# PRACTICAL ASTRONOMICAL ACTIVITIES DURING DAYTIME

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**Abstract:** These daytime astronomy activities arose from research done in New Zealand by a group of teachers and astronomers into the problems of teaching astronomy. This showed that it was generally regarded as a difficult subject to take, traditionally relying on books, films and models. The fortunate may have had a visit to an observatory or planetarium, the adventurous may have attempted an outdoor evening viewing session, which sometimes had weather-related difficulties.

The problem of not having many 'hands-on' activities, the feelings of inadequate knowledge, the felt need for astronomical equipment and expertise become too daunting for many teachers to do the subject justice. If astronomy was to be taught then a way around these difficulties needed to be found. Our group, working with teachers and children using the constructivism teaching approach, found that the principles of astronomy could be discovered during the day when the students are at school. Working co-operatively they measured and recorded observations of their shadows caused by the motions and interactions of the nearest star, the Sun (Sol), and our planet, Earth.

Because children were involved so personally they were much more interested in the results of the study. Astronomy became enthralling and challenging for both teacher and class after applying their daytime experiences to night time viewing at home and reporting back to class.

**Keywords:** Daytime astronomy. Hands-on. Sun-Earth-Moon System.

## ATIVIDADES ASTRONÔMICAS PRÁTICAS DIURNAS

**Resumo:** Estas atividades astronômicas diurnas surgiram de uma investigação feita na Nova Zelândia por um grupo de professores e astrônomos a respeito dos problemas do ensino da Astronomia. Este trabalho mostrou que a Astronomia é geralmente considerada uma disciplina difícil de ensinar, tradicionalmente baseada em livros, filmes e modelos. Os mais afortunados podem ter feito alguma visita a um observatório ou planetário, e os mais avançados podem talvez ter tentado uma sessão de observação noturna, as quais sofrem às vezes de dificuldades relacionadas ao tempo.

O problema de não dispor de suficientes atividades práticas, a sensação de possuir conhecimentos inadequados, a necessidade de dispor de equipamento astronômico e experiência tem sido, em geral, demasiado intimidante para que os professores introduzam a matéria nas suas aulas. Se a Astronomia ia ser introduzida, então era preciso encontrar uma forma de resolver essas dificuldades. Nosso grupo, trabalhando com professores e alunos numa abordagem construtivista, encontrou que os princípios da Astronomia podem ser descobertos durante o dia, enquanto os alunos estão na escola. Trabalhando de forma cooperativa os alunos mediram e registraram observações de suas próprias sombras causadas pelos movimentos da estrela mais próxima, o Sol, e nosso planeta Terra.

Devido ao fato de os alunos se envolverem muito pessoalmente nas atividades, eles ficaram muito mais interessados nos resultados do estudo. A Astronomia passou a ser um desafio para o professor e seus alunos quando aplicaram suas experiências diurnas à observação noturna desde suas casas, relatada depois em sala de aula

**Palavras-chave:** Astronomia diurna. Atividades práticas. Sistema Sol-Terra-Lua.

## ACTIVIDADES ASTRONÓMICAS PRÁCTICAS DIURNAS

**Resumen:** Estas actividades astronómicas diurnas surgieron de una investigación hecha en Nueva Zelandia por un grupo de maestros y astrónomos sobre los problemas de la enseñanza de la Astronomía. Este trabajo mostró que la Astronomía es generalmente considerada una disciplina difícil de enseñar, y tradicionalmente basada en libros, filmes y modelos. Los más afortunados pueden haber efectuado alguna visita a un observatorio o planetario, y los más aventajados pueden tal vez haber intentado una sesión de observación nocturna, las cuales sufren a veces de dificultades relacionadas al mal tiempo.

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El problema de no tener suficientes actividades prácticas, la sensación de poseer conocimientos inadecuados, la necesidad de disponer de equipamiento astronómico y experiencia suelen ser demasiado intimidantes para que los profesores introduzcan la materia en sus clases. Si la Astronomía iba a ser introducida, entonces era preciso encontrar una forma de resolver estas dificultades. Nuestro grupo, trabajando con maestros y alumnos dentro de un marco constructivista, encontró que los principios de la Astronomía pueden ser descubiertos durante el día, en cuanto los alumnos están en la escuela. Trabajando de forma cooperativa los alumnos midieron y registraron observaciones de sus propias sombras causadas por los movimientos de la estrella más próxima, el Sol, y nuestro planeta Tierra.
Debido a que los alumnos se involucraran tan personalmente en las actividades, estuvieron mucho más interesados en los resultados del estudio. La Astronomía pasó a ser un desafío para el maestro y sus alumnos cuando aplicaron sus experiencias diurnas a la observación nocturna desde sus casas, reportada después en clase.

