Astronomy 101 Quiz 5+6 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!)

In this quiz, the questions from Unit 5 (thermal radiation) and Unit 6 (light and atoms) are arranged randomly. (Part of the skill we are evaluating is the knowledge of which is which!) So, regardless of your performance on Quiz 5, you should do all twenty questions.

Instructions:

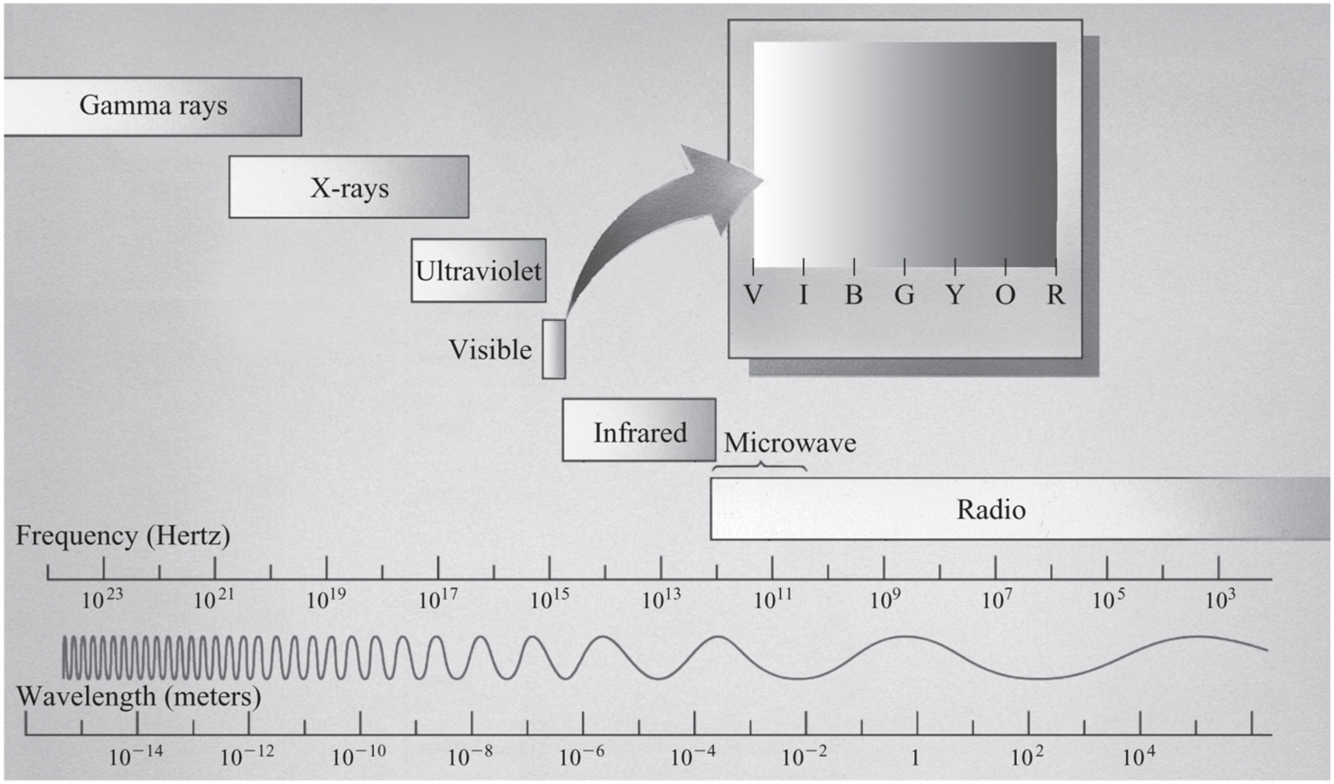
- Quiz time: 45 minutes
- Please put bags under your seats to allow proctors to move around the room.
- There is a reference sheet included behind this page which you will need.
- You may use notes that you handwrote yourself, or wrote with a stylus and printed, along with your exercises and homework. 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!

