# Day-Night Globe

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The ***Day-Night Globe*** (***DNG***) — ***globus*** is another term for *globe* in this context —demonstrates directly the effect of daylight on every place on our home planet, Earth. In particular, using a DNG, you can see how and *why* sunlight, or lack thereof, effects the place where you are the way it does.

> A DNG is a ***terrestrially-synchronized globe.*** But who wants to remember such a name. What you care about is the fact that, when set correctly, it is oriented exactly as the planet under your feet.
>
> By the way, if you have a suggestion for a different name for the Day-Night Globe, don't be shy. Send it to MathVentures (DayGlobe@MathVentures.com) and if we like it we may use it.

The simplest and easiest way to set up a DNG is to use an ordinary globe. As usual when using maps, the larger the scale, the better is the outcome. In other words, using a larger globe is easier and will produce more obvious results.

However, the success of the DNG also depends on the material from which the globe itself is constructed. Most modern globes are constructed from cardboard or plastic. Old globe may be constructed from metal. in general, the better heat-conducting material, the better the DNG. For example, plastic is better than cardboard and metal is better than plastic.

> An exception to this rule is concrete. Since the heat-conducting properties of concrete are similar to those of rocks, a DNG that is constructed from concrete will resemble heat-related, terrestrial phenomena best. But don't expect to find such a globe in your local bookstore, buy it and take it home. The only such globe that I know of, a one-meter diameter DNG, is located at the Clore Garden of Science, Weizmann Institute of Science (http://www.weizmann.ac.il/young/english/garden.htm) Rehovot (approximately half an hour south of Tel Aviv) Israel. Its designer and creator is Reuven Anati (http://www.designshop.co.il/), Chief Exhibit Developer of the Clore Garden. (Unfortunately, as of October 2002, no photos are available of this DNG.)

## Making a DNG

To get your own DNG, all you need are:

- ✓ One globe
- ✓ One sunny day
- ✓ One compass, the kind that points to the north (not the circle-drawing tool), or some other means to tell where the geographic north is.
- ✓ **A stand for your DNG.**

  If your globe includes a stand on which you can rotate **and** tilt it, that's great.

  If not, you need a makeshift stand. You can improvise one, using a cereal bowl, a small cooking pot or a vase. Whatever you use, it should be round and you should be able to rest your globe on its rim without the globe falling inside.

  > Actually, the smaller the size of the circular rim that support your globe, the less area of the surface of the globe will be obscured by it. So, if you can balance your globe on a bottle, you're doing great.

- **Do you know where you are?**

  If you are lost, get yourself found first. DNG is useless for lost people and lost people cannot make DNG.

## Now do the following:

- ➢ **Take your globe outdoors and find a nice sunny space.**
- ➢ **Place your globe on its stand in direct sunlight.**

  All of the globe should be exposed to the sun. Well, that's impossible. No matter how much you try, half of the globe will always be in the shade. If you noticed this on your own, you are one step ahead of me. What's important is that nothing else shades your globe. That is, the shade that is cast on part of the globe is the globe's own.

- ➢ **Find your location on the globe.**
- ➢ **Now orient your globe on its stand such that where you are is at its very top.**

  For example, if you are in San Francisco, orient the globe such that ***its*** San Francisco it at its top,

  If your globe has a built-in stand and you can do that, wonderful. If not, improvise a stand as suggested above.

  The Day-Night Globe is set with the San Francisco Peninsula on top. It not oriented yet toward the true geographic north.

The built-in stand of our globe lets us only spin the globe. Therefore, we removed the base of the stand and the globe was placed on top of a glass vase. If the base were not removed, its weight would have interfered with proper balancing of the globe on the vase. Also visible is the electric cord for illuminating this globe from its inside.

- **Now it is time to find the true geographic north.**

(In case you live down under or anywhere else south of the equator, you know what do to when we, northerners, talk about our pole. I sure don't. You are on your own, mate; I certainly have no clue.)

If you have a magnetic compass, it will point to the magnetic north. The magnetic north is different from the geographic north and in some locations the directional deviation is quite significant. For example, around San Francisco the direction to the magnetic north is 16 degrees east of the direction to the geographic north.

But, not to worry. Most home and school globes are too small for making this sort of an error significant enough to spoil your DNG.

If you don't have a compass but you know the general direction of the north this may be good enough.

See, working with a small-scale globe may be beneficial after all. It is more tolerant to errors.

If you really want to know where is the true geographic north and be a little more accurate, you just need a little planning work. On a clear night, prior to making your DNG, go outdoors and find the North Star. This is the direction to the geographic north.

Now take some measures to remember this direction when you need it. How to do this you are on your own. It shouldn't be too difficult.

