Electromagnetic Energy
Zumdahl Chapter 7

15. $E = h\nu$ $c = \lambda\nu$
wavelength ↑, frequency ↓, energy ↓
1 J in fundamental units = $1 \frac{kg \cdot m^2}{s^2}$

16. when light at a minimum energy (or higher) strikes the surface of a metal, an electron is released. As light increases in frequency, more electrons with higher energy are released

17. The baseball has a much smaller wavelength - basically travelling in a straight line with respect to its size. The electron has a longer wavelength, more significant when you consider how small it is

31. $\lambda = 660 \text{ nm} = 6.60 \times 10^{-7} m$

$\nu = \frac{c}{\lambda} = \frac{2.998 \times 10^8}{6.60 \times 10^{-7}} = 4.54 \times 10^{-14} Hz$

32. $\nu = 99.5 \text{ MHz} = 9.95 \times 10^7 Hz$
$\lambda = \frac{c}{\nu} = \frac{2.998 \times 10^8}{9.95 \times 10^7} = 3.01 m$

33. $\lambda = 0.010 m$
$\nu = \frac{c}{\lambda} = \frac{2.998 \times 10^8}{0.010} = 3.0 \times 10^{-10} Hz$
$E = h\nu = (6.626 \times 10^{-34})(3.0 \times 10^{-10})$
$= 2.0 \times 10^{-23} J/photon$
$E_{total} = (2.0 \times 10^{-23})(6.022 \times 10^{23}) = 12 J/mol$

34. $E = \frac{hc}{\lambda} = \frac{(6.626\times10^{-34})(2.998\times10^{8})}{2.5\times10^{-8}}$

$= 7.9\times10^{-18}$ J/photon

$E_{total} = (7.9\times10^{-18})(6.022\times10^{23})$

$= 4.8\times10^{6}$ J/mol

35. • a has longer λ

$\lambda_a = \frac{1.6\times10^{-3}\text{ m}}{4\text{ cycles}} = 4.0\times10^{-4}$ m

$\lambda_b = \frac{1.6\times10^{-3}\text{ m}}{8\text{ cycles}} = 2.0\times10^{-4}$ m

• b has larger ν and E

$\nu_a = 7.5\times10^{11}$ Hz $E_a = 5.0\times10^{-22}$ J

$\nu_b = 1.5\times10^{12}$ Hz $E_b = 9.9\times10^{-22}$ J

• same velocity (speed of light)
• both are infrared radiation

36. ① $\nu = 1.071\times10^{8}$ Hz $\lambda = 2.799$ m

② $\lambda = 2.12\times10^{-10}$ m

③ $E = 3.97\times10^{-19}$ J $\lambda = 5.00\times10^{-7}$ m

increasing frequency:

→ ③ → ②

radio   visible light   x-rays

37. $\lambda = 1.50\times10^{-7}$ m

$E_{total} = 1.98\times10^{5}$ J

$E = \frac{hc}{\lambda} = \frac{(6.626\times10^{-34})(2.998\times10^{8})}{1.50\times10^{-7}}$

$= 1.32\times10^{-18}$ J/photon

atoms $= \frac{E_{total}}{E_{photon}} \quad \frac{1.98\times10^{5}}{1.32\times10^{-18}} = 1.5\times10^{23}$ atoms

$$E = \frac{hc}{\lambda}$$

38. $\nu = 6.0 \times 10^{13}$ Hz

(a) $\lambda = \frac{c}{\nu} = \frac{2.998 \times 10^{8}}{6.0 \times 10^{13}} = 5.0 \times 10^{-6}$ m

(b) infrared

(c) $E = 4.0 \times 10^{-20}$ J/photon

$E = 2.4 \times 10^{5}$ J/mol

(d) less

39. $E = 279.7$ kJ/mol $= 2.797 \times 10^{5}$ J/mol

$E = 4.645 \times 10^{-19}$ J/electron

$\lambda = \frac{hc}{E} = 4.28 \times 10^{-7}$ m

41. (a) $\lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34}}{(9.11 \times 10^{-31})(0.10)(2.998 \times 10^{8})}$

