Session 1 – Modelling the Universe

General Description

Students are challenged to create a model of the Universe. This is an introductory activity that helps students think about where we fit in the Universe, and allows them to model the size, shape, and relative position of objects in the Universe. The activity has three major steps: discussion, modelling, and sharing models with the group. Students can work in groups of 3 or 4. This activity can also be done in pairs if the overall group is small.

Objectives

- To draw out the students' mental model of the structure of the Universe.
- To use the context of space science exploration of the structure of the Universe to help students reflect on the nature of models, evidence, and explanation in science.

Concepts Addressed

- Strengths and weaknesses of models
- Astronomical size and scale
- Earth's physical place in the solar system and Universe

Materials

- Copy of *Universe Model Analysis Student Worksheet* for each group of students (included in Appendix E)
- Examples of models (toy car, doll or action figure, paper airplane, map, etc.)
- A variety of crayons/colored pencils/markers
- 8.5″ × 11″ white paper — one sheet per student
- Model construction supplies — anything you have available that seems appropriate (some examples: construction paper, balloons, balls of different sizes, marbles, string, straws, pipe cleaners, pasta)
- Large sheet of sturdy paper on which students create their models — one per group
- Scissors, glue, and tape
- (Optional) Clay or Play-Doh

Other Requirements

- Enough table or floor space for several groups of students to work together on their models

Background

A model is a simplified imitation of something that is used to better understand or work with it. Models can take different forms, including physical devices or sculpture, drawings or plans, conceptual analogies, mathematical equations, and computer simulations.

Models serve many different purposes in astronomy and other fields. A model can make something large more portable and accessible, such as representing the Earth with a tabletop globe. Models can also make something small easier to see and manipulate, such as a model of a tiny cell or DNA. And some models are the same size as the original object, used for testing or display purposes.

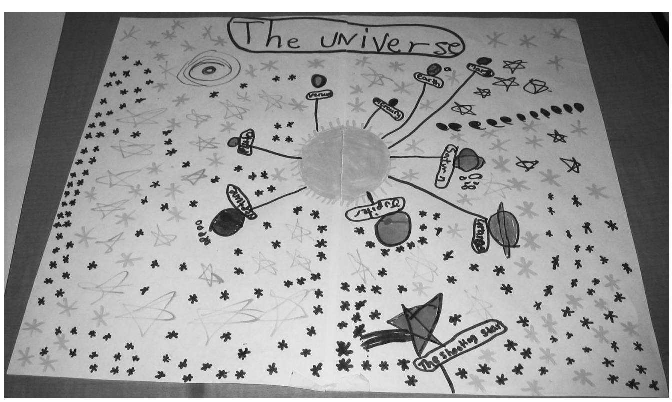
Models can be "to scale," which means that they accurately represent the proportions of an actual object. The scale model can be smaller, larger, or the same size as the original object, but the proportions must be accurate. Some models are not to scale, and do not accurately reflect the actual proportions of the original. These models can be useful when it is difficult to create a scale model, or an accurate scale model is not needed.

Session Overview

As a warm-up, students make a quick model (drawing) of something in their lives. This introduces the concept of modelling.

Students then make physical models to represent as much of the Universe as they can. They then analyze their own and others' models with regard to what they represent, what they misrepresent, what they omit, and what questions they raise.

While the idea of creating a physical model of the entire Universe can seem overwhelming, this activity quickly reveals students' ideas and preconceptions. Most students are somewhat familiar with solar system objects but may be confused about, for example, the relationship of stars to planets and the relative distances between them. The overall organization and structure of the Universe is not well known to most.



An example of a student group's model, depicting a variety of objects, and showing stars mixed in throughout the solar system.

Students should not be corrected in any way during this session, as this is intended to determine the current state of their understanding for later evaluation.

Preparation

- Make copies of the *Universe Model Analysis Student Worksheet* for each group
- Set out all listed materials equally among the groups

Activity

I. Warm-up (10 minutes)

Instruct students to individually make a quick model of something in their lives, using the white paper and crayons/colored pencils/markers available. Allow about five minutes for students to complete these drawings. Alternatively, if you think clay or Play-Doh will make this task clearer to the students, you might consider providing those materials instead of the two-dimensional paper. Students may be more comfortable with the idea of models in three-dimensions.

