Astronomy 101 Quiz 34+5 Form Akey

Name: ______________________________

Lab section number: ________________

(In the format “M0**”. See back page; if you get this wrong you may not get your quiz back!)

Contents:

- Question 1: which form do you have?
- Questions 2-11: Quiz 3+4 retake (10 questions)
- Questions 12-21: Quiz 5 (10 questions)

Instructions:

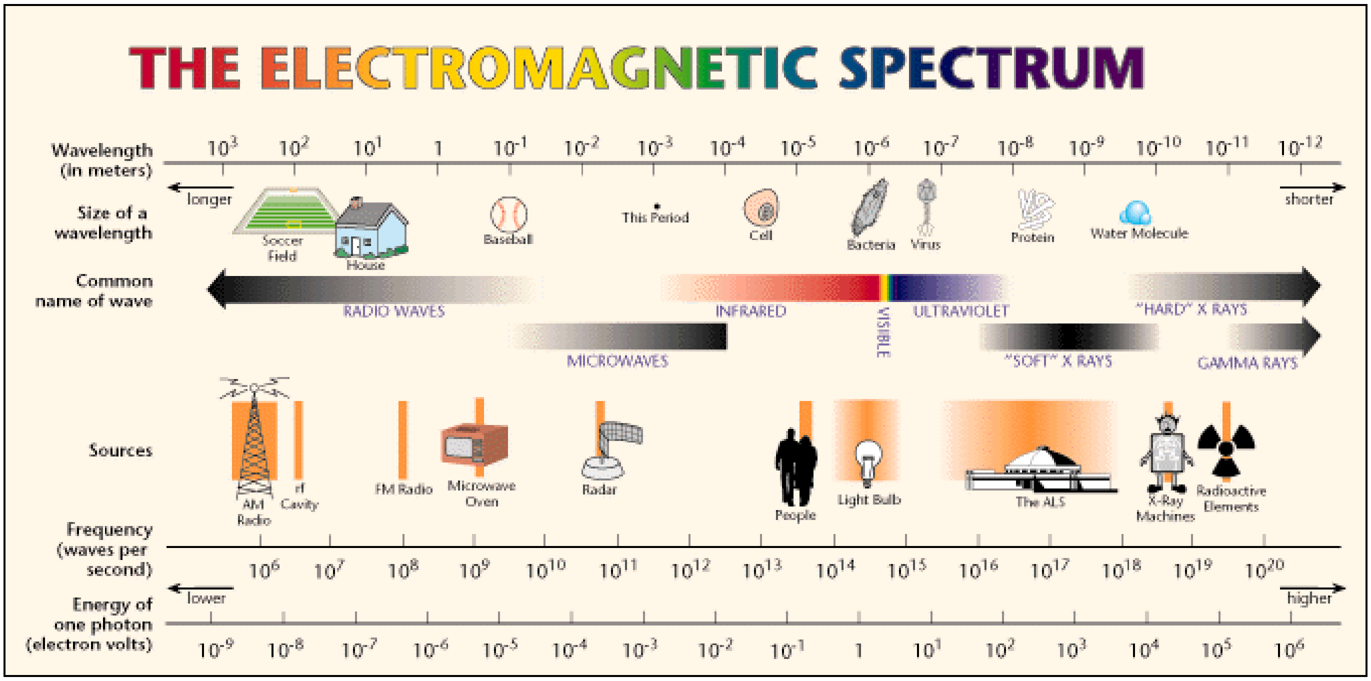
- Quiz time: 45 minutes
- Please put bags under your seats to allow proctors to move around the room.
- There is scratch paper and a blank seasons diagram on the back. You may tear these off.
- You may use notes that you handwrote yourself, or wrote with a stylus and printed, along with your exercises. No electronic devices or things written by others are allowed.
- If you have a question, raise your hand, and a proctor will assist you.
- Do not attempt to communicate with anyone other than teaching staff during the quiz.
- **Circle your answers on this paper as well as completing the Scantron. Turn both in to us at the end of class.**
- **Put your name as “Last First” on your Scantron as well as entering your SUID.**

Good luck!

