ALL ABOUT ATOMS

The magnitude of the orbital angular momentum of an electron in an atom is what multiple of ¯h? (is a positive integer.)

1
1/2
(+1)
2 + 1
2

ans: C

The magnetic quantum number m is most closely associated with what property of an electron in an atom?

Magnitude of the orbital angular momentum
Energy
z component of the spin angular momentum
z component of the orbital angular momentum
Radius of the orbit
ans: D

The quantum number m_s is most closely associated with what property of the electron in an atom?

Magnitude of the orbital angular mome tum
Energy
z component of the spin angular momentum
z component of the orbital angu ar momentum
Radius of the orbit
ans: C

Possible values of the principal quantum number n for an electron in an atom are:

only 0 and 1
only 0, 1, 2, . . ., ∞
C. only 0, 1, . . ., − 1
only 1/2 and −1/2
only 1, 2, 3, . . ., ∞
ans: E

The number of values of the orbital quantum number associated with the principal quantum number n = 3 is:

1
2
3
4
7
ans: C

The number of possible values of the magnetic quantum number m associated with a given value of the orbital quantum number is:

1
2

2
2 + 1
ans: E

An atom is in a state with orbital quantum number = 2. Possible values of the magnetic quantum number m are:

1, 2
0,1,2
0, 1
−1, 0, 1
−2, −1, 0, 1, 2
ans: E

An electron is in a quantum state for which the magnitude of the orbital angular momentum is $6\sqrt{2}\hbar$. How many allowed values of the z component of the angular momentum are there?

4
5
7
8
9
ans: D

An electron is in a quantum state f r which there are seven allowed values of the z component of the angular momentum. The magnitude of the angular momentum is:

$\sqrt{3}\hbar$
$\sqrt{7}\hbar$
$\sqrt{9}\hbar$
$\sqrt{12}\hbar$
$\sqrt{14}\hbar$
ans: D

The number of states in a subshell with orbital quantum number = 3 is:

2
3
7
9
14
ans: E

The number of states in a shell with principal quantum number n = 3 is:

3
9
15
18
25
ans: D

An electron in an atom is in a state with principal quantum nu ber n = 4. The possible values of the orbital quantum number are:

1,2,3
1,2,3,4
−3, −2, −1, 0, 1, 2, 3
0,1,2,3
0,1,2
ans: D

Space quantization means that:

space is quantized
L_z can have only certain discrete values
C. L and $\vec{\mu}$ are in the same direction
D. L and $\vec{\mu}$ are in opposite directions
E. an electron has a magnetic dipole mome t
ans: B

An electron in an atom is in a state with = 3 and m = 2. The angle between L and the z axis is:

48.2°
60°
30°
35.3°
54.7°
ans: E

An electron in an atom is in a state with = 5. The minimum angle between L and the z axis is:

0°
18.0°
24.1°
36.7°
33.6°
ans: C

In the relation $\mu_z = -m\ \mu_B$, the quantity μ_B is:

the Bohr magneton
the component of the dipole moment along the magnetic field
the permeability of the material
a friction coefficient
none of the
above ans: A

The electron states that constitute a single shell for an atom all have:

the same value of n
the same value of
the same value of n and the same value of
D. the same value of and the same value of m
the same set of all four quantum
numbers ans: A

The electron states that constitute a single subshell for an atom all have:

only the same value of n
only the same value of
only the same value of n and the same value of
D. only the same value of and the same value of m
the same set of all four quantum numb rs
ans: C

The total number of electron states w th n = 2 and = 1 for an atom is:

two
four
six
eight
ten
ans: C

The possible values for the magnetic quantum number m_s of an electron in an atom:

depend on n
depend on
depend on both n and
depend on whether there is an external magnetic field present
are ±1/2
ans: E

The Stern-Gerlach experiment makes use of:

a strong uniform magnetic field
a strong non-uniform magnetic field
a strong uniform electric field
a strong non-uniform electric field
strong perpendicular electric and magnetic
fields ans: B

The magnetic field B is along the z axis in a Stern-Gerlach experiment. The force it exerts on a magnetic dipole with dipole moment μ is proportional to:

μ^2_z
B^2
dB/dz
d^2B/dz^2
$
B dz
ans: C

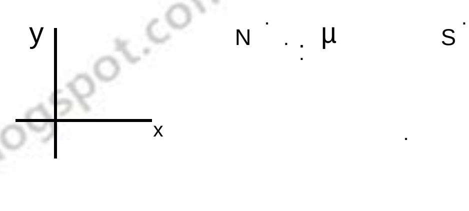
A magnetic dipole μ is placed in a strong uniform magnetic field B. The associated force exerted on the dipole is:

along μ
along − μ
along B
along μ × B
zero
ans: E

The force exerted on a magnetic dipole as it moves with velocity v through a Stern-Gerlach apparatus is:

proportional to v
proportional to 1/v
zero
proportional to v^2
independent of
v ans: E

