INDEPENDENT	Factor that's intentionally varied by experimenter
DEPENDENT	Factor which may change as a result of changes to other variable
CONTROL	Group that serves as standard of comparison

CONSTANT	Factors the experimenter tries to keep the same
TRIAL	Replicate groups that are exposed to the same conditions in an experiment
HYPOTHESIS	Possible answer to a problem or question

VARIABLE	Factor that changes

Scientific Method

OBSERVE/RESEARCH

DEFINE PROBLEM

FORMULATE A HYPOTHESIS

GATHER EVIDENCE/EXPERIMENT

COLLECT AND ANALYZE RESULTS

CONCLUSION

An Overview of the 5Es		
Phase	**Purpose**	**Role of Teacher**
Engage	Create interest and stimulate curiosity. Set learning within a meaningful context. Raise questions for inquiry. Reveal students' ideas and beliefs, compare students' ideas.	Activity or multi-modal text used to set context and establish topicality and relevance. Motivating/discrepant experience to create interest and raise questions. Open questions, individual student writing, drawing, acting out understandings, and discussion to reveal students' existing ideas and beliefs so that teachers are aware of current conceptions and can plan to extend and challenge as appropriate – a form of diagnostic assessment.
Explore	Provide experience of the phenomenon or concept. Explore and inquire into students' questions and test their ideas. Investigate and solve problems.	Open investigations to experience the phenomenon, collect evidence through observation and measurement, test ideas and try to answer questions. Investigation of text-based materials (e.g. newspaper articles, web-based articles) with consideration given to aspects of critical literacy, including making judgments about the reliability of the sources or the scientific claims made in the texts.
Explain	Introduce conceptual tools that can be used to interpret the evidence and construct explanations of the phenomenon. Construct multi-modal explanations and justify claims in terms of the evidence gathered. Compare explanations generated by different students/groups.	Student reading or teacher explanation to access concepts and terms that will be useful in interpreting evidence and explaining the phenomenon. Small group discussion to generate explanations, compare ideas and relate evidence to explanations. Individual writing, drawing and mapping to clarify ideas and explanations. Formative assessment to provide feedback to teacher and students about development of investigation skills and conceptual understandings. Small group writing/design to generate a communication product (e.g. poster, oral report, formal written report or PowerPoint presentation, cartoon strip, drama presentation, letter) with attention to form of argumentation, genre form/function and audience, and with integration of different modes for representing science ideas and findings.
Elaborate (extend)	Use and apply concepts and explanations in new contexts to test their general applicability. Reconstruct and extend explanations and understandings using and integrating different modes, such as written language, diagrammatic and graphic modes, and mathematics.	Further investigations, exercises, problems or design tasks to provide an opportunity to apply, clarify, extend and consolidate new conceptual understandings and skills. Further reading, individual and group writing may be used to introduce additional concepts and clarify meanings through writing. A communication product may be produced to re-represent ideas using and integrating diverse representational modes and genres consolidating and extending science understandings and literacy practices.
Evaluate	Provide an opportunity for students to review and reflect on their own learning and new understandings and skills. Provide evidence for changes to students' understandings, beliefs and skills.	Discussion of open questions or writing and diagrammatic responses to open questions – may use same/similar questions to those used in Engage phase to generate additional evidence of the extent to which the learning outcomes have been achieved. Reflections on changes to explanations generated in Engage and Evaluation phases to help students be more metacognitively aware of their learning.

Planning with the 5 Es

Topic: ____

Engage (introduce with excitement)	
Explore (meaning of the concept)	
Explain (how the concept applies, an investigation)	
Elaborate (on the meaning or application of concept)	
Evaluate (student's level of understanding)	

Engage example: using a video as a stimulus

http://ed.ted.com/lessons/how-antibiotics-become-resistant-over-time-kevin-wu

WHO?	
WHAT?	
WHEN?	
WHERE?	
WHY?	

Explore and Explain

Read the article "Antibiotics: Understanding the Pros and Cons" by Dr. Cara Natterson.