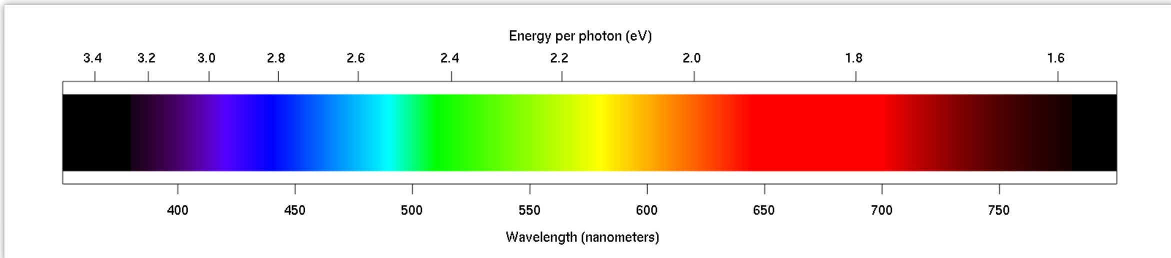
Lab Schedule

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

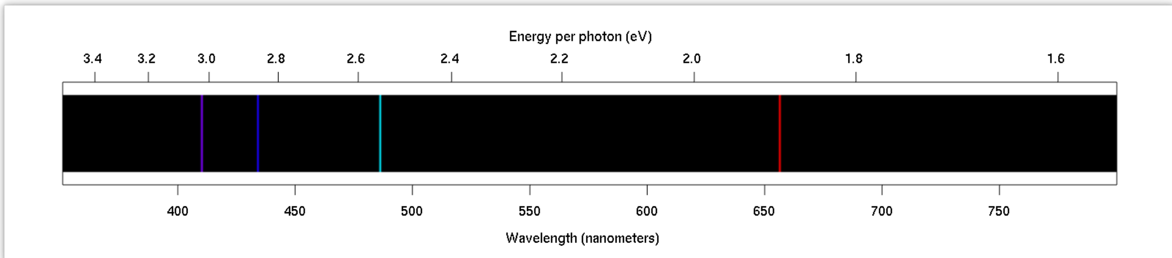
Reference



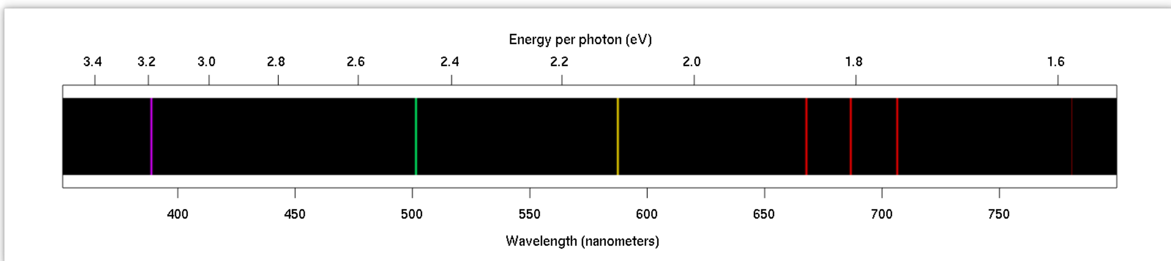
Gamma rays
X-rays
Ultraviolet
Visible
V I B G Y O R
Infrared
Microwave
Radio
Frequency (Hertz)
10^{23} 10^{21} 10^{19} 10^{17} 10^{15} 10^{13} 10^{11} 10^{9} 10^{7} 10^{5} 10^{3}
Wavelength (meters)
10^{-14} 10^{-12} 10^{-10} 10^{-8} 10^{-6} 10^{-4} 10^{-2} 1 10^{2} 10^{4}



