How long does it take light to travel from the Moon to the Earth, a distance of 384,000km?

time = distance/speed (note the units work out to be units of time)

= 384,000km/300,000 km/sec

= 384/300 seconds

A source emits infrared radiation at a wavelength of 1060×10^{-9} m. What is the frequency of this radiation?

frequency=speed/wavelength = (300,000km/sec x 1000m/1km)/(1060×10^{-9} m)

= (3×10^{8} m/s)/(1060×10^{-9}m)

= $3/1060 \times 10^{17}$ 1/s

The reason we experience different seasons is:

____ The Earth's orbit around the Sun is an ellipse so sometimes we are closer to the Sun (summer in Santa Cruz) and sometimes further from the Sun (winter in Santa Cruz)
____ The Earth spins on its axis
__X__ The spin axis of the Earth around its center is tilted with respect to the orbital axis of the Earth around the Sun
____ The gravitation attraction of the moon changes throughout the year

What color would a yellow banana slug appear if it is illuminated with white light?

Yellow

Suppose the particles in the Earth's atmosphere scattered red light effectively, but not blue light. Which of the following would be true, which false?

____ The daylight sky looking away from the Sun would be black
__X__ The Sun would appear bluer than it does with our current atmosphere
____ The Greenhouse effect would no longer act to heat the Earth's atmosphere
____ At sunset the Sun's apparent color would be no different than the noontime Sun

For a 2900K object, at what wavelength is the peak of the Plank radiation curve? λ_{max}(cm)=0.29/2900

At what time does the new moon rise? Draw a figure to demonstrate your answer.

at Sunrise

Sun moon Earth

Suppose you have a solid gold sphere and a solid silver sphere each at a temperature of 3000K. Label the following statements True(T) or False(F).

__**X**__ The two spheres would have identical spectra

____ Both spheres would show identical absorption-line spectra

____ Both spheres would show continuous spectra with the silver sphere spectrum peaking at a shorter wavelength

____ The spheres would show different absorption-line spectra

Star A has twice the trigonometric parallax and twice the luminosity of Star B (assume no dust toward either star).

a) What is the relative distance of the two stars?

Star A is at ½ the distance of Star B

b) What is the relative brightness of the two stars?

Star B will be $(1/2)^2$=1/4 as bright because it is twice as far away and it will be ½ as bright because it is half the luminosity so in total it will be ¼ x ½ =1/8 as bright as Star A

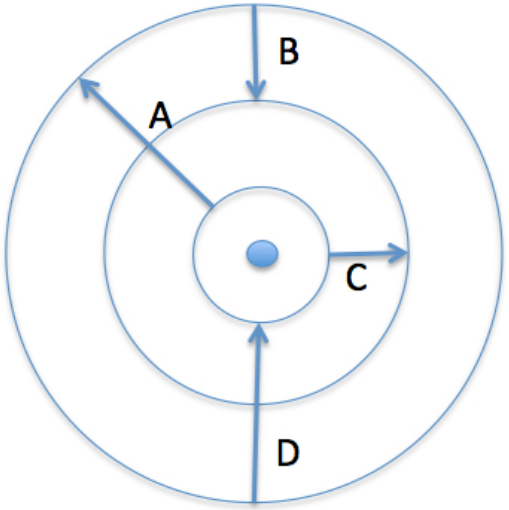
Based on the schematic diagram below of the allowed energy levels in an atom:

__**A,C**__ Which transition(s) correspond(s) to the absorption of a photo?

__B__ Which transition corresponds to the lowest energy photon emitted?

__D__ Which transition corresponds to the shortest wavelength photon emitted?

__B__ Which transition corresponds to the lowest frequency photon emitted?



1. **The Sun will eventually become which of the following (you can select more than one with a check mark)?**

___a neutron star

___a $0.6M_{Sun}$ main-sequence star

___a SNII

__X__a white dwarf

2. **In the fusion of three helium^4 nuclei into a carbon^{12} nucleus, 1.3×10^{-28} grams of matter is converted into energy. How much energy (in ergs) does this amount of matter produce?**

$E=mc^2=1.3 \times 10^{-28}$ g x $(3 \times 10^{10}$ cm/sec$)^2 = (1.3 \times 3^2) \times 10^{(-28+20)}=(1.3x9)x10^{-8}$ ergs

3. **What element would result from adding 10 neutrons to $^{56}_{26}$Fe and then having 2 of the neutrons "β-decay" (that is, eject an electron each)? Give the full designation including element name, number of protons and total number of nucleons in the nucleus.**

10 n addition gives $^{66}Fe_{26}$; 2 beta decays converts two n to p^+ so end up with $^{66}Ni_{28}$

