

# Gamma rays

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Complete terms can be found at <http://www.ck12.org/terms>.

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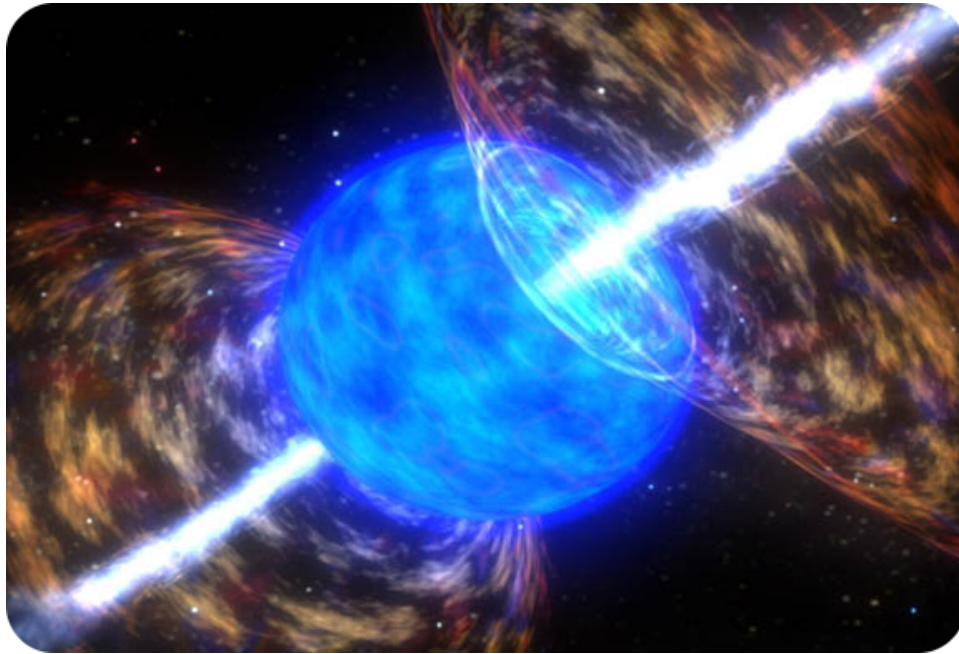
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# CONCEPT 1

## Gamma rays

- Describe gamma rays and their place in the electromagnetic spectrum.
- Identify sources of gamma rays.
- Explain why gamma rays are dangerous and how they can be used to treat cancer.



This amazing image is an artist's rendition of a gamma ray burst. You can see an animated version at the URL below. What is a gamma ray burst? It's an incredibly energetic explosion that is thought to occur when a massive star collapses. The burst lasts just seconds or minutes, but it has more energy than a million billion suns! As you might have guessed, gamma rays are released during a gamma ray burst. Gamma rays are extremely energetic electromagnetic waves. [http://www.nasa.gov/centers/goddard/mov/97789main\\_GRBstar2.mov](http://www.nasa.gov/centers/goddard/mov/97789main_GRBstar2.mov)

### The Range of Electromagnetic Waves

Electromagnetic waves transfer energy across space as well as through matter. They vary in their wavelengths and frequencies, and higher-frequency waves have more energy. The full range of wavelengths of electromagnetic waves, shown in the **Figure 1.1**, is called the electromagnetic spectrum.

### What Are Gamma Rays?

As you can see in the diagram above, **gamma rays** have the shortest wavelengths and highest frequencies of all electromagnetic waves. Their wavelengths are shorter than the diameter of atomic nuclei, and their frequencies are greater than 10<sup>19</sup> hertz (Hz). That's 10 quadrillion waves per second! Because of their high frequencies, gamma rays are also the most energetic of all electromagnetic waves. If you want to learn more about gamma rays, watch the video at the URL below. <http://www.youtube.com/watch?v=okynnBaSOtA>

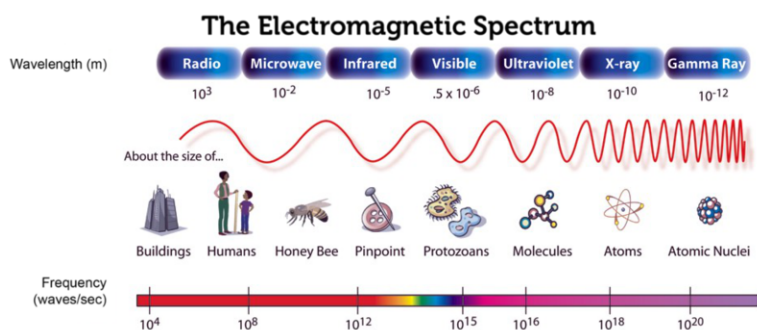


FIGURE 1.1

## Sources of Gamma Rays

Gamma rays are given off by radioactive atoms and nuclear explosions. They are also given off by the sun and other stars, as well as by collapsing stars in gamma ray bursts. Fortunately, gamma rays from space are absorbed by Earth's atmosphere before they can reach the surface.

**Q:** Predict how gamma rays might affect living things on Earth if they weren't absorbed by the atmosphere.

**A:** Gamma rays would destroy most living things on Earth because they have so much energy.

## Dangers and Uses of Gamma Rays

The extremely high energy of gamma rays allows them to penetrate just about anything. They can even pass through bones and teeth. This makes gamma rays very dangerous. They can destroy living cells, produce gene mutations, and cause cancer. Ironically, the deadly effects of gamma rays can be used to treat cancer. In this type of treatment, a medical device sends out focused gamma rays that target cancerous cells. The gamma rays kill the cells and destroy the cancer.

## Summary

- Electromagnetic waves vary in their wavelengths and frequencies. Higher-frequency waves have more energy.
- Of all electromagnetic waves, gamma rays have the shortest wavelengths and highest frequencies. Because of their very high frequencies, gamma rays have more energy than any other electromagnetic waves.
- Sources of gamma rays include radioactive atoms, nuclear explosions, and stars. Gamma rays from space are absorbed by Earth's atmosphere.
- Gamma rays can destroy living cells, produce mutations, and cause cancer. They can be used to treat cancer by focusing the deadly rays on cancer cells.

## Vocabulary

- **gamma ray:** Type of wave in the electromagnetic spectrum that has the shortest wavelength and greatest amount of energy.

## Practice

Explore gamma rays with NASA at the following URL. Then answer the questions below. [http://missionscience.nasa.gov/ems/12\\_gammarays.html#top](http://missionscience.nasa.gov/ems/12_gammarays.html#top)

1. Gamma rays are produced by
  - a. stars.
  - b. lightning.
  - c. nuclear explosions.
  - d. all of the above.
2. Gamma rays cannot be reflected by mirrors because gamma rays are
  - a. absorbed by mirrors.
  - b. refracted by mirrors.
  - c. transmitted by mirrors.
  - d. scattered by mirrors.
3. The most energetic electromagnetic event in the universe is a gamma-ray
  - a. collision.
  - b. burst.
  - c. flash.
  - d. recoil.
4. If we could see gamma rays, the night sky would look like
  - a. cosmic flashbulbs.
  - b. black holes.
  - c. X rays.
  - d. crystals.
5. NASA has used gamma rays to determine the composition of
  - a. visible light.
  - b. cosmic rays.
  - c. planets.
  - d. photons.

## Review

1. What are gamma rays?
2. Describe the wavelength, frequency, and energy of gamma rays.
3. What are some sources of gamma rays?
4. Identify how gamma rays can affect living things.
5. Explain how gamma rays can be used to treat cancer.