LN–1 IDLE MIND SOLUTIONS

1. [To answer this question we remember: The nuclear masses of atomic species in amu (given) are numerically equal to their molar masses in grams.]

   We have: $\Delta E = \Delta mc^2$

   for: $^{2}_{1}H + ^{3}_{2}He \rightarrow ^{4}_{2}He + ^{1}_{1}H$

   $$\Delta m = (4.00150 + 1.00728) - (2.01345 + 3.01493)\ g = -0.01960\ g$$

   $$= -1.96 \times 10^{-5}\ kg/mole$$

   $$\Delta E = -1.96 \times 10^{-5}\ kg \times 9 \times 10^{16}\ m^2/s^2 = \boxed{-1.76 \times 10^{12}\ J/mole}$$

   Alternatively, we may solve the problem on the atomic mass level:

   $$\Delta m = -0.0196\ amu/atom\ ^{4}_{2}He$$

   since 1 amu = 1.66057×10^{-27} kg, $\Delta m = -3.25 \times 10^{-29}$ kg/atom He

   $$\Delta E = \Delta mc^2 = -2.95 \times 10^{-12}\ J/atom\ He$$

   $$= -2.95 \times 10^{-12}\ J/atom \times \frac{6.02 \times 10^{23}\ atom}{mole}$$

   $$\boxed{\Delta E = -1.76 \times 10^{12}\ J/mole}$$

2. Required: $\Delta E = \Delta mc^2$

   (a) $$\Delta E = \Delta mc^2 = 10\ g \times \frac{1\ kg}{1000\ g} \times (3 \times 10^{8}\ ms^{-1})^2$$

   $$= 9 \times 10^{14}\ kg\ m^2 s^{-2} = 9 \times 10^{14}\ J = \boxed{9 \times 10^{11}\ kJ/bomb}$$

   (b) $E_{total} = 10 \times 9 \times 10^{11} = 9 \times 10^{12}$ kJ/year

   $$\text{No. gallons of gasoline saved} = \frac{1\ gal}{1.5 \times 10^{5}\ kJ} \times 9 \times 10^{12}\ kJ/year$$

   $$\boxed{= 6 \times 10^{7}\ gallons/year}$$

3. (In class we defined the atomic weight as the “weighted average atomic mass” in AMU of naturally occurring elements.) In the present problem we are not given atomic masses of the Sb isotopes 121 and 123. We are given the mass numbers of the two isotopes which (for atoms with M > 2) are only slightly larger than the isotopic masses in AMU (^{121}Sb = 120.9 AMU, ^{123}Sb = 122.9 AMU) and may be used for “none–too–critical” atomic weight determinations:

Mass #	Approx. Mass	Fractional Abundance	Isotopic Contribution
121	121 (AMU)	0.5725	121 x 0.5725 = 69.27
123	123 (AMU)	0.4275	123 x 0.4275 = 52.58

$$\text{atomic weight (weighted ave.)} = \boxed{121.8 \text{ (AMU)}}$$

4. To get the requested answer, let us formulate a “stoichiometric” equation (molar quantities) for the reaction: $C_2H_6 + 7O \rightarrow 2CO_2 + 3H_2O$. Each C_2H_6 (ethane) molecule requires 7 oxygen atoms for complete combustion. In molar quantities:

$$1 \text{ mole of } C_2H_6 = 2 \times 12.01 + 6 \times 1.008 = 30.07 \text{ g}$$

$$\text{requires } 7 \times 15.9984 \text{ g} = 1.12 \times 10^2 \text{ oxygen} = \boxed{0.112 \text{ kg oxygen}}$$

(We recognize the oxygen forms molecules, O_2, and therefore a more appropriate formulation would be: $C_2H_6 + 7/2\ O_2 \rightarrow 2CO_2 + 3H_2O$. The result would be the same.

5. $$^{56}_{26}A^{+++} = \boxed{^{56}_{26}Fe^{+++}}$$

6. 30 protons + 34 neutrons yield a nucleus: $^{64}_{30}A = \boxed{^{64}_{30}Zn}$

7. We know that the velocity of propagation for electromagnetic radiation is approximated as 3×10^8 m/s. Accordingly, any “radio–message” from Mars, reported to be at a distance of 5.6×10^6 km from earth, will take:

$$\left(\frac{5.6 \times 10^9}{3 \times 10^8}\right)\left(\frac{m}{m \cdot s^{-1}}\right) = \boxed{18.67 \text{ s}}$$

(One student from the class pointed out correctly that the shortest distance of Mars is indeed not 5.6×10^6 km, but rather 5.6×10^7 km! He is correct: it takes 186.7 s for the “message” to reach us.

8. The atomic weight is the arithmetic average of the atomic weights of the isotopes, taking into account the fractional abundance of each isotope.

$$\text{At.Wt.} = \frac{23.985 \times 0.7870 + 24.986 \times 0.1013 + 25.983 \times 0.1117}{0.7870 + 0.1013 + 0.1117} = \boxed{24.310}$$

9.

NH_4OH:

$$\begin{aligned} 5 \times 1.01 &= 5.05 \text{ (H)} \\ 1 \times 14.01 &= 14.01 \text{ (N)} \\ 1 \times 16.00 &= \underline{16.00 \text{ (O)}} \\ NH_4OH &= 35.06 \text{ g/mole} \end{aligned}$$

$NaHCO_3$:

$$\begin{aligned} 3 \times 16.00 &= 48.00 \text{ (O)} \\ 1 \times 22.99 &= 22.99 \text{ (Na)} \\ 1 \times 1.01 &= 1.01 \text{ (H)} \\ 1 \times 12.01 &= \underline{12.01 \text{ (C)}} \\ NaHCO_3 &= 84.01 \text{ g/mole} \end{aligned}$$

CH_3CH_2OH:

$$\begin{aligned} 2 \times 12.01 &= 24.02 \text{ (C)} \\ 6 \times 1.01 &= 6.06 \text{ (H)} \\ 1 \times 16.00 &= \underline{16.00 \text{ (O)}} \\ CH_3CH_2OH &= 46.08 \text{ g/mole} \end{aligned}$$

10. (a) $E_{Kin} = (mv^2)/2$ (Joule) $\quad (m_e = 9.1 \times 10^{-31}$ kg)

$$v = \sqrt{\frac{2E_{Kin}}{m}} = \sqrt{\frac{2 \times 2.7\ 10^{-16}}{9.1 \times 10^{-31}}} = \boxed{2.4 \times 10^7 \text{ ms}^{-1}}$$

10. (b) The isotopic distribution of Li is 93% $^{7}_{3}Li$, 7% $^{6}_{3}Li$. Let us therefore assume we deal with an isotope $^{7}_{3}Li$. The atomic mass in g is then given as $7/(6.02 \times 10^{23})$ = 1.16×10^{-26} kg/Li. (We may ignore the mass of the two missing electrons – it is smaller than the last decimal figure given.)

