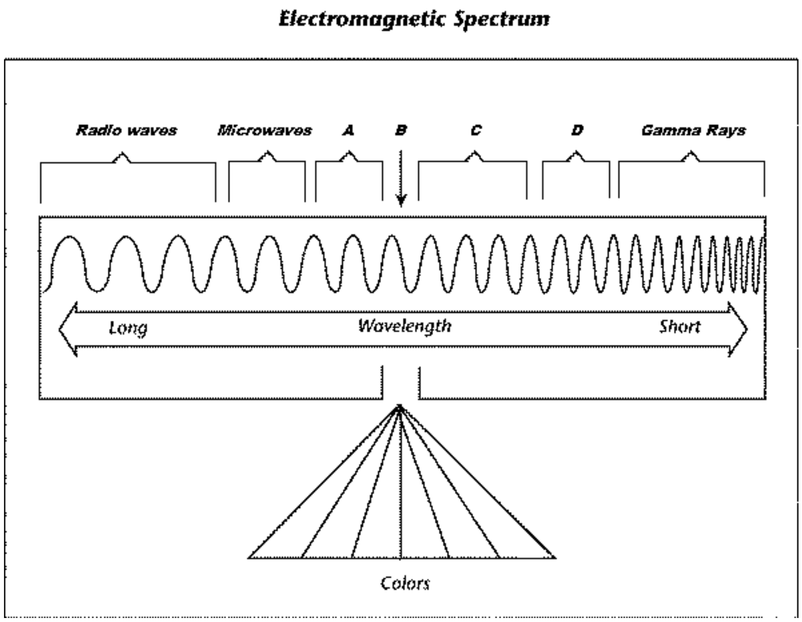
Part 1 - EMS



1. Name the type of wave that has the highest frequency.
   Gamma

2. Name the type of wave labeled C.
   Ultraviolet

3. Name the type of wave that has the greatest energy.
   Gamma

4. Which letter shows the type of wave that can be seen by the human eye?
   B – Visible Light

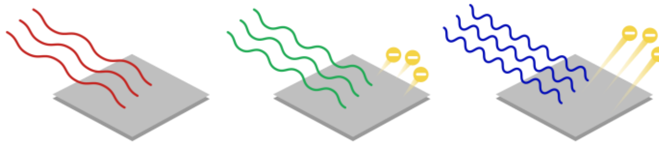
5. Name the type of wave labeled A.
   Infrared

6. Which letter indicates X-rays?
   D- X-rays

7. Compared to wavelengths of visible light, the wavelength of UV light is (longer/shorter/the same).
   UV is shorter in wavelength than visible.

8. What is the relationship between frequency and wavelength? Wavelength and energy? Energy and frequency?
   Frequency is inversely proportional to wavelength, wavelength is inversely proportional to energy, energy and frequency are directly proportional

Part 2 – Photoelectric Effect (Particle Behavior of Light)



1. What does the model about tell us in terms of frequency, energy, photons, and electrons?
   Red light: long wavelengths, low frequency, low energy, photons will not eject electrons.
   Blue light: short wavelengths, high frequency, high energy, photons will eject electrons

2. Compare what is happening between the red and blue waves.
   Red light does not have a high enough frequency (high enough energy) to eject electrons. Blue light does.

3. The photoelectric effect is proof that light act like what?
   The photoelectric effect is the emission of electrons when electromagnetic radiations (light waves, photons) having sufficient frequency strike metal surfaces and knock electrons off. We call the emitted electrons photoelectrons, and the current they create is a photocurrent.

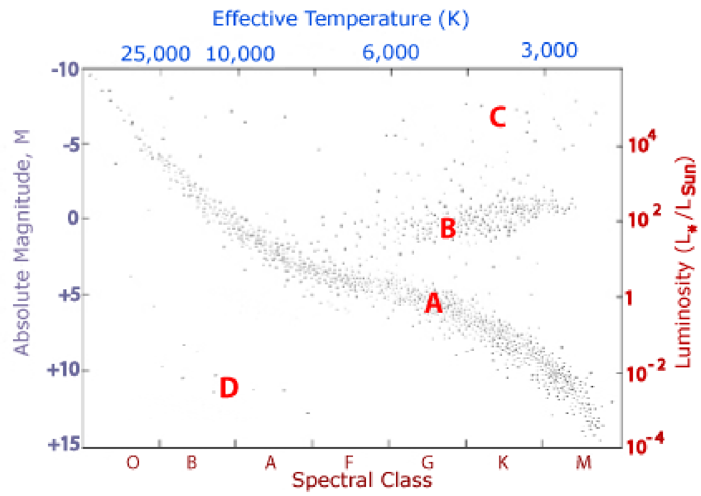
4. Photons are extremely important in the photoelectric effect. What is a photon? Why are they important?
   A photon is a particle representing a quantum of light or other electromagnetic radiation. (AKA package of energy) A photon carries energy proportional to the radiation frequency.

