Test bank chapter (7)

سؤال 23 ✗
(d) الفترة الرابعة

Choose the most correct answer

1. The lowest energy state of an atom is referred to as its
   a) bottom state.
   b) **ground state.**
   c) fundamental state.
   d) original state.

2. All (s) orbitals are
   a) shaped like four-leaf clovers.
   b) dumbbell-shaped.
   c) spherical.
   d) triangular.

3. $[He]2s^2 2p^2$ is the electron configuration of which element?
   a) Beryllium Be
   b) Boron B
   c) carbon C
   d) nitrogen N

$2s^2 2p^2 = 4$ عدد الالكترونات
الدورة الثانية

4. What are the valence electrons of vanadium (V)?
   a) $4s^2$
   b) $3d^3$
   c) $4s^2 3d^3$
   d) $3d^5$

$V^{23}: 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$

5. What are the valence electrons of gallium Ga?
   a) $4s^2$
   b) $3d^3$
   c) $4s^2 4p^1$
   d) $3d^5$

$Ga^{31}: 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^1$
$ns^2 np^1$

6. The electron configuration of a neutral atom is [Ne] $3s^2 3p^1$. The four quantum numbers of the last electron are:
   a) (2, 1, -1, +1/2)
   b) (3, 3, -1 , +1/2)
   c) (3, 0, -1, +1/2)
   d) (3, 1, -1, +1/2)

-1 0 +1
1
last one

$n=3, \ell=1, m\ell=-1, m_s=+\frac{1}{2}$
$(3, 1, -1, +\frac{1}{2})$

7. How many unpaired electrons does chromium (Cr) have?
   a) 0
   b) 2
   c) 4
   d) 6

$Cr^{24}: [Ar] 4s^2 3d^4$ less stable
$: [Ar] 4s^1 3d^5$ more stable

1 | 1 1 1 1 1 | 6 unpaired e

8. How many unpaired electrons does selenium (Se) have?
   a) 0
   b) 2
   c) 4
   d) 6

$Se: [Ar] 4s^2 4p^4$

1↓ | 1↓ 1↑ 1↑ | 1↑
2 unpaired

9. What is the maximum number of orbitals described by the quantum numbers: $n = 3$ $l = 2$

a) 1
b) 3
c) **5**
d) 9

$m_l = 2l+1$

$m_l = 2(2)+1 = 5$

10. What is the maximum number of orbitals described by the quantum numbers: $n = 4$

a) 7
b) 14
c) **16**
d) 48

$n^2 = 4^2 = 16$

11. The maximum number of electrons that can occupy an energy level described by the principal quantum number, n, is

a) $n+1$
b) $2n$
c) $2n^2$
d) n^2

$2n^2$

12. A possible set of quantum numbers for the last electron added to complete an atom of sodium (Na) in its ground state is

a) $n=3$, $l=1$, $m_l=0$, $m_s=½$
b) $n=3$, $l=0$, $m_l=0$, $m_s=½$
c) $n=2$, $l=1$, $m_l=-1$, $m_s=½$
d) $n=2$, $l=0$, $m_l=-1$, $m_s=½$

$Na^{11}: 1s^2 2s^2 2p^6 3s^1$ last é

$(3, 0, 0, +\frac{1}{2})$

$n = 3$
$l = 0$
$m_l = 0$
$m_s = +\frac{1}{2}$

13. The ground-state electron configuration of a calcium atom is

a) $[Ne]3s^2$
b) $[Ne]3s^23p^6$
c) $[Ar]4s^13d^1$
d) $[Ar]4s^2$

$Ca^{20}: [Ar]4s^2$

14. Which one of the following sets of quantum numbers is not possible?

	n	l	m_l	m_s
Row 1	4	3	−2	+1/2
Row 2	3	2	−3	−1/2
Row 3	3	0	0	+1/2
Row 4	4	1	1	−1/2
Row 5	2	0	0	+1/2

