OCESS Planetarium Presentation

One could just learn stars and constellations by playing around with Stellarium. However, the procedures outlined here are meant to aid your identifications when you are outside at night.

Set Up

1) Start Stellarium.
2) Set location Ottawa.
3) Set time to 10 PM on current date, or early December if it is not early winter.
4) Turn on constellation lines and labels as well as the equatorial grid.

Constellations

The major stars only with lines showing the formal constellations
These are the shapes that the ancient Greeks saw when they looked up at the sky.
Asterisms are informal shapes, the big and little dippers, for example.

5) Rotate the view around to look north and tilt it up to find the two dippers.
Polaris is the star at the end of the little dipper's handle.
Polaris is exactly above the earth's north pole which is why Polaris is always to the north.
   a) Open the time adjustment window and verify this claim by advancing time hour by hour.
      Polaris should stay stationary while other stars circle counter-clockwise around it.

6) Swing the view around to look south again .
   a) Press "," (comma) to show the ecliptic (the plane of the solar system).
      It is not the same the equator as earth's rotation axis is tilted about 23 degrees relative to the rotation plane of the solar system.
      The sun, moon, and planets move along the ecliptic line.

   b) Advance time to spin Earth on its axis.
      Since the earth spins counter clock-wise (when viewed from the north) which is west to east the sun, the stars, planets and the moon all will rise in the east move across the sky and set in the west.
      They are, in fact, rotating clockwise around the south pole which is below the horizon.

   c) Advance the date a day at a time.
      The stars still shift from east to west as they did when time was advanced over a single night.
      This is because Earth's orientation at the same solar time changes from one day to the next as it orbits the sun.
      The sun, moon, and planets move along the ecliptic line.
      The all rotate from east to west with the stars as the earth rotates, but each of the solar system objects moves a little less farther west along the ecliptic each night as they are orbiting the sun from west to east.
         The moon moves the greatest amount in this way.
         The planets move less the more distant they are.

7) What would the sky look like if we were lying on the ground looking upward while at the north pole?
   Change location to the north pole.
   Polaris is at the Zenith (top of the sky).
   a) What do the stars will appear to do in the sky as the earth rotates: advance time to see.
      Polaris should not appear to move much.
      The stars rotate around parallel to the horizon: nothing rises and sets, things just spin around.

8) What would the sky look like if we were at the equator?
Change location to a city near the equator.
Polaris will be at the northern horizon.
a) What do the stars appear to do in the sky as time is advanced?
b) Could we see polaris if we were south of the equator?

9) Return location to Ottawa.
Press comma to erase the ecliptic plane.
Since we are about half way between the equator and the north pole, that polaris is about half way between the Zenith and the horizon.

10) <u>The major ***North-Sky*** constellations and asterisms and how to find them</u>.
Rotate the view back to north and tilt the view up. You can use you mouse scroll wheel to expand your field of view.

a) When you are out at night, there are easy ways to measure angles.
Held at arm's length, your fist measures 10 degrees and a finger measures 1 degree.

Our starting point for the northern sky is the asterism called the **big dipper**.
b) Find the **big dipper**: a box shape of four stars with three other stars forming a bent handle.
Briefly turn on constellation
Our goal is to use this to find the **little dipper**, **Cassiopeia**, **Cepheus**, **Cygnus**, and **Draco**.

c) The big dipper's pointer stars are the two stars in the cup (box) opposite from the handle.
Imagine pouring water out of the cup of the big dipper.
Follow the line of the pointer stars in that direction.
Polaris is the first bright star, about 30 degrees from the near pointer star, or about three fists.
Polaris is the end of the handle of the little dipper. Most of the little dipper is rather faint.
d) Cepheus is about 1.5 more fists past Polaris along the same line from the pointer stars.
Cepheus is a dim, house-shaped constellation. The first major star you come to past Polaris is the top of Cepheus' roof.
e) Continue the line past Cepheus, Cassiopeia starts 2 fists in that direction.
Cassiopeia is an "M" or "W" shaped constellation. Following the pointer-star line leads to the left-hand end of the "M." Cassiopeia's stars are all fairly bright.
f) Draco's tail starts half way between the cups of the little and big dipper. Draco curls around the cup of the little dipper back towards Cepheus and then make a 180° turn back on itself towards its pointy head.