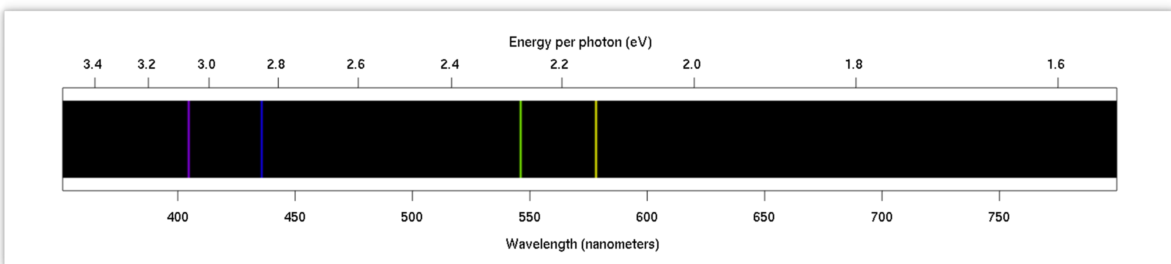
Visible light



Hydrogen



Helium



Mercury

`(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 size-relation)`

2. Two stars are the same size and the same distance away. One is red; the other is blue.

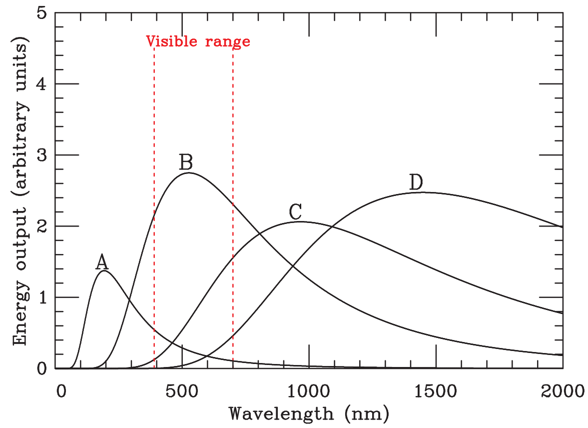
   Which one is brighter? ("Brighter" here refers to the total amount of light produced by the star.)

   (A) You cannot determine this without a spectroscope to examine the spectral lines that appear in their spectra
   (B) The red star
   (C) **The blue star**
   (D) They are the same brightness
   (E) You cannot determine this without additional information about the chemical elements they contain

   The blue star is hotter. Thermal radiation from hotter objects is more intense, so the hotter object is brighter.

(Question fourspectra-blue)

3. Which one of these spectra would appear blue to a human observer?

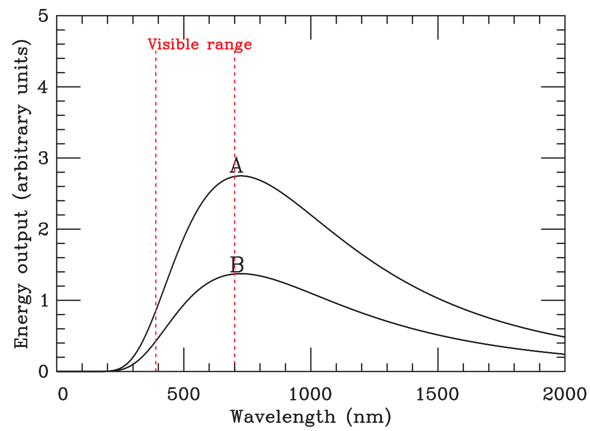


(A) **Spectrum A**
(B) Spectrum B
(C) Spectrum C
(D) Spectrum D
(E) None of them would appear blue to a human observer

The color something appears is based on which wavelengths in the visible spectrum are most prominent. For something to appear blue, it must emit more blue light (short wavelength end of visible) than red light (long wavelength end of visible). Spectrum A is the only one that does this. It generates more UV light than anything, which we cannot see, but within the visible, it emits more blue than red.

`(Question in-common)`

4. Which statement is true about these two spectra?



   (A) They are produced by gases of the same type

   (B) They would appear the same color to a human observer

   (C) They are produced by objects that are the same size

   (D) They are produced by objects that are the same temperature

   (E) **More than one of the above is true**

These are thermal emission spectra. We know that the temperature of an object determines the peak wavelength it emits. Since these two thermal emission spectra have the same peak wavelength, they are created by objects with the same temperature. They also have the same balance between short and long wavelengths, so they would appear the same color.

`(Question red-blue)`

5. Consider a very bright red light and a dim blue light. Which is true?

   (A) The total power emitted by the red light is higher, but photons from both lights have the same energy

   (B) **The total power emitted by the red light is higher, but one photon from the blue light carries more energy**

   (C) The total power emitted by the blue light is higher, but photons from the red light carry more energy

   (D) The total power emitted by both lights in the same, but photons from the red light carry more energy

   (E) None of the above are correct.

Brightness is related to total power. So the red light emits more total power. However, blue photons have more energy than red ones since they are shorter wavelength. (This is on the reference.)

(Question calculate-lines)

6. A hypothetical element Syracusium has energy levels of 0 eV, 5 eV, 7 eV, and 7.5 eV. If you put a diffuse gas of this element in a tube and run electric current through it, what sort of light will come out?

