

## Part I

# REVIEW

Key

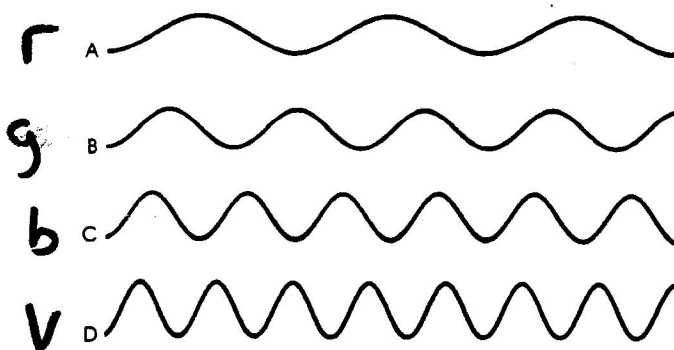
- Copyright © by D.C. Heath and Company

- b 11. The number of electrons that can exist in the same orbital of an atom is \_\_\_\_\_.  
 a. 1 c. 4  
 b. 2 d. 8
- c 12. The number of *p* orbitals in the third energy level is \_\_\_\_\_.  
 a. 1 c. 3  
 b. 2 d. 9

## Part II

Select the answer that best completes each statement. Assume, wherever appropriate, that the orbital filling order for many-electron atoms is 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p.

13. Three of the following values are the energies needed to raise an electron from a certain energy level to different higher levels. The remaining value is the ionization energy for that atom. Which value must be the ionization energy?  
 a. 450 kJ c. 840 kJ  
 b. 610 kJ d. 1710 kJ
- c 14. How many electrons are represented by the following configuration?  
 $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$   
 a. 18 c. 24  
 b. 22 d. 42
- c 15. Assume that the four waves A-D shown below represent the waves for the four following colors of light: violet, green, red, and blue (not necessarily in that order). Which wave would represent blue light?  
 a. A c. C  
 b. B d. D



- b 16. Which of the following is the orbital diagram for bromine (element 35) in the ground state?
- |    | 1s | 2s | 2p  | 3s | 3p  | 4s | 3d    | 4p  | 5s |
|----|----|----|-----|----|-----|----|-------|-----|----|
| a. | ⊗  | ⊗  | ⊗⊗⊗ | ⊗  | ⊗⊗⊗ | ⊗  | ⊗⊗⊗⊗⊗ | ⊗⊗⊗ | ○  |
| b. | ⊗  | ⊗  | ⊗⊗⊗ | ⊗  | ⊗⊗⊗ | ⊗  | ⊗⊗⊗⊗⊗ | ⊗⊗⊗ | ○  |
| c. | ⊗  | ⊗  | ⊗⊗⊗ | ⊗  | ⊗⊗⊗ | ⊗  | ⊗⊗⊗⊗⊗ | ⊗⊗⊗ | ⊗  |
| d. | ⊗  | ⊗  | ⊗⊗⊗ | ⊗  | ⊗⊗⊗ | ⊗  | ⊗⊗⊗⊗⊗ | ⊗⊗⊗ | ⊗  |

a

17. Which of the following is the orbital diagram for the  $Mg^{2+}$  ion?  
(Magnesium is element 12.)

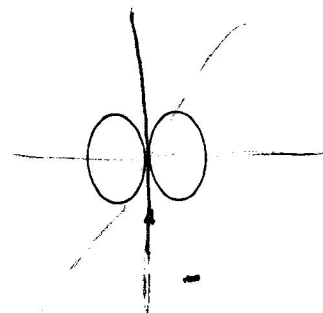
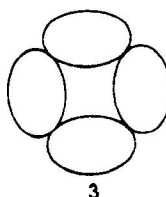
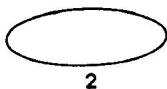
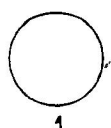
	1s	2s	2p	3s	3p
a.	$\otimes$	$\otimes$	$\otimes\otimes\otimes$	$\circ$	$\circ\circ\circ$
b.	$\otimes$	$\otimes$	$\otimes\otimes\circ$	$\circ$	$\circ\circ\circ$
c.	$\otimes$	$\otimes$	$\otimes\otimes\otimes$	$\otimes$	$\otimes\circ\circ$
d.	$\otimes$	$\otimes$	$\otimes\otimes\otimes$	$\otimes$	$\circ\circ\circ$

