The MEL Project Teacher Guide

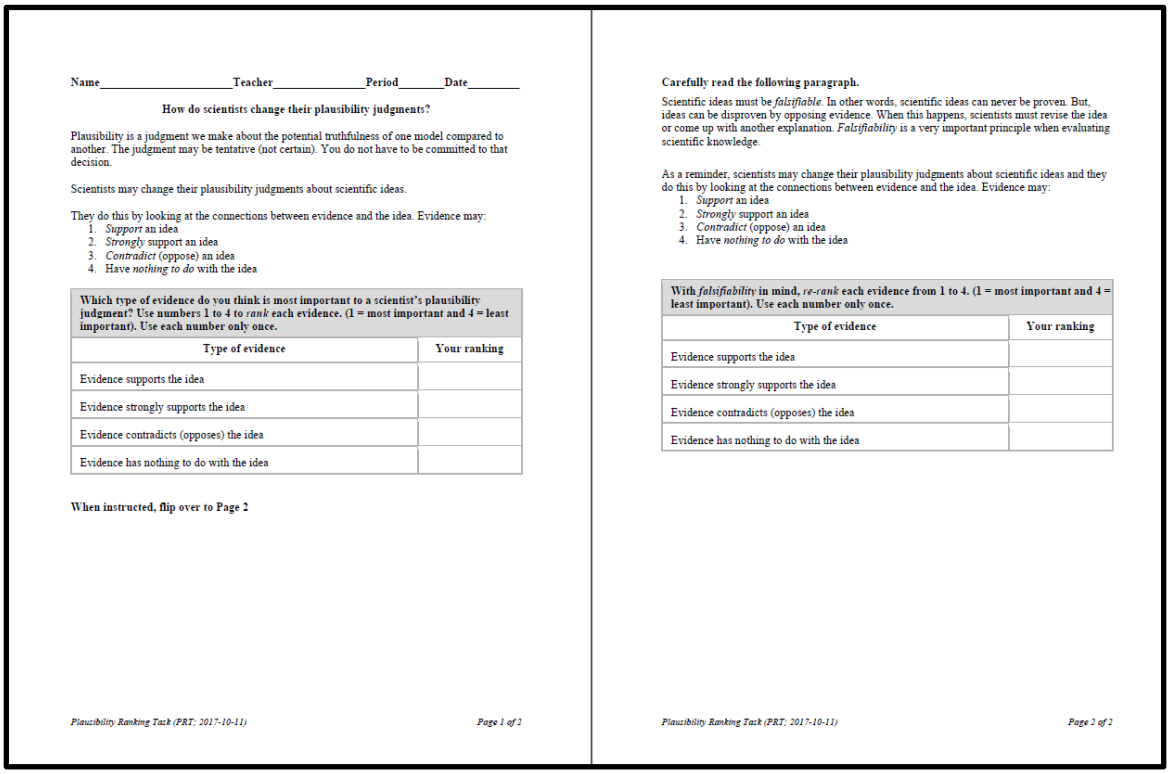
MEL and baMEL Directions and Hints

Temple University
SCIENCE LEARNING
RESEARCH GROUP

The MEL activities help students to be critically evaluative to support scientific thinking. Models must be coordinated with lines of evidence to help build an argument about the causes and effects of a particular phenomenon and its systematic relationships.

1. Complete the ***Plausibility Ranking Task*** (PRT)

   This task normally takes about 20 minutes and is only done once, or twice at most. If you do multiple MELs/baMELs with a given set of students, keep that in mind. This task helps develop understanding about how scientists make judgments about the connection between evidence and models.



Name_____Teacher_____Period_____Date_____

How do scientists change their plausibility judgments?

Plausibility is a judgment we make about the potential truthfulness of one model compared to another. The judgment may be tentative (not certain). You do not have to be committed to that decision.

Scientists may change their plausibility judgments about scientific ideas.

They do this by looking at the connections between evidence and the idea. Evidence may:
1. *Support* an idea
2. *Strongly* support an idea
3. *Contradict* (oppose) an idea
4. Have *nothing to do* with the idea

Which type of evidence do you think is most important to a scientist's plausibility judgment? Use numbers 1 to 4 to *rank* each evidence. (1 = most important and 4 = least important). Use each number only once.

