Astronomy 101 Exam 3 Form A

Name: _____

Lab section number: _____

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

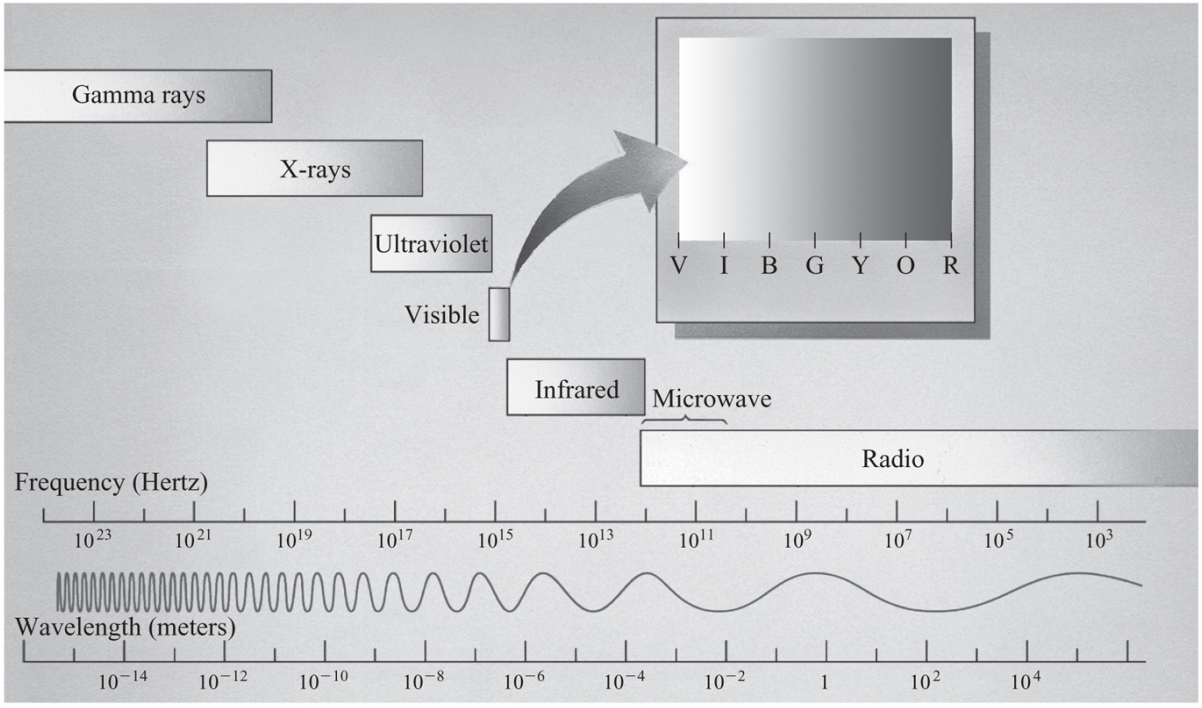
- Exam time: one hour and twenty minutes
- Please put bags under your seats to allow proctors to move around the room.
- Please choose the **best** answer to each question.
- You may use only pencils and pens for this exam; no notes, **or cellphones** are allowed. You do not need a calculator; this exam requires no complicated calculations.
- 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 exam.

Good luck!