d

18. Which of the shapes 1-4 in the figure below corresponds to that of a p orbital?

a. 1  
b. 2

c. 3  
d. 4



### Part III

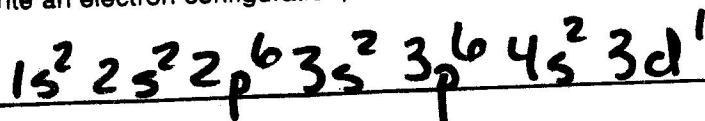
Solve the following.

19. Calculate the wavelength of light whose speed is  $3.00 \times 10^8$  m/s and whose frequency is  $5.50 \times 10^{14}$  hertz (or  $5.50 \times 10^{14}$  waves/s).

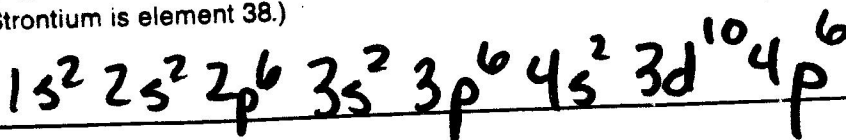
$$\lambda = \frac{c}{f} = \frac{3.00 \times 10^8 \text{ m/s}}{5.50 \times 10^{14} \text{ /s}} = 5.45 \times 10^{-7} \text{ m}$$

20. The ionization energy for a given atom X is 1050 kJ. The ionization energy for another atom, Y, is 1210 kJ. Write a chemical equation that shows the ionization of X and that includes the energy term. Then write an equation, including the energy term, for the recombination of a  $Y^+$  ion and an electron. Which of the two processes involves a release of energy?

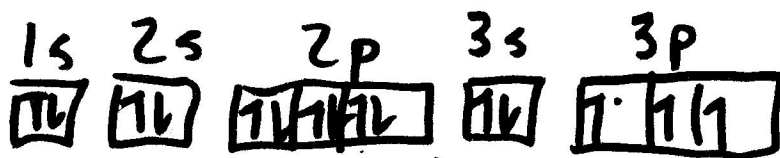
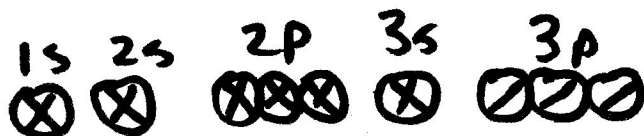
21. Write an electron configuration, in short form ( $1s^2$ , etc.), for scandium (element 21).



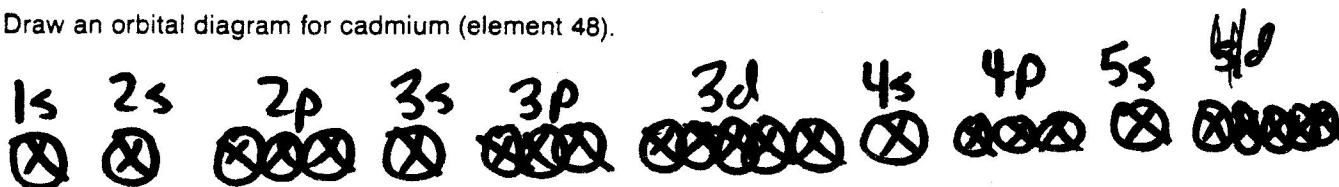
22. Write an electron configuration, in short form, for the  $Sr^{2+}$  ion.  
(Strontium is element 38.)