$= 2.4 \times 10^{-11}$ m

(b) $\lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34}}{(0.055)(35)}$

$= 3.4 \times 10^{-34}$ m

42. (a) $\lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34}}{(1.675 \times 10^{-27})(0.0100)(2.998 \times 10^{8})}$

$= 1.32 \times 10^{-13}$ m

(b) $v = \frac{h}{m\lambda} = \frac{6.626 \times 10^{-34}}{(1.675 \times 10^{-27})(7.5 \times 10^{-11})}$

$= 5.3 \times 10^{3}$ m/s

43. $m = \frac{h}{\lambda v} = \frac{6.626 \times 10^{-34}}{(1.5 \times 10^{-15})(0.90)(2.998 \times 10^{8})}$

$= 1.64 \times 10^{-27}$ kg

44. $v_1 = \frac{h}{\lambda m} = \frac{6.626 \times 10^{-34}}{(1.0 \times 10^{-7})(9.11 \times 10^{-31})} = 7.3 \times 10^{3}$ m/s

$v_2 = \frac{h}{\lambda m} = \frac{6.626 \times 10^{-34}}{(1.0 \times 10^{-9})(9.11 \times 10^{-31})} = 7.3 \times 10^{5}$ m/s

OpenStax Chapter 6

2. $\nu = 1.031 \times 10^8$ Hz

$$\lambda = \frac{c}{\nu} = \frac{2.998 \times 10^8}{1.031 \times 10^8} = 2.908 \text{ m}$$

3. $\nu = 9.51 \times 10^7$ Hz

$$\lambda = \frac{c}{\nu} = \frac{2.998 \times 10^8}{9.51 \times 10^7} = 3.152 \text{ m}$$

4. $\lambda = 435.8 \text{ nm} = 4.358 \times 10^{-7}$ m

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34})(2.998 \times 10^8)}{4.358 \times 10^{-7}}$$

$$= 4.558 \times 10^{-19} \text{ J}$$

5. $\lambda = 6.145 \times 10^{-7}$ m

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34})(2.998 \times 10^8)}{6.145 \times 10^{-7}}$$

$$= 3.23 \times 10^{-19} \text{ J}$$

$E = 2.018$ eV

6. $E = 2.961 \times 10^{-19}$ J

$$\nu = \frac{E}{h} = \frac{2.961 \times 10^{-19}}{6.626 \times 10^{-34}} = 4.469 \times 10^{14} \text{ Hz}$$

$$\lambda = \frac{c}{\nu} = \frac{2.998 \times 10^8}{4.469 \times 10^{14}} = 6.708 \times 10^{-7} \text{ m}$$

$E_{total} = 6.022 \times 10^{23} E = 1.783 \times 10^5$ J

ORANGE

7. $E = 3.027 \times 10^{-19}$ J

$$\nu = \frac{E}{h} = 4.568 \times 10^{14} \text{ Hz}$$

$$\lambda = \frac{c}{\nu} = 6.563 \times 10^{-7} \text{ m}$$

$E_{total} = 1.823 \times 10^5$ J

RED

8. (a) $\nu = \frac{c}{\lambda} = \frac{2.998 \times 10^8}{7.9 \times 10^{-7}} = 3.8 \times 10^{14}$ Hz RED

(b) $\nu = \frac{c}{\lambda} = \frac{2.998 \times 10^8}{4.2 \times 10^{-7}} = 7.1 \times 10^{14}$ Hz

PURPLE

9. (a) $\lambda = \frac{c}{\nu} = \frac{2.998\times10^{8}}{3.45\times10^{14}} = 8.69\times10^{-7}\,m$ IR

$E = h\nu = (6.626\times10^{-34})(3.45\times10^{14}) = 2.29\times10^{-19}\,J$

(b) $\lambda = \frac{c}{\nu} = \frac{2.998\times10^{8}}{6.53\times10^{14}} = 4.59\times10^{-7}\,m$ BLUE

