Question #: 1

___________ is the emission and transmission of energy in the form of a wave with an electrical and a magnetic component.

A. Electricity  
B. Nuclear radiation  
C. Electromagnetic radiation  
D. Thermochemistry

Question #: 2

Consider the two waves in the image.

Use smaller than, equal to, or greater than to complete each sentence.  
The amplitude of wave A is __1__ the amplitude of wave B.  
The wavelength of wave A is __2__ the wavelength of wave B.  
The frequency of wave A is __3__ the wavelength of wave B.

1. __________
2. __________
3. __________
Question #: 3

Fill in the blanks with either increases or decreases. As the frequency of electromagnetic radiation increases, the wavelength _1_ and the energy _2_.

1. __________
2. __________

Question #: 4

In comparing green light to purple light, which statement is true?

A. Green light has a shorter wavelength and a higher frequency than purple light.
B. Green light has a shorter wavelength and a lower frequency than purple light.
C. Green light has a longer wavelength and a higher frequency than purple light.
D. Green light has a longer wavelength and a lower frequency than purple light.

Question #: 5

What are the wavelengths of each end of the visible light spectrum in nanometers? Select from the following values: 100, 200, 300, 400, 500, 600, 700, 800 and 900 and do NOT include units in your answer.

(A) = _1_ nm
(B) = _2_ nm

1. __________
2. __________
Question #: 6

Place the following in order of **increasing** (smallest to largest) energy.

A. X-ray waves < visible waves < radio waves
B. visible waves < X-ray waves < radio waves
C. radio waves < visible waves < X-ray waves
D. visible waves < radio waves < X-ray waves
E. radio waves < X-ray waves < visible waves

Question #: 7

Examine the image and fill in the blank to complete the sentence. Choose one of the terms given in square brackets following the blank.

The image shows __1__ [constructive, destructive] interference.

1. __________
Question #: 8

What is represented in the image below?

A. Diffraction, which is the bending of a wave as it passes through a slit
B. Sublimation, which is the behavior of particles as they pass through a slit
C. Interference, which can only be exhibited by electromagnetic radiation
D. Construction, which is only seen when objects have a dual nature

Question #: 9

Finish the sentence.
In the equation $c = \lambda \nu$, the symbol $c$ represents the _____.

1. _________
Question #: 10

Unlike humans, birds and bees can see ultraviolet light, which has an approximate wavelength of 324 nm. What is the frequency of this light? Report your answer with **three** significant figures. Do **NOT** include units in your answer. For numbers in scientific notation, use the format 2.22E2 for $2.22 \times 10^2$.

$\text{Hz}$

1. 

Question #: 11

What is the wavelength of light, in nanometers, if one photon has an energy of $3.15 \times 10^{-15} \text{J}$?

A. $3.15 \times 10^{-4} \text{ nm}$  
B. $6.89 \times 10^{-11} \text{ nm}$  
C. $631 \text{ nm}$  
D. $932 \text{ nm}$

Question #: 12

A laser pulse of green light with wavelength of 510 nm has a total energy of 2.0 J. Calculate the number of photons in the pulse.

A. $4.3 \times 10^{18} \text{ photons}$  
B. $6.4 \times 10^{19} \text{ photons}$  
C. $3.2 \times 10^{19} \text{ photons}$  
D. $5.1 \times 10^{18} \text{ photons}$
Question #: 13

In the photoelectric effect experiment, _______ strike(s) a metal surface and _______ are emitted.

A. electrons of various energies; electrons
B. light of various frequencies; electrons
C. electrons of various energies; photons
D. light of various frequencies; photons

Question #: 14

Which statement is part of the experimentation or conclusion from the photoelectric effect?

A. Electrons strike a metal surface and the metal glows.
B. All light, regardless of frequency can eject electrons from a metal surface, if the light is intense enough.
C. The photoelectric effect led to the understanding that photons are particles with energy equal to Plank's constant times the frequency.
D. If a photon of light ejects an electron from a metal surface, the energy of the photon must be less than the binding energy of the electron.

Question #: 15

The minimum energy to remove electrons from the surface of lithium metal is 520. kJ/mol. Calculate the threshold frequency of light needed to remove a single electron from the metal surface.