4. **Which of the following statements are true (T) and which false (F) regarding the formation of elements heavier than iron (Fe)?**

__X__Most are made by the addition of neutrons to existing nuclei

___Most are made by the fusion of lighter elements with Fe

__X__Most are made by the S-process and R-process

___Most are made by fission reactions involving Uranium and other rare-earth elements

5. **Label the following True (T) or False (F)**

__T__Stars with less mass than the Sun have lower temperatures in their cores

__T__The reason main-sequence stars do not collapse due to gravity is the thermal pressure of the gases they are composed of

__T__The fuel that provides the energy source for main-sequence stars is mass

__T__A star that is not in hydrostatic equilibrium will react by changing its radius

6. **How much mass does the Sun lose per day in producing its luminosity?**

Mass/second: $m=L/c^2=(4\times10^{33}\text{ergs/sec})/(3\times10^{10}\text{cm/sec})^2=4/9\times10^{13}$ grams/sec

$=4/9\times10^{13}$g/s x 60s/minute x 60m/hour x 24hr/day

7. **Which of the following are part of the scenario for SNI?**

X Mass transfer from a close companion onto a white dwarf.

___A star with 8 or more times the mass of the Sun produces elements up through Uranium then explodes.

X The collapse of a white dwarf whose mass exceeds $1.4M_\odot$.

___The Fe core of a massive star reaches the Chandrasekar limit.

8. **For the standard model of a SN II that results from core-collapse of a massive star, which of the following are predicted? (indicate with check marks)**

X a debris cloud expanding at 10,000 - 20,000km/sec

X a debris cloud enriched in elements up to Fe

X a rapidly-spinning neutron star

X association with star formation regions

9. **Given that hydrogen fusion produces 10^{18} ergs per gram of hydrogen (make sure you put the right units in the answer):**

A. How much energy can the Sun produce with the 2×10^{32} grams of hydrogen in the core region where it is hot enough for fusion?

2×10^{32} grams x 10^{18} ergs/gram = 2×10^{50} ergs

B. How long could the Sun produce energy via this mechanism at its luminosity of 4×10^{33} ergs/second?

$(2\times10^{50}\text{ ergs})/(4\times10^{33}\text{ ergs/second})=0.5\times10^{17}$ seconds

10. **Calculate the spin rate of a neutron star assuming it forms from the collapse of the Fe core of a 25 solar mass star. The original core was spinning at 1 revolution per day and had a radius of 500,000km. The final radius of the neutron star is 10km.**

1. Which of the following are predictions of Special or General Relativity?

_X_ If you are in a spaceship moving at 0.9 the speed of light and shine a flashlight in the direction of travel, you will measure the speed of the light beam to be c ($3x10^8$ m/sec).

_X_ Mass creates "warps" in the space-time fabric of the universe

___ Time reverses as an object approaches the speed of light

_X_ The clock in a spaceship traveling at a high velocity with respect to the Earth will run more slowly than a clock on Earth

2. Which of the following are observed galaxy types (select with an X)?

_X_ dwarf galaxies with mass less than 1/100 that of the Galaxy

_X_ giant elliptical galaxies composed of old stars

___ galaxies dominated by supernovae resulting in significantly higher abundances of elements

_X_ galaxies with bright emission at their cores from supermassive black holes accreting matter

3. If the Sun could be compressed to a small enough radius, it would become a black hole. What is that critical radius in km?

V_{escape}=SQRT(2xMxG/R)

R_{sch}=(2xMxG)/c^2

$R_{sch} = (2 \times 2 \times 10^{30} \times 6.673 \times 10^{-11})/(3 \times 10^8)^2$ (all meters, kg and seconds)

4. Which of the following are observations that have led us to believe there is a supermassive black hole at the center of the Galaxy?

___ the complete lack of electromagnetic radiation in the central parsec of the Galaxy

_X_ orbits of stars near the center of the Galaxy

___ the regular disappearance of stars near the center of the Galaxy

___ the orbits of stars beyond the Sun in the Galaxy are much higher than expected

5. **Which of the following are True (T) and which False (F) in describing an event horizon?**

T It is the distance from a singularity where the escape velocity is the speed of light

___ It is the extent of the gravitational influence of a black hole

___ Only black holes that are $10M_{Sun}$ or larger have an event horizon

T The size of the event horizon of a black hole increases as mass is added to the black hole

6. **Which of the following are components of the Milky Way Galaxy?**

X Rotating, flattened disk containing stars, gas and dust

X 4×10^6 M_{Sun} Black Hole at the center

X Extended, low-density spherical halo with stars and globular clusters

X A dark matter halo

7. **What is the evidence for a dark matter component of the Galaxy?**

___ Planets in the outer solar system orbit the Sun at larger and larger speeds

___ gravitational lens experiments have demonstrated a population of black holes in the Galactic bulge

X the "rotation curve" of the Galaxy is flat: stars in the outer parts of the Galactic disk orbit faster tha expected based on the stars and gas seen inside their orbits

