Chapter 13 Review Questions:

1. A scientist is trying to eject electrons from a metal by shining light on it, but none are coming out. To eject electrons, she should change the light by...

   increasing the frequency

   increasing the intensity

   decreasing the frequency

   changing the angle

2. A 10 eV electron has a wavelength of \( \sim 0.4 \) nm. What is the wavelength of a 40 eV electron?

   0.1 nm

   0.2 nm

   0.4 nm

   0.8 nm
3. Quantum mechanics is important in describing light in that

   It is the only way to explain interference.
   It explains how colors mix together
   It says that light comes in discrete units
   It relates the wavelength and the frequency.

4. A photon is found to have 1 eV of energy. Which answer is closest to its wavelength?

   1 nm
   10 nm
   100 nm
   1000 nm
5. According to Einstein, increasing the brightness of a beam of light without changing its color will increase:

- the number of photons.
- the energy of each photon.
- the speed of the photons.
- the frequency of the photons.

6. That light has a dual nature is referring to light

- having high- or low-energy photons.
- acting as waves and particles.
- having both energy and momentum
- having both wavelength and frequency
7. Red (700 nm) and green (500 nm) lasers both produce 2.5 mW of power. How do the number of photons per second from each compare?

Red produces more

Green produces more.

Both the same.

Cannot be compared since they are different colors.

8. When an object is heated to very high temperature, it gives off light. As the temperature is increased, the wavelength at which most of the light is given off

decreases

increases

stays the same

changes color
9. A macroscopic (large, massive) object does not usually show effects of quantum mechanics (QM) because...

QM does not hold for macroscopic objects

the quantization is too small to notice.

the photon has zero mass

the probability becomes greater than 1

10. A phenomenon that demonstrates that an electron has wavelike properties is

the blackbody spectrum

the photoelectric effect.

electron diffraction.

All of the above.
1. *This is the photoelectric effect, where one photon transfers its energy to one electron. The energy of one photon is hf. If this is not enough energy, the frequency should be increased.*

2. *The deBroglie relation says that the wavelength is Planck's constant / momentum = h/p. Since the energy is p^2/2m, the wavelength is proportional to 1/sqrt(E). If the energy increases by a factor of 4, the wavelength goes down by a factor of 2.*

3. *Quantum mechanics says that everything is quantized. Here it says that the energy of the light is quantized, meaning that it comes in discrete units (photons), each with energy hf.*

4. *The photon energy is hf=hc/wavelength. This means that wavelength=hc/energy. We found that hc=1240 eV-nm. The wavelength is then 1240 nm.*
5. The photon energy is determined only by the frequency of the light. Increasing the brightness increases the number of photons/second passing some point.

6. We speak of a wave-particle duality. This means that light shows both wave-like properties (interference) and particle like properties (photons).

7. The red photons are have longer wavelength, and so the energy of a red photon is less than that of a green photon. The power is the energy / sec produced by the laser. Since the powers are equal, there must be more red photons per second since each has lower energy.

8. The blackbody spectrum shifts to higher energy (higher frequency, shorter wavelength) as the temperature increases.
9. Quantum mechanics applies to all objects. Macroscopic objects appear to behave classically because the differences between quantized states (for instance the energy difference) are much smaller than the properties of the states (for instance their energy).

10. Diffraction is the only wavelike property listed here. The others are explained by quantum mechanics, but do not use the wave nature of the electron.