**Palabras clave:** Astronomía diurna. Actividades prácticas. Sistema Sol-Tierra-Luna.

## 1. Introduction

Astronomical observations are usually regarded as night-time activities so doing "hands-on" astronomy activities during the day when children are at school or camp may be surprising.

There are two views or explanations of what happens in the sky.

*The earthbound view* — On Earth, our perception is that the sun, stars, and all other natural objects in the solar system move around us from *east to west*. We say that the sun "goes across the sky."

*The astronaut's view* — An astronaut looking at the Earth from space sees the Earth rotating from *west to east* as it revolves around the sun. They say that, "it is the earth that is turning."

This apparent motion of the sky varies depending on where you are on the Earth, so latitude, or where you live is important. To understand our place in space, we need to hold both views in our mind together.

Many teachers who are apprehensive about offering astronomy sessions at night never think of doing something during the day. Before attempting a night astronomy program it is recommended that you establish some principles of astronomy during the day.

## 2. Implementing the Program

A group of teachers and astronomers in New Zealand have produced a series of 9 Daytime Astronomy Activity sheets for children that could be done by individuals or groups at school and explored further at home or camp. These were mainly based on observing and recording shadows, particularly around the time of solar noon.

- Draw my shadow
- Working out solar noon
- Earth turns west to east
- Timing sunlight
- I'm a compass
- Plotting the sun's path
- How high is the sun?
- My shadow at home
- What is in the sky tonight?

These activities will be intriguing for both students and their teachers to explore, and offers information that most didn't know or understand.

- There are two noons every day — 12 o'clock "standard" time and noon by the sun which is called *Solar Noon*. The sun is half way in time between sunrise and sunset at your location and therefore can also be called *Local Noon*.
- At solar noon (in the Southern Hemisphere) the sun is directly north of your location and all shadows point to the true (geographic) South Pole.
- If a person stands with their back to the sun at solar noon, their shadow lies along a line from the true North Pole to the true South Pole through the place where they are standing. Their heels point north and their head's shadow points true south.
- Being the true or geographic poles raises the issue of the magnetic poles and the difference between them. People can use their shadows as the basis for a compass to determine directions.
- At solar noon we say that, "The sun is on the meridian[1]"— and that it is noon. Before then, the sun is before the meridian, or *ante meridian* (a.m.). After then, the sun is past the meridian, or *post meridian* (p.m.) and is *after*noon.
- The length of the person's solar noon shadow is directly related to the season. Short shadows occur in the summer; long shadows in winter.

Arising out of these points are some basic observations upon which many astronomical understandings are built. These observations set the scene for night-time observations by the students at home.

- At solar noon local time, the meridian is on the sun. All shadows point to the nearest pole and are aligned true north/south.
- The sun appears to move in a wide band across the sky between the longest and shortest days (the solstices). The azimuth of its rising and setting along the horizon changes daily.
- Along this band (the ecliptic) are found the moon, all the planets, and the constellations of the zodiac.
- The altitude of the sun at solar noon increases from the shortest to longest day and decreases back to the shortest day. This is related to the earth's orbit around the sun, creating the seasons.
- Working with altitude and azimuth makes it easier to understand right ascension and declination.

When students discover that solar noon is different to clock noon and that their shadows point to the South Pole at solar noon is a most significant finding and will lead to many questions and research showing that this method has the prospect to make the introduction to astronomy an exciting daytime experience.

[1] The meridian is an earthbound concept; the correct observation is the 'meridian is on the Sun'.

The nearest star is the Sun (Sol[2]), the nearest planet is Earth, and the nearest moon is our moon. All three can be seen during the day. By understanding the motions and interaction of them helps explain what is happening daily, nightly, seasonally, and yearly, and how eclipses and tides occur.

### 3. Confusing Conventions

When it comes to talking about astronomy, there are two problems that are worldwide.

*The first*, is that the *traditional ideas* we use to describe what the sun does in the sky every day, are misleading, e.g. the sun does not "go across the sky", nor "is overhead at noon" outside of the tropics.

*The second*, and much more serious, is that *by convention* north is accepted as the "top". From this, much of our understanding about our position on the earth and its associated vocabulary has arisen. We commonly talk about being "down under" or going "up north". As there is no top or bottom in space it is just as correct to have the South Pole at the "top", and much more helpful when relating the view above, to the Earth below. Many people have difficulty with this idea because our astronomical vocabulary and models are Northern Hemisphere based. It is important to develop a Southern Hemisphere mental model if we live there.

*Traditional ideas* and *convention* are confusing to children. What they see is often different from what they are told.

Many books about astronomy depict the Northern Hemisphere view of the moon and constellation patterns which are upside-down to viewers in the Southern Hemisphere. Therefore traditional zodiac star patterns make little sense to most children. Probably the star pictures of the indigenous people of Southern Hemisphere countries would be more relevant.

### 4. Children's Constructions

This series of practical "hands on" daytime activities came about as a result of working with children. Many of their explanations, arising from their observation of daily and seasonal celestial changes are intuitive, constructed by themselves from their own observations, from their peers, from answers given by adults, and information from other sources1. Many of their constructions are incorrect and grow into strongly held alternative conceptions that become the "default settings" to which children will return even after being given more acceptable and correct information. These "settings" are not peculiar to the children; they are embedded in the general population.
So, how can these 'default setting' be upgraded?

We found that getting children to do activities that introduced some very basic understandings of daily events ignited their interest, excitement and enthusiasm for further involvement.

There is nothing more important to children than themselves.

Attached are the nine pages of the Daytime Activities. The following are comments on those activities.

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[2] The name of the Sun is Sol so that words containing 'Sol' have some connection with the Sun. On Mars days are known as 'Sols'.

- *DRAW MY SHADOW*

The activities start with pairs of students drawing around each other's shadows over a 2 hour period.

*Different frames of reference:* The students were intrigued by their shadow's movement and size. When asked, "Why are the shadows changing?"
Two common answers were given. Because "The sun's going across the sky" or "It's the earth that's turning".

The first is the *earthbound view* .

The second is the *astronaut's view*.

- *WORKING OUT SOLAR NOON*

The second activity is based on a surprising event, 'Solar' or local noon.. This is different from clock noon, and is usually after 12 midday and, with daylight saving, it may be later than 1:30 p.m. particularly in increasingly southern latitudes.

The time of solar noon can be worked out from sunrise and sunset times given in newspapers, Astronomical Yearbooks or downloaded from the web site <http://www.sunrisesunset.com>. This website also gives the changing lengths of daylight for each month. To get sunrise and sunset times for your place you need know your latitude and longitude.

- *EARTH TURNS WEST TO EAST*

This is a Southern Hemisphere activity where the globe is turned with the South Pole at the 'top' and rotated so that your country is in sunlight. The model person (give it a name) stands on your place in the country facing north with arms outstretched; right hand pointing east and left hand west. Position the globe in sunlight so that the bright spot (the sun's reflection) is in the tropics (the ecliptic) and eastwards of the model. Their shadow should point about southwest (about 220º). This should be the same as the shadow of a student on the ground outside at this time.

The 'earth' turning eastwards means that it is turning towards the sun and away from night.

While holding the globe steady turn it eastwards until the model is facing the bright spot (north) and their shadow is pointing towards the South Pole. This represents solar noon.

Turn the globe again so that the model's shadow is now pointing about southeast (135º).

- *TIMING SUNLIGHT.*

The relevance of this activity is for the students to be involved with a time interval for sunlight to travel the 150,000,000 km from the sun to illuminate the earth. This is to compare with the time of 4 years that light from the next nearest star (Alpha Centauri) takes to reach Earth.

- *I'M A COMPASS*

*Directions from the sun* - The sun is true north at Solar Noon and all shadows point to the South Geographic Pole. This means that students can use their shadow as a compass. This activity can also be used to highlight the difference between geographic or 'true' bearings and magnetic bearings.

The solar noon shadow occurs when the sun is at its zenith for that day and the meridian (the imaginary line in the sky running overhead from north to south) is on the sun. If a student stands facing the sun at this time they are looking north.

By stretching their hands out sideways to shoulder height, their right hand points to east and a.m. and the left hand points to west and p.m. The meaning of these abbreviations now makes sense. Ante (before) the meridian and Post (after) the meridian. The meridian is also the noon line so the student will observe morning (when the sun is before noon, become noon, then afternoon. These observations give meaning and understanding to those words.

Measuring the changing angle of the student's shadow at hourly intervals will show the rate of the rotation of the earth at 15° (being 360° divided by 24 hours). The relevance of this measurement is to show that the apparent movement of celestial objects across the sky during the day and night is caused by the turning of the Earth.