A magnetic dipole is placed between the poles of a magnet as shown. The direction of the associated force exerted on the dip le is:



positive x
positive y
negative x
negative y
into or out of the page
ans: C

To observe the Zeeman effect one uses:

a strong uniform magnetic field
a strong non-uniform magnetic field
a strong uniform electric field
a strong non-uniform electric field
mutually perpendicular electric and magnetic fields ans: B

An electron in a K shell of an atom has the principal quantum nu ber:

$n = 0$
$n = 1$
$n = 2$
$n = 3$
$n = \infty$
ans: B

An electron in an L shell of an atom has the principal quantum number:

$n = 0$
$n = 1$
$n = 2$
$n = 3$
$n = \infty$
ans: C

The most energetic photon in a continuous x-ray spectrum has an energy approximately equal to:

the energy of all the electrons in a target atom
the kinetic energy of an incident-beam electron
the rest energy, mc^2, of an e ectr n
the total energy of a K-e ectron in the target atom
E. the kinetic energy of K-electron in the target atom
ans: B

Two different electron beams are incident on two different targets and both produce x rays. The cutoff wavelength for target 1 is shorter than the cutoff wavelength for target 2. We can conclude that:

target 2 has a higher atomic number than target 1
target 2 has a lower atomic number than target 1
the electrons in beam 1 have greater kinetic energy than those in beam 2
the electrons in beam 1 have less kinetic energy than those in beam 2
target 1 is thicker than target 2
ans: C

A photon with the smallest wavelength in the continuous z-ray spectrum is emitted when:

an electron is knocked from a K shell
a valence electron is knocked from the atom
the incident electron becomes bound to the atom
the atom has the greatest recoil energy
the incident electron loses all its energy in a single decelerating
event ans: E

Radiation with the minimum wavelength as well as the K x-ray lines are detected for a certain target. The energy of the incident electrons is then doubled, with the result that

the minimum wavelength increases and the wavelengths of the K lines remain the same
B. the minimum wavelength decreases and the wavelengths f the K lines remain the same
the minimum wavelength and the wavelengths of the K lines all increase
the minimum wavelength and the wavelengths of the K lines all decrease
the minimum wavelength increases and the wavelengths of the K lines all
decrease ans: B

Characteristic K x-radiation of an element occurs wh n:

the incident electron is absorbed by a target nucleus
the incident electron is scattered by a target atom without an energy loss
an electron is ejected from an outer sh ll of a target atom
an electron in a target atom makes a transition to the lowest energy state
the incident electron goes into the lowest energy
state ans: D

The K_α x rays arising from a cobalt (Z = 27) target have a wavelength of about 179 pm. The atomic number of a target that gives rise to K_α x rays with a wavelength one-third as great (≈ 60 pm) is:

Z = 9
Z=10
Z=12
Z=16
Z=46
ans: E

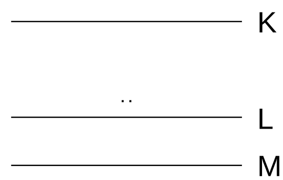
In connection with x-ray emission the symbol K_α refers to:

an alpha particle radiation
an effect of the dielectric constant on energy levels
x-ray radiation from potassium
x-ray radiation associated with an electron going from n = ∞ to n = 1
x-ray radiation associated with an electron going from n = 2 to n = 1
ans: E

In connection with x-ray emission the symbol L_β refers to:

a beta particle radiation
an atomic state of angular momentum h/2π
the inductance associated with an orbiting electron
x-radiation associated with an electron going from n = 4 to n = 2
none of the
above ans: D

The transition shown gives rise to an x-ray. The correct label for this is:



K_α
K_β
L_α
L_β
KL
ans: A

In a Moseley graph:

the x-ray frequency is plotted as a fu ct on of atomic number
the square of the x-ray frequency is p otted as a function of atomic number
the square root of the x-ray freque cy is plotted as a function of atomic number
the x-ray frequency is plotted as a fu ction of the square root of atomic number
the square root of the x-ray frequency is plotted as a function of atomic
mass ans: C

In calculating the x-ray energy levels the effective charge of the nucleus is taken to be Z − b, where Z is the atomic number. The parameter b enters because:

an electron is removed from the inner shell
a proton is removed from the nucleus
the quantum mechanical force between two charges is less than the classical force
the nucleus is screened by electrons
the Pauli exclusion principle must be
obeyed ans: D

