Topic 6D-Skills 11
Energy of Photons

316. Moving electrons are found to exhibit properties of

A) particles, only
B) waves, only
C) both particles and waves
D) neither particles nor waves

Known as wave particle duality

317. Light demonstrates the characteristics of

A) particles, only
B) waves, only
C) both particles and waves
D) neither particles nor waves

318. Which phenomenon best supports the theory that matter has a wave nature?

A) electron momentum
B) electron diffraction
C) photon momentum
D) photon diffraction

→ matter → wave

319. Which phenomenon can best be explained by the wave model of light rather than the particle model of light?

A) interference
B) reflection
C) energy transfer
D) photoelectric effect

320. Which phenomenon is most easily explained by the particle theory of light?

A) photoelectric effect
B) constructive interference
C) polarization
D) diffraction

321. Which phenomenon can be explained by both the particle model and wave model?

A) reflection B) polarization
C) diffraction D) interference

322. A monochromatic beam of light has a frequency of 7.69×10^{14} hertz. What is the energy of a photon of this light?

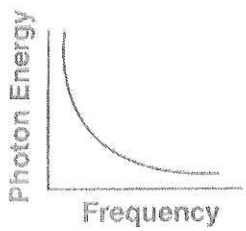
A) 2.59×10^{-40} J B) 6.92×10^{-31} J
C) 5.10×10^{-19} J D) 3.90×10^{-7} J

$E = hf$ ← all choices in Joules

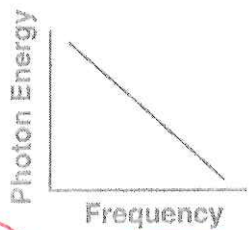
$E = (6.63 \times 10^{-34}\ Js)(7.69 \times 10^{14}\ Hz)$

323. Which graph best represents the relationship between photon energy and photon frequency?

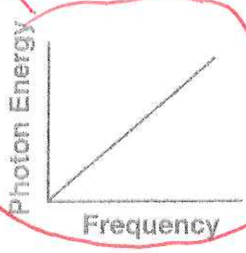
A)



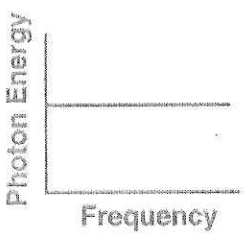
B)



C)



D)



$E = hf$ direct

324. A variable-frequency light source emits a series of photons. As the frequency of the photon increases, what happens to the energy and wavelength of the photon?

A) The energy decreases and the wavelength decreases.

B) The energy decreases and the wavelength increases.

C) The energy increases and the wavelength decreases.

D) The energy increases and the wavelength increases.

325. A photon of light traveling through space with a wavelength of 6.0×10^{-7} meter has an energy of

A) 4.0×10^{-40} J **B) 3.3×10^{-19} J**
C) 5.4×10^{10} J D) 5.0×10^{14} J

$E = \frac{hc}{\lambda} = \frac{(6.63\times10^{-34}\ Js)(3\times10^{8}\ m/s)}{6.0\times10^{-7}\ m} = 3.31\times10^{-19}\ J$

326. All photons in a vacuum have the same

A) speed B) wavelength
C) energy D) frequency

Speed of light in a vacuum is c

327. Light of wavelength 5.0×10^{-7} meter consists of photons having an energy of

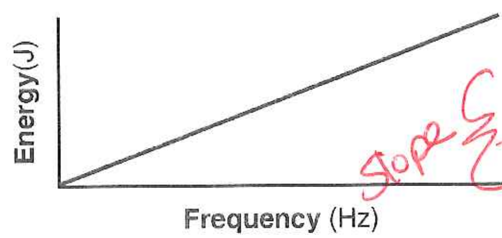
A) 1.1×10^{-48} J B) 1.3×10^{-27} J
C) 4.0×10^{-19} J D) 1.7×10^{-5} J

$E = \frac{hc}{\lambda} = \frac{(6.63\times10^{-34}\ Js)(3\times10^{8}\ m/s)}{5\times10^{-7}\ m}$

$E = hf$
$v = f\lambda$ $\lambda = v/f$

328. Base your answer to the following question on the data table and graph below. The data table lists the energy and corresponding frequency of five photons. The graph represents the relationship between the energy and the frequency of photons.

