NAME: _____ PERIOD: _____ DATE: _____

LAB PARTNERS: _____ LAB # 38

INVESTIGATING THE SUN'S APPARENT MOTION

INTRODUCTION

Every day you can see the sun rise on the eastern horizon, move steadily in a giant arc across the sky, and set on the western horizon. The ancients believed that the sun takes a daily trip around the earth while the earth remains at rest. However, we now know that the earth rotates on its axis from west to east. This rotation makes it appear that the sun is moving east to west. The daily motion of the sun therefore is not real but an apparent motion. Since seasonal changes in the intensity and duration of sunshine regulate growing seasons and since life is so organized around the behavior of the sun, man came to realize the regularity and predictability of the sun's actions.

OBJECTIVES

When you finish this investigation you should be able to:

1. Construct a graph from given data on the sun's altitude and date.
2. Determine from the graph the periods of maximum and minimum hours of daylight.
3. Identify from the graph the appropriate seasons and the sun's altitude on the solstices and equinoxes.
4. Use celestial sphere and hemisphere diagrams to determine Earth's seasons
5. Determine clock time using Earth's longitude system
6. Draw the relative length of the noon shadow for locations in New York State for each season

MATERIALS

Graph Paper
Pencil
Protractor

APPROXIMATE TIME 2 Periods

PROCEDURES

1. Graph the data for date of the year versus maximum altitude on the graph paper. Connect all points with a smooth curved line.

2. On your graph label the points representing the Vernal and Autumnal Equinoxes and the Summer and Winter Solstices.

3. Answer the laboratory summary questions for Part 1.

LAB DATA TABLE

Observations of the sun were made each week for one year. Measurements of the maximum altitude of the sun were taken. The time of day at which the maximum altitude occurred was also noted.

The table contains the observation as recorded on these days. Each point represents where the sun was at "High Noon" on that particular day.

DATE/ MONTH	MAXIMUM ALTITUDE (Degrees	TIME OF MAXIMUM ALTITUDE
J 1	25	12:03
A 8	26	12:06
N 15	27	12:09
22	28	12:11
29	32	12:13
F 5	33	12:14
E 12	34	12:14
B 19	36	12:14
26	39	12:13
M 4	42	12:12
A 11	44	12:10
R 18	47	12:08
25	50	12:06
A 1	52	12:04
P 8	55	12:02
R 15	58	12:00
22	60	11:58
29	62	11:57
M 6	65	11:56
A 13	66	11:56
Y 20	68	11:56
27	69	11:57
J 3	70	11:58
U 10	71	11:59
N 17	71	12:01
E 24	71	12:02

DATE/ MONTH	MAXIMUM ALTITUDE (Degrees	TIME OF MAXIMUM ALTITUDE
J 1	71	12:04
U 8	70	12:05
L 15	69	12:06
Y 22	68	12:06
29	67	12:06
A 5	65	12:06
U 12	63	12:05
G 19	61	12:03
26	58	12:02
S 2	56	12:00
E 9	53	11:57
P 16	51	11:55
T 23	48	11:52
30	45	11:50
O 7	43	11:48
C 14	40	11:46
T 21	37	11:45
28	36	11:44
N 4	33	11:44
O 11	31	11:44
V 18	29	11:45
25	27	11:47
D 2	26	11:50
E 9	25	11:52
C 16	25	11:56
23	25	11:59
30	25	12:03

LABORATORY QUESTIONS (PART 1)

1. In degrees what was the **MAXIMUM** altitude observed? _____

   What date(s) did the **MAXIMUM** occur? _____

2. In degrees what was the **MINIMUM** altitude observed? _____

   What date(s) did the **MINIMUM** occur? _____

3. How does the clock time noon compare with solar time noon for the entire year?

4. How does the length of the sun's path and number of daylight hours vary with the seasons?

   Summer _____

   Winter _____

   Spring/Fall _____

5. Based on data in the lab and your personal observations determine if the following statements are true or false and explain why.