$(mv^2)/2 = 2.7 \times 10^{-16}$ Joules

$$v = \sqrt{\frac{2 \times 2.7 \times 10^{-16}}{1.16 \times 10^{-26}}} = \boxed{2.16 \times 10^{5}\ ms^{-1}}$$

You may ask yourself, what about the ($^{++}$) double charge on the lithium? The energy acquired with an accelerating potential of V is now E = 2eV or, generally for a charge Z: E = ZeV. Presently, the required voltage to achieve an energy of 2.7×10^{-16} Joule is only half that required for a singly charged (Li^+) ion.

11. To solve this problem we must know the following relationships:

$\nu\lambda = c$; $1/\lambda = \bar{\nu}$; $1\ nm = 10^{-9}\ m = 10$ Å

$E = h\nu$; $E_{molar} = h\nu \times N_A$ ($N_A = 6.02 \times 10^{23}$)

(a) $$\nu\ \text{(frequency)} = \frac{c}{\lambda} = \frac{3 \times 10^{8}\ m/s}{408 \times 10^{-9}\ m} = \boxed{7.353 \times 10^{14}\ s^{-1}}$$

(b) $$\bar{\nu}\ \text{(wavenumber)} = \frac{1}{\lambda} = \frac{1}{408 \times 10^{-9}\ m} = \boxed{2.45 \times 10^{6}\ m^{-1}}$$

(c) $$\lambda = 408 \times 10^{-9}\ m \times \frac{10^{10}\ \text{Å}}{m} = \boxed{4080\ \text{Å}}$$

(d) $$E = h\nu \times N_A = 6.63 \times 10^{-34} \times 7.353\ 10^{14} \times 6.02 \times 10^{23}\ J/mole$$

$$= \boxed{2.93 \times 10^{5}\ J/mole = 293\ kJ/mole}$$

(e) visible spectrum: violet (500 nm) red (800 nm) $\boxed{408\ nm = UV}$

12. (a) The equation relating ν and λ is $c = \nu\lambda$ where c is the speed of light = 3.00×10^8 m.

$$\lambda = \frac{c}{\nu} = \frac{3.00 \times 10^8 \text{ m/s}}{5.09 \times 10^{14} \text{ s}^{-1}} = \boxed{5.89 \times 10^{-7} \text{ m}}$$

(b) The wave number is 1/wavelength, but since the wavelength is in m, and the wave number should be in cm^{-1}, we first change the wavelength into cm:

$$\lambda = 5.89 \times 10^{-7} \text{ m} \times 100\text{cm/m} = 5.89 \times 10^{-5} \text{ cm}$$

Now we take the reciprocal of the wavelength to obtain the wave number:

$$\bar{\nu} = \frac{1}{\lambda} = \frac{1}{5.89 \times 10^{-5} \text{ cm}} = \boxed{1.70 \times 10^4 \text{ cm}^{-1}}$$

(c) The Einstein equation, $E = h\nu$, will give the energy associated with one photon since we know h, Planck's constant, and ν. We need to multiply the energy obtained by Avogadro's number to get the energy per mole of photons.

$h = 6.62 \times 10^{-34}$ J·s
$\nu = 5.09 \times 10^{14}$ s^{-1}
$E = h\nu = (6.62 \times 10^{-34} \text{ J·s}) \times (5.09 \times 10^{14} \text{ s}^{-1}) = 3.37 \times 10^{-19}$ J per photon

This is the energy in one photon. Multiplying by Avogadro's number:

$$E \cdot N_{Av} = (3.37 \times 10^{-19} \text{ J per photon})\left(\frac{6.023 \times 10^{23} \text{ photons}}{\text{mole}}\right)$$

$$= 2.03 \times 10^5 \text{ J per mole of photons}$$

we get the energy per mole of photons. For the final step, the energy is converted into kJ:

$$2.03 \times 10^5 \text{ J} \times \frac{1 \text{ kJ}}{1000 \text{ J}} = \boxed{2.03 \times 10^2 \text{ kJ}}$$

13. (a) A simple question on unit conversion, since the values are given in your “periodic table of the elements”. (Ionization energies appear as kcal/g–mole in older tables and as Volts – ionization potential in newer ones; the solutions are given for both.)

$$\begin{aligned} \text{H}: \quad \text{Listed value} &= 313 \text{ kcal/g} - \text{mole} = 313 \times 4.18 \text{ kJ/g} - \text{mole} \\ &= 313 \times 10^3 \times 4.18 \text{ J/g} - \text{mole} \\ &= 313 \times 10^3 \times \frac{4.18}{6.02 \times 10^{23}} \text{ J/atom} \\ \text{(H) I.E.} &= \boxed{2.17 \times 10^{-18} \text{ J/atom}} \end{aligned}$$

Listed value = 13.598 Volts (Volts in this context are to be taken as “eV”, electron volts, and you will actually, in most tables, find the units given as

$$\begin{aligned} 13.598 \text{ Volts} &= 13.598 \text{ eV} = 13.598 \times 1.6 \times 10^{-19} \text{ J/atom} \\ \text{(H) I.E.} &= \boxed{2.18 \times 10^{-18} \text{ J/atom}} \end{aligned}$$

$$\begin{aligned} \text{He}: \quad \text{I.E.} &= 567 \text{ kcal/g} - \text{mole} = 567 \times 10^3 \times \frac{4.18}{6.02 \times 10^{23}} \text{ J/atom} \\ &= \boxed{3.94 \times 10^{-18} \text{ J/atom}} \\ \text{I.E.} &= 24.587 \text{ V} = 24.587 \times 1.6 \times 10^{-19} \text{ J/atom} \\ &= \boxed{3.93 \times 10^{-18} \text{ J/atom}} \end{aligned}$$

$$\begin{aligned} \text{Cs}: \quad \text{I.E.} &= 90 \text{ kcal/g} - \text{mole} = 90 \times 10^3 \times \frac{4.18}{6.02 \times 10^{23}} \text{ J/atom} \\ &= \boxed{6.25 \times 10^{-19} \text{ J/atom}} \\ \text{I.E.} &= 3.894 \text{ V} = 3.894 \times 1.6 \times 10^{-19} \text{ J/atom} \\ &= \boxed{6.23 \times 10^{-19} \text{ J/atom}} \end{aligned}$$

