

1. The time for light to travel a distance d in free space is $t = d/c$, where c is the speed of light (3.00×10^8 m/s).

(a) We take d to be $150 \text{ km} = 150 \times 10^3 \text{ m}$. Then,

$$t = \frac{d}{c} = \frac{150 \times 10^3 \text{ m}}{3.00 \times 10^8 \text{ m/s}} = 5.00 \times 10^{-4} \text{ s} .$$

(b) At full moon, the Moon and Sun are on opposite sides of Earth, so the distance traveled by the light is $d = (1.5 \times 10^8 \text{ km}) + 2(3.8 \times 10^5 \text{ km}) = 1.51 \times 10^8 \text{ km} = 1.51 \times 10^{11} \text{ m}$. The time taken by light to travel this distance is

$$t = \frac{d}{c} = \frac{1.51 \times 10^{11} \text{ m}}{3.00 \times 10^8 \text{ m/s}} = 500 \text{ s} = 8.4 \text{ min} .$$

(c) We take d to be $2(1.3 \times 10^9 \text{ km}) = 2.6 \times 10^{12} \text{ m}$. Then,

$$t = \frac{d}{c} = \frac{2.6 \times 10^{12} \text{ m}}{3.00 \times 10^8 \text{ m/s}} = 8.7 \times 10^3 \text{ s} = 2.4 \text{ h} .$$

(d) We take d to be 6500 ly and the speed of light to be 1.00 ly/y . Then,

$$t = \frac{d}{c} = \frac{6500 \text{ ly}}{1.00 \text{ ly/y}} = 6500 \text{ y} .$$

The explosion took place in the year $1054 - 6500 = -5446$ or 5446 BCE .