"The sun is directly overhead at 12:00 Noon"

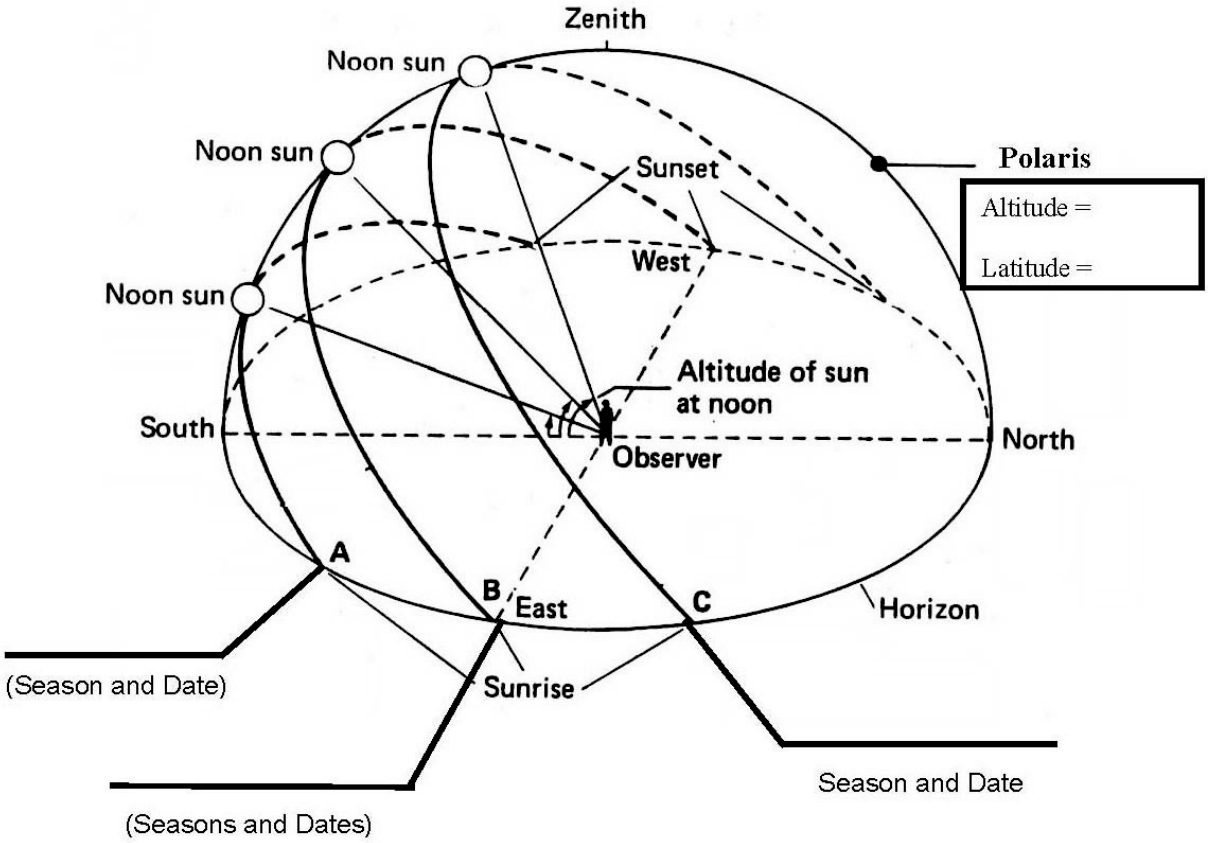
_____

"The sun always rises due east and sets due west"

_____

PART 2

HEMISPHERE DRAWINGS



LABORATORY QUESTIONS (PART 2)

Google: Solar Motion Simulator or
http://astro.unl.edu/naap/motion3/animations/sunmotions.swf

1. Use a protractor to measure the altitude of Polaris. **Label this altitude and latitude as well as the seasons and dates.**

2. The sun's apparent path through the sky is caused by what actual motion? _____

   _____

3. What is the altitude of the noon sun for Sachem (41°N) on the summer solstice? _____
4. What is the direction of the shadow cast by the person at noon? _____
5. What happens to the length of the shadow from sunrise to sunset? _____

   _____

6. At a latitude of 41°N, if you look toward the East to view the location of sunrise. Where does the sun rise on the following dates?

December 21 (Circle one)	**March 21** (Circle one)	**June 21** (Circle one)
South of East, **East**, **North of East**	**S of East**, **East**, **N of East**	**S of East**, **East**, **N of East**

7. What direction must an observer at 41°N look to see the noon sun? _____

   The noon sun is ALWAYS in the _____ for observers in New York State.