   (A) Photons of energies 0.5 eV, 5 eV, 7 eV, and 7.5 eV

   (B) Visible and infrared photons of a wide range of energies, depending on its temperature

   (C) Photons of all energies up to 7.5 eV

   (D) Photons of energies 5 eV, 2 eV, and 2.5 eV

   (E) **Photons of energies 0.5 eV, 2 eV, 2.5 eV, 5 eV, 7 eV, and 7.5 eV**

   All possible transitions will happen. There are six different results from subtracting the energy levels given: 7.5-7 = 0.5, 7.5-5 = 2.5, 7.5-0 = 7.5, 7-5 = 2, 7-0 = 7, and 5-0 = 5.

(Question stove-burner)

7. Blacksmiths use the visible appearance of the thermal radiation of hot metal to judge its temperature.

   Suppose a metal is heated to the point where its glow is barely visible to the human eye, around 1000 Kelvin. What type of light is it mostly emitting?

   (A) White light

   (B) Blue light

   (C) Red light

   (D) Ultraviolet light

   (E) **Infrared light**

   If it is just barely emitting a little bit of red light, most of its emission would still be in the near infrared.

`(Question star-temperature)`

8. Two stars, Star X and Star Y, are the same color and size. However, Star X has more dark lines in its spectrum. Which star has the higher temperature?

   (A) We don't know, since the dark lines contain colors the human eye can't see

   (B) **They are both the same temperature**

   (C) Star X is hotter

   (D) Star Y is hotter

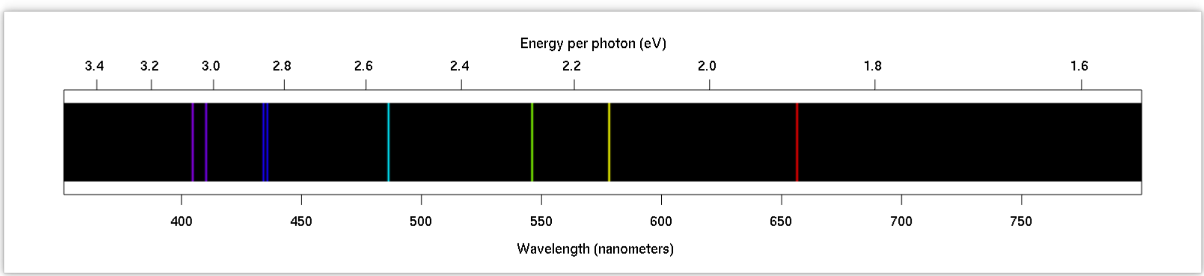
   (E) There is not enough information to figure out the answer

   A star's color is determined by the peak wavelength of its thermal radiation, which directly depends on its temperature.

`(Question broken-bulb)`

9. A mixup has happened in a fluorescent light factory with the gas supply. They now have lots of unlabeled gas discharge tubes. Even worse, some of them may contain mixtures of several different gases.

   You are sent in with a spectrometer and a set of reference spectra (included with your exam) to figure out which is which. You see the following spectrum from the first tube you look at:



   What is in this tube? Consult the reference spectra provided with your exam.

   (A) Hydrogen and helium

   (B) Helium and mercury

   (C) **Hydrogen and mercury**

   (D) Only mercury

   (E) Another element not listed here

   The lines shown here are a combination of the lines from hydrogen and mercury.

`(Question sun-discover)`

10. In the 1800's, astronomers noticed spectral lines in the Sun that did not correspond to any of the known chemical elements. They concluded that this was a new element; a few decades later, it was first isolated on Earth. Which element is this?

    (A) Sodium
    (B) Solarium
    (C) Argon
    (D) Uranium
    (E) **Helium**

    This is the story of the discovery of helium, a story we told in class.

`(Question star-know-temperature)`

11. How can astronomers best determine the temperature of stars near us in the Milky Way?

    (A) **By looking at the peak wavelength at which they emit light (or, equivalently, their color)**
    (B) By examining them with a thermal camera similar to the ones we used in class/lab
    (C) By looking at the location of the thin bright lines that appear in their spectra
    (D) By looking at the location of the thin dark lines that appear in their spectra
    (E) None of the above would allow us to measure the temperature of a star

    The peak wavelength of thermal radiation tells you the temperature.