$E = h\nu = (6.626\times10^{-34})(6.53\times10^{14}) = 4.33\times10^{-19}\,J$

10. $q = mc\Delta T = (175)(4.184)(40-25)$

$= 10983\,J$

$E = \frac{hc}{\lambda} = \frac{(6.626\times10^{-34})(2.998\times10^{8})}{1.5\times10^{-6}}$

$= 1.3\times10^{-19}\,J/\text{photon}$

$\#\text{photons} = \frac{q}{E} = \frac{10983}{1.3\times10^{-19}} = 8.4\times10^{22}$ photons

11. $\lambda = 2.090\times10^{-11}\,m$

$E = \frac{hc}{\lambda} = 9.505\times10^{-15}\,J$

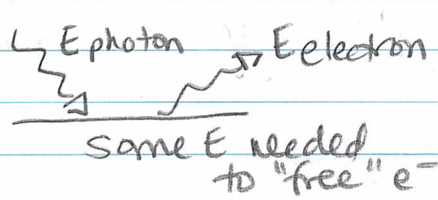
$\nu = \frac{c}{\lambda} = 1.434\times10^{19}\,Hz$

12. $E = \frac{hc}{\lambda} = 2.3\times10^{-19}\,J$

$\#\text{photons} = \frac{3.15\times10^{-14}}{2.3\times10^{-19}} = 1.4\times10^{5}$ photons

15. $\nu = 6.66\times10^{14}\,Hz$ $\quad E = 7.74\times10^{-20}\,J$ ← energy of electron

$\nu = \frac{E}{h} = \frac{7.74\times10^{-20}}{6.626\times10^{-34}} = 1.17\times10^{14}\,Hz$



$E_{needed} = E_{photon} - E_{electron}$

$\nu_{needed} = \nu_{photon} - \nu_{electron}$

$\nu_{threshold} = 5.49\times10^{14}\,Hz$

orange light $\lambda = 590nm$

$\nu = 5.08 \times 10^{14}\ Hz \rightarrow$ too low

AP Question

(a) $q = mc\Delta T = 200(4.184)(60-23)$

$= 3.1 \times 10^5\ J$

$E_{photon} = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34})(2.998 \times 10^8)}{0.112}$

$= 1.8 \times 10^{-24}\ J$

$\#\ photons = \frac{q}{E} = 1.7 \times 10^{29}$ photons

(b) $P = \frac{E}{t}$

$t = \frac{q}{P} = \frac{3.1 \times 10^5}{900} = 344s = 340s.$

The Bohr Model
Zumdahl Chapter 7

45. $\Delta E = -2.178 \times 10^{-18} \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

(a) $\Delta E = -2.178 \times 10^{-18} \left(\frac{1}{3^2} - \frac{1}{2^2}\right) = 3.025 \times 10^{-19} J$

$\lambda = \frac{hc}{E} = 6.567 \times 10^{-7} m$

visible light (orange)

(b) $\Delta E = -4.084 \times 10^{-19} J$

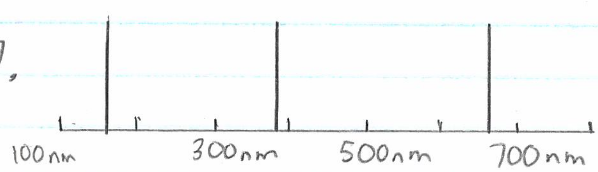
$\lambda = \frac{hc}{E} = 4.864 \times 10^{-7} m$

visible light (blue)

(c) $\Delta E = -1.089 \times 10^{-18} J$

$\lambda = \frac{hc}{E} = 1.051 \times 10^{-7} m$ ultraviolet

47.



49. $\Delta E_{1-5} = -2.178 \times 10^{-18} \left(\frac{1}{5^2} - \frac{1}{1^2}\right) = 2.091 \times 10^{-18} J$

$\Delta E_{2-6} = -2.178 \times 10^{-18} \left(\frac{1}{6^2} - \frac{1}{2^2}\right) = 4.84 \times 10^{-19} J$

$E_{700nm} = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34})(2.998 \times 10^{8})}{7.00 \times 10^{-7}} = 2.84 \times 10^{-19} J$

high enough for 1-5, not for 2-6

50. (a) $\Delta E = -2.178 \times 10^{-18} \left(\frac{1}{0^2} - \frac{1}{1^2}\right) =$

$\Delta E = -2.178 \times 10^{-18} \left(\frac{1}{0^2} - \frac{1}{3^2}\right)$

false → it takes less energy

(b) true

(c) false → longer (more energy for 3→1 than 3→2)

(d) true

(e) no - second (n=1 is ground, n=2 is first...)

