**PHYS 284 – End of Chapter Answers:**

**Chapter 5:**

1. What is the difference between energy and power? What units do we use to measure power?

The difference between energy and power is that energy is the ability to do work whereas power is the amount of work done in a given period of time. The SI unit for power is Watts whilst that of power is kilowatt per hour. Both terminologies are physical concepts.

1. What are the four major ways light and matter can interact? Give an example of each from everyday life.

Emission: a copper wire in a light bulb gets heated and emits photons  
Transmission: a transparent object like window glass transmits the Sunlight into your house  
Absorption: the walls however absorb the light and make a shadow  
Reflection: mirrors

1. Why do we say that light is an electromagnetic wave? Describe the relationship among wavelength, frequency, and speed for light.

Wavelength is related to electromagnetic waves, and all this is related to the electron valences within the given material or compound. A given compound or any atomic structure has different combinations of materials and when the electron orbits, or valences are stimulated, ( heat, radiation, lasers,or another compound ), the material or compound will vibrate at a given frequency depending on the electrons that move up or down in each of the valence orbits it normally occupies. Light is the combination of the frequencies of the material that has been stimulated or excited.

1. What is a photon? In what way is a photon like a particle? In what way is it like a wave?

Elementary particle, the quantum of light and all other forms of electromagnetic radiation, and the force carrier for the electromagnetic force, even when static via virtual photons.

Particle:

It is absorbed and emitted from a surface in discrete packets called Quanta.

Wave:

Interference, especially through two slits.

1. List the different forms of light in order from lowest to highest energy. Is the order the same from lowest to highest frequency? From shortest to longest wavelength? Explain.

Blue light has a shorter wavelength and higher frequency than red light.

Light is an electromagnetic wave same as radio, microwaves, UV and X-rays.

It's also made of photons, which are the smallest amount of light you can have.

There's clearly more energy in a heat lamp than a blue LED, but the individual photons are less energetic. A photon of blue light has more energy than a photon of red light, and a photon of UV has more, so it has enough energy to make your skin tan while standing in front of a heat lamp all week won't.

If you list electromagnetic waves from lowest photon energy to highest, it goes:

radio, microwaves, infra-red, red, green, blue, ultraviolet, X-Rays, gamma rays

which is also lowest to highest frequency

1. Briefly describe the structure and size of an atom. How big is the nucleus in comparison to the entire atom?

The atom is made of three different parts: the Electrons (negative charge), protons (positive charge), and the neutrons (no charge). The protons and neutrons make up the nucleus (the center of the atom) and the electrons fly around the nucleus. The nucleus (in comparison to the entirety of the atom) is the smallest part but holds the most mass.

1. Define atomic number and atomic mass number. Under what conditions are two atoms different isotopes of the same element? What is a molecule?

Atomic number is determined by the number of protons. atomic mass number is determined by the number of protons and neutrons put together. A molecule is an electrically neutral group of two or more atoms held together by chemical bonds. Isotopes are variants of a particular chemical element such that, while all isotopes of a given element share the same number of protons in each atom, they differ in neutron numbers.

1. What is electrical charge? Will an electron and a proton attract or repel each other? How about two electrons? Explain.

Electric charge is the physical property of matter that causes it to experience a force when close to other electrically charged matter. they will attract each other because they have positive and negative charges. they will repel because they have like charges which means they won't accept each other.

1. Describe the phase changes of water as you heat it, starting from its solid phase, ice. What happens at very high temperatures? What is a plasma?

Water starts off as ice (solid) and as it heats up the atomic structure of the compound h2o breaks down and the atoms move more freely which turns the ice into its liquid form which we know as water. as the heating up continues it eventually evaporates into its gas form. it's an amplified version of the previous stage in the way that the atoms move even more freely once they become a gas. gasses are the most unstable form of matter.

Plasma is one of the four fundamental states of matter (the others being solid, liquid, and gas). It comprises the major component of the Sun. Heating a gas may ionize its molecules or atoms (reducing or increasing the number of electrons in them), thus turning it into a plasma, which contains charged particles: positive ions and negative electrons or ions. Ionization can be induced by other means, such as strong electromagnetic field applied with a laser or microwave generator, and is accompanied by the dissociation of molecular bonds, if present. Plasma can also be created by the application of an electric field on a gas, where the underlying process is the Townsend avalanche.

1. Describe the energy levels that we find for electrons in atoms. Under what circumstances can energy level transitions occur?

It means that there are certain discrete energy levels that an atom can attain, by promoting electrons to higher-energy orbitals. The energy state of an atom is not continuously variable: each possible orbital to which an electron can be promoted has a certain energy level. As an electron "drops" from a high-energy orbital to a lower-energy one, a discrete amount of energy is released in the form of a photon. Whether this is visible light, IR, UV, gamma or X ray depends on the photon's energy (and therefore its wavelength). Electrons that are tied to a nucleus have an energy, which dictates how far and where they can "orbit" around the nucleus.

If they have more energy, they change there orbit. Quantized means that they can't change there energy to any value, but have to move if fixed jumps.

One effect of this is that an electron in orbit can only absorb photons that will move it to one of its fixed energy levels. Electrons not tied to a nucleus can have any energy level.