The ratio of the avelength of the K_α x-ray line for Nb (Z = 41) to that of Ga (Z = 31) is:

9/16
16/9
3/4
4/3
1.15
ans: A

The Pauli exclusion principle is obeyed by:

all particles
all charged particles
all particles with spin quantum numbers of 1/2
all particles with spin quantum numbers of 1
all particles with mass
ans: C

No state in an atom can be occupied by more than one electron. This is most closely related to:

the wave nature of matter
the finite value for the speed of light
the Bohr magneton
the Pauli exclusion principle
the Einstein-de Haas
effect ans: D

Electrons are in a two-dimensional square potential n rgy well with sides of length L. The potential energy is infinite at the sides and ze o inside. The single-particle energies are given by $(h^2/8mL^2)(n^2_x + n^2_y)$, where n_x and n_y are intege s. At most the number of electrons that can have energy $8(h^2/8mL^2)$ is:

1
2
3
4
any number
ans: B

Five electrons are in a two-dimensi nal square potential energy well with sides of length L. The potential energy is infinite at the sides and zero inside. The single-particle energies are given by $(h^2/8mL^2)(n^2_x + n^2_y)$, where n_x and n_y are integers. In units of $(h^2/8mL^2)$ the energy of the ground state of the system is:

0
10
19
24
48
ans: C

Five electrons are in a two-dimensional square potential energy well with sides of length L. The potential energy is infinite at the sides and zero inside. The single-particle energies are given by $(h^2/8mL^2)(n^2_x + n^2_y)$, where n_x and n_y are integers. In units of $(h^2/8mL^2)$ the energy of the first excited state of the system is:

13
22
24
25
27
ans: B

Electrons are in a two-dimensional square potential energy well with sides of length L. The potential energy is infinite at the sides and zero inside. The single-particle energies are given by $(h^2/8mL^2)(n^2_x + n^2_y)$, where n_x and n_y are integers. The number of single-particle states with energy $5(h^2/8mL^2)$ is:

1
2
3
4
5
ans: B

Six electrons are in a two-dimensional square potential energy well with sides of length L. The potential energy is infinite at the sides a d zero inside. The single-particle energies are given by $(h^2/8mL^2)(n^2_x + n^2_y)$, where n_x and n_y are integers. If a seventh electron is added to the system when it is in its ground state the east energy the additional electron can have is:

$2(h^2/8mL^2)$
$5(h^2/8mL^2)$
$10(h^2/8mL^2)$
$13(h^2/8mL^2)$
$18(h^2/8mL^2)$
ans: C

When a lithium atom is made from a helium atom by adding a proton (and neutron) to the nucleus and an electron outside, the electron goes into an n = 2, = 0 state rather than an n = 1, = 0 state. This is an indication that electrons:

obey the Pauli exclusion principle
obey the minimum energy principle
undergo the Zeeman effect
are diffracted
and protons are
interchangeable ans: A

When a lithium atom in its ground state is made from a helium atom by adding a proton (and neutron) to the nucleus and an electron outside, the electron goes into an n = 2, = 0 state rather than an n = 3, = 0 state. This is an indication that electrons:

obey the Pauli exclusion principle
obey the minimum energy principle
undergo the Zeeman effect
are diffracted
and protons are
interchangeable ans: B

If electrons did not have intrinsic angular momentum (spin) but still obeyed the Pauli exclusion principle, the states occupied by electrons in the ground state f helium would be:

(n = 1, = 0); (n = 1, = 0)
(n = 1, = 0); (n = 1, = 1)
(n = 1, = 0); (n = 2, = 0)
(n = 2, = 0); (n = 2, = 1)
(n = 2, = 1); (n = 2, = 1)
ans: C

. The minimum energy principle tells us that:

the energy of an atom with a high atomic number is less than the energy of an atom with a low atomic number
B. the energy of an atom with a low atomic umber is less than the energy of an atom with a high atomic number
when an atom makes an upward trans t on the energy of the absorbed photon is the least possible
the ground state configuration of a y atom is the one with the least energy
the ground state configurati n f any atom is the one with the least ionization energy
ans: D

Which of the following (n, , m , m_s) combinations is impossible for an electron in an atom?

3, 1, 1, −1/2
6, 2, 0, 1/2
3, 2, −2, −1/2
3, 1, −2, 1/2
1, 0, 0, −1/2
ans: D

Which of the follo ing subshells cannot exist?

