TACKLE SOME STUDENT'S PROBLEMS THROUGH EXERCISE PARADOX, SOPHISTRY IN PARTICLE KINETICS AND PARTICLE DYNAMICS IN PHYSICS TEXTBOOK FOR GRADE 10

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Abstract: *Teaching Physics in high schools is associated with teaching and solving exercises, thereby forming and developing for students major qualities and general competencies; at the same time, preventing and avoiding for students some common mistakes. The research works on teaching methods of Physics subject paid attention to correcting mistakes for students in solving the problem in general. This article researches and identifies some mistakes and fixes through the paradoxical exercises and the fallacy chapters of "Score Kinetics" and "Quality of the Score". Because paradox and fallacy exercises contain many factors that are contrary or inconsistent with the concepts and laws of physics. If you only look at one form, you can mistakenly think they are consistent with the concepts, laws of physics and common logic, the students will easily make mistakes.*

Key words: *Exercise paradox and sophistry, particle kinetics, particle dynamics.*

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1. INTRODUCTION

Teaching is a process under dialectical influences of both subjective and objective factors: natural and social conditions, infrastructure, equipment, the dispersion of thoughts, and the lack of student's concentration, etc. During the Physics teaching process in high schools, one of the most important factors that need to be considered is students' conception: their understanding of concepts, phenomena, and physical processes before studying them in class. It is highly individualistic. If their knowledge forms spontaneously and carries subjective factors of the individual, they often lack objectivity and do not properly reflect the true concepts of physics. They become misconceptions. Conceptions often derived from life experience or form the richness of language in daily life. In fact, students' conception of objects and phenomena in life is rich, diverse, and also deeply ingrained in their subconscious. Thus, these conceptions often are long lasting and conservative. Many misconceptions in nature are inconsistent with the nature of science, which causes various difficulties in teaching Physics. Misconceptions are obstacles on the road of perceiving the

physics of objects and phenomena. Despite the teacher's thorough introduction about a problem, students still make mistakes while applying their knowledge into solving specific exercises. Therefore, tackling some problems of students while solving exercises is essential in order to help them correctly understand the problems and bring higher efficiency in the learning and teaching process.

2. CONTENT

2.1. Basic Argument

- *Psychological basic:* According to Vurgotsky, the advancement of students' cognitive structure is gradual; it is generated and developed by environmental impacts. He also stated that different aspects of learning, including cognitive, social and cultural aspects, need to be examined in the teaching process.

- *Philosophical basic:* Students must be proactive, active and creative to apply their knowledge to solve their learning problems. In the process of solving homework problems, students can interact with each other and with teachers, are free to give their own opinions and protect their opinions, and are given scientific evidence by their friends and teachers to prove debatable problems. By this way, learners' knowledge will be challenged and applied, which helps them master the knowledge and arouse a greater passion for science.

- *Exercise paradox, sophistry:* There are exercises that contain contradictory factors or conflict with the concepts and laws of physics. If these exercises are summarily considered, they can be mistaken for conforming the concepts and laws of physics and common logics. However, if they are put under careful examination following scientific evidence, the paradox and sophistry in these exercises will be identified. Therefore, solving these problems will help students master the content and the scope of application of the laws. With this type of problem, students often make subtle mistakes, which sometimes are difficult to be identified, perhaps due to the lack of attention to all the data of the problem or improperly applying the formulas or laws. Analyzing it often becomes an interesting discussion stimulating students to find answers. Through teacher's guidance, they become aware of the problem's correctness, thus, dispel previous misconceptions by themselves.

- *The role of teachers and students in tackling some problems for students through exercise paradox and sophistry:* For the teacher**:** creating a teaching atmosphere; create conditions for students to express their opinions; organize student's debates; be a referee controlling the debate; help students recognize their misconceptions and tackle them; create conditions for students to apply the obtained scientific knowledge. *For students*: students actively express their opinions during solving problems; students actively discuss problems with each other and with the teacher in order to solve exercises, thereby self-reflecting and adjusting their knowledge.

2.2. Current situation of solving exercises in "particle kinetics" and "particle dynamics" Grade 10 Physics

Most teachers introduce and instruct students to solve absolutely correct exercises but have little interest in introducing paradoxical and sophisticated one to give students opportunity to express their own conceptions. Some students do not thoroughly understand theoretical knowledge introduced by the teacher. Before doing an exercise, some students have already had some concepts about these knowledge but they are often incomplete or incorrect. Many students are afraid of involving in activities, raising questions and arguments. Due to these above reasons, conceptions students already have (most of them are incomplete or incorrect) have not been revealed. Because students often solve exercises based on those concepts, they still make mistakes. However, if respecting the existing conceptions of students and having correct attitudes towards the misconceptions, they can be a foundation for the acquisition of scientific knowledge. The problem is that when organizing the teaching process, teachers need to help students correct their misconceptions; promote their critical thinking to solve learning problems.