What is the **main idea?**

Pros	Cons

Key vocabulary:

Predict: what do you think will happen if a person takes the same antibiotic six times in one year?

Elaborate: Imagine you have a farm and raise livestock. Think about what you know and have learned and decide whether you would give all of your livestock antibiotics as a preventative measure. Why/why not?

December 2, 2015

Dr. Cara Natterson Become a fan
Pediatrician and Author

Antibiotics: Understanding the Pros and Cons

Posted: 11/22/2010 7:59 am EST | Updated: 05/25/2011 6:15 pm EDT

Our country likes to split into teams over just about everything--from the broad swaths of political beliefs and religion to the narrowest minutiae of our favorite athletes. On the topic of medicine, the divisions are no less plentiful. Some prefer Western medicine and others Eastern; some are pro-vaccine and others anti; some are antibiotic enthusiasts and some are medication refusers. Ultimately, these beliefs guide what people put (and don't put) into their bodies.

Next week begins "Get Smart About Antibiotics Week," a three year old invention of the Centers for Disease Control. The goal, simply, is to educate people. You see, when it comes to medical notions, it's not okay just to pick a side. If you hail antibiotics as silver bullets or if you categorically reject them, neither approach is exactly right--or healthy. How did we wind up with such strong emotions about medication?

The antibiotic over-enthusiasts came by it honestly. When I was young, just after oral penicillin had become widely available, a pink, bubble gum flavored version 2.0 arrived in the form of amoxicillin. Most of us in our 30s, 40s and 50s can vividly remember the taste of that perfectly sweet, slightly chalky liquid going down. It seemed like whenever there was a sore throat or the slightest runny nose in our house, amoxicillin rushed to the rescue.

Apparently, I wasn't alone. Antibiotic enthusiasm was in full swing through the 1970s and 80s. Doctors admittedly overused the drugs and, as newer more potent variations were developed, they overused those too. We are seeing the repercussions today in the form of antibiotic resistance. It turns out that these drugs aren't magic bullets at all: when you have a common cold you are infected with a virus--not a bacteria--and as a result antibiotics have no benefit.

Though antibiotics do wipe out certain bacterial infections--like the bugs that cause sinusitis, pneumonia, urinary tract infections, and other ailments--whatever doesn't kill you does make you stronger and this goes for bacteria too. So when a patient is given an antibiotic, a series of things must go right: the infection needs to be susceptible to antibiotics, the doctor has to prescribe the right drug at the right dose, the patient has to take the entire course (which usually goes well beyond when he feels better), and all of the targeted bacteria must die. If one of these steps is missed, the bacteria residing in your body can build resistance to the very antibiotic you are taking. So much for over-enthusiasm.

The antibiotic rejecters generally understand the concepts of inappropriate antibiotic use and resistance, but their rationale isn't completely right either. This group will do anything possible to avoid the use of antibiotics. They will stay home from school or skip work in order to rest and hydrate and heal. These are terrific solutions, don't get me wrong, because the very act of staying put limits the spread of the infection. But the majority of antibiotic-rejecters will also pump themselves full of over-the-counter drugs, vitamins, supplements or herbs that promise non-pharmaceutical-grade remedies.

The problem here is that over-the-counter medicines are exactly that: medicines, just sold without a prescription. And because you can buy these straight off the shelf (the label usually replete with medicinal looking flowers or claims of "organic" or "natural" healing powers), consumers believe they are less dangerous. But it's actually the reverse that is true. Over-the-counter medicines are not subject to the rigorous testing that prescription drugs are--there is no agency assigned to make sure that your therapeutic concoction really includes what is promised. Add to this that no one is studying the safety of its "all natural" ingredients. It actually takes consumer advocacy groups and vigilant individuals to identify the problems in vitamins, nutritional supplements, and other over-the-counter cures.

Antibiotic refusers also run the risk of rejecting the one treatment that can make them better. In many cases, the body gets through an illness and all ends well. But not infrequently enough, the bacteria organize a coup in the body and they take over. Infections that go untreated can cause grave illness, sometimes even death. If you need an antibiotic, refusing to take one can be life-threatening.

