

CHEMISTRY EXERCISES IN IGCSE EXAM AND VIETNAMESE EXAM FOR STUDENT IN GRADE 9: WHAT ARE THE DIFFERENCES?

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Abstract. IGCSE is the short term of International General Certificate of Secondary Education. This is one of the most popular Certificates for secondary school seniors before they come to the next levels such as A-level or pre-university. This article introduces about IGCSE chemistry program of the United Kingdom, one of the best educations in the world, and focuses on analyzing the differences between chemistry exercises in Vietnamese grade 9 students' exams and the ones of the IGCSE program. From the comparison, the research also gives some comments about the chemistry exercises in IGCSE exams like strong points or limitations when we apply it in Vietnam. The object of this research is the comparison between the IGCSE program and the Vietnamese program in terms of chemistry exams, apply to Vietnamese grade 9 students, except the ones who take the national/international exams for outstanding students. The experiences of building up diverse and practical chemistry exercises, focusing on the chemical nature of Cambridge are valuable lessons for Chemistry teachers in Vietnam.

Keywords: chemistry exercise, IGCSE, grade 9, exam, differences, strong points, limitations.

1. Introduction

In teaching chemistry, exercises play a very important role. However, in Vietnam, chemistry exercises are too focused on calculation and disregard the chemical nature, far from the goal of teaching [1-4]. Chemical exercises in Vietnamese textbooks often require low levels of awareness, assignments in the exam are very complex and impractical [5, 6]. IGCSE is a Certificate for students who have completed their secondary program and come to the next levels (A-level or pre-university). This certificate is issued by the countries which belong to the United Kingdom [7-17]. With this certificate, students are recognized by the educational systems of 53 countries around the world including England, Australia, Canada, New Zealand, Singapore, Malaysia, South Africa, India, etc. In Vietnam, the exam is held annual by the British Council and the certificate is issued by Cambridge International Examination (CIE). The IGCSE Chemistry program aims to develop general competency as well as chemistry-specific competency such as the ability to use the language of chemistry, the ability to perform chemistry experiments, the calculation ability, the ability to solve problems through chemistry, the ability to apply chemistry knowledge to real life. The exercises focus on the nature of chemistry rather than puzzling students with difficult questions. The parts are closely related and not discrete.

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Learning program: The particular nature of matter; Elements, compounds, and experimental techniques; Atomic structure and bonding; Stoichiometry – chemical calculations; Electricity and chemistry; Chemical energetics; Chemical reactions; Acids, bases, and salts; The Periodic Table; Metals; Air and water; Sulfur; Inorganic carbon chemistry; Organic chemistry 1; Organic chemistry 2; Experimental chemistry.

The IGCSE Chemistry program contains 16 chapters as above, but only 6 of them are included in the Vietnamese grade 9 Chemistry program (Acids, bases, and salts/ The Periodic Table/ Metals/ Inorganic carbon chemistry/ Organic chemistry 1 and 2/ Experimental chemistry). That leads to difficulty for students who want to continue their studying with the A-level program or the foreign pre-university program because the IGCSE program requires a larger amount of knowledge than the one of Vietnam. Each year, Vietnam has more than 100,000 students studying abroad. This figure shows that the trend of studying abroad is increasingly popular in Vietnam. At the same time, the demand for studying international program certificates, including IGCSE, is also increasing. The situation of learning IGCSE in Vietnam has changed dramatically. As the certificate is increasingly popular, the situation of studying IGCSE in Vietnam is very attractive, though still new. In recent years, many secondary schools have introduced the Cambridge IGCSE program into teaching such as Vin School, TH School, Nguyen Sieu School or Hanoi Academy School. However, due to being too new, the teaching staff for this program is also very limited. Only teachers who are proficient in both professional and foreign languages can undertake to teach.

Therefore, we decided to select the topic "Chemistry exercises in IGCSE exam and Vietnamese exam for students in grade 9: What are the differences?" to do research. The main purpose of this study is to analyze the strengths and weaknesses of chemical exercises in Vietnam in the comparison with the chemistry exercises of Cambridge IGCSE, thereby making some recommendations for changing the design of chemical exercises to improve learning Chemistry in Vietnam.

