Except for questions 20, 21, 28, 31 and 32 marks/answers on these sheets are not graded.

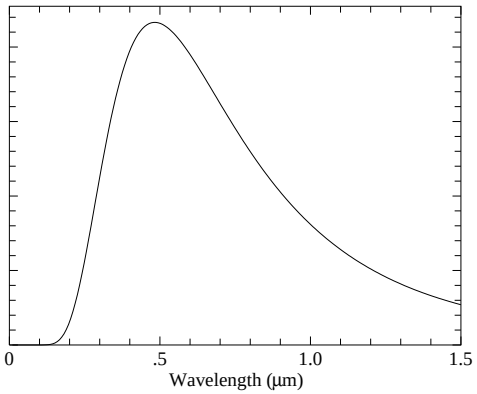
Answer *TRUE* or *FALSE* (<u>not</u> *T* or *F*) (2 pts each)

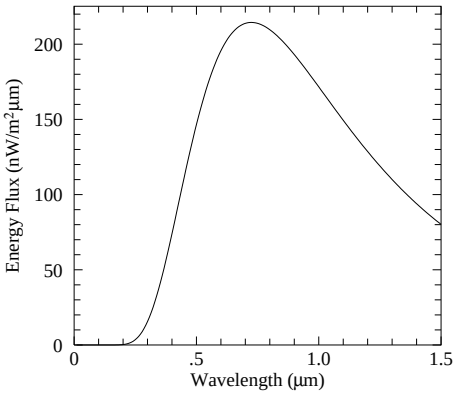
1. Since an ice skater spins faster and faster as she draws her arms in close to her body, her angular momentum is increasing.
2. For sound or light: the smaller the wavelength the bigger the frequency.
3. Doppler effect: Stopped in the station the train's whistle sounds an A (440 Hz), but when it is approaching me at high speed it sounds an A$^\sharp$ (466 Hz).
4. Standard incandescent (Edison) light bulbs produce an emission spectra.
5. Every object is incandescent, but the light emitted may not be visible to humans.
6. High temperatures break apart composites.
7. The ions in a plasma are atoms that have lost electrons.
8. Deuterium is like normal hydrogen, except it has exactly one neutron.
9. A microwave photon carries more energy than a ultraviolet photon.
10. Radio waves move slower through space than X-rays.
11. The main reason for building large Earth-based telescopes is to magnify the tiny images of stars.
12. Smaller resolution is the aim of a radio interferometer.
13. "The seeing has improved," said the astronomer. "The resolution is now two arc seconds instead of one arc second."
14. When taking pictures in dim light one usually uses a larger aperture, which means a larger f number: say f/11 instead of f/2.
15. Long focal length lenses make big images; large f-number lenses make dim images.
16. In the Sun, convection dredges up newly created helium from the core.

Give a short explanation (5 pts each)

17. Define *wavelength*, *frequency*, and *amplitude*.
18. Rank order the following types of light from from longest to shortest wavelength: infrared, AM radio, microwave, blue, gamma ray.
19. What is the difference between hot gas and cool gas, i.e., on the atomic scale what changes as temperature increases?

20. The below left is a spectra of a thermal (blackbody) light source at a temperature of 6000 K. Sketch directly on top of this graph the spectra of an otherwise identical thermal light source at a temperature of 4000 K.





21. Consider the above right spectra. If blue light corresponds to a wavelength of .450 μm,, and red light corresponds to a wavelength of .700 μm, calculate (approximately) the ratio of the amount of red light to blue light. For each of the below actions report if it would change that ratio: (A) moving the star further away, (B) increasing the radius of the star, (C) increasing the surface temperature of the star, (D) observing the star through material that particularly absorbed blue light.

22. How did you in class measure the focal length of a lens?

23. Why does a single-dish radio telescope produce images much more blurred than big single-mirror visible-light telescopes? How can we get detailed images using radio light?

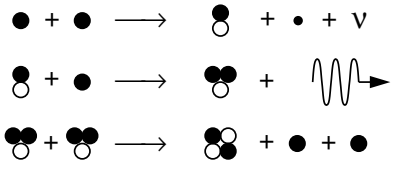
24. Why are some telescopes put in space?