a) Row 1
b) Row 2
c) Row 3
d) Row 4

15. The number of orbitals in a d subshell is

a) 1
b) 3
c) **5**
d) 7

$l = 2$ بالقانون $\rightarrow m_l = 2l+1 = 2(2)+1 = 5$

5 عدد الأفرع

16. Which ground-state atom has an electron configuration described by the following *orbital diagram*?

[Ar] ↑↓ (4s) ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ (3d) ↑↓ ↑ ↑ (4p)

a) phosphorus
b) germanium
c) selenium
d) tellurium

بالدورة الرابعة
والمجموعة الـ 6 سادسة

$4s^2 4p^4 = 6$

17. A ground-state atom of nickel has ___ unpaired electrons and is _____.

Ni^{28} : $[Ar]4s^2 3d^8$

a) 0, diamagnetic
b) 6, diamagnetic
c) 3, paramagnetic
d) 2, paramagnetic

↑↓ ↑↓ ↑↓ ↑ ↑ 2 unpaired é

18. What is the frequency (s^{-1}) of electromagnetic radiation that has a wavelength of 0.53 m?

$c = \lambda\nu$

a) **5.7×10^8**
b) 1.8×10^{-9}
c) 1.6×10^8
d) 1.3×10^{-33}

$\nu = \frac{c}{\lambda} \Rightarrow \nu = \frac{3\times10^8}{0.53} = 566037735.8$ (s) 5.7×10^8

Explanation: The frequency and wavelength of electromagnetic radiation are related by the equation $c = \lambda\nu$, where c is the speed of light (=3.00 x 108 m/s), λ is the wavelength in m and v is the frequency is s^{-1} or Hz. The frequency can be calculated by rearranging the above formula to get $\nu = c/\lambda = 3 \times 10^8 / 0.53 = 5.7 \times 10^8\ s^{-1}$

19. The energy of a photon of light is____ proportional to its frequency and _____ proportional to its wavelength.

$E = h\nu$ (علاقة طردية (متعامد)) $E = h\frac{c}{\lambda}$ (علاقة عكسية (مقلوب))

a) directly, directly
b) inversely, inversely
c) inversely, directly
d) directly, inversely

20. The wavelength of a photon of energy 5.25×10^{-19} J is _____m.

$E = h\frac{c}{\lambda}$

$5.25\times10^{-19} = \frac{6.63\times10^{-34}\times3\times10^8}{\lambda}$

$\lambda = \frac{6.63\times10^{-34}\times3\times10^8}{5.25\times10^{-19}}$

$\lambda = 3.79\times10^{-7}\ m$

a) 2.64×10^6
b) **3.79×10^{-7}**
c) 2.38×10^{23}
d) 4.21×10^{-24}

Explanation: The wavelength and energy are related by the formula $E = hc/\lambda$, where h (6.626×10^{-34} Js) is Planck's constant , c is the speed of light (3.00×10^8 m/s) and λ is the wavelength in meters. The wavelength can then be calculated by rearranging the above formula as follows: $\lambda = hc/E = 6.63\times10^{-34}\times 3\times10^8 / 5.25\times10^{-19} = 3.79 \times 10^{-7}$ m

21. What is the frequency (s^{-1}) of a photon of energy 4.38×10^{-18}J?

a) 438
b) 1.45×10^{-16}
c) **6.61×10^{15}**
d) 2.30×10^{7}

$E = h\nu$

$\nu = \frac{E}{h} \Rightarrow \nu = \frac{4.38 \times 10^{-18}}{6.63 \times 10^{-34}} = 6.61 \times 10^{15}\ Hz, \frac{1}{s}, s^{-1}$

Explanation: The frequency ν of this photon can be calculated by rearranging the equation E = h ν where E is the energy, h = Planck's constant and ν = frequency in s^{-1}. ν =E/h =4.38×10^{-18}/ 6.63×10^{-34} = 6.61×10^{15}

22. An electron is a Bohr hydrogen atom has energy of -1.362×10^{-19}J. The value of n for this electron is _____.

a) 1
b) 2
c) 3
d) **4**

$\left(\frac{n^2}{1}\right) E_n = -R_H \left(\frac{1}{n^2}\right)\left(\frac{n^2}{1}\right)$

