Lecture 6 - The sun and stars

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) How are wavelength, frequency, and energy related for photons of light? 1) _____
   A) Longer wavelength means higher frequency and higher energy.
   B) Longer wavelength means lower frequency and higher energy.
   C) Longer wavelength means lower frequency and lower energy.
   D) Longer wavelength means higher frequency and lower energy.
   E) There is no simple relationship because different photons travel at different speeds.

2) From lowest energy to highest energy, which of the following correctly orders the different categories of electromagnetic radiation? 2) _____
   A) infrared, visible light, ultraviolet, X–rays, gamma rays, radio
   B) gamma rays, X–rays, visible light, ultraviolet, infrared, radio
   C) radio, infrared, visible light, ultraviolet, X–rays, gamma rays
   D) radio, X–rays, visible light, ultraviolet, infrared, gamma rays
   E) visible light, infrared, X–rays, ultraviolet, gamma rays, radio

3) From shortest to longest wavelength, which of the following correctly orders the different categories of electromagnetic radiation? 3) _____
   A) gamma rays, X–rays, ultraviolet, visible light, infrared, radio
   B) radio, infrared, visible light, ultraviolet, X–rays, gamma rays
   C) visible light, infrared, X–rays, ultraviolet, gamma rays, radio
   D) infrared, visible light, ultraviolet, X–rays, gamma rays, radio
   E) gamma rays, X–rays, visible light, ultraviolet, infrared, radio

4) Which of the following statements about X–rays and radio waves is *not* true? 4) _____
   A) X–rays and radio waves are both forms of light, or electromagnetic radiation.
   B) X–rays travel through space faster than radio waves.
   C) X–rays have higher energy than radio waves.
   D) X–rays have shorter wavelengths than radio waves.
   E) X–rays have higher frequency than radio waves.

5) Without telescopes or other aid, we can see the Moon because it 5) _____
   A) emits visible light.
   B) glows through radioactive decay.
   C) emits thermal radiation.
   D) reflects visible light.
   E) reflects infrared light.

6) *Thermal radiation* is defined as 6) _____
   A) radiation in the form of emission lines from an object.
   B) radiation that is felt as heat.
   C) radiation produced by a hot object.
   D) radiation that depends only on the emitting object's temperature.
   E) radiation in the infrared part of the spectrum.

7) A perfectly opaque object that absorbs all radiation and reemits the absorbed energy as thermal radiation is 7) _____
A) a thermal emitter.
B) transparent.
C) a hot, dense cloud of gas.
D) a cold, dense cloud of gas.
E) an infrared radiation emitter.

8) Which of the following statements about thermal radiation is *always true*? 8) _____
A) A hot object emits less total radiation than a cool object.
B) A hot object emits more radio waves than a cool object.
C) A hot object emits more total radiation than a cool object.
D) A hot object emits more X–rays than a cool object.
E) A hot object emits more total radiation per unit surface area than a cool object.

9) Which of the following statements about thermal radiation is *always true*? 9) _____
A) A hot object emits photons with a higher average energy than a cool object.
B) A hot object emits more X–rays than a cool object.
C) A hot object emits more radio waves than a cool object.
D) A hot object emits photons with a longer wavelength than a cool object.

10) If two objects are the same size but one object is 3 times hotter than the other object, the hotter object emits 10) _____
A) 81 times more energy.
B) 9 times more energy.
C) 12 times more energy.
D) 3 times more energy.
E) none of the above

11) We can learn a lot about the properties of a star by studying its spectrum. All of the following statements are true except one. Which one? 11) _____
A) We can identify chemical elements present in the star by recognizing patterns of spectral lines that correspond to particular chemicals.
B) The total amount of light in the spectrum tells us the star's radius.
C) We can look at Doppler shifts of spectral lines to determine the star's speed toward or away from us.
D) The peak of the star's thermal emission tells us its temperature: Hotter stars peak at shorter (bluer) wavelengths.