2. Content

2.1. The differences between IGCSE and Vietnamese Grade 9 Chemistry exams

2.1.1. The form of the examinations

Each IGCSE exam consists of 6 papers: papers 1, 3, 5 are for students studying core programs and papers 2, 4, 6 are for extended students. Paper 1 and 2 include forty multiple-choice questions with the time of forty-five minutes. With papers 3 and 4, students need to answer different questions in 1 hour and 15 minutes. Paper 5 and 6 are practical tests so that students have to perform the required experiments as well as answer some short questions. The total time for this part is 1 hour and 15 minutes.

In Vietnam, chemistry has not been introduced as an official exam subject in the entrance examination for students in grade 9. Chemistry tests are usually regular tests. There are 3 common tests, which are the 15-minute test, the 45-minute test, and the end-of-term test. They can be multiple choice questions or essay exercises.

2.1.2. The content of the exams

Because of the difference in the content of the curriculum, the content of the test is naturally different. The questions in the Vietnamese exam concentrate on increasing the ability of memorizing and calculating for students in terms of Organic and Inorganic Chemistry. Most of them are lack of practicality and so heavy on calculations. The qualitative exercises (explain the phenomena, select suitable chemicals, identify/separate the chemicals, and suggest the solutions for reality's problems) are not focused on. They only occupy a small part of the exercise system. Calculation exercises occupy a large proportion of the Vietnamese exam questions. This method

of focusing on such calculations leads to a departure from the nature of chemistry. The chemical processes described in the exam are often bogus because they are too complicated, too expensive, or because they have no purpose at all.

Meanwhile, the content of the IGCSE program is very comprehensive, so the content of the test questions is also richer. The questions of the exam cover the content of all 16 chapters in the program. In the multiple-choice and theory papers, some questions require students to apply their knowledge to solve reality problems. The quantitative exercises of the IGCSE exam are not heavy in the calculation like the ones in the Vietnamese exam, they only have simple questions with the basic formulas. Skills of processing tables and charts are also included in the IGCSE exam questions. This is not only a necessary skill in chemistry but also in a lot of other fields. In the IGCSE, we may encounter many questions of this type, while our Vietnamese exam questions are completely absent. In addition, the IGCSE exam also has a separate paper that tests students' practical skills. Students must perform different experiments and record reports for these experiments within the time allowed.

2.1.3. The analysis of some exercises in IGCSE and Vietnamese exam questions

* *The Vietnamese exam questions*

Because there is no official national chemistry exam for Vietnamese secondary school, so we have collected and analyzed the chemistry questions in some admission exam of specialized school:

Example 1.

Question 2 (2018 - HUS High School for Gifted Students's entrance exam for grade 10)
Organic compound Y (contains C, H, O) has the molecular formula that coincides with the simplest formula. Completely combust 1.48 grams then lead the product mixture through 2 flasks respectively: the first one contains excess concentrated H_2SO_4 solution, the second one contains excess KOH solution. After the experiment, the mass of the solution in the first flask increases by 0.72 grams; the mass of the solution in the second flask increases by 3.96 grams.

Write the structure and the name of Y, know that Y does not take part in silver-coated reaction; Y reacts with cool, diluted $KMnO_4$ solution to form Y_1 , which has $M_{Y_1} = M_Y + 34$; and 1.48 grams Y reacts with 20 mL NaOH 1M solution to form 2 salts.

Example 2.

Question 2 (2019 - HUS High School for Gifted Students's entrance exam for grade 10)
Completely dissolve 49.14 grams metal M into 1 liter of 2M HNO_3 solution into form 3.6736 liters (at the standard condition) mixture A contains N_2O and N_2 has the mass ratio in comparison with H_2 equal to 17.122 grams. On the other hand, carefully dissolve 69.712 grams two alkali metals into 2 liters of HCl acid. After the experiment, we have 29.2096 liters of H_2 and solution E. Slowly pour E into solution B, 54.846 grams of precipitate G is formed. Determine M, X, Y, and the molecular concentration of HCl solution.