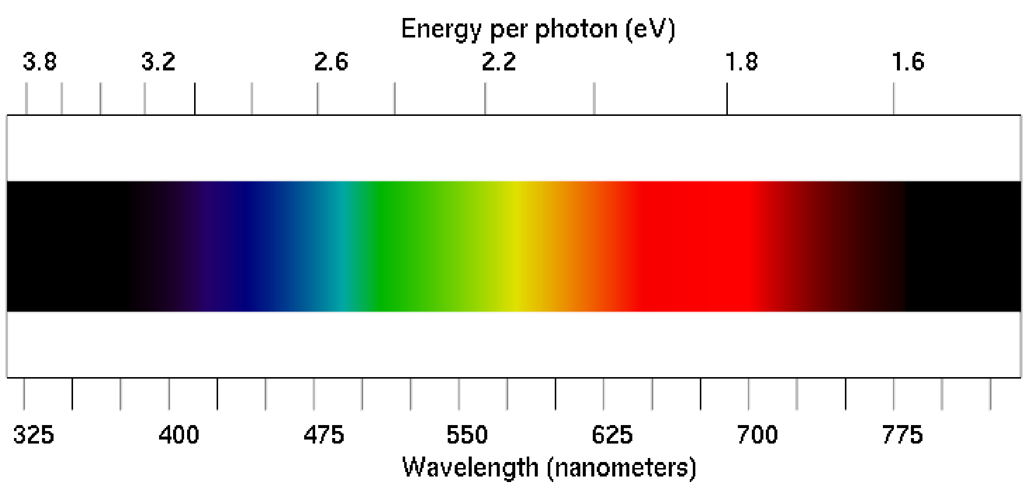
Lab Schedule

Section	Instructor	Time
M024	Sierra Thomas	Monday 8:00 AM-9:20 AM
M003	Sierra Thomas	Monday 9:30 AM-10:50 AM
M004	Kishan Sankharva	Monday 11:00 AM-12:20 PM
M005	Kishan Sankharva	Monday 12:45 PM-2:05 PM
M006	Chad Skerbec	Monday 2:15 PM-3:35 PM
M007	Chad Skerbec	Monday 3:45 PM-5:05 PM
M008	Tyler Hain	Monday 5:15 PM-6:35 PM
M009	Tyler Hain	Monday 6:45 PM-8:05 PM
M010	Vidyesh Rao	Monday 8:15 PM-9:35 PM
M027	Tyler Hain	Tuesday 3:30 PM-4:50 PM
M028	Tyler Hain	Tuesday 5:00 PM-6:20 PM
M029	Vidyesh Rao	Tuesday 6:30 PM-7:50 PM
M030	Vidyesh Rao	Tuesday 8:00 PM-9:20 PM
M025	Sierra Thomas	Wednesday 8:00 AM-9:20 AM
M011	Sierra Thomas	Wednesday 9:30 AM-10:50 AM
M012	Chad Skerbec	Wednesday 11:00 AM-12:20 PM
M013	Chad Skerbec	Wednesday 12:45 PM-2:05 PM
M014	Byron Sleight	Wednesday 2:15 PM-3:35 PM
M015	Byron Sleight	Wednesday 3:45 PM-5:05 PM
M016	Byron Sleight	Wednesday 5:15 PM-6:35 PM
M017	Patrick Adams	Wednesday 6:45 PM-8:05 PM
M018	Patrick Adams	Wednesday 8:15 PM-9:35 PM
M019	Byron Sleight	Thursday 5:00 PM-6:20 PM
M020	Patrick Adams	Thursday 6:30 PM-7:50 PM
M031	Vincent Musso	Thursday 8:00 PM-9:20 PM
M026	Vidyesh Rao	Friday 8:00 AM-9:20 AM
M021	Kishan Sankharva	Friday 9:30 AM-10:50 AM
M022	Vincent Musso	Friday 11:00 AM-12:20 PM
M023	Vincent Musso	Friday 12:45 PM-2:05 PM