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16. distance from the nucleus decreases the electrostatic attraction between +ve and -ve charges

17. they can only have specific values of energy, not continuous values

28 (a) six ($2\to1$, $3\to1$, $4\to1$, $3\to2$, $4\to2$, $4\to3$)

(b) lowest ($4\to3$)

$$\Delta E_l = -2.178\times10^{-18}\left(\frac{1}{n_f^2}-\frac{1}{n_i^2}\right)$$
$$= -2.178\times10^{-18}\left(\frac{1}{3^2}-\frac{1}{4^2}\right)$$
$$= -1.059\times10^{-18}\ J$$

highest ($4\to1$)

$$\Delta E_h = -2.178\times10^{-18}\left(\frac{1}{n_f^2}-\frac{1}{n_i^2}\right)$$
$$= -2.178\times10^{-18}\left(\frac{1}{1^2}-\frac{1}{4^2}\right)$$
$$= -2.042\times10^{-18}\ J$$

(c) $$\nu_l = \frac{E}{h} = 1.598\times10^{15}\ Hz$$

$$\nu_h = \frac{E}{h} = 3.082\times10^{15}\ Hz$$

29. Rutherford → dense +ve nucleus contain bulk of atom, with electrons orbiting in a large space around

SAME:
- positive, dense nucleus
- electrons in majority of space (around nucleus)

DIFFERENT
- orbits / energy levels of electrons

30.
- lines are caused by electrons being excited (higher energy level), then dropping back to ground state.
- energy translates to a specific frequency / wavelength of EMR, so different colours for vis light
- more electrons in calcium, plus more energy levels

AP Question

(a) released - conservation of energy requires that total energy is equal before & after transition

$n = 6 \Rightarrow$ high energy

$n = 2 \Rightarrow$ lower energy + some energy released

(b) $\Delta E = -2.178 \times 10^{-18} \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$

$= -2.178 \times 10^{-18} \left(\frac{1}{2^2} - \frac{1}{6^2} \right)$

$= -4.84 \times 10^{-19} J$

$\lambda = \frac{hc}{E} = \frac{(6.626 \times 10^{-34})(2.998 \times 10^{8})}{4.84 \times 10^{-19}}$

$= 4.10 \times 10^{-7} m$

$= 410 nm$

(c) Helium has a large nucleus (two protons instead of one), so the electron has more energy absorbed to excite it to a higher energy level to overcome the stronger electrostatic attraction.

Quantum Theory

Zumdahl Chapter 7

57. $n = 1, 2, 3, 4 \ldots$
    $l = 0, 1, 2, 3 \ldots$
    $m_l = -3, -2, -1, 0, 1, 2, 3$

58. 1p, 7d, 9s, 3f, 2d
    (7d, 9s: periodic table stops before these)

59. (a) fine
    (b) m_l has to be $-l$ to l → too high
    (c) n must be a positive integer (1+)
    (d) l must be a positive number (0+)

60. (a) l must be $n-1$ or lower
    (b) fine
    (c) fine
    (d) m_s can only be $+\frac{1}{2}$ or $-\frac{1}{2}$
    (e) l must be positive
    (f) m_l can only be $-l$ to l

61. the probability of finding an electron at that point

62. because the electron can be anywhere around the nucleus, and is not confined to strict boundaries.