Example 3.

Question 2 (2018 – Ben Tre gifted High School's entrance exam for grade 10)

a. There are 4 unlabeled tubes, each containing a solution of ethyl alcohol, acetic acid, starch, and benzene. By the chemical method, please distinguish the above solutions. Writing method chemical process (specify conditions if any).

b. Six tubes have lost their labels, numbered from 1 to 6. Each of the tubes has 1 in the following solutions: $BaCl_2$, H_2SO_4 , $Ca(OH)_2$, $MgCl_2$, Na_2CO_3 , $KHSO_4$. Please specify the solution there.

In each test tube, write down the chemical equations that occur (specify conditions if any).

Know that when conducting an experiment, the following results are obtained:

- Solutions in tube 2 for precipitation with solutions in tubes 3 and 4.
- Solution in tube 6 for precipitation with solutions in tubes 1 and 4.
- Solutions in tube 4 for air to fly up when interacting with solutions in tubes 3 and 5.

These three examples are all essay exercises. The first example is about finding the molecular and structure of an organic compound by the combustion method. This method is not incorrect, but it does not fit with modern chemistry. Nowadays, to determine the formula of a compound, we use the spectrum method. The combustion method is not really suitable for the current context. In addition, this exercise is too heavy on calculation.

The second example has the same problem that students have to apply a lot of Mathematics skills to solve. Another problem with this example is the information “*In the other hand, carefully dissolve, 69.712 grams two alkali metals into 2 liters of HCl acid*”. We all know that, when we put alkali metal into acid solution or pure water, it can cause an explosion. Moreover, with a large number of alkali metals, it will be more and more dangerous that we cannot apply this point into reality.

The last example is a practical question: students must write down the description of all experimental steps, however, they are not allowed to perform the experiments. That leads to the fact that Vietnamese students can be good at theoretical, but their practice skills are still poorer.

* **The IGCSE exam questions**

Each IGCSE has six papers: three of them (papers 1, 3, 5) are for core programs, the others are for students who learn extended programs. I have been studying for the IGCSE exams since March 2018, however, due to the limitations of the article, I will only present the last exam released in October and November 2019 with the core part (papers 1, 3 and 5). All the below examples are in the 0620/13 – October/ November 2019 IGCSE papers.

Paper 1. Multiple choice (core)

Question 11: An energy level diagram for a reaction is shown in Figure 1.

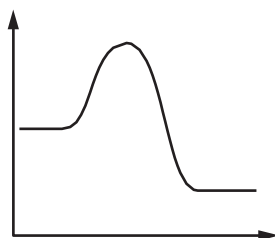


Figure 1. Energy progress of the reaction

Which statement and explanation about this reaction are correct?

Table 1. Statement and explanation about the reaction for choosing A, B, C or D

| Items | Statement | Explanation |
|-------|-----------------------------|--|
| A | The reaction is endothermic | The products have more energy than the reactants |
| B | The reaction is endothermic | The products have less energy than the reactants |
| C | The reaction is exothermic | The products have more energy than the reactants |
| D | The reaction is exothermic | The products have less energy than the reactants |

Question 13: In experiment 1, small lumps of limestone are added to dilute hydrochloric acid at 40°C. The volume of carbon dioxide released is measured at regular time intervals. The results are shown in Figure 2.

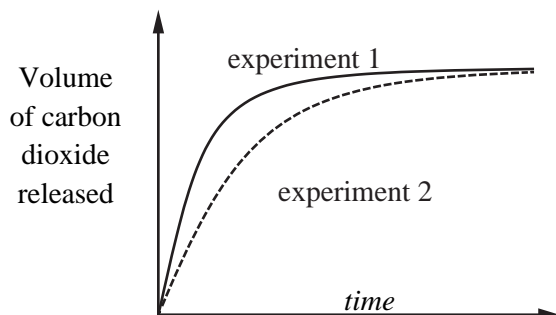


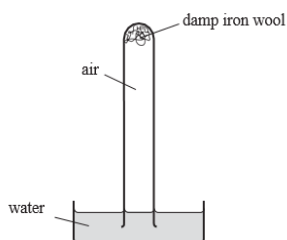
Figure 2. The results of experiments 1 and 2

Which changes give the results shown in experiment 2?