So in the end, neither group is right and neither group is wrong. When we get sick, we should absolutely take good care of ourselves. That includes vigilant hand washing and pulling ourselves out of circulation so that we don't spread our illness to others. But we also need to rely upon the help of our doctors rather than using a self-diagnosis to demand or refuse particular treatment. Next week, educate yourself a-la CDC and learn a bit more about why and how particular antibiotics really work.

MORE: Antibiotics Antibiotic Resistance Amoxicillan Antibiotic Drugs Penicillin What Is Antibiotic Antibiotics Safe

Scientific Inquiry – Which Falls Fastest?

Which shape of paper falls fastest: An unfolded sheet of paper, a loosely crumpled piece of paper, or a tightly crumpled piece of paper? Or can you create a different shape with paper that falls even faster?

Make Your Plan:

What is your independent (manipulated variable)?	
What is your dependent (responding) variable	
What is your question?	
What is your hypothesis?	If, then . . .
What are the constants? (name at least 3)	

Data:

Identify your dependent and independent variables for each trial.

- Independent variables are the variables that are changed in a given model or equation. One can also think of them as the 'input' which is then modified by the model to change the 'output' or dependent variable.
- Dependent variables are considered to be functions of the independent variables, changing only as the independent variable changes.

Dependent Variables ____

Independent Variables ____

Effects of Air Resistance	
Paper Type	**Time**
Flat paper	
Loosely crumpled paper	
Tightly crumpled paper	
Your paper design	

Conclusion:
Based on the data from my experiment, I reject or accept the hypothesis that (Restate your hypothesis WORD FOR WORD)

____

____

The evidence to support this is that _________________________________

Sample Questions for Guiding Scientific Thinking

Question Type	Sample Question Starters
Recalling	**Who, what, when, where, how ____?**
Comparing	How is _____ similar to/different from_____?
Identifying Attributes and Components	What are the characteristics/parts of _____?
Classifying	How might we organize _____ into categories?
Ordering	Arrange _____ into sequence according to _____.
Identifying Relationships and Patterns	Develop an outline/diagram/web of _____.
Representing	In what other ways might we show/illustrate _____?
Identifying Main Ideas	What is the key concept/issue in _____? Retell the main idea of _____ in your own words.
Identifying Errors	What is wrong with _____?
Inferring	What might we infer from _____? What conclusions might be drawn from _____?
Predicting	What might happen if _____?
Elaborating	What ideas/details can you add to _____? Give an example of _____. Summarizing Can you summarize _____?
Establishing Criteria	What criteria would you use to judge/evaluate _____?
Verifying	What evidence supports _____? How might we prove/confirm _____?

A **scatter plot** might be the proper graph if you're trying to show how two variables may be related to one another. (In Microsoft Excel, choose the "XY (scatter)" chart type, and then choose a sub-type that does not draw a line.)

Sample

Here is a sample Excel spreadsheet (http://www.sciencebuddies.org/science-fair-projects/project_sample_data.xls) (also available as a pdf (http://www.sciencebuddies.org/science-fair-projects/project_sample_data.pdf)) that contains data analysis and a graph.

Data Analysis Checklist

What Makes for a Good Data Analysis Chart?	For a Good Chart, You Should Answer "Yes" to Every Question
Is there sufficient data to know whether your hypothesis is correct?	Yes / No
Is your data accurate?	Yes / No
Have you summarized your data with an average, if appropriate?	Yes / No
Does your chart specify units of measurement for all data?	Yes / No
Have you verified that all calculations (if any) are correct?	Yes / No

Graph Checklist

What Makes for a Good Graph?	For a Good Graph, You Should Answer "Yes" to Every Question
Have you selected the appropriate graph type for the data you are displaying?	Yes / No
Does your graph have a title?	Yes / No
Have you placed the independent variable on the x-axis and the dependent variable on the y-axis?	Yes / No
Have you labeled the axes correctly and specified the units of measurement?	Yes / No
Does your graph have the proper scale (the appropriate high and low values on the axes)?	Yes / No
Is your data plotted correctly and clearly?	Yes / No