Name: _____ Class: _____ Date: _____ ID: A

SCH4U Chapter 3 Quiz 1

Multiple Choice
Identify the choice that best completes the statement or answers the question.

1. One of the downfalls of Dalton's theory was
Ⓐ that it did not support the four elements theory Ⓑ the discovery of the electron Ⓒ that the atoms could not be seen Ⓓ that it was not true

2. In Thomson's raisin bun model,
Ⓐ the dough represents the positively charged sphere, and the raisins represent the negatively charged electrons Ⓑ the dough represents the negatively charged sphere, and the raisins represent the positively charged electrons Ⓒ the dough represents an uncharged sphere, and the raisins represent the negatively or positively charged electrons Ⓓ none of the above

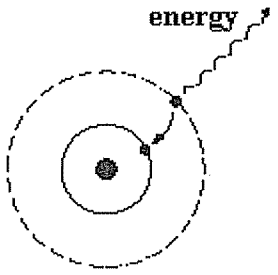
3. Niels Bohr was able to explain the line spectrum of
Ⓐ helium Ⓑ hydrogen Ⓒ neon Ⓓ sodium

4. Bohr's theory is based on the fact that an electron's energy is
Ⓐ negligible Ⓑ very large Ⓒ always the same Ⓓ quantized

5. Bohr compared the electrons in an atom to
Ⓐ raisins in a bun Ⓑ bees around a beehive Ⓒ planets orbiting the sun Ⓓ stars in the sky

6. Bohr's model was successful because
Ⓐ it could explain the line spectrum of hydrogen Ⓑ it introduced the idea of quantized energy Ⓒ it explained why the atom did not collapse Ⓓ all of the above

7. With his model, Bohr hypothesized that there were different energy levels. How many energy levels are there?
Ⓐ 3 Ⓑ 10 Ⓒ 15 Ⓓ infinite



8. The diagram above represents an atom whose electron is
Ⓐ moving from the ground state to an excited state Ⓑ moving from an excited state to the ground state Ⓒ absorbing a quantum of energy Ⓓ none of the above

9. Which electron configuration represents the most reactive metallic element?
Ⓐ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$ Ⓑ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$ Ⓒ $1s^2\ 2s^2\ 2p^6\ 3s^2$ Ⓓ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ Ⓔ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

10. How many *p* orbitals are in each energy level, except $n = 1$?
Ⓐ 1 Ⓑ 3 Ⓒ 5 Ⓓ 6 Ⓔ 7

11. What is the maximum number of electrons in $n = 3$?
Ⓐ 2 Ⓑ 3 Ⓒ 6 Ⓓ 9 Ⓔ 18

12. What is the total number of electrons in the $2p$ orbitals of a sulfur atom at ground state?
Ⓐ 8 Ⓑ 6 Ⓒ 4 Ⓓ 3 Ⓔ 2

13. Which sublevel, when full, corresponds to the first row of transition elements?
Ⓐ $3d$ Ⓑ $3f$ Ⓒ $4d$ Ⓓ $4f$ Ⓔ $4p$

14. Which sublevel, when full, corresponds to the lanthanide series of elements?
Ⓐ $3d$ Ⓑ $3f$ Ⓒ $4d$ Ⓓ $4f$ Ⓔ $5f$

15. Which element has the highest electron affinity?
Ⓐ Li Ⓑ N Ⓒ O Ⓓ F Ⓔ B

16. Which metal is the most reactive?
Ⓐ Al Ⓑ K Ⓒ Cu Ⓓ Zn Ⓔ Ca

17. Which element has the largest atomic radius?
Ⓐ Sr Ⓑ Be Ⓒ F Ⓓ Cl Ⓔ Si

18. Which element has the smallest effective nuclear charge?
Ⓐ Al Ⓑ S Ⓒ I Ⓓ Be Ⓔ Na

19. Which element has the lowest first ionization energy?
Ⓐ Ca Ⓑ Cs Ⓒ Br Ⓓ O Ⓔ Ba

20. The special band of light waves that the human eye can detect is known as the
Ⓐ continuous spectrum Ⓑ line spectrum Ⓒ radio spectrum Ⓓ visible spectrum

