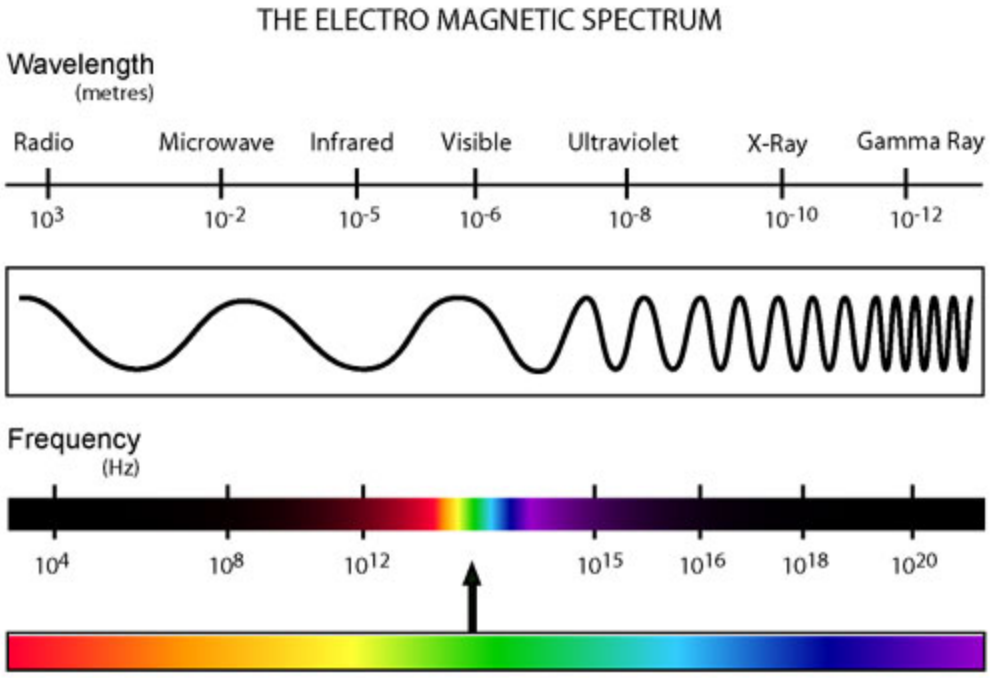
1. Rank the following types of electromagnetic radiation from highest to lowest frequency: IR, TV, X-ray, Green.

a. TV > IR > Green > X-ray
b. X-ray > IR > Green > TV
c. Green > X-ray > TV > IR
d. X-ray > Green > IR > TV **Correct**
e. TV > Green > IR > X-ray

Explanation:



2. Which of the following scientists originated that debate over whether light was a wave or a particle?

I. Christiaan Huygens
II. Albert Einstein
III. Isaac Newton

a. I only
b. II only
c. III only
d. I and II
e. I and III **Correct**
f. II and III
g. I, II and III

Explanation: Christiaan Huygens proposed that light was wave. Isaac Newton proposed that light was a corpuscle (particle). These disparate ideas were eventually reconciled by scientists such as Albert Einstein with the concept of wave-particle duality.

3. What was the main reason that classical mechanics did such a bad job of describing and predicting the interactions of light and matter?

a. Classical mechanics incorrectly assumed that the speed of light is a constant.
b. Classical mechanics treated light exclusively as a wave, which failed to account for the

quantized nature of its energy. **Correct**

c. Isaac Newton, founder of classical mechanics, believed light was a particle and not a wave.

d. Classical mechanics actually did an excellent job of predicting and describing interactions between light and matter.

Explanation: In spite of Isaac Newton's opinions on the matter, classical mechanics regarded light as exclusively wave-like in nature which lead to numerous erroneous predictions about its properties and its interactions with matter.

4. What is the de Broglie wavelength of planet earth as it revolves around the sun (mass = 5.9736 E24 kg and velocity = 29.783 km/s)?

a. 3.724 E-59 m **Correct**

b. 3.724 E-56 m

c. 3.724 E-57 m

d. 3.724 E-61 m

Explanation:

$\lambda = h/(m \cdot v)$

$v = 29.783\ km \cdot s^{-1} = 2.9783\ E4\ m \cdot s^{-1}$

$\lambda = 6.626\ E-34 / (5.9736\ E24 \cdot 2.9783\ E4)$

$\lambda = 3.724\ E-59\ m$

5. Which of the following is/are true concerning the particle in a box?

I. the electron can be found anywhere in the box with equal probability

II. the electron is always in motion

III. the electron's energy can be equal to zero

a. I only

b. II only **Correct**

c. III only

d. I and II

e. I and III

f. II and III

g. I, II and III

Explanation: Statement I is false; a wave function describes the location of the particle in a box. Statement II and III are mutually exclusive; for an electron (which has a mass) to have zero energy it would need to have zero momentum, but the electron described by particle is a box is massive and always in motion and thus always has non-zero momentum.

6. What is the minimum uncertainty in Earth's position if the uncertainty in its velocity is 0.1 $m \cdot s^{-1}$(mass = 5.9736 E24 kg)?

a. 1.1 E-57 m

b. 5.5 E-58 m

c. 1.8 E-58 m

d. 8.8 E-59 m **Correct**

Explanation:

$\Delta x \cdot \Delta p \geq \hbar/2$

$\Delta x \cdot m \cdot \Delta v \geq \hbar/2$

$\Delta x \cdot 5.9736\ E24 \cdot 0.1 \geq 1.054\ E-34 / 2$

$\Delta x \geq 8.8\ E-59\ m$

7. How many total orbitals are found in principal energy levels 3 and 4?

a. 32

b. 50

c. 9

d. 25 **Correct**
e. 18
f. 16

Explanation: The number of orbitals in a given principal energy level is equal to n^2. $3^2 + 4^2 = 25$.

8. The highest energy ground state electron in an Yttrium (Y) atom could be described by which of the following sets of quantum numbers.

a. $n = 4$, $l = 3$, $m_l = 0$, $m_s = -½$
b. $n = 4$, $l = 2$, $m_l = 2$, $m_s = +½$ **Correct**
c. $n = 5$, $l = 2$, $m_l = -1$, $m_s = +½$
d. $n = 5$, $l = 3$, $m_l = -4$, $m_s = -½$

Explanation: The highest energy ground state electron in an Yttrium atom is its first and only 4d electron, which corresponds to $n = 4$, $l = 2$. This eliminates all but answer choice b.