Additional Constellations
h) i) On the far side of Cepheus from Cassiopeia is a bright star (Deneb) that is part of a cross-shaped constellation called Cygnus (the swan).
ii) Draco's face points to a bright star called Vega (our not-so-soon-to-be north star) which is part of the constellation Lyra.
iii) Follow the arc of the big dipper's handle (for about twice its length) and it will lead you to a bright star called Arcturus which forms the bottom point of an icecream-cone-shaped constellation called Boötes.

11) <u>The major ***South-Sky*** constellations and asterisms and how to find them</u>.
The previous constellations can be seen at any time of year. The southern constellations change from season to season. This is because we only can see stars when out part of the earth is facing away from the sun. However, because the earth revolves around the sun, we are facing a different direction when the earth rotates around so that our location is on the far side from the sun in each different season.

a) To face the south at night, we can use one of the northern constellations to guide us:
September: trace a line from Polaris up and through Cepheus
Extend the line of the handle of the little dipper up and over the sky to reach the constellation Orion.
Trace the pointer star line of the big dipper ***away from Polaris*** to reach the constellation Leo.

c) Main constellations:
Leo: (the lion) is easiest to recognise as a backwards question mark. This shape makes up his head and front legs. The rest of the body is rather dim. Leo is far to the left of Orion.
Orion: (the hunter) is a prominent figure-8 shape.
The other main constellations can be found starting from Orion which is really easy to spot.
Canis Major: follow Orion's belt down to the left. It really looks like a small dog with one bright star forming its collar.
Taurus: look for a small V-shape by following Orion's belt up to the right. It has one bright, reddish star (Aldebaran) meant to be the eye of the bull.
Gemini: box shape half-way between Taurus and Leo found by tracing a line up from Orion's belt (the centre of the figure 8) up through his left shoulder. The two bright stars at the far end of the box are the heads of the twins (Castor and Pollux, the latter being the lower one).

12) Get some practice following the directions in parts 10 and 11.

13) Remove the constellation lines and labels and try repeating part 12.
Go outside on a clear night and try to follow the same procedures.

14) Identifying stars:
Betelgeuse (beetle juice)
right shoulder of Orion, 500 LY away: the light you are seeing was emitted before the birth of Shakespear
name modified from the original arabic name that meant something like "armpit of the great one "
faintly red in colour, therefore rather cool for a star
more than 1000 times bigger than the sun: if it was our sun, even Mars would be inside it

Rigel
left knee of Orion, nearly 900 LY away
it is faintly blue in colour, therefore quite hot for a star
a large star, but not as large as Betelgeuse (about 75 time the size of the sun)
it is about 10,000 times more luminous than the sun

Sirius
bright star on the collar of Canis Major
about 8 LY away
whitish in colour: a bit hotter than our sun
about the same size as the sun
the brightest star in the night sky

All three stars look about equally bright, but Rigel and Betelgeuse are much more luminous than the Sirius.
brightness is a measure of how the star looks to our eyes
luminosity is a measure of how much light energy is given off per second (power).

Brightness is proportional to luminosity over distance squared.
If Rigel is about the same brightness as Sirius, but is about 100 times farther away, then to seem about as bright as Sirius, it must be 10,000 times more luminous, since a distance of 100 times more squared means dividing by a factor 10,000.

15) Other Constellations to Find

Canis Minor: follow the line from the left shoulder star through the right shoulder star and go about two fists in that direction. Just two stars.

Half-way between Taurus and Cassiopeia is **Perseus**, the hero. He looks like a person leaning forward with one arm curving up behind his back (well, sort of).

Perseus rescued (almost) his girl friend **Andromeda** (Daughter of Cassiopeia and Cepheus) from Hades. Constellation Andromeda looks like a big, upper-case "A" with the base of the "A" half way between Perseus and Cassiopeia. From the middle (cross bar) of the "A" and about 2 or 3 fingers towards Cepheus, you will see a faint smudge. This is the centre of the Andromeda Galaxy, a huge spiral of stars like the Milky Way that is 2.5 million light years away.

16) Motion over a night and from night to night

The stars near the equator move about 1.5 fists across the sky per hour.

As the earth revolves around the sun the stars positions, at a given time of night, also will shift. They move about 3 fists per month, from the east to the west, or about as far as they move in two hours on a given night. So, Orion at 10 PM on February 1st is in the same position that it was at midnight on January 1st.

