

Developing Generalizing Thinking Ability for High School Students through Organic Chemistry Problems

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Received August 01, 2018; Revised September 07, 2018; Accepted September 25, 2018

Abstract Generalization is the activity of thinking which is used to associate, organize the phenomena of the same type, and to have the same general structure. There are two generalizations: generalization of experience and generalization of reasoning: (1) Generalizing experience helps individuals acquire elementary concepts and is implemented through comparisons to separate the common and similar relationships of phenomena. (2) Generalizing theory (or generalizing content) to acquire scientific concepts made through analysis to separate the intrinsic properties, the normative relationships of things Phenomenon, conceptualization, is a form of objective reality reflection in thought. Both are defined by a series of sequential operations, called the logic of the general concept of the group, of the species, of the things and phenomena and of a single concept of things, and specific, individual phenomenon. In this article, we will present a generalized thinking diagram for students to solve organic chemistry exercises in high school.

Keywords: *generalizing thinking ability, generalization of experience, generalization of reasoning, organic chemistry problems*

Cite This Article: Nguyen Xuan Truong, and Nguyen Tri Ngan, "Developing Generalizing Thinking Ability for High School Students through Organic Chemistry Problems." *World Journal of Chemical Education*, vol. 6, no. 4 (2018): 180-183. doi: 10.12691/wjce-6-4-4.

1. Introduction

Generalization is the activity of thinking that is used to associate, organize the phenomena of the same type, and to have the same general structure. Generalizing activities with products are concepts, rules, laws, rules [1,2].

In the generalization system, according to levels of abstraction, concepts are classified and arranged in the system. Every concept is always related to things and phenomena around and to other concepts.

There are two generalizations:

1. Generalizing experience helps individuals acquire elementary concepts and is made possible through comparisons to separate the common and similar relationships of phenomena.

2. Generalizing reasoning (or generalizing content) to acquire scientific concepts is made through analysis to separate the intrinsic properties, the normative relationships of things Phenomenon, conceptualization, is a form of objective reality reflection in thought.

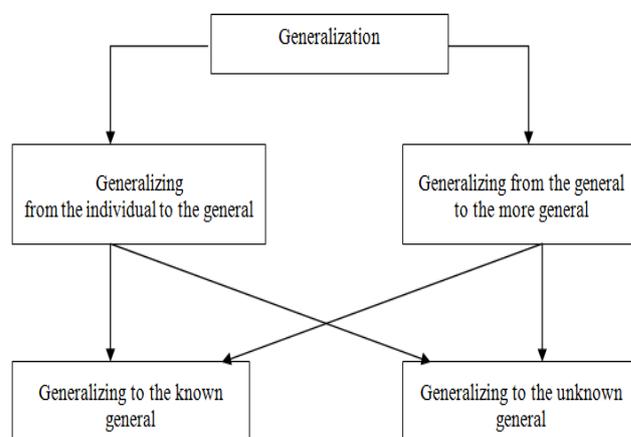
The concept as a psychological product (the action of generalizing thought), the form of external existence (physical or symbolic model) and the form of inner existence, The content of the concept, is the structure, the logical relationship of things, objective phenomena.

Both are defined by a series of sequential operations, called the logic of the general concept of the group, of the

species or of the species, of the things and phenomena and of a single concept of things. specific, individual phenomenon. The concept is always related to things and phenomena around and to other concepts

Chemistry is theoretical and empirical science, so there are many conditions for developing students' general thinking and generalizing thinking.

Generalizations in chemistry can be represented in the following diagram:



So there are two generalization paths, the first one based on the comparison of individual cases, the second is not based on comparison, but on the analysis of only one phenomenon in a series of current the same [3].

Generalized thinking is thinking activities are of high quality, the higher the level of education in this mindset will be mobilized as a powerful way of thinking because thinkinggeneralized scientific theory [4].

2. Sample Examples of Organic Chemistry Problems for the Developing Generalized Thinking Ability of High School Students

Example 1. Lycopene (red pigment in ripe tomatoes) $C_{40}H_{56}$ only contains double bonds and single bonds in the molecule. The number of double bonds in the lycopene molecule is
A. 12. B.13. C.14. D.15.



Tomatoes contain many natural lycopene

Answer is B:

Apply double bonding counting formula, we have:

$$a = \frac{(2.40) + 2 - 56}{2} = \frac{26}{2} = 13$$

Example 2. Carotene (orange-yellow pigment in carrot) $C_{40}H_{56}$ contains double bonds and saturated rings in the molecule. Recognize that when fully hydrogenated carotene is obtained $C_{40}H_{78}$ saturated hydrocarbons. The number of double bonds and number of rings in the carotene molecule respectively are
A. 12; 2 B.13; 2 C.14; 3 D.13; 3



Carrots containing many natural carotene

Answer is B:

The total number of double bonds and the number of rings in the molecule are:

$$a = \frac{(2.40) + 2 - 56}{2} = 13.$$

If the molecule does not contain double bonds and rings, then the maximum number of H atoms must be: $(2.40) + 2 = 82$

So the number of rings is:

$$\frac{(2.40) + 2 - 78}{2} = 2$$

Example 3. In lemon essential oil is $C_{10}H_{16}$ limonene. Know that the hydrolysis of the limonene is $C_{10}H_{20}$. Number of double bonds and number of rings in the limonene molecule respectively are
A. 2; 2 B. 4 ; 3 C. 3; 1 D. 5 ; 3



Answer is C:

The total number of double bonds and the number of rings in the molecule are:

$$a = \frac{(2.10) + 2 - 16}{2} = 3$$

Number of no is:

$$\frac{(2.10) + 2 - 20}{2} = 1.$$

Example 4. $C_{20}H_{32}$ cembrene (separated from pine resin), when applied to add excess H_2 with catalyzes nickel to form X with $C_{20}H_{40}$ molecular formula. This proves

- Cembrene molecules have four bonds π and one ring.
- Cembrene molecules have four $C = C$ double bonds and one ring.
- Cembrene molecules have two triple bonds and one ring.
- Cembrene molecules have a total pi bonds and rings is 5.