- *PLOTTING THE SUN'S PATH*

There is a common alternative conception that the sun rises in the east and sets in the west every day but this only happens twice a year; on the equinoxes. For half the year sunrises and sets are north of east and west and the other half, south of east and west. The bearing of sunrise and sunset and the elevation of the sun at its zenith, when on the meridian, are related to its position north and south of the Equator. The apparent movement of the sun across the sky each day is an arc that reduces slightly each day from the summer solstice down to the winter solstice and increases up to the summer solstice again. It is important that students understand that this "sun, moon and planets band" is the view out to the solar system from your place. Once students are shown how to determine it, night-time astronomy is much easier and much more rewarding.

The solar system is a fried egg!

Comparing the solar system with something that is familiar can make sense to students. The sun (the yoke) is in the centre with the planets in the 'white' on the same plane.

- *HOW HIGH IS THE SUN?*

This activity is for students to record their solar noon shadows on a three metre length of paper. They then hold the end of a length of string on the top of their head and the other end is stretched out to the ‘top’ of the shadow of their head. Use a protractor to measure the angle between the string and the ground. What in fact being measured is the altitude or elevation of the Sun.

We found that getting students to do activities that introduced some very basic understandings of daily events stimulated their interest, excitement and enthusiasm for further involvement.

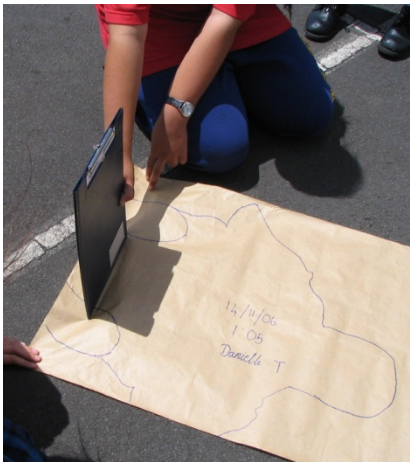
Daytime Astronomy is relevant to several aspects of school curricula; Mathematics and Statistics, Science, Technology, Geography and Social Studies. It gives the opportunity for some practical observations, recording, measurement, prediction, tables of data, statistics, making and using models.

The length of the solar noon shadow is related to the season and determined by the elevation of the sun, the height of the observer, and their latitude.

The length of daylight is related to the season, determined by the latitude of the place and the azimuths of sunrise and set along the eastern and western horizons between the winter and summer solstices.

A problem arising from this ‘shadow on the paper’ is assessing the area of the shadow. Assuming that the incoming energy from the sun is the same year round at about 1366 $w/m^2$ it can be shown that its heating affect is determined by the angle of incoming light, how much is reflected from the surface, and the length of exposure. The area of the shadow is smallest in summer (the light most concentrated) and greatest in winter (the light most spread out). When this is related to the length of daylight in each season it is easier for students to make the connection between the altitude or elevation of the sun, the length of daylight and of course the length of darkness.

To understand why the temperature of each season changes can be illustrated by measuring the area of shadows cast by objects.



Because it is difficult to measure the area covered by a student’s shadow this activity makes it possible by using the ratio of the shadow of a known size. In this case an A4 folder (24cm x 37cm = 888 $cm^2$).

The area covered by the shadow cast by an object is related to the elevation of the sun.

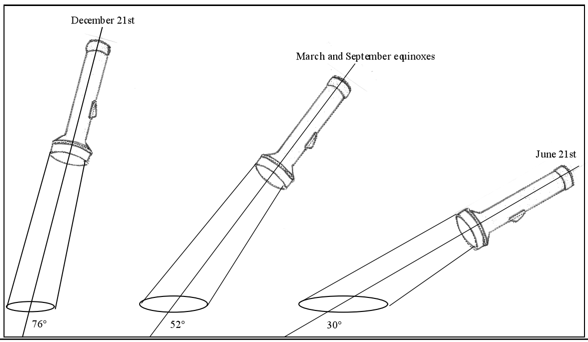
In winter the sun is low in the sky. Incoming sunlight (and heat) is spread out over a larger area for maybe only 9½ hours. Being low more light and heat are reflected and with night being 14½ hours long more heat is lost into the sky, compounding the loss each day.

The higher the elevation the smaller the shadow.

In summer the sun is high in the sky. Incoming sunlight (and heat) is concentrated over a smaller area for maybe 14½ hours each day. Being high less light and heat are reflected and with night being 9½ hours long less heat is lost into the sky, compounding the gain each day.

At the summer solstice (December 21st), the sun reaches its greatest elevation and the shadows are the shortest that they get for your location. They lengthen slightly each day as the noon altitude of the sun decreases until the winter solstice (June 21st). Then the sun at its lowest elevation and shadows are at their greatest length. The difference between the highest and lowest noon elevation of the sun is 47º, being twice 23.5º. This 23.5 degrees is the tilt of the earth relative to its orbit around the sun.