Reference



THE ELECTROMAGNETIC SPECTRUM
Wavelength (in meters)
10^{3} 10^{2} 10^{1} 1 10^{-1} 10^{-2} 10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7} 10^{-8} 10^{-9} 10^{-10} 10^{-11} 10^{-12}
longer
shorter
Size of a wavelength
Soccer Field
House
Baseball
This Period
Cell
Bacteria
Virus
Protein
Water Molecule
Common name of wave
RADIO WAVES
INFRARED
VISIBLE
ULTRAVIOLET
"HARD" X RAYS
MICROWAVES
"SOFT" X RAYS
GAMMA RAYS
Sources
AM Radio
rf Cavity
FM Radio
Microwave Oven
Radar
People
Light Bulb
The ALS
X-Ray Machines
Radioactive Elements
Frequency (waves per second)
10^{6} 10^{7} 10^{8} 10^{9} 10^{10} 10^{11} 10^{12} 10^{13} 10^{14} 10^{15} 10^{16} 10^{17} 10^{18} 10^{19} 10^{20}
Energy of one photon (electron volts)
lower
higher
10^{-9} 10^{-8} 10^{-7} 10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2} 10^{-1} 1 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6}



Energy per photon (eV)
3.8 3.2 2.6 2.2 1.8 1.6
325 400 475 550 625 700 775
Wavelength (nanometers)

`(Question formid)`

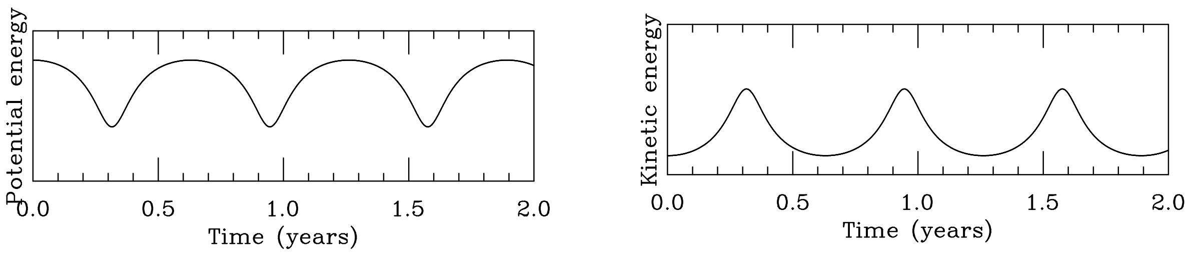
1. What form is your exam? (Your exam is form Akey.)
   - (A) Form A
   - (B) Form B
   - (C) Form C
   - (D) Form D
   - (E) Form E

(Question energy-earth)

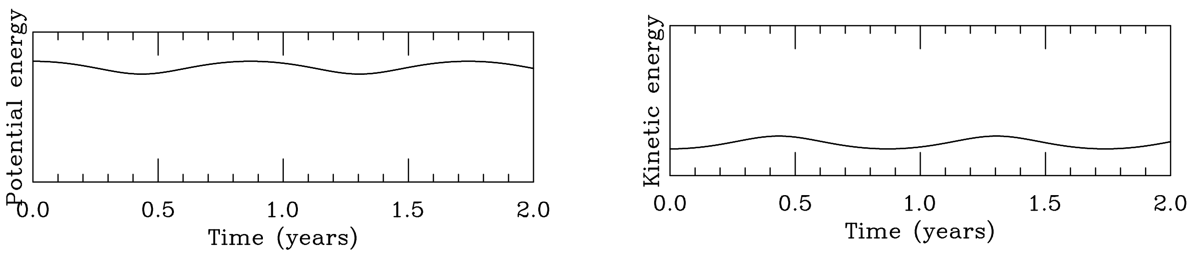
2. Here are some pairs of plots for kinetic and gravitational potential energy. Which one represents the fluctuation of KE and GPE for a planet in a slightly eccentric orbit, like Earth?