8. What month is the sun's path through the sky longest? _____

   What month is the sun's path through the sky shortest? _____

9. How many degrees is the earth tilted on its axis? _____

10. When is the sun directly overhead in New York State? _____

11. As latitude increases the amount of daylight on June 21 **increases or decreases** (circle one)?

12. If the South Pole has 6 consecutive months of daylight, why is it always cold there?

    _____

Base your answers to questions 13 through 15 on the diagram below, which shows the parts of Earth experiencing daylight and darkness as Earth orbits the Sun. Letters *A*, *B*, *C*, *D*, and *E* are positions in Earth's orbit as viewed from above the Northern Hemisphere.

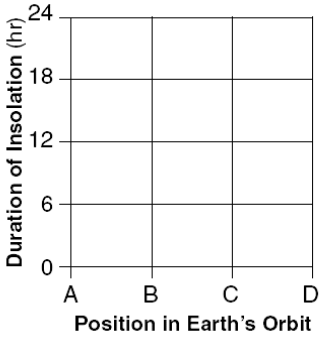
13. Approximately how many days/months does it take Earth to move from position *A* to position *C* in its orbit?
    Days: _____ Months: _____

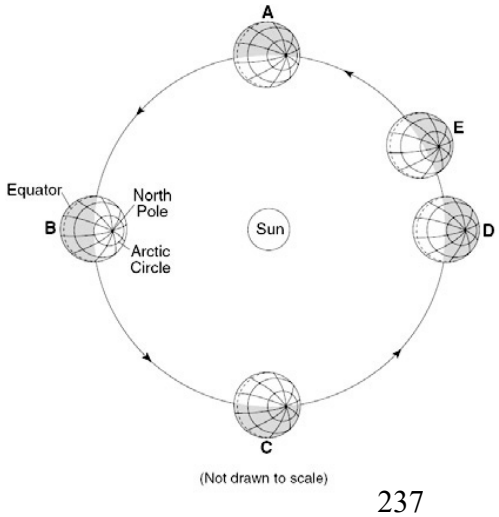
14. Explain why cold winter temperatures occur in New York State when Earth is at position *E*.

    _____

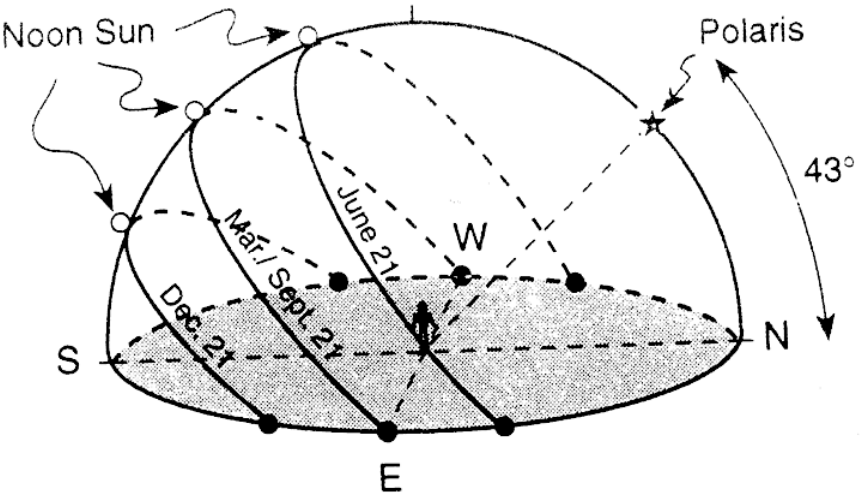
    _____

15. On the grid provided place **X**s to show the duration of insolation at the North Pole (90° N) as Earth orbits the Sun at positions *A*, *B*, *C*, and *D*. Connect the **X**s with a line.





Use the diagram below to answer questions 16 through 19. The diagram represents the apparent path of the Sun on the dates indicated for an observer in New York State. The diagram also shows the angle of Polaris above the horizon.



16. State the latitude of the location represented by the diagram to the *nearest degree*. Include the latitude direction in your answer.