**Angle of the Sun for the latitude of Auckland (37°) at summer solstice, equinoxes and winter solstice.**




There are some very good science teaching opportunities regarding how the angle of incidence and reflection of the sun's rays is related to the amount of heat absorbed or reflected, which, throughout the year determines the warmth or coldness of the seasons.

- *MY SHADOW AT HOME*

The reason for introducing students to the activities during the day at school is to have them practice them for repeating them at home and report back to school what they have seen.

- *WHAT IS IN THE SKY TONIGHT?*

When students can be shown where to look in the night sky and start to find some significant stars it is a great way to introduce them to astronomy.

## 5. Final Remarks

We've given students something more than just doing activities. It is an introductory technique to allow them to make their own observations and report back to their peers their "astronomical discoveries".

These Daytime Astronomy activities developed into Pipehenge, an astronomical climbing frame, but that is another story.

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DANAIA, L., MCKINNON, D., Common Alternative Astronomical Conceptions Encountered in Junior Secondary Science Classes: Why Is This So?, **The Astronomy Education Review**, Issue 2, Volume 6: 32-53, 2008.

## 7. Useful web sites.

<http://www.skyandtelescope.com>
<http://www.skymaps.com>
<http://www.pipehenge.com>
<http://www.stardome.org.nz>
<http://www.astrosociety.org>
<http://www.sunrisesunset.com>

# DAYTIME ASTRONOMY

Daytime 1 - 9 introduce students to a series of astronomical observations and activities during the day while they are at school. They lead to students doing their own night-time observations at home.

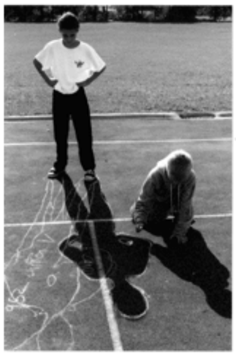
**Daytime 1**

## DRAW MY SHADOW

***Required:*** chalk, students, sunny day, paved area outside.

### Do this 1st

At 9.30 a.m. on a day that is likely to remain sunny, take the group outside to an open paved area clear of any trees and buildings that may cast shadows in that area later. Working in pairs, the students draw with chalk around each other's shadows and their shoes (so they can stand back in the same position later). The students should print their names and the time on their shadow outlines.



At 10 a.m. the students should stand back in their shoe outlines, draw around their shadows again and record the time.

Repeat this activity at 10.30 and discuss possible reasons why the shadows changed.
Get each student to draw a circle on the ground where they guess the shadow of their head would be at 11 o'clock.
At 11 the students should stand in their shoe outlines again to see how close the shadow of their heads were to their guesses. Draw around their shadows again.

### Do this later

It is likely that the students will want to keep recording their shadows until later in the day. Then ask them to draw a line connecting the top of the shadows of their heads. The point along the line where the shadow would have been shortest was when the Sun was halfway between sunrise and sunset and was on the meridian for your place. This was the time of solar noon*. All shadows cast at solar noon point to the true South Pole.

### On another day

Alternatively a series of observation may be done as a separate activity on a later occasion by starting the observations at, say 11 a.m. and doing them every half hour until 1 p.m. Draw a line across the top of the heads (as above) and determine solar noon. (During daylight saving or summer time make all observations one hour later in order to cover solar noon).

**Note:**
*There are two noons every day. 'Clock' noon (12 o'clock) and Solar noon when the Sun is half way in time between sunrise and set at your location.
Identifying solar noon and shadow direction (true south) are critical for most of the other following activities.
Discovering that there is such a daily event as solar noon and that all shadows at this time point to the true South Pole will be new to most students and teachers.

**Vocabulary:** shadows, solar noon, South Pole

# DAYTIME ASTRONOMY

**Daytime 2**

Daytime 1 - 9 introduce students to a series of astronomical observations and activities during the day while they are at school. They lead to students doing their own night-time observations at home.

## WORKING OUT SOLAR NOON

**(From the Weather section of a daily newspaper).**

***Required:*** Daily newspaper

Solar noon is when the Sun is half way in time between sunrise and sunset.

From sunrise and sunset times given in the weather section of a daily newspaper e.g.:-

**Sunrise 6:44 a.m.**
**Sunset 6:02 p.m.**

work out the time of solar noon by using this method:

From 12 noon subtract sunrise time (e.g. 6:44 a.m.) and add sunset time (e.g. 6:02 p.m.).
**Important: Remember to calculate in hours and minutes.**

12:00 - 6:44 = 5:16 + 6:02 = 11:18
There are therefore 11 hours and 18 minutes of sunlight for this day.

