Astronomy 110
Homework #05
Assigned: 02/13/2007
Due: 02/20/2007

Name:

Directions: Listed below are twenty (20) multiple-choice questions based on the material covered by the lectures thus far. Choose the correct response from those listed, **along with at least a one (1) sentence justification for your answer**. Alternate justification techniques include math calculations and labeled sketches. Each question is worth 5 points: 2 for the letter response and 3 for the justification. Collaboration with your peers is permitted, but all justifications must be in your own words. If you are unsure about a question, make an educated guess, and justify your guess (which can include why you can rule out certain choices from the list). If you get stuck, **please seek assistance from your peers, the TA, or the professor**. Note: It may be helpful to place your answers on a separate sheet of paper and staple it to this assignment sheet.

WARNING: Please **DO NOT** copy material word for word from sources such as textbooks, a peer's notes, online references (i.e. Google or Wikipedia), etc in any responses to homework, quiz, or exam questions. Ideas should be expressed in your own words. Not only does this protect you from illegal acts of plagiarism and/or accusations of cheating, but it also aids your future studying by having ideas expressed in a way that you, personally, can best understand. If for some reason you MUST quote text from a source in your answer, properly reference your quote.

1. The average temperature of Mars is lower than that of Earth. If a distant observer measures the infrared radiation from both Mars and Earth, then
   A) the emission from the two planets will peak at the same wavelength, but that from Mars will be less intense than that from Earth.
   B) the wavelength of peak emission from Earth will be longer than that from Mars.
   C) the wavelength of peak emission from Mars will be longer than that from Earth.
   D) it is not possible to predict the behavior of the radiation from the information given.

2. The human eye has evolved over time so that its peak wavelength sensitivity is about 0.5 μm (1 μm = 10^{-6} m). Use Wien's law to calculate the temperature of blackbody radiation to which the eye is most sensitive.
   A) 14,240 K
   B) 0.58 K
   C) 580 K
   D) 5,800 K

3. Large quantities of X rays are seen to come from the direction of Cygnus X-1 (see Chapter 24, Freedman and Kaufmann, *Universe,* 7th ed.) with a spectrum that looks similar to that of a blackbody, with a peak wavelength of 1.45 nm (1 nm = 10^{-9} m). These X rays are probably emitted by matter being heated as it falls into a black hole. What temperature is this gas?
   A) 4205 K
   B) 2×10^4 K
   C) 2×10^6 K
   D) 2×10^{-2} K

4. A piece of iron is heated from 400 to 800 K (127 to 527°C). By what factor will the total energy per second emitted by this iron increase?
   A) 2
   B) 296.5
   C) 4
   D) 16

5. The energy flux arriving at the Earth from the Sun is known as the solar constant and has a value of 1.37×10^3 watts per square meter. Assuming that the atmosphere absorbs 50% of the energy and that a 5-m^2 roof collector is available to collect energy with a 30% efficiency, how much of this solar energy would then be available for use in the house for water or house heating, etc.? (1 KW = 1 kilowatt = 1000 W.)
   A) about 1 KW
   B) about 46 KW
   C) about 1 W
   D) about 10 KW

6. The hot, dense gas existing in the Sun emits energy
   A) at all wavelengths uniformly.
   B) at all wavelengths, with a peak at one particular wavelength (color).
   C) only at certain wavelengths and no others.
   D) mostly at the longest and shortest wavelengths, less in between.

7. In its interaction with matter, light behaves
   A) only as waves.
   B) alternatively as particles or as waves, switching its properties about once every second.
   C) as both waves and particles, depending on the type of interaction.
   D) only as small particles, photons.

8. In comparing photons of different wavelengths, we find that the energy carried by a photon
   A) increases as the wavelength increases up to a wavelength equal to λ_{max}, then decreases again.
   B) does not depend on its wavelength.
   C) is larger if the wavelength is shorter.
   D) is larger if the wavelength is longer.