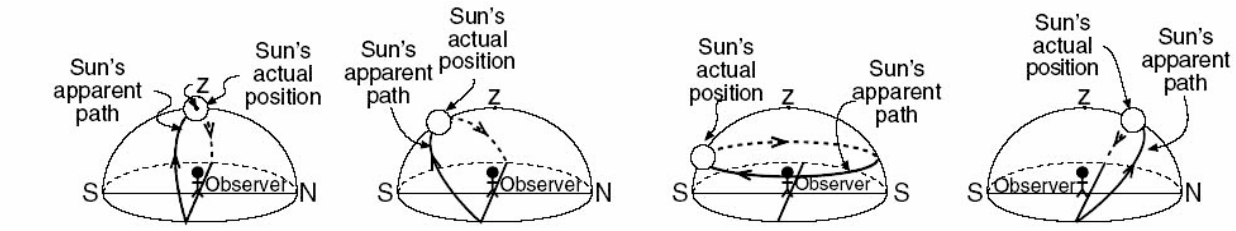
_____

17. On the diagram above, label the zenith.

18. On the diagram above, draw the apparent path of the Sun on May 21. Mark the position of sunrise on May 21 and label it sunrise. Mark the position of sunset on May 21 and label it sunset.

19. Using the March and September path of the sun on the diagram above, state how many hours it would take for the sun to go from **sunrise** to the **noon** sun position.

_____

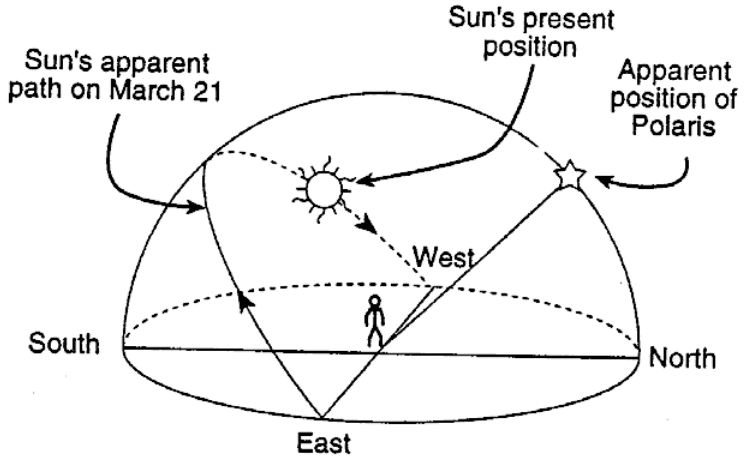


20. Which location is in the Southern hemisphere? _____ because…

21. Which location is at the North Pole? _____ because…

22. Which location is at the Equator? _____ because…

Use the diagram below to answer questions 23 and 26. The diagram below shows the sun's apparent path as viewed by an observer in New York State on March 21.



23. At approximately what hour of the day would the sun be at the position shown in the diagram?

_____

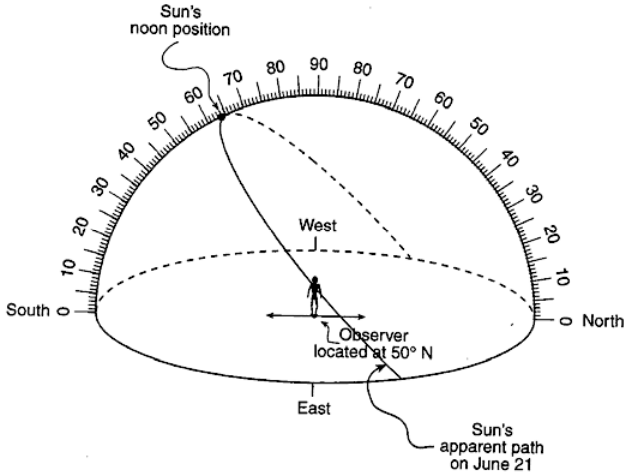
24. On the diagram above, draw the sun's apparent path as viewed by the observer on December 21.

25. What is the direction of the person's shadow based on the present position of the sun?

_____

26. Draw in the shadow from the previous question on the diagram above.

Use the diagram below to answer questions 27 and 28. The diagram is a model of the sky for an observer at **50° N latitude**. The sun's apparent path on June 21 is shown.