Photon	Energy (J)	Frequency (Hz)
A	6.63×10^{-15}	1.00×10^{19}
B	1.99×10^{-17}	3.00×10^{16}
C	3.49×10^{-19}	5.26×10^{14}
D	1.33×10^{-20}	2.00×10^{13}
E	6.63×10^{-26}	1.00×10^{8}



The slope of the graph would be

A) **6.63×10^{-34} J•s**
B) 6.67×10^{-11} N•m²/kg²
C) 1.60×10^{-19} J
D) 1.60×10^{-19} C

329. The energy of a photon is inversely proportional to its

A) **wavelength**
B) frequency
C) speed
D) phase

$E = \frac{hc}{\lambda}$

330. Compared to a photon of red light, a photon of blue light has a

A) **greater energy**
B) longer wavelength
C) smaller momentum
D) lower frequency

higher f
higher E

331. Which characteristic of electromagnetic radiation is directly proportional to the energy of a photon?

A) wavelength
B) period
C) **frequency**
D) path

332. What is the energy of a photon with a frequency of 5.00×10^{14} hertz?

A) 3.32 eV
B) 3.20×10^{-6} eV
C) 3.00×10^{48} J
D) **3.32×10^{-19} J**

$E = hf = (6.63\times10^{-34}\,Js)(5\times10^{14}\,Hz)$

333. What is the energy of a quantum of light having a frequency of 6.0×10^{14} hertz?

A) 1.6×10^{-19} J
B) **4.0×10^{-19} J**
C) 3.0×10^{8} J
D) 5.0×10^{-7} J

$E = hf$

334. Electrons in excited hydrogen atoms are in the $n = 3$ energy level. How many different photon frequencies could be emitted as the atoms return to the ground state?

A) 1
B) 2
C) **3**
D) 4

2+1

335. In which part of the electromagnetic spectrum does a photon have the greatest energy?

A) red
B) infrared
C) violet
D) ultraviolet

336.

The momentum of a photon, p, is given by the equation $p = \frac{h}{\lambda}$ where h is Planck's constant and λ is the photon's wavelength. Which equation correctly represents the energy of a photon in terms of its momentum?

A) $E_{photon} = phc$
B) $E_{photon} = \frac{hp}{c}$
C) $E_{photon} = \frac{p}{c}$
D) $E_{photon} = pc$

E = mc² p = mv E = hc/λ
p = h/λ
E = pc

337. A photon of light carries

A) energy, but not momentum
B) momentum, but not energy
C) both energy and momentum
D) neither energy nor momentum

338. On the atomic level, energy and matter exhibit the characteristics of

A) particles, only
B) waves, only
C) neither particles nor waves
D) both particles and waves

339. A photon is emitted as the electron in a hydrogen atom drops from the $n = 5$ energy level directly to the $n = 3$ energy level. What is the energy of the emitted photon?

A) 0.85 eV
B) 0.97 eV
C) 1.51 eV
D) 2.05 eV

ΔE = -1.51eV - -.54eV = .97eV

340. An electron in the c level of a mercury atom returns to the ground state. Which photon energy could *not* be emitted by the atom during this process?

A) 0.22 eV
B) 4.64 eV
C) 4.86 eV
D) 5.43 eV

c = 5.52eV
can't be greater than c

341. An electron in a mercury atom drops from energy level *f to energy level c by emitting a photon having an energy of*

A) 8.20 eV
B) 5.52 eV
C) 2.84 eV
D) 2.68 eV

E at f = -2.68eV
E at c = -5.52eV
Δ = 2.84 eV

Base your answers to questions **342** and **343** on the statement below.

The spectrum of visible light emitted during transitions in excited hydrogen atoms is composed of blue, green, red, and violet lines.

342. What characteristic of light determines the amount of energy carried by a photon of that light?

E=hf

A) amplitude
B) frequency
C) phase
D) velocity

343. Which color of light in the visible hydrogen spectrum has photons of the shortest wavelength?

A) blue
B) green
C) red
D) violet

high f means low λ

---

344. A photon having an energy of 9.40 electronvolts strikes a hydrogen atom in the ground state. Why is the photon *not* absorbed by the hydrogen atom?

