

LEAP YEAR ANY TIME

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Time: 45-120 minutes+

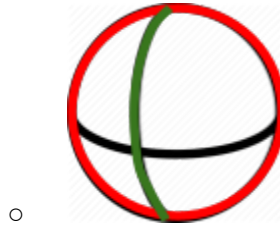
Content Connections:

- Science
- Astronomy
- Social Studies (celebrations, history)

Overview: Students explore the concept that mass bends space, creating orbital rotations. The interesting part comes in the implication on days and seasons.

Materials:

- Pencils, crayons, colored pencils, markers
- paper, construction paper
- calculators,
- Hula hoop
- Cloth big enough to cover hula hoop
- (optional) 8-10 binder clips to hold cloth to hula hoop
- 3-5 marbles (analogs for planets)
 - (option for Hard and Extreme- each marble has the X, Y, and Z axis drawn in three distinct colors of sharpie (red, black, green)



- <1lb item to lightly depress the cloth (simulating the sun bending space time)
- Device able to capture and playback 3-5 seconds of video
 - (option for Hard and Extreme - SlowMo feature on the recording).

DIRECTIONS

Part One: Simulating Orbits

- Stretch a piece of fabric over a hula hoop. You can have students hold the cloth to the hoop, or attach the cloth to the hoop with binder clips.
- Explain that this is a representation of space.
- Roll a marble across the surface, allowing for observations
 - Note that the ball keeps rolling in a direction
- Place an item in the middle <1lb that will push down the cloth in the middle--a subtle depression
- Briefly explain to the students that this is like the sun, an object with such a large mass that it literally bends space! Ask for predictions on what will happen when you spin a marble around the sun.
- Do your best to spin a marble into orbit around the sun; allow the students to try. We'll never have a perfect orbit because gravity is acting in a downward direction in our classroom, but the idea is that the Earth is the marble spinning around the sun.
- (optional - connects to Medium, Hard, and Extreme options) Record the spinning of one marble with a phone (one student rolls an orbit while you record.. multiple students can record if technology is available).
 - (optional) connects to Extreme option. Do another recording, but this time use 3-5 marbles at the same time to try and simulate the rotation of multiple planets.
- Ask how long it took for the marble to make its way around. Maybe 1-2 seconds depending on the speed. Explain that this is the orbit.

Part Two: Leap Year concept and voting

- Ask how long it takes for the Earth to go around the sun (answer = 365.25 days). Be sure to answer with either .25 or $\frac{1}{4}$ depending on the students readiness to these concepts.
- Instead of telling students about leap year and the extra day, start by asking: **“What would you do with an extra quarter of day each year?” Have the students put to a vote. For example, would you rather...**
 - **Have a six-hour party each year?** (be sure the students understand that .25 or $\frac{1}{4}$ of 24 hours is 6 hours). What is the benefit, what are the problems? *For example, we could pause the clock for six hours, but when it started back up, it would be 6 hours behind the sun (night time would be at noon for an entire year unless we did some clock adjusting).*
 - **Wait 4 years (6+6+6+6=24 hours) and add an extra day into the calendar?** *It's what we currently do, but nobody really celebrates leap day, and people who are born on leap day only get a birthday every four years.*
 - Another option? (psst, some ancient calendars saved the time up and had entire leap months! ...link in the extension options below).

Part Three: Application Options

- Based on the level of readiness (and access to recording software mentioned above) choose the activity(ies) that best fit your group.

EASY	MEDIUM	HARD	EXTREME
<p>Depending on how you voted, create either a 6-hour party each year or a 1-day party each four years.</p> <p>Use paper to create the invitation.</p> <p>How could the whole Earth celebrate?</p> <p>What would you call the celebration?</p> <p>How would you explain to other kids why the world is celebrating?</p>	<p>Use the recorded video to see how long it took to make an orbit around the sun (round to the nearest second).</p> <p>If a second is equal to a month, how many months are in your calendar? (ex. the marble took 4 seconds, so you get four months on your new planet).</p> <p>Create a new calendar. What would you name your months? Why?</p> <p>Lets say you have a few extra hours in your rotation (just like the Earth)...</p> <p>What would you do with this extra time? (reflect back on the earlier discussion).</p> <p>What would you call this time? If you decide on a celebration, how could the whole planet celebrate?</p>	<p>Use the recorded video of one marble going in orbit.</p> <p>Determine how many seconds it took to make it around the sun. Do NOT round. If each second is equal to a month, how many months (and extra days) does your calendar have? <i>For example, 3.1 seconds would be 3.1 months.</i></p> <p>Let's get more tricky, watch the slow motion video and count how many times the marble rotated on its axis! <i>For example, it may have made the orbit is 3.1 seconds, but it spun 75 times.</i></p> <p>Now you know the number of rotations on its axis (days) and how long the orbit is (years). Make a calendar.</p> <p>How do you make your calendar work? How many days does</p>	<p>Do the same thing as the hard column except do this for every marble in the solar system! (i.e.--you rolled 4 marbles in orbit at the same time; that's four planets in the solar system).</p> <p>You may want to work with a team...unless you're super hardcore focused.</p> <p>Once you're done with all the calendars, be sure to name your planets.</p> <p>Present your solar system.</p>

		<p>a calendar have? How do you make it fit into a year? Does it come out evenly? If not, you will have to make a decision for what to do with the extra time each orbit...is it a leap day, year, month?</p> <p>Present your calendar and solution for any extra days.</p>	
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EXTENSION

- Research some factoids about leap day/year:
<https://www.history.com/news/why-do-we-have-leap-year>
- Research the history of the first leap year and how it was added to the calendar:
<https://www.nationalgeographic.com/news/2016/02/160226-leap-year-science-time-world-cultures-february/>