A toy airplane, one example of a model for participants to consider.

Ask students to identify some models in their lives, such as toy cars, dolls and action figures, models made for school assignments, model airplanes, maps, etc. It is helpful to have a couple of these examples to show during this discussion. Introduce the idea of scale – models that accurately reflect the proportions of the original object. Are the models you have discussed to scale or not to scale? Why is scale important? When does and doesn't it matter to a model?

Ask a few students to share their warm-up drawings. Are these models to scale or not to scale? Tell students to keep these ideas about models and scale in mind during the next activity.

II. Discussion (10 minutes)

Facilitate a group discussion of what models are and what they are used for. Discuss how scientists use models to help them think about how things work, and to make predictions. Ask students to name some familiar models (e.g., globe, dollhouse) and lead a discussion on whether these models are exactly like the real thing. Stress that a model is not the real thing, it is usually a simplified or modified version so it can possibly misrepresent features of the real thing. Make sure they understand that models can be two-dimensional as well as three-dimensional.

Lead an open discussion about what is **<u>in</u>** the Universe, and what the Universe **<u>is</u>**. You should leave this discussion fairly short, because their project should reflect their own introductory ideas. The models around the room may end up quite different, and this is entirely acceptable. The more of a discussion you have with the students beforehand, the more likely their models will reflect this discussion rather than their own concepts.

III. Modelling (20 minutes)

(Adapted with permission from the Cosmic Questions Educator's Guide)

1. Divide students into small groups. Groups should decide among themselves who will fill the roles of Model Maker, Recorder of Model Features, and Spokesperson. Students may have more than one role, but all three must be filled.

2. Ask the students to write their names on both the model they create and their worksheet.

3. With the materials in front of them, challenge students to create a model of the Universe in 20 minutes.

   Tell students they should have an explanation as to why they put objects where they do, regardless of the fact that ***<u>they are not required or expected to have all of the scientifically correct answers!</u>***

4. It is important to go around and help with the group dynamics in this activity. All members of the groups should be contributing ideas instead of letting one member give all of the "answers." ***Remember, students should not be corrected in any way during this session, as this is intended to determine the current state of their understanding for later evaluation.***

Participants hard at work on their models of the Universe.

5. As they work, the Recorder in each group should use the Universe Model Analysis Student Worksheet to list information about the features of their model, and any questions or other thoughts that arise on this topic.

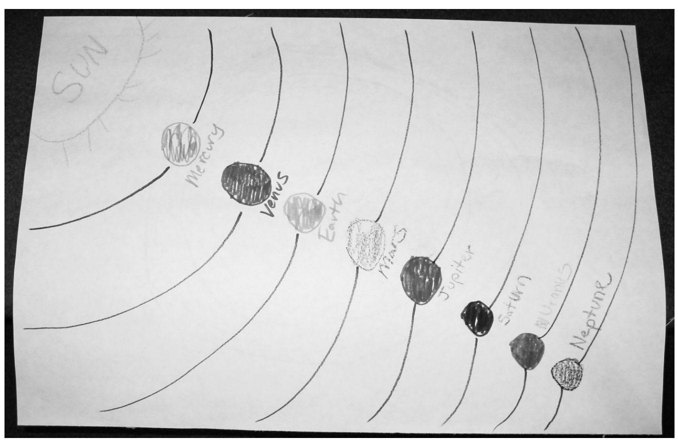
IV. Sharing models with the group (15-20 minutes)

Now, ask the spokesperson in each group to present their model. As they do so, ask them to comment on these four questions:

- What features of the Universe does your model represent?
- What things — that you know of — does your model misrepresent?
- What things — that you know of — does your model omit, or not represent at all?
- What questions came up as your group worked on your model?