A. $7.61 \times 10^{38} \text{1/s}$
B. $1.30 \times 10^{15} \text{1/s}$
C. $5.21 \times 10^{12} \text{1/s}$
D. $3.22 \times 10^{32} \text{1/s}$
An emission spectrum  **1**
The spectrum of white light  **2**
An absorption spectrum  **3**
An emission spectrum of a gaseous element  **4**

1. __________
2. __________
3. __________
4. __________
Examine the image and complete the sentence.
The violet line at 434 nm in the spectrum of hydrogen corresponds to the...

A. frequency of light absorbed as the electron undergoes a transition from the $n=5$ to the $n=2$ energy level in a hydrogen atom.
B. wavelength of light emitted as an electron undergoes a transition from the $n=5$ to the $n=2$ energy level in a hydrogen atom.
C. wavelength of light emitted as the electron undergoes a transition from the $n = 5$ to the $n=2$ energy level; the wavelength for this transition would be 424 nm for any element.
D. frequency of light absorbed as the electron undergoes a transition from the $n=5$ to the $n=2$ energy level; the wavelength for this transition would be 424 nm for any element.
Question #: 18

What does the actual electron behavior versus the expected behavior (shown in the image below) tell us about the nature of electrons?

- A. The interference pattern observed indicates that electrons have a wave nature.
- B. The interference pattern observed is indicative of the particle nature of the electrons.
- C. The interference pattern helped establish the mass of the electron.
- D. The interference pattern helped identify that electrons have a negative charge.

Question #: 19

Select the true statement based on the de Broglie equation for the wavelength of a particle.

- A. The wavelength is inversely proportional to the velocity of a particle.
- B. The velocity used in the equation is the speed of light, $3.00 \times 10^8$ m/s.
- C. The wavelength increases as Planck’s constant increases.
- D. The wavelength is independent of mass and velocity.

Question #: 20

Calculate the de Broglie wavelength of Dr. Woodrum, mass 72.0 kg, running at a speed of 3.0 m/s.

- A. $2.2 \times 10^2$ m
- B. $2.6 \times 10^{-35}$ m
- C. $3.1 \times 10^{-36}$ m
- D. $4.2 \times 10^{-2}$ m
The Heisenberg Uncertainty Principle can be mathematically expressed as:

\[ \Delta x \times m \Delta v \geq \frac{\hbar}{4 \pi} \]

where \( \Delta x \) = uncertainty in position and \( \Delta v \) = uncertainty in velocity.

What then is true concerning electrons?

A. It is possible to observe the wave nature and the particle nature of an electron simultaneously.
B. Knowing both the location and velocity an electron allows us to predict where an electron is at any moment in time.
C. The more accurately you know the position of an electron, the less accurately you can know its velocity.
D. Electrons are particles with a mass and have no wave nature. Light is a wave and has no particle nature.

**Question #:** 22

Fill in the blanks with n, l, or ml (for ml). Options may be used more than once or not at all.

This quantum number defines the relative distance from the nucleus. **1**

This quantum number can have values of –1, 0 or +1 for a p subshell. **2**

This quantum number can never be zero. **3**

1. __________
2. __________
3. __________

**Question #:** 23

For an electron in the 5d subshell, \( n = \) **1**, and \( l = \) **2**.

1. __________
2. __________
Question #: 24

Which two sets of quantum numbers \([n, l, m]\) are allowed?

A. \([3, 0, 0]\)
B. \([3, 3, 2]\)
C. \([3, 1, 0]\)
D. \([3, 0, 1]\)

Question #: 25

Examine the two images of orbitals below labeled (A) and (B), and select the true statement.

A. The \(l\) value for both (A) and (B) is 2 and the \(m\) values must be different for each.
B. The \(m\) value for both (A) and (B) is 3 and the \(l\) values must be different for each.
C. The \(l\) value for (A) is greater than the \(l\) value for (B).
D. The \(n\) value for both (A) and (B) is 2.

Question #: 26

What is the frequency of the photon emitted by a hydrogen atom when its electron makes a transition from the \(n = 4\) to \(n = 1\) principal energy level?

