

## Determine when winter solstice and full moon occur simultaneously

Given a winter solstice day,  $p = 1/30$  is the chance that it will be when moon is full (Note:  $(1/30)(1/365) \sim 1/11000$  is the *random selection of a day* that is both winter solstice and full moon).

A general discussion on the winter solstice is found here,  
<http://scienceworld.wolfram.com/astronomy/WinterSolstice.html>

The winter solstice may fall somewhere between Dec 21-23 because of the shift in the Gregorian calendar.

The online calculator for new and full moons for any given year is found here,  
[http://www.migrant.org/assets/math/scripts/science/new\\_and\\_full\\_moon\\_calculator.html](http://www.migrant.org/assets/math/scripts/science/new_and_full_moon_calculator.html)

Similarly, an equinox and solstice calculator for 100 BC to 4000 AD (accuracy 20 minutes) is found here,  
[http://www.hermetic.ch/cal\\_sw/ve/ve.htm](http://www.hermetic.ch/cal_sw/ve/ve.htm)

The results of first finding the years that the full moon falls between Dec 21 and Dec 23 are itemized. The, the winter solstice is calculated for bracketing years and the results are correlated. (Note: times are universal coordinated time (UTC)).

### Marching backward (starting with 2006)

	<b>Full Moon</b>	<b>Winter solstice</b>
1999	Dec 22 17:33	Dec 22 07:36 MATCH
1991	Dec 21 10:24	Dec 22 08:59
1988	Dec 23 05:29	Dec 21 15:31
1980	Dec 21 18:08	Dec 21 16:54 MATCH
1969	Dec 23 17:35	Dec 22 00:49
1961	Dec 22 00:42	Dec 22 02:13 MATCH
1942	Dec 22 15:04	Dec 22 11:31 MATCH
1923	Dec 23 07:34	Dec 22 20:50
1915	Dec 21 12:53	Dec 22 22:13
1904	Dec 22 18:02	Dec 22 06:08 MATCH
1893	Dec 23 04:37	Dec 21 14:03

### advancing forward

	<b>Full Moon</b>	<b>Winter solstice</b>
2010	Dec 21 08:15	Dec 21 23:41 MATCH
2018	Dec 22 17:50	Dec 21 16:27
2037	Dec 22 13:41	Dec 21 12:58
2056	Dec 22 01:37	Dec 21 21:08
2064	Dec 23 18:17	Dec 21 02:16
2075	Dec 22 08:50	Dec 21 18:21
2094	Dec 21 19:59	Dec 21 09:02 MATCH
2105	Dec 21 07:23	Dec 22 01:07

2113 Dec 22 15:08    Dec 21 23:43  
2124 Dec 21 07:49    Dec 21 15:48 MATCH

### **Conclusion**

In this statistical sampling, here are 8 occurrences in 232 years => 1 once every 29 years (3.44% chance any given year will have a full moon during its winter solstice), agrees well with the theoretical 1/29.57 (or 3.38%).

The last time a winter solstice had a full moon was Dec 22, 1999 (full moon 17:33 /solstice 07:36). The next time this will occur is Dec 21, 2010 (full moon 08:15/solstice 23:41). Unfortunately, the next one won't be until Dec 21, 2094.

Consulting Starry Night Planetarium software, Dec 21, 2010 23:41 UTC = Dec 21, 2010 18:41 EST (6:41 PM). But there is a real bonus. There will be a total eclipse of the moon around 3:39 AM EST Dec 21, which means Seattle will enjoy it too shortly before midnight. (The umbral phase begins 6:32 UT Dec 21 = 10:32 PM PST Dec 20).

Now this is very uncommon. I estimate the chance of a full moon on the winter solstice being eclipsed. Since there are about 3 lunar eclipses possible in a year visible from somewhere on the Earth, then given a full moon, the chance it will be eclipsed by Earth's shadow is 25%, but expect less than one total lunar eclipse per year. But for it to be visible from where you live, the chances are somewhat smaller (see Espenak's page, <http://sunearth.gsfc.nasa.gov/eclipse/LEcat/LEdecade2001.html>). In any case, the probability is reduced to around 1/400.

So, if I may quote you,

*I love the full moon. My dream is to ride the trans-Canadian railway at winter solstice during a full moon, and watch moonlight on snow. If I could write poetry, I'd write about the magic of moonlight on snow, and the healing of loneliness and dark thoughts.*

Linda M. Donovan

Now I think you will be able to plan this and be delighted further with a total lunar elipse.

Below is a poem I wrote immediately after the lunar eclipse of Oct 27, 2004 while in Charlotte, NC:

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September 9, 2006  
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## **Lunar Eclipse**

The great light sunken below the horizon  
has the heightened moon fully locked in its sight  
My world quietly coasts in between  
casting shadow on her lunar face  
A sheer black veil  
tinted red from all collected sunsets  
trapped in the spherical annulus of our atmosphere  
Mysterious queen of the night  
her reign of darkness eclipsed by time  
As the umbrella folds away  
blushing cheeks yield to satin blue of crystal clouds  
until they too are gone  
and the golden globe sinks below the inky black  
No less a lesser light