Name _____ Date _____ Period _____

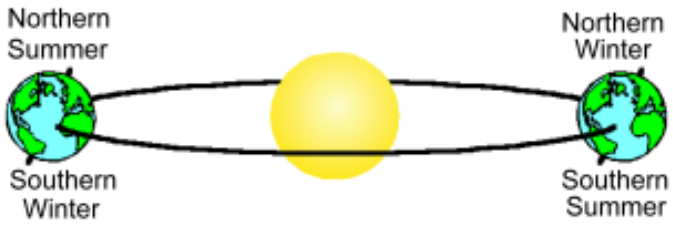
Lab: Making a Capuchin Sundial

CONCEPTUAL PHYSICS: PRACTICAL PHYSICS

Background: As the earth turns on its axis, the sun appears to move across our sky. The shadows cast by the sun move in a clockwise (hence the definition of clockwise) direction for objects in the northern hemisphere.

Shadow sticks or obelisks are simple sundials. If the sun rose and set at the same time and spot on the horizon every day, they would be fairly accurate clocks. However, the sun's path through the sky changes every day because the earth's axis is tilted. On earth's yearly trip around the sun the North Pole is tilted toward the sun half of the time and away from the sun the other half. This means the shadows cast by the sun change from day to day.

In addition, because the earth's surface is curved, the ground at the base of the shadow stick or obelisk is not at the same angle to the sun's rays as at the equator. This means that the shadow does not move at a uniform rate during the day. That is, if you mark the shadow at sunrise and sunset, you cannot evenly divide the space between for the individual hours.



There are several ways to overcome these problems. One is to build a ***horizontal*** sundial, where the base plate is level, and the "stick," called the style, is angled so it is parallel to the earth's axis. The hour marks can then be drawn by trigonometric calculations, correcting for the sundial's latitude.

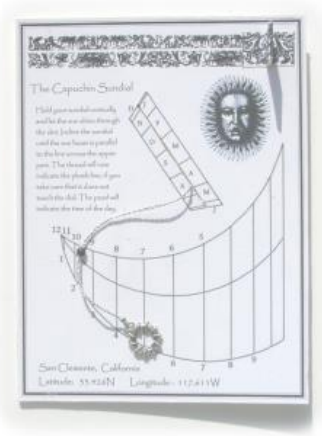
Another solution is an ***equatorial*** sundial, where the base plate is titled at an angle equal to the latitude, and the style is perpendicular to the base, which will align it with the earth's axis. The base can then be marked with regularly-spaced hour marks.

In this activity, you will have a chance to construct one of the three different types of sundials. If you wish to try and construct the other types of sundials I will provide you with the instructions and templates.

Procedure:

1. Follow the directions step-by-step to complete your sundial. You may work with a partner, or construct your own sundial.
2. Obtains handouts and copied sundial pattern to cut out. *(NOTE: Be very careful when using the exacto knifes……they are extremely sharp!)*
3. Answer conclusion questions when you have completed your sundial and have attempted to tell the time using your completed sundial.
4. Clean up after yourself and put away all materials and tools!

Building a Capuchin Sundial

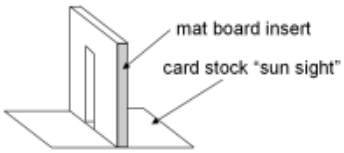


The Capuchin Sundial is an ***altitude dial***, which tells time by the altitude of the sun above the horizon. It can be drawn on a card, and is very portable. The Capuchin sundial takes its name from the hoods of Capuchin monks who belonged to a branch of the Roman Catholic Order of Franciscans, which were apparently long and pointed and resembled the design on the sundial. The Capuchin hoods also gave their name to the Capuchin monkey, whose hair resembles the hood coloring, and the Cappuccino coffee, whose color and froth also resemble the hood.

This particular Capuchin sundial is designed to work only at a specific ***latitude*** (In this case, our latitude here at San Clemente). Universal Capuchin sundials were also designed to be used at any latitude, though it is cumbersome above 70 degrees. The design below was modified from a project produced by Anders Bergström and originally published in Swedish on his website (Links to these sites can be found on my website)

Proceedure:

1. Obtain a copy of the **Capuchin Sundial template** *(you may also download and print your own if you would like – links are available on my website)*. The paper template works best if you use card-stock paper.
2. Carefully cut out the sundial along the dashed lines as shown. Also cut out the “sun sight” along the dashed lines.
3. Cut out the mat board template piece and transfer these lines to a small piece of mat board. You will need to carefully cut this out with an exacto knife. You need to be careful to cut out the “slit” that will allow the sun to shine through.
4. Glue the “sun sight” together as shown to the right.



5. You will also want to cut out a piece of mat board onto which you can glue your sundial. The mat board should be 6 ¼” x 8¼”. Glue the card stock sundial to the mat board. Make sure to center it as you glue it together.
6. Now you are ready to glue the complete “sun sight” to your sundial. Glue it to the right hand side of the sighting area. This is marked on the template.
7. Carefully cut a slot through the sundial between the month markings. This is also marked by a dashed line on the template,
8. Get a cotton thread with a small weight and a small bead which can slide up and down the thread. Insert the thread in the slot cut out in step 7. Fix a small button on the back side to make it possible to slide the thread up and down along the slot.
9. Calibrate the sundial by moving the thread to current date. Then align the thread with the tip of the "hood" and move the bead to the tip ("Twelve noon").
10. Hold your sundial vertically and let the sun shine through the slot. Incline the sundial until the sun beam is parallel to the line across the upper part. The thread will now indicate the plumb line, if you take care that it does not touch the dial. The bead will indicate the time of the day.
11. If you wish to construct your own Capuchin sundial, there are links on my website to can use to design your own custom dial.