Type of evidence	Your ranking
Evidence supports the idea	
Evidence strongly supports the idea	
Evidence contradicts (opposes) the idea	
Evidence has nothing to do with the idea	

When instructed, flip over to Page 2

Plausibility Ranking Task (PRT; 2017-10-11) *Page 1 of 2*

Carefully read the following paragraph.

Scientific ideas must be *falsifiable*. In other words, scientific ideas can never be proven. But, ideas can be disproven by opposing evidence. When this happens, scientists must revise the idea or come up with another explanation. *Falsifiability* is a very important principle when evaluating scientific knowledge.

As a reminder, scientists may change their plausibility judgments about scientific ideas and they do this by looking at the connections between evidence and the idea. Evidence may:
1. *Support* an idea
2. *Strongly* support an idea
3. *Contradict* (oppose) an idea
4. Have *nothing to do* with the idea

With *falsifiability* in mind, *re-rank* each evidence from 1 to 4. (1 = most important and 4 = least important). Use each number only once.

Type of evidence	Your ranking
Evidence supports the idea	
Evidence strongly supports the idea	
Evidence contradicts (opposes) the idea	
Evidence has nothing to do with the idea	

Plausibility Ranking Task (PRT; 2017-10-11) *Page 2 of 2*

   a. First, have students make an initial ranking of the importance of four categories of connections between evidence and models, where a line of evidence:
      i. strongly supports a model,
      ii. supports a model,
      iii. has nothing to do with a model, or
      iv. contradicts a model.

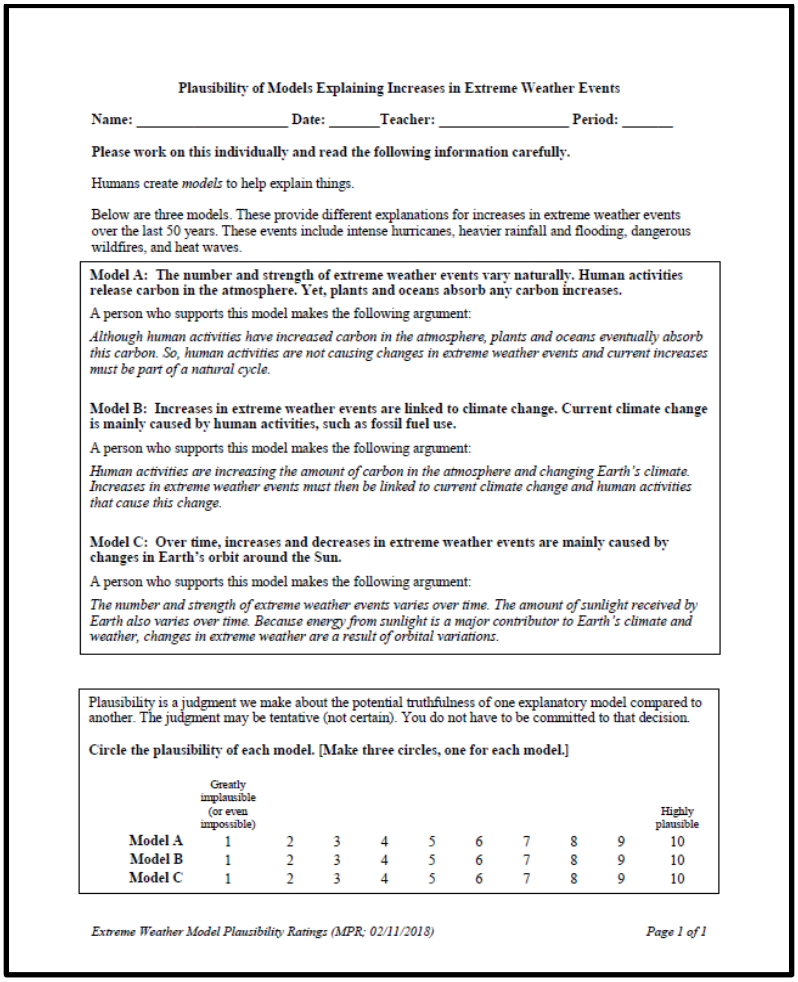
> *Guiding Questions:*
> Workshop teachers: What do you think?

   b. Second, have the students read the short passage about tentative nature of scientific information and falsifiability (the ability for a scientific idea to be proven false), as well as the relationship between contradictory evidence and falsifiability

c. Third, conduct a short, whole class discussion with the students about the falsifiability passage.
d. Fourth, then have the students re-rank the importance of the categories.

