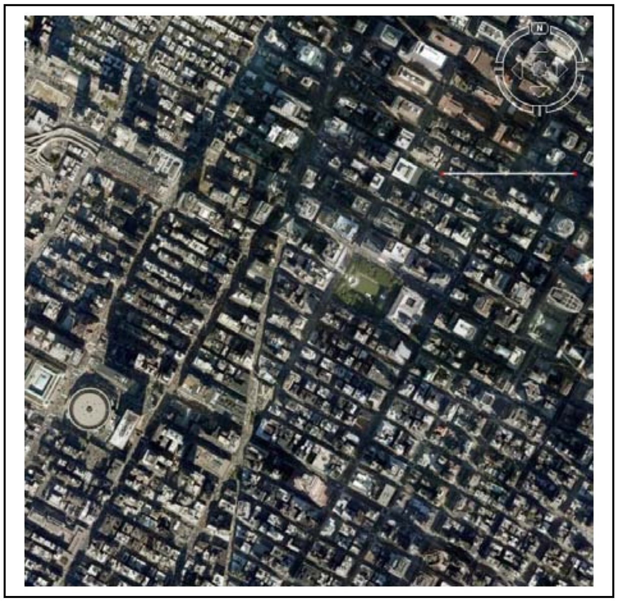
Accidental New York City Solar Alignments



A major problem in the field of archeoastronomy is to determine whether a particular temple or monument was intentionally designed with an astronomical event in mind, or whether the alignment we now see was just an accident of the way the monument or building was constructed.

The satellite image to the left is a view of the streets of New York City. The fact that so many of them 'line up' along a north-south axis leads to some interesting astronomical events for New York City traffic.

An important geometric principle is that 'two points on a plane determine a line'. Once you define a geographic coordinate grid with north-south and east-west directions, if you plane a line randomly on this plane, it will point in exactly two unique directions that are 180 degrees apart.

When archeologists survey an ancient monument or field of neatly-carved stones, each possible pairing of stones yields a huge number of directions of interest. When you have enough of these to work with, random chance will dictate that some of these will point 'close' to any particular direction that you consider important. This direction can be, for example, the rising point of the sun during the Spring Equinox, or perhaps the direction of the setting moon on a particular date. There are even some proposed alignments that involve bright stars!

The biggest source of controversy in interpreting what an ancient monument was used for often involves whether the alignment is real or accidental. It is often hard to make this call unless you have some other supporting information, such as the same alignment is also found on other buildings or monuments of a particular civilization.

The streets of New York City, or of your own town or city, are an excellent place to search for interesting, and presumably accidental, alignments that may be obvious to us as accidental, but in 1000 years may cause future archeologists to also wonder whether they were intentional!

Many cities have 'notorious' streets that have unfavorable solar alignments that cause problems for motorists near sunrise and sunset. These streets often become temporarily congested as motorists slow down and squint as the blinding sunlight interferes with safe driving.

This is a satellite view from GOOGLE Earth, of downtown New York City. The wide street running diagonally from the left-hand corner to the top of the image is the Avenue of the Americas (6th Street). The street running almost vertically through the center down to the bottom of the page, and intersecting the Avenue of the Americas is Broadway. The round building to the left edge is Penn Station, and the rectangular park just above the center of the image is Bryant Park

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 directions in the circle in the top right corner of the image, what is the azimuth angle of each of the three major street orientations in this image?

Answer: Axis 1: Top-left to lower-right : 70 degrees
Axis 2: Top-right to lower-left: 120 degrees
Axis 3: Broadway: 100 degrees.

Problem 2 - The table below gives the dates and azimuth angles for the sunrise location on the horizon as viewed from New York City. During which dates will a motorist traveling southbound on these streets probably be looking straight into the rising sun?

Date	Azimuth	Date	Azimuth
May 12	65	March 9	95
May 9	66	March 8	96
May 6	67	March 6	97
May 3	68	March 3	98
May 1	69	March 1	99
April 29	70	February 28	100
April 26	71	February 27	101
April 25	72	February 25	102
April 23	73	February 22	103
April 20	74	February 19	104
April 18	75	February 17	105
April 16	76	February 15	106
April 13	77	February 13	107
April 11	78	February 11	108
April 9	79	February 8	109
April 7	80	February 6	110
April 5	81	February 4	111
April 3	82	February 1	112
April 1	83	January 29	113
March 30	84	January 27	114
March 28	85	January 25	115
March 26	86	January 24	116
March 23	87	January 16	117
March 21	88	January 12	118
March 20	89	January 8	119
March 19	90	January 6	119
March 18	91	January 4	120
March 15	92	January 2	120
March 12	93	December 31	120
March 11	94	December 5	119

Answer Key

Problem 1 - Using the compass directions in the circle in the top right corner of the image, what is the azimuth angle of each of the three major street orientations in this image?

Answer: Axis 1: Top-left to lower-right : 70 degrees
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Axis 3: Broadway: 100 degrees.

Problem 2 - The table below gives the dates and azimuth angles for the sunrise location on the horizon as viewed from New York City. During which dates will a motorist traveling southbound on these streets probably be looking straight into the rising sun?

Answer: On 70 degrees; April 29,
100 degrees: February 28 and
120 degrees: between December 31 and January 4.