13. (b) The ionization energy for Li is given as

$$\text{I.E.} = 5.392 \text{ eV} = 5.392 \times 1.6 \times 10^{-19} \text{ J} = \boxed{8.6 \times 10^{-19} \text{ J}}$$

If we use an electron to ionize the Li atom, this electron must therefore have a kinetic energy [$E_K = (mv^2)/2$] of 8.6×10^{-19} J and $(mv^2)/2 = 8.6 \times 10^{-19}$, or

$$v = \sqrt{\frac{2 \times 8.6 \times 10^{-19} \text{ J}}{9.1 \times 10^{-31} \text{ kg}}} = \boxed{1.37 \times 10^6 \text{ m/s}}$$

14. The energy of the ground state electron in hydrogen is $-K = -2.18 \times 10^{-18}$ J (I.E. = 2.18×10^{-18} J/atom); the kinetic energy of an electron travelling at $v = 7.2 \times 10^6$ km/hr is

$$E_{Kin} = \frac{mv^2}{2} = \frac{9.1 \times 10^{-31} \text{ kg} \times (2 \times 10^6 \text{ m/s})^2}{2}$$

$$E_{Kin} = \boxed{1.8 \times 10^{-18} \text{ J}}$$

$\boxed{E_{Kin} < \text{I.E. (H)}}$ – the electron cannot ionize the hydrogen atom.

15. Required: $1 \text{ eV} = 1.6 \times 10^{-19}$ J
$E_{rad} = (hc)/\lambda$; $1 \text{ nm} = 10^{-9}$ m

$$E_{rad} \text{ (eV)} = \frac{hc}{\lambda} \text{ (J)} \times \frac{1 \text{ eV}}{1.6 \times 10^{-19} \text{ (J)}}$$

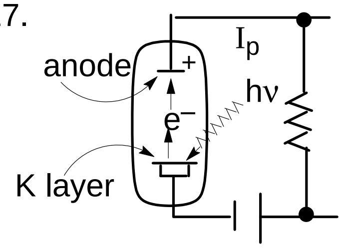
$$E_{rad} = \frac{hc}{340 \times 10^{-9}} \times \frac{1}{1.6 \times 10^{-19}} \text{ (eV)} = \boxed{3.65 \text{ eV}}$$

16. Required: $\bar{\nu} = 1/\lambda$; $1 \text{ nm} = 10^{-9}$ m
$\nu\lambda = c$

(a) $$\lambda = \frac{1}{2 \times 10^5 \text{ m}^{-1}} \times \frac{10^9 \text{ nm}}{\text{m}} = \boxed{5 \times 10^3 \text{ nm}}$$

(b) $$\nu = \frac{c}{\lambda} = \frac{3 \times 10^8 \text{ m/s}}{5 \times 10^{-6} \text{ n}} = \boxed{6 \times 10^{13} \text{ s}^{-1}}$$

17.



I_p, the photocurrent, is proportional to the intensity of incident radiation, i.e. the number of incident photons capable of generating a photoelectron.

This device should be called a phototube rather than a photodiode – a solar cell is a photodiode.

Required: $1\ eV = 1.6 \times 10^{-19}\ J$
$E_{rad} = h\nu = (hc)/\lambda$

The question is: below what threshold energy (hν) will a photon no longer be able to generate a photoelectron?

$$2.15 \times 10^5\ J/mole\ photoelectrons \times \frac{1\ mole}{6.02 \times 10^{23}\ photoelectrons}$$

$$= 3.57 \times 10^{-19}\ J/photoelectron$$

$$\lambda_{threshold} = \frac{hc}{3.57 \times 10^{-19}} = \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{3.57 \times 10^{-19}} = 5.6 \times 10^{-7}\ m = \boxed{560\ nm}$$

18. Given data: Periodic Table: Ca 1st Ionization Energy (E_I) = 141 kcal/mole
Required relationships: $1\ mole = 6.02 \times 10^{23}$ atoms
$1\ cal = 4.18\ J$

Thus : $$E_I = 141\ \frac{kcal}{mole} \times \frac{1\ mole}{6.02 \times 10^{23}\ atoms} \times \frac{4.18\ kJ}{1\ kcal}$$

$$\boxed{E_I = 9.8 \times 10^{-22}\ kJ/atom = 9.8 \times 10^{-19}\ J/atom}$$

19. (a) $c = \lambda\nu$ and $\nu = c/\lambda$ where ν is the frequency of radiation (number of waves/s).

For: $\lambda = 6.7102 \times 10^{-5}\ cm = 6.7102 \times 10^{-7}\ m$

$$\nu = \frac{2.9979 \times 10^8\ ms^{-1}}{6.7102 \times 10^{-7}\ m} = \boxed{4.4677 \times 10^{14}\ s^{-1}} = 4.4677\ Hz$$

(b) $$\bar{\nu} = \frac{1}{\lambda} = \frac{1}{6.7102 \times 10^{-7}\ m} = 1.4903 \times 10^6\ m^{-1} = \boxed{1.4903 \times 10^4\ cm^{-1}}$$

(c) $$\lambda = 6.7102 \times 10^{-5}\ cm \times \frac{1\ nm}{10^{-7}\ cm} = \boxed{671.02\ cm}$$

19. (d) $$E = \frac{hc}{\lambda} = \frac{6.62 \times 10^{-34} \text{ Js} \times 2.9979 \times 10^{8} \text{ ms}^{-1}}{6.7102 \times 10^{-7} \text{ m}}$$

$$= 2.96 \times 10^{-19} \text{ J/photon} = \boxed{1.78 \times 10^{5} \text{ J/mole photons}}$$

20. $E(J) = e \cdot V$

$$V = \frac{E}{e} = \frac{2 \times 10^{-6} \text{ J}}{1.6 \times 10^{-19} \text{ C}} = \boxed{1.25 \times 10^{13} \text{ Volt}}$$

21. This problem may be solved in a variety of ways, the simplest of which makes use of the Bohr quantization of the angular momentum:

$$mvr = n \times \frac{h}{2\pi} \qquad (r = r_o n^2)$$

$$mvr_o n^2 = n \times \frac{h}{2\pi}$$

$$v = \frac{h}{2\pi m r_o n} = \boxed{5.47 \times 10^{5} \text{ ms}^{-1}}$$

(A numerically correct result is obtained by taking:

$$E_{el} = -\frac{1}{n^2}K = \frac{mv^2}{2}$$

The negative sign reflects the E_{pot} term, which happens to be $-2E_{Kin}$.)