Use the following questions with the whole group to further probe students' understanding of their models:

- Do you see any patterns?
- Which parts of the models do you think represent the "real thing" particularly well? Why?
- Which parts of the models do you think misrepresented the "real thing"?
- Are these models to scale or not to scale? Why?
- Why is making a model of the whole Universe so difficult?
- How can these models be used to predict what might happen in the Universe?
- What would an observer on Earth see if they lived in this Universe? (Where is Earth in your model?)
- What would you need to know to design a better model?



A typical model of the Universe, depicting only the Solar System.

At the end of the activity, ***collect and save the models (or take a digital photo of them)***. They will be used in concert with the final session to evaluate student progress.

Suggestions/Misconceptions

- Modelling the entire Universe may seem like a daunting task, but remember, there is no right or wrong answer. The purpose of this activity is to see what their current views are and to get them started thinking about the topic.

- Allow students to take over as much of the discussions as possible, trying not to lead or discourage them in any way except to ensure that all members of the groups are participating. Also, make sure that students understand that there has to be a reason for where they place objects when they created their model.

- To engage students in discussion as models are presented, consider taking them on a "gallery walk" to see other groups' models. All students can gather around each model to see it as its creators explain it.

- The materials provided for this activity often have an impact on the models made by students. If you give the group 9 or 10 round objects, they will likely immediately think of planets and possibly not think any further. Keep this in mind as you choose your materials. For consistency, provide the same materials in Session 1 and the repeated modelling activity in Session 12.

- Everyone needs to contribute in this activity. Depending on your group, you may need to work to facilitate this, because sometimes it can be very easy for one or two group members to take over for everybody. If this is a problem with your group, you might consider having the groups go around in a circle and have each member say one idea in turn.

- If you feel your students need it, you may have them brainstorm a list of objects in the Universe that can be viewed with a telescope, and write these objects on a blackboard or flip chart. Ask what they know about each one as they are offered. Remember that doing this will probably ensure that each group will try to put all objects on the list into their model, regardless of whether they would have thought of this on their own or not.

Useful websites for background or activity extension

- **NASA's Universe Education Forum**
  Answers to questions about the structure and evolution of the Universe are available at this site
  http://www.cfa.harvard.edu/seuforum/questions/

  - Extensive learning resources for investigations of the Universe
    http://www.cfa.harvard.edu/seuforum/learningresources.htm

  - *Cosmic Questions Educator's Guide*
    http://www.cfa.harvard.edu/seuforum/download/CQEdGuide.pdf

- ***Cosmic Distance Scale***
  This feature gives a feeling for how immense our Universe is, starting with an image of the Earth and then zooming out to the furthest visible reaches of our Universe — as in the "Power of 10" films.
  http://heasarc.gsfc.nasa.gov/docs/cosmic/

- ***Bad Astronomy* — Astronomy misconceptions explained**
  A great site to deal with questions about the accuracy of "science" encountered in the movies, news, books, or TV. In addition to science explanations at an easy-to-read level, topics are presented in a fun way. The site contains a blog and a bulletin board for questions.
  http://www.badastronomy.com/

Afterschool Universe Session 1 - Universe Model Analysis Student Worksheet

Date: ____________ Name: ____

A model is a simplified imitation of something designed to help us understand it better. It may represent the whole or only part of a system. Because a model is not the real thing, it can always misrepresent some features of the real thing.

As you create your model of the Universe, you should have an explanation for why you are doing something. It is completely ok if are taking a guess – but you should explain why you guessed that way.

You will be asked to explain your model to the rest of the class, commenting on these questions:

- What features of the universe does your model represent?
- What things does your model not represent well?
- What things about the universe does your model leave out, or not represent at all?
- What questions came up as your group worked on your model?

Features Represented	Misrepresented Features	Features Omitted by Model
Questions we had		

Session 8 – Our Cosmic Connection to the Elements

General Description

An interactive discussion of elements and compounds begins with the leader and class breaking down a substance into smaller and smaller pieces that still retain its identity. The discussion continues with the periodic table, common elements and compounds, and the astronomical origin of the elements that make up our bodies. Students determine the composition of a sample of "space particles" and discuss the difficulties of finding a truly representative sample. They view printed elemental spectra and discuss how astronomers determine the composition of distant objects (reinforces Session 4 on spectroscopy).