OpenStax Chapter 6

31 SAME
- electrons exist a specific energy levels

DIFFERENT
- 3D orbitals (areas in space) instead of "orbits"

32. $n = 1, 2, 3, 4$
    $l = 0, 1, 2, 3$
    $m_l = -3$ to 3
    $m_s = +\frac{1}{2}$ or $-\frac{1}{2}$

33. n → energy level of the electron
l → shape of the orbital in which the electron is found
m_l → orientation of the orbital
m_s → spin of the electron

34. (a) shells refers to energy level ("3")
subshell is the shape of the area is space where an electron is likely to be found ("p")
orbitals are the specific orientation in each sub shell ("p_x")
(b) each depends on the value of the one above
orbitals $\underset{on}{\Rightarrow}$ subshells $\underset{on}{\Rightarrow}$ shells

35 (a) 2p
(b) 4d
(c) 6s

36. 2p has three } degenerate means orbitals
4d has five } with the same energy level

37 (a) 3d
(b) 1s
(c) 4f

41. (a) all can only contain 2 e^-
(b) X → 1 Y → 3 Z → 5
(c) X, n=4, l=0, m_l = 0, m_s = $+\frac{1}{2}$/$-\frac{1}{2}$
Y, n=2, l=1, m_l = -1/0/1, m_s = $+\frac{1}{2}$/$-\frac{1}{2}$
(d) X 1
Y 2
Z 3
(e) X l 0 m_l 0
Y l 0, 1 m_l -1, 0, 1
Z l 0, 1, 2 m_l -2, -1, 0, 1, 2

42. • Cannot precisely know location and momentum
• electron location is all based on probabilities

44. (a) wave → defines frequency & wavelength, which are wave characteristics
(b) particle → includes mass (not relevant to waves)
(c) SKIP.
(d) wave → frequency (wave behaviour)
(e) both → contains both mass (particle) and λ / ν (wave).

AP Question

(a) Ag has 47 e^-

5s: ↑↓ 4d: ↑↓ ↑↓ ↑↓ ↑↓ ↑

4p: ↑↓ ↑↓ ↑↓
3d: ↑↓ ↑↓ ↑↓ ↑↓ ↑↓
4s: ↑↓

3p: ↑↓ ↑↓ ↑↓
3s: ↑↓
2p: ↑↓ ↑↓ ↑↓
2s: ↑↓
1s: ↑↓

(b) outer shell should be

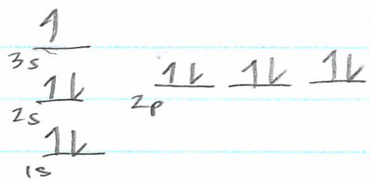
5s: ↑ 4d: ↑↓ ↑↓ ↑↓ ↑↓ ↑↓

- more repulsion in 5s orbital than 4d
- orbitals are similar energy levels
- more stable for 4d to be full than 5s

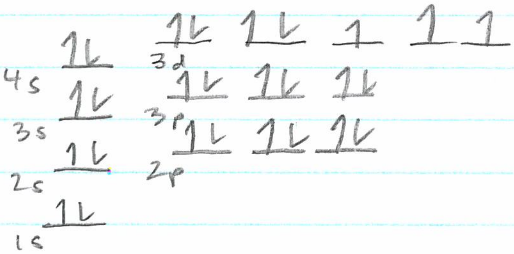
Electron Configuration
Zumdahl Chapter 7