9. In what way does a photon of blue light NOT differ from a photon of yellow light in a vacuum?
   A) wavelength
   B) color
   C) energy
   D) speed

10. The human eye is most sensitive to light with a wavelength near 550 nm. To what photon energy is the human eye most sensitive?
   A) 3.99×10^{-19} J
   B) 3.60×10^{-19} J
   C) 2.93×10^{-19} J
   D) 3.60×10^{-10} J

11. Atoms in a thin, hot gas (such as a neon advertising sign) emit light at
    A) specific wavelengths, depending on the element.
    B) all wavelengths, with the shape of the continuum distribution depending on the temperature of the gas.
    C) only visible wavelengths.
    D) only a specific single wavelength.

12. The star P Cygni (in the constellation Cygnus, the Swan) is surrounded by an extensive low-density atmosphere. Its spectrum consists of a bright, continuous spectrum with many narrow, dark absorption lines and a few bright emission lines. The dark absorption lines are produced by
    A) all parts of the star, the stellar surface and the atmosphere, equally.
    B) only the part of the low-density atmosphere that is between us and the surface of the star.
    C) the hot, dense, opaque gas of the star's surface.
    D) the hot, low-density atmosphere of the star emitting light in all directions.

13. Why is the sky blue?
    A) The air molecules absorb red light better than blue light, allowing more blue light to reach our eyes.
    B) The air molecules scatter blue light better than red light, so more blue light reaches our eyes.
    C) The air molecules scatter red light better than blue light, so less red light reaches our eyes.
    D) The air molecules absorb blue light better than red light, making the sky appear bluer.

14. The physical structure of an atom is
    A) neutrons orbiting an electrically neutral nucleus of protons and electrons under the influence of their intense gravitational field.
    B) negatively charged electrons moving around a very small but massive, positively charged core.
    C) positively and negatively charged particles orbiting a small but powerful black hole.
    D) negatively charged electrons and positively charged protons mixed uniformly in the volume of the atom.

15. The proton, the nucleus of the hydrogen atom, has a mass that exceeds that of the electron by approximately what factor?
    A) 10^4
    B) 100
    C) 2000
    D) 2

16. When astronomers look for evidence of hydrogen gas in the spectra of the Sun, the planets, and nearby stars, the positions of the spectral features or "lines" due to hydrogen
    A) are in a very different pattern, depending on the location of the planet or star, and are reproduced only with difficulty in the laboratory.
    B) are always in the same pattern, characteristic of hydrogen gas, as seen in the laboratory.
    C) change systematically, depending on the distance from the source, starting with a laboratory pattern.
    D) are in the same pattern for solar and planetary sources but are very different for stars at larger distances because of absorption of light by the interstellar matter.

17. What happens in general when a beam of radiation with a range of UV wavelengths passes through a tube of neutral (non-ionized) hydrogen gas?
    A) Radiation at all wavelengths is absorbed, reducing the intensity at all wavelengths uniformly.
    B) It is unhindered except at the specific wavelengths of the Lyman series, Lα, Lß, etc, which are absorbed by the atoms.
    C) It is unhindered except the Lyman Lα wavelength, which is absorbed by the atoms.
    D) It is unhindered since the hydrogen gas is cool and cannot absorb energy.

18. 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.

19. The observed change in wavelength due to the Doppler effect occurs
    A) whenever the light source is moving with respect to the observer (regardless of direction).
    B) only when the light source has a radial velocity relative to the observer.
    C) only when the temperature of an object changes.
    D) only when the light source has a proper motion (across the line of sight).

20. A police radar bounces radio waves of wavelength 3 mm from the front of a speeding car and measures the Doppler shift in wavelength of the reflected waves. The shift is doubled because of the reflection. What will be the wavelength shift if the speeding car is moving at 60 mph (80 km/h or 22.2 ms^{-1}) (in a 30 mph zone!)?
    A) 0.44 nm
    B) 0.88 nm
    C) 4.4 nm
    D) 8.8 nm