21. Each element has a characteristic
Ⓐ continuous spectrum Ⓑ line spectrum Ⓒ radio spectrum Ⓓ visible spectrum

22. Which object(s) would you use to describe the shape of the $2p$ orbital?
Ⓐ a dumb-bell Ⓑ a shamrock Ⓒ a sphere Ⓓ a doughnut with a dumb-bell in the centre Ⓔ a doughnut

23. Which object(s) would you use to describe the shape of the $2s$ orbital?
Ⓐ a dumb-bell Ⓑ a shamrock Ⓒ a sphere Ⓓ two perpendicular dumb-bells Ⓔ a doughnut

24. The neutron was discovered by
Ⓐ Thomson Ⓑ Dalton Ⓒ Rutherford Ⓓ Chadwick

25. Which situation must be true for two electrons to occupy the same orbital?
Ⓐ The electrons must have the same principal quantum number, but the other quantum numbers must be different. Ⓑ The electrons must have the same spin. Ⓒ The electrons must have identical sets of quantum numbers. Ⓓ The electrons must have low energy. Ⓔ The electrons must have the opposite spin.

26. An electron has the following set of quantum numbers: $n = 3$, $l = 1$, $m_l = 1$, $m_s = +\frac{1}{2}$. In which orbital is this electron found?
Ⓐ $3s$ Ⓑ $3p$ Ⓒ $3d$ Ⓓ $3f$ Ⓔ $4p$

27. Which element contains a full $3s$ orbital?
Ⓐ B Ⓑ Na Ⓒ Mg Ⓓ Be Ⓔ Ne

28. When an electron gains a specific amount of energy,
Ⓐ it moves to a higher energy level Ⓑ it gives off light energy Ⓒ it moves to its ground state Ⓓ none of the above

29. An electron that occupies a higher energy level than normal is said to be in
Ⓐ the wrong energy level Ⓑ an excited state Ⓒ a higher state Ⓓ the ground state

30. Electrons in their ground state
Ⓐ are not moving Ⓑ give off light energy continually Ⓒ do not emit any light energy Ⓓ none of the above

31. Which set of quantum numbers is not possible?
Ⓐ $n = 3, l = 0, m_l = 0, m_s = \frac{1}{2}$ Ⓑ $n = 5, l = 3, m_l = 2, m_s = \frac{1}{2}$ Ⓒ $n = 4, l = 3, m_l = -1, m_s = -\frac{1}{2}$ Ⓓ $n = 5, l = 3, m_l = -3, m_s = -\frac{1}{2}$ Ⓔ $n = 4, l = 4, m_l = 2, m_s = -\frac{1}{2}$

32. Which element has the ground state electron configuration [Ne] $3s^2 3p_x^1 3p_y^1$ for its valence electrons?
Ⓐ Mg Ⓑ Al Ⓒ Si Ⓓ P Ⓔ S

33. Which electron configuration represents a reactive non-metallic element?
Ⓐ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$ Ⓑ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$ Ⓒ $1s^2\ 2s^2\ 2p^6\ 3s^2$ Ⓓ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ Ⓔ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

34. Rutherford's atomic model solved problems inherent in Thomson's atomic model, but it also raised others. Which of the following is **NOT CORRECT.**
Ⓐ an atomic nucleus composed entirely of positive charges should fly apart due to electrostatic forces of repulsion. Ⓑ the model could not adequately explain the total mass of an atom. Ⓒ an electron in motion around a central body *must* continuously give off radiation. Consequently, one should be able to observe a continuous spectrum (a "rainbow") of light energy as the electron gives off its radiation. Ⓓ the electron should also lose energy as a result of this radiation, the radius of its orbit should continuously decrease in size until it spirals into the nucleus Ⓔ All the above are correct

35. Which statement about the 4 quantum numbers is **INCORRECT.**
Ⓐ The principal quantum number, n, indicates the energy level of an atomic orbital and its relative size.
Ⓑ The orbital-shape quantum number, l, indicates the shape of the orbital.
Ⓒ The magnetic quantum number, m_l, indicates the orientation of the orbital.
Ⓓ The spin quantum number, m_s, indicates the direction in which the orbital is spinning.
Ⓔ All of the above are correct