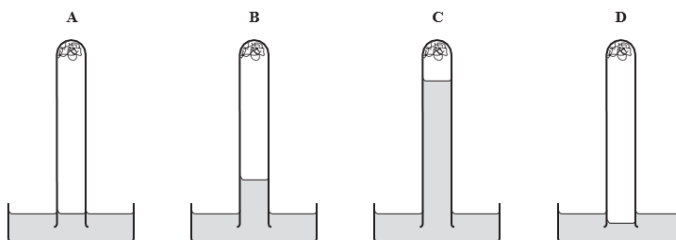
Table 2. Limestone and temperature for choosing A, B, C or D

| Items | Limestone | Temperature (°C) |
|-------|-------------|------------------|
| A | Large lumps | 40 |
| B | Powder | 40 |
| C | Powder | 60 |
| D | Small lumps | 60 |

Question 30: The apparatus shown is set up and left for a week.

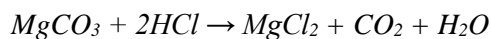


Which diagram shows the level of water at the end of the week?



Paper 2. Theory (core)

Question 3: A student investigated the reaction of magnesium carbonate with an excess of dilute hydrochloric acid.



The rate of reaction can be found by measuring the decrease in the mass of the reaction mixture over time. The results are shown in Figure 3.

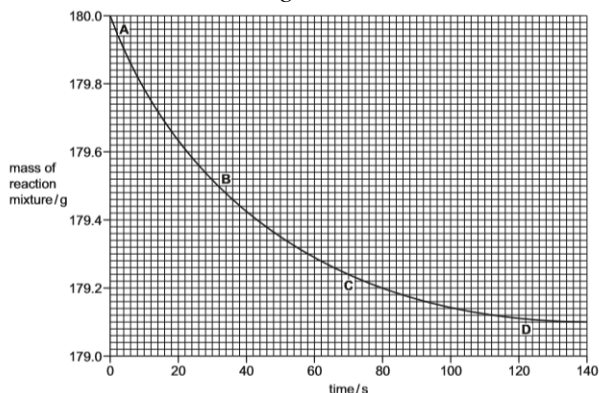


Figure 3. The mass of the reaction mixture over time

(a) Determine the mass of the reaction mixture after 58 seconds.

(b) At which point on the graph, A, B, C or D, was the rate of reaction the fastest? Use the graph to explain your answer.

(c) When 0.42 g of magnesium carbonate is used, 120 cm³ of carbon dioxide is formed.

Determine the volume of carbon dioxide produced when 1.26 g of magnesium carbonate reacts completely.

Volume of carbon dioxide = cm³

(d) What effect do the following have on the rate of this reaction?

- Decreasing the concentration of the acid. All other conditions are kept the same.
- Using smaller pieces of magnesium carbonate. All other conditions are kept the same.

Question 8: This question is about dyes.

(a) Chromatography can be used to separate a mixture of dyes.

S, T, U and W are four different mixtures of dyes.

S, T, U and W were placed on a piece of chromatography paper.

Two pure dyes, X and Y, were also placed on the same piece of chromatography paper. The results of the chromatography are shown in Figure 4.

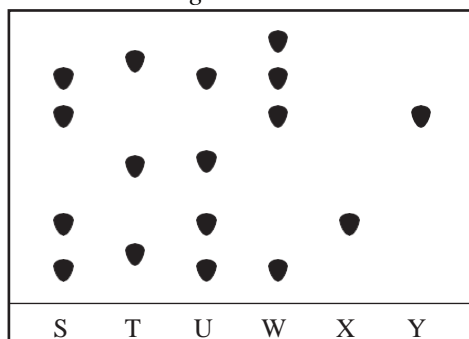


Figure 4. The chromatography of X and Y

(i) Which mixture, S, T, U or W, contains dye X but not dye Y?.....