`(Question star-know-composition)`

12. How can astronomers best determine what chemical elements are present in the outer layer of stars?

    (A) By examining the energies of the neutrinos produced in nuclear reactions in their core
    (B) By examining the peak wavelength at which they emit light (equivalently, their color)
    (C) **By examining the locations of the thin dark lines that appear in their spectra**
    (D) By determining their age, and thus the elements they are producing with nuclear fusion
    (E) By examining the amount of light they produce in total

    The hot inner core of a star produces light of all colors. The elements in the outer layers of stars absorb photons corresponding to their energy level transitions. These colors are thus missing in the light that leaves the star.

`(Question neon-light)`

13. Suppose you work for a shop on Marshall Street, and the store owner tells you that they've bought a new blue neon sign: "Everyone else's neon signs are red, but I have a fancy blue one!"

    What would you say to the shop owner?

    (A) "Be careful with the ultraviolet coming from that thing; you don't want to get a sunburn"
    (B) "The stuff inside must be really hot; I hope it doesn't melt the glass"
    (C) "That's beautifully-colored glass"
    (D) "The energy levels in that type of neon must be very far apart"
    (E) **"Uh, I don't think that's neon..."**

    As you saw in lab, different elements make different colors. It is a common fallacy to call them all "neon" lights.
    Neon cannot produce blue light using colored glass. Blue glass blocks all light except for blue, but there are no blue emission lines in neon. So neon viewed through blue glass would look black.

`(Question blacklight)`

14. Suppose that a particular element has its first four energy levels of 0 eV, 3 eV, 5.2 eV, and 7 eV. You have a sample of this element at room temperature, so almost all of its atoms are initially in their ground state.

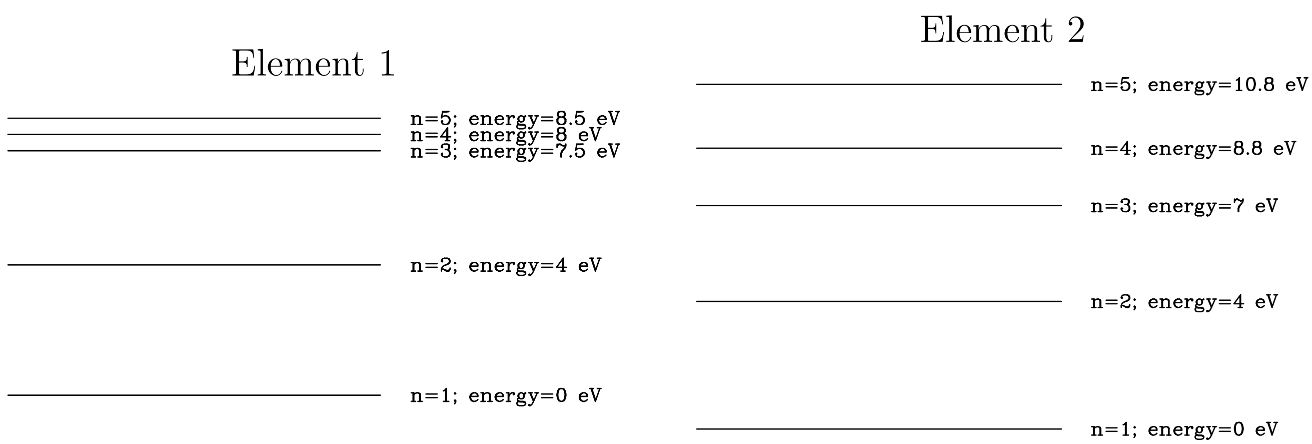
    If you illuminate it with ultraviolet light whose photons have 5.2 eV of energy while looking at it with a handheld spectroscope, what will you see? *(Reference the mapping of photon energy to color included with your exam.)*

    (A) **One bright blue/violet line and one bright yellow/green line**
    (B) Nothing, because you can't see ultraviolet light of that energy
    (C) One bright blue/violet line
    (D) One bright blue/violet line, one bright yellow/green line, and one bright red line
    (E) A continuous band of color, like a rainbow

    The atoms will absorb the 5.2 eV photons and transition to the third energy level. In transitioning back to the ground state, they will make two jumps of 2.2 eV (yellow-green) and 3 eV (blue/violet).

