

Activity 33 - Transit of Venus simulation

Year Level : Years 7 to 12 (typically 12 to 18 years of age).

Background : A transit of Venus occurred on 6 June 2012. This activity uses simulation software to view the transit of Venus and predict transit timing. The activity includes a tutorial to learn the basics of the program “Stellarium” which is free astronomical simulation software that is available from the internet. Once downloaded, the tutorial will provide an insight into some of the many possibilities of this sky simulation program. It shows a realistic sky in 3D, just like the view with the naked eye, binoculars or a telescope. If Activity 04 has been completed the tutorial section can be skipped.

Aim : To determine the timing and the path across the Sun of the 2012 transit of Venus from a specific location using the simulation program Stellarium.

Safety Warning: Students should be reminded to never look directly at the bright surface of the Sun without suitable eye protection as permanent eye damage may result. This applies at any time and especially during the partial phases of a solar eclipse or during a solar transit.

Shape of the Australian Curriculum: Science strands on focus areas.

Content descriptors: Year 5, 7 and 10

Science Understanding	Science as a Human Endeavour	Science Inquiry Skills
<p>Yr 5</p> <p>The Earth is part of a system of planets orbiting around a star (the sun) (ACSSU078)</p>	<p>Yr 5</p> <p>Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena (ACSHE081)</p> <p>Important contributions to the advancement of science have been made by people from a range of cultures (ACSHE082)</p>	<p>Yr 5</p> <p>With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be (AC SIS231)</p>
<p>Yr 7</p> <p>Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon (ACSSU115)</p>	<p>Yr 7</p> <p>Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people’s understanding of the world (ACSHE119)</p>	<p>Yr 7</p> <p>Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (AC SIS124)</p> <p>Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (AC SIS125)</p>

<p>Yr 10</p> <p>The universe contains features including galaxies, stars and solar systems and the Big Bang theory can be used to explain the origin the universe (ACSSU188)</p>	<p>Yr 10</p> <p>Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community (ACSHE191)</p> <p>Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE192)</p> <p>People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions (ACSHE194)</p>	<p>Yr 10</p> <p>Plan, select and use appropriate investigation methods, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS199)</p> <p>Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data (ACSIS200)</p> <p>Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS204)</p> <p>Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS208)</p>
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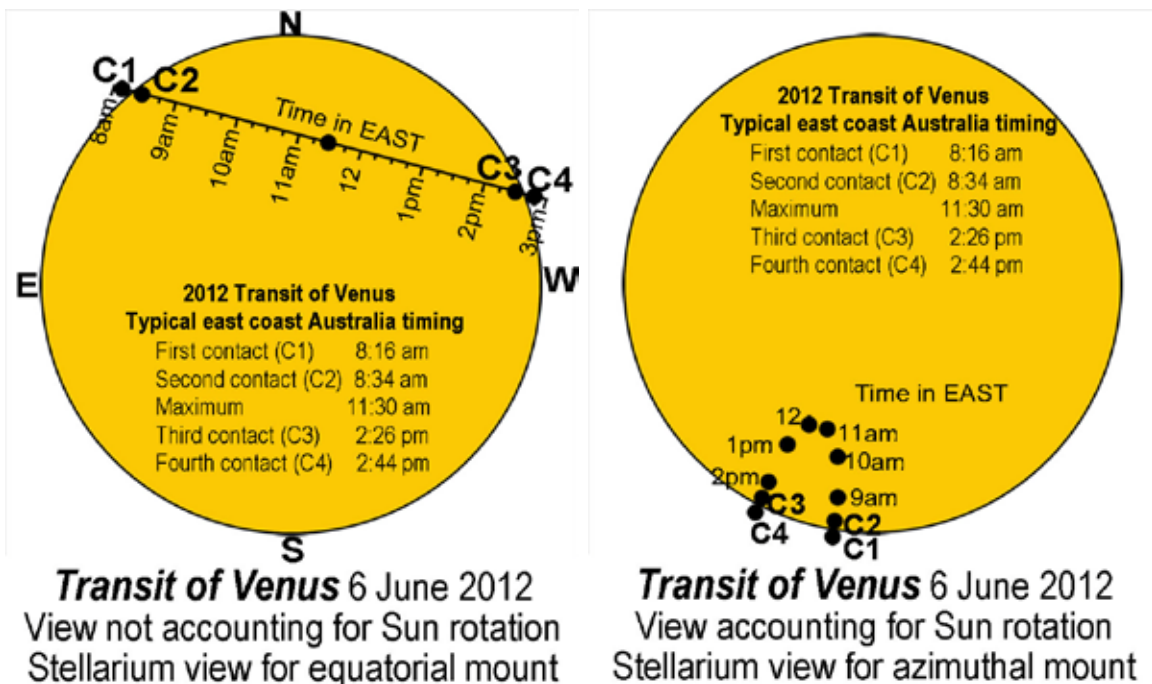
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FOR THE TEACHER:

For the transit of Venus that occurred on 6th June 2012, Venus took about six and a half hours to travel across the face of the Sun. The eastern and central portion of Australia were very well placed to observe this transit as it was one of the few countries from where the entire transit was visible.

The path of Venus across the Sun's disc is shown in the diagrams below. Venus travelled in a straight line across the Sun however because the Sun appears to rotate as it crosses the sky, Venus appeared to move in an inverted "U" shape when viewed from the eastern states of Australia



The diagram on the left is with Stellarium set for the view through a telescope on an equatorial mount (with north up). The diagram on the right is the view with Stellarium in the azimuth mount mode (normal) and is the view when observing with the naked eye or binoculars (sun appears to rotate as it crosses the sky). Any observation of the transit must of course use safe observing methods.

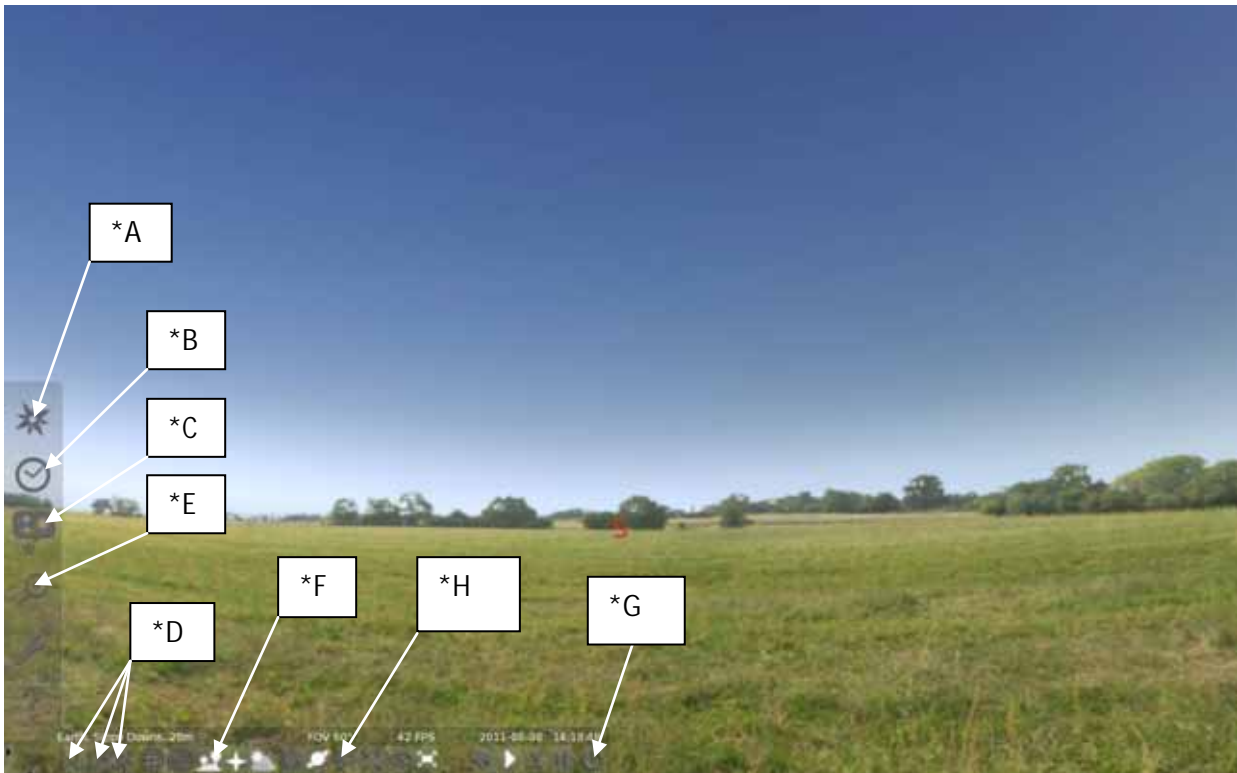
The contact times shown are typical for eastern Australia. The times varied by a few minutes depending on the exact location.