(ii) Which mixture, S, T, U or W, contains the smallest number of dyes?.....

(iii) Which mixture, S, T, U or W, contains neither dye X nor dye Y?.....

(b) Indigo is a blue dye. When an alkaline solution of indigo undergoes reduction, it turns colorless.

(i) What is meant by the term reduction?.....

(ii) A piece of white cloth is soaked in a colorless solution. When the cloth is left in the air it turns blue.

What type of chemical reaction occurs? Draw a circle around the correct answer.

Decomposition fermentation oxidation polymerization

Paper 3. Practical test

* You are going to investigate the reaction between dilute hydrochloric acid and three different concentrations of aqueous sodium hydroxide, labeled R, S, and T.

Read all the instructions carefully before starting the experiments. Instructions

You are going to do three experiments.

• Experiment 1:

- Fill the burette up to the 0.0 cm^3 mark with dilute hydrochloric acid.
- Use the measuring cylinder to pour 20 cm^3 of solution R into the conical flask.
- Add six drops of methyl orange indicator to the conical flask.
- Add dilute hydrochloric acid from the burette to the conical flask, 1.0 cm^3 at a time, while swirling the conical flask, until the solution just changes color.
- Record the burette readings in the table.
- Empty the conical flask and rinse it with distilled water.

• Experiment 2

- Repeat Experiment 1 using solution S instead of solution R.
- Record the burette readings in the table.

• Experiment 3

- Repeat Experiment 1 using solution T instead of solution R.
- Record the burette readings in the table.

(a) Complete the following table:

| Burette reading/ cm^3 | Experiment 1 solution R | Experiment 2 using solution S | Experiment 3 using solution T |
|--------------------------------|----------------------------|----------------------------------|----------------------------------|
| Final burette reading | | | |
| Initial burette reading | | | |
| Volume used | | | |

(b) What color change is observed in the conical flask at the end-point?

from..... to.....

(c) Suggest why universal indicator is not a suitable indicator to use in these experiments.

(d) Complete the sentences.

(i) Experiment needed the smallest volume of dilute hydrochloric acid to change the colour of the methyl orange indicator.

Experiment needed the largest volume of dilute hydrochloric acid to change the colour of the methyl orange indicator.

(ii) Determine the simplest whole number ratio of volumes of dilute hydrochloric acid used in Experiments 1 and 2.

(iii) Deduce the order of concentrations of the solutions of aqueous sodium hydroxide, R, S and T.

The most concentrated.....

The least concentrated.....

(e) What would be the effect on the results, if any, if the solutions of aqueous sodium hydroxide were warmed before adding the dilute hydrochloric acid? Give a reason for your answer.

Effect on the results

Reason

(f) Suggest how the reliability of the results could be checked.

(g) Suggest a different method, not involving an indicator, of finding the order of concentrations of the solutions of aqueous sodium hydroxide, R, S and T.

* You are provided with solid U and liquid V.

Do the following tests on solid U and liquid V, recording all of your observations at each stage.

Tests on solid U

(a) Do a flame test on a small sample of solid U. Record your observations?

Add the rest of solid U to about 10 cm³ of distilled water in a boiling tube. Stopper the boiling tube and shake the mixture to dissolve solid U and form solution U.

(b) Describe the colour of the solution

Divide solution U into three approximately equal portions into three test-tubes.

(c)

(i) Add a few drops of aqueous sodium hydroxide to the first portion of solution U. Record your observations.

(ii) Now add an excess of aqueous sodium hydroxide to this mixture. Record your observations.

(d)

(i) Add a few drops of aqueous ammonia to the second portion of solution U. Record your observations.

(ii) Now add an excess of aqueous ammonia to this mixture. Record your observations.

