

Ability to represent information in multiple ways

Scientific Ability		Missing	Inadequate	Needs some improvement	Adequate
1	Is able to extract the information from representation correctly	No visible attempt is made to extract information from the problem.	Information that is extracted contains errors such as labeling quantities incorrectly.	Some of the information is extracted correctly, but not all of the information. Numbers are just extracted with correct labels but no units are extracted with them.	All necessary information has been extracted correctly and is visible through a constructed representation.
2	Is able to construct new representations from previous representations	No attempt is made to construct a different representation.	Representations are attempted, but use incorrect information or the representation does not agree with the information used.	Representations are created without mistakes, but there is information missing, i.e. labels, variables.	Representations are constructed with all given (or understood) information and contain no major flaws.
3	Is able to evaluate the consistency of different representations and modify them when necessary	No representation is made to evaluate the consistency.	At least one representation is made but there are major discrepancies between the constructed representation and the given one.	Representations created agree with each other but may have slight discrepancies with the given representation. Can be seen that modifications were made to a representation.	All representations, both created and given, are in agreement with each other.
4	Is able to use representations to solve problems	No attempt is made to answer the problem.	Question is answered incorrectly.	Question is answered correctly without the use of a representation.	Question is answered correctly with the use of a representation other than a mathematical.

Representations students can make

5	Free-Body Diagram	No representation is constructed.	FBD is constructed but contains major errors such as incorrect mislabeled or not labeled force vectors, length of vectors, wrong direction, extra incorrect vectors are added, or vectors are missing.	FBD contains no errors in vectors but lacks a key feature such as labels of forces with two subscripts or vectors are not drawn from single point or axes are missing.	The diagram contains no errors and each force is labeled so that it is clearly understood what each force represents.
6	Motion Diagram	No representation is constructed.	Diagram does not show proper motion, either by lengths of arrows are incorrect or missing and or spacing of dots are incorrect.	Diagram has no errors but is missing a key feature such as dots that represent position r velocity arrows or velocity change arrows.	The diagram contains no errors and it clearly describes the motion of the object.
7	Picture	No representation is constructed.	Picture is drawn but it is incomplete with no physical quantities labeled, or important information is missing, or it contains a wrong information, or coordinate axes are missing.	Picture has no incorrect information but has either no or very few labels of given quantities. Majority of key items are drawn in the picture.	Picture contains all key items with the majority of labels present.

8	Energy Bar Chart	No representation is constructed.	Bar chart is either missing energy values, values drawn do not show the conservation of energy or are drawn in the wrong places. Bar chart levels could also be labeled incorrectly	Bar chart has the energy levels drawn correctly, but are missing labels. Energy levels could be in the correct spot, but may not be of proper relative size.	Bar chart is properly labeled and has energy levels at appropriate magnitudes.
9	Mathematical	No representation is constructed.	Mathematical representation lacks the algebraic part (the student plugged the numbers right away) has the wrong concepts being applied, signs are incorrect, or progression is unclear. The first part should be applied when it is appropriate.	No error is found in the reasoning, however they may not have fully completed steps to solve problem or one needs effort to comprehend the progression.	Mathematical representation contains no errors and it is easy to see progression of the first step to the last step in solving the equation.
10	Ray Diagram	No representation is constructed.	The rays that are drawn in the representation do not follow the correct paths. Object or image may be located at wrong position.	Diagram is missing key features but contains no errors. One example could be the object is drawn with the correct lens/mirror but rays are not drawn to show image. Or the rays are too far from the main axis to have a small-angle approximation.	Diagram has object and image located in the correct spot with the proper labels. Rays are correctly drawn with arrows and contain at least two rays.