Astronomy 301 Introduction to Astronomy

HOMEWORK 3

Due Tuesday, October 6, 2015

Answer all questions in Part A and **one** from Part B.

Part A questions may be answered on these sheets. As usual, answers to Part B questions mostly require a few complete sentences at a minimum and should be written out on separate sheets.

Part A

A1. The following are names for portions of the wave family to which light belongs. Arrange them in order of increasing wavelength.

FM radio, visible, γ-rays, infrared, AM radio, X-rays

A2. Photon energy is inversely proportional to
a. wavelength
b. frequency
c. velocity
d. brightness

A3. How much more energy is carried by a photon of wavelength 10 nm (an X-ray) than by a photon of wavelength 500 nm (visible light)?

A4. What color is visible light with the longest wavelength?

A5. The theoretical resolving power (i.e., that set by diffraction) of a telescope is proportional to
a. aperture divided by wavelength
b. wavelength divided by aperture
c. (aperture divided by wavelength)^2
d. (wavelength divided by aperture)^2

A6. If diffraction sets the resolving power of telescope, which of the following combinations provides the highest resolving power:
a. a 10 cm telescope operated at a wavelength of 5000 Å.
b. a 200 cm telescope operated at a wavelength of 5000 Å.
c. a 10 cm telescope operated at a wavelength of 2000 Å.
d. a 100 cm telescope operated at a wavelength of 1 cm.

[Note: 1,000 Å = 10^{-5} cm]

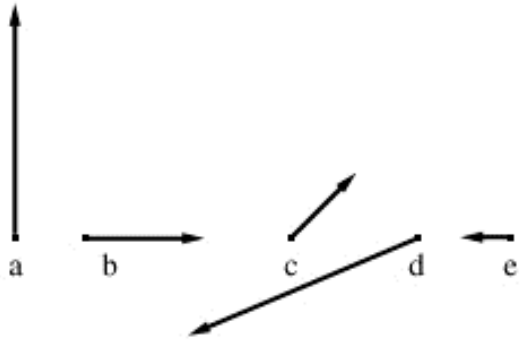
A7. Telescope A has a 60-inch diameter but Telescope B has a 4-centimeter diameter. Which telescope gathers more light and how much more?

A8. The radial velocity of a body is the velocity
a. perpendicular to the line of sight
b. toward the observer
c. away from the observer
d. either toward or away from the observer
e. either perpendicular to the line of sight or along the line of sight

A9. If we observe a blue laser on a space probe moving away from Earth, we shall find its wavelength _____compared with the laboratory standard laser of the same type.
a. unchanged
b. shifted toward to red
c. increases in intensity
d. shifted toward the violet

A10. In a laboratory, the Balmer beta line of hydrogen has a wavelength of 486.1 nm. The line appears in a star's spectrum at 486.3 nm. Is the star approaching or receding?

A11. The following diagram depicts the velocity (speed and direction) of several stars.



You observe these stars (all at the 'same' large distance) from a position far off to the RIGHT. Please order them by increasing radial velocity from maximum radial velocity of approach to maximum radial velocity of recession.

A12. Stars UT-X and UT-Y are at distances of 5 and 20 light years, respectively. If the stars are equally luminous, how much brighter will UT-X appear than UT-Y?

A13. Star UT-A is 40,000 brighter than an identical star, UT-B. If UT-A is at a distance of 250 light years, what is the distance of UT-B?

A14. What is the difference between a neutral atom and a positive ion of the same element?

A15. Ionization of an atom occurs when
a. the nucleus undergoes fission, or splitting
b. an electron is removed from the atom.
c. an electron is lifted from the ground state to an excited level.
d. an electron is allowed to return to the ground state.

Part B [Answer **ONE**!]
In answering a question, imagine you are an author of a book for junior high students. Do not simply copy or paraphrase the text's glossary. Be imaginative!

B1. a. What is the Doppler effect?
b. Explain *why* the Doppler effect occurs.
c. In January and July you observe a star near the ecliptic to have no radial velocity. In Feb-May the star has a positive radial velocity and in Aug-Dec it has a negative radial velocity. What is causing the observed velocity to vary in this way?

B2. a. Describe the major characteristics of a neutral atom – size of atom and nucleus, and constituent particles, distribution of mass and electrical charge. Include a telling analogy highlighting the very small size of the nucleus within an atom.
b. The Rutherford-Bohr model atom is sometimes referred to as a miniature solar system with electrons (≡ planets) orbiting the nucleus (≡ Sun). Discuss one way in which this analogy is imperfect and misleading.
c. Write a short section for a junior-high school text describing the carbon atom and explain how it differs from that of oxygen.

B3. a. Explain the difference between 'the brightness' and 'the (absolute) luminosity' of a star.
b. **Prove** that the brightness (B) of a star, its absolute luminosity (L) and its distance (d) are related as:
$B \propto L/d^2$.
c. What is Olber's paradox? Discuss the paradox explaining how it arises from simple assumptions about the Universe.

B4. a. If you had limited funds to build a LARGE optical telescope on Earth, which type would you choose: a reflector or a refractor? And state why.
b. Why do optical astronomers put their telescopes at the tops of mountains whereas radio astronomers sometimes put their telescopes in deep valleys?
c. What advantages would you have if you built an observatory on the lunar surface? The Moon has no atmosphere and gravity is less than on Earth.

"I read Shakespeare and the Bible and I can shoot dice.
That's what I call a liberal education."

Tallulah Bankhead (1903 – 1968)

"Science is built up of facts, as a house is built of stones; but an accumulation of facts is no more a science than a heap of stones is a house."

Henri Poincaré (1854 – 1912)

"Youth is imaginative, and if the imagination can be strengthened by discipline, this energy of imagination can in great measure be preserved through life. The tragedy of the world is that those who are imaginative have but slight experience, and those who are experienced have feeble imagination. Fools act on imagination without knowledge, pedants act on knowledge without imagination. The task of a university is to weld together imagination and experience."

Alfred North Whitehead (1861 - 1947)