(e) Add a few drops of dilute nitric acid and about 1 cm³ of aqueous barium nitrate to the third portion of solution U. Leave to stand for 5 minutes.

Record your observations.

(f) Solid U contains three different ions.

What conclusions can you draw about the ions present in solid U?

tests on liquid V

(g) Describe the appearance of liquid V. Record your observations.

(h) Use a teat pipette to place a few drops of liquid V onto a watch-glass. Put the stopper back into the test-tube of liquid V. Use a lighted splint to touch the surface of liquid V carefully.

Record your observations.

(i) Use a spatula to transfer a small crystal of iodine carefully into the rest of liquid V in the stoppered test-tube. Put the stopper back into the test-tube and shake the test-tube.

Record your observations.

(j) Draw one conclusion about liquid V.

** Potassium nitrate and ammonium chloride are two salts. The energy change when they each dissolve in water is endothermic.*

Plan an experiment to show which of these two salts produces the larger endothermic energy change per gram.

Your answer should include the following:

- Any measurements you would take and record.*
- How the results could be used to conclude.*

You are provided with potassium nitrate and ammonium chloride, distilled water, and common laboratory apparatus.

Through some examples of chemistry questions in the IGCSE exam, we must consider that the forms of these exercises are diverse such as: multiple-choice questions, theory questions, and especially practical questions. The contents of the exercises are not only theory and calculation, but also some questions require students to analyze the graphs and charts. Besides, the questions really relate to reality (Question 8 - Paper 3). However, the highlighted point is the last paper. Students have to perform the experiments instead of writing the procedures only. Calculation questions are integrated with other exercises, but they are not too difficult that students only need to apply simple equation the solve.

2.2. Experimental survey results

In order to make our comments more objectively, we surveyed more than 40 pupils studied in the Faculty of Chemistry of Hanoi National University of Education as well as teachers and students studied at some secondary schools in Hanoi. And these results are following:

- Among the survey participants, only about 75% have ever heard of the IGCSE program. And only half of those have ever been exposed to the exercises in the IGCSE exam.

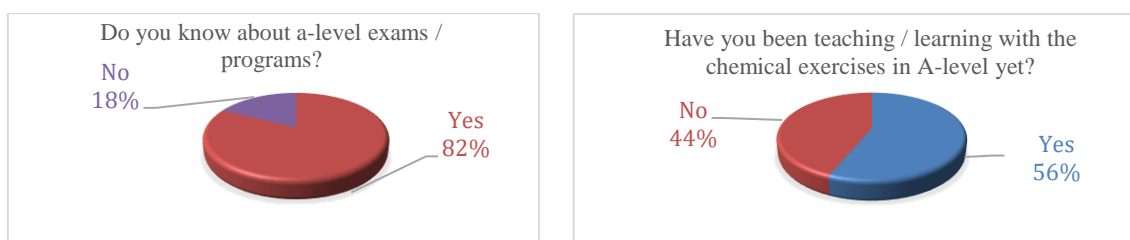


Figure 5. The survey of the IGCSE exams

- Comparing the level of exercises in the IGCSE program with the Vietnamese program, most people surveyed said that IGCSE exercises are more difficult.

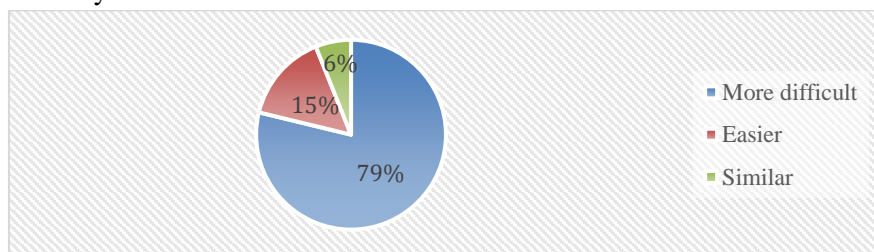


Figure 6. The survey of level of chemistry exercises of the IGCSE program compared with the Vietnamese program

- When being asked to choose a key difference of A-level exercises from the options available, many people chose the most outstanding feature, the "wide and deep knowledge".