Lab Schedule

Day	Time	Section	Instructor
Monday	8:00-9:20 AM	M024	Scott Bassler
Monday	9:30-10:50 AM	M003	Scott Bassler
Monday	11:00 AM - 12:20 PM	M004	Lindsay DeMarchi
Monday	12:45-2:05 PM	M005	Lindsay DeMarchi
Monday	2:15-3:35 PM	M006	Jiaxin Sun
Monday	3:45-5:05 PM	M007	Jiaxin Sun
Monday	5:15-6:35 PM	M008	Manu Mannattil
Monday	6:45-8:05 PM	M009	Manu Mannattil
Monday	8:15-9:35 PM	M010	Manu Mannattil
Tuesday	3:30-4:50 PM	M027	Scott Bassler
Tuesday	5:00-6:20 PM	M028	Scott Bassler
Tuesday	6:30-7:50 PM	M029	Ohana Benevides Rodrigues
Tuesday	8:00-9:20 PM	M030	Ohana Benevides Rodrigues
Wednesday	8:00-9:20 AM	M025	Manu Mannattil
Wednesday	9:30-10:50 AM	M011	Manu Mannattil
Wednesday	11:00 AM - 12:20 PM	M012	Ohana Benevides Rodrigues
Wednesday	12:45-2:05 PM	M013	Ohana Benevides Rodrigues
Wednesday	2:15-3:35 PM	M014	Ohana Benevides Rodrigues
Wednesday	3:45-5:05 PM	M015	Nouman Butt
Wednesday	5:15-6:35 PM	M016	Nouman Butt
Wednesday	6:45-8:05 PM	M017	Jiaxin Sun
Wednesday	8:15-9:35 PM	M018	Jiaxin Sun
Thursday	5:00-6:20 PM	M019	Lindsay DeMarchi
Thursday	6:30-7:50 PM	M020	Lindsay DeMarchi
Thursday	8:00-9:20 PM	M031	Lindsay DeMarchi
Friday	8:00-9:20 AM	M026	Nouman Butt
Friday	9:30-10:50 AM	M021	Nouman Butt
Friday	11:00 AM - 12:20 PM	M022	Nouman Butt
Friday	12:45-2:05 PM	M023	Jiaxin Sun

Reference



1. You discover a star whose spectrum resembles our Sun's, but without many of the dark lines its spectrum. What is true about this star? *(Thanks to Yanxi for the question!)*

   (A) This star has a lot in common with our Sun

   (B) There are not many different elements in this star

   (C) There are many different elements in this star

   (D) This star is hotter than our Sun

2. A certain rock is observed to emit visible light when it is illuminated by ultraviolet light of around 4 eV/photon. Upon examination with a spectroscope, you see two bright lines.

   (Visible light photons have energies from 1.6 to 3.2 eV.)

   What is a plausible explanation for this?

   (A) The rock is made of a mix of two kinds of atom; when illuminated with ultraviolet light, one type makes a transition corresponding to one line, and the other type makes a transition corresponding to the other line.

   (B) The rock splits the 4 eV photon into two photons whose energies add up to 4 eV, then reflects them back at the viewer, creating the two bright lines.

   (C) The ultraviolet light ionizes the atoms in the rock and heats them to two different temperatures, each one corresponding to one of the lines.

   (D) The absorption of a 4 eV ultraviolet photon caused electrons to jump up two energy levels; some of them return to the ground state in two jumps, emitting two lower-energy photons inthe process.

3. Why are incandescent light bulbs, which heat a metal filament to around 3000 K, an inefficient way to illuminate a room? *Thanks to Jennifer for the question!*

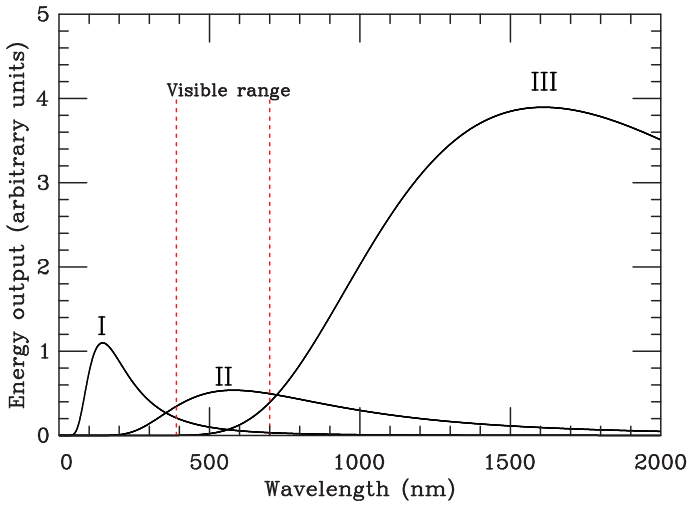
   (A) They produce an emission spectrum in which only certain wavelengths/ colors can be seen.

   (B) They produce an absorption spectrum in which a large section of the spectrum is blocked away.

   (C) They produce more light within the infrared part of the spectrum than they produce visible light.

   (D) They produce too much ultraviolet light, which is not safe to look at for a long time

4. Here are the spectra of three hot objects, labeled I, II, and III.



Which of these objects has the highest temperature?

(A) Object I

(B) Object III

(C) It will depend on their size

(D) Object II

5. An incandescent light bulb consists of a thin wire that is heated to around 3000 K. (The Sun is around 5500 K.) This wire can be made out of any substance that won't melt from the heat. If you look at such a light bulb through a spectrograph, what will you see?

(A) A few thin, bright lines

(B) A continous band of color, favoring the red/orange end of th spectrum

(C) A continuous band of color, with dark lines superimposed on top of it

(D) None of the above

(E) A continuous band of color, favoring the blue/purple end of the spectrum

6. The leftover radiation from the Big Bang looks like the thermal radiation coming from an object with a temperature of around 3 K. (For reference, room temperature is around 300 K, incandescent light bulbs are around 3000 K, and the Sun is around 5500 K.)

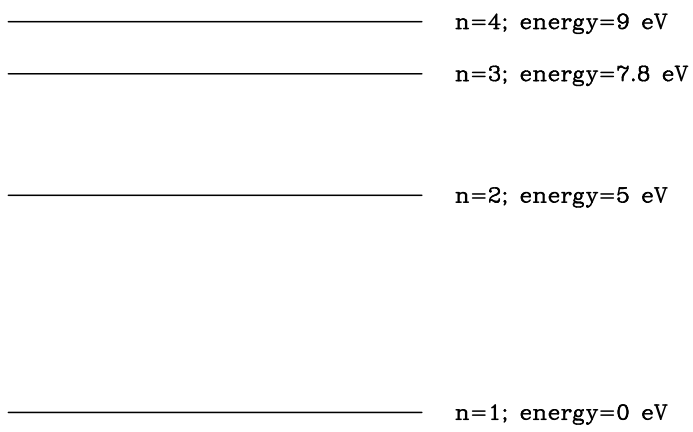
   What type of light is this radiation?

   (A) Gravitational waves
   (B) Ultraviolet
   (C) Infrared
   (D) Microwaves
   (E) Visible light

7. Where do the elements like carbon, oxygen, iron, and silicon around us come from?

   (A) They are created in the core of the Sun
   (B) They were created in the core of a star which has since exploded in a supernova
   (C) They were created in the Big Bang
   (D) They are created when the solar wind interacts with Earth's atmosphere
   (E) None of the above

8. Consider an atom with the following energy levels:



If sunlight shines through a cloud of this gas, what absorption lines will be seen in its spectrum? (Consider all lines, not just ones we can see with our eyes.)

(Visible light photons have energies from 1.6-3.2 eV.)

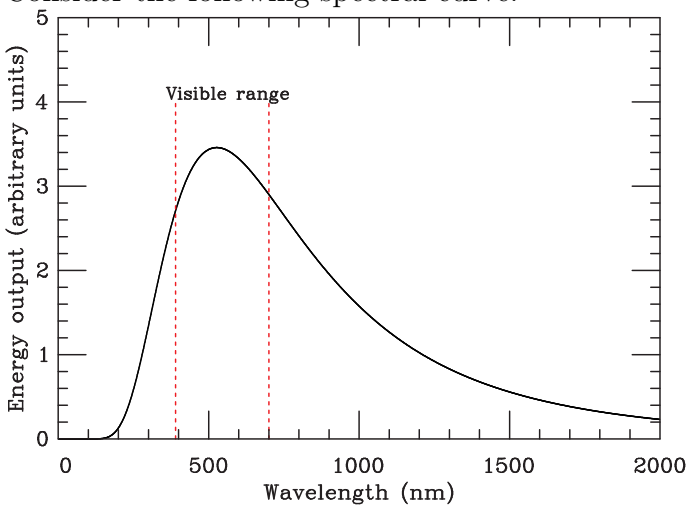
(A) One in the infrared, one in the visible, and four in the ultraviolet
(B) Six in the visible
(C) One in the infrared, one in the visible, and one in the ultraviolet
(D) Three in the ultraviolet
(E) None of the above

9. Atomic nuclei have energy levels just like electrons do. However, the gaps between them can be several million eV, rather than several eV.

If nuclear physicists want to study the light associated with these transitions, they need to look for...

(A) Gamma rays
(B) Infrared
(C) Visible light
(D) Ultraviolet light
(E) Radio waves

10. Consider the following spectral curve:



What object might produce this curve?

(A) An object with a temperature around 5,000 K, like the Sun

(B) A diffuse gas with an electric current running through it, like in a fluorescent light

(C) An object with a temperature around 50,000 K, like the hottest stars

(D) An object with a temperature around 300 K, like the people around us

11. Which element was discovered in the Sun before it was discovered on Earth?

(A) Uranium

(B) Solarium

(C) Sodium

(D) Helium

(E) Hydrogen

12. The "Experience Physics" sign that you've probably all seen outside the auditorium is made of glass tubes bent into the shapes of words and arrows, much like the neon signs at restaurants. These tubes glow different colors; why?

(A) They all contain neon, but different isotopes of neon glow different colors

(B) They contain different elements

(C) They all contain neon, but are made of different colors of glass

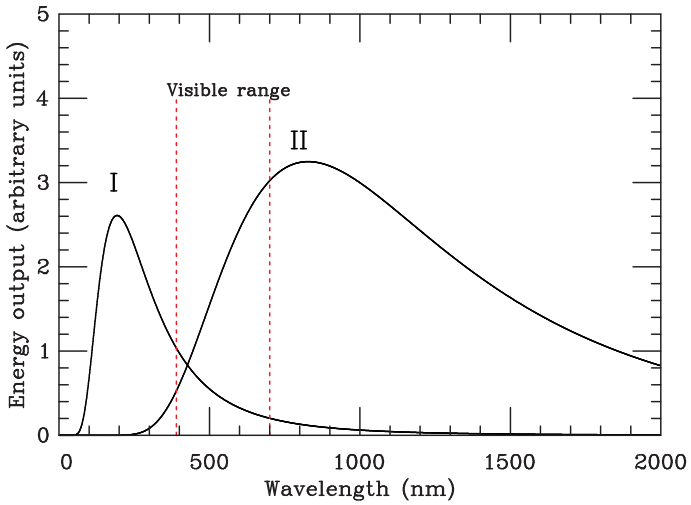
(D) They are heated to different temperatures

(E) None of the above

13. In general, what causes spectral lines? *(Thanks to Sarah for the question!)*

(A) High frequency electromagnetic waves
(B) Protons and neutrons spinning in an atom
(C) Black body radiation
(D) Electron energy transitions in the atom

14. 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 II is both hotter and larger
(B) Star I is hotter, but Star II is larger
(C) Star I is both hotter and larger
(D) Star I is larger, but Star II is hotter
(E) There isn't enough information to determine one of these two things

15. Why have we only seen gravitational waves coming from black hole and neutron star mergers?

(A) General relativity doesn't apply to objects made of ordinary matter like stars
(B) Strong gravitational waves only come from very violent motions of large masses
(C) Strong gravitational waves only come from very hot objects
(D) We've actually seen gravitational waves coming from other things already

16. An atom in its ground state is unable to do what?

(A) Emit light via incandescence
(B) Absorb light via electron transitions to another energy level
(C) Emit light via electron transitions to another energy level
(D) Gain energy by absorbing light
(E) An atom in its ground state can do all four of the above

17. If the temperature of the Sun were increased to 10000 K, but its size and composition weren't changed, what else would happen?