2.3. Some mistakes and ways to overcome them through inverse exercises argument and sophistry

2.3.1. The units of knowledge have paradoxical and sophisticated exercise

Some knowledge units that contain the problem of paradox and sophistry in the chapter "Essence Kinetics" and "Quality of the Score" include: Average speed, many students conceive it as the average value of the velocities; uniform variable motion, many students have incomplete conceptions about the elements in this movement and how to apply mathematical formulas; motion of an object thrown up vertically, many students have incomplete conception about the going up and down process of the object; Newton's First Law of Motion, many students have incorrect conceptions about the inertial frame ò reference and the non-inertial frame of reference system; Newton's Second Law of Motion, many students have misconceptions about explaining the magnitude of the free fall acceleration; Newton's Third Law of Motion, many students have misconceptions about equal and opposite force pairs; friction force, many students have not fully understood about sliding friction and rolling friction.

2.3.2. The way to correct the mistakes through some following examples

Example 1: A car travels from A to B at a speed of 20km/h and returns at a speed of 30 km/h. Calculate the average speed of the car for the whole journey.

- Teacher: How to solve this problem?

Student A: According to the rule of finding the average value, we get:

$$v_{tb} = \frac{v_1 + v_2}{2} = \frac{20 + 30}{2} = 25km/h$$

Student B: According to the formula for determining average speed $v_{tb} = \frac{s}{t}$

We get: $v_{tb} = \frac{2s}{t_1 + t_2} = \frac{2s}{\frac{s}{v_1} + \frac{s}{v_2}} = \frac{2v_1v_2}{v_1 + v_2} = \frac{2.20.30}{20 + 30} = 24km/h$

Which of the solutions is correct?

If you disagree with A or B, please give my opinion .....

The teacher can guide the students:

- Teacher: How is average speed defined?

- Student: Average speed $v_{tb} = \frac{s}{t}$

- Teacher: If the motion consists of many uniform motions with different speeds, how to find average speed?

- Student:.....

- Teacher: $v_{tb} = \frac{v_1t_1 + v_2t_2 + ... + v_nt_n}{t_1 + t_2 + ... + t_n}$

If the intervals in which the object move at the same speed $v_1, v_2, ..., v_n$ are equal ($t_1 = t_2 = ... = t_n$) then $v_{tb} = \frac{(v_1 + v_2 + ... + v_n)t}{nt} = \frac{v_1 + v_2 + ... + v_n}{n}$

Conclusion: Formula $v_{tb} = \frac{v_1 + v_2}{2}$ will be correct if the motion times from A to B and from B to A are equal, which is not given in this problem. Therefore, student B has the correct solution.

Example 2: A car is moving at a speed of 10 m/s, the driver starts to brake the car slowly and steadily. The car stops after covering 8m distance in 2s. Calculate the acceleration of the car?

- Teacher: How to solve this problem?

Student A: According to the formula $s = v_0t + \frac{1}{2}at^2 \rightarrow a = -6m/s^2$

Student B: According to the formula $a = \frac{v - v_0}{t} \rightarrow a = -5m/s^2$

Student C: According to the formula $v^2 - v_0^2 = 2as \rightarrow a = \frac{v^2 - v_0^2}{2s} = -6,25m/s^2$

Which of the solutions is correct?

If you disagree with A or B, please give my opinion.....

The teacher can guide the students:

- Teacher: This problem has no meaning, the problem condition is not suitable for uniform retarded motion.

$$s = v_0 t + \frac{1}{2}at^2 \rightarrow s = v_0 t + \frac{1}{2}\frac{v - v_0}{t}t^2 = \frac{v + v_0}{2}t$$

Substitute numbers: $8m \neq \frac{10}{2}.2 = 10m$

Conclusion: There is no acceleration that satisfies the problem's condition. Before each problem, it is necessary to consider the data and conditions of the problem, and its requirements.

Example 3: An uniform accelerated motion: If we get $v_0 = 0$ and $v = a.t$ and $v = \sqrt{2as}$

If we have $v_0 \neq 0$, $v = v_0 + a.t$, substitute $a.t$ by $\sqrt{2as}$, we have $v = v_0 + \sqrt{2as}$.

However students all know the physical formula $v^2 = v_0^2 + 2as$ and the algebraic formula $x^2 = a^2 + b^2 \rightarrow x \neq a + b$. Where does the mistake come from ?

- Teacher: Where do you think the mistake came from?

Conclusion: From the substitution of $a.t$ with $\sqrt{2as}$. This is only permissible when the condition $v_0 = 0$ is met.

Example 4: A ball is thrown upward in vacuum. What is the initial speed of the ball so that it can reach 29,4m high in 6s and 3s. Take g = 10 m/s^2.

- Teacher: Find v_0 ?

- A student solve the problem as below: Applying formula: $h = v_0 t - \frac{1}{2}gt^2$

With t = 6 s $\rightarrow v_0 = 34,3m/s$

With t = 3 s $\rightarrow v_0 = 24,5m/s$

- Teacher: To bring an object to the same height, why does it take longer time when the speed is high? How to resolve the above conflict?

