Types of Spectra

Photons (light-waves) are emitted from an atom when an electron moves from a higher energy level to a lower energy level.

Photons (light-waves) can also be absorbed by an atom when an electron moves from a lower energy level to a higher energy level.

Which drawing (not to scale) represents the process by which an photon with the greatest energy is absorbed?

Which drawing (not to scale) represents the process by which an photon with the shortest wavelength is emitted?

Two Properties of Blackbody Radiation: Wein’s Law

- The hotter an object is, the shorter is the wavelength of its maximum output.
- Hot objects tend to emit radiation at shorter wavelengths and look bluer than cooler objects.
**Two Properties of Blackbody Radiation: Stefan-Boltzmann**

- Hotter objects emit more energy than cooler objects of the same size
- An object emits energy at a rate proportional to the fourth power of its temperature

**How these four stars compare? Temp, Energy output, Color, size (area)…..**

The three spectral curves shown in the graphs below illustrate the energy output versus wavelength for three unknown stars X, Y, and Z. These three plots have the same scales and ranges in wavelength and energy output. Which star has the highest temperature?

A. X  
B. Y  
C. Z  
D. Same

**How do telescopes help us learn about the universe?**

- Telescopes collect more light than our eyes - light-gathering power
- Telescopes can see more detail than our eyes - resolving power
- Telescopes can gather, focus, and detect light that is invisible to our eyes (e.g., infrared, ultraviolet)

**What do astronomers do with telescopes?**

- **Imaging:** Taking pictures of the sky
- **Spectroscopy:** Breaking light into spectra
- **Timing:** Measuring how light output varies with time
How does Earth’s atmosphere affect ground-based observations?

- The best ground-based sites for astronomical observing are
  - Calm (not too windy)
  - High (less atmosphere to see through)
  - Dark (far from city lights)
  - Dry (few cloudy nights)

![Solar Thermostat Diagram]

- Core
- Radiation zone
- Convection zone

Energy generated in the core of the Sun propagates outward through these different layers, and finally, through the atmosphere of the Sun. This process takes tens of thousands of years or more.
The Sun’s “Atmosphere”

- **Photosphere** – inner
  - About 500 km thick
  - Average temp: 5,800 K
- **Chromosphere** – middle
  - Roughly 1,000 times fainter than the photosphere
  - Temps: 10,000 K
- **Corona** – outer
  - Temps up to 1,000,000 K!
  - Most of Sun’s X rays

Sunspots

- Sunspots are regions of the photosphere that appear darker
- Cooler than the rest of the surface
  - About 1000 K cooler on average
- Sizes: 1500 – 50,000 km

The annual change in numbers of sunspots reveals that the Sun experiences an 11-year Sun Spot cycle

Feature of our solar system

1. Patterns of motion of the large bodies
   - Orbit in same direction and plane
2. Existence of two types of planets
   - Terrestrial and jovian
3. Existence of smaller bodies
   - Asteroids and comets
4. Notable exceptions to usual patterns
   - Rotation of Uranus, Earth’s moon, etc.

Two Basic Types of Planets

<table>
<thead>
<tr>
<th></th>
<th>Terrestrial Planets</th>
<th>Jovian Planets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smaller size and mass</td>
<td></td>
<td>Larger size and mass</td>
</tr>
<tr>
<td>High density</td>
<td>Made mostly of rock and metal</td>
<td>Made mostly of hydrogen, helium, and hydrogen compounds</td>
</tr>
<tr>
<td>Solid surface</td>
<td>Few (if any) moons and no rings</td>
<td>No solid surface</td>
</tr>
<tr>
<td>Closer to the Sun</td>
<td>(and closer together, with warmer surfaces)</td>
<td>Further from the Sun (and farther apart, with cooler temperatures at cloud tops)</td>
</tr>
</tbody>
</table>

Nebular Hypothesis

- Our solar system formed from the gravitational collapse of an interstellar cloud of gas
- Kant and Laplace proposed the *nebular hypothesis* over two centuries ago
- A large amount of evidence now supports this idea
Radioactive Decay

- Some isotopes decay into other nuclei
- A half-life is the time for half the nuclei in a substance to decay

Suppose you find a rock originally made of potassium-40, half of which decays into argon-40 every 1.25 billion years. You open the rock and find 15 atoms of argon-40 for every atom of potassium-40. How long ago did the rock form?

a) 1.25 billion years ago  
b) 2.5 billion years ago  
c) 3.75 billion years ago  
d) 5 billion years ago