1. The color it appears to our eyes would change significantly
2. The amount of light that it gives off would change significantly
3. The locations of the dark lines in its spectrum would change significantly

(A) 3 only
(B) 1 only
(C) 1 and 3
(D) 1 and 2
(E) 2 only

18. Suppose a hot object with a temperature around 10,000 K was in orbit around the Earth. If we looked at it with a telescope on the Earth, what would its spectrum look like?

(A) A continuous band of color, with a few dark lines superimposed on top of it corresponding to the absorption spectra of the gases in the Earth's atmosphere
(B) A few thin bright lines
(C) A continuous bright band of color

19. 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

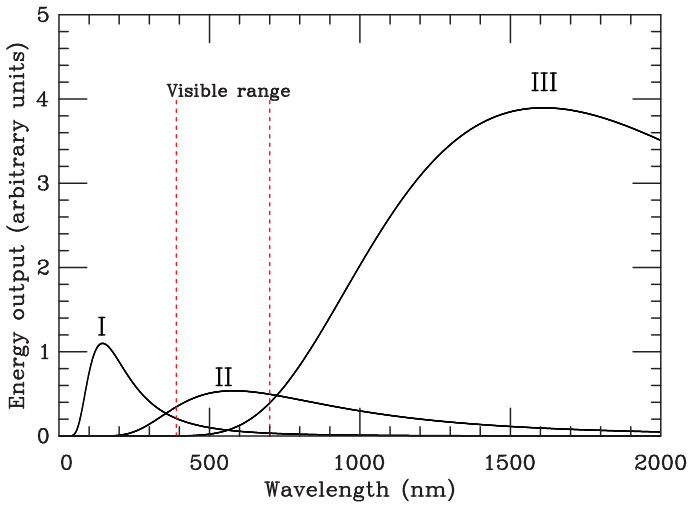
(B) Both you and the snowman are emitting infrared light; the light coming from you is more intense and has longer wavelength than the light coming from the snowman.

(C) Neither of you is emitting light

(D) You are emitting infrared light, and the snowman is emitting ultraviolet light

(E) 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.

20. Here are the spectra of three hot objects, labeled I, II, and III.



Which of these objects *appears brighter* to a human observer?

(A) Object III

(B) Object I

(C) It will depend on their size

(D) Object II

21. The star Sirius appears blue, and the star Betelgeuse appears red. What can you conclude from this?

    1. Sirius gives off more light than Betelgeuse
    2. Sirius is larger than Betelgeuse
    3. Sirius is hotter than Betelgeuse

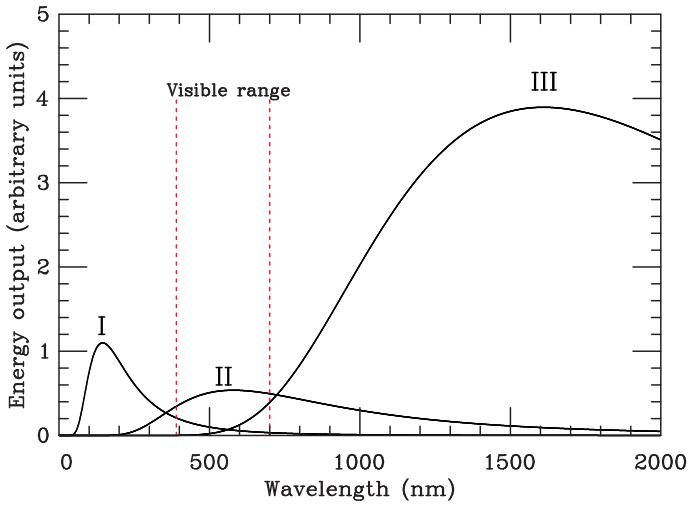
    (A) 1 and 3
    (B) 1 only
    (C) 3 only
    (D) 2 only
    (E) 1, 2, and 3

22. The aspiring supervillain Dr. Horrible constructs his ultimate weapon: a machine that projects an intense beam of neutrinos at a target, bombarding them with a trillion neutrinos per square inch per second.

    If he uses this superweapon against his nemesis, the superhero Captain Hammer, what will happen?