   Hint: Examine these plots carefully. You will need to compare the behavior of the kinetic energy with behavior of the potential energy at the same time.

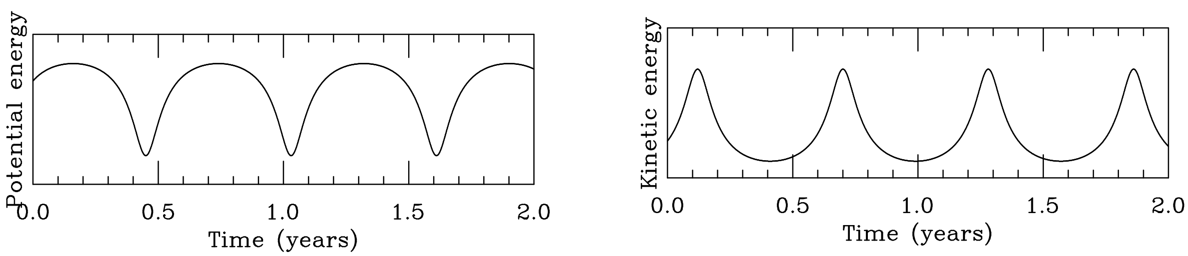
(A)



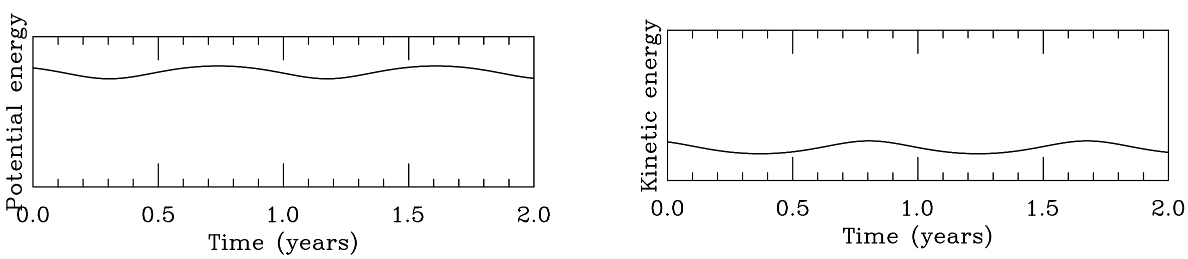
(B)



(C)



(D)



We know two things: (1) The kinetic energy must increase as the potential energy decreases, since energy is conserved; (2) The Earth's orbit is not very eccentric, so those fluctuations must be small.

`(Question moon-mass-change)`

3. Suppose that the mass of the Moon were doubled, without changing the shape of its orbit. Which of the following would happen?

   - I. The gravitational force that the Moon exerts on the Earth would double
   - II. The gravitational force that the Earth exerts on the Moon would double
   - III. The time that it would take to orbit the Earth would double

   (A) Only II
   (B) I, II, and III
   (C) I and III
   (D) **I and II**
   (E) Only I

   The gravitational force is proportional to the product of the masses of the two objects, so increasing the mass of the Moon would both make it apply more force to the Earth and feel more force. However, we know that the time a planet takes to orbit the Sun (or that the Moon takes to orbit the Earth) does not depend on its own mass. This is because the gravitational acceleration imparted to an object does not depend on its own mass: a small rock and a large rock fall at the same rate, and so do a "small Moon" and "large Moon".

`(Question moon-gravity)`

4. The Moon has only about 1/100 the mass of the Earth.
   However, astronauts on the Moon don't experience gravity that is only 1 percent of Earth's; instead, gravity on the Moon's surface is about 15 percent as strong as on Earth's surface. Why is this?

   (A) Because the Earth's gravity provides the other 14 percent
   (B) Because the centrifugal force from the Moon's rotation holds the astronauts down
   (C) Because the Moon is in orbit around the Earth
   (D) **Because the Moon is also smaller than the Earth, meaning that the astronauts are closer to its center**
   (E) Because the Moon is more dense than Earth, and more dense material has stronger gravity

   This is a direct consequence of $F_g = \frac{Gm_1m_2}{r^2}$, since r here is the distance between the two objects' centers. We are further from the Earth's center than an astronaut on the Moon is from its center.