Divide your answer (i.e. 11:18) in half (5:39), and add it to the sunrise time (i.e. 6:44).

11:18 ÷2 = 5:39 + 6.44 = 12:23

Therefore 12.23 p.m. is solar noon in this example.

The meridian is on the Sun, which is half way between sunrise and sunset.
The Sun is on true north at this time and all shadows point to the true South Pole.

Can the students work out other ways for finding solar noon, e.g. try 24 hour clock time.

**Note:**
During the period of daylight saving, solar noon may be as "late" as 1.50 p.m.

**Vocabulary:** meridian, solar noon, sunrise, sunset.

# DAYTIME ASTRONOMY



Daytime 1 - 9 introduce students to a series of astronomical observations and activities during the day while they are at school. They lead to students doing their own night-time observations at home.

## EARTH TURNS WEST TO EAST

***Required:*** A globe of the Earth with the South Pole at the 'top', a model person

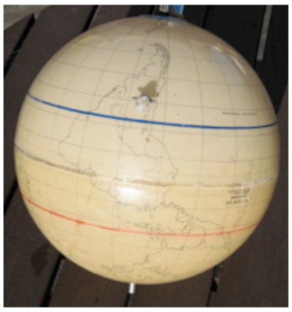
To show that it is the turning of the Earth from ***west*** to ***east*** that makes the shadows change as the Sun appears to move from east to west.
Have the students stand with their backs to the Sun.
Kneel facing them holding a globe of the Earth by the South Pole with South America in sunlight. Draw attention to the bright spot on the globe.
Ask "What is making it?" (It is a reflection of the Sun). As you turn the globe ask the students to watch the spot and notice if it moves. Can the students work out which way the globe must turn to make the Sun appear to travel across the South America from the Atlantic to the Pacific.

Make a 2-3 cm model of the head, arms and body of a person (a class member) from plastercine or blutac and stand it on your place on the globe.

Hold the globe in the Sun in the same way as for the "spot on the globe". Notice that the model makes a shadow on the globe as it is turned.

**1. Morning shadow**
Hold the globe in sunlight with the bright spot of the Sun in the tropics.
Stand the model so that it faces north, right hand pointing east and left hand west.
Turn the globe so that the shadow points toward the south west.
Note that the bright spot (reflection of the Sun) is east of the model.
Compare this with students' morning shadows outside.

**2. Noon shadow (Solar noon)**
Turn the globe so that the model faces the Sun.
This is the same as a student standing outside facing the Sun.
Note that the bright spot is true north of the model. Their shadow points true south (towards the South Pole)
The Earth is turning eastwards towards afternoon.



**3. Afternoon shadow**
Turn the globe so that the Sun is west of the model
Note that the bright spot is west of the model.
To the east the Earth is moving into darkness.
To the west the Earth is brighter as the Sun goes "over the horizon"

# DAYTIME ASTRONOMY

Daytime 1—9 introduce students to a series of astronomical observations and activities during the day while they are at school. They lead to students doing their own night-time observations at home.

**Daytime 4**

## TIMING SUNLIGHT

***Required:*** Stop watch.

While talking to the group outside ask if someone has a stopwatch function, or a large second hand on their watch and can time 8 minutes for you from the time that you clap your hands.

Get them to tell you when to start. Clap your hands once.

Tell the time keeper to let you know when 7 minutes and 40 seconds has past so that the group can count down the last 20 seconds when everyone will clap their hands once.

Tell the group that in 8 minutes something amazing is going to happen.

Go on with Daytime 5 (I'm A Compass) activity in the meantime.

Ask the timekeeper occasionally how much time has passed or how much is left of the 8 minutes.

Get the group to count down the 20 seconds and everyone claps their hands once.

Get the students to look around and tell you some things that they can see.
Accept 4 or 5 then ask, "Why can you see them"? Several answers will be given, such as, "We've got eyes", "Because they are there". "It's daylight". Seek several explanations.

If an answer is given including light ask where the light came from.—"The Sun". "How long did the light take to get here from the Sun?" "8 minutes".

Tell the group. "The light arriving around us now left the Sun just over 8 minutes ago and has travelled 150,000,000 kilometres to get here. That is at the speed of light (300,000 kilometres per second).

That light has come from our nearest star the Sun.

The next nearest star that we can see in the Southern Hemisphere is Alpha Centauri; the outer Pointer to the Southern Cross. Its light takes 4 years to travel to Earth.