22. From the Rydberg relationship we obtain:

$$\frac{1}{\lambda} = \bar{\nu} = R\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right) = 1.097 \times 10^{7}\left(\frac{1}{36} - \frac{1}{4}\right) = (-)2.44 \times 10^{6}$$

$$\lambda = \frac{1}{\bar{\nu}} = \frac{1}{2.44 \times 10^{6}} = \boxed{4.1 \times 10^{-7} \text{ m} = 0.41\ \mu\text{m} = 4100\ \text{Å}}$$

23. $_7N$ $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow}$ $\boxed{\uparrow}$ $\boxed{\uparrow}$

$1s^2$ $2s^2$ $2p_x$ $2p_y$ $2p_z$

$_3Li$ $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow}$ $\boxed{}$ $\boxed{}$ $\boxed{}$

$1s^2$ $2s^1$ $2p_x$ $2p_y$ $2p_z$

$_{12}Mg$ $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow\downarrow}$ $\boxed{}$ $\rightarrow$

$1s^2$ $2s^2$ $2p_x$ $2p_y$ $2p_z$ $3s^2$ $3p$

24. E = hν = (hc)/λ; λ = (hc)/E. We see that the problem can be solved by converting the ionization energy given in the P.T. into J/atom (E).

(a) I.E. = 21.564 V

$$\lambda = \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{21.564 \times 1.6 \times 10^{-19}} = 5.8 \times 10^{-8} \text{ m}$$

$$\lambda_{max} = \boxed{5.8 \times 10^{-8} \text{ m} = 580 \text{ Å}}$$

(b) I.E. = 497 kcal/mole

$$\lambda_{max} = \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{\frac{497 \times 10^3 \times 4.18}{6.02 \times 10^{23}}} = 5.8 \times 10^{-8} \text{ m} = \boxed{580 \text{ Å}}$$

25. We can picture this problem more clearly: an electron is accelerated by a potential, V_x, and thus acquires the kinetic energy e x V_x [= $(mv^2)/2$] which is to be exactly the energy required to excite an electron in hydrogen from n=1 to n=5.

$$e \cdot V_x = -K\left(\frac{1}{25} - \frac{1}{1}\right)$$

$$V_x = \frac{K}{e} \times \frac{24}{25} = \frac{2.18 \times 10^{-18}}{1.6 \times 10^{-19}} \times \frac{24}{25} = \boxed{13.1 \text{ Volt}}$$

$$[13.1 \text{ eV} = 13.1 \text{ eV} \times \frac{1.6 \times 10^{-19} \text{ J}}{\text{eV}} = 2.08 \times 10^{-18} \text{ J} = -K\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)]$$

26. For the one electron system, He^+, the Rydberg equation applies in the form:

$$\bar{\nu} = RZ^2 \left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right) \qquad \text{(see Lecture Notes)}$$

$$= R \times 4 \left(\frac{1}{4} - 1\right)$$

$$\bar{\nu} = -1.097 \times 10^7 \times 4 \times \frac{3}{4} = (-)3.29 \times 10^7 \text{ m}^{-1} = \frac{1}{\lambda}$$

$$\lambda = \frac{1}{3.29 \times 10^7} = \boxed{3.04 \times 10^{-8} \text{ m} = 304 \text{ Å}}$$

27. The Lyman series in hydrogen spectra comprises all electron transitions terminating in the ground state (n=1). In the present problem it is convenient to convert λ into $\bar{\nu}$ and to use the Rydberg equation. Since we have an “emission spectrum”, the sign will be negative in the conventional approach. We can avoid the sign problem, however:

$$\bar{\nu} = R \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) = R \left(1 - \frac{1}{n_i^2}\right)$$

$$\frac{\bar{\nu}}{R} = \left(1 - \frac{1}{n_i^2}\right)$$

$$\frac{1}{n_i^2} = 1 - \frac{\bar{\nu}}{R} = \frac{R - \bar{\nu}}{R}$$

$$n_i^2 = \frac{R}{R - \bar{\nu}}$$

$$n_i = \sqrt{\frac{R}{R - \bar{\nu}}} \qquad \bar{\nu} = \frac{1}{9.5 \times 10^{-8} \text{ m}} = 1.053 \times 10^7 \text{ m}^{-1}$$

$$n_i = \sqrt{\frac{1.097 \times 10^7}{1.097 \times 10^7 - 1.053 \times 10^7}} = \boxed{5}$$

28. In its most general form, the Bohr theory considers the attractive force (Coulombic) between the nucleus and an electron being given by:

$$F_c = \frac{Ze^2}{4\pi\varepsilon_o r^2}$$

where Z is the charge of the nucleus (1 for H, 2 for He, etc.). Correspondingly, the electron energy (E_{el}) is given as:

$$E_{el} = -\frac{Z^2}{n^2}\frac{me^4}{8h^2\varepsilon_o^2}$$

and the electronic orbit (r_n):

$$r_n = \frac{n^2}{Z}\frac{h^2\varepsilon_o}{\pi me^2}$$

$$r_n = \frac{n^2}{Z} a_o$$

$$\text{For } He^+ \ (Z = 2),\ r_1 = \frac{1}{2} a_o = \frac{0.529}{2} \times 10^{-10} \text{ m} = \boxed{0.264 \text{ Å}}$$

29. Required: $E = eV$ J/particle
1 cal = 4.18 Joule

For convenience, the energy units are best converted at the onset:

$$E = (20 \times 10^3 \frac{\text{cal}}{\text{mole}}) \times 4.18 \times \frac{\text{J}}{\text{cal}} \times \frac{1}{6.02 \times 10^{23} \frac{\text{ions}}{\text{mole}}} = \boxed{1.39 \times 10^{-19} \text{ J/ion}}$$

$$E = eV = 1.39 \times 10^{-19}$$

$$V = \frac{1.39 \times 10^{-19}}{1.6 \times 10^{-19}} = \boxed{0.87 \text{ Volt}}$$

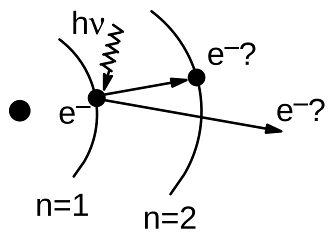
(Some convenient data to remember: 1 eV = 1.6 x 10^{-19} J. Thus, it corresponds to the energy of radiation with a λ = 1.24 μm.)