2. Rate the plausibility of the three baMEL models using ***Model Plausibility Ratings*** (MPR) sheet

Completing this sheet takes about 10 minutes and introduces students to the models they will be considering for the baMEL and re-introduces students to idea of plausibility judgements. This should be done as the first activity for each baMEL



Plausibility of Models Explaining Increases in Extreme Weather Events

Name: _____ **Date:** _____ **Teacher:** _____ **Period:** _____

Please work on this individually and read the following information carefully.

Humans create *models* to help explain things.

Below are three models. These provide different explanations for increases in extreme weather events over the last 50 years. These events include intense hurricanes, heavier rainfall and flooding, dangerous wildfires, and heat waves.

Model A: The number and strength of extreme weather events vary naturally. Human activities release carbon in the atmosphere. Yet, plants and oceans absorb any carbon increases.

A person who supports this model makes the following argument:

Although human activities have increased carbon in the atmosphere, plants and oceans eventually absorb this carbon. So, human activities are not causing changes in extreme weather events and current increases must be part of a natural cycle.

Model B: Increases in extreme weather events are linked to climate change. Current climate change is mainly caused by human activities, such as fossil fuel use.

A person who supports this model makes the following argument:

Human activities are increasing the amount of carbon in the atmosphere and changing Earth's climate. Increases in extreme weather events must then be linked to current climate change and human activities that cause this change.

Model C: Over time, increases and decreases in extreme weather events are mainly caused by changes in Earth's orbit around the Sun.

A person who supports this model makes the following argument:

The number and strength of extreme weather events varies over time. The amount of sunlight received by Earth also varies over time. Because energy from sunlight is a major contributor to Earth's climate and weather, changes in extreme weather are a result of orbital variations.

Plausibility is a judgment we make about the potential truthfulness of one explanatory model compared to another. The judgment may be tentative (not certain). You do not have to be committed to that decision.

Circle the plausibility of each model. [Make three circles, one for each model.]

	Greatly implausible (or even impossible)									Highly plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10
Model C	1	2	3	4	5	6	7	8	9	10

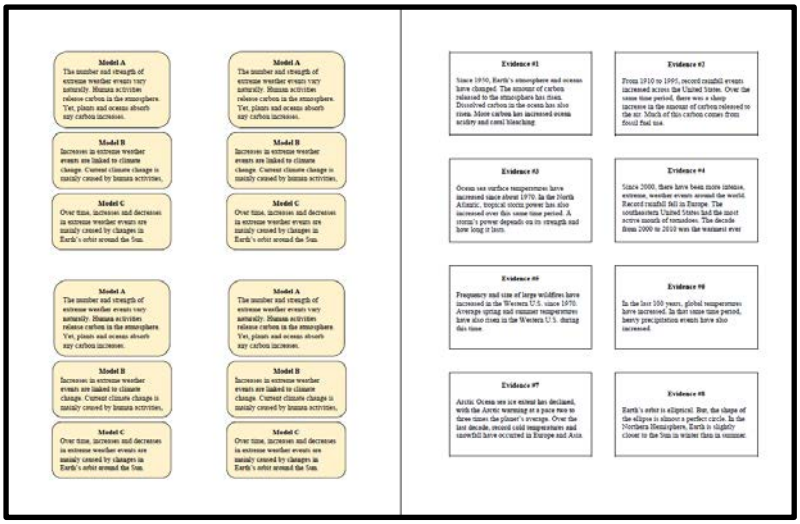
Extreme Weather Model Plausibility Ratings (MPR; 02/11/2018) *Page 1 of 1*

e. Students individually read about the three models and plausibility
f. Hold a class discussion to answer questions about the model and plausibility
g. Have the students rate the plausibility of each model...make sure the draw a circle around one number for each model (there should be three circles)

Topic Hint: Origins of the Universe
The distinction between models A and C is subtle. Encourage students to look at the differences in vocabulary.

