

Some Questions on High School Chemistry

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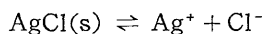
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Abstract

Some questions on high school chemistry were given to the author by high school chemistry teachers and university students, as follows;

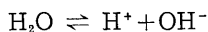
- 1) Is the Avogadro's number changed by changing the basis for an atomic weight?
- 2) Is the mass of reaction product changed, compared with the mass of reacting substance, according to the Einstein's equation, even in chemical reactions?
- 3) An electrolysis of AgCl reaches the following equilibrium;



$$\therefore K (\text{equilibrium constant}) = [\text{Ag}^+][\text{Cl}^-]/[\text{AgCl(s)}]$$

What is the value of K and what is the concentration of pure solid AgCl represented by the $[\text{AgCl(s)}]$?

- 4) Water dissociates electrolytically in the following way;



$$\therefore K (\text{equilibrium constant}) = [\text{H}^+][\text{OH}^-]/[\text{H}_2\text{O}]$$

What is the value of K and what does the concentration of pure water represented by the $[\text{H}_2\text{O}]$ mean?

- 5) The reaction, $1/2 \text{Cu} + \text{FeCl}_3 \longrightarrow 1/2 \text{CuCl}_2 + \text{FeCl}_2$ occurs. On the basis of the ionization tendency, this reaction should not occur, because the ionization tendency of Fe is larger than that of Cu. Why does the reaction occur?
- 6) In the classification of subgroups of long type periodic Table, which is correct, (i) or (ii) ?

(i) Ia, IIa, IIIa, , VIIa, VIII, Ib, IIb, IIIb, , VIIb, 0

(ii) Ia, IIa, IIIb, , VIIb, VIII, Ib, IIb, IIIa, , VIIa, 0

- 7) Is it correct that Zn, Cd, and Hg are not considered as transition elements?
- 8) La and Ac are not the internal transition elements. Nevertheless, why are the series of internal transition elements called lanthanides or actinides which were derived from La or Ac?

Questions

Some questions on high school chemistry were given to the author by high school chemistry teachers and university students. The author gave each questioner his answers and published the questions and answers in "Science Bulletin of the Faculty of Education, Nagasaki University". This caused a good deal of comment, because the almost of the author's answers resulted in opposition to descriptions which have so far been familiarly understood as right facts for years. These comments seem to originate in misunderstanding and prejudice. Therefore, the author is going to contribute the manuscript entitled "Some Questions on High School Chemistry" to this Bulletin, in order to get the answers from all over world. He hopes many people will give the answers for these questions.

1) Is the Avogadro's number changed by changing the basis for an atomic weight? The answer was "yes", or "it will change", which is most of the answers which were obtained so far. The reason was as follows: the oxygen atom in Nature contains 99.75% ^{16}O , 0.037% ^{17}O , and 0.2039% ^{18}O . Accordingly, the mass of the Avogadro's number (N) atoms of oxygen in Nature can be obtained by the following method. The weights in grams of ^{16}O , ^{17}O , and ^{18}O are $16/N$ g, $17/N$ g, and $18/N$ g, respectively, and thus the masses of 1 mole oxygen in Nature become $(16/N \times 0.99758 N + 17/N \times 0.000373 N + 18/N \times 0.002039 N)$ g = 16.0044 g. Chemical atomic weights are referred to the average mass of the natural mixture of oxygen isotopes taken as 16.0000, and physical atomic weights are referred to the mass of the ^{16}O -isotope of oxygen taken as 16.0000. Thus, the conversion ratio is

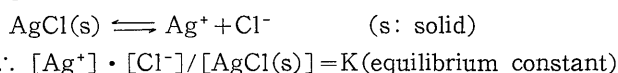
$$\frac{\text{physical atomic weight}}{\text{chemical atomic weight}} = \frac{16.0044}{16.0000} = 1.000272 .$$

In consequence, when the atomic weight is converted from chemical atomic weight into physical atomic weight, the Avogadro's number must be 1.000272 N. However the absolute mass of ^{16}O is $16/N$ g, whether by chemical atomic weight or by physical atomic weight. Accordingly, in the case of the physical atomic weight, one mole of ^{16}O becomes $16/N \text{ g} \times 1.000272 N = 16.0044 \text{ g}$, but not 16.000 g. How should such a contradictory fact be explained?

2) A question of "Is the mass of reaction product changed, compared with the mass of reacting substance according to endothermism and exothermism in chemical reactions?" is related to the formula, showing the equality between mass and energy, $\Delta E = \Delta mc^2$ (where ΔE is the change of energy, Δm is the change of mass, and c is the velocity of light). Most of chemistry books, including text books of high school, state that if there is change in reaction heat, mass is changed corresponding to $\Delta m = \Delta E/c^2$, but with extremely small change which the most sensitive balance fails to detect. A questioner takes objection against this, as follows: The heat of chemical reaction corresponds to the difference in bond energy between reaction product and

reacting substance. Thus, there must be no change in mass. If chemical reaction were accompanied by change in mass, the quantity of heat would be converted into mass which is a kind of energy, in endothermic reaction, as the Einstein's equation $\Delta E = \Delta mc^2$ shows. This disobeys the secondary law of thermodynamics showing that heat can not be changed to energy other than heat completely. However a questioner says that he never denies the Einstein's equation, $\Delta E = \Delta mc^2$ and is proposing here the question on "it can be applied in the case of nuclear reaction, but is it applicable to chemical reaction?"