___ Galaxies at increasing distances have larger recessional velocities

8. **Which of the following statements are true (T) and which false (F) regarding the era of nucleosynthesis in first 30 seconds of the Big Bang?**

T Only H, He and trace amounts of Be and Li were formed

___ Elements through Fe were produced, but the energetic photon field disintegrated the heavy elements back to Hydrogen

T the Big Bang nucleosynthesis ended when the mean temperature of the Universe dropped below the critical value for the fusion of light elements

___ Helium and anti-helium atoms were produced in equal numbers

9. **Suppose Galaxy A is receding from the Earth at twice the rate of Galaxy B. Which galaxy is more distant and by what factor (half credit for the qualitative and half for the quantitative answer)?**

Hubble's Law, velocity is proportional to distance: Galaxy A is twice the distance of Galaxy B

10. **Calculate the escape velocity in meters/second from the surface of the Earth for a hydrogen atom with a mass of 1.66×10^{-27}kg.**

$$V_{escape} = SQRT[(2 \times M_{earth} \times G)/R_{Earth}]$$

1. **Which of the following are true (T) and which false (F) regarding Dark Matter (DM) in the Universe?**

____ DM is invoked to explain the orbits of the planets around the Sun

__T__ DM is a necessary ingredient of models of the formation of large-scale structure in the Universe

____ Most research points to DM being composed of mini Black Holes formed in the early Universe

__T__ DM is invoked to explain how galaxies can be gravitationally bound in large clusters

2. **Which of the following statements are true (T) and which false (F) regarding the large scale distribution of galaxies in the Universe?**

____ galaxies are randomly distributed in space

__T__ galaxies are distributed in clusters and filaments with some regions devoid of galaxies

____ galaxies are almost always seen in close groups in the process of merging

____ galaxies are never seen in close proximity to one another because of the expansion of the Universe

3. **In the spectrum of a distant galaxy the absorption line of hydrogen that in the lab is at a wavelength of 656.3 nm is measured at 856.3 nm.**

a. What is the redshift, z, of this galaxy?

$z = (\lambda_0 - \lambda)/\lambda_0 = 200/656.3$

b. By what factor has the size of the Universe changed since the light left the galaxy?

Scale factor = $1 + z = 1 + 200/656.3$

4. **Which of the following describe the "horizon problem" in cosmology?**

__X__ the cosmic microwave background is at a uniform temperature over the entire sky yet regions separated by large angles would not have been in causal contact in a Universe that had expanded uniformly since the Big Bang

____ we see the same galaxies looking directly forward and directly back because light is curved around the universe which confuses investigations of large-scale structure

____ if the Universe was not spatially flat it would have collapsed back on itself

____ because of the curvature of the Universe we can not see a large part of the observable Universe

5. **Which of the following are true (T) which false (F)?**

____ the total star formation rate in the Universe has been relatively steady since about 1 billion years after the Big Bang

__T__ Quasars were much more common in the period between 1 and 3 billion years after the Big Bang than before or after that time

6. **Which of the following is true of the Cosmic Microwave Background?**

__X__ it originates from radiation that filled the Universe as it cooled to 3000K

____ it is detected in the red and near-infrared part of the spectrum

____ it is the underlying cause of the era of inflation

__X__ it shows variations at the level of one part in 100,000

7. **The theory of cosmic inflation was originally motivated to understand why magnetic monopoles were so rare in the Universe. What other cosmological puzzles does inflation resolve?**

__X__ That we appear to live in a spatially "flat" universe with $\Omega_{total}=1.0$

___ The energy released during the inflationary period that resulted in the formation of the light elements H, He and Li

__X__ The growth of quantum fluctuations during inflation provided the small fluctuations in the cosmic microwave background that were the seeds of galaxy and structure formation

___ Inflation allows us to understand what existed before the Big Bang

3. **Which of the following are true (T), which false (F)?**

___ the merger rate of galaxies has been steadily increasing over time as the Universe expands

__T__ Dark Matter is much more common in the Universe than the type of matter that makes up stars, planets and humans (baryonic matter)

). **Which of the following are consistent with our best current knowledge of the future of the Universe?**

____ the acceleration of the Hubble expansion will cause a re-heating of the Universe

__T__ M31, the Andromeda Galaxy, will collide with the Milky Way Galaxy

__T__ the fraction of mass in in gas will decrease along with the overall star formation rate in the Universe

____ the expansion of the Universe will be reversed by gravity due to normal and dark matter