This Pretty Planet

"*This pretty planet spinning through space...*" --John Forster & Tom Chapin

It took the human race a long time to learn that our planet is a big ball spinning and traveling through space. Many people and cultures contributed to our understanding. In this POW, pick one project that will give you a better understanding of our planet and how it moves through space and time.

I. Leap Years!

Okay, a year has 365 days. Except one year in every four has 366. Why is that? Does the earth travel a little slower one year out of every four? Can you find out why we have leap years? What would happen if we didn't? Why are they called "leap" years? When will the next ones be? How did people decide there were 365 days in a year anyway? And then what about my friends Richard and David, when I was in fifth grade? They were twins, born on February 29, 1944, eight days before me. So they were eight days older than me. But in fifth grade everyone teased them and said they were only three years old, because February 29 had only come back twice since they were born. Were they really only three years old in fifth grade??

II. North, South, East, and West

Can you find out how to "orient" yourself? (How can you know which direction is north, etc.? Can you do it without a magnetic compass?) Can you learn some differences between north and south compared to east and west? What if you wanted to fly your airplane from Princeton to Ankara, Turkey, which is about at our latitude. Would you fly straight east? Why not? If you start flying west in your airplane, can you travel west forever? If you start flying north, can you travel north forever?

III. A Simple Sundial

You can make a simple sundial that will tell you the time without any moving parts. (Well, actually, there's one very BIG moving part. Can you tell what it is?) Use a protractor to make two 24 hour clock faces, one with the numbers going counterclockwise. Then get further instructions from Richard, Dave or Brian.

IV. Our Planets Path

Our planet travels in a path called an ellipse. Can you find out who the first human being to figure that out was? Here are three fun ways to draw an ellipse:

1) Nails and String: Put two nails in a board, and tie a string to them with some slack. Then trace your ellipse by moving around with a pencil pulling the string taut. Do top and bottom. A circle is the set of all points (in a plane) an equal distance from a given point. With an ellipse it's the points where the sum of the distances from the two foci stays the same. This construction with the string shows that.
2) Concentric Circles: Draw two circles centered on the origin on a coordinate plane. Draw "radii" (lines through the origin, intersecting the circles). For each radius, take the x coordinate of the point where it intersects the outer circle, and the y coordinate where it intersects the inner circle, and mark the point on the plane with those coordinates. As you do this for many radii, your new points will graph an ellipse.
3) Equation: Graph an equation in the form of $x^2/a^2 + y^2/b^2 = 1$.

Can you learn more about ellipses? Why did Kepler say the earth sang "mi, fa, mi"?

V. Magellan and the Missing Day

On Sunday, September 7, 1522 the Victoria, one of five ships that had set out under Ferdinand Magellan, arrived back in Spain. The seventeen men aboard had been sailing for about three years, and were now the first people ever to have sailed all around the earth. But their ship's log and journal said it was September 6! Had they missed a day in their record keeping? Can you explain what happened?

VI. Circumnavigating Africa

The Greek historian Herodotus wrote about 400 BCE. In his history he mentions being told that an Egyptian pharaoh, around 600 BCE, sent out an expedition of Phoenician sailors to sail all around Africa. According to the story, the sailors accomplished this, and they reported that as they were sailing westward around the southern part of Africa, they "had the sun on their right hand." This detail made the report seem unbelievable to Herodotus. Can we believe it?! Explain!

VII. Eratosthenes Measures the Earth! (While Sipping Lemonade in his Backyard!)

Well, I don't know for sure if he was sipping lemonade, but the mathematician Eratosthenes, who lived in Alexandria, Egypt, around 250 BCE, measured the earth's circumference, quite accurately, without leaving his backyard! Explain how he was able to do this! Can you learn more about Eratosthenes?

VIII. Latitude and Longitude

Oh no! You went on a one hour hot air balloon trip, and this storm came out of nowhere, and after four days of being blown around in a super storm, you're stranded on a desert island! (I stole this idea from *The Mysterious Island,* a wonderful book by Jules Verne.) Is there a way to decide if you're in the northern or southern hemisphere? Let's say you're in the northern hemisphere; is there a way to determine your latitude? Oh, and you're still wearing your digital watch, which is still going. Is there a way to determine your longitude? Explain fully!

IX. The Precession of the Equinoxes

Have you ever spun a top? The top can be spinning very quickly, and as it slows down a little, you may notice its axis is also slowly rotating. Guess what! The earth spins, completing a full turn in a day, but its axis is also slowly turning. This is called the "precession of the equinoxes." Why does it have that funny name? Who first discovered this, and how? How long does it take for our axis to make a complete turn? What causes precession? In ancient times people spoke of the sun "being in" a constellation such as Pisces or Gemini, meaning those were the background for the sun during a certain time of the year. Has that changed?

X. The Speed of Light

You can read that the speed of light is 186,000 miles per second. Let's see, how can we test that? You stand over there, 186,000 miles away, and I'll yell "Go!" when I turn on my flashlight. When you hear me yell "Go!" you start your stopwatch... Okay, why isn't that plan going to work? Can you find out how a Danish astronomer named Ole Roemer first determined the speed of light? (It's a cool story! And he did it way back in 1676!)

XI. Newton's Apple

Okay Isaac Newton is not called a universal genius for figuring out that apples fall down. He was definitely not the first to figure that out! But as he sat in his mother's garden and saw the apple fall, he also saw the moon up in the sky. And he was the first to figure out that.... Well, you tell us!

XII. Just for fun: In *A Midsummer Night's Dream* Puck says,

"I'll put a girdle round about the earth
  In forty minutes."

Assuming Puck plans to travel in a great circle around the earth, how fast will he be going? Even forgetting about the friction as you fly through the air, is it possible to travel around the earth that fast?