

Unit III Answers

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1. Bohr's model proposed that the electrons could only be in certain orbits, not in any orbit as Rutherford proposed. The kinds of particles did not change.
2. It gives off the energy change as light (electromagnetic radiation).
3. n represents the principal quantum level.
4. Atomic number 22
5. $1s^2 2s^2 2p^6 3s^2 3p^1$
6. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$
7. five
8. a) Each orbital can hold at most two electrons. The s sublevel has only one orbital so it can only hold two electrons, not $2s^3$.
b) Orbitals fill from the lowest energy level (or even sublevel) first so it should be $2p^6$, not $2p^5 3s^1$.
9. Shorter wavelengths represent emission of more energy in the $n=4$ to $n=1$ change than the $n=2$ to $n=1$ change.
10. 18.
11. The $4s$ orbital has less energy than the $3d$.

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1. Atomic mass is the **average** mass of all the isotopes of an atom measured in either atomic mass units or in grams/mole.
4. grams/mole.
5. 6.022×10^{23} particles is one mole.
6. 0.500 moles 7. 2.4×10^{24} atoms 8. 2.00 mole 9. 1.3 mole
10. 2.2 grams; 1.2×10^{23} atoms
11. Molar mass is the mass in grams of one mole of atoms of an element.

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10. An orbital is a region in space (it is near the nucleus) where there is a high probability of finding an electron.
23. It limits the number of electrons in an orbital to two where each must have opposite spin. In this way no two electrons can have the same set of the four quantum numbers.
24. Electrons are placed in the next lowest (bottom energy) levels.
25. The electron must gain potential energy.

26. The p sublevel has three orbitals that can hold two electrons each. The s sublevel only has one orbital.
27. Light has properties of both particles and waves.
28. Both electrons and light have properties of both particles and waves.
29. Only 3 of the 4 quantum numbers can have the same value for two electrons. In this way each electron's probable position in the atom is uniquely described.
30. An electron has the lowest energy when it is in the ground state.
31. Frequency (f) and wavelength (λ) are inversely related $\rightarrow c=f\lambda$
32. The 4s orbital has less energy than the 3d.
33. a) the superscript 6 means that there are 6 electrons in the 2p sublevel
 b) s indicates the shape of the sublevel. It also indicates how many orbitals will be present.
 c) The coefficient 3 refers to the energy level or the value of the principal quantum number (n).
34. A mole is 6.022×10^{23} particles. It is Avogadro's number of particles.

44.

Isotope	Number of Protons	Number of Electrons	Number of Neutrons
Si-28	14	14	14
Si-29	14	14	15
Si-30	14	14	16

47. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$
48. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^2$
49. 6 orbitals are filled
50. 9 orbitals are filled
51. a) 0.500 mole of sodium b) 4.7 mole of sulfur c) 0.100 mole of nickel
52. 319 grams of Te
53. 0.005 grams of H
54. 1.2×10^{24} atoms of K
55. a) 1.2×10^{24} atoms of iron b) 6.02×10^{23} atoms of calcium c) 2.7×10^{24} atoms of boron-11
56. 1.30 mole of potassium
57. a) protons and neutrons b) electrons
58. a) 144 amu b) 3 amu
59. 99.8 grams of silver
61. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$
63. a) 42 grams C b) 1.7×10^{-13} grams Ne 0.449 grams of C
64. 4.5×10^{23} atoms of Np
65. Because some of the particles shot at the gold bounced back there must be a very massive and dense place in the atom.
68. a) 6.00 g b) 72.1 g
69. 0.307 kg
70. 6.022×10^{23} particles/mole

71. 0.39 mole; 2.3×10^{23} atoms 72. 89 mole; 5.4×10^{25} atoms 73. 5
76. 3851 g 77. The mass is reduced by half because only half of the amount is present.
78. 8.1×10^{22} atoms 79. $1s^2 2s^2 2p^6 3s^2 3p^3$ 80. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$
81. -1, +1, 0 82. a) green has higher energy b) 680 nm, red; 500 nm, green
90. Like an address, quantum numbers describe the probable location of an electron. It is only the probable location, not the exact location that an address represents.
91. a) The 2p needs to be filled before the 3s gets any electrons.
b) The 2p (any p sublevel) can only hold 6 electrons, not the 8 indicated.
92. 2.0 grams of sulfur 95. a) 3 b) 1 c) 5 96. Because l has a maximum value of n-1
97. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1$ 98. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^2$
101. These atoms have no unpaired electrons, each of them have only full energy levels.