END OF TEACHER INFORMATION

STELLARIUM TUTORIAL

The following Tutorial will help you learn the basics of using Stellarium. Stellarium is a safe interactive astronomy software program that can be downloaded free from: <http://www.stellarium.org/>

Once downloaded and installed, double-click the Stellarium icon on your computer. If you move your computer mouse to the lower left hand edge or bottom edge of the screen a transparent pop up menu appears which will allow you to control your actions. The screen for the program should look like the following including the pop up menu. This screen shot below will be referred to for various actions throughout this tutorial.



- 1. SELECTING YOUR LOCATION :** Open the *location window* by clicking on the compass rose on the left pop up tool bar (*A). If you live in a city or major town eg Brisbane, Sydney, Mildura, Townsville etc, type this in next to the magnifying glass and then select your town from the list above. If your town is not listed or if you want a more accurate result put in the latitude and longitude of your exact location. Using another program, such as **GOOGLE EARTH**, find the location of your house or school in terms of degrees minutes and seconds for both latitude and longitude. You should have something that is in the form of, for example 23° 34' 12.00" S for latitude and 142° 34' 34.12" E for longitude. The symbols (°) refers to degrees, (') to minutes and (") for seconds.



To adjust Stellarium to your location use the arrows up/down in the **Latitude** box. Adjust to suit your latitude in degrees. To change both minutes and seconds you will have to click in the minutes and then use the arrow keys. Do the same with the seconds box. For any location in Australia make sure Latitude includes the letter S (to show south of the equator).

Adjust the **Longitude** setting as required (making sure that it is E (for east) for Australia. You can also highlight the **Altitude** value and put in your own height above sea level.

To name your location highlight the town in the **Name/City** box and type in your location. Change the country if necessary but leave planet as is but this can be changed for later use (to simulate the view from a different planet). If you have put in your latitude and longitude and town name click on the **Add to list** box and you will see your location appear next to the map of the Earth. By clicking on **Use as default** Stellarium will always open at your location.

You can toggle full screen mode on and off using the **Full Screen Mode** button (to the right of *H)

Continue on for the Stellarium tutorial. If you want to go straight to the simulation of the transit of Venus skip forward to paragraph 10.

2. To see the sky at night we need to change the time. **Click the Date/time window (*B) and scroll the hours forward to 20:00:00.** Set the date to **2011 04 28** as shown below.



Close this Date and Time pop up by clicking on the **X**.