`(Question galileo-empiricism)`

5. Galileo argued that the planets and Earth must orbit the Sun. His arguments were based strongly on direct observations of the sky made through a telescope.

   Which of the properties of science that we have discussed was Galileo exhibiting by basing his arguments about the nature of the Solar System on observations?

   (A) Objectivity
   (B) Universality
   (C) Self-skepticism
   (D) **Empiricism**

   Empiricism is the practice of treating observational and experimental data as the highest authority. This is what Galileo exhibited by founding his arguments on direct observations.

`(Question newtons-laws)`

6. Which of the following is **not** true regarding Newton's laws of motion and gravity? (Or, if all of them are true, choose option E.)

   (A) Newton's laws of motion describe the response of objects to forces that act upon them
   (B) Kepler's laws of orbital motion are a consequence of Newton's laws of motion and gravity
   (C) Newton's laws of motion and gravity apply in space in the same way that they apply on Earth
   (D) When combined with mathematics, Newton's laws of motion and gravity can explain why the planets move in elliptical orbits
   (E) **All of the above are true.**

(Question gravity-cancel)

7. A spacecraft is launched from Earth toward the Moon.

   Note that the Earth's mass is about 81 times greater than the Moon's mass.

   Somewhere between the Earth and the Moon, there is a point where the gravitational forces of the Earth and the Moon on the spacecraft cancel out, since they pull in opposite directions and equal strength. Where is that point?

   (A) **9 times closer to the Moon than to the Earth**
   (B) 9 times closer to the Earth than to the Moon
   (C) 81 times closer to the Earth than to the Moon
   (D) Equally distant from the Earth and the Moon
   (E) 81 times closer to the Moon than to the Earth

   Since the Earth is 81 times more massive than the Moon, the spacecraft must be closer to the Moon for their gravitational forces to be equal. We know that gravitational force is proportional to distance squared. Thus, to balance out 81 times the mass, one must be nine times further away, since $9^2 = 81$.

(Question drop-rock)

8. An astronaut travels to another planet (with no air), holds a rock a meter above the ground, and drops it. Which of the following things affect how long it takes the rock to hit the ground?

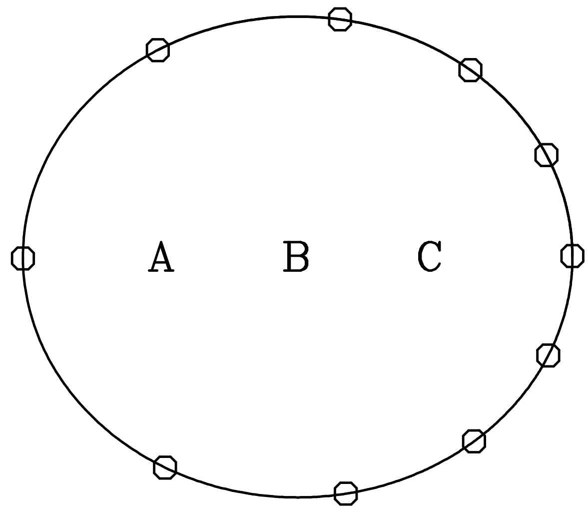
   - I. The mass of the planet
   - II. The mass of the rock
   - III. The size (radius) of the planet

   (A) **I and III**
   (B) I only
   (C) II and III
   (D) I and II
   (E) I, II, and III

   We know that objects of different sizes fall at the same rate. But more massive planets have more gravity and larger planets have less gravity, by $F_g = \frac{GM_{\text{planet}} m_{\text{rock}}}{r^2}$.

(Question sun-location)

9. An asteroid orbits the Sun in an orbit like the one shown below.



This asteroid takes ten months to make one complete orbit. Its position after each month is indicated, *i.e.* the labeled points are located one month apart.