Objectives

- To explore the concept of composition in the context of the Universe and astronomical objects.
- To improve students' understanding of the origin of the chemical elements.

Concepts Addressed

- Elements and compounds
- Composition of the Universe
- Spectroscopy

Materials

- One poundcake. Choose one with the fewest artificial ingredients so that the students will recognize the ingredients. This activity will work best if you choose something that is as uniform looking as possible. If you substitute with a different type of cake, or another type of food, keep in mind that it must be dense enough to not fall apart when cut.
- Knife to cut the cake
- Gloves or wet wipes for safe food handling
- Enough paper plates to hold pieces of cake as it is cut (enough to serve the class, if allowed)
- Sample of a pure element (piece of copper tubing works well)
- Periodic table, one copy per student (black and white version included in Appendix E and color version included in Appendix F) *
- *Universe Trail Mix* ingredients (see *Universe Trail Mix* Procedure for amounts): rice, split peas, macaroni, black beans, pink beans, and colored sprinkles
- Large bowl to mix the trail mix
- Small paper cups or bowls, one per student
- Paper towels, one sheet per student (paper towels without patterns are better for this)

- Plastic spoons (only one is required, but have extras on hand)
- *Universe Trail Mix* worksheet (included in Appendix E)
- Universe Trail Mix key (included in Appendix F) *
- Elemental Spectra handout (included in Appendix F) *
- Paper to write on, 1 sheet per student
- (Optional) Poster showing the periodic table (such as the What is Your Cosmic Connection to the Elements? poster from NASA)

  * *You can laminate these handouts if you want to use them with other groups. You only need to hand out one of these sheets per group of students.*

Other Requirements

- A room with sufficient space for students to spread out and count their “elements”
- Access to a blackboard or flip chart is advised

Background

Atom: The smallest particle of an element that still has the characteristics of that element

Element: A *material* consisting of all the same atoms

Molecule: Two or more atoms of the same or different elements that are chemically bound together

Compound: A *material* consisting of atoms of two or more different elements that are chemically bound together

The copper/other pure element used here is an element, while the pound cake is a compound since it is made of many different substances (or elements).

The lightest elements (hydrogen, helium, and some lithium) were created in the Big Bang.

Then, as the Universe cooled, matter clumped together to form stars. In the stars, those first elements were fused into heavier ones by the energy from the stars’ gravity — up to a certain point. Remember that we covered this is Sessions 6 and 7.

The formation of elements heavier than iron and lead requires more energy than a star has. But the explosion of a star at the end of its life (a supernova) provides enough energy to make the much heavier elements. A supernova throws all of its elements out into space, where new stars can use them as they form.

We know the Sun is a later-generation star because it has those heavier elements (we know that from spectroscopy, among other ways). So the elements in our bodies — like carbon, hydrogen, nitrogen, oxygen, and trace amounts of many others — came from the explosion of earlier stars!

We are made of star stuff!

Session Overview

An interactive discussion of elements and compounds begins with the leader and class breaking down a substance (poundcake) into smaller and smaller pieces that still retain its identity (its "atoms").

The discussion continues with the periodic table, common elements and compounds, and the astronomical origin of the elements we are made of. Students take a sample of "space particles in the Universe" (a prepared mixture of rice, beans, etc.), determine its composition, and discuss the difficulties of finding a truly representative sample.

Students view a chart of spectra matched with the elements that produce them, and they discuss how astronomers determine the composition of distant objects (reinforces Session 4 on spectroscopy).

Preparation

- ***Universe Trail Mix***

  This takes a bit of time, so prepare this mixture at least a few hours before you implement this session:

  Using the recipe below, measure the ingredients into a large bowl and mix well. Use the same size "measuring cup" (a plastic spoon) for all of the ingredients.

