

# Teaching Design of "Properties of Sodium" based on the Core Literacy of Chemistry

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**Abstract.** The learning of sodium and its chