Name _____

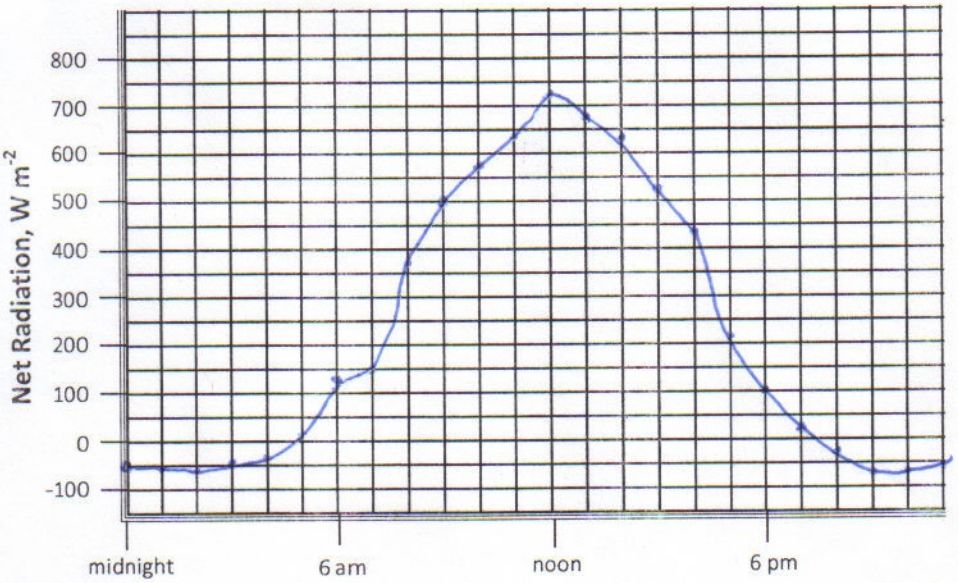
Net Radiation and Temperature

Recall that net radiation is equal to the energy coming into the earth (from the sun) and energy going out of the earth (as heat from the earth's surface). The following table shows the daily cycle of net radiation from June 15, 2005 at Professor Dunn's field site in Northern Manitoba, Canada at 55°N.

Negative numbers indicate an energy deficit, positive numbers an energy surplus.

Time	Net Radiation (W m^{-2})	Time	Net Radiation (W m^{-2})
Midnight	-50	Noon	729
1 am	-52	1 pm	676
2 am	-56	2 pm	641
3 am	-49	3 pm	522
4 am	-39	4 pm	442
5 am	14	5 pm	208
6 am	130	6 pm	102
7 am	151	7 pm	24
8 am	375	8 pm	-28
9 am	500	9 pm	-70
10 am	577	10 pm	-69
11 am	641	11 pm	-66

Use the data from the table to plot out the daily cycle of net radiation at this location. Connect your points with a smooth line. You may use the graph coordinates shown below:



a. What happens to the earth's temperature when it experiences an energy deficit (negative net radiation)?

Earth will cool down when it experiences an energy deficit, because there is less incoming radiation than outgoing radiation. The earth must cool in response to this deficit.

b. What happens to the earth's temperature when it experiences an energy surplus (positive net radiation)?

Earth will warm when it experiences an energy surplus, because there is more incoming than outgoing radiation. The earth must warm in response to this surplus.

c. Using your graph from the previous page, estimate the time at which the energy deficit turned to surplus.

The earth switched from a deficit to a surplus sometime between 4:00 am and 5:00 am – about 4:45 am. We can tell this by the fact that the net radiation switches from negative to positive.

d. Using your graph from the previous page, estimate the time at which the energy surplus turned to deficit.

The earth switched from a surplus to a deficit sometime between 7:00pm and 8:00 pm – about 4:45 am. We can tell this by the fact that the net radiation switched from positive to negative.

e. Estimate the time when the minimum temperature was experienced at the site, keeping in mind how net radiation affects the earth's temperature.