17) How Many Can We Stars

You need to be away from the city to do this.
Hold hands at arms length with the thumbs and index fingers making a square
You should get about 15-20 stars in this space
The patch you just measured should represent about ½ a percent of the whole sky (both hemispheres).
This means that there are about 3000-4000 stars visible to the unaided eye.
All these stars are in our own galaxy, and fairly close to us (less than a few thousand LY)
(1 LY is the distance light travels in one year (300,000 km/sec for 1 year = 10 trillion km)
(the galaxy is about 100,000 LY across) If the galaxy was drawn on a standard sheet of paper, most of the stars that we see would be contained in an area less than 5 mm across.

For comparison:
if stars were grains of sand, all 3000 that we can see would fit in a thimble
if all the stars in the universe were grains of sand, they would amount to more sand than all the beaches on the earth; if put in rail-road box-cars, the train would be so long, it would take more than three years to travel past a rail-road crossing.

18) Other stars

Capella

The bright star in Auriga, the charioteer, (above Orion and to the back side of Perseus)
It is the brightest star in a solar system that has at least 10 known suns

Algol - the demon

The bright star near the foot of Perseus' forward leg (the one towards Andromeda)
Consists of a pair of stars - one much dimmer than the other
Every 2 days and 21 hours the dimmer star passes right between us and the brighter star
Over a four-hour period, you can see Algol dim to about a tenth its normal brightness

Procyon

The bright star in Canis minor; it is very similar to our sun, about 11 LY away

Regulus

Bright star in Leo, 79 LY away.
Show this to a grandparent on their 79th birthday. Tell them that they light that they are seeing now left the star the year that they were born and for all their life and during all the things that they have done, the light that they are seeing now has been traveling through space towards them.
It is an odd star, being a blue (hot) dwarf star

Castor and **Pollux**

bright stars forming the heads of the twins in Gemini
Pollux is the brighter star, closer to the horizon
Pollux is an orange giant star - cooler than the sun, hotter and smaller than red Betelgeuse
Pollux is about 35 LY from us

Aldebaran

The bright "eye" in the head of Taurus, the bull
Another orange giant star, 68 light years away
It is only half the distance away as all the other stars in the head of Taurus.
The stars in most constellations do not actually form real groups in space
They only appear close together when viewed from earth because they are in the same direction

The **Pleiades** star cluster is an example of a real group of stars close together in space.
It is about 1 fist towards Perseus from Aldebaran. It looks really cool seen through binoculars.

Deneb

Name means "tail" in arabic - it is the tail of Cygnus
One of the most luminous of all stars that we can see
Only the 13 most bright since it is 3000 LY away
If it was as close as Pollux, it would be as bright as the moon

Vega

the bright star in Lyra
In 12,000 years, the earth's spin axis will point very near Vega, which will be the north star.
Back when the pyramids were being built, the north star was the second star from the end of Draco's tail.

Arcturus

The bright star at the base of Bootes.
A orange giant star only 37 LY from earth.

Antares

The bright star at the back of the head of Scorpio.
A very bright red super giant like Betelgeuse

Spica

A hot blue star in the middle of Virgo.

Not all the objects in the sky are stars.
The sword of Orion, hanging from his belt, is made up of three bright points. Only the lowest is a star. The middle point is the great nebula of Orion, a vast cloud of dust and gas bigger than several solar systems. From our distance of 1300 LY, it looks like a star, unless you use a telescope. Orion "contains" several other nebulas, the upper point of the sword and the horse-head nebula beside Barnard's star on the belt (one of the closest stars, 6 LY).

Our own galaxy shows up as a faint hazy band (it looks like a band of spilled milk) across the sky from Cygnus through Cassiopeia, Perseus, and Orion's right arm and between Orion's two dogs. We do not see the shape of the Milky Way spiral in the sky because we are embedded in it.

The ecliptic, which goes through Leo, Gemini, and Taurus. The solar system is tilted by 65 degrees relative to the disk of our galaxy. The boundary between Gemini and Taurus points directly away from the centre of the galaxy. The eastern edge of Sagittarius, not visible in the winter, points towards the center of our galaxy. Coma Berenices points directly out from the surface of the galactic disk. Deneb points roughly in the average direction that our part of the galaxy is moving as it orbits the galactic centre. Our solar system is moving towards the boundary between Hercules and Lyra. This is termed the ***solar apex***. Our solar system follows a roughly sinusoidal path around the galaxy, passing above then below the disk of the galaxy several times in each orbit.

Figure 1. Sky Maps