30. Required: $E = eV = (mv^2)/2$
$m_p = 1.67 \times 10^{-27}$ kg (m$_p$ = from the Table of Constants)

$$eV = \frac{mv^2}{2}$$

$$v = \sqrt{\frac{2eV}{m}} = \sqrt{\frac{2 \times 1.6 \times 10^{-19} \times 10^6}{1.67 \times 10^{-27}}} = \boxed{1.38 \times 10^7 \text{ m/s}}$$

31. Required: First of all, a sketch:



possibly to n=∞ (ionization), depending on the magnitude of E(hv)

Let us see: $E(hv) = (hc)/\lambda = 4.6 \times 10^{-19}$ J

To move the electron from n=1 to n=2 (minimum energy required for absorption of the photon), we have:

$$\Delta E = \left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)K = \frac{3}{4}\ K$$

$$= \frac{3}{4} \times 2.18 \times 10^{-18} \text{ J} = \boxed{1.6 \times 10^{-18} \text{ J}}$$

We recognize that the photon energy is less than the ΔE_{min} (for n=1 → n=2). This means that no interaction can take place – the photon will "pass by" and the electron wil continue to orbit in its 1s state! Its orbiting velocity can be obtained from:

$$mvr = n\ (\frac{h}{2\pi})$$

$$v = n\ (\frac{h}{2\pi mr}) = \boxed{2.19 \times 10^6 \text{ m/s}}$$

(You will get full credit if you simply state that no interaction is possible, or something equivalent. You will get "Brownie points" if you go beyond this statement – for example, assume an excited electron in motionless hydrogen, an unlikely occurrance, which could absorb the photon and enter a different excited state.)

32. Required: $$\Delta E_{el} = \left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right) K \quad ; \quad K = 2.18 \times 10^{-18}$$

or $$\bar{\nu} = \left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right) R \quad ; \quad R = 1.097 \times 10^{7} \text{ m}^{-1}$$

(Since only the energy gap is asked, we are not concerned about the sign.)

$$\Delta E = (1/9 - 1/65)\ K = 0.0955 \times 2.18 \times 10^{-18} \text{ J}$$

$$\boxed{\Delta E = 2.08 \times 10^{-19} \text{ J} = 1.3 \text{ eV}}$$

33. Required: P.T. (ionization potential for B is 8.298 Volt)

$$E = eV = (mv^2)/2$$

$$\boxed{v = \frac{2eV}{m} = 1.7 \times 10^{6} \text{ m/s}}$$

34. (a) The required data can be obtained by multiplying the ionization potentials (listed in the Periodic Table) with the electronic charge ($e^- = 1.6 \times 10^{-19}$ C).

Element	E.I. x 10^{18} (J)	Element	E.I. x 10^{18} (J)
Na	0.822	Ca	0.978
Ng	1.22	Sc	1.05
Al	0.958	Ti	1.09
Si	1.30	V	1.08
P	1.68	Cr	1.08
S	1.66	Mn	1.19
Cl	2.07	Fe	1.26
Ar	2.52	Co	1.26
		Ni	1.22
		Cu	1.24

34. (b) [The purpose of this question is to provide you with an opportunity for graphic data presentation. By scaling, the E.I. dependence on the atomic number can be accentuated or suppressed.]

Acceptable Answer:
In the series of elements with Z 11 to 18, the 3s and 3p subshells are being successively filled. The E.I. for this series increases from 8.22 x 10^{-19} J (Na) to 2.52 x 10^{-18} J (Ar). This pronounced increase can be attributed to the effect of increasing nuclear charge (increasing attraction) on the electrons in the M shell.

In the series Ca to Cu, the 3d subshell is successively filled. We again observe an increase in E.I. However, this increase is much less pronounced than in the series Na to Ar because of effective shielding of the nuclear charge by the electrons in the K and L shells as well as by those in 3s and 3p sublevels.

[For the inquisitive, let us analyze the behavior in more detail. The increase in E.I. from Na to Mg (increased suitability) can be attributed to the formation of a filled subshell and the ensuing drop (Al) to first occupancy of the p subshell. The irregularity (a slight E.I. drop) from P to S is the result of the first double occupancy of the p orbitals.

The question is: why should the 3d level, which is successively filled form Sc to Cu, be so much less sensitive to increasing nuclear charge? The answer to this question is provided buy wave–mechanics. s and p orbitals are “penetrating”. This means they “spend part of their time” in close proximity of the nucleus and, to a significant extent, “benefit” form increasing nuclear charge. (Remember: we saw that 2s levels also have a finite probability of occupying 1s areas, for example.) d levels and, even moreso, f levels are virtually “non–penetrating”. Therefore, since the screening effect of underlying electrons is pronounced and the increase in the “effective nuclear charge” from Z 21 to Z 29 is small, the ionization energy does not change significantly.]

35. Here we need to know the “basis” of the Rydberg equation [$E_{el} = -(1/n^2)K$] and 1 eV = 1.6 x 10^{-19} J:

$$\Delta E_{el} = K\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right) = 2.18 \times 10^{-18}\left(\frac{1}{49} - \frac{1}{64}\right) = 1.043 \times 10^{-20}\ \text{J}$$

$$\Delta E_{el} = 1.043 \times 10^{-20}\ \text{J} \times \frac{1\ \text{eV}}{(1.6 \times 10^{-19}\ \text{J})} = \boxed{6.5 \times 10^{-2}\ \text{eV}}$$