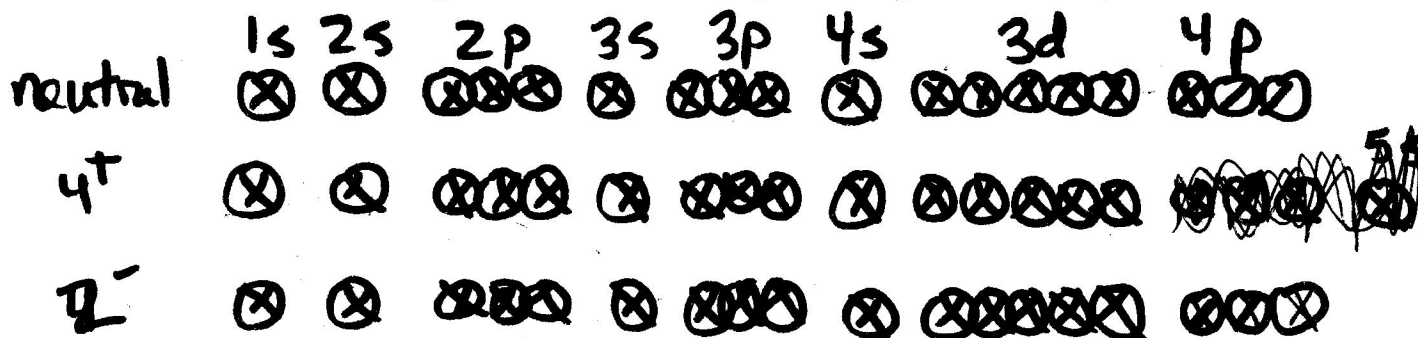
23. Draw an orbital diagram (using circles and slashes, and labeling the orbitals) for phosphorus (element 15).



24. Draw an orbital diagram for cadmium (element 48).



25. Draw orbital diagrams for neutral selenium (element 34), for the  $\text{Se}^{4+}$  ion, and for the  $\text{Se}^{2-}$  ion.



## TEST A

# 13 Electron Configurations

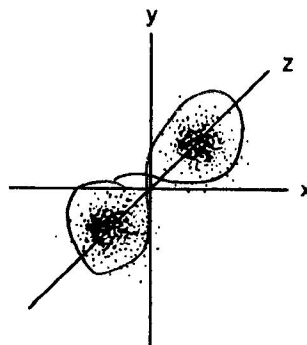
## A. Multiple Choice

Select the word, number, or phrase that best completes each statement and write its letter in the answer space at the left.

- C 1. The number of orbital pairs of electrons in an atom with an electron configuration of  $1s^2 2s^2 2p^4$  is 2 1 1  
a. 1. b. 2. c. 3. d. 4.
- D 2. The electron configuration for oxygen ( $Z = 8$ ) is  
a.  $1s^2 2s^2 2p^6$ . c.  $1s^2 2s^6$ .  
b.  $1s^2 2s^2 2p^6 2d^2$ . d.  $1s^2 2s^2 2p^4$ .
- D 3. The electron configuration of a neutral atom is  $1s^2 2s^2 2p^6 3s^1$ . The number of electrons in the atom is  
a. 3. b. 6. c. 8. d. 11.
- B 4. Two electrons can occupy the same region of space only if the electrons have  
a. opposite charges. c. the same charge.  
b. opposite spins. d. the same spins.
- A 5. The regions of space best represented by a spherical shape are the orbitals labeled  
a. s. b. p. c. d. d. f.
- B 6. The regions of space occupied by electrons can hold at most (orbitals)  
a. one electron. c. three electrons.  
b. two electrons. d. four electrons.
- B 7. The region(s) within an energy level where electrons can be found are called  
a. orbits. c. shells.  
b. orbitals. d. rings.
- C 8. The energy level with a principal quantum number equal to three has how many sub-levels?  
a. 1 b. 2 c. 3 d. 4  $n=3$
- D 9. The information about electrons provided by modern physics includes  
a. exact orbits for the electrons around the nucleus.  
b. exact distances of the electrons from the nucleus.  
c. velocity of the electrons as they move around the nucleus.  
d. probabilities of finding electrons in certain regions of space.
- A 10. A central idea in modern physics is the  
a. wave character exhibited by all particles.  
b. acceleration of charged particles moving around the nucleus.  
c. opportunity to locate the position of an electron exactly.  
d. continuous range of energies that electrons can have.
- C 11. The theory that seems to fit subatomic particles the best is  
a. Relativity Mechanics.  
b. Newtonian Mechanics.  
c. Quantum Mechanics.  
d. Classical Mechanics.
- B 12. The parts of Bohr's model of the atom that conflicted with classical mechanics were the  
a. moving electric charges.  
b. quantized energy levels.  
c. positive nuclear charges.  
d. forces of attraction between opposite charges.