Which position is the correct position of the Sun?

(A) **Position A**
(B) Position B
(C) Position C
(D) There's isn't enough information given to know for sure

The Sun could be at either A or C by the orbital shape alone, since they are the foci of the ellipse. But Kepler's second law says that planets move fastest near the Sun.

`(Question kepler-not-apply)`

10. Which object do Kepler's laws of orbital motion *not* apply to?

    (A) Halley's comet
    (B) Ganymede, one of the moons of Jupiter
    (C) **A spacecraft with a rocket engine that is turned on**
    (D) Earth's Moon
    (E) Kepler's laws of orbital motion apply to all of these

    Kepler's laws of orbital motion apply to anything that is influenced only by the gravity of a central body that it orbits. A rocket has another force acting on it (the rocket's thrust), so it will move in different ways.

`(Question jupiter-mass)`

11. Suppose you wanted to measure the mass of Jupiter by examining its moons. Which of the following things would you need to measure about its moons to determine the mass of Jupiter?

    - I. The time it takes one of the moons to orbit Jupiter
    - II. The mass of one of its moons
    - III. The length of the long axis of one of its moons' orbit

    (A) I and II
    (B) II only
    (C) III only
    (D) **I and III**
    (E) I only

    This is straight out of your lab, where you looked at the time that a star took to orbit the black hole and the length of the long axis of its orbit to determine the black hole's mass. This works for Jupiter too!

(Question types-of-light)

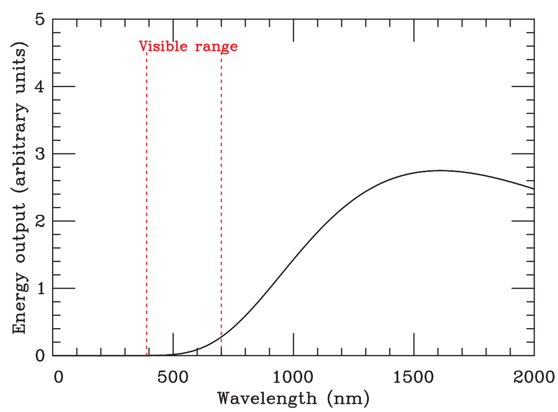
12. Which of the following is not a type of light (as the term is used in astronomy)?

    (A) Infrared
    (B) Ultraviolet
    (C) Microwaves
    (D) Gamma rays
    (E) **All of the above are types of light**

    "Light" refers to the whole electromagnetic spectrum, not just the bits our eye can detect.

(Question 1800k)

13. What kind of object could produce the spectrum shown here?



    (A) A hot asphalt parking lot on a summer day (50° C / 323 K)
    (B) A very hot star, hotter than the Sun
    (C) A living human body
    (D) **A red-hot piece of metal being worked by a blacksmith, heated to 1800 K**
    (E) A star like the Sun

    This spectrum shows a hot object that is radiating a little visible light, but is shifted to longer wavelengths than the Sun. So it is hotter than things around room temperature (like the person or the parking lot) – things must be thousands of degrees before they generate visible light. But it is cooler than the Sun.

`(Question snowman)`

14. Suppose we get one of those famous Syracuse snowstorms, and you build a snowman in the Quad that is about the same size as you and stand next to it.

    Which statement is true?

    (A) You are emitting infrared light, but the snowman is not emitting light
    (B) Neither of you is emitting light
    (C) Both you and the snowman are emitting infrared light; the light coming from you is more intense and has longer wavelength than the light coming from the snowman.
    (D) **Both you and the snowman are emitting infrared light; the light coming from you is more intense and has shorter wavelength than the light coming from the snowman.**
    (E) You are emitting infrared light, and the snowman is emitting ultraviolet light

    The snowman is 273 K (the freezing point of water), while you are 310 K. The key here is that on a relative scale, you and the snowman are not that different. Both of you are thus producing infrared radiation, since you are both "around" room temperature. However, since you are a bit warmer than the snowman, your radiation will be a bit shorter wavelength and a bit more intense.