  – 40 spoonfuls of rice (to represent 89% abundance of hydrogen in Universe)
  – 4 spoonfuls of split peas (to represent 9% abundance of helium)
  – 2 spoonfuls of macaroni (to represent 0.75% abundance of carbon)
  – 2 spoonfuls of black beans (to represent 0.75% abundance of oxygen)
  – 1 spoonful of pink beans (to represent 0.25% abundance of nitrogen)
  – fraction of a spoonful of sprinkles (to represent the tiny abundance of all other elements)

  The amounts of macaroni, black beans, pink beans, and sprinkles are highly exaggerated, because they would not be visible in the mixture in smaller amounts.

- Laminate handouts if desired.
- Have the poundcake and knife ready. Wash your hands or wear gloves while handling the poundcake, if it is to be consumed after use. Save the ingredient label.

Activity

I. Poundcakium activity (15-20 minutes)

1. Remind the group about the previous session and the fact that the calcium and iron — and many other elements — in our bodies were created in a star that exploded. In fact, all of the elements originated well outside our Solar System. Elicit student thoughts about this.

2. Hold up the poundcake. And ask the students what it is.

   Tell the students that you are going to pretend to have just discovered this new element, called "poundcakium." Ask about its characteristics, and let them answer. Answers should include that it's all one flavor, texture, and color (at least on the inside).

3. Cut the cake in half.

   Ask the students what you have now. Will it taste the same? The answer is yes, so it is the same thing we had before. Still poundcakium, but in two pieces.

4. Cut it in half again.

   Ask what it is now. The answer is that it is still poundcakium.

   If you were to continue to cut it in half, you would eventually get to single crumbs. Ask the students if you would have destroyed or created any poundcakium as you did this? Does it become something else other than poundcakium by cutting it? The answer is no.

Sliced poundcake.

5. If allowed, serve the poundcake! You can continue while students munch.

6. Discuss with the students how many things are made of more than one ingredient. Ask them what they think the ingredients are in poundcake (which you used to represent poundcakium). Let them answer, then read through the pronounceable ingredients on the poundcake label.

7. Tell the students that flour, sugar, milk, and eggs (or whatever the recognizable ingredients are) are made of elements such as carbon and hydrogen.

Pass out the individual copies of the periodic table, and put up the poster if you have one. Point out carbon and hydrogen.

8. Ask the students if they know anything about elements. Tell them that an element is a material made of atoms of a single type, like carbon or hydrogen. Elements are the building blocks for matter — everything that we can see and touch.

9. Hold up your pure element. (For our example, we will say you are using a piece of copper tubing. You can also use other examples of pure elements if you have them readily available.)

   If the kids handle the copper (or other elements), make sure to have them wash their hands afterwards. Wet wipes might make this process easier.

   Tell them that copper is an element that occurs naturally on Earth.

   Say that copper is very hard to cut, but in theory we could do the same thing we did with poundcakium. If we could cut the copper in half, would it be a different substance? No, it's still the same thing, and the weight is still the same. Since copper is an element, no matter how many times it's cut it in half, we will always have copper.

An example of a copper pipe.

10. Refer back to their handouts or the poster if you are using it. Tell them that all of the known elements have been organized into this Periodic Table of the Elements. It is arranged so that the elements in the same rows and columns have common characteristics, though each remains unique. Some are solids, some are gases, and some are liquids at room temperature, for example.

    Ask if they recognize any of the elements. See if they can give examples of everyday objects, and the elements they're made of. (Examples: aluminum in soda cans, silver/gold in jewelry, diamonds (carbon), iron in steel, hydrogen and oxygen in water — “lead in pencils” should be corrected to “carbon (in the form of graphite) in pencils”.)

Some common substances like table salt (NaCl — sodium chloride) or water (H_2O) are compounds, which are made of two or more elements chemically bound together.

Ask if poundcakium is an element or a compound. Wait for responses with explanations. They should answer that we were pretending that it was an element for our purposes.

Now ask if the poundcake is an element or compound. Again, wait for responses with explanations. The answer is that it is a compound, because it’s made of more than one element.

11. Ask what are people are made of. Wait for the students to respond and provide explanations. The truth is that we’re made of a lot of the elements on the periodic table, many in the form of compounds like water.

