



This image was taken by NASA's Solar Dynamics Observatory on July 6, 2012 and shows a brilliant X-ray solar flare erupting from the sun.

Solar flares are not all the same. Some produce less energy than others, and so astronomers classify them by their X-ray energy using four different letters: B, C, M and X. C-class flares produce 10 times more X-ray energy than B-class flares. M-class flares produce 10 times more energy than C-class flares, and X-class flares produce 10 times more energy than M-class flares. One B-class flare can produce more energy than 240,000 million tons of TNT!

The table below lists all of the M and X-class flares detected between January 1, 2013 and August 15, 2013 at a time when solar activity was near its maximum. This period of time spans the first 227 days of 2013. Also during this time, there were about 690 C-class flares and 440 B-class flares. All of these flares were seen on the side of the sun facing Earth, which represents  $\frac{1}{2}$  of the total surface area of the sun.

| Day  | Flare | Day  | Flare   | Day  | Flare |
|------|-------|------|---------|------|-------|
| 1-5  | M     | 5-2  | M       | 5-20 | M     |
| 1-11 | M, M  | 5-3  | M, M    | 5-22 | M     |
| 1-13 | M, M  | 5-5  | M       | 5-31 | M     |
| 2-17 | M     | 5-10 | M       | 6-5  | M     |
| 3-5  | M     | 5-12 | M, M    | 6-7  | M     |
| 3-15 | M     | 5-13 | X, M, X | 6-21 | M     |
| 3-21 | M     | 5-14 | X       | 6-23 | M     |
| 4-5  | M     | 5-15 | X       | 7-3  | M     |
| 4-11 | M     | 5-16 | M       | 8-12 | M     |
| 4-22 | M     | 5-17 | M       |      |       |

**Problem 1** - What were the total number of M and X-class flares during this period of time?

**Problem 2** – What were the total number of B, C, M and X-class flares detected during this period?

**Problem 3** – What percentage of all flares were B, C, M and X?

**Problem 4** – What was the average number of B and C-class flares seen each day?

**Problem 5** – An astronaut wants to do a spacewalk on a particular day during this period. What are the odds that she will see an M or X-class flare?

The flare data was obtained from

[http://www.swpc.noaa.gov/ftpmenu/warehouse/2013/2013\\_events.html](http://www.swpc.noaa.gov/ftpmenu/warehouse/2013/2013_events.html)

**Problem 1** - What were the total number of M and X-class flares during this period of time?

Answer: By counting Ms in the table, there were **31 M-class and 4 X-class flares**.

**Problem 2** – What were the total number of B, C, M and X-class flares detected during this period?

Answer:  $690 + 440 + 31 + 4 = 1165$  flares.

**Problem 3** – What percentage of all flares were B, C, M and X?

Answer:  $B = 100\% \times (440/1165) = 38\%$   
 $C = 100\% \times (690/1165) = 59\%$   
 $M = 100\% \times (31/1165) = 3\%$   
 $X = 100\% \times (4/1165) = 0.3 \%$

**Problem 4** – What was the average number of B and C-class flares seen each day?

Answer: B:  $440 \text{ flares}/227 \text{ days} = \text{about } 2 \text{ flares}$   
C:  $690 \text{ flares}/227 \text{ days} = \text{about } 3 \text{ flares}$

**Problem 5** – An astronaut wants to do a spacewalk on a particular day during this period. What is the probability that she will see each an M or X-class flare?

Answer: There are 227 days in the sample and 35 M or X-class flares were seen, so the probability is  $35/227 = 0.15$  which is also stated as 15%. The low probability means that it is not likely that on a random day the astronaut will see anything. In order to have a 50/50 chance, she would have to observe for at least 4 days ( $4 \times 0.15 = 0.60$  which is greater than 0.50 or 50%).