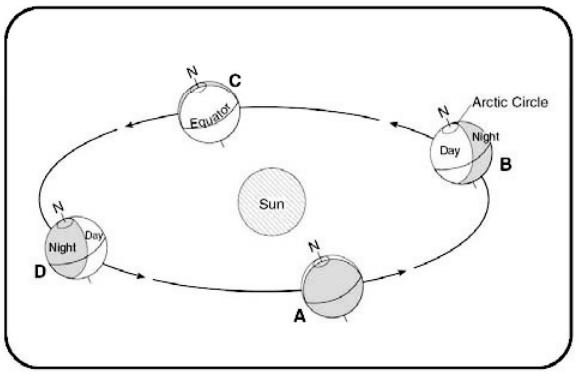
27. On the diagram above, mark with a dot the position of Polaris as viewed by the observer. Label this dot "Polaris".

28. The altitude of the Sun's position at noon on March 21 is 40° at this location. On the diagram above, draw and label the approximate path of the sun on March 21.

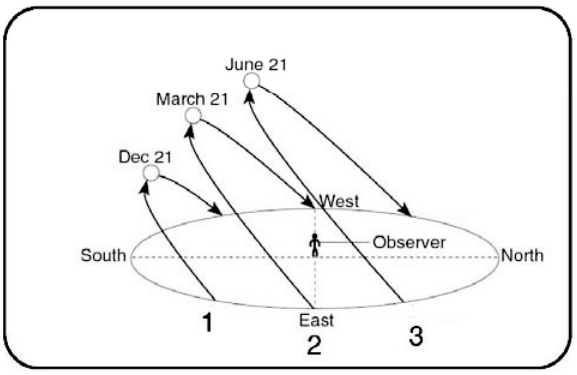
Earth's Revolution and the Seasons

Directions- Match up the seasonal position of the earth with the daily path of the sun. Answers will be either A,B,C,D for seasonal view or 1,2,3 for daily view.

Seasonal View



Daily View



Sun / Earth Characteristics	Seasonal Position	Daily Position
Winter		
Spring		
Fall		
Summer		
Highest Altitude of Sun in NY		
Lowest Altitude of Sun in NY		
Zenith at Tropic of Cancer		
Zenith at Tropic of Capricorn		
Zenith at the Equator		
Longest Day		
Greatest Insolation		
Least Insolation		
Sunrise North of East		
Sunrise in East		
Sunrise South of East		
Sunset South of West		
Sunset in West		
Sunset North of West		

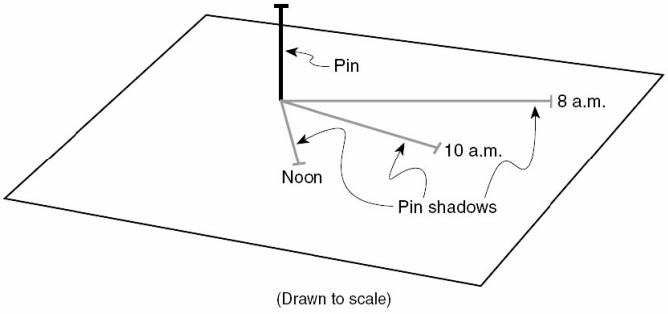
Sun / Earth Characteristics	Seasonal Position	Daily Position
Earth Closest to the Sun		
Earth Furthest from the Sun		
Longest Duration of Insolation		
Shortest Duration of Insolation		
North Pole gets 24hrs of Darkness		
North Pole gets 24hrs of Daylight		
South Pole gets 24hrs of Darkness		
South Pole get 24hrs of Daylight		
Longest Noon Shadow		
Shortest Noon Shadow		
8 Hours of Daylight		
16 Hours of Daylight		
12 Hours of Daylight		
Summer Solstice		
Winter Solstice		
Vernal Equinox		
Autumnal Equinox		