12) Suppose you see two stars: a blue star and a red star. Which of the following can you conclude about the two stars? 12) _____
A) The blue star has a hotter surface temperature than the red star.
B) The blue star is more massive than the red star.
C) The blue star is farther away than the red star.
D) The red star is more massive than the blue star.
E) The red star has a hotter surface temperature than the blue star.

13) What are the appropriate units for the Sun's *luminosity*? 13) _____
A) joules
B) Newtons
C) watts
D) meters
E) kilograms

14) What is the average temperature of the *surface* of the Sun? 14) _____
A) 100,000 K
B) 1,000 K
C) 1 million K
D) 6,000 K
E) 10,000 K

15) Which is closest to the temperature of the *core* of the Sun? 15) _____
A) 10 million K
B) 100 million K
C) 10,000 K
D) 1 million K
E) 100,000 K

16) From the center outward, which of the following lists the "layers" of the Sun in the correct order? 16) _____
A) core, convection zone, radiation zone, corona, chromosphere, photosphere
B) core, convection zone, radiation zone, photosphere, chromosphere, corona
C) core, radiation zone, convection zone, corona, chromosphere, photosphere
D) core, corona, radiation zone, convection zone, photosphere, chromosphere
E) core, radiation zone, convection zone, photosphere, chromosphere, corona

17) Which layer of the Sun do we normally see? 17) _____
A) photosphere
B) convection zone
C) radiation zone
D) chromosphere
E) corona

18) The core of the Sun is 18) _____
A) at the same temperature but denser than the surface.
B) at the same temperature and density as the surface.
C) constantly rising to the surface through convection.
D) composed of iron.
E) hotter and denser than the surface.

19) Where does nuclear fusion occur in the Sun? 19) _____
A) just above the visible surface
B) on the surface
C) in its core
D) anywhere below the surface
E) all of the above

20) Why do sunspots appear dark in pictures of the Sun? 20) _____

A) They are holes in the solar surface through which we can see to deeper, darker layers of the Sun.
B) They are too cold to emit any visible light.
C) They emit light in other wavelengths that we can't see.
D) They actually are fairly bright but appear dark against the even brighter background of the surrounding Sun.
E) They are tiny black holes, absorbing all light that hits them.

21) At the center of the Sun, fusion converts hydrogen into 21) _____

A) radiation and elements like carbon and nitrogen.
B) hydrogen compounds.
C) radioactive elements like uranium and plutonium.
D) helium, energy, and neutrinos.
E) plasma.

22) The overall fusion reaction by which the Sun currently produces energy is 22) _____

A) 3 He $\Rightarrow$ 1 C + energy.
B) 4 H $\Rightarrow$ 1 He + energy.
C) 3 H $\Rightarrow$ 1 Li + energy.
D) 6 H $\Rightarrow$ 1 He + energy.
E) 4 H $\Rightarrow$ 4 He + energy.

23) What happens to energy in the convection zone of the Sun? 23) _____

A) Energy is transported outward by the rising of hot plasma and the sinking of cooler plasma.
B) Energy is consumed in the convection zone by the creation of electrons and positrons.
C) Energy is conserved so while the gas moves up and down, there is no net transport of energy.
D) Energy slowly leaks outward through the diffusion of photons that repeatedly bounce off ions and electrons.
E) Energy is produced in the convection zone by nuclear fusion.

24) What is the *solar wind*? 24) _____

A) the strong wind that blows sunspots around on the surface of the Sun
B) a stream of charged particles flowing outward from the surface of the Sun
C) the uppermost layer of the Sun, lying just above the corona
D) the wind that causes huge arcs of gas to rise above the Sun's surface

25) A star's *luminosity* is the 25) _____

A) lifetime of the star.
B) apparent brightness of the star in our sky.
C) surface temperature of the star.
D) total amount of light that the star will radiate over its entire lifetime.
E) total amount of light that the star radiates each second.