(Question lightbulb-design)

15. You are put in charge of designing a new sort of fluorescent light bulb, and have to choose what sort of gas to put inside. A chemist presents you with two options. *(A fluorescent light bulb is one that produces light from atomic energy level transitions, like the discharge tubes you used in lab.)*



Are either of these gases suitable for use by humans? *(The visible range is 1.6 eV - 3.2 eV.)*

(A) **Element 2 is suitable, but Element 1 is not**

(B) Both elements are suitable to use in a fluorescent light bulb

(C) Neither element is suitable to use in a fluorescent light bulb

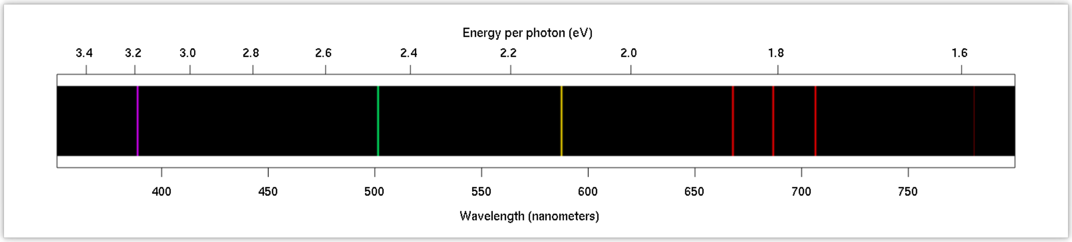
(D) Element 1 is suitable, but Element 2 is not

(E) Either element could be suitable, depending on the temperature that they are heated to

Element 1 has no transitions in the visible range, but Element 2 does. Thus, Element 2 is suitable for making a fluorescent lightbulb that produces light that humans can see.

(Question what-source)

16. What sort of object would produce a spectrum that looks like this?

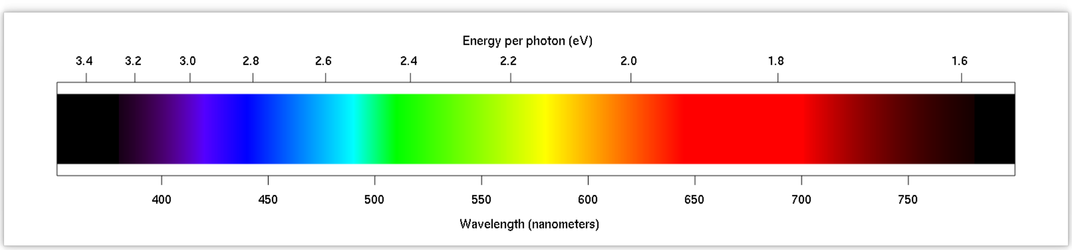


(A) **A diffuse gas in an electrified tube, such as the ones you used in lab**
(B) A hot object heated to thousands of degrees
(C) A hot object heated to thousands of degrees, seen through the atmosphere of a planet or star
(D) Reflected light from the wall of a room that was lit by a mixture of incandescent and fluorescent lamps
(E) None of the above

This is an emission spectrum: a few thin bright lines. (It's helium, but that doesn't matter for this problem.)

(Question what-source-2)

17. What sort of object would produce a spectrum that looks like this?

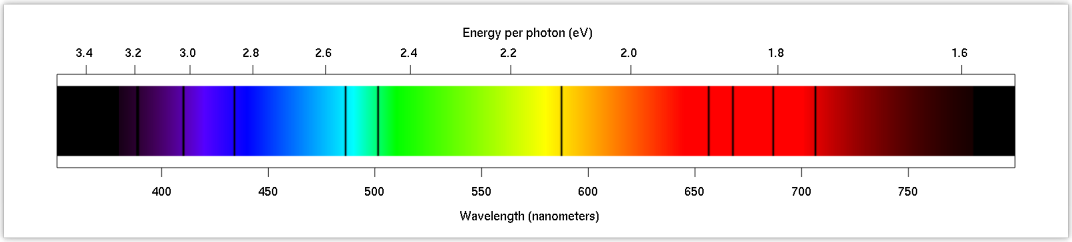


(A) **A hot object heated to thousands of degrees**
(B) Reflected light from the wall of a room that was lit by a mixture of incandescent and fluorescent lamps
(C) A diffuse gas in an electrified tube, such as the ones you used in lab
(D) A hot object heated to thousands of degrees, seen through the atmosphere of a planet or star
(E) None of the above

This is a continuous spectrum without features: a thermal radiation spectrum. It contains a lot of visible light, so it is thousands of degrees.