3. Use the ***baMEL*** lines of evidence and three models to construct a ***MEL diagram.***
   This is a completely new activity and the essence of the new build-a-MEL (baMEL). We don't know how long this will take, but thinking that this, along with the MPR (see above) will take one traditional class period (~50 minutes). The students should have the opportunity to consider and discuss all the different models and lines of evidence when making their selections.
   h. Give students the model cards and the evidence cards (these should be pre-cut prior to using). Have students lay these out. You may with to laminate the cards as they are intended for reuse.

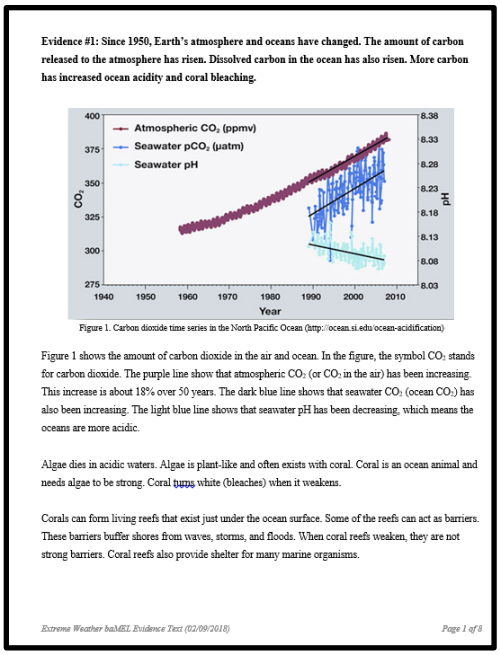
Accommodation Hint:
Laminated cards can be annotated with dry erase markers by students with language difficulties.



   i. Students should select 4 lines of evidence and 2 models from the set from which they will construct a MEL diagram.
   j. To help them in their selection of lines of evidence, they should read the one-page evidence texts. An example of one of the evidence texts is below:

Teacher Hint
Have the students place unused evidence texts to the side, face down, to make collection easier at the end of the activity.

Topic Hint: Fossils
Evidence 5 refers to coral reefs. Students might be confused by the fact that reefs are on the Earth's surface even though they are under water.



Evidence #1: Since 1950, Earth's atmosphere and oceans have changed. The amount of carbon released to the atmosphere has risen. Dissolved carbon in the ocean has also risen. More carbon has increased ocean acidity and coral bleaching.

Figure 1. Carbon dioxide time series in the North Pacific Ocean (http://ocean.si.edu/ocean-acidification)

Figure 1 shows the amount of carbon dioxide in the air and ocean. In the figure, the symbol CO_2 stands for carbon dioxide. The purple line show that atmospheric CO_2 (or CO_2 in the air) has been increasing. This increase is about 18% over 50 years. The dark blue line shows that seawater CO_2 (ocean CO_2) has also been increasing. The light blue line shows that seawater pH has been decreasing, which means the oceans are more acidic.

Algae dies in acidic waters. Algae is plant-like and often exists with coral. Coral is an ocean animal and needs algae to be strong. Coral turns white (bleaches) when it weakens.

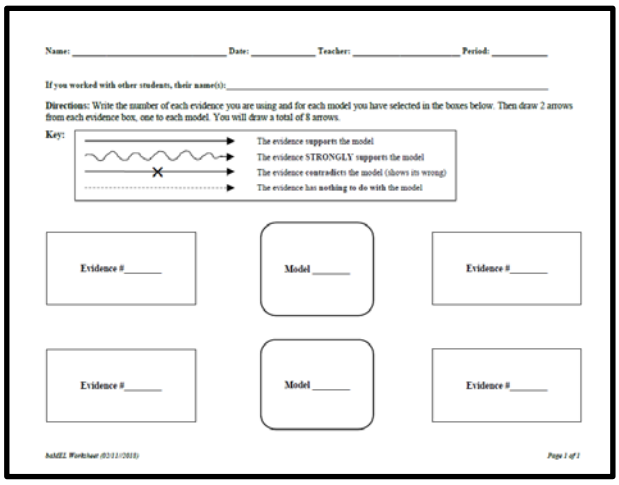
Corals can form living reefs that exist just under the ocean surface. Some of the reefs can act as barriers. These barriers buffer shores from waves, storms, and floods. When coral reefs weaken, they are not strong barriers. Coral reefs also provide shelter for many marine organisms.

