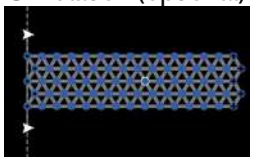
Lesson 4: Answer Key 1

Evaluating Models Key

Every model has advantages (merits) and limitations. Understanding what these are can allow us to move more flexibly between different types of models, which can help us develop a more complete explanation of how and why phenomena occur.

What types of phenomena will we be trying to explain with the different models below?
Earthquakes, elastic deformation, breaking/crack, volcanic eruptions

	Which frame(s) are you using to evaluate this model?	What are some advantages (merits) of this model?	What are some limitations of this model?
Model 1 2 foam panels slipping/breaking 	❑ Stability or change over time or space ❑ Thinking across different scales ❑ Cause and effect in M-E-F relationships	• It allows us to see some changes near the boundaries--breaking in particular, like we see on Earth--fault lines. • We can test (and have tested) the effect of external forces on matter in different directions. • The foam's structure approximates our model of two plates. • We can see evidence of energy transferred into/out of the matter. • We can see the system go from stable to changing and back again.	• It is at a different scale--much smaller than Earth plates. • The elastic deformation is still at a very small scale. We would need to slow down the video and zoom in to see it. We can't see what actually breaks and when (too fast). • We cannot see the particle-level changes. • We cannot see where energy is stored in the matter.
Model 2 Inverter magnets 	❑ Stability or change over time or space ❑ Thinking across different scales	• We can understand that two kinds of distance forces (repulsion and attraction) act on two bonded particles. • Magnetic and electric fields have a similar magnitude versus distance relationship--getting weaker with distance (but never reaching zero like Coulomb's law). • It helps us understand the particles that produce these forces (protons and electrons).	• We cannot use it directly to test our ideas. • Not all matter is magnetic. • Matter has more than two particles. • It seems hard to measure force magnitudes or energy with this model. • It is at a different scale--much smaller than Earth plates.

	❑ Cause and effect in M-E-F relationships	• It helps us use net force thinking at a particle level to explain why the bond is a certain length and goes back to that length when the distance changes a little bit. • It helps us better explain why matter returns to its original shape after it has been elastically deformed and external forces are removed. • It helps us better explain how energy is transferred into/out of matter that is elastically deformed. • It helps us visualize that breaking a bond is a result of moving two particles far enough apart, which is related to reaching an elastic limit.	
Model 3 Particle-Level Simulation (optional)  Wilensky, U. 1999. NetLogo. http://ccl.northwestern.edu/netlogo/. Center for Connected Learning and Computer-Based Modeling, Northwestern University. Evanston, IL.	❑ Stability or change over time or space ❑ Thinking across different scales ❑ Cause and effect in M-E-F relationships	• We can measure and study the net focus acting on particles. • We can see changes in energy and how they relate to changes in deformation. • We can change the timescale (slow down or speed up). • We can collect data quickly. • We can study various changes in matter, including changes in shape and breaking.	• We cannot investigate the role of temperature. • There are probably other factors affecting real materials that are not simulated.