Callister 7th

2.1 Atomic mass of a specific atom refers to the sum of the masses of the protons and neutrons in the nucleus. The atomic weight corresponds to the weighted average of the atomic masses of the atom's naturally occuring isotopes.

2.2

$$.9223(27.9769\text{ amu}) + .0468(28.9765\text{ amu}) + 0.0309(29.9738\text{ amu})$$

$$\boxed{= 28.0854\text{ amu}}$$

2.3 a. $1\text{ amu/atom} = 1\text{ g/mol}$

$$1\text{ amu} = 1\text{ g}\ \frac{\text{atom}}{\text{mol}} = 1\text{ g}\ \frac{\text{atom}}{\text{mol}}\ \frac{\text{mol}}{6.02\times10^{23}\text{ atoms}}$$

$$\boxed{1\text{ amu} = 1.661\times10^{-24}\text{ g}}$$

b. $1\text{ gram-mole}\left(\frac{6.02\times10^{23}\text{ atoms}}{\text{mol}}\right)$

$$1\text{ lb mole}\left(\frac{6.02\times10^{23}\text{ atoms}}{\text{mol}}\right)\left(\frac{453.59\text{ g}}{1\text{ lb}}\right)$$

$$\boxed{= 2.731\times10^{26}\text{ atoms}}$$

2.4 a. Two important quantum mechanical concepts associated with the Bohr model are the position of electrons being in discrete orbitals and the quantized energy levels of electrons.

b. Two important refinements that resulted from the wave-mechanical model are the electron was now considered to exhibit both wave-like and particle-like characteristics and the position of the electron is described by a probability distribution.

2.5 The first quantum number is related to the distance of an electron to the nucleus, "which shell the electron belongs to".
The second quantum number signifies the subshell and is related to the shape of the subshell.
The third quantum number determines the number of energy states for each subshell.
The fourth quantum number describes the spin orientation of the electron.

2.6 L shell

$2\,0\,0\,(\frac{1}{2})$ s subshell
$2\,0\,0\,(-\frac{1}{2})$ s subshell
$2\,1\,1\,(\frac{1}{2})$ p subshell
$2\,1\,1\,(-\frac{1}{2})$
$2\,1\,-1\,(\frac{1}{2})$
$2\,1\,-1\,(-\frac{1}{2})$
$2\,1\,0\,(\frac{1}{2})$
$2\,1\,0\,(-\frac{1}{2})$

M shell

$3\,0\,0\,(\frac{1}{2})$ s subshell
$3\,0\,0\,(-\frac{1}{2})$
$3\,1\,1\,(\frac{1}{2})$ p subshell
$3\,1\,1\,(-\frac{1}{2})$
$3\,1\,-1\,(\frac{1}{2})$
$3\,1\,-1\,(-\frac{1}{2})$
$3\,1\,0\,(\frac{1}{2})$
$3\,1\,0\,(-\frac{1}{2})$

$3\,2\,1\,(\frac{1}{2})$ d subshell
$3\,2\,1\,(-\frac{1}{2})$
$3\,2\,-1\,(\frac{1}{2})$
$3\,2\,-1\,(-\frac{1}{2})$
$3\,2\,0\,(\frac{1}{2})$
$3\,2\,0\,(-\frac{1}{2})$

$3\,2\,2\,(\frac{1}{2})$ d sub shell
$3\,2\,2\,(-\frac{1}{2})$
$3\,2\,-2\,(\frac{1}{2})$
$3\,2\,-2\,(-\frac{1}{2})$

Callister 7th

2.7 P^{5+}
$Z = 15 \Rightarrow 10 \Rightarrow \boxed{1s^2 2s^2 2p^6}$

P^{3-} $Z = 15 \Rightarrow 18 \Rightarrow \boxed{1s^2 2s^2 2p^6 3s^2 3p^6}$

Sn^{4+}
$Z = 50 \Rightarrow 46$ $\boxed{1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10}}$

Se^{2-}
$Z = 34 \Rightarrow 36$ $\boxed{1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6}$

I^-
$Z = 53 \Rightarrow 54$ $\boxed{1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4p^8}$

Ni^{2+}
$Z = 28 \Rightarrow 26$ $\boxed{1s^2 2s^2 2p^6 3s^2 3p^6 3d^8}$

2.8 $\boxed{\begin{matrix} K^+ & \rightsquigarrow & Ar \\ I^- & \rightsquigarrow & Xe \end{matrix}}$

