Multiple Representations

1 What are they?

An external representation is something that stands for, depicts, symbolizes or represents objects and/or processes. Examples in physics include words, diagrams, equations, graphs, and sketches. The positive role of multiple representations in student learning has been suggested by many educators. H. Simon said: "Finding facilitating representations for almost any class of problem(s) should be seen as a major intellectual achievement, one that is often greatly underestimated as a significant part of both problem solving efforts in science and efforts in instructional design."

2 Why do you want to use them?

- *Multiple Intelligences*
  Students learn in different ways. Different representations are compatible with different learning styles.

- *Visualization for the brain*
  Physical quantities and concepts can often be visualized and understood better using concrete representations.

- *Help construct another type of representation*
  Some concrete representations help in constructing a more abstract (often mathematical) representation.

- *Some representations are useful for qualitative reasoning*
  Qualitative reasoning is often assisted by using a concrete representation.

- *Abstract math representations are used for quantitative reasoning*
  A mathematical representation can be used to find a quantitative answer to a problem.

3 How do you use them?

- *Steps in using representations*

  1. Identify key components
     Each representation can help students understand and use a key physics concept. Identify what those concepts are and how students can benefit from the representations.

2. Construct other representations
   With a key concept in mind, you can create another type of representation focusing on that same concept.

- *Using in the classroom*

1. Formative assessment
   (a) Give one representation, have students create another.
   (b) Give two or more representations, have students check for consistency between them.
   (c) Give one representation, have students choose a second consistent one from multiple choices.
2. Summative assessment
   These representations can be used as an alternative to traditional test questions using the methods described above.

4 What are some types?

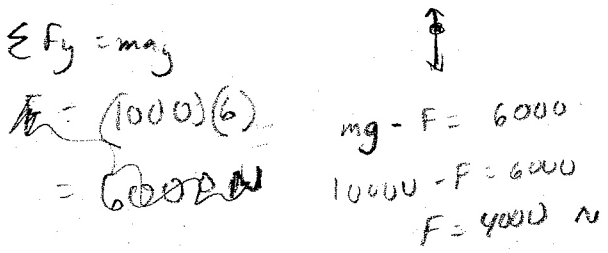
- Verbal Descriptions
- Pictures
- Graphs
- Mathematical
- Motion Diagrams
- Free Body Diagrams
- Energy Bar Charts
- Momentum bar charts
- Field line diagrams
- Electrical Circuit Diagrams
- Ray Diagrams
- Wave front diagrams
- Energy states diagrams

5 How do you score them?

Look at the example and the multiple representation rubric to see how and why we scored this problem the way we did.

12. The cable in a 1000-kg elevator snaps and it slides down the shaft with a 6.0-m/s^2 downward acceleration (friction pads prevent it from free fall). What answer below is closest to the magnitude of the friction force of the pads on the elevator?

    a) 16000 N
    b) 4000 N
    c) 14000 N
    d) 6000 N
    e) 10000 N



- Is able to extract information from the representation
  SCORE: 2
  The information is not clearly labeled by using something like a dictionary of variables. Even though all information is extracted correctly, the student did not use any labels.

- Is able to construct a different helpful representation (other than mathematical) from a previous representation
  SCORE: 2
  You can see that the free body diagram is drawn. Even though there are no labels and no axis, the lengths and directions of the arrows are not flawed.

- Is able to evaluate the consistency of different representations and modify them when necessary
  SCORE: 3
  Even though the representation is missing labels, you can see that the mathematical description below it is in agreement with the above free body diagram. You can also see that the mathematical representation on the left has been crossed out because it is not consistent with the problem situation.

- Is able to use a helpful representation to solve problems
  SCORE: 3
  The student gave choice b as an answer for this problem. The question was answered correctly with the use of a representation other then mathematical.

- Free-Body Diagram
  SCORE: 2
  The lengths of the arrows are appropriate in magnitude and in the correct direction, but there are no labels and there is no axis labeled.

- Mathematical representation
  SCORE: 3
  To solve the problem take the sum of the forces in the y direction equal to mass times acceleration in the y direction. Progression of steps is easy to follow.