    (A) Nothing at all
    (B) They will start to glow green, as the electrons in their tissue jump back down to the ground state
    (C) The neutrinos will ionize atoms in their cells, causing radiation sickness and cancer
    (D) They will absorb heat from the neutrinos until they start to boil

23. Here are the spectra of three hot objects, labeled I, II, and III.



Which of these objects gives off the *most light in total*?

(A) Object I
(B) Object II
(C) Object III
(D) It will depend on their size

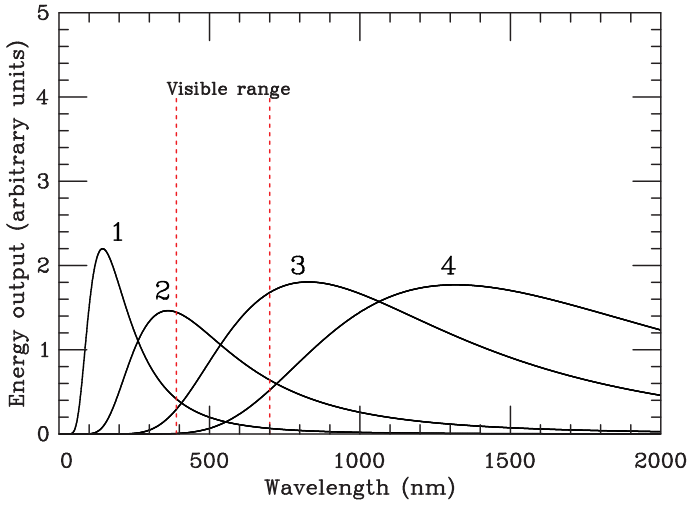
24. Which is true about white light?

(A) It has a longer wavelength than yellow light
(B) White photons have higher energy than green or blue photons
(C) White doesn't correspond to a particular wavelength of light, but refers to a mix of various wavelengths of visible light
(D) It has a shorter wavelength than yellow light

25. Which of the following statements is *false*?

(A) Blue light has a higher frequency than red light
(B) An object glowing red is hotter than an object glowing blue
(C) Blue photons have more energy than red photons
(D) Blue light has a longer wavelength than red light
(E) More than one of statements A-D is false

26. Which of the following radiation curves represents the thermal radiation coming from a warm-blooded creature, like a human?



(A) 3

(B) 1

(C) 4

(D) 2

(E) None of the above

27. If the chemical composition of the Sun's atmosphere were changed, but its temperature and size were kept the same, what else would happen?

1. The color it appears to our eyes would change significantly
2. The amount of light that it gives off would change significantly
3. The locations of the dark lines in its spectrum would change significantly

(A) 3 only

(B) 1 and 3

(C) 2 only

(D) 1 only

(E) 1 and 2

28. If you were to remove all of the hydrogen from the Sun, what is the most noticeable thing that would happen?

    (A) The Sun would no longer shine

    (B) The temperature of the Sun would increase

    (C) Some of the dark lines would disappear from the Sun's spectrum

    (D) Some of the bright lines would disappear from the Sun's spectrum

29. An electron-volt is a unit used to measure what physical quantity?

    (A) Electric potential (voltage)

    (B) Power

    (C) Energy

    (D) Electric current

    (E) Electric charge

30. Suppose a particular type of atom has three energy levels:

    - $n = 1$ (ground state): 0 eV
    - $n = 2$: 2.5 eV
    - $n = 3$: 4 eV

    Suppose that you have a large amount of this gas, and all of the atoms start in the ground state. If you illuminate them with 4 eV photons, what will principally happen?

    (A) They will absorb the 4 eV photons, and then emit only 4 eV photons again as they transition back down to the ground state.

    (B) The 4 eV photons will pass right through, since the atoms are not at an appropriate energy level to absorb them.

    (C) They will absorb the 4 eV photons, and then emit 4 eV, 2.5 eV, and 1.5 eV photons as they transition back down to the ground state.

    (D) They will absorb the 4 eV photons and heat up, emitting thermal radiation of shorter wavelengths.

Scratch Paper

Scratch Paper

Scratch Paper

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