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- In order to have elements with similar properties in the same group there needed to be “blanks” in the table. Mendeleev predicted that these blanks would be occupied by yet undiscovered elements.
- He discovered protons and then arranged the periodic table by atomic number instead of atomic mass.
- Elements arranged according to their atomic number exhibit a repeating (periodic) pattern of properties.
- Elements of a period have electrons occupying the same energy level.
- Elements of a group have similar properties, the most important (and the cause of the most of the others) is that they have the same number of valence electrons.
- There are only two elements in the first period because the first energy level can hold only two electrons.
- The element is Rb, period 5, group 1.
- $[\text{Xe}] 6s^2$

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- The noble gases are the most unreactive group because they have 8 valence electrons (or a full energy level).
- Elements of a group have similar chemical behavior because they have the same number of valence electrons.
- Elements of the halogen group have the same number of valence electrons. They all like to react by gaining one electron. They are all very reactive, reacting easily with many different metals.
- Hydrogen has only one proton and one electron. It reacts in many special ways that does not match very well with other elements.

5. The alkali metals all have one valence electron.
6. The alkaline earth metals have a full s sublevel, a more stable configuration than only 1 electron in the s sublevel. In order to react they must lose two electrons which requires more energy than losing only one.

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1. Ionization energy is the energy required to remove an electron from an atom.
2. Atoms are very small and the almost all of the size is due to the electrons which are not in a definite space.
3. It will strongly attract electrons from other atoms.
4. Electron shielding will cause the size of the atom to increase because it reduces the effect of the protons on outer electrons.
5. Ionization energy decrease further down a group and increases to the right in a period.
9. Electron affinity is the energy change (usually negative or energy is released) when an atom gains an electron. Electronegativity is the atom's ability to attract electrons shared in a chemical bond.
10. Electronegativity increases in the period to the right and decreases in a group going down.
11. Electron shielding is not a factor in a periodic trend because all of the atoms have the same core of electrons giving the same amount of shielding.

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19. Hydrogen has only one proton and one electron. It reacts in many special ways that does not match very well with other elements.
20. Elements of the halogen group have the same number of valence electrons. They all like to react by gaining one electron. They are all very reactive, reacting easily with many different metals.
21. The noble gases are the most unreactive group because they have 8 valence electrons (or a full energy level).
22. The transition metals have electrons in a lower d sublevel than the metals in groups 1 and 2.
29. As electrons are added (and protons along with them) the atom gets smaller. The electrons are entering the same energy level (same shielding) but there is more nuclear charge (protons) to attract them.
30. The electron affinity increases. The nuclear charge increases (more protons) attracting electrons in the same energy level with the same amount of shielding.
31. Letter c diagrams the atomic radius trend correctly.
32. Electronegativity increases in the period to the right and decreases in a group going down. The group trend causes the ability of the atom to attract electrons to decrease going down the group because the electron shielding and size of the atom gets bigger, decreasing the ability of an atom to attract electrons. The period trend is for electronegativity to increase to the right because the shielding remains the same but the nuclear

charge (number of protons) increases causing greater attraction of electrons and the size also increases putting the electrons closer to the nucleus.

60. No. Helium has a lower density than the molecules of “normal” air so the molecules vibrate more quickly causing a higher pitch to your voice. If you inhaled a “heavier” (more dense) gas your voice would be lower **and** you would be in danger of suffocating because the more dense gas would displace needed oxygen and be very difficult to expel.