5. We studied photons when we talked about the layers of stars. What can you tell me about the layer(s) of stars in terms of photons?
   The photosphere is the layers of the star that allows us to see light because of photons.

6. Are all photons able to eject electrons? Explain your answer.
   Only a photon of a minimum energy to break the bonding energy of the electron can successfully knock off an electron (not dependent on increasing intensity which just means increasing the number of photons hitting the metal, if photons do not have enough energy is does not matter how many hit the metal)

7. Do all substances eject electron or just metals? Explain your answer.
   Metals require less energy to eject electron (break the binding energy) – lower binding energy (also called ionization energy) and a "sea of electrons" that are not locked into place.

Part 3 – HR Diagram



Hertzsprung-Russell Diagram

1. What happens to the stars' size as you move from left to right the HR diagram?
   Left to right across HR diagram, size of star increases.

2. What happens to the stars' temperature as you go from left to right on the HR diagram?
   Temperature decreases left to right.

3. Temperature tells us the color of the stars. What color would the really hot stars be? What color would the cold stars be?
   Blue is really hot, Red is cold

4. What could you tell me about the stars in region C? Region A? or Region D? (Hint: size, color, temperature, brightness)
   Region C – Red Super Giants: cool and bright.
   Region A – Main Sequence: all sizes, colors, temperatures, and luminosity.
   Region D – White Dwarfs: hot and dim.

4. Which group of stars is considered to have lower than average luminosity as well as higher than average temperature?
   D - white dwarfs

5. Which group of stars are near the end of their lifecycle, very large, but very cold?
   B and C – red giants and super giants

6. What is the luminosity of The Sun?
   Luminosity of the Sun is 1

7. What is the difference between apparent magnitude and absolute magnitude? What does this mean in terms of The Sun?
   The sun only appears to be the brightest star in the sky because it is the closest star to Earth. Its apparent magnitude is a -26 but its absolute magnitude is only a +5. So no it is not really the brightest star in the sky.

Part 4 – Wave Behavior of Light

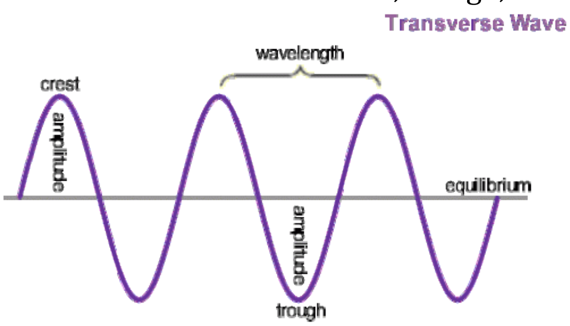
1. What two pieces of evidence do we have that tells us that light travels as waves?
   Evidence of the wave behavior of light: light **reflects** off shiny surfaces, **refracts** (or bends) when moving from one material into another, and **diffracts** (or spreads) around objects or when moving through slits. We can see interference, where peaks or troughs of waves add up to create brighter light, and peaks and troughs cancel out to create darker areas.

2. Destructive interference occurs when the crest of one wave lines up with the **trough** of another wave. This results in wave cancellation.

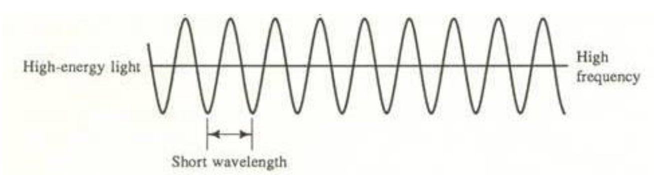
3. In constructive interference, the two waves are **added** to create a greater amplitude.

4. What is light diffraction?
   Diffraction is the process by which a beam of light or other system of waves is spread out as a result of passing through a narrow aperture or across an edge.