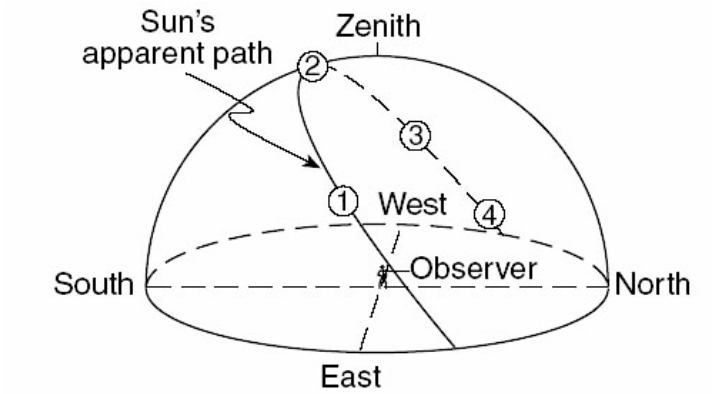
PART 3
SHADOWS

1. Draw in the shadow for 11 am.

2. Draw the shadow for 2 pm.

3. Why does the shadow change its length?





4. What is the date of this diagram? _____

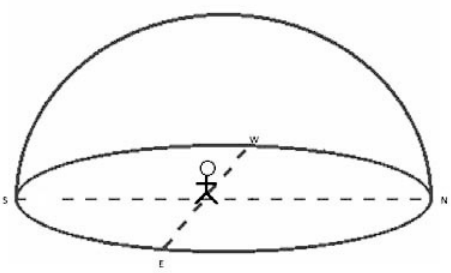
5. Which number represents the time of day with the shortest shadow? _____

6. Which number represents the time of day with the longest shadow? _____

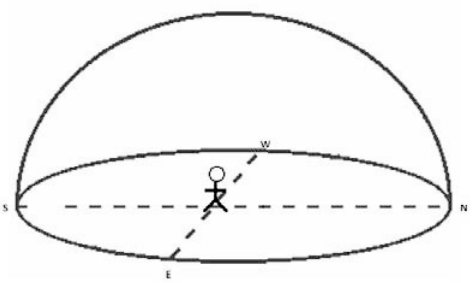
7. If this location was in New York State, label the approximate position of Polaris.

Draw the Sun's path and the length of the shadow at **NOON** for each date.

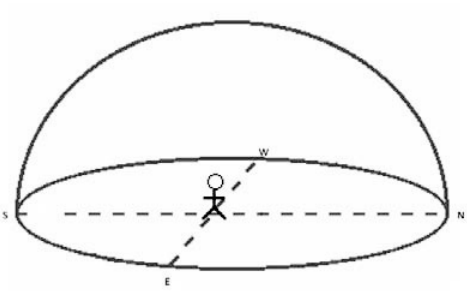
June 21st



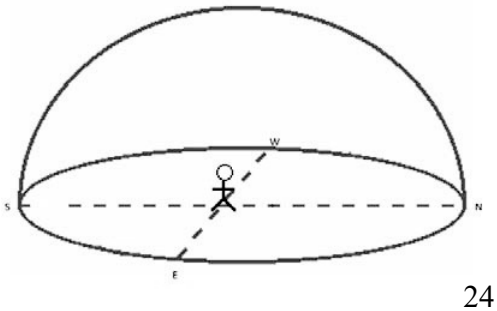
September 21st



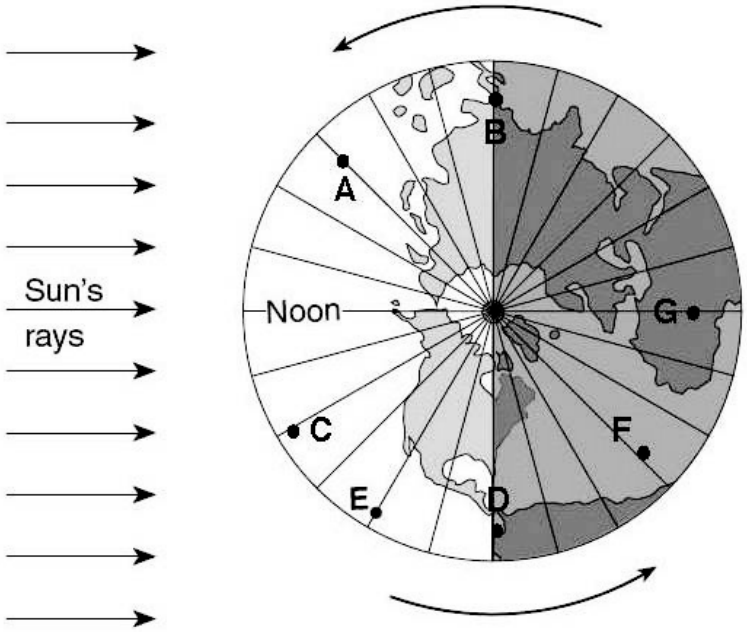
December 21st



March 21st



PART 4
VIEW FROM NORTH POLE



1. What date(s) are represented by the diagram above? _____

2. How can you tell? _____

_____

Location	Time	AM or PM
A		
B		
C		
D		
E		
F		
G		