    Ask the students where they think these elements came from. Wait for ideas. They may remember from Session 7 that the lightest elements (hydrogen, helium, some lithium) were created in the Big Bang and then heavier elements (up to iron) were formed in stars. Anything heavier than that was formed during supernova explosions. So the elements in our bodies — like carbon, hydrogen, nitrogen, oxygen, and trace amounts of many other — came from the explosion of stars!

    We are made of star stuff!

II. *Universe Trail Mix* activity (15-20 minutes)

1. Before beginning this activity, everyone should finish eating if they were doing so. Remove all traces of remaining poundcake to avoid distraction.

   Distribute the *Universe Trail Mix* worksheets, the *Universe Trail Mix* keys (so that they know which ingredient represents which element), small cups, and sheets of paper towel.

2. Ask the group what element we have the most of in the Universe. If we grabbed a handful of space particles, what would we have? Solicit ideas.

3. Pull out the trail mix and plastic spoon to serve it.

   Tell the students that this trail mix was prepared to imitate the proportions of the most common elements in the Universe.

   Have each student take a spoonful of the mix and put it in a cup. Back in their own workspace, they empty it onto the paper towel. Students then count or estimate how much of each ingredient (element) they have, and record it on their worksheet.

4. When all have finished, ask how many of them found hydrogen? Helium? Carbon? They should all have mostly hydrogen, some helium, and very few of the others.

Ask how many of them had any oxygen, nitrogen, or sprinkles (which represent small amounts of other elements). Note that these are rare and not found in every spoonful.

On a blackboard or flip chart, draw a table with a column heading for each element. Have each

Student participants counting components of their Universe Trail Mix.

student come up and record how much of each “element” they found. Have two volunteers come up and tally the entries to arrive at total for each element (having two volunteers should verify the addition).

5. With prompting as needed, students should discuss the *relative* amounts of the elements.

   Ask why some of the elements not appear in all of the samples. Do they think this would be similar to when we look out into space? That is, if we looked at one region in space near a star, do you think we would find the same sorts of elements as if we looked where there no stars? The answer is no — where we look is very important and tells us what that region is made of.

6. Have everyone look at a periodic table again, and go through the true percentages of elements in the Universe: Almost 90% of the Universe is hydrogen, and more than 9% is helium. The rest of the elements add up to less than 1%, but that 1% includes ***all*** of the heavier elements that are out there.

III. Follow-up discussion (10-15 minutes)

Discuss with the students how they just used spoonfuls of the *Universe Trail Mix* to try to figure out what the Universe is made of. But we can’t get a spoonful of things in space, since they are so far away. We have to figure out what they are made of without touching them. We can do this with light.

Remind them about the Session 5 activity on spectroscopy, if they did it.

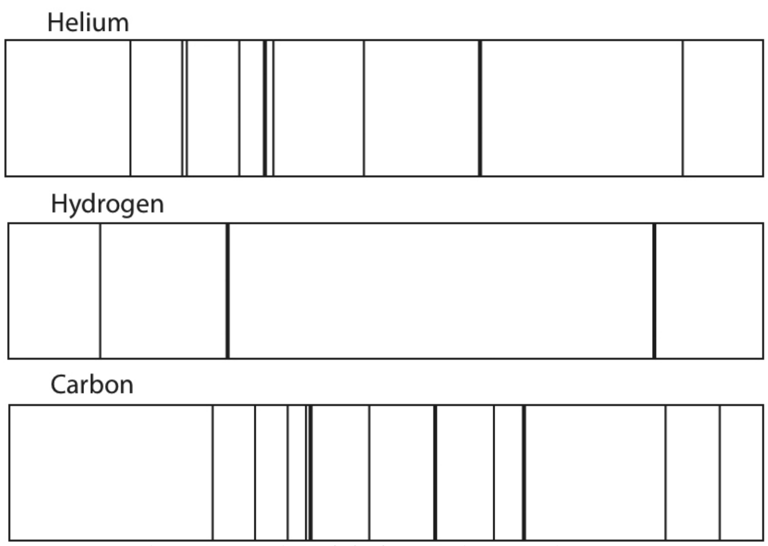
Remind them that one way you can tell what an object is made of is to look at its spectrum. A spectrum is like an element's "fingerprint." Each element produces a unique pattern of specific wavelengths of light, which we see as bright lines in the spectrum. A scientist looking at the spectrum of an object in space, like a star or planet, can figure out which elements are in that object by looking at the different lines in its spectrum — they use spectroscopy.

