



Sunlight plays an important role in understanding the design of this fabled Inca city. Incan architects designed practical homes for Machu's residents. They also marked in their creations, the ephemeral connection between time and space.

Machu Pichu is located north east of Cusco, Chile in the district of Machu Picchu, province of Urubamba.

A number of features distributed throughout the site are aligned with the June solstice azimuth of 65-245 degrees. The Sacred Plaza is enclosed on three sides but is open to the west with an alignment of 245 degrees.

The Temple of the Three Windows forming the easterly side of the plaza, opens to the plaza and faces the solstice sunset. The solstice alignment, and the importance of solstice rituals to the Inca, suggest that this was a primary ceremonial consideration of this shrine.

The Torreón is popularly called the Temple of the Sun. A stone enclosed within the Torreón is reported to receive a ray of sun light through the east facing window during the June solstice



Education Standards Satisfied by This Activity

(See Benchmarks for Science Literacy, Project 2061, AAAS)

1c – The Scientific Enterprise

G6-8 “Important contributions to the advancement of science, mathematics and technology have been made by different kinds of people, in different cultures, at different times.

G9-12 “The early Egyptian, Greek, Chinese, Hindu and Arabic cultures are responsible for many scientific and mathematical ideas and technological innovations.

2a – Patterns and Relationships

G9-12 “Although mathematics began long ago in practical problems, it soon focused on abstractions from the material world, and then on even more abstract relationships among these abstractions.

3A - Technology and Science:

G6-8 “Engineers, architects and others who engage in design and technology use scientific knowledge to solve practical problems. But they usually have to take human values and limitations into account as well.

4B – The Earth

G6-8 “Because the Earth turns daily on an axis that is tilted relative to the plane of earth’s yearly orbit around the sun, sunlight falls more intensely on different parts of the Earth during the year. The difference in heating produces the planet’s seasons and weather patterns.

11B – Models

G3-5 “Geometric figures, diagrams, and maps can be used to represent objects, events and processes in the real world although such representations can never be exact in every detail.

Problem 1 - Using the compass circle in the upper right corner and a protractor, draw a series of lines that indicate the most obvious orientation lines of the building architecture. Measure the azimuth angles of these lines.

Problem 2 - At the location of Machu Pichu, the rising solstice and equinox suns occurs at a horizon azimuth of Winter Solstice (114 degrees), Spring Equinox (87 degrees), Summer Solstice (66 degrees) and Fall Equinox (91 degrees). During which times will the light from the rising sun pass along the major axis of the compound?

Problem 3 - Although the major axis of Machu Pichu represents the plaza/main street, the buildings are 'facing' in another directions. At sunset, the azimuth angles for these dates are Winter solstice (245 degrees), Spring Equinox (272 degrees), Summer Solstice (293 degrees) and Fall Equinox (268 degrees). Which buildings are facing close to these directions in Machu Pichu?

Note: Each axis crosses the horizon at two points that differ in azimuth by exactly 180 degrees, so an axis measured at 45 degrees azimuth also has a crossing at $45 + 180 = 225$ degrees. Each of these points may be a valid solar alignment position so both have to be considered.

Problem 1 - See below:

A = 140; B = 155; C= 200 D = 159; E = 69; F=58; G=63 and H=47.



Problem 2 - Answer: The azimuth angle is 145 degrees, so this will not occur on any of these dates.

Problem 3 - The axis drawn through the streets (E, F, G and H) have azimuths of 69 or 249 degrees, 58 or 238 degrees, 63 or 243 degrees and 47 or 227 degrees since the angles for each line differ by 180 degrees. The complementary azimuths of 249, 238, 243 and 227 are similar to the sunset azimuth of 245 degrees among all of the possibilities. In fact, axis E and G face the winter solstice sunset to within 4 degrees!