We solve the problem inversely: Calculate the necessary time for the rock to reach a height of 29.4 m by giving it the initial velocities of 34.3 m/s and 24.5 m/s. Ask students to discuss then come to the board to present their solution.

Student: Applying formula: $h = v_0 t - \frac{1}{2}gt^2$

When $v_0 = 34,3m/s$ we get $t_1 = 1s$, $t_2 = 6s$ or the ball at the height of 29,4m when $t_1 = 1s$ when the object goes up and at $t_2 = 6s$ when the object falls down.

When $v_0 = 24,5m/s$ we get $t_1 = 2s$, $t_2 = 3s$ or the ball at the height of 29,4m when $t_1 = 2s$ when the object goes up and at $t_2 = 3s$ when the object falls down.

Conclusion: If the initial speed is smaller, the object will take longer time to reach the height of 29,4 m; and 6s or 3s are the time the object falls down.

Example 5: A student asserted that Newton's third law of motion was not correct because if the action and reaction forces are equal, there will not be any movement. Because no matter how much force is applied to the object, there will be an equal friction force. Where is this student's mistake? The student's mistake is: According to Newton's third law of motion, the action and reaction force are a pair of opposite forces: same line, opposite direction, same magnitude. These two forces are applied on two different objects, therefore they cannot balance each other.

Example 6: A soft string fixed at an end and has not stretched. Apply a force F at the other end. Calculate the force exerted on the entire rope?

- Teacher: Ask students to solve the problem.

- Student A: Force exerted on the entire rope is F.

- Student B: The tension at each point of the string is F, but the string consists of countless points, so the force applied to the entire string is extremely large.

- Teacher: Which answer is correct?

- Students: Student A's answer.

- Teacher: What is the mistake in student B's answer?

Here, student B has not paid attention to Newton's third law of motion. According to Newton's third law, at each pair of adjacent points of the string appears an action-reaction force pair. Therefore, two adjacent points will exert equal forces on each point of the string in terms of magnitude, same line, opposite direction. Thus, all forces applying to the points of the string are equal. Both ends of the string are the force F and the reaction force of the object at the point to which the rope is tied, which is as equal in magnitude as the force F and in the opposite direction to F.

Example 7: According to Newton's second law of motion, acceleration is directly proportional to the force. The greater the gravity is, the greater the acceleration of the free-fall object is. However, the acceleration of free-falling for all objects at the same position is the same. How to resolve this contradiction?

- Teacher: Ask students to discuss and answer.

- Student: The gravity force is proportional to the mass of an object. Therefore, the more mass we increase, the more gravity increases, so the ratio between them, which is the

acceleration of free-falling, remains the same quantity.

Example 8: Applying oil to surfaces reduces friction. But why do people often wet their hands when holding the handle of the axe?

- Teacher: Please explain the phenomenon.

- Student: The wood gets wet in contact with water; therefore, the fibers on the axe's handle expand and swell, which increases the friction between the handle and the hand. In this case, water does not work as lubricating oil.

3. CONCLUSION

In the teaching process, along with the transmission of knowledge, training in general skills and prevention skills, avoiding mistakes is one of the tasks that realize the goal of teaching Physics. This article introduces some fairly simple exercises, but students are easy to confuse and make mistakes. At the same time, orientation of the way to correct some mistakes for students helps them avoid mistakes while studying Physics; contribute to the realization of the current educational innovation goals.

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KHẮC PHỤC MỘT SỐ SAI LẦM CỦA HỌC SINH THÔNG QUA BÀI TẬP NGHỊCH LÝ VÀ NGỤY BIỆN CHƯƠNG "ĐỘNG HỌC CHẤT ĐIỂM" VÀ ĐỘNG LỰC HỌC CHẤT ĐIỂM" SÁCH GIÁO KHOA LỚP 10

Tóm tắt: *Dạy học Vật lý ở trường phổ thông gắn liền với dạy học giải bài tập, qua đó hình thành, phát triển cho học sinh (HS) các phẩm chất chủ yếu và năng lực chung; đồng thời phòng, tránh cho HS một số sai lầm thường mắc phải. Các công trình nghiên cứu về phương pháp dạy học bộ môn Vật lý đã quan tâm đến việc sữa chữa sai lầm cho HS trong giải bài tập nói chung. Bài viết này nghiên cứu, xác định một số sai lầm và cách khắc phục thông qua bài tập nghịch lý và ngụy biện chương "Động học chất điểm" và "Động lực học chất điểm". Bởi vì, bài tập nghịch lý và ngụy biện là những bài tập chứa đựng nhiều yếu tố trái ngược hoặc không phù hợp với các khái niệm, định luật vật lý. Nếu chỉ nhìn nhận một cách hình thức thì có thể nhầm tưởng chúng phù hợp với các khái niệm, định luật vật lý và lôgic thông thường, HS sẽ dễ mắc những sai lầm.*

Từ khóa: *Bài tập nghịch lí và ngụy biện, động học chất điểm, động lực học chất điểm.*