Critical Thinking Items

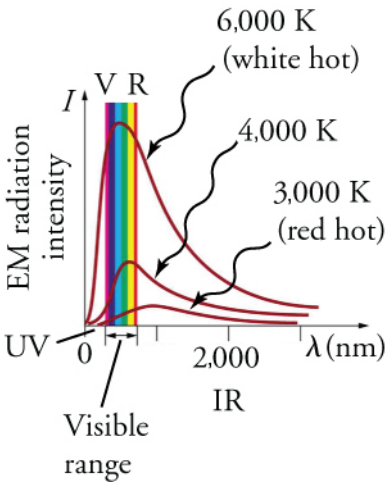
21.1 Planck and Quantum Nature of Light 10.

How is the frequency of a blackbody's emission influenced by temperature?

a. The frequency is independent of temperature.
b. The frequency scales linearly with temperature.
c. The frequency scales with T^2.
d. The frequency scales with T^4.

11.

Why does the intensity shown in the blackbody radiation graph decrease after its peak frequency is achieved?



a. Because after reaching the peak frequency, the photons created at a particular frequency are too many for energy intensity to continue to decrease.
b. Because after reaching the peak frequency, the photons created at a particular frequency are too few for energy intensity to continue to decrease.
c. Because after reaching the peak frequency, the photons created at a particular frequency are too many for energy intensity to continue to increase.
d. Because after reaching the peak frequency, the photons created at a particular frequency are too few for energy intensity to continue to increase.

12.

Photography development laboratories generally use red lighting to allow workers to see without damaging the developing photographs. Why might this be the case?

a. Red light carries less damaging energy than other wavelengths of visible light.

b. Red light carries more energy than other wavelengths of visible light and can pass through without causing damage.
c. The greater frequency of red light compared with other visible light causes fewer vibrations in the developing photos.
d. The shorter wavelength of red light compared with other visible light causes fewer vibrations in the developing photos

13.

Why is it assumed that a perfect absorber of light (like a blackbody) must also be a perfect emitter of light?

a. To achieve electrostatic equilibrium with its surroundings
b. To achieve thermal equilibrium with its surroundings
c. To achieve mechanical equilibrium with its surroundings
d. To achieve chemical equilibrium with its surroundings

21.2 Einstein and the Photoelectric Effect 14.

Light is projected onto a semi-conductive surface. If the intensity is held constant but the frequency of light is increased, what will happen?

a. As frequency is increased, electrons will stop being ejected from the surface.
b. As frequency is increased, electrons will begin to be ejected from the surface.
c. As frequency is increased, it will have no effect on the electrons being ejected as the intensity is the same.
d. As frequency is increased, the rate at which the electrons are being ejected will increase.

15.

Why is it important to consider what material to use when designing a light meter? Consider the worked example from Section 21-2 for assistance.

a. A light meter should contain material that responds only to high frequency light.
b. A light meter should contain material that responds to low frequency light.
c. A light meter should contain material that has high binding energy.
d. A light meter should contain a material that does not show any photoelectric effect.

16.

Why does overexposure to UV light often result in sunburn when overexposure to visible light does not? This is why you can get burnt even on a cloudy day.

a. UV light carries less energy than visible light and can penetrate our body.
b. UV light carries more energy than visible light, so it cannot break bonds at the cellular level.

c. UV light carries more energy than visible light and can break bonds at the cellular level.
d. UV light carries less energy than visible light and cannot penetrate the human body.