`(Question rattlesnake-nom)`

15. Rattlesnakes make use of their ability to see infrared light to hunt their prey at night. Which of the following animals is *least* likely to be detected by a hungry diamondback rattlesnake on a dark night in Arizona using its infrared vision?

    Assume that the desert rocks are all brown, that the Moon or other sources of visible light are not present in the sky, and that the temperature at night is 30° C.

    (A) A brown-colored kangaroo rat whose body temperature is 39° C
    (B) A black phainopepla (a kind of American desert bird) whose body temperature is 40° C
    (C) **A blue and yellow lizard whose body temperature is 30° C**
    (D) A grey-colored toad that has just hopped out of cool water, and whose skin is 24° C
    (E) It depends on which critter speaks Parseltongue most fluently

    The rattlesnake only sees infrared light emitted as a result of thermal radiation. There is no visible light; the snake is hunting solely by this infrared light, so color doesn't matter at all. The snake will easily detect an object that is a different temperature than its background, such as the warm kangaroo rat or the cool toad. But the lizard is the same temperature as the rock it sits on, so the snake cannot tell the difference between its thermal radiation and the thermal radiation coming from the object it is standing on. (Any Arizonans out there: yes, a phainopepla wouldn't be hanging out down on the ground at night! But I needed another warm-blooded critter. :))

`(Question evolve-red-star)`

16. Suppose that humans evolved on a planet orbiting a star whose temperature was 3000 K. (The Sun's surface is around 5800 K.)

    What might be true about our eyes if they evolved to make best use of the light provided by this star?

    (A) We might lose the ability to see red light, but might be able to see ultraviolet light
    (B) We might gain the ability to see much longer wavelengths of infrared light (around 10,000 nm), giving us vision like a rattlesnake's, since the star would produce a lot of this light
    (C) We might gain the ability to see X-rays
    (D) **We might lose the ability to see blue light, but might be able to see into the near infrared**
    (E) None of the above would be an evolutionary advantage on this world.

    A star that is a bit cooler than the Sun would emit a spectrum of light that is shifted somewhat to longer wavelengths. It is still much hotter than 300 K, so it wouldn't produce infrared light that is as long-wavelength as what we produce. So rattlesnake-vision wouldn't be helpful. However, this star would produce very little blue light, but a lot more near-infrared.

`(Question skin-cancer)`

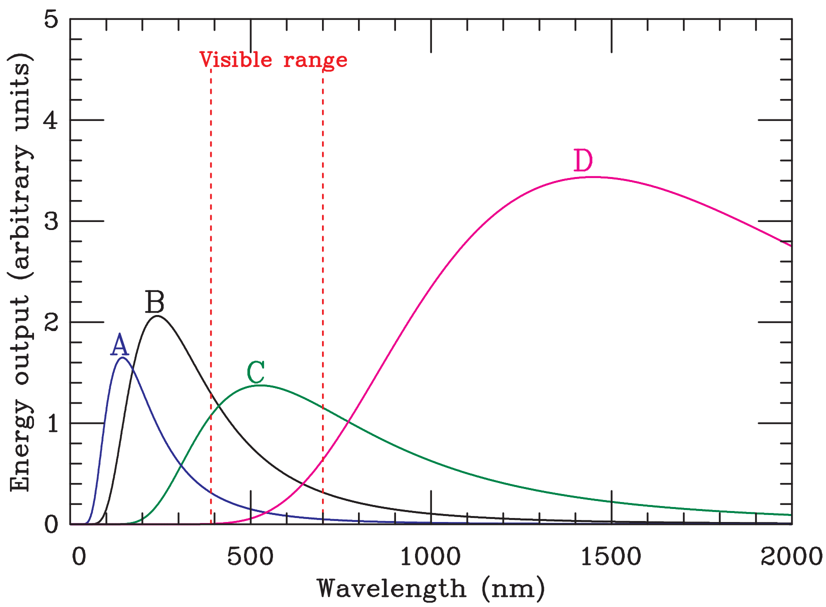
17. Extended exposure to direct sunlight can cause skin cancer in susceptible people. Why is this?