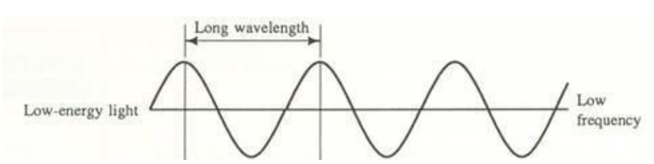
5. Draw a wave. Label the crest, trough, wavelength.



6. Make another way with a shorter wavelength. List what is directly proportional. List what is inversely proportional.
   Shorter wavelength, higher frequency, more energy. Wavelength is inversely proportional to frequency and energy. Frequency is directly proportional to energy.



7. Make another way with a longer wavelength that the 1st. List what is directly proportional. List what is inversely proportional.
   Longer wavelength, lower frequency, less energy. Wavelength is inversely proportional to frequency and energy. Frequency is directly proportional to energy.



Part 5 – Stars and Big Bang

1. Why do the position of stars in the universe change?
   The universe is expanding.

2. What evidence do we have that shows us this change?
   Cosmic Background Radiation, Red Shift of Stars and Galaxies, Stellar Composition

3. What stage of life is The Sun in? What is the percentage of H and He in The Sun? Will The Sun go Supernova, why or why not?
   4.5 billion years old, 75% H and 25% He, the sun will not go super nova because it is too small, medium/average mass star

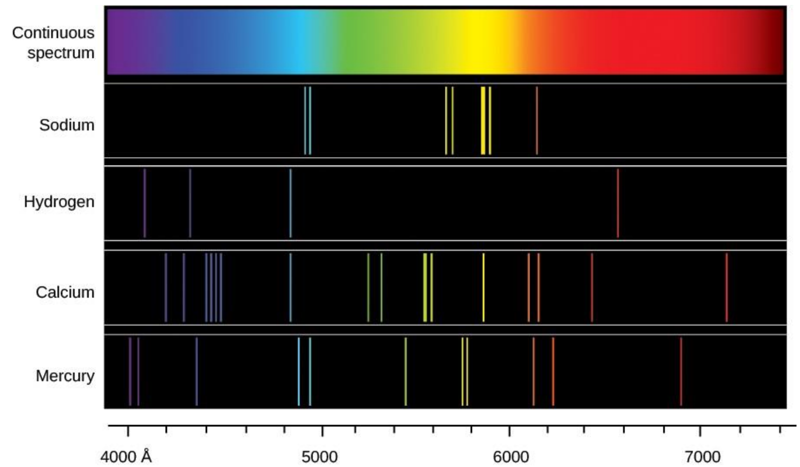
4. The color a star is determined by what?
   Temperature

5. The universe was formed 13.7 billion years ago. The Sun was born 4.5 billion years ago.

6. Tell me what you know about The Sun? (Age, Size, Lifecycle, Color, Temperature, Brightness, etc.)
   The Sun: 4.5 billion years old, average/medium mass star (109x bigger than the Earth), main sequence, the sun is white (looks yellow because of our atmosphere), surface temperature is 5778K (5,500°C, 10,000°F), absolute magnitude +5, apparent magnitude is -26, 75% H and 25% He, will end as a white dwarf.

7. Is The Sun the brightest star in the sky? How do you know?
   The sun only appears to be the brightest star in the sky because it is the closest star to Earth. Its apparent magnitude is a -26 but its absolute magnitude is only a +5. So no it is not really the brightest star in the sky.

Part 6 - Light Spectra



This is a bright line spectra. It shows us the difference between the continuous spectrum versus the bright line spectra of individual elements.

1. Explain why each element gives off different spectral lines. (Hint: excited electrons, ground state electrons, etc.)
   Each element absorbs and emits light as photons when electrons jump from higher energy levels (excited states) to lower energy levels (ground states). Each element has a different number of occupied energy levels with different spacing between them. One elements electrons will never occupy the same space or move the same distance as another elements electron.

2. Why would sodium give off the same color spectral lines each and every time it is heated?
   Sodium's electrons always occupy the same energy levels and occupy the same space and move the same distances when excited, so all sodium atoms will produce the same bright line emission spectrum.

3. When a salt or metal is heated in a flame, the flame has a distinctive color. This information was eventually extended to the study of stars. What can the color spectra of stars tell us?
   The color spectra of the stars tells us the stars elemental composition.

4. Draw a model that explains how an atom gives of light/color. Be as detailed as you can. Include electrons, ground state, excited state, absorbed energy, released energy, and a bright line spectra.