The nearest star in the Northern Hemisphere is Sirius. The light seen from Sirius takes 9 years to get here.

# DAYTIME ASTRONOMY

Daytime 5

Daytime 1 - 9 introduce students to a series of astronomical observations and activities during the day while they are at school. They lead to students doing their own night-time observations at home.

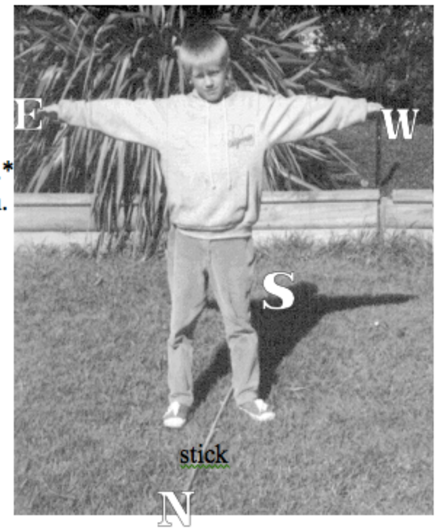
## I'M A COMPASS

***Required:*** orienteering compass, a 2 metre stick, solar noon shadow

At solar noon have the students stand facing the Sun.
(They will be facing true north, true south is behind them).

By raising their left hand out sideways they will point to west and the western horizon.
Their raised right hand will point to east and the eastern horizon.*
It is important that every one should practice this for use later on.

Place a magnetic compass in the middle of the solar noon shadow and note:-
1. in which directions the head and shoes of the shadow lie.*2
2. the time at which the shadow was shortest.*3
Find out the magnetic variation for your place.




**Note:**
In the Southern Hemisphere the Sun appears to travel from the eastern horizon to the western horizon via north.
*1 Standing in this position the student has used their body as a compass to show the four cardinal points. Discuss what they are and their degrees. Also, their right hand point to starboard and their left hand to port (in the Southern Hemisphere). This activity can be used to introduce map reading, orienteering and navigation.
*2 The magnetic compass points to magnetic north and south poles which are different from true or geographic north and south poles. This may be the first time that the students have learnt that there is a difference between the two norths. On a globe of the Earth point to the geographic poles and find magnetic north and south poles.
*3 Shortest shadows of each day always occur at solar noon when the Sun is at its highest point, half way between sunrise and set at the place where you live. This time varies throughout the year depending on the season and time changes, such as daylight saving, and is usually after "clock" noon.

**Vocabulary:** daylight saving, horizon, magnetic variation, meridian, navigation, orienteering, port, starboard, solar noon, summer time,

# DAYTIME ASTRONOMY

Daytime 6

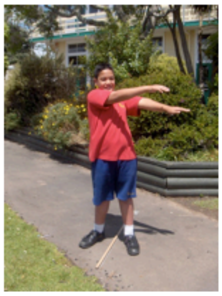
Daytime 1 - 9 introduce students to a series of astronomical observations and activities during the day while they are at school. They lead to students doing their own night-time observations at home.

## PLOTTING THE SUN'S PATH

***Required:*** solar noon shadow, stick or string

Repeat Daytime 5 activity at a solar noon time with the students raising their hands out sideways to point to the western and the eastern horizons.

By bringing their outstretched right hand above their face to touch their outstretched left hand they will make the path that the Sun appears to take across the sky.



The students should practice this for use at home later.

### Do this at home

When this activity is done at solar noon at home over the weekend, the students are able to set up a north-south line at their place. They should mark it somehow (with a string or stick).

### Note:

Solar noon is when the Sun is half way in time between sunrise and set at the place where you live. The time of solar noon changes slowly from week to week and varies throughout the year depending on the season and time changes, such as daylight saving, and is usually after "clock" noon. The students should know when solar noon is for the coming weekend at home.

### Do this next

Have the students find out which meridian is used for determining the time for your place.
Discuss how "daylight saving" or "summer time" works.

**Vocabulary:** daylight saving, horizon, meridian, solar noon, summer time.

# DAYTIME ASTRONOMY

Daytime 1 - 9 introduce students to a series of astronomical observations and activities during the day while they are at school. They lead to students doing their own night-time observations at home.

**Daytime 7**

## HOW HIGH IS THE SUN?

***Required:*** protractor, tape measure, 3 metre length of paper, string, solar noon shadow.

Have a volunteer stand on the end of a three metre length of paper at or near solar noon looking at their shadow.
Draw around the shadow. Run a string from the top of their head to the top of the shadow of their head. Use a protractor to measure the angle where the string meets the ground. Record the students name, date, angle and time.