3. **Go to the *Sky and Viewing options window* menu to the left (*C), go to *Markings* Tab and click on the box for **Ecliptic Line**.** This is a red line that shows the plane of the solar system. The planets, sun and the moon (and the constellations of the zodiac) all lie on this plane, or close to, this line. **Close the View pop up menu by clicking the top right box in the menu.**

To see this line you will have to click and drag the Horizon sideways until you see the EAST (E). The ecliptic line is between (E) and the star Antares. Clicking and dragging will change the location of the sky you are looking at, left and right and up and down.

4. **To turn on the constellations**, their lines, labels and their art, click on the 3 buttons on the bottom pop up row (*D). You can **click on them again to turn them off**.
5. With the **EAST (E)** approximately in the centre of the screen **click and drag** the sky from top to bottom until Saturn comes into view. Click on Saturn with the mouse arrow and you will notice a red rotating cross around the object. In the top left hand side of the screen information about Saturn will be displayed. Press **Space** to centre it and zoom in. **Zooming in or out of the sky can be done with the scroll wheel. Alternatively you can zoom in using the Page Up Key or out using the Page Down Key on the keyboard.**
6. Select the moon Tethys, centre it and then zoom in. Once finished, **zoom back to normal sky view** with the horizon visible. If the horizon is circular in shape you can **click** on the horizon near the EAST (E) and **drag** the horizon towards the top of the screen to straighten it out and then zoom in until it looks as it did before.
7. You can **search for other objects by pressing the *Magnifying Glass* button on the left (*E) and typing in the object's name** (or ID number). **Type in M104** and click the magnifying glass button. This is the **SOMBRERO GALAXY**. Zoom in on this object. This is how it would look through a telescope. Once finished looking zoom back to the normal sky view with the horizon. This makes it easier to see new objects as you search for them.
8. Some objects at this time of the year will appear below the horizon. You can still go to these objects but will need to **turn off** the horizon. Go to M20 and it appears below the horizon. To turn off the ground use the **Ground** button on the bottom pop up as marked (*F). Once turned off you can zoom into and out of this object. Once finished **return to the normal sky view** (To do this quickly go to Saturn and turn the ground back on).
9. As suggestions, try **M83**, remembering to click on the magnifying glass and zoom in and out. You can use the internet to find out about this object such as distance and other features. Search for and zoom in on the **Moon** and the other **planets**.

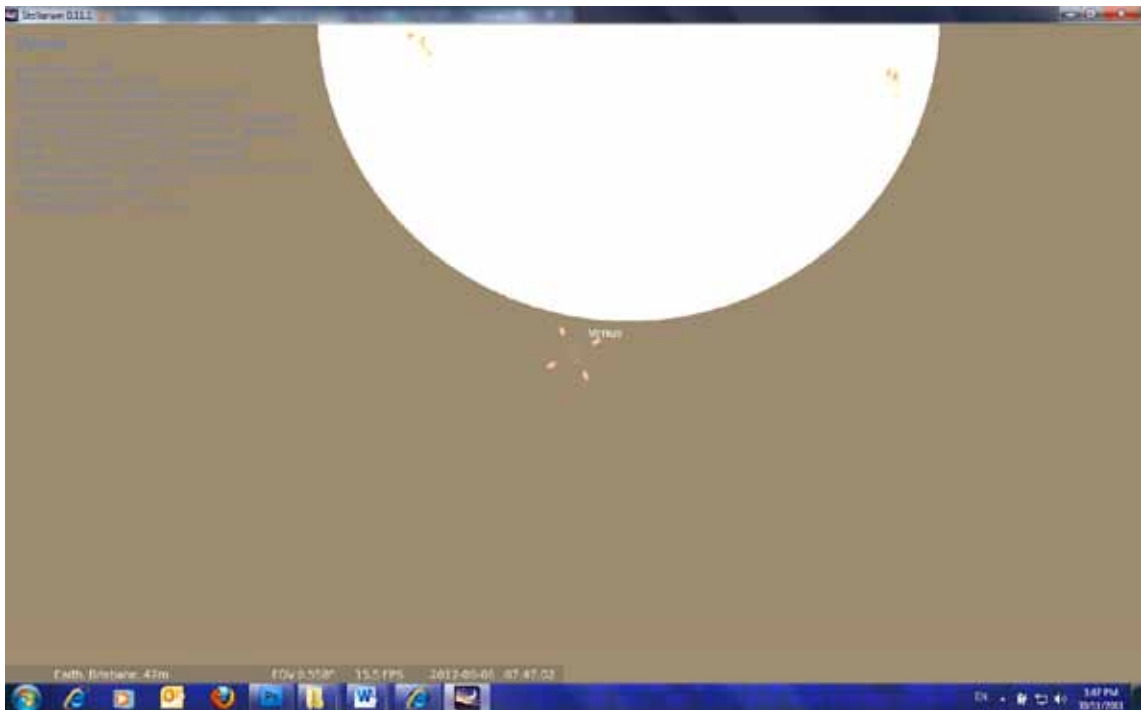
10. To see the transit of Venus we need to change the date and time. **Click the Date/time window (*B) and scroll the hours to 08:00:00.** Set the date to **2012/06/06** as shown below.