36. $$\begin{array}{lccccc} {}_{17}Cl & \boxed{\uparrow\downarrow} & \boxed{\uparrow\downarrow} & \boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow} & \boxed{\uparrow\downarrow} & \boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow} \\ & 1s^2 & 2s^2 & 2p^6 & 3s^2 & 3p^5 \end{array}$$ $(1s^2 2s^2 2p^6 3s^2 3p^5)$

$$\begin{array}{lcccc} {}_{12}Mg & \boxed{\uparrow\downarrow} & \boxed{\uparrow\downarrow} & \boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow} & \boxed{\uparrow\downarrow} \\ & 1s^2 & 2s^2 & 2p^6 & 3s^2 \end{array}$$ $(1s^2 2s^2 2p^6 3s^2)$

$$\begin{array}{lccc} {}_{7}N & \boxed{\uparrow\downarrow} & \boxed{\uparrow\downarrow} & \boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow} \\ & 1s^2 & 2s^2 & 2p^3 \end{array}$$ $(1s^2 2s^2 2p^3)$

$$\begin{array}{lccc} {}_{6}C & \boxed{\uparrow\downarrow} & \boxed{\uparrow\downarrow} & \boxed{\uparrow}\boxed{\uparrow}\boxed{} \\ & 1s^2 & 2s^2 & 2p^2 \end{array}$$ $(1s^2 2s^2 2p^2)$

37. Remember the ground state electron energy in hydrogen ($K = -2.18 \times 10^{-18}$ J). The radiation in question will impart to the removed electron a velocity of 1.3×10^6 ms^{-1}, which corresponds to:

$$E_{Kin} = \frac{mv^2}{2} = \frac{9.1 \times 10^{-31} \times (1.3 \times 10^6)^2}{2} \text{ Joules} = 7.69 \times 10^{-19} \text{ J}$$

$$E_{rad} = E_{Kin} + E_{ioniz} = 7.69 \times 10^{-19} + 2.18 \times 10^{-18} = 2.95 \times 10^{-18} \text{ J}$$

$$E_{rad} = h\nu \quad ; \quad \nu = \frac{E}{h} = \frac{2.95 \times 10^{-18}}{6.63 \times 10^{-34}} = \boxed{4.45 \times 10^{15} \text{ s}^{-1}}$$

38. (a)

$$E_{el} = -\frac{1}{n^2} K$$

$$-1.362 \times 10^{-19} \text{ J} = -\frac{1}{n^2} \times 2.18 \times 10^{-18} \text{ J}$$

$$n = \sqrt{\frac{2.18 \times 10^{-18}}{1.362 \times 10^{-19}}} = 4.00 \qquad \boxed{\text{The answer is YES.}}$$

(b) $\boxed{n = 4.0}$

39.

$$E_K = eV = \frac{m_p v^2}{2} \quad ; \quad v_p = \sqrt{\frac{2\ eV}{m_p}}$$

$$\lambda_p = \frac{h}{m_p v} = \frac{h}{m_p \sqrt{\frac{2eV}{m_p}}} = \frac{h}{\sqrt{2eVm_p}} = \frac{6.63\ x\ 10^{-34}}{(2x1.6x10^{-19}x15x1.67x10^{-27})^{\frac{1}{2}}} = \boxed{7.4x10^{-12}m}$$

40. The definition of an eV is the energy gained by an electron when it is accelerated through a potential of 1V, so an electron accelerated by a potential of 10V would have an energy of 10 eV.

(a) $E = \frac{1}{2}mv^2 \rightarrow v = \sqrt{2E/m}$

$E = 10\ eV = 1.60\ x\ 10^{-18}$ J

m = mass of electron = $9.11\ x\ 10^{-31}$ kg

$$v = \sqrt{\frac{2\ x\ 1.6\ x\ 10^{-18}\ J}{9.11\ x\ 10^{-31}\ kg}} = \boxed{1.87\ x\ 10^{6}\ m/s}$$

(b) $\lambda_p = h/mv$

$$\lambda_p = \frac{6.63\ x\ 10^{-34}}{9.11\ x\ 10^{-34}\ kg\ x\ 1.87\ x\ 10^{6}\ m/s} = \boxed{3.89\ x\ 10^{-10}\ m}$$

(c) The energy the electrons have ($E = e \cdot V = 1.6\ x\ 10^{-18}$ J) must be compared with the smallest energy required to excite a H electron – that needed to move the electron from the n=1 shell to the n=2 shell.

$$E = k\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) = 2.18\ x\ 10^{-18}\ J\ \left(\frac{1}{4} - \frac{1}{1}\right) = 1.64\ x\ 10^{-18}\ J$$

The E that the electrons have ($1.6\ x\ 10^{-18}$ J) is less than that required to excite an electron from the n=1 to the n=2 shell ($1.64\ x\ 10^{-18}$ J), so **no excitation could occur**.

41. (All required information is in the Periodic Table and the Table of Constants; remember 1 cm^3 = 1 ml)

$$\#\text{ of Hg atoms/10 ml} = \frac{1\ mole}{14.82\ ml}*\ x\ \frac{6.02\ x\ 10^{23}\ atoms}{1\ mole}\ x\ 10\ ml$$

$$\boxed{= 4.06\ x\ 10^{23}}$$

* [atomic (molar) volume listed in P/T]

42. (a) $CO + 1/2\ O_2 \rightarrow CO_2$

(b) [Information only at 1 digit!]
Molecular Weight (M.W.) of O_2: 32.0
(M.W.) of CO: 28.0
available oxygen: 32.0g = 1 mole, correspondingly the reaction involves 2 moles of CO [see (a)]:

$$O_2 + 2\ CO \rightarrow 2\ CO_2$$

mass of CO reacted = 2 moles x 28 g /mole= $\boxed{56.0\ g}$

43. (a) $(NH_4)_2SO_4\ (s) \rightarrow 2NH_3\ g + H_2SO_4\ (l)$

(b) From (a): 1 mole ammonium sulfate on decomposition will generate 2 moles of ammonia (NH_3); corresspondingly, 0.15 mole of the reactant will create 0.300 mole of the product in question.
M.W. $(NH_4)_2SO_4$: 2N = 2 x 14.0067 = 28.0134
8H = 8 x 1.0079 = 8.0632
S = 32.06
4O = 4 x 15.9994 = 63.9984
132.13

$$g(NH_4)_2SO_4 \text{ needed} = \frac{132.13\ g(NH_4)_2SO_4}{2\ \text{moles}\ NH_3} \times 0.300\ \text{moles}\ NH_3$$

$$\boxed{=19.82}$$

44. (We know: $E_{photon} = h\nu = hc/\lambda$ to determine the wavelength associated with a photon we need to know its energy, the wavelengthe of the visible spectrum are given in Ln 1 page 4).