1. How do we convert a spectrum shown as a band of light (like a rainbow) into a graph of the spectrum?

You need to measure the intensity at each position. This can be done with a monochromatic CCD but most spectrographs use photomultiplier tubes for greater accuracy, since it is not necessary to build up an image. The optical elements are tilted to present different positions to the PMT and the photon rate (or current for brighter light sources) is recorded and used to determine the vertical component of each point on the curve.

1. Describe the conditions that lead to each of the three basic types of spectra. Which type is the Sun’s visible-light spectrum, and why?

1. Continuous Spectrum - light like the rainbow  
  
2. Absorption Line Spectrum - dark lines on a continuous spectrum (used for astronomy and remote sensing)  
  
3. Emission Line Spectrum - mostly dark, no continuity (electromagnetic radiation) radio waves, gamma waves

1. How can we use emission or absorption lines to determine the chemical composition of a distant object?

Spectroscopes are attached to telescopes to separate the spectral lines. Then, the wavelengths and intensities indicate the elements and amount of the elements in that object (star, or in some cases, planet atmosphere.

You have to have an idea of a prism or diffraction grating being able to separate the wavelengths of the light into their constituents, and that specific elements emit or absorb light of particular set of wavelengths.

1. Describe two ways in which the thermal radiation spectrum of an 8000 K star would differ from that of a 4000 K star.

1. The peak wavelength of the 8000 K star would be shorter than the peak wavelength of the 4000 K one. (Wien's Law)  
  
2. The energy emitted at EVERY wavelength is higher for the hotter star (Stefan Boltzman Law)

1. Describe the Doppler effect for light and what we can learn from it. What does it mean to say that radio waves are blue-shifted? Why does the Doppler effect widen the spectral lines of rotating objects?

The doppler effect is the change in frequency of a wave (or other periodic event) for an observer moving relative to its source. Blue shift means things are moving closer to each other, so they are shorter radio waves. it could be because the objects are constantly moving and never at rest.

**Chapter 6:**

1. How does your eye focus light? How is a glass lens similar? What do we mean by the focal plane of a lens?

By bending light to a focus point on the retina; by bending parallel rays of light to a focus point of the lens; focal plane is where the image appears in focus.

1. How does a camera record light? How are images affected by exposure time? What are pixels?

Camera has a small opening for light to enter, like the pupil of the eye, lens bends the light, bringing it to a focus on a detector that makes a permanent record of the image. Longer exposure= more detail. Pixels- electronic chips that are physically divided into grids of picture elements, used in modern detectors.

1. What are the two key properties of a telescope, and why is each important?

Light-collecting area: determines how much light it gathers. angular resolution: determines how much detail we can see in its images.

1. What is the diffraction limit, and how does it depend on a telescope’s size and the wavelength of light being observed?

Diffraction limit: the angular resolution that a telescope could achieve if it were limited only by the interference of light. Larger telescope= smaller diffraction limit. Diffraction limit is larger for light with longer wave length.

1. How do reflecting telescopes differ from refracting telescopes? Which type is more commonly used by professional astronomers, and why?

Refracting telescope: operates like an eye, using transparent glass lenses to collect and focus light. Reflecting telescope: uses a precisely curved primary mirror to gather light. Reflecting telescopes are more commonly used because only the reflecting surface of a mirror must be precisely shaped, quality of the underlying glass is not a factor, and since mirror is located at the bottom its weight isn't a problem.

1. What are the three basic categories of astronomical observation, and how is each conducted?

Imaging: yields photographs of astronomical objects.  
Spectroscopy: astronomers obtain and study spectra.  
Time monitoring: tracks how a distant object's brightness changes with time.

1. What do we mean when we speak of images made from invisible light, such as X-ray or infrared images? What do the colors in these images mean?

Images made with invisible light cannot have any natural color because color is a property only of visible light. We can use color-coding to interpret them. Sometimes color can respond to different energy levels or according to light intensity or to physical properties of objects in the images.

1. What do we mean by spectral resolution? Why is higher spectral resolution more difficult to achieve?

Spectral resolution is the amount of detail we can see. The higher the spectral resolution, the more detail. BUT, b/c the spectral resolution depends on how widely the spectrograph spreads out the light, if the light is spread out more, you need more total light in order for it to be recorded successfully. So making a spectrum of an object requires a longer exposure time than making an image, and higher resolution spectra require longer exposures than low-resolution spectra.

1. List at least three ways in which Earth’s atmosphere can hinder astronomical observations. What problem can adaptive optics help with?

Scattering of human-made light, blurring of images by atmospheric motion, and the fact that most forms of light cannot reach the ground at all. Adaptive optics help eliminate blurring.

1. Describe how deeply each portion of the electromagnetic spectrum penetrates Earth’s atmosphere. Based on your answers, why are space telescopes so important?

Only radio waves, visible light, the very longest wavelengths of ultraviolet light, and small parts of the infared spectrum can be observed from the ground. Space telescopes are important because they allow us to observe the rest of the electromagnetic spectrum.

1. Briefly describe how telescopes for invisible wavelengths differ from those for visible light. Are there observatories for studying “cosmic messengers” besides light? Explain.

Radio telescope: angular resolution important because they aren't used to make images of the satellites in space

1. What is interferometry, and how can it improve astronomical observations?

Interferometry: linking of two or more individual telescopes to achieve angular resolution of a much larger telescope; works by taking advantage of wave-like properties of light that cause interference.