36. The maximum number of subshells permitted for a particular shell or energy level is equal to

Ⓐ n^2 Ⓑ 2 x n^2 Ⓒ 0 to n-1 Ⓓ n - +1/2 Ⓔ none of the above

37. Ionization energy increases as you go from left to right on the periodic table because
Ⓐ atomic radius decreases
Ⓑ n levels increase
Ⓒ atomic redius increases
Ⓓ Zeff decreases
Ⓔ none of the above

38. The major factor that causes ionization energy to decreases as you go down a group is because
Ⓐ atomic radius increases
Ⓑ n levels decrease
Ⓒ atomic redius decreases
Ⓓ Zeff decreases
Ⓔ none of the above

39. This scientist demonstrated that the atomic nuclei must contain heavy neutral particles as well as positive particles. These neurtal subatomic particles are called neutrons.
Ⓐ Chadwick Ⓑ Dalton Ⓒ Rutherford Ⓓ Thomson Ⓔ Nagaoka

40. The maximum number of electrons permitted in a particular shell is equal to

Ⓐ n^2 Ⓑ 2 x n^2 Ⓒ 0 to n-1 Ⓓ n - +1/2 Ⓔ none of the above

41. The azimuthal quantum number tells us which subshell the electron is found in, and therefore it tells us the shape of the orbital. l can have values ranging from

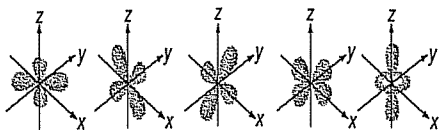
Ⓐ 0 to n-1 Ⓑ 1 to n-1 Ⓒ 0 to n-2 Ⓓ 0 to n^2 Ⓔ both A and B

42. The number of orbitals permitted for a particular subshell is equal to

Ⓐ $2l + n$ Ⓑ $2l + 1$ Ⓒ $2l + 2$ Ⓓ $2l + 3$ Ⓔ $2l - 1$

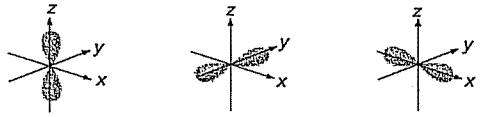
43. The magnetic quantum number, m_l, can have values ranging from
Ⓐ 0 to $+l$ Ⓑ $-l$ to $+l$ Ⓒ n to $+l$ Ⓓ n^2 to $-n^2$ Ⓔ 2n to -2n

44. The following diagram represents which type of orbital



Ⓐ p Ⓑ s Ⓒ d Ⓓ f Ⓔ l

45. The following diagram represents which type of orbital



Ⓐp Ⓑs Ⓒd Ⓓf Ⓔl

Short Answer

46. Briefly explain Rutherford's experiment? **10 level marks**

47. Rutherford's atomic model solved many problems inherent in Thomson's atomic model, but it also raised others. List and explain these. **10 level marks**

48. What are the allowed values of l and m_l if $n = 2$? What is the total number of orbitals and their names in this energy level? Show equations to get numbers if possible. **10 level marks**

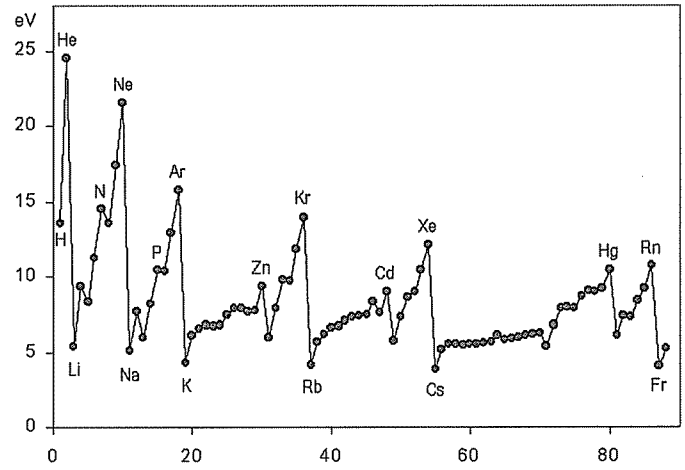
49. Explain Hund's rule and the Pauli exclusion principle.**10 level marks**