    (A) The Sun's surface is hot enough to generate a great deal of gamma rays; these gamma rays are an invisible component of sunlight that can cause genetic damage by ionizing atoms in cells.
    (B) Sunlight consists of mostly ultraviolet light; it is so intense that it can disrupt the chemical processes in cells
    (C) The Sun produces a great deal of infrared light with extremely long wavelengths; long-wavelength light can travel through the outer layer of skin to alter the structure of DNA in mesothelial cells beneath
    (D) The Sun produces sunlight by nuclear reactions; these nuclear reactions can cause cancer by changing the structure of DNA, much like exposure to radioactive materials found on Earth
    (E) **The individual ultraviolet photons that make up sunlight have enough energy to ionize atoms and change the chemical structure of DNA**

    Ionizing radiation causes genetic damage because single photons have enough energy to disrupt the structure of atoms and molecules that they strike. The intensity is not the issue; it is the energy carried by single photons. Thus infrared isn't important. Nuclear reactions taking place in the Sun don't produce radioactive material nor does that material make its way to Earth, and the Sun doesn't produce gamma rays by thermal radiation (it is not that hot).

(Question fourspectra-brightest-eye)

18. This question and the next two all concern this set of spectra:



(The colors here are purely there to allow you to distinguish the curves, and have no other meaning.) Which of these spectra appears brightest to *the human eye*?

(A) A

(B) B

(C) **C**

(D) D

(E) You can't tell from the information here.

Object C has the largest total amount of radiation in the visible range.

(Question fourspectra-appear-red)

19. In the spectra shown in the previous problem, which object would appear to glow reddish-orange to a human observer?

    (A) Object A
    (B) Object B
    (C) Object C
    (D) **Object D**
    (E) You cannot tell from these spectra

    Object D emits a little bit of visible light, biased toward the long-wavelength end of that spectrum – reddish-orange.

(Question fourspectra-highest-temperature)

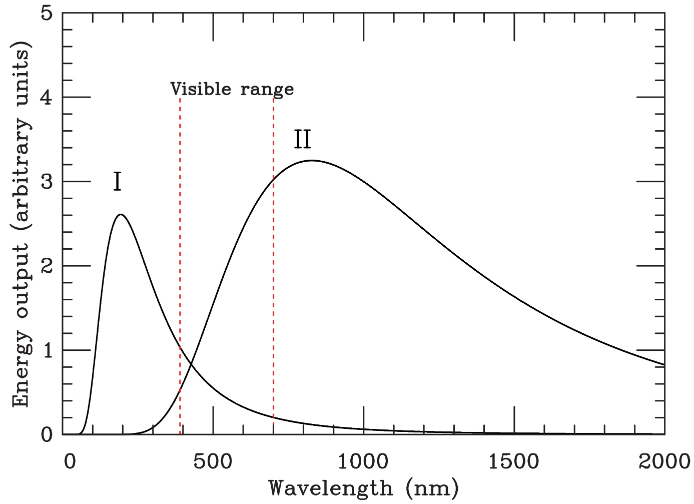
20. Which of these objects has the highest temperature?

    (A) **Object A**
    (B) Object B
    (C) Object C
    (D) Object D
    (E) You cannot tell from the spectra shown

    Object A's peak emission is at the shortest wavelength.

(Question twostars)

21. Two different stars (I and II) give off light with the spectral curves shown here.



What do you conclude about their temperatures and sizes?

(A) Star I is larger, but Star II is hotter

(B) **Star I is hotter, but Star II is larger**

(C) Star I is both hotter and larger

(D) Star II is both hotter and larger

(E) There isn't enough information to determine one of these two things

Star I must be hotter since it emits shorter wavelengths. Since hotter things are normally brighter, the only way for a cool object to match a large object's brightness (in thermal radiation) is to physically be larger.

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