Hand out papers with the spectra of different elements.

Ask them to describe what they see. Wait for ideas.

It looks like a faint rainbow, with some bright lines here and there. Have them look at the spectrum for hydrogen, and discuss where the bright lines are.

Have them look at the spectrum for helium. Discuss where the bright lines are, and compare this spectrum to the spectrum for hydrogen.



Three examples of different elemental spectra.

So when astronomers look out into space and study the spectra of objects, they can figure out which elements are present from the lines they are seeing. Each element has a unique spectrum and how bright or faint it is tells us how much of that element is present.

Suggestions/Misconceptions

- If you are unable to have food in your classroom at all, or if food allergies are a concern, you should be able to do the poundcakium activity with a sponge (spongium), styrofoam (styrofoamium), Play-Doh (pladoium), or some other substance that can be easily cut or broken, and with easily recognizable properties.
- If dark matter comes up, explain that we still don't know exactly what it is, and we are only talking about normal matter in these activities.

Useful websites for background or activity extension

- **Los Alamos National Laboratory**
  Great interactive periodic table, with much information about each element
  http://periodic.lanl.gov/

- **University of Colorado Physics 2000**
  Good follow-up site if you would like to see spectra for more elements, as well as for white light.
  http://www.colorado.edu/physics/2000/quantumzone/index.html

- ***Imagine the Universe!***

  – Extended activity about composition using beans and rice, with bottles full of objects on Earth and space:
  http://imagine.gsfc.nasa.gov/docs/teachers/elements/imagine/OutThere/outthere.html

  – Good explanations of the electromagnetic spectrum and spectroscopy:
  http://imagine.gsfc.nasa.gov/docs/teachers/lessons/xray_spectra/background-spectroscopy.html

  – Lesson plan at high school level on the origin of the elements and our connection to them:
  http://imagine.gsfc.nasa.gov/docs/teachers/elements/elements.html

  – High-school level activity and discussion of the formation of elements in stars and their release in supernovae:
  http://imagine.gsfc.nasa.gov/docs/teachers/calcium/calcium_intro.html

PERIODIC TABLE

Atomic Properties of the Elements

Solids
Liquids
Gases
Artificially Prepared

Period																		
1	1 H Hydrogen																	2 He Helium
2	3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
3	11 Na Sodium	12 Mg Magnesium											13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon
4	19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
5	37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
6	55 Cs Cesium	56 Ba Barium		72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
7	87 Fr Francium	88 Ra Radium		104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Uun Ununnilium	111 Uuu Unununium	112 Uub Ununbium		114 Uuq Ununquadium		116 Uuh Ununhexium		

Lanthanides	57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium
Actinides	89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

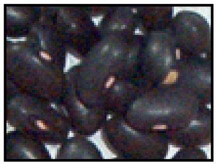
Atomic Number — 58
Symbol — Ce
Name — Cerium

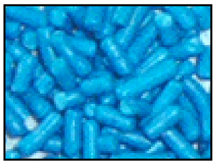
Afterschool Universe Session 8 - Universe Trail Mix Worksheet

INGREDIENT	ELEMENT	HOW MANY?
Black Beans	______________________	_________
Blue Sprinkles	______________________	_________
Green Split Peas	______________________	_________
Macaroni	______________________	_________
Orange Sprinkles	______________________	_________
Green Sprinkles	______________________	_________
Pink Beans	______________________	_________
Rice	______________________	_________
Red Sprinkles	______________________	_________
Yellow Sprinkles	______________________	_________

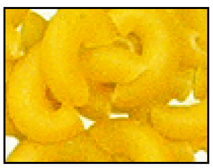
1. Which element is the most abundant? _______________
2. Which element is the second most abundant? _______________
3. Did you find all of the elements in your sample? _______________
4. Were the elements evenly distributed? _______________