Conclusion Questions:

1. How did the **Capuchin Sundial** get its name?

2. Why does the **shadow** cast by the Sun change a little each day?

3. How accurate was your **Capuchin Sundial**? How far off of clock time was it?

4. If the earth rotates every **24 hours** (approximately), how many **degrees** does the sun appear to move in **one hour**? In **four minutes**? (Hint: one full rotation of the earth is 360 degrees).

5. Why don't we use **local solar time** instead of time zones in our everyday lives? Would it be easy to know what time your favorite TV program starts?

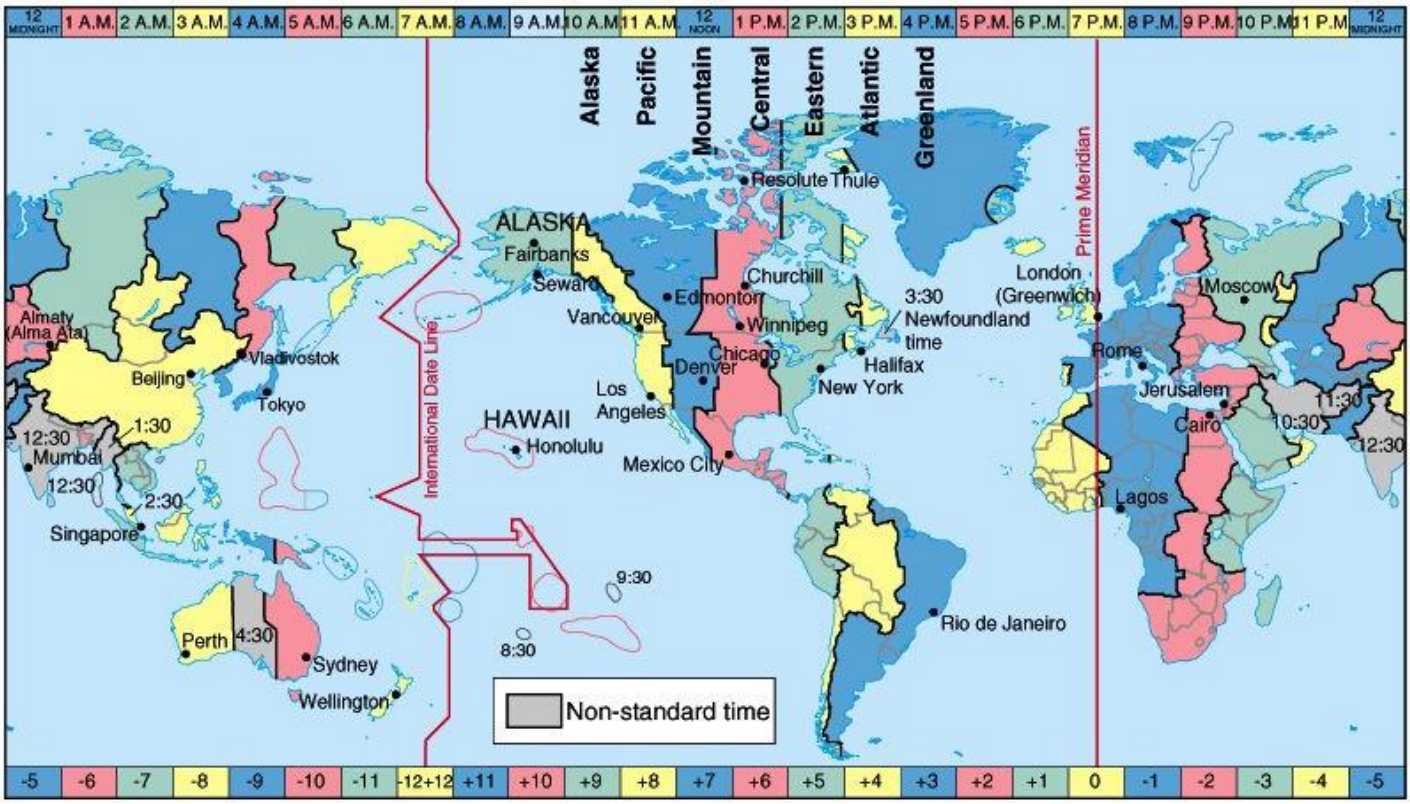
6. Why do **time zones** generally run north-south instead of east-west?

7. Does a sundial work the same north and south of the **equator**? Explain.

8. Would your sundial read the same time if you were 100 miles directly **north** of you? Would the shadows be the same length?

9. Would your sundial read the same time if you were 100 miles directly **east** of you? Would the shadows be the same length?

Look at the diagram below to help you answer questions 10-12



10. Why are ***time zones*** established around the world?

11. What is the ***International Date Line***?

12. What is the ***Prime Meridian***?