2.9 All the elements in Group IIA of the periodic table have two electrons in excess of stable structures.

2.10 An element with atomic number 112 would belong to Group IIB

2.11 a) $1s^2 2s^2 2p^6 3s^2 3p^5$ → halogen, 1 electron deficient of stable structure
b) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2$ → transition metal, 4s orbital filled before 3d
c) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$ → inert gas, filled p orbital
d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ → alkali metal, 1 electron excess of stable structure
e) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^5 5s^2$ → transition metal, 5s orbital before 4d
f) $1s^2 2s^2 2p^6 3s^2$ → alkaline earth metal, 2 electrons excess of stable structure

2.12 a) the 4f shell
b) the 5f shell

2.13 Ca^{2+} O^{2-} $d = 1.25\,nm$

Farad

$$\left(F = \frac{C^2}{\underbrace{N \cdot m}_{J}} \right)$$

$$F_a = -\frac{A}{r^2} \qquad A = \frac{1}{4\pi\varepsilon_0}(Z_1 e)(Z_2 e)$$

$$F_a = \frac{1}{4\pi(8.85\times10^{-12}\,F/m)} \frac{(2(1.6\times10^{-19}\,C))(2(1.6\times10^{-19}\,C))}{(1.25\times10^{-9}\,m)^2}$$

$$\boxed{F = 5.892\times10^{-10}\,N}$$

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2.14

$$E_n = -\frac{A}{r} + \frac{B}{r^n}$$

1. $\frac{dE_n}{dr} = +\frac{A}{r^2} - \frac{nB}{r^{n+1}} = 0$

2. $\frac{A}{r^2} = \frac{nB}{r^{n+1}}$

$$\frac{r^{n+1}}{r^2} = \frac{nB}{A}$$

$$r^{n-1} = \frac{nB}{A}$$

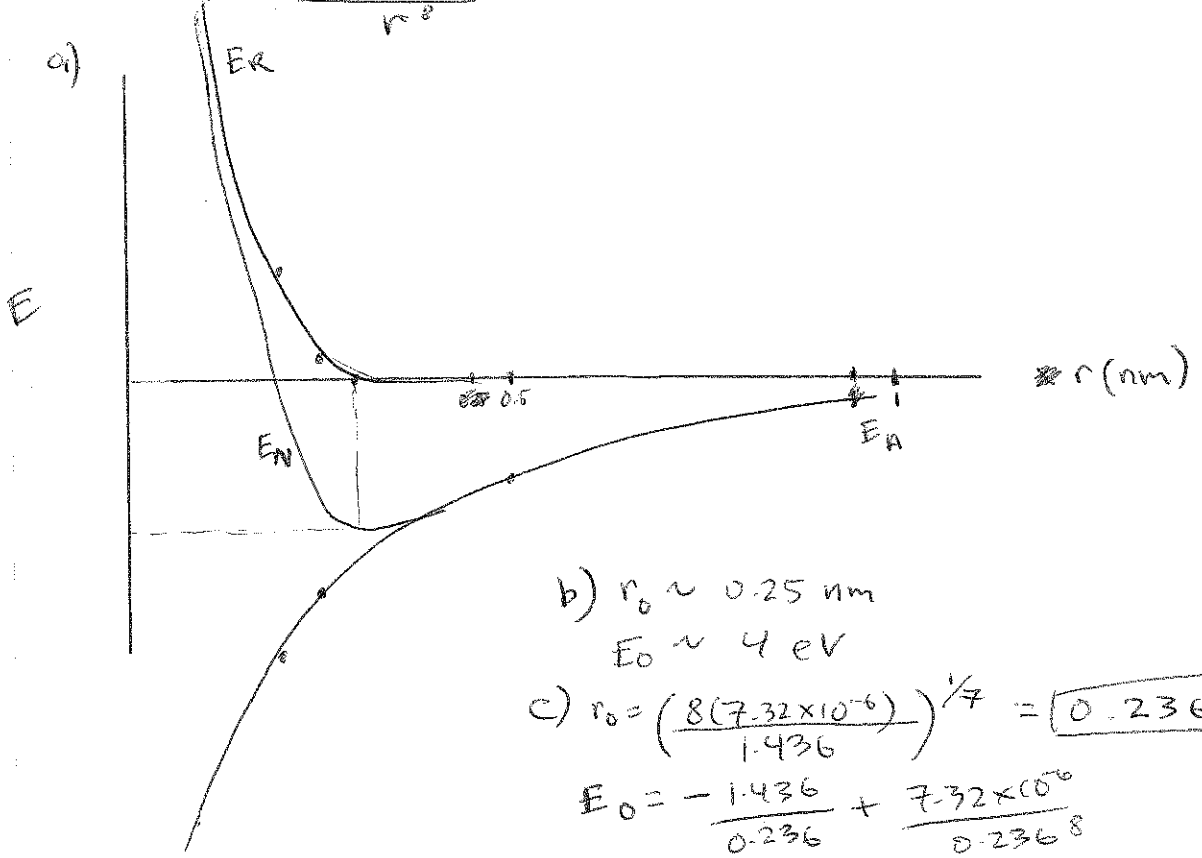
$$\boxed{r_0 = \left(\frac{nB}{A}\right)^{\frac{1}{n-1}}}$$