3) When a great amount of silver chloride, AgCl is put into pure water and after stirring is allowed to stand, all of small amounts of dissolved AgCl undergo electrolysis into Ag^+ and Cl^- and reaches the following equilibrium:



Since $[\text{AgCl(s)}]$ is considered to be constant, then

$$[\text{Ag}^+] \cdot [\text{Cl}^-] = K[\text{AgCl(s)}] = L_{\text{AgCl}}$$

L_{AgCl} : solubility product of AgCl

This is the description stated in a text book of high school and in a chemical reference book. A questioner wants to know the value of $[\text{AgCl(s)}]$ and that of K , because he could not calculate the value of $[\text{AgCl(s)}]$, according to the above equation: $L_{\text{AgCl}} = K[\text{AgCl(s)}] = [\text{Ag}^+] \cdot [\text{Cl}^-]$. And he says that the values of $[\text{AgCl(s)}]$ and K could not be found in any books and tables. In addition, before this question, comes the following question: What is the concentration of pure AgCl(s) represented by the $[\text{AgCl(s)}]^{*1)}$?

4) Water, though very small, dissociates electrolytically in the following way: $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$. Assuming one liter of water, because the amount of electrolytically dissociated water is very small, the concentration of undissociated water H_2O can be regarded as being almost equal to the whole concentration, or one liter of water. In short, it is considered to be constant ($1000/18 = 55.5 \text{ mol/l}$). Thus, $[\text{H}^+] \cdot [\text{OH}^-] / [\text{H}_2\text{O}] = K$ (equilibrium constant) becomes

$$[\text{H}^+] \cdot [\text{OH}^-] = K \times 55.5 = K_1(\text{ionic product})$$

The value of $[\text{AgCl(s)}]$ is not given, but that of $[\text{H}_2\text{O}]$ is given to be 55.5 mol/l . What is the concentration of pure water represented by the $[\text{H}_2\text{O}]$? A questioner says it is nonsense. And he wants to know the value of K .

5) A teacher of high school questions following: "In the case in which printed circuit is made, wire (Cu) is polished with FeCl_3 . This is questionable from a point of

*1) Since the formula weight and specific gravity of AgCl are 143.3 and 5.56, respectively, one liter of AgCl is 5.56 kg, which corresponds to 38.8 mol AgCl. Thus, some people say that the concentration of solid AgCl is 38.8 mol/l. A questioner says that he can not agree with that.

view of ionization tendency ($\text{Fe} > \text{Cu}$)” The polishing of copper wire with FeCl_3 should cause the following reaction: $\frac{1}{2} \text{Cu} + \text{FeCl}_3 \longrightarrow \frac{1}{2} \text{CuCl}_2 + \text{FeCl}_2$. As shown by this equation, the advance of this reaction is made possible only when the ionization tendency of Cu is greater than that of Fe. Actually, the ionization tendency of Cu is smaller than that of Fe, so that the advance of the above-mentioned reaction is in reality questionable.

6) In the classification of subgroups of long type periodic Table, the following two classification methods are seen:

(i) Ia, IIa, IIIa, IVa, Va, VIa, VIIa, VIII, Ib, IIb, IIIb, IVb, Vb, VIb, VIIb, 0

(ii) Ia, IIa, IIIb, IVb, Vb, VIb, VIIb, VIII, Ib, IIb, IIIa, IVa, Va, VIa, VIIa, 0

Which is correct, (i) or (ii)?

7) Some chemistry books describe that Zn, Cd, and Hg which belong to the IIb group are not considered as transition element, because they are out of the definition of transition element in which the elements have imperfectly filled d -orbital. Is this correct? A questioner does not agree with this. Because the typical elements ($ns^2p^1 \sim 6$) should be grouped with a-subgroup, and the transition elements ($ns^2np^6 nd^{1 \sim 10} (n+1)s^2$) should be grouped with b-subgroup. The Zn, Cd, and Hg belonging to the IIb group should be transition elements from a point of view of electronic configuration ($ns^2np^6nd^{10}(n+1)s^2$).

8) The lanthanoid group elements and the actinoid group elements, which are internal transition elements, are usually carried on the margin of the periodic Table. However many of text books show ${}_{57}\text{La}$ as the leading element of the internal transition elements of 6th period and also ${}_{89}\text{Ac}$ as the leading element of the ones of 7th period. However the ${}_{57}\text{La}$ is the element which ought to appear at the head of the transition elements of the 6th period in which follow ${}_{72}\text{Hf}$, ${}_{73}\text{Ta}$,, ${}_{80}\text{Hg}$, and also the ${}_{89}\text{Ac}$ is the one which ought to appear at the head of the transition elements of the 7th period in which follow 104th,, 112th elements. Accordingly the leading element of the internal transition elements of the 6th period must be ${}_{58}\text{Ce}$, and also that of the 7th period must be ${}_{90}\text{Th}$. Thus the elements of these series, it is considered, should be called the serial names suitable for each leading elements, Ce or Th, for example, ceriumides in the place of lanthanides, or thoriumides in the place of actinides.