25. The Hubble Space Telescope (HST) is 'soon' to be replaced with the James Webb Space Telescope (JWST). The JWST is a f/20, 6.5 meter telescope that will be placed about a million miles from Earth. HST is a f/13, 2.4 meter telescope which is deployed in low-Earth orbit (about 400 miles above the Earth). The f/1.75, 10 meter Keck telescope is on the summit of Hawaii's dormant Mauna Kea volcano, 4 km above sea level. Which telescope should you use to photograph dim objects? Which telescope shows the finest details? Which telescope produces the most "magnified" images?

26. How do we know the temperature deep inside the Sun?

27. What is a *sunspot*? What is the sunspot cycle?

28. The above right cartoon is a representation of the nuclear reactions that power the Sun. Directly on this diagram label/name all the participants.



Write out a complete answer (10 pts each)

29. Describe why the Sun doesn't explode. Your explanation should include a full statement of the Virial theorem, an explanation of why things "usually" explode, and an explanation of why you haven't seen anything explode recently.

30. Sketch a cross section of the Sun. Show and label: chromosphere, core, corona, convective zone, photosphere, and radiative zone. Rank the previous items in terms of temperature from highest to lowest. Label in your sketch where the apparent surface of the Sun is and where thermonuclear reactions take place.

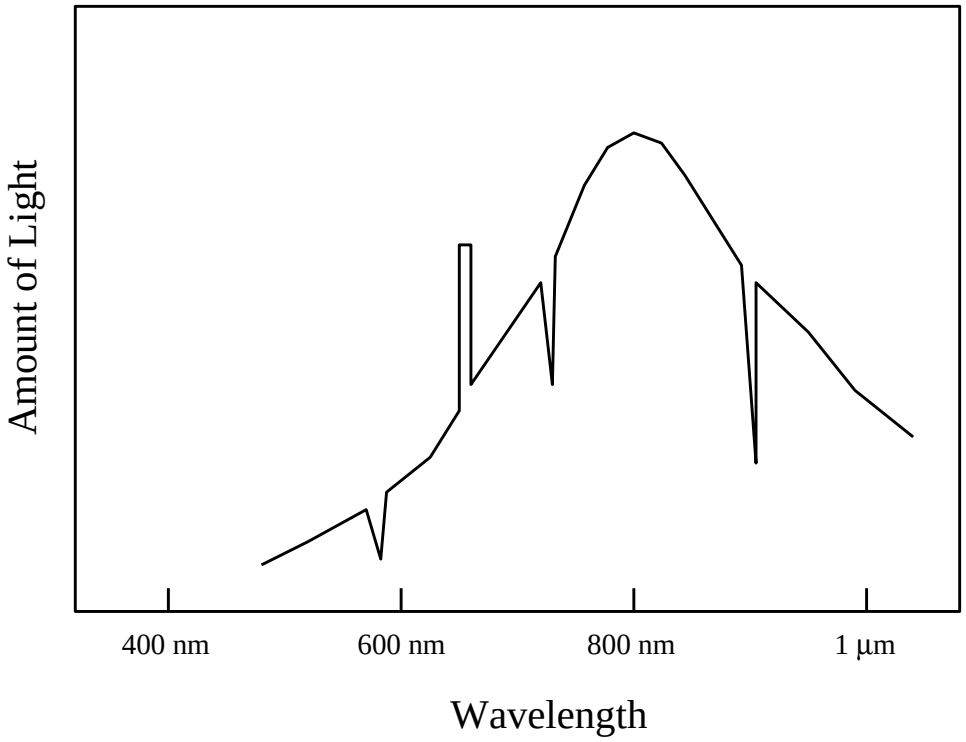
31. Answer this question by directly drawing/labeling on the graph below.

    (a) Locate/label **UV** where the ultraviolet light is and **IR** where the infrared light is.

    (b) Label: an absorption line **A**, an emission line **E**.

    (c) Draw a set of energy levels and electron jumps that would produce both the absorption line and the emission line you labeled above. Include arrows showing the direction of electron motion for each jump and label: **A** for the absorption line and **E** for the emission line. Careful: how does wavelength relate to the size of the energy jump?

    (d) What is the numerical value of the peak wavelength?



32. Identify the below three constellations.