Extreme Weather baMEL Evidence Text (02/09/2018) *Page 1 of 8*

k. Students may need to manipulate the cards and try different combinations in making their decisions about which models and which lines of evidence they will use in their MEL diagrams.
l. It may work best if students work in groups of three or four in constructing a MEL.
m. Once students decide their two models and four lines of evidence, they should complete the baMEL worksheet by writing in their selected model letters (A, B, or C) and lines of evidence numbers (1-8, or 1-9 for freshwater).

Teacher Hint

Have students place models in alphabetical order from top to bottom and the lines of evidence in numerical order from top to bottom/left to right. This will help everyone keep track of their work.



Name: _____ **Date:** _____ **Teacher:** _____ **Period:** _____

If you worked with other students, their name(s): _____

Directions: Write the number of each evidence you are using and for each model you have selected in the boxes below. Then draw 2 arrows from each evidence box, one to each model. You will draw a total of 8 arrows.

Key:

- The evidence supports the model
- The evidence STRONGLY supports the model
- The evidence contradicts the model (shows its wrong)
- The evidence has nothing to do with the model

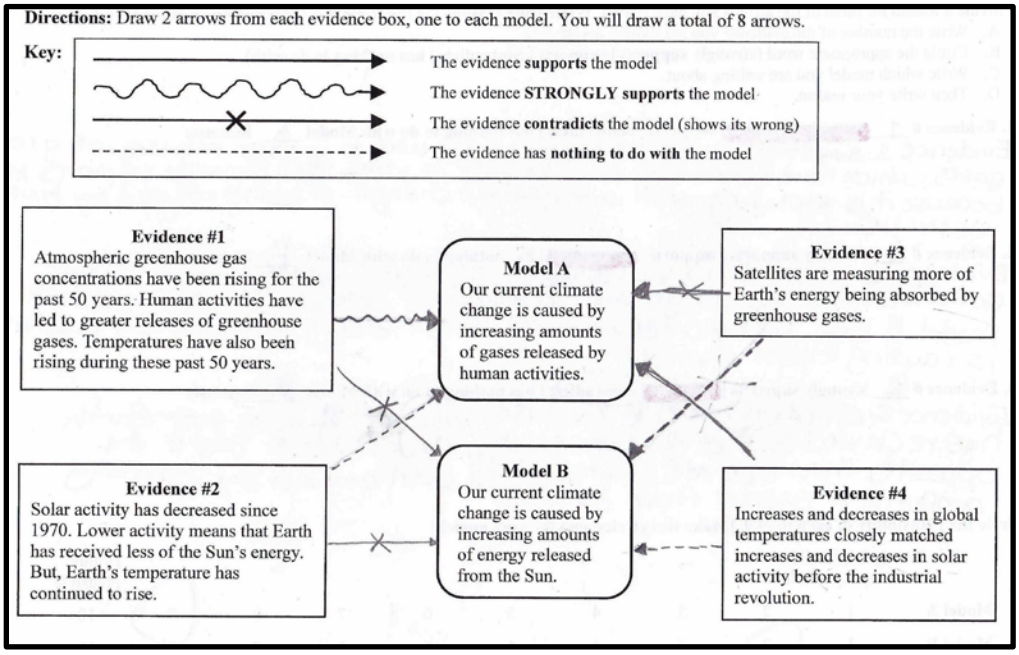
Evidence #_____ Model _____ Evidence #_____

Evidence #_____ Model _____ Evidence #_____

baMEL Worksheet (02/11/2018) *Page 1 of 1*

4. Now students are ready to complete their own ***MEL diagram***.

Along with completing the Explanation Task (see below for a student example from the Climate Change pre-constructed MEL), drawing arrows on the MEL diagram and discussing arrows in groups takes just under 1 traditional class period (~30-40 minutes).



