TUTORIAL #3 - SOLUTIONS

7-40 E = (208 400 J/mol) / (6.022 x 10^{23} /mol) = 3.461 x 10^{-19} J for one atom

$\lambda = hc / E$ = (6.626 x 10^{-34} Js)(2.9979 x 10^{8} m/s) / 3.461 x 10^{-19} J = 5.739 x 10^{-7} m

7-44 (for 100 nm) $v = h / \lambda m$ = (6.626 x 10^{-34} Js) / [(1.0 x 10^{-7} m)(9.11 x 10^{-31} kg)] = 7.3 x 10^{3} m/s

(for 1.0 nm) v = 7.3 x 10^{5} m/s

7-52 to completely remove an ion, $n_f = \infty$, or $1/n_f = 0$, therefore,

$E_{photon} = hc / \lambda$ = (6.626 x 10^{-34} Js)(2.9979 x 10^{8} m/s) / (1460 x 10^{-9} m) = 1.36 x 10^{-19} J

ΔE = -2.178 x 10^{-18} J ($1/\infty$ - $1/n_i^2$)
n_i^2 = 2.178 x 10^{-18} J / (ΔE) = 2.178 x 10^{-18} J / (1.36 x 10^{-19} J) = 16, or n = 4

7-66
(a) 0 (no such thing as n = 0 level)
(b) 1 (all quantum numbers defined)
(c) 9 (in the n = 3 shell there are one *s*, three *p*, and 5 *d* orbitals. Each could have an m_s = ½ electron)
(d) 0 (l cannot equal n)
(e) 2 (this is the 1*s* orbital)

7-70
Cu: [Ar]$3d^9\ 4s^2$
O: [He]$2s^2\ 2p^4$
La: [Xe]$5d^1\ 6s^2$
Y: [Kr]$4d^1\ 5s^2$
Ba: [Xe]$6s^2$
Tl: [Xe]$4f^{14}\ 5d^{10}\ 6s^2\ 6p^1$
Bi: [Xe]$4f^{14}\ 5d^{10}\ 6s^2\ 6p^3$

7-72.
Cl: [Ne]$3s^2\ 3p^5$
Sb: [Kr]$4d^{10}\ 5s^2\ 5p^3$
Sr: [Kr]$5s^2$
W: [Xe]$4f^{14}\ 5d^4\ 6s^2$
Pb: [Xe]$4f^{14}\ 5d^{10}\ 6s^2\ 6p^2$
Cf: [Rn]$5f^{10}\ 7s^2$

7-86
(a) Be < Na < Rb
(b) Ne < Se < Sr
(c) O < P < Fe

7-88 (a) Rb < Na < Be
(b) Sr < Se < Ne
(c) Fe < P < O

7-106 (for 589.0 nm) $\nu = c / \lambda = (2.998 \times 10^{8}) / (589.0 \times 10^{-9}\ \text{m}) = 5.090 \times 10^{14}\ \text{s}^{-1}$
$E = h\nu = (6.626 \times 10^{-34}\ \text{Js})(5.090 \times 10^{14}\ \text{s}^{-1}) = 3.373 \times 10^{-19}\ \text{J}$
$E = (3.373 \times 10^{-22}\ \text{kJ})(6.022 \times 10^{23}\ \text{mol}^{-1}) = 203.1\ \text{kJ/mol}$

(for 589.6): $\nu = 5.085 \times 10^{14}\ \text{s}^{-1}$; $E = 3.369 \times 10^{-19}\ \text{J} = 202.9\ \text{kJ/mol}$

18-14 (a) ${}_{-1}^{0}e$ (b) ${}_{2}^{4}\text{He}$ (c) ${}_{1}^{0}e$ (d) ${}_{-1}^{0}e$

18-20 (a) ${}_{95}^{240}\text{Am}$ (b) ${}_{98}^{244}\text{Cf}$ (c) ${}_{7}^{15}\text{N}$ (d) $2\ {}_{0}^{1}n$

18-28 $k = (\ln 2) / t_{½} = (\ln 2) / 8.1\ \text{days} = 0.0856\ \text{day}^{-1}$

$\ln(N / N_0) = -kt$
$t = -[\ln(N / N_0)] / k = -\ln(1/100) / 0.0856\ \text{day}^{-1} = 54\ \text{days}$

18-38 ^{56}Fe has 26 protons (therefore 26 electrons) and 30 neutrons.
mass of 26 protons + 30 neutrons + 26 electrons
$= 26(1.67262 \times 10^{-27}\ \text{kg}) + 30(1.67493 \times 10^{-27}\ \text{kg}) + 26(9.10939 \times 10^{-31}\ \text{kg}) = 9.37597 \times 10^{-26}\ \text{kg}$

$m_{\text{Fe}} = 0.0559349\ \text{kg/mol} / 6.02214 \times 10^{23}\ \text{mol}^{-1} = 9.28821 \times 10^{-26}\ \text{kg}$

$\Delta E = \Delta mc^2 = (9.28821 \times 10^{-26}\ \text{kg} - 9.37597 \times 10^{-26}\ \text{kg})(2.998 \times 10^{8}\ \text{m/s})^2 = -7.89 \times 10^{-11}\ \text{J}$

Therefore, the total binding energy (released when particles came together) is 7.89×10^{-11} J
Per nucleon = 7.89×10^{-11} J / 56 nucleons = 1.41×10^{-12} J (or 8.48×10^{8} kJ/mol)

18-58 If you assume the absolute value of the mass of an electron and a proton is equal, then,

$\Delta E = \Delta mc^2 = [0 - 2(9.10939 \times 10^{-31}\ \text{kg})](2.998 \times 10^{8}\ \text{m/s})^2 = -1.638 \times 10^{-13}$ (for 2 gamma rays)
for 1 gamma ray = $-1.638 \times 10^{-13} / 2 = 8.19 \times 10^{-14}$ J (or 4.93×10^{7} kJ/mol)

$\lambda = hc / E = (6.626 \times 10^{-34}\ \text{Js})(2.998 \times 10^{8}\ \text{m/s}) / (8.19 \times 10^{-14}\ \text{J}) = 2.43 \times 10^{-12}\ \text{m}$