Photon PBL
Concept Mapping “101”
Tutorial & Scoring Rubric
Concept Mapping “101”

What is a concept map?

- Developed in the early ’70s by Joseph Novak at Cornell University as a graphical way for science students to show how well they understand concepts taught in the classroom.
- Concept mapping is a technique for visualizing the relationships among different concepts.
  - **Nodes** represent concepts
  - **Lines** represent relations between concepts, arrowheads indicate direction
  - **Labels** on the lines describe the nature of the relationship
- These three components create **propositions** or units of meaning
Coffee Beans

Hot Water

A Cup of Coffee

contains

can be lightened with

Caffeine

increases

Coffee Beans

naturally have

inhibits

Mental Alertness

Sugar

can be sweetened with

A Cup of Coffee

can be removed from

Sleep
Concept Mapping “101”

Constructing a Concept Map

1. Generate a question relating to a particular topic of interest
2. List all concepts or items related to that topic
3. Write each concept or item on a Post-It® note – one word or phrase per note
4. On a white board or table, group related concepts or items together in a hierarchal manner
5. Connect concepts or items using lines and arrows with words or short phrases that describe the relationship between them
6. Examine the linkages to make sure each relationship forms a valid proposition.
7. Rearrange and/or remove concepts to simplify and clarify the concept map
8. When you are satisfied with your concept map, convert it to a permanent graph on a piece of paper
Example: How to make pasta like an Italian mother

Concepts & Items Related to Making Pasta
- Pasta
- Boiling Water
- A Good Pot
- Sauce
- Spices
- Grated Cheese
- Al dente
- Colander
- Good Wine
- Crusty Bread
- Italian Mother
**Concept Map Exercise: What is Light?**

1. **Break students into groups of 3-4 people**
2. **Construct a concept map for the following photonics-related concepts (Use Post-Its and a White Board)**

   - Lasers
   - Reflection
   - Diffraction
   - Rays
   - Optics
   - Interference
   - Refraction
   - Wavelength
   - Mirrors
   - Polarization
   - Lenses
   - Coherence
   - Light
   - Photons
   - Waves
   - Fraunhofer
   - Fresnel
   - Electro-Magnetic Energy

- **Add additional concepts if necessary**
- **Show as many connections as possible**
- **Label each connection**
Example: What is Light?

- **Electro-Magnetic Energy**
  - Refraction
    - Lenses
      - Optics
        - Rays
          - Photons
            - Waves
              - Light

- **Diffraction**
  - Fraunhofer
    - interferes
      - waves
        - Coherence
          - Wavelength
            - single
              - interference

- **Reflection**
  - Mirrors
    - Transmissive
      - Lenses
        - Optics
          - Rays
            - Photons
              - Waves
                - Light

- **Lasers**
  - are generated by stimulated emission
    - Polarization
      - can produce light with
        - coherence
          - wavelength
            - single
              - interference

- **Reflection**
  - produces feedback needed for stimulated emission
    - Lasers
      - Optical energy is required for stimulated emission
        - Coherence
          - Wavelength
            - single
              - interference

- **Fraction**
  - bend light through
    - Lenses
      - Optics
        - Rays
          - Photons
            - Waves
              - Light

- **Interference**
  - is a measure of the phase relationship between
    - Waves
      - can combine to produce
        - light
          - interference

- **Coherence**
  - requires light of single
    - Wavelength
      - coherence
        - interference

- **Index**
  - is dependant on
    - and incident angle can affect
      - Lasers
        - Optical energy is required for stimulated emission
          - Coherence
            - Wavelength
              - single
                - interference

Concept Mapping “101”
# Concept Mapping “101”

## Photon PBL Concept Map Scoring Rubric

<table>
<thead>
<tr>
<th>Assessment Criteria</th>
<th>Excellent = 4</th>
<th>Good = 3</th>
<th>Fair = 2</th>
<th>Poor = 1</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concept Validity</strong></td>
<td>• Student correctly identifies all relevant concepts and items related to the topic.</td>
<td>• Student correctly identifies most relevant concepts and items related to the topic</td>
<td>• Student correctly identifies some relevant concepts and items related to the topic</td>
<td>• Student correctly identifies few or no relevant concepts and items related to the topic</td>
<td></td>
</tr>
</tbody>
</table>
| **Proposition Validity** | • All propositions are complete and valid.  
  • Linking lines connect related terms and point in correct direction.  
  • Linking words accurately describe relationship between concepts.  
  • Student shows a deep understanding of the relationship between concepts.  
  • All or most concepts are linked to more than one related concept. | • Most propositions are complete and valid.  
  • Most linking lines connect properly.  
  • Most linking words accurately describe the relationship between concepts.  
  • Student shows a good understanding of the relationship between concepts.  
  • Most concepts are linked to more than one related concept. | • Correct but incomplete propositions.  
  • Linking lines not always pointing in correct direction.  
  • Linking words are absent or don’t clarify relationships between concepts.  
  • Student shows a partial understanding of the relationship between concepts.  
  • Some concepts are linked to more than one related concept. | • Few or no valid propositions.  
  • Linking lines do not point in correct direction.  
  • Linking words are absent or incorrectly identify relationships between concepts.  
  • Student shows a lack of understanding of the relationship between concepts.  
  • Some concepts are not linked to more than one related concept. | |
| **Presentation** | • Concept map is neat, clear, legible, and has easy to follow links.  
  • No spelling or grammatical errors. | • Concept map is neat, clear, legible, and has easy to follow links.  
  • Has some spelling or grammatical errors. | • Concept map is messy and has somewhat difficult to follow links.  
  • Has many spelling or grammatical errors. | • Concept map is sloppy and links are difficult or impossible to understand.  
  • Has many spelling or grammatical errors. | |

**Total Score**