26) What are the standard units for apparent brightness or flux? 26) _____

A) watts
B) joules
C) watts per square meter
D) watts per second
E) Newtons

27) If the distance between us and a star is doubled, with everything else remaining the same, the luminosity 27) _____

A) remains the same, but the apparent brightness is decreased by a factor of four.
B) is decreased by a factor of four, and the apparent brightness is decreased by a factor of four.
C) remains the same, but the apparent brightness is decreased by a factor of two.
D) is decreased by a factor of four, but the apparent brightness remains the same.
E) is decreased by a factor of two, and the apparent brightness is decreased by a factor of two.

28) Which of the following correctly states the luminosity–distance formula? 28) _____

A) $\text{distance} = \dfrac{\text{luminosity}}{4\pi \times (\text{apparent brightness})^2}$

B) $\text{luminosity} = \dfrac{\text{apparent brightness}}{4\pi \times (\text{distance})^2}$

C) $\text{apparent brightness} = \text{luminosity} \times 4\pi \times (\text{distance})^2$

D) $\text{apparent brightness} = \dfrac{\text{luminosity}}{4\pi \times (\text{distance})^2}$

29) The spectral sequence sorts stars according to 29) _____

A) mass.
B) radius.
C) core temperature.
D) luminosity.
E) surface temperature.

30) The spectral sequence in order of decreasing temperature is 30) _____

A) OBAGFKM.
B) OFBAGKM.
C) ABFGKMO.
D) BAGFKMO.
E) OBAFGKM.

31) Which of the following statements about spectral types of stars is *true*? 31) _____

A) The spectral type of a star can be used to determine its surface temperature.
B) A star with spectral type F2 is hotter than a star with spectral type F3.
C) A star with spectral type A is cooler than a star with spectral type B.
D) The spectral type of a star can be used to determine its color.
E) All of the above are true.

32) Suppose you see two main-sequence stars of the *same spectral type*. Star 1 is dimmer in apparent brightness than Star 2 by a factor of 100. What can you conclude? (Neglect any effects that might be caused by interstellar dust and gas.) 32) _____

A) Without first knowing the distances to these stars, you cannot draw any conclusions about how their true luminosities compare to each other.
B) The luminosity of Star 1 is a factor of 100 less than the luminosity of Star 2.
C) Star 1 is 10 times more distant than Star 2.
D) Star 1 is 100 times more distant than Star 2.
E) Star 1 is 100 times nearer than Star 2.

33) Which of the following best describes the axes of a Hertzsprung–Russell (H–R) diagram? 33) _____

A) surface temperature on the horizontal axis and radius on the vertical axis
B) mass on the horizontal axis and luminosity on the vertical axis
C) interior temperature on the horizontal axis and mass on the vertical axis
D) surface temperature on the horizontal axis and luminosity on the vertical axis
E) mass on the horizontal axis and stellar age on the vertical axis

34) On a Hertzsprung–Russell diagram, where would we find stars that are cool and dim? 34) _____

A) upper right B) lower right C) upper left D) lower left

35) On a Hertzsprung–Russell diagram, where would we find stars that are cool and luminous? 35) _____

A) upper right B) lower right C) upper left D) lower left

36) On a Hertzsprung–Russell diagram, where would we find stars that have the largest radii? 36) _____

A) upper right B) lower right C) upper left D) lower left

37) On a Hertzsprung–Russell diagram, where on the main sequence would we find stars that have the greatest mass? 37) _____

A) upper right B) lower right C) upper left D) lower left

38) On a Hertzsprung–Russell diagram, where would we find red giant stars? 38) _____

A) upper right B) lower right C) upper left D) lower left

39) On a Hertzsprung–Russell diagram, where would we find white dwarfs? 39) _____

A) upper right B) lower right C) upper left D) lower left

40) You observe a star in the disk of the Milky Way, and you want to plot the star on an H–R diagram. You will need to determine all of the following, *except* the 40) _____

A) apparent brightness of the star in our sky.
B) rotation rate of the star.
C) spectral type of the star.
D) distance to the star.

41) Where do we find our star on the H–R diagram? 41) _____

A) On the lower left B) In the middle of the main sequence
C) On the far left of the main sequence D) With the red giants