A) The atom's orbital electron is moving too fast.
B) The photon striking the atom is moving too fast.
C) The photon's energy is too small.
D) The photon is being repelled by electrostatic force.

n=1 ground state = 13.6eV
n=2=3.40
Δ=10.2eV
9.4eV doesn't meet threshold

345. Which type of photon is emitted when an electron in a hydrogen atom drops from the n = 2 to the n = 1 energy level?

A) ultraviolet
B) visible light
C) infrared
D) radio wave

n=2=3.40eV
n=1=13.6eV
convert to J
ΔeV=10.2eV
$10.2eV \times \frac{1.6\times10^{-19}J}{1eV} = 1.63\times10^{-18}J$

346. A hydrogen atom with an electron initially in the n = 2 level is excited further until the electron is in the n = 4 level. This energy level change occurs because the atom has

A) absorbed a 0.85-eV photon
B) emitted a 0.85-eV photon
C) absorbed a 2.55-eV photon
D) emitted a 2.55-eV photon

n=4=.85eV
n=2=3.4eV
Δ=2.55eV

347. White light is passed through a cloud of cool hydrogen gas and then examined with a spectroscope. The dark lines observed on a bright background are caused by

A) the hydrogen emitting all frequencies in white light
B) the hydrogen absorbing certain frequencies of the white light
C) diffraction of the white light
D) constructive interference

absorbing means the colors disappear
emitting means color show up

348. After electrons in hydrogen atoms are excited to the n = 3 energy state, how many different frequencies of radiation can be emitted as the electrons return to the ground state?

A) 1
B) 2
C) 3
D) 4

2+1

349. What is the minimum energy needed to ionize a hydrogen atom in the n = 2 energy state?

A) 13.6 eV
B) 10.2 eV
C) 3.40 eV
D) 1.89 eV

The number on the chart is the amount of energy need to ionize the atom

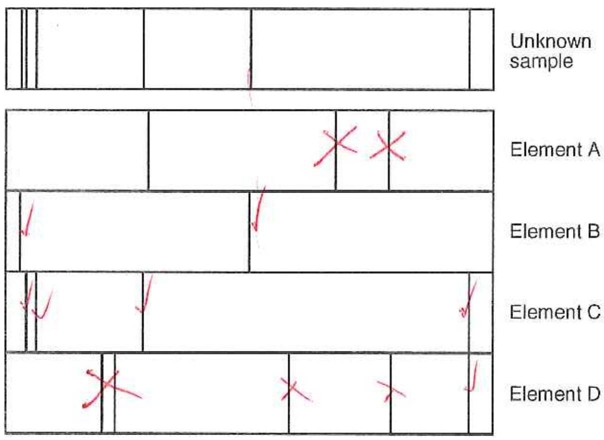
use $f = E/h = 2.46\times10^{15}$ Hz

350. A mercury atom in the ground state absorbs 20.00 electronvolts of energy and is ionized by losing an electron. How much kinetic energy does this electron have after the ionization?

A) 6.40 eV **B) 9.62 eV**
C) 10.38 eV D) 13.60 eV

KE is whatever is left over after ionization is achieved
Ionization required 13.6eV 20-13.6=9.62eV

351. The diagram below represents the bright-line spectra of four elements, *A*, *B*, *C*, and *D*, and the spectrum of an unknown gaseous sample.



Based on comparisons of these spectra, which two elements are found in the unknown sample?

A) *A* and *B* B) *A* and *D*
C) *B* and *C* D) *C* and *D*

352. How much energy is required to move an electron in a mercury atom from the ground state to energy level *h*?

A) 1.57 eV **B) 8.81 eV**
C) 10.38 eV D) 11.95 eV

n=a = 10.38eV ΔeV = 8.81eV
n=h = 1.57eV

353. The bright-line emission spectrum of an element can best be explained by

A) electrons transitioning between discrete energy levels in the atoms of that element
B) protons acting as both particles and waves
C) electrons being located in the nucleus
D) protons being dispersed uniformly throughout the atoms of that element

354. Excited hydrogen atoms are all in the $n = 3$ state. How many different photon energies could possibly be emitted as these atoms return to the ground state?

A) 1 B) 2 **C) 3** D) 4