$\frac{n^2 E_n}{E_n} = \frac{-R_H}{E_n}$

$\sqrt{n^2} = \sqrt{\frac{-R_H}{E_n}}$

$n = \sqrt{\frac{-2.18 \times 10^{-18}\ J}{-1.362 \times 10^{-19}\ J}}$

$n \simeq 4$

Explanation: The energy of an electron in a particular energy state in the hydrogen atom can be calculated by using the formula E = (-2.18×10^{-18} J)/n^2, where n is the principal quantum number for the energy state. The value of n can be found by rearranging the above formula as follows:

$$n = \sqrt{\frac{-2.18 \times 10^{-18}\ J}{-1.362 \times 10^{-19}\ J}} = 4$$

$n_i < n_f$

19. The n = 2 to n = 6 transition in the Bohr hydrogen atom corresponds to the __ of a photon with a wavelength of__ nm.

a) emission, 411
b) **absorption, 411**
c) absorption, 657
d) emission, 389

$\Delta E = R_H \left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$

$\Delta E = 2.18 \times 10^{-18} \left(\frac{1}{4} - \frac{1}{36}\right)$

$= 2.18 \times 10^{-18} (0.22) = 4.84 \times 10^{-19}\ J$

$E = h\frac{c}{\lambda}$

$4.84 \times 10^{-19} = 6.63 \times 10^{-34} \times \frac{3 \times 10^{8}}{\lambda}$

$\lambda = 4.109 \times 10^{-7}\ m$

$= 4.11 \times 10^{-7} \times 10^{9} = 411\ nm$ nm

Explanation: There are 2 parts to this question. Since the electron is moving from a smaller value of n (ni) to a larger value of n (n_f), it must be absorbing energy. The wavelength responsible for this transition can be calculated by using the formula: $E = R_H (1/n_i^2 - 1/n_f^2)$ & $E = hc/\lambda$

20. How many quantum numbers are necessary to designate a particular electron in an atom _____?

a) 3
b) **4** → n, l, m_l, m_s
c) 2
d) 1

21. The _____ quantum number defines the shape of an orbital.

a) spin
b) magnetic
c) principal
d) **angular** → l

22. There are _____ orbitals in the third shell

a) 25
b) 4
c) **9**
d) 16

Explanation: The number of orbitals in a shell is easily calculated by the formula # of orbitals = n^2 where n = principal quantum number, which is 3 in this case.

23. The angular quantum number is 3 in _____ orbitals.

a) s
b) p
c) d
d) f

24. The n = 1 shell contains _____p orbitals. All the other shells contain _____p orbitals.

a) 3, 6
b) **0, 3**
c) 6, 2
d) 3, 3

Explanation: If n = 1, then the only possible value of ℓ is 0 which means that n = 1 can contain only s orbitals. When n > 1, the value of ℓ = 1 is possible making the existence of 3 p orbitals possible.

25. The principal quantum number of the first d subshell is _____.

a) 1
b) 2
c) **3**
d) 4

26. The total number of orbitals in a shell is given by _____.

a) L^2
b) $\mathbf{n^2}$
c) 2n
d) 2n + 1

28. Each p-subshell can accommodate a maximum of _____electrons.

a) **6**
b) 2
c) 10
d) 3

Explanation: There are 3 different p orbitals: px, py and pz. Each of these can contain 2 electrons leading to the maximum number of electrons as 6.

29. Each p-subshell can accommodate a maximum of _____ electrons.

a) **6**
b) 2
c) 10
d) 3

Explanation: There are 3 different p orbitals: p_x, p_y and p_z. Each of these can contain 2 electrons leading to the maximum number of electrons as 6.

30. The 3p subshell in the ground state of atomic xenon contains _____ electrons.

a) 2
b) **6**
c) 36
d) 10

Explanation: Since Xe is a noble gas, its subshells will be completely filled regardless of their principal quantum number. Thus the 3p subshell will contain 6 electrons.

