example of a Level 2 Response

- **Q: What do you think happens to the atoms in fuel when it is combusted?**
- A: *The atoms are being rearranged and moved to different objects and loses mass.*
- **Q: What do you think happens to the chemical energy in fuel when it is combusted?**
- A: *The chemical energy is used to form different molecules.*

- **Accuracy**
  - *The atoms are rearranged into new molecules; however, much of the chemical energy is transformed into heat & light.*
- **Precision**
  - *There is limited use of some of the terms from the unit.*
- **Completion**
  - *These answers only partially address what happens to matter and energy. It does not tell us what the products and reactants are. It does not address where all of the energy is going.*

Example of a Level 3 Response

- **Q: What do you think happens to the atoms in fuel when it is combusted?**
- A: *The atoms in O2 and ethanol molecules are rearranged into CO2 and H2O molecules.*
- **Q: What do you think happens to the chemical energy in fuel when it is combusted?**
- A: *The chemical energy (high energy bonds: C-C & C-H) in ethanol is being changed into heat and light energy.*

- **Accuracy**
  - *All of the content here is accurate, and their response clearly indicates they understand that matter and energy are different but both are conserved.*
- **Precision**
  - *This response uses most unit terms in a precise manner that accurately conveys their understanding.*
- **Completion**
  - *This response addresses the movement of all matter and energy during the combustion reaction. It indicates the movement of specific atoms on specific molecules and addresses how energy is transformed.*

What about grading?

- **Generally, summative assessments (i.e., unit tests) will consist of a mixture of multiple choice questions, written justifications, and short answer questions.**
  - Multiple choice questions are typically graded as either correct/incorrect (i.e., full credit or no credit).
  - Written answers are graded based on sophistication.
    - For example, an answer at a Level 2 sophistication could receive 2 out of 3 points.
- **Note that a "sophistication level" and a "grade" are not necessarily the same thing.**
  - If warranted, a test question could potentially use a grading scale that isn't perfectly aligned with the sophistication scale.
  - For example, if an assessment consists entirely of short answer questions, it may be more appropriate to make a Level 3 response worth 100%, Level 2 responses worth 80%, and provide retake options for Level 1 responses.