Is there any difference between the angles measured for the shortest and tallest people in the group[1]?
Does the angle change if the activity is done at other times between 9 a.m. and 3 p.m.?

Keep the paper for repeating the activity at later month's time to compare results.

**NOTE:**
[1]The angle for each student should be the same which will be a surprise, because what is actually being measured is the height of the Sun. This activity is usually done at school over a period of weeks to observe the changing height of the Sun as the seasons change.

This is an interesting activity because there is a relationship between the length of their shadow and their height, and the length of the shadows cast by other objects and their height. Can they work out the height of some of those objects such as a flag pole or tree?

Would the students expect there to be any difference in the height of the Sun at other seasons? If so, what would they be?

This activity is best started near one of the solstices as the path of the Sun gets lower in the sky as the winter solstice approaches (June 21st) when the Sun reaches its northern most point (the Tropic of Cancer). And higher towards the summer solstice (December 21st) when it reaches its southern most point (the Tropic of Capricorn). The band across the sky between the two paths is called the plane of the ecliptic or the path of the moon, planets and constellations of the zodiac.
As the solar noon angle of the Sun gets lower in the sky the length of daylight get less.
As the solar noon angle of the Sun gets higher in the sky the length of daylight increases.

**Vocabulary:** angle, arc, Cancer, Capricorn, constellations, decreasing, ecliptic, increasing, measurement, protractor, solstice, tropic, zodiac

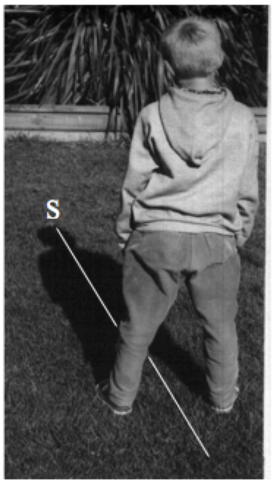
# DAYTIME ASTRONOMY

Daytime 8

Daytime 1 - 9 introduce students to a series of astronomical observations and activities during the day while they are at school. They lead to students doing their own night-time observations at home.

## MY SHADOW AT HOME

***Required:*** solar noon shadow, stick or string.




At school get the students to stand outside at solar noon with their backs to the Sun and facing their shadows.

(By now the students should know that at solar noon all shadows point to the South Pole).

Get them to practice this a few times and mark it with a string or stick.

Work out the time of solar noon for the weekend so that the students can mark a line at home from their heels to their head with a string or stick.

They will have set out on the ground at their place, a north/south line. This line should have a reasonably clear view to the north and south for making observations at night.

Get the students now to practice making a circle around their eyes and nose by touching the tips of their thumbs and middle fingers together.

When the student does this on their line at home the Southern Cross will be inside this circle.

**Note:**
When students discover that a north/south line can be made at solar noon, can use it for compass bearings and for introducing a simple method of finding their way around the heavens, they are well on the way to doing some practical astronomy.

**Vocabulary:** astride, circumpolar, South Celestial Pole, Southern Cross

# DAYTIME ASTRONOMY

**Daytime 9**

Daytime 1 – 9 introduce students to a series of astronomical observations and activities during the day while they are at school. They lead to students doing their own night-time observations at home.

## WHAT IS IN THE SKY TONIGHT?

***Required:*** A north/south line at home

Have the students stand astride their home line just after dusk, **facing north**, raising their hands out sideways and bringing their outstretched right hand above their face to touch their outstretched left hand they will make the path of the Moon, planets and constellations of the zodiac.
Bright objects along this path, besides the Moon, could be planets. The constellation of the zodiac for the season will also be seen along the path. To find them a sky map* would be useful.

**Facing south** and making a circle around their eyes and nose by touching the tips of their thumbs and middle fingers together the Southern Cross will be inside the circle.

When a student does this at home the light that they see arriving from Alpha Centauri (the outer pointer of the Southern Cross) left there when they were 4 years younger that they are now!

All the stars inside the circle are circumpolar; they move around the South Celestial Pole (SCP).

The bright stars Achernar and Canopus are also around the circle.

**Note:**
When students discover that a north/south line can be made at solar noon, can use it for compass bearings and for introducing a simple method of finding their way around the heavens, they are well on the way to doing some practical astronomy.

* You can find positions of these for any location or time in Astronomical Yearbooks or at websites such as www.skymaps.com or www.skyandtelescope.com.

**Vocabulary:** Achernar, astride, Canopus, circumpolar, South Celestial Pole, Southern Cross