Haterpin contains terpinhydrate

Answer is B:

Number of pi bonds and number of rings are

$$\frac{20.2 + 2 - 32}{2} = 5$$

Example 5. Vietnam is the second largest exporter of coffee in the world. Coffee beans contain significant amounts of caffeine $C_8H_{10}N_4O_2$. Caffeine used in medicine in small amounts will have the effect of stimulating the nerves. Excess caffeine, however, can cause sleeplessness and addiction. Identification of the nitrogen element in caffeine has turned into something that goes into the body?

- A. NH_3 B. N_2 C. NaCN D. NO_2



Coffee in Vietnam

Answer is A: NH_3

Example 6. After the distillation of lemongrass by steam, a mixture of the essential oil on the water is obtained. What method to separate the oil from the water layer?

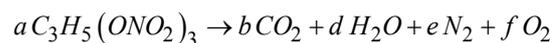
- A. Filtration method.
B. Segment crystallization method.
C. Distillation method.
D. Extraction method.



lemongrass essential oil

Answer is D: Extraction method.

Example 7. Glycerol trinitrate (a very powerful explosive substance) has a molecular formula $C_3H_5(ONO_2)_3$. The explosion created the product consisting of CO_2 , H_2O , N_2 and O_2 according to the equation:



The set of coefficients (a, b, d, e, f) is true

- A. 1; 3; 2,5; 3; 3. B. 2; 6; 5; 5; 1.
C. 2; 6; 5; 5; 2. D. 4; 12; 10; 6; 1.

Answer is D: 4; 12; 10; 6; 1.

Example 9. From jasmine extract, compound A was isolated. Quantitative analysis gave the result: 73.14% C; 7.24% H, the rest is O. Given $M_A = 164u$. The molecular formula of A is

- A. $C_{10}H_{12}O_2$. B. $C_9H_{10}O_2$.
C. $C_8H_{12}O_2$. D. $C_8H_{10}O_2$.



Jasmine essential oil

Answer is A:

$$x : y : z = \frac{73,14}{12} : \frac{7,24}{1} : \frac{19,62}{16} = 5 : 6 : 1$$

$M_A = 162 = n.(12.5 + 6.1 + 16) \rightarrow n = 2 \rightarrow A: C_{10}H_{12}O_2$

Example 10. Petroleum is a mixture of high hydrocarbons. To have products such as gasoline, kerosene, mazut, etc. in the refinery people do **not** use the following separation methods?

- A. Normal distillation.
B. Distillation at low pressure.
C. Distillation of steam.
D. Fractional distillation.



Binh Son Oil Refinery - Vietnam

Answer is C: Distillation of steam.

Example 11. To clean plastic fruit stick to the knife when cutting (Plastic jackfruit) people often

- A. Dip the knife into the gasoline or oil.
B. Dip the knife into the soap water.
C. Soak the knife in hot water.
D. Soak in knives in salt water.



jackfruit plastic adhesive knife

Answer is A: Dip the knife into the gasoline or oil.

Example 12. In the market today, some soy sauce (soy sauce) has been banned because of the amount of 3-MCPD (3-monoclopropane-1,2-diol) exceeds the permitted standard. In the process of producing soy sauce, the manufacturer uses HCl to hydrolyze vegetable proteins to increase the saltiness and taste. In this process, there is a fatty acid hydrolysis that produces glycerol. HCl reacted with glycerol to produce a 2-isomer mixture of 3-MCPD. The 3TP-3's MCPD is

- A. $C_3H_7O_2Cl$. B. $C_3H_8O_2Cl$.
 C. $C_3H_7O_2Cl_3$. D. $C_3H_8O_2Cl$.



**3-MCPD test
 contained in soy sauce**



Soy sauce Maggi

Answer is A: $C_3H_7O_2Cl$.

Example 13. On the label of medical alcohol labeled "alcohol 70⁰ⁿ". What does it mean?

- A. This alcohol boils at 70°C.
 B. 100ml of alcohol in a bottle with 70 mol of pure alcohol.
 C. 100ml of alcohol in a bottle with 70 mL of pure alcohol.
 D. In alcohol bottle is 70 mL pure alcohol.

Answer is C: 100 mL of alcohol in a bottle with 70ml of pure alcohol.

Example 14. In herbal oils there are unsaturated aldehydes that form the aroma characteristic of these oils. Example cinnamon essential oil with $C_{12}H_{14}O$ and citric aldehyde $C_9H_{17}CHO$.

Which of the following can be used to refine these aldehydes?

- A. $AgNO_3/NH_3$.
 C. $H_2/Ni(t^0)$.
 B. $Cu(OH)_2/NaOH$.
 D. $NaHSO_3$ saturated and HCl.

Answer is D : $NaHSO_3$ saturated and HCl.

3.Conclusion

By analyzing these exercises, it is easy to see that generalizing thinking will be formed for high school students when solving generalizing exercises of individual events such as composition, properties or method of preparation of substances. We have conducted pedagogical experiments for various groups of students learning about organic chemistry. The results show that using generalizing exercises will develop generative thinking as well as develop the capacity to apply knowledge into practice. These initial studies will serve as a basis for us to continue to design exercises that develop generalized thinking capacity at a higher level.

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