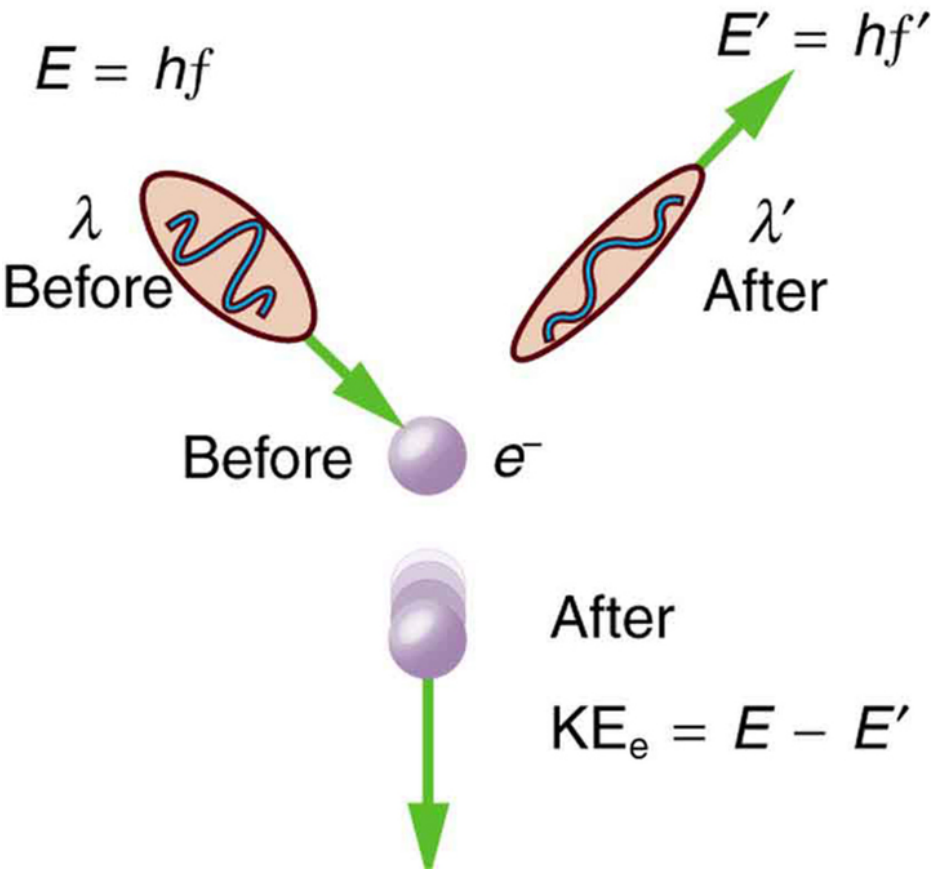
17.

If you pick up and shake a piece of metal that has electrons in it free to move as a current, no electrons fall out. Yet if you heat the metal, electrons can be boiled off. Explain both of these facts as they relate to the amount and distribution of energy involved with shaking the object as compared with heating it.

a. Thermal energy is added to the metal at a much higher rate than energy added due to shaking.
b. Thermal energy is added to the metal at a much lower rate than energy added due to shaking.
c. If the thermal energy added is below the binding energy of the electrons, they may be *boiled off.*
d. If the mechanical energy added is below the binding energy of the electrons, they may be *boiled off.*

21.3 The Dual Nature of Light 18.

In many macroscopic collisions, a significant thermal energy term is required to conserve energy. Why is no such term required in the collision depicted in the figure?



a. The figure depicts Rayleigh scattering, in which all terms are thermal already.
b. The figure depicts Compton scattering, which is on the molecular level where all thermal energy exists as kinetic energy.
c. The figure depicts a perfectly elastic collision, so no thermal term is required.
d. The figure depicts Raman scattering, so all thermal energy is stored as vibrations in the particles.

19.

In what region of the electromagnetic spectrum will photons be most effective in accelerating a solar sail?

a. ultraviolet rays
b. infrared rays
c. X-rays
d. gamma rays

20.

True or false—Electron microscopes can resolve images that are smaller than the images resolved by light microscopes.

a. false
b. true

21.

How would observations of Compton scattering change if ultraviolet light were used in place of X-rays?

a. Ultraviolet light carries less energy than X-rays. As a result, Compton scattering would be easier to detect.
b. Ultraviolet light carries less energy than X-rays. As a result, Compton scattering would be more difficult to detect.
c. Ultraviolet light carries more energy than X-rays. As a result, Compton scattering would be easier to detect.
d. Ultraviolet light has higher energy than X-rays. As a result, Compton scattering would be more difficult to detect.