3p
2p
4d
3d
2d
ans: E

For any atom other than hydrogen and helium all electrons in the same shell have:

the same energy
the same magnitude of angular momentum
the same magnetic quantum number
the same spin quantum number
none of the
above ans: E

The states being filled from the beginning to end of the lanthanide series of atoms are:

n = 3, = 2 states
n = 4, = 1 states
n = 4, = 2 states
n = 4, = 3 states
n = 5, =2 states
ans: D

The most energetic electron in any atom at the b ginning of a period of the periodic table is in:

A. an = 0 state
B. an = 1 state
C. an = 2 state
an n = 0 state with unspecified angular mom ntum
an n = 1 state with unspecified angular
momentum ans: A

The most energetic electron in any atom at the end of a period of the periodic table is in:

A. an = 0 state
B. an = 1 state
C. an = 2 state
an n = 0 state with unspecified angular momentum
an n = 1 state with unspecified angular
momentum ans: B

The group of atoms at the ends of periods of the periodic table are called:

alkali metals
rare earths
transition metal atoms
alkaline atoms
inert gas
atoms ans: E

The group of atoms at the beginning of periods of the periodic table are called:

alkali metal atoms
rare earth atoms
transition metal atoms
alkaline atoms
inert gas
atoms ans: A

Suppose the energy required to ionize an argon atom is i, the energy to excite it is e, and its thermal energy at room temperature is t. In increasing order, these three energies are:

i, e, t
t, i, e
e, t, i
i, t, e
t, e, i
ans: C

The ionization energy of an atom in its ground state is:

the energy required to remove the least ene getic electron
the energy required to remove the most energetic electron
the energy difference between the most n rg tic electron and the least energetic electron
the same as the energy of a K_α photon
the same as the excitation energy of the most energetic
electron ans: B

The effective charge acting on a si gle valence electron outside a closed shell is about N e, where N is:

the atomic number of the nucleus
the atomic mass of the at m
usually between 1 and 3
half the atomic number
less than
1 ans: C

In a laser:

excited atoms are stimulated to emit photons by radiation external to the laser
the transitions for laser emission are directly to the ground state
the states which give rise to laser emission are usually very unstable states that decay rapidly
D. the state in hich an atom is initially excited is never between two states that are involved in the stimulated emission
a minimum of two energy levels are
required. ans: D

Photons in a laser beam have the same energy, wavelength, polarization direction, and phase because:

each is produced in an emission that is stimulated by another
all come from the same atom
the lasing material has only two quantum states
all photons are alike, no matter what their source
none of the
above ans: A

A laser must be pumped to achieve:

a metastable state
fast response
stimulated emission
population inversion
the same wavelength for all
photons ans: D

Photons in a laser beam are produced by:

transitions from a metastable state
transitions to a metastable state
transitions from a state that decays rapidly
splitting of other photons
pumping
ans: A

Which of the following is essential for laser action to occur between two energy levels of an atom?

the lower level is metastable
the upper level is metastab e
the lower level is the ground state
there are more atoms in the lower level than in the upper level
E. the lasing material is g s
ans: B

Which of the following is essential for laser action to occur between two energy levels of an atom?

the lower level is metastable
there are more atoms the upper level than in the lower level
there are more atoms in the lower level than in the upper level
the lower level is the ground state
the lasing material is a
gas ans: B

Population inversion is important for the generation of a laser beam because it assures that:

spontaneous emission does not occur more often than stimulated emission
photons do not split too rapidly
more photons are emitted than are absorbed
photons do not collide with each other
photons do not make upward
transitions ans: C

A metastable state is important for the generation of a laser beam because it assures that:

spontaneous emission does not occur more often than sti ulated emission
photons do not split too rapidly
more photons are emitted than are absorbed
photons do not collide with each other
photons do not make upward
transitions ans: A

Electrons in a certain laser make transitions from a m tastable state to the ground state. Initially there are 6×10^{20} atoms in the metastable state and 2×10^{20} atoms in the ground state. The number of photons that can be produced in a single burst is about:

2×10^{20}
3×10^{20}
4×10^{20}
6×10^{20}
8×10^{20}
ans: C

. In a helium-neon laser, the laser light arises from a transition from a _____ state to a _____ state.

A. He, He
B. Ne, Ne
C. He, Ne
D. Ne, He
E. N, He

ans: B

. The purpose of the mirrors at the ends of a helium-neon laser is:

A. to assure that no laser light leaks out
B. to increase the number of stimulated emissions
C. to absorb some of the photons
D. to keep the light used for pumping inside the laser
E. to double the effective length of the laser

ans: B

A group of electromagnetic waves might

be monochromatic

II. be coherent

III. have the same polarization direction

Which of these describe the waves from a laser?

I only
II only
III only
I and II only
I, II, and III
ans: E

A laser beam can be sharply focused because it is:

highly coherent
plane polarized
intense
circularly polarized
highly directional
ans: E

The “e” in laser stands for:

electric
emf
energy
emission
entropy
ans: D