Close this Date and Time pop up by clicking on the **X**.

Note that the times in this tutorial are for the eastern states of Australia. Other locations will need to adjust the time to account for the local time zone. For example for South Australia subtract 30 minutes, for Western Australia subtract 2 hours from the time.

11. You can search for other objects by pressing the **Magnifying Glass** button **on the left (*E) and typing in the object's name** (or ID number). **Type in Venus** and click the magnifying glass button. You will notice a red rotating cross around the object. In the top left hand side of the screen information about Venus will be displayed. Press **Space** to centre it and zoom in. **Zooming in or out** of the sky can be done with the **scroll wheel**. Alternatively you can **zoom in using the Page Up Key** or **out using the Page Down Key** on the keyboard. Zoom in until the sun occupies the screen as shown below.



Click on the Sun and press the spacebar to centre the Sun

Adjust the type of view to see the transit as it would be seen from your position on Earth using telescope projection with the telescope mounted on an equatorial mount (a mount that tracks the movement of the stars across the sky). Click on the **(*H)** (switch between equatorial and azimuthal mount). This will cause the Sun to rotate to North uppermost and Venus to reposition itself to the upper left area just outside the sun..

12. READ THE NEXT TWO PARAGRAPH IN THEIR ENTIRITY BEFORE CARRYING OUT ANY ACTIONS.

If you want to **go forward in time** (speed time up) you can **press the L key** and this will make time go faster. You can return to normal speed (time) by pressing the **K key once**. Press the **L key twice** and watch what happens. When Venus has crossed the boundary of the sun and appears as an entire black disk return to normal speed (time) by pressing the **K key once**.

Try going backwards by pressing the J key FOUR TIMES until back to 8:00: 00 (look at the time in the bottom pop up window). Make sure you press the K key to return to normal time. DO NOT PRESS THE L KEYS MORE THAN TWICE AND OR THE J KEY FOUR TIMES (AFTER RETURNING TO NORMAL SPEED), AS IT SPEEDS UP THE DISPLAY TOO MUCH.

13. Timing for the transit is given in terms of “contacts”.

First Contact (C1) is when Venus first touches the Sun.

Second Contact (C2) is when Venus is just inside the Sun on the way “in”.