$$\boxed{E_0 = -\frac{A}{r_0} + \frac{B}{r_0^n}}$$

2.15 $E_a = \frac{-1.436}{r}$

$E_r = \frac{7.32 \times 10^{-6}}{r^8}$

a)



b) $r_0 \sim 0.25$ nm

$E_0 \sim 4$ eV

c) $r_0 = \left(\frac{8(7.32\times10^{-6})}{1.436}\right)^{1/7} = \boxed{0.236 \text{ nm}}$

$$E_0 = -\frac{1.436}{0.236} + \frac{7.32\times10^{-6}}{0.236^8}$$

$$\boxed{E_0 = -5.318 \text{ eV}}$$

Callister 7th

2.16 $r_0 = 0.38\,nm$
$E_0 = -5.37\,eV$
$n = 8$

$$r_0 = \left(\frac{8B}{A}\right)^{1/7} \Rightarrow r_0^{\,7} = \frac{8B}{A} \Rightarrow A = \frac{8B}{r_0^{\,7}}$$

$$E_0 = -\frac{A}{r_0} + \frac{B}{r_0^{\,8}}$$

~~B~~ $$E_0 = -\frac{8B}{r_0^{\,8}} + \frac{B}{r_0^{\,8}}$$

$$E_0 = -\frac{7B}{r_0^{\,8}}$$

$$B = \frac{-E_0 r_0^{\,8}}{7} = -\frac{(-5.37)(.38)^8}{7} = 3.335 \times 10^{-4}$$

$$A = \frac{8(3.335\times10^{-4})}{(.38)^7} = 2.332$$

$$\boxed{E_A = \frac{-2.332}{r_0} \qquad E_r = \frac{3.335\times10^{-4}}{r_0^{\,8}}}$$

2.17 $$E_N = \frac{-C}{r} + D\exp\left(\frac{-r}{\rho}\right)$$

1. $$\frac{dE_N}{dr} = \frac{C}{r^2} - \frac{D}{\rho}\exp\left(\frac{-r}{\rho}\right) = 0$$

2. $$\frac{C}{r^2} = \frac{D}{\rho}\exp\left(\frac{-r}{\rho}\right) \Rightarrow C = \frac{Dr^2}{\rho}\exp\left(\frac{-r}{\rho}\right)$$

3. $$E_0 = \frac{-\left(\frac{Dr^2}{\rho}\exp\left(\frac{-r}{\rho}\right)\right)}{r} + D\exp\left(\frac{-r}{\rho}\right)$$

$$E_0 = -\frac{Dr}{\rho}\exp\left(\frac{-r}{\rho}\right) + D\exp\left(\frac{-r}{\rho}\right)$$

$$\boxed{E_0 = D\exp\left(\frac{-r}{\rho}\right)\left[1 - \frac{r}{\rho}\right]}$$

b) $$\frac{D}{\rho}\exp\left(\frac{-r}{\rho}\right) = \frac{C}{r^2} \Rightarrow D = \frac{C\rho}{r^2\exp\left(\frac{-r}{\rho}\right)}$$

$$E_0 = \frac{-C}{r} + \left(\frac{C\rho}{r^2\exp\left(\frac{-r}{\rho}\right)}\right)\exp\left(\frac{-r}{\rho}\right)$$

$$\boxed{E_0 = -\frac{C}{r} + \frac{C\rho}{r^2}}$$

Callister 7th

2.18 a) For ionic bonds, electrically charged ions are formed by the transference of valence electrons from one atom type to another. In covalent bonds there is a sharing of valence electrons between adjacent atoms. In Metallic bonding, the valence electrons form a "sea of electrons" that is uniformly dispersed around the metal ion cores and acts as a form of glue for them.

b) The pauli ~~exclusi~~ exclusion principle stipulates that each electron state can hold no more then two electrons, which must have opposite spins.