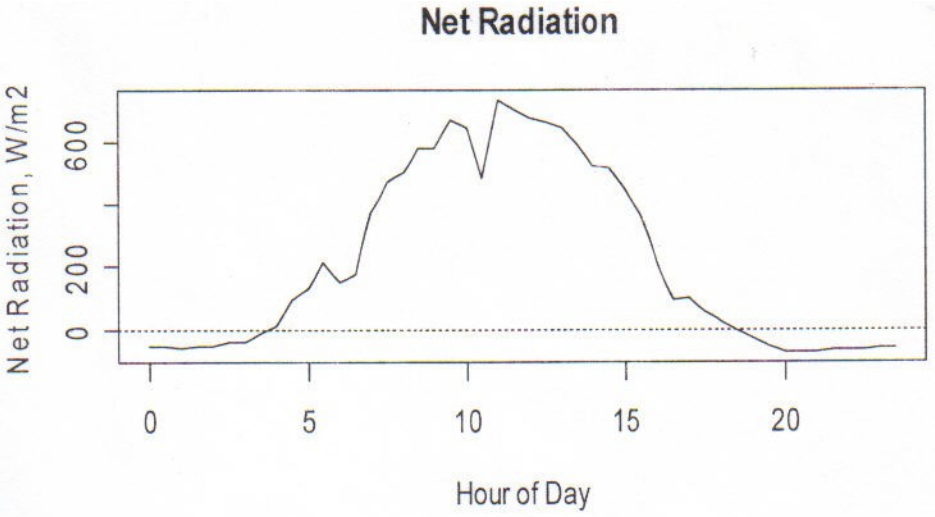
The minimum temperature at this site was probably experienced around 4:45 am, right when the earth switched from a deficit to a surplus. We know that the earth will cool down as long as net radiation is negative. Each hour where an energy deficit is observed will result in further cooling. Therefore, the coolest temperatures are not observed at the time of maximum hourly energy deficit, but at the time of maximum *cumulative* energy deficit.

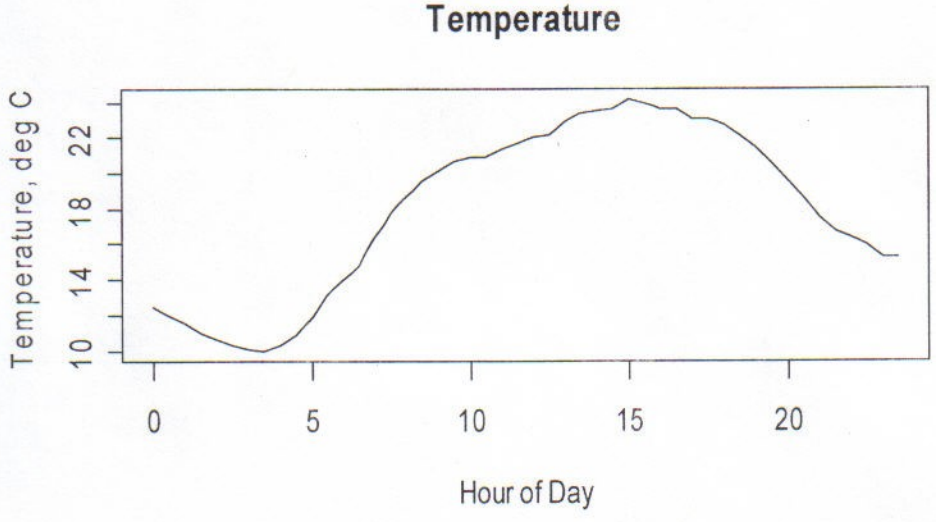
By 4:45 am, the site has been cooling down ever since net radiation switched from surplus to deficit the previous evening. Therefore, this will represent the coldest time at the site.

f. This data was taken from a day in the middle of June at a location in the subarctic Northern Hemisphere (55°N). Explain two ways in which the data would be different if you looked at a day from mid-December, both in terms of the *total* net radiation and the *timing* of the net radiation curve.

1. In December, the maximum net radiation surplus (which occurs around noon) would be much less. This is because the solar angle will be much lower in December due to the site's latitude (55°N), decreasing total insolation.
2. In December, the *timing* of the curve will look different because day length will be much shorter. This means that the site will shift from deficit to surplus *later* in the morning and shift from surplus to deficit *earlier* in the afternoon.

SEE NEXT PAGE FOR PLOT OF ACTUAL TEMPERATURE DATA!





Note how minimum temperature is observed when deficit switches to surplus.