Third Contact (C3) is when Venus is just inside the Sun on the way “out”

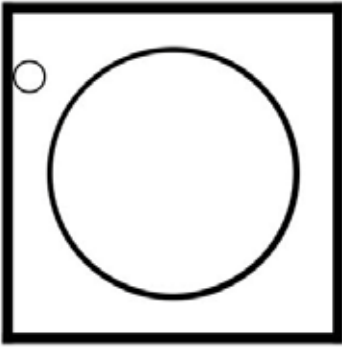
Fourth Contact (C4) is when Venus last touches the Sun

Now, try this:

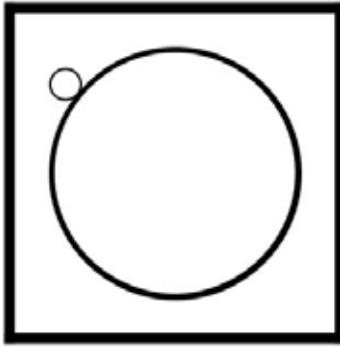
One at a time, use the L key (with J and K if needed) to move the time forward to predict when Venus will be in the positions shown in the diagrams below. Write the predicted times in the boxes above the diagrams.

Identify which diagrams represent first, second, third and fourth contact.

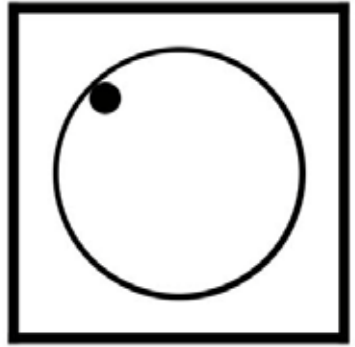
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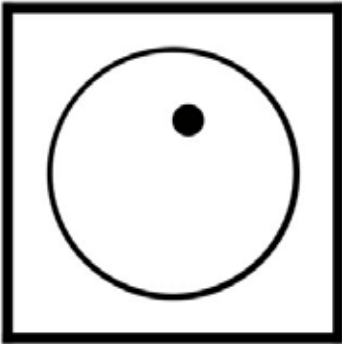
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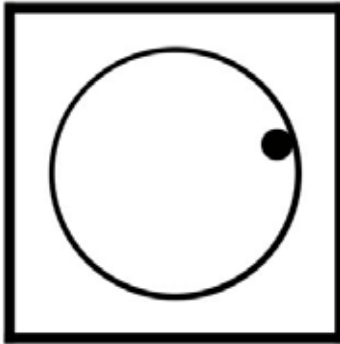
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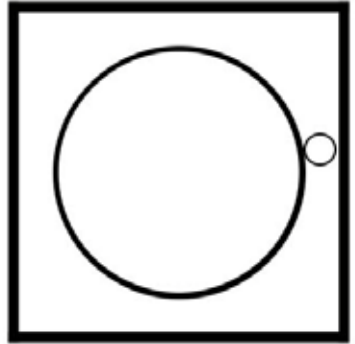
Time: ___:___:___



Time: ___:___:___



Time: ___:___:___



Write down the time for each contact.