66. (a) 0 (d) 0
(b) 1 (e) 2
(c) 4

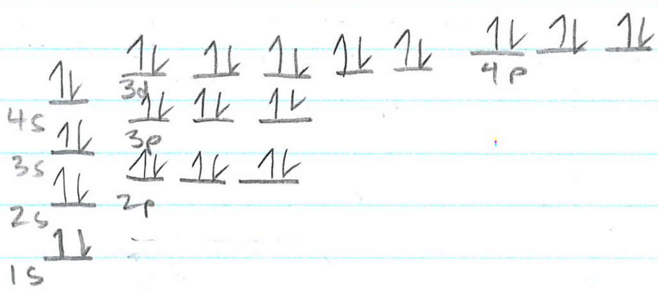
67. (a) 1 unpaired



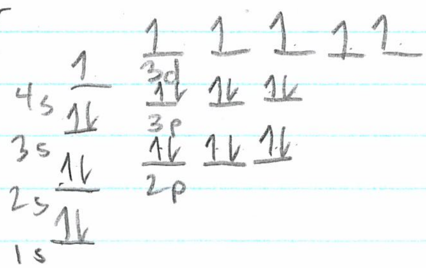
(b) 3 unpaired



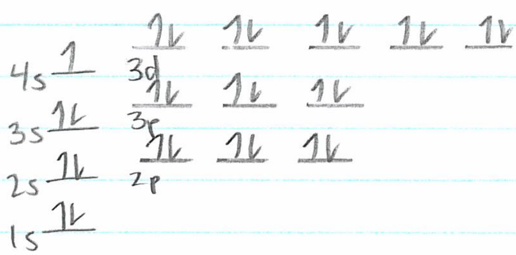
(c) 0 unpaired



68. Cr 6 unpaired



Cu 1 unpaired



69. Si $1s^2 2s^2 2p^6 3s^2 3p^2$
Ga $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^1$
As $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$
Ge $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^2$
Al $1s^2 2s^2 2p^6 3s^2 3p^1$
Cd $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 3d^{10}$
S $1s^2 2s^2 2p^6 3s^2 3p^4$
Se $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$

71. Sc $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$
Fe $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$
P $1s^2 2s^2 2p^6 3s^2 3p^3$
Cs $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^1$
Eu $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^7$
Pt $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^8$
Xe $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6$
Br $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$

73. (a) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^4$ (iodine)
(b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6$ ...
... $6s^2 4f^{14} 5d^{10} 6p^6 7s^2 5f^{14} 6d^{10} 7p^6 8s^2$
(c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^6$
(radon)
(d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$ (Mn)

74. (a) As $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$
(b) Lv $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6$ ...
... $6s^2 4f^{14} 5d^{10} 6p^6 7s^2 5f^{14} 6d^{10} 7p^4$
(c) Ta OR Pt
[Xe] $6s^2 4f^{14} 5d^3$ OR [Xe] $6s^2 4f^{14} 5d^8$
(d) At [Xe] $6s^2 4f^{14} 5d^{10} 6p^5$

75. Hg $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10}$
(a) 18
(b) 30
(c) 8
(d) 40

80. (a) B - excited (ground $1s^2 2s^2 2p^1$)
(b) Ne - ground
(c) F - excited (ground $1s^2 2s^2 2p^5$)
(d) Fe - excited (ground [Ar] $4s^2 3d^6$)

83. Li - paramagnetic - 1 unpaired
N - paramagnetic - 3 unpaired
Ni - paramagnetic - 2 unpaired
Te - paramagnetic - 2 unpaired
Ba - diamagnetic - no unpaired
Hg - diamagnetic - no unpaired

OpenStax

48. (a) $1s^2 2s^2 2p^2$
(b) $1s^2 2s^2 2p^6 3s^2 3p^3$
(c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$
(d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^3$
(e) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^6$

49. (a) $1s^2 2s^2 2p^3$
(b) $1s^2 2s^2 2p^6 3s^2 3p^2$
(c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$
(d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^4$
(e) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^9$

52. (a) 2s ↑↓ 2p ↑ ↑ __   (b) 3s ↑↓ 3p ↑ ↑ ↑

(c) $\frac{\uparrow\downarrow}{4s}$ $\frac{\uparrow}{3d}$ $\uparrow$ $\uparrow$ __ __

(d) $\frac{\uparrow\downarrow}{5s}$ $\frac{\uparrow\downarrow}{4d}$ $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$ $\frac{\uparrow}{5p}$ $\uparrow$ $\uparrow$

(e) $\frac{\uparrow}{5s}$

53. check answers in text!

54. (a) $1s^2 2s^2 2p^6$
(b) $1s^2 2s^2 2p^6 3s^2 3p^6$
(c) $1s^2 2s^2 2p^6 3s^2 3p^6$
(d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6$
☆exception (e) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4$ (loses $4s^2$)
☆exception (f) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 4f^7$
(loses $6s^2$ & $4f^1$)

55. Zr
56. Co
57. Rb^{+1}, Se^{2-}
58. B

60. Bi
61. K