Also, do not change location. I mean, if you live in San Francisco and find the North Star there then do not try to impress your friends by making a DNG for New York. It will not work.

- **Once you know the direction of the geographic north, point the North Pole on your globe in that direction.**

If your globe has an axis, on which you can spin it, this axis is between the North and South poles.

Do this by rotating the globe horizontally, while keeping your location at the top of the globe.

**This is it. You are now the proud engineer and owner of a *Day-Night Globe.***

## What Is a DNG Good For? You Ask

- **Watch it for a while.**

  Walk around it and look at it from all possible angles. Avoid casting your own and any other shadow on it!

  What do you notice?

  - Pay attention to its sunny side and to its shady side
  - What time is it where you are?
    - How does the current time effect the sunlight or shade on the DNG?
    - Is Daylight Saving Time in effect now where you are? How does it effect your findings?
    - Where is the dawn line on the globe? This is the line where the shade meets the sunlight, marking the transition from night to day.
      - Where is morning on the globe now?
    - Where is the dusk line on the globe? This is the line where the sunlight meets the shade, marking the transition from day to night.
      - Where is evening on the globe now?
  - Check what is happening around Earth's poles?
    - Which is in daylight and which is in the shade?
    - Can you estimate how long do the day and night last at the poles? At the equator? At other latitudes?
  - After the DNG stands in the sun for a while touch its surface in different places.

    Be careful! Do **not** disturb the orientation of your DNG!

- Do you notice any differences? What? What kind? Isn't it cool?

  (Now is the time to figure out why the material from which the globe is fabricated makes a difference.)

- ❑ Leave the DNG for a few daylight hours and then come back and repeat all of these observations. What's the difference?

## Day-Night Globe -- What is Going On?

**Think of what you have just done:**

1. You placed your Day-Night Globe in direct sunlight.

2. You oriented it such that

   2.1. Your location on the globe is at its very top; and

   2.2. Its north pole points toward the true geographic north.

**Think of what you have just accomplished:**

***You have set your DNG such that sun rays hit it exactly the same way they are hitting planet Earth right now!***

The Day-Night Globe is correctly oriented to the true geographic north and the San Francisco Peninsula is on top.

Notice that the built-in stand of this Globe lets us only spin the globe. Therefore, the base of the stand was removed and the globe was placed on top of a glass vase. (If the base is not removed, its weight interferes with proper balancing of the globe on the vase. Also visible is the electric cord for illuminating this globe from its inside.)

## So What?

- ✓ The illuminated half of the sphere shows the Earth's half where now is daytime.
- ✓ The shaded half of the sphere shows the Earth's half where now is nighttime.
- ✓ The area where shade and light meet are where right now dawn and dusk are happening.
  - ✓ Dawn is where shade is west of the light.

Dawn is approaching the Far East

✓ Dusk is where light is west of the shade.

As the earth rotates eastbound the sunlit areas on both Earth and your DNG move toward the west. If you wait till dusk, you will see the dusk area on the globe.

**By the sea.** If you can do this on a seashore where sunrise or sunset takes place, you will see a more pronounced difference between daylight and night on your DNG.

✓ **Feel the heat.** After your DNG has stood in the sun for a while, the illuminated surface is much warmer than the surface of the shaded side.

✓ More subtle temperature differences exist even on the surface of the illuminated half of the DNG. They are the result of the ***angle at which sunlight hits the surface***.

In October daylight in Antarctica lasts longer and longer.
However, because of the differnce in the angle of incidence between
the equator and Antarctica, Antarctica is much cooler than the tropics.

✓ **Position yourself such that the globe is between you and the sun (so you do not cast a shadow on the globe) and your eyes are exactly above your location -- a high-flying pilot point of view.**

Pay attention to the reflection of the sun on the surface of the DNG.

➔ The longitude (meridian) of this reflection is the one above which the sun is currently located.

## Now Try This:

1. Move your head vertically, exactly (as best you can) above your location.

   Notice that while you do so, the reflection of the sun on the globe moves along the same longitude.

2. Move your head from side to side or in any angle.
   Notice that while you do so, the reflection of the sun on the globe moves all over the surface.

   Can you explain the reason for the difference?

   Can you move your head such that the sun reflection remains stationary?

- **Look at the poles.**

  - If it is summer in the Northern Hemisphere the North Pole is illuminated. If you rotate the DNG around its axis, you will see that there is no night at the North Pole. At the South Pole there is long night.

  - If it is summer in the Southern Hemisphere the North Pole is illuminated. If you rotate the DNG around its axis, you will see that there is no night at the South Pole. At the North Pole there is long night.

# References


- Reuven Anati, (http://www.designshop.co.il/) Chief Exhibit Developer in the Clore Garden of Science at the Weizmann