**13 Electron Configurations** (continued)

- B 13. The number of sublevels of energy found in the second principal energy level is <sup>n=2</sup>  
 a. 1. b. 2. c. 4. d. 9.
- C 14. The first example of overlapping energy levels found in building up the electron configuration involves the principal energy levels  
 a. 1 and 2. c. 3 and 4. 4s/3d overlap  
 b. 2 and 3. d. 4 and 5.
- D 15. The spectrum of the hydrogen atom includes a series of lines in the  
 a. ultraviolet. c. infrared.  
 b. visible. d. all of the above.
- A 16. The d orbitals would not be found at the principal energy level equal to  
a. 2. b. 3. c. 4. d. 5.
- C 17. The electron configuration for the aluminum atom ( $Z = 13$ ) is  
 a.  $1s^2 2s^2 2p^3$ .  
 b.  $1s^2 2s^2 2p^5$ .  
c.  $1s^2 2s^2 2p^6 3s^2 3p^1$ .  
 d.  $1s^2 2s^2 2p^6 3s^2 3p^4$ .
- B 18. The regions of space in which electrons are found that are in the shape shown at the right are labeled  
 a. s orbitals.  
b. p orbitals.  
 c. d orbitals.  
 d. f orbitals.

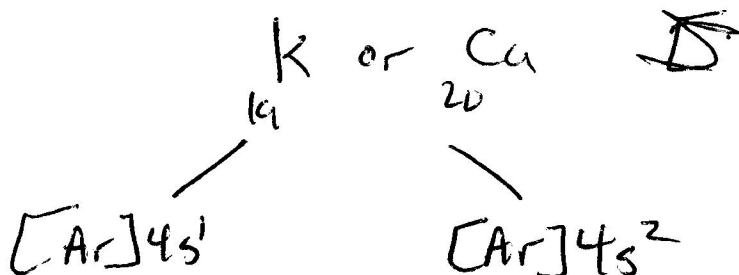


- D 19. The uncertainty principle is credited to  
 a. Bohr. c. deBroglie.  
 b. Pauli. d. Heisenberg.
- B 20. A characteristic that the noble gases (except helium) have in common is  
 a. the same total number of electrons.  
b. eight electrons in the outermost energy level. - Stable octet  
 c. the same total electron configuration.  
 d. the same number of protons.

**B. Problems**

Solve the following problems in the spaces provided. Show all your work.

21. If an atom in the ground state has its highest energy electron in the 4s orbital what is (are) the possible atomic number(s) of the atom?

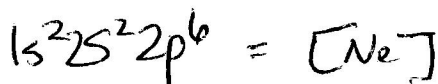


**13 Electron Configurations** (continued)

22. How many orbital pairs are present in an atom with an electron configuration of  $1s^2 2s^2 2p^6 3s^2 3p^3$ ?

$$1 + 1 + 3 + 1 = 6$$

23. Write the notation of the electron configuration of the kernel of a magnesium atom ( $Z = 12$ ).



↑

**C. Essay Question**

24. Describe the shape and orientation of  $p$  orbitals. Contrast the  $p$  orbitals with the  $s$  orbital.

—  $p$  orbitals are  $\pi$  or dumbbell shaped

there are 3 of them  $p_x, p_y, p_z$  oriented along the 3 main planes ( $x, y, z$ )

—  $s$  orbitals are ~~spherical~~ spherical  
there is only one kind