50. The condensed electron configuration for Cr is [Ar] $4s^1 3d^5$ which does not follow the aufbau principle. Explain why this is the case. **10 level marks**

51. Describe and explain the general trends in atomic radius across a period from left to right on the periodic table. **10 level marks**

52. The ionization energies of a given atom are IE_1 = 800 kJ/mol, IE_2 = 2400 kJ/mol, IE_3 = 3700 kJ/mol, IE_4 = 25 000 kJ/mol, and IE_5 = 32 800 kJ/mol. Predict the valence electron configuration for the atom, and explain your reasoning. **10 level marks**

53. Consider the following graph of IE vs Atomic Number.



a) Explain the "dip"at element Oxygen. **10 level marks**

b) Given what you have learned in this chapter provide a reasonable explanation for the value at element Zn. **10 level marks**

SHORT ANSWER

46. ANS:
Rutherford based his model on evidence from his alpha particle scattering experiments. In these experiments, most alpha particles passed through the gold foil with almost no deflection. About one in every 8000, however, was deflected significantly. A few of the particles even bounced back. These results were inconsistent with Thomson's model, which predicted that alpha particles would be deflected by no more than 0.005°.

PTS: 10

47. ANS:

it could not explain the following.
1. If the nucleus of an atom contained several positive protons that repelled each other, how did it stay together?
   or
   An atomic nucleus composed entirely of positive charge should fly apart due to the electrostatic forces of replusion.
2. It could not explain the total mass of an atom.
3. An electron giving off radiation should lose energy and spiral into the nucleus
   why didn't the negatively charged electrons rush toward and crash into the positively charged nucleus?
3. *electrons in motion around the nucleus should continuously give off radiation in the form of light and one should observe a continuous spectrum*

PTS: 10 DIF: Average

48. ANS:
If $n = 2$, then $l = 0, 1$.
For $l = 0$, $m_l = 0$.
For $l = 1$, $m_l = -1, 0, 1$.
There are four orbitals in this energy level.

PTS: 10 DIF: easy REF: K/U | C

49. ANS:
The Pauli exclusion principle states that no two electrons in an atom have the same four quantum numbers. (In other words, no two electrons can occupy the same orbital with the same spin.) For example, boron's electron configuration is $1s^2\ 2s^2\ 2p^1$.

Hund's rule states that whenever electrons are added to orbitals of the same energy sub-level, each orbital receives one electron before any pairing occurs. When electrons are added singly to separate orbitals of the same energy sublevel, the electrons must all have the same spin. For example, the electron configuration of nitrogen is $1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^1$.

PTS: 10 DIF: average REF: K/U | C

50. ANS:
The reason that Cr does not follow the aufbau principle is that this configuration gives the atom greater stability with an electron configuration that does not conform to predicted patterns

PTS: 10

51. ANS:
Atomic radius decreases as you go left to right across a period in the periodic table. The valence electrons are found in orbitals of the same energy level. At the same time, the effective nuclear charge is increasing with the increase in nuclear charge, which results in a greater force of attraction pulling the valence electrons closer to the nucleus. Thus, atomic size decreases.

PTS: 10 DIF: average REF: K/U | C

52. ANS:
The atom probably has three valence electrons because the increase from the third to the fourth ionization energies is much greater than the increase from the first to the second to the third ionization energies. This large increase can be explained by the fact that the fourth electron is being removed from a filled energy level, which is closer to the nucleus. Thus, the outer (valence) electrons have all been removed.
The electron configuration could be $1s^2ns^2np^1$ or n=2,3,4,5

PTS: 10

53. ANS:
a) The X axis would be atomic number and the Y axis would be IE
b) The dip at O is because this is the first pairing of the p orbital. np3 is more stable (all three p orbitals half filled) than np4. e replusions increase orbital nrg therefore the e is more easily removed and IE drops
c) Zn is the last transition element and is the last d orbital to be filled. A full d orbital or any orbital for that matter is very stable. This stability would cause the IE for Zn to be sig higher than the other transition elements.

PTS: 20