First Contact: _ : _ : _

Second Contact: _ : _ : _

Third Contact: _ : _ : _

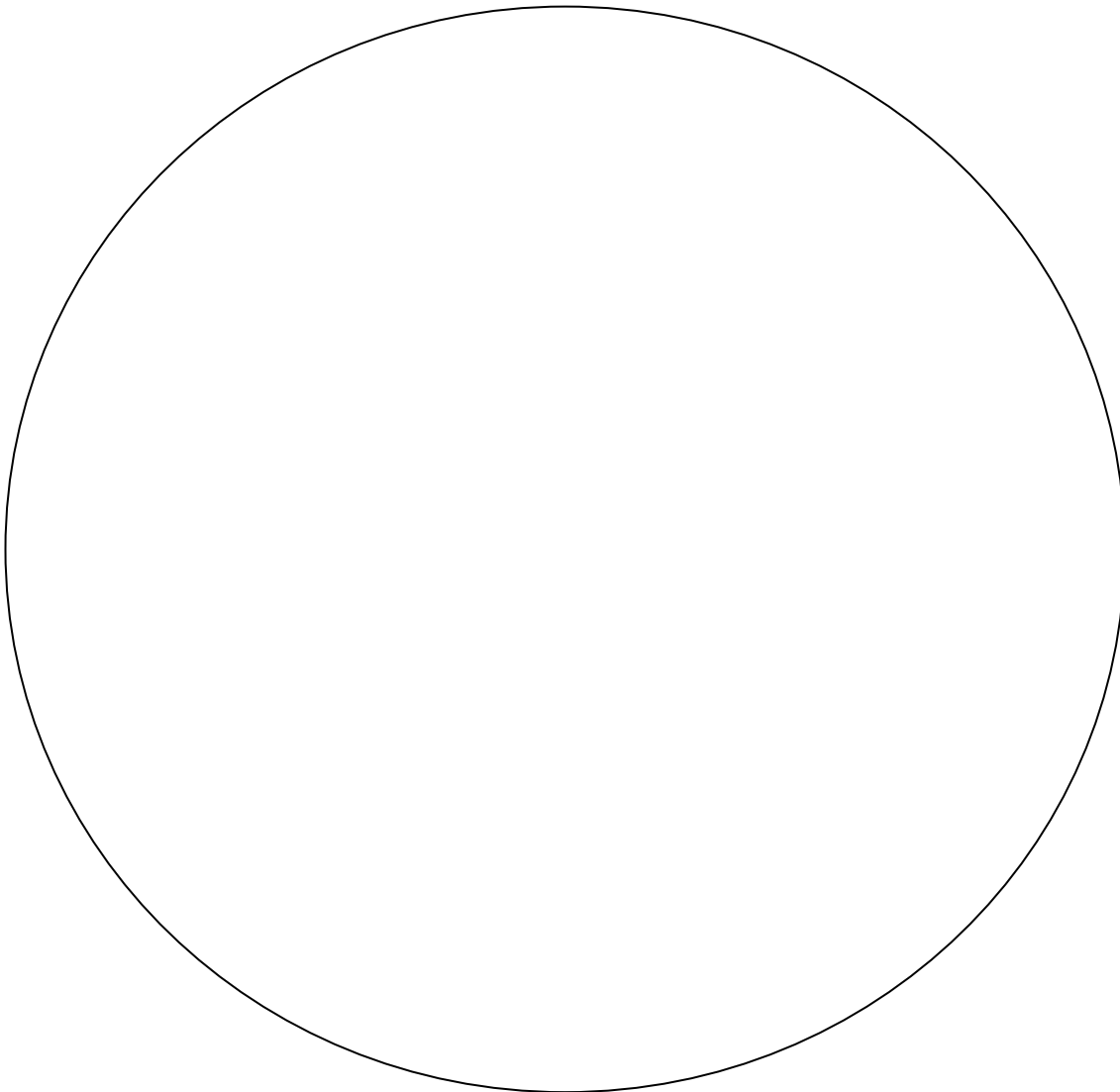
Fourth Contact: _ : _ : _

Calculate and record the duration of the Transit of Venus based on your diagrams

The duration is (Show how you calculated this.)

14. You will see the transit pass across the Sun in the way Stellarium has shown above only if you are observing with telescope projection and the telescope is on an equatorial mounting (a mounting that tracks the movement of the stars). If you go back to step 9 and go back to the beginning of the transit using the relevant keys and then click on the (*H) you will see the actual path of Venus as seen from an observer on Earth (using a SolarScope or other safe method of observing).

15. SKETCH THE PATH OF VENUS FOR THE ENTIRE TRANSIT ON THE FOLLOWING BLANK CANVAS. ADD TIMES FOR VARIOUS POSITIONS.



16. Research why this occurs.

17. If you wish to **Exit** this program you need to click on the bottom right hand end of the pop up as shown on the screen shot marked (*G).

18. Comparing predicted times with the actual transit. You can compare your result (times and diagram) with a calculator at:

http://xjubier.free.fr/en/site_pages/VenusTransitCalculator.html

This calculator provides results that are more accurate than Stellarium so results within five minutes are acceptable.