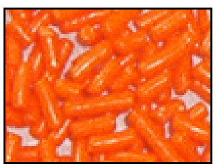
Universe Trail Mix Key


Black Beans = Oxygen (O)

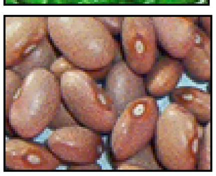

Blue Sprinkles = Magnesium (Mg)

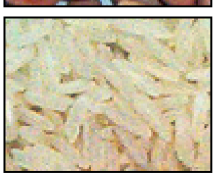

Green Split Peas = Helium (He)

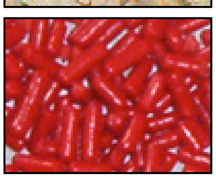

Macaroni = Carbon (C)

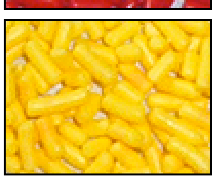

Orange Sprinkles = Silicon (Si)


Green Sprinkles = Neon (Ne)


Pink Beans = Nitrogen (N)

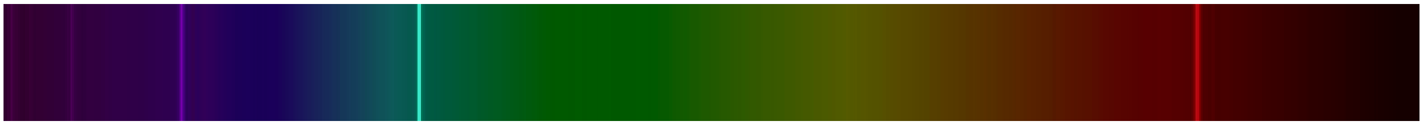

Rice = Hydrogen (H)


Red Sprinkles = Iron (Fe)


Yellow Sprinkles = Sulfur (S)

Spectra of Common Elements

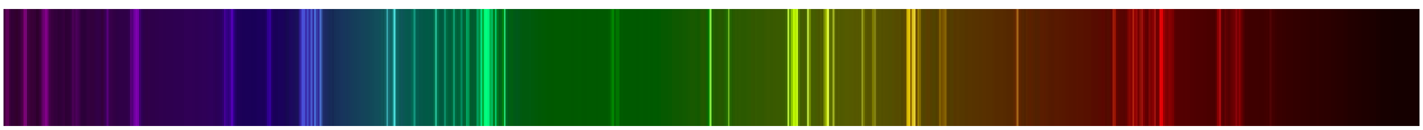
Hydrogen



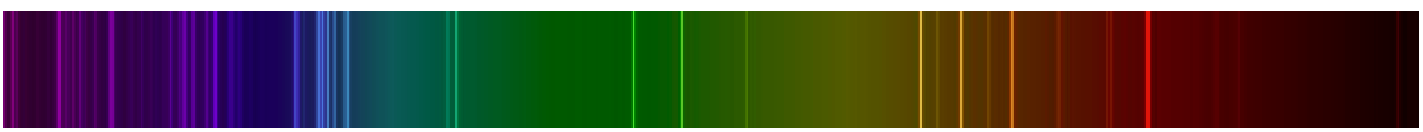
Helium

Carbon

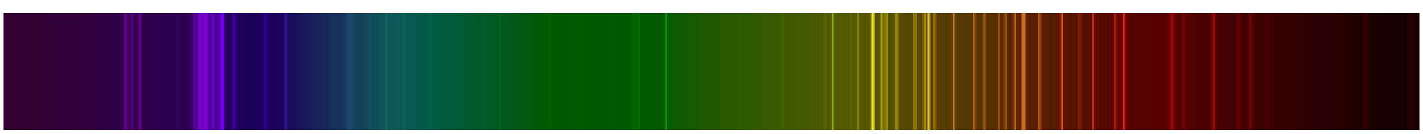
Nitrogen



Oxygen



Neon



Sodium

Mercury