31. $[Ar]4s^2 3d^{10} 4p^3$ is the electron configuration of a(n) _____ atom.

a) **As**
b) V
c) P
d) Sb

Explanation: The easiest way to answer this question is to count the total number of electrons and find which element that number corresponds to. The total number of electrons is = 18 (for the Ar) + 2 +10 + 3 = 33 which corresponds to As.

32. The principal quantum number for the outermost electrons in a Br atom in the ground state is _____.

a) 2
b) 3
c) **4**
d) 5

Explanation: The electronic configuration of bromine is $[Ar]3d^{10}4s^24p^5$ shows that the outermost electrons are in the s and p orbitals in the 4th energy level making the principal quantum number = 4.

33. All of the _____ have a valence shell electron configuration ns^1.

a) noble gases
b) halogens
c) chalcogens
d) **alkali metals**

34. Which one of the following is correct?

a) $v + \lambda = c$
b) $v/\lambda = c$
c) $\lambda = cv$
d) $v\lambda = c$

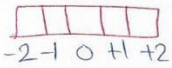
$C = \lambda \times \upsilon$

35. In the Bohr model of the atom, _____.

a) electrons travel in circular paths called orbitals
b) electrons can have any energy
c) **electron energies are quantized**
d) electron paths are controlled by probability

36. Which one of the following is not a valid value for the magnetic quantum number of an electron in a 5d subshell?

a) 2
b) 3
c) 0
d) 1



Explanation: For an electron in the 5d subshell the value of $\ell = 2$ and the magnetic quantum number $m\ell$ can have values from –l,…0,…+l, meaning $m\ell$ could not have a value = 3.

37. Which of the subshells below do not exist due to the constraints upon the angular quantum number?

a) 2s
b) **2d**
c) 2p
d) none of the above

Explanation: The values of the azimuthal quantum number "l" are decided by the values of the principal quantum number "n". The values of l will only be from 0…n – 1. Thus for n = 2, only the values of 0 and 1 will be possible for ℓ, which means that only the 2s and 2p orbitals will be possible.

38. An electron cannot have the quantum numbers n = _____, l = _____, $m\ell$ = _____.

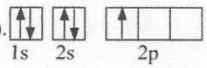
a) 2, 0, 0
b) 2, 1, -1
c) 3, 1, -1
d) 1, 1, 1

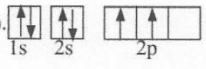
Explanation: The values of 1, 1, 1 would be impossible since if n = 1, the only value of ℓ would be = 0.

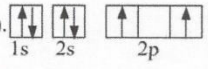
39. Which quantum number determines the energy of an electron in a hydrogen atom?

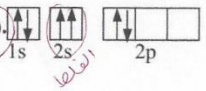
a) n
b) n and ℓ
c) ml
d) ℓ

39. Which electron configuration represents a violation of the Pauli exclusion principle?

(a). 

(b). 

(c). 

(d). 

Explanation: According to the Pauli Exclusion Principle no two electrons in an atom cannot have the same 4 quantum numbers. The2 electrons in the 2s orbital have the same value for their ms which is not allowed. **(d)**

40. Which of the following is a valid set of four quantum numbers? (n, ℓ, mℓ, ms)

a) **2, 0, 0, + ½**
b) 2, 2, 1, - ½
c) 1, 0, 1, + ½
d) 2, 1, +2, + ½

Explanation: Here is why only option (a) is the correct answer: In option (b), ℓ =2 which is not allowed, in (c) mℓ ≠ 1 since l = 0 and in (d) m ℓ > l which are all not allowed.

41. Which of the following is not a valid set of four quantum numbers? (n, ℓ, mℓ, ms)

a) 2, 0, 0, + ½
b) 2, 1, 0, - ½
c) 1, 1, 0, + ½
d) 1, 0, 0, + ½

Explanation: Since n can never be equal to ℓ, option c is the only set that is not valid.