(a) $$E = \frac{171kJ}{mole} = \frac{1.71 \times 10^5\ J}{mole} \times \frac{1\ mole}{6.02 \times 10^{23}\ photons}$$

$$= \frac{2.84 \times 10^{-19}\ J}{photon}\ ; \qquad E_{photon} = 2.84 \times 10^{-19} J = h\nu = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E_{photon}} = \frac{6.63 \times 10^{-34}\ Js \times 3 \times 10^8\ \frac{m}{s}}{2.84 \times 10^{-19}\ J} = 7.00 \times 10^{-7}\ m$$

$$\boxed{= 700\ nm\ (\text{red light})}$$

(b) (IS or SI units are in m, k, s)

$$\lambda\nu = c$$

$$\nu = \frac{c}{\lambda} = \frac{3 \times 10^8\ \frac{m}{s}}{7.00 \times 10^{-7}\ m} \boxed{= 4.29 \times 10^{14}\ s^{-1} = 4.29 \times 10^{14}\ Hz}$$

45. We know: $\Delta E = \Delta mc^2$; 1 U. S. gallon = 3.785 ltr. ; energy as heat required to increase the temperature of 1 ml H_2O by 1°C is 1 cal (4.18 J)

$$\text{energy required} = 300 \text{ gal} \times \frac{3.785 \text{ ltr}}{\text{gal}} \times \frac{1000 \text{ ml}}{1 \text{ ltr}} \times \frac{1 \text{ cal}}{\text{ml}/^{o}\text{C}} \times \frac{4.18 \text{ J}}{\text{cal}} \times 6^{o}\text{C}$$
$$= 2.85 \times 10^{7} \text{ J}$$

$$\Delta E = \Delta mc^2$$

$$\text{mass to be converted } \Delta m = \frac{\Delta E}{c^2} = \frac{2.85 \times 10^{7} \text{ J}}{(3 \times 10^{8})^{2}(\frac{m}{s})^{2}} \boxed{= 3.16 \times 10^{-10} \text{ kg}}$$

46. We know: $E_{kin} = mv^2/2 = e \times V$ (charge applied potential) $m_e = 9.1 \times 10^{-31}$ kg

$$E_{kin} = e \times V = mv^2/2$$

$$v = \sqrt{\frac{2eV}{m}} = \frac{\sqrt{2 \times 1.6 \times 10^{-19} \times 150}}{9.1 \times 10^{-31}} \boxed{= 7.26 \times 10^{6} \text{ m/s}}$$

47. $$E_{(eV)} = \frac{hc}{\lambda} \times \frac{l \text{ eV}}{1.6 \times 10^{-19} \text{ J}} = \frac{6.63 \times 10^{-34} [\text{Js}] \times 3 \times 10^{8} [\frac{m}{s}]}{8.00 \times 10^{-7} \text{ m}} \times \frac{l \text{ eV}}{1.6 \times 10^{-19} \text{ J}}$$
$$\boxed{= 1.55}$$

48. (The temperature induction here is superfluous)

$$\# \text{ of Au atoms} = \frac{6.02 \times 10^{23} \text{ atom/mole}}{196.96 \text{ g/mole}} \times 12 \text{ g}$$
$$\boxed{= 3.67 \times 10^{22}}$$

49. atomic weight of Cl : 34.96885 x 0.75771 = 26.4962
36.96590 x 0.24229 = 8.95647

$\boxed{35.4527 \text{ a.m.u.}}$

50. (All relevant data are in the P/T and T/C.)

(a) The mass of the constituents (2p + 2n) is given as:

2p = $2 \times 1.6726485 \times 10^{-24}$ g
2n = $2 \times 1.6749543 \times 10^{-24}$ g
(2p + 2n) = $6.6952056 \times 10^{-24}$ g

The atomic weight (calculated) in amu is given as:

$$\frac{6.6952056 \times 10^{-24} \text{ g}}{1.660565 \times 10^{-24} \text{ g}} \text{ /amu}$$

$\boxed{\text{He} = 4.03188}$ amu

50. (b) The listed atomic weight for He is 4.00260 (amu). The data indicate a mass defect of 2.92841×10^{-2} amu, corresponding to 4.8628×10^{-26} g/atom.

This mass defect appears as nuclear bond energy:

$$\Delta E = 4.8628 \times 10^{-29} \text{ kg} \times 9 \times 10^{16} \text{ m}^2/\text{s}^2 = 4.3765 \times 10^{-12} \text{ J/atom}$$

$$= 2.6356 \times 10^{12} \text{ J/mole}$$

$$\Delta m = \frac{\Delta E}{c^2} = 2.928 \times 10^{-5} \text{ kg/mole} = 0.02928 \text{ g/mole}$$

51. (You need to know the Bohr atom, $E = -(1/n^2)K$, and energy conservation, $E_{radiation} = \Delta E_{ioniz} + E_{Kin}$.)

$$\Delta E_{ioniz} = (E_f - E_i) = K\left[\frac{1}{n_i^2} - \frac{1}{n_f^2}\right] = K\left(\frac{1}{4} - \frac{1}{\infty^2}\right) = \frac{K}{4} \text{ J}$$

$$= \frac{2.18 \times 10^{-18}}{4} \text{ J} = 5.45 \times 10^{-19} \text{ J}$$

$$E_{radiation} = h\nu = \frac{hc}{\lambda} = \frac{hc}{1 \times 10^{-8}} = 1.989 \times 10^{-17} \text{ J}$$

$$E_{Kin} = (E_{radiation} - E_{ionization}) = 1.934 \times 10^{-17} \text{ J} = \frac{mv^2}{2}$$

$$v_{electron} = \sqrt{\frac{2E}{m}} = \sqrt{\frac{2 \times 1.934 \times 10^{-17}}{9.1 \times 10^{-31} \text{ kg}}} = \boxed{6.52 \times 10^6 \text{ m/s}}$$

52. (First determine the radius, then the perimeter of the orbit and the velocity; this will give the number of revolutions/lifetime.)

$r_n = n^2 r_o$

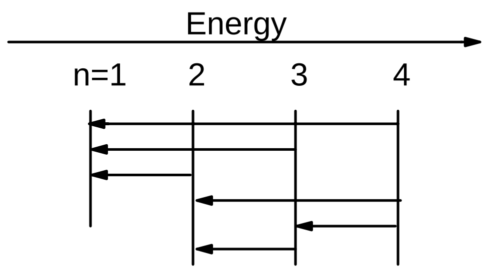
Perimeter $= 2\pi n^2 r_o$

$$\text{velocity of electron: } mvr = n\frac{h}{2\pi} \quad ; \quad v = \frac{nh}{2\pi m r_n}$$

$$\#\text{ revolutions} = \frac{v \cdot t}{\text{perimeter}} = \frac{nh}{2\pi m r_o n^2} \times t \times \frac{1}{2\pi n^2 r_o}$$

$$= \frac{ht}{4\pi^2 m r_o^2 n^3} = \boxed{2.44 \times 10^6 \text{ revolutions}}$$

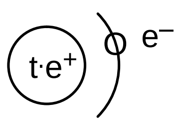
53. We have to find out from which excited state stabilization will yield radiation with 6 different frequencies (wavelengths).



We have to excite the electron to n=4.

$$\Delta E = (E_f - E_i) = K\left(\frac{1}{1^2} - \frac{1}{4^2}\right) = K\frac{15}{16} = h\nu$$

$$\nu = \frac{K}{h} \times \frac{15}{16} = \frac{2.18 \times 10^{-18}\ \mathrm{J}}{6.63 \times 10^{-34}\ \mathrm{J{\cdot}s}} \times \frac{15}{16} = \boxed{3.08 \times 10^{15}\ \mathrm{Hz}}$$

54. 

We need to know:

1. $mvr = \frac{nh}{2\pi}$
2. centripetal force $= \frac{mv^2}{r}$
3. Coulombic force $= \frac{-e^2t}{4\pi\varepsilon_o r^2}$

For equilibrium, Σ Forces = 0.

$$\frac{mv^2}{r} - \frac{e^2t}{4\pi\varepsilon_o r^2} = 0$$

$$\frac{mv^2}{r} = \frac{e^2t}{4\pi\varepsilon_o r^2}$$ multiply with mr^3 on both sides

$$m^2v^2r^2 = \frac{e^2tmr}{4\pi\varepsilon_o}$$ from eq. 1

$$\frac{n^2h^2}{4\pi^2} = \frac{e^2tmr}{4\pi\varepsilon_o}$$

$$r = \frac{n^2}{t}\left(\frac{h^2\varepsilon_o}{\pi e^2 m}\right) \qquad \boxed{r = \frac{n^2}{t}\,r_o}$$

55. Look at a radio (for range of frequency).

AM $\rightarrow$ 550 to 1600 [kHz] (10^3 Hz)
FM $\rightarrow$ 88 to 108 [MHz] (10^6 Hz)

(a) AM:

$$\lambda_{min} = \frac{c}{\nu} = \frac{3 \times 10^8 \text{ m/s}}{1600 \times 10^3\text{/s}} = 187.5 \text{ m}$$

$$\lambda_{max} = \frac{c}{\nu} = \frac{3 \times 10^8 \text{ m/s}}{550 \times 10^3\text{/s}} = 545.4 \text{ m}$$

(b) FM

$$\lambda_{min} = \frac{c}{\nu} = \frac{3 \times 10^8 \text{ m/s}}{108 \times 10^6\text{/s}} = 2.78 \text{ m}$$

$$\lambda_{max} = \frac{c}{\nu} = \frac{3 \times 10^8 \text{ m/s}}{88 \times 10^6\text{/s}} = 3.4 \text{ m}$$

56. Same as #52.

$$r = n^2 r_o = (3)^2(0.529 \times 10^{-10} \text{ m}) = 4.76 \times 10^{-10} \text{ m}$$

$$v = \frac{nh}{2\pi mr} = \frac{3 \times 6.63 \times 10^{-34} \text{ J/s}}{2\pi \times 0.9109 \times 10^{-30} \text{ kg} \times 4.76 \times 10^{-10} \text{ m}}$$

$$= \boxed{7.31 \times 10^5 \text{ m/s}}$$

57. $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ + Energy

Each two moles of octane = 2 x [8 x 12 + 18 x 1] = 228 g

React with twenty-five moles of oxygen = 25(32) = 800 g O_2

We need to determine the total octane used for the round trip (2 x 239 miles):

(continued)

57. Continued.

$$2 \times \frac{239 \text{ (miles)}}{28 \text{ (mile/US gal)}} \times 3785 \text{ (ml/US gal)} \times 0.679 \text{ (g/ml)} = 43,873.8 \text{ g of } C_8H_{18}$$

$$= 43.9 \text{ kg } C_8H_{18}$$

$$\text{Total oxygen needed in kg} = \frac{0.8 \text{ (kg } O_2)}{0.228 \text{ (kg } c_8H_{18})} \times 43.9 \text{ (kg } C_8H_{18})$$

$$= \boxed{154 \text{ kg of } O_2}$$

58. Chlorine (Cl) has a valence shell configuration of s^2p^5. If we add an electron to it, it will reach the more stable octet configuration. It will release energy. The electron affinity is negative. Argon, on the other hand, has an octet configuration already in its valence shell (s^2p^6). If an electron is added to it, it will become less stable by assuming a higher energy configuration. Energy should be spent to accomplish this $\rightarrow \Delta EA > 0$.

59.

		1s	2s	2p	2p	2p	3s	3p	3p	3p
(1.) N	:	↑↓	↑↓	↑	↑	↑				
(2.) P^{3+}	:	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓			
(3.) S	:	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑	↑
(4.) S^{4+}	:	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓			

60. Sulfur has six electrons in its valence shell (s^2p^4). It needs two electrons to form a stable octet configuration $\boxed{S^{2-} \rightarrow S^2P^6}$. [$S^+$ is less stable than the atomic S because it is more removed from octet stability. S^-, at a higher energy level, assumes a Cl-like electron affinity].

61. For 2p

n	l	m	s
2	1	–1	1/2
2	1	–1	–1/2
2	1	0	1/2
2	1	0	–1/2
2	1	1	1/2
2	1	1	–1/2

62. (We will assume the element of concern is hydrogen.)
ground state = n
lowest state = n+1 For Hydrogen: (n=1)
from Rydberg's equations:

$$\frac{1}{\lambda} = R\left[\frac{1}{n_2^2} - \frac{1}{n_f^2}\right] = R\left[\frac{1}{n_2} - \frac{1}{(n+1)^2}\right] = R\left[\frac{2n+1}{n^2(n+1)^2}\right]$$

$$\lambda = \frac{1}{R}\left(\frac{4}{3}\right) = \frac{1}{1.097 \times 10^7}\left(\frac{4}{3}\right) = \boxed{1.21 \times 10^{-7} m}$$

(ultraviolet)