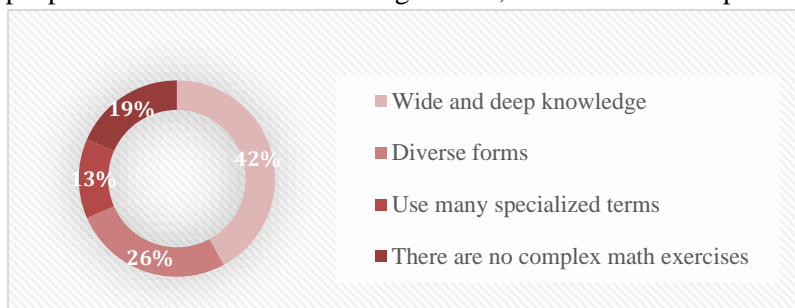


Figure 7. The survey of the outstanding differences of IGCSE chemistry exercises compared with Vietnamese chemistry exercises

2.3. Discussion about IGCSE chemistry exercises

2.3.1. The strong points of IGCSE chemistry exercises in the comparison with Vietnamese chemistry exercises for grade 9 students

The strongest point of IGCSE chemistry exercises is being designed by the prestigious International Examinations Council of Cambridge University. This helps students equip necessary knowledge for the next programs such as university or A-level. Studying IGCSE also allow learners to study abroad.

Moreover, the exercise in the IGCSE program focuses on the chemistry nature of the objects and emphasizes the maturity in students' practical skills. They will have the opportunity to apply their judgment skills to solve problems in life, perform experiments, use scientific equipment, take notes, explain and draw conclusions based on collected data.

2.3.2. The limitations if we apply the same chemistry exercises with those of the IGCSE program in Vietnam

With the fact that teaching and learning chemistry in our country today, the application is very difficult because the content of the curriculum is not completely the same. In addition, the chemistry knowledge for grade 9 students in Vietnam is not as deep as the one of IGCSE. However, chemistry exercises like those of IGCSE are well worth applying. In my opinion, we do not need to use IGCSE exercises for teaching and learning in Vietnam. Instead of that, we should change the Vietnamese exercises by omitting unrealistic calculation exercises, adding practical exercises (explain the phenomena, select suitable chemicals, identify/separate the chemicals, and suggest the solutions for reality's problems, etc.). To do that, first of all, the curriculum must be basic, scientific, modern, and systematic; improve the theoretical level, while enhancing experimental skills as well as other necessary soft skills.

3. Conclusions

According to the analysis above, we can draw some conclusions as follows:

1. The IGCSE Chemistry program is comprehensive. The content is very rich covering almost all areas of Chemistry, many of which are only mentioned in high school in Vietnam. The exercises of IGCSE have not only rich in content but also the deep theoretical level that requires learners to grasp the chemical nature of the problems.

2. Some chemistry exercise in our country is still very theoretical and far from practical. Although some part of the theory has not gone into the nature of chemistry, they are still heavy on description, lacking the contents of theoretical chemistry, physical chemistry, analytical

chemistry. The exercises are heavy on calculation; they require more calculation skills rather than understanding the chemical nature of the problems.

3. Chemistry is a science that is both theoretical and experimental but the experiment part occupies a small proportion in Vietnam or is cut off in the curriculum so teaching and learning is just about dealing with exams, not highly effective.

4. Chemistry exercise in our country still has many limitations on the content of theory and practice. We need to change the way we design the exercises as well as the curriculum content, teaching, and learning methods, testing, and evaluation methods so that teaching Chemistry in Vietnam will have a brighter future.

5. Survey results on a small scale show that many chemistry teachers in Vietnam do not have information about the Cambridge program. Among the teachers approached, 42% recognized the advantages of Cambridge's chemistry exercise system. Currently, we are in the process of renewing the general education curriculum oriented to the development of student competencies. The experiences of building up diverse and practical chemistry exercises, focusing on the chemical nature of Cambridge are valuable lessons.

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