2.19 MgO % ionic character $= \left[1 - \exp\left(-0.25(X_A - X_B)^2\right)\right] \times 100$

$$1 - \exp\left(-0.25(3.5 - 1.2)^2\right) = \boxed{0.7335}$$

$$\boxed{73.35\%}$$

GaP

$$1 - \exp\left(-0.25(2.1 - 1.6)^2\right) = \boxed{6.06\%}$$

CsF

$$1 - \exp\left(-0.25(4.0 - 0.7)^2\right) = \boxed{93.43\%}$$

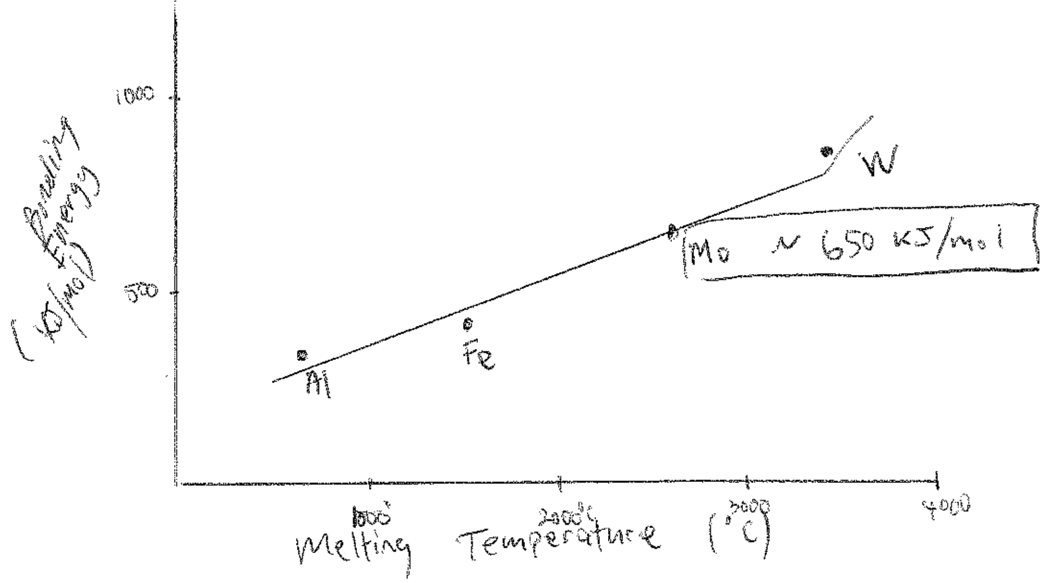
CdS

$$1 - \exp\left(-0.25(2.5 - 1.7)^2\right) = \boxed{14.79\%}$$

FeO

$$1 - \exp\left(-0.25(3.5 - 1.8)^2\right) = \boxed{51.45\%}$$

2.20



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2.21

Silicon ⇒ 4 bonds $N' = 4$ $8 - N' =$ ④

Bromine ⇒ 1 bonds $N' = 7$ $8 - N' = 1$

Nitrogen ⇒ 3 bonds $N' = 5$ $8 - N' = 3$

Sulfur ⇒ 2 bonds $N' = 6$ $8 - N' = 2$

Neon ⇒ 0 bonds $N' = 8$ $8 - N' = 0$

2.22 solid Xenon ⇒ secondary bonding
Calcium Fluoride ⇒ ionic bonding
bronze ⇒ metallic bonding
cadmium teluride ⇒ covalent bonding
rubber ⇒ hydrogen bonding
tungsten ⇒ metallic bonding

2.23 Hydrogen fluoride has a higher boiling temperature, because of hydrogen bonding which are generally greater than other types of secondary bonding such as HCl. The stronger bonds make it harder to seperate molecules and thus have higher boiling temperatures.