(Question what-source-3)

18. What sort of object would produce a spectrum that looks like this?



(A) A diffuse gas in an electrified tube, such as the ones you used in lab

(B) **A hot object heated to thousands of degrees, seen through the atmosphere of a planet or star**

(C) Reflected light from the wall of a room that was lit by a mixture of incandescent and fluorescent lamps

(D) A hot object heated to thousands of degrees

(E) None of the above

This is an absorption spectrum: a continuous spectrum from a hot object with some dark lines that correspond to wavelengths absorbed by gas in the way, as from the atmosphere of a star.

(Question fusion-earth)

19. Why don't humans use nuclear fusion, as in the Sun, as an energy source on Earth?

(A) Because there is nothing on Earth that is suitable fuel for nuclear fusion; only stars have the needed raw materials

(B) Because nuclear fusion is an inefficient energy source and doesn't produce much energy per ton of fuel

(C) **Because it requires temperatures of millions of degrees to produce, and containing these temperatures is a difficult engineering challenge**

(D) Because nuclear fusion produces highly radioactive byproducts that are difficult to store safely

It takes a tremendous amount of heat and pressure to stick hydrogen atoms together to make helium – millions of degrees. On Earth, other than in a few extremely exotic research machines that use far more power than they produce via fusion, the only way to achieve these temperatures and pressures is next to a detonating fission bomb... not exactly a good thing to put in a power plant!

`(Question star-cool)`

20. Suppose that the Sun were to cool down from its current temperature to 3000 K, while keeping its size and chemical composition the same.

    Which of the following would be true?

    (A) **The position of the dark lines in its spectrum would stay the same**
    (B) Its color would stay the same
    (C) Its brightness would stay the same
    (D) The peak wavelength of sunlight would stay the same
    (E) Either none of the above are true, or more than one is

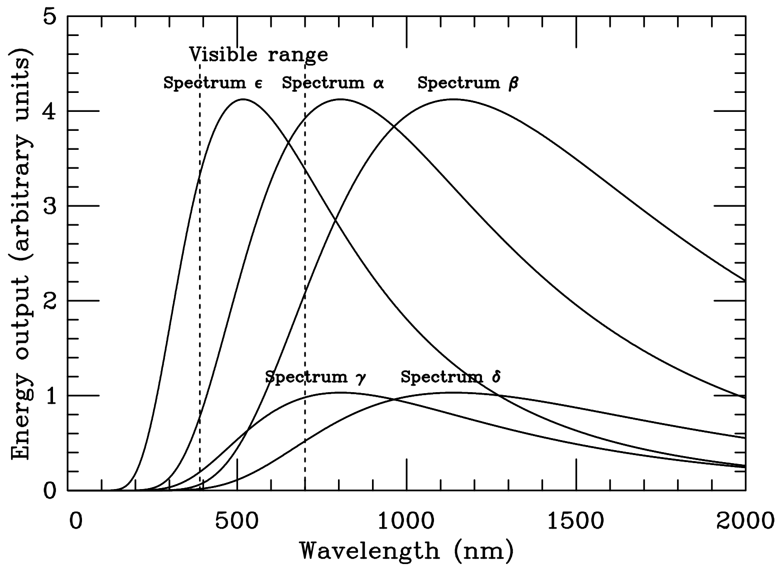
    If the Sun were to cool down, it would get redder and dimmer, and the peak wavelength of its emission would become longer ("get redder"). However, since the positions of the spectral lines are dependent on its chemical composition, and this wouldn't change, they wouldn't move.

(Question cooling-carbon)

21. You heat a block of carbon up to 3600 K. When you do this, it emits thermal radiation corresponding to Spectrum α.

    You then allow the block to cool. After a while, it has cooled down to 2500 K.

    Which spectrum corresponds to the light emitted by the block of carbon after it cools down? *(Nothing has changed about the block other than its temperature.)*



(A) Spectrum γ

(B) Spectrum β

(C) **Spectrum** δ

(D) Spectrum ϵ

(E) None of the above are correct.

The block of carbon will get dimmer as it cools, and its emission will shift to longer wavelengths ("become redder"). Thus the curve will shift downward (dimmer) and to the right (redder).

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