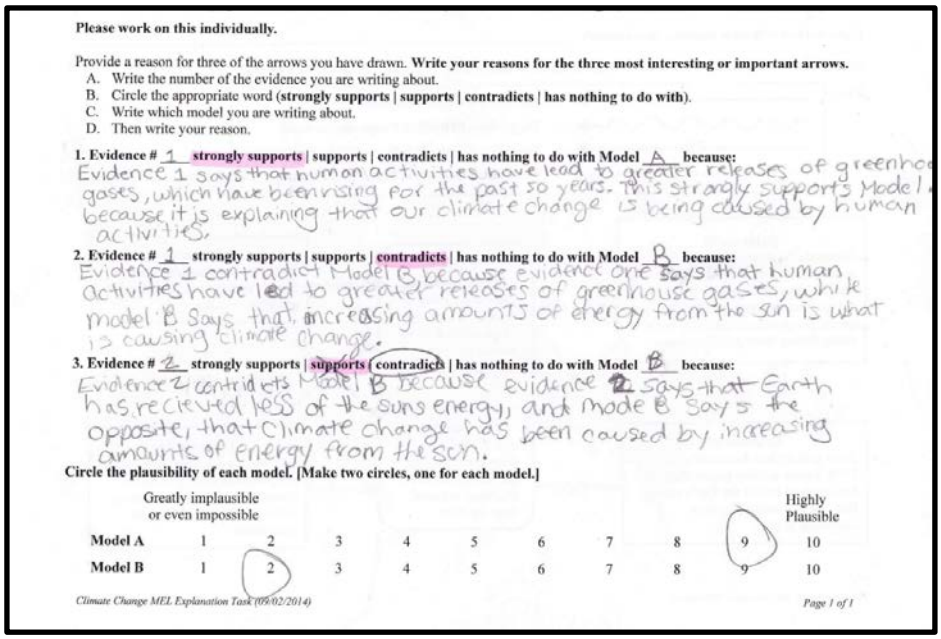
To do so:

a. Students draw arrows in different shapes to indicate their judgments (which correspond to the four categories in the ranking task) about the strength of the connection between each line of evidence and a model.
b. Straight arrows indicate that evidence supports the model; squiggly arrows indicate that evidence strongly supports the model; straight arrows with an "X" through the middle indicate the evidence contradicts the model; and dashed arrows indicate the evidence has nothing to do with the model.
c. Have students work in teams to discuss the types of connections made between the evidence and models; however, students should be told that if their thoughts lie with an arrow type that's different from their teammates, that they should not change it.

5. Students next use completed MEL diagrams in an ***Explanation Task*** to critically evaluate their links and construct understanding. This task asks students to select and write about evidence-to-model links that they had made on their MEL diagram.

Conversation Tip

Students may ask which is "scientifically correct" model. Remind them that they have pieces of evidence to help them form their own ideas about that.



Please work on this individually.

Provide a reason for three of the arrows you have drawn. **Write your reasons for the three most interesting or important arrows.**

A. Write the number of the evidence you are writing about.
B. Circle the appropriate word (**strongly supports | supports | contradicts | has nothing to do with**).
C. Write which model you are writing about.
D. Then write your reason.

1. Evidence # 1 **strongly supports | supports | contradicts | has nothing to do with Model** A **because:**
Evidence 1 says that human activities have lead to greater releases of greenho gases, which have been rising for the past 50 years. This strongly supports Model because it is explaining that our climate change is being caused by human activities.

2. Evidence # 1 **strongly supports | supports | contradicts | has nothing to do with Model** B **because:**
Evidence 1 contradicts Model B, because evidence one says that human activities have lead to greater releases of greenhouse gases, while model B says that increasing amounts of energy from the sun is what is causing climate change.

3. Evidence # 2 **strongly supports | supports | contradicts | has nothing to do with Model** B **because:**
Evidence 2 contradicts Model B because evidence 2 says that Earth has recieved less of the suns energy, and model B says the opposite, that climate change has been caused by increasing amounts of energy from the sun.

Circle the plausibility of each model. [Make two circles, one for each model.]

	Greatly implausible or even impossible									Highly Plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10

Climate Change MEL Explanation Task (09/02/2014) *Page 1 of 1*

a. In their written explanations, students identify each end of the link, with an evidence statement (which are numbered) at one end and the model (either Model A or B) at the other.
b. Students write their judgment about the strength of the link (i.e., the evidence strongly supports the model, the evidence supports the model, the evidence has nothing to do with the model, or the evidence contradicts the model).
c. Students then provide a justification for their weighting of link strength.

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