1 Cognitive reasoning in the chemical sciences 1.7

1. The following three relations are true:

   (a) $E_{trans} \propto nmv_{rms}^2$

   (b) $nT \propto E_{trans}$

   (c) $pV \propto nT$

2. Please answer the following questions:

   (a) How is v_{rms} proportional to the variables m and T?

   (b) How is pV related by proportion to E_{trans}?

   (c) How is p proportional to m, v_{rms}, V, and n?

   (d) What is the proportionality relation between n/p and T/V?

3. Without using a calculator, estimate to two significant figures the averages of the following situations:

   (a) A group of students is 3/4 right-handed amd 1/4 left-handed. Strangely the right-handed people are all 5 feet tall while the left handed people are 6 feet tall. What is the average height of a person in this group? Remember, no calculator should be used.

   (b) 99% of carbon atoms are ^{12}C, almost all the remaining are ^{13}C. To four significant figures, what is carbon's atomic weight?

   (c) 93% of lithium atoms are ^{7}Li, almost all the remaining are ^{6}Li. To three significant figures, what is lithium's atomic weight?

   (d) 76% of chlorine atoms are ^{35}Cl, almost all the remaining are ^{37}Cl. To three significant figures, what is chlorine's atomic weight?

   (e) 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 ,13, 14, 15, 16, 17.

4. To solve the problems below, you will need to reduce all the given information to either one algebraic equation with one unknown or two algebraic equations with two unknowns.

   (a) A sample of Li composed sole of two isotopes is 23.135% ^{6}Li with atomic mass 6.0012 amu, while the rest of the sample is ^{7}Li. The measured amu for the sample is 6.7435. What is the amu for ^{7}Li?

   (b) Sally only eats fish-patty sandwiches and hamburgers. Every week she eats on the average 20.3 such sandwiches a week. Fish sandwiches cost 44.96 HK\$ while hamburgers cost 55.85 HK\$. If the total amount on the average Sally spends on food a week is 1020 HK\$, on the average how many fish sandwiches and how many hamburgers does she eat each week?

   (c) The mine in Rainbow Lake, Canada has high quality ore composed purely of CoO and Fe_2O_3. Every week 9.61×10^5 kg of ore are mined in this mine. The mine refines the ore into pure Co and pure Fe. The weight of the refined metal is 7.20×10^5 kg. By weight percent, what percentage of the original mined ore is CoO?

   (d) Upon heating, 120.34 g of a mixed $AlCl_3$ and $CaCl_2$ sample is reduced into 33.456 g of a metallic alloy which contains no chlorine. What was the molar ratio of the $AlCl_3$ to the total number of moles of compound in the initial chloride-containing sample?

   (e) Europium has two naturally occuring isotopes. The lighter one comprises 47.810% of all europium atoms. The heavier isotope weighs 2.0013 g more than the lighter isotope. The atomic mass of europium is 151.9640 g/mol. To four significant figures after the decimal place, please calculate the atomic masses of each of the two isotopes.

(f) The atomic weight for all elements is given in the periodic table. The element Sb has only two naturally occuring isotopes. Both isotopes have an even number of neutrons. The mass of one isotope is 2.000 g/mol greater than the other. What are the two isotopes, and what is the natural percentage of each?