A. \(3.08 \times 10^{15}\) Hz
B. \(1.03 \times 10^{8}\) Hz
C. \(2.06 \times 10^{14}\) Hz
D. \(8.22 \times 10^{14}\) Hz
Question #1:

__________ is the emission and transmission of energy in the form of a wave with an electrical and a magnetic component.

A. Electricity
B. Nuclear radiation
✓C. Electromagnetic radiation
D. Thermochemistry

Question #2:

Consider the two waves in the image.
Use smaller than, equal to, or greater than to complete each sentence.

The amplitude of wave A is _1_ the amplitude of wave B.
The wavelength of wave A is _2_ the wavelength of wave B.
The frequency of wave A is _3_ the wavelength of wave B.

1. equal to
2. greater than
3. less than

**Question #: 3**

Fill in the blanks with either **increases** or **decreases**.
As the frequency of electromagnetic radiation increases, the wavelength _1_ and the energy _2_.

1. decreases
2. increases

**Question #: 4**

In comparing green light to purple light, which statement is **true**?

A. Green light has a shorter wavelength and a higher frequency than purple light.
B. Green light has a shorter wavelength and a lower frequency than purple light.
C. Green light has a longer wavelength and a higher frequency than purple light.
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**Question #**: 5

What are the wavelengths of each end of the visible light spectrum in nanometers? Select from the following values: 100, 200, 300, 400, 500, 600, 700, 800 and 900 and do **NOT** include units in your answer.

![Visible Light Spectrum](image)

(A) = \_1\_ nm \\
(B) = \_2\_ nm

1. 400 \\
2. 700

**Question #**: 6

Place the following in order of **increasing** (smallest to largest) energy.

A. X-ray waves <visible waves <radio waves \\
B. visible waves <X-ray waves <radio waves \\
✓C. radio waves <visible waves <X-ray waves \\
D. visible waves <radio waves <X-ray waves \\
E. radio waves <X-ray waves <visible waves

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Examine the image and fill in the blank to complete the sentence. Choose one of the terms given in square brackets following the blank.
The image shows ___1__ [constructive, destructive] interference.

1. destructive

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What is represented in the image below?

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Question #: 9

Finish the sentence.
In the equation \( c = \lambda \nu \), the symbol \( c \) represents the \( 1 \).

1. speed of light

Question #: 10

Unlike humans, birds and bees can see ultraviolet light, which has an approximate wavelength of 324 nm. What is the frequency of this light?
Report your answer with three significant figures. Do NOT include units in your answer. For numbers in scientific notation, use the format 2.22E2 for \( 2.22 \times 10^2 \).

1 Hz

1. 9.26E14

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  ✓
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- D. $3.22 \times 10^{32} \text{ 1/s}$
Question #: 16

Fill in the blanks with
A, if the statement applies to the image labeled A,
B if the statement applies to the image labeled B,
AB if it applies to both or
0 if it applies to neither.

An emission spectrum 1
The spectrum of white light 2
An absorption spectrum 3
An emission spectrum of a gaseous element 4

1. AB
2. B
3. 0
4. A

Question #: 17

Examine the image and complete the sentence.
The violet line at 434 nm in the spectrum of hydrogen corresponds to the...
A. frequency of light absorbed as the electron undergoes a transition from the n=5 to the n=2 energy level in a hydrogen atom.

✓B. wavelength of light emitted as an electron undergoes a transition from the n=5 to the n=2 energy level in a hydrogen atom.

C. wavelength of light emitted as the electron undergoes a transition from the n = 5 to the n=2 energy level; the wavelength for this transition would be 424 nm for any element.

D. frequency of light absorbed as the electron undergoes a transition from the n=5 to the n=2 energy level; the wavelength for this transition would be 424 nm for any element.

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This quantum number can have values of $-1, 0$ or $+1$ for a p subshell. **2**

This quantum number can never be zero. **3**

1. n
2. ml
3. n

Question #: 23

For an electron in the 5d subshell, $n =$ **1**, and $l =$ **2**.

1. 5
2. 2

Question #: 24

Which **two** sets of quantum numbers $[n, l, m_l]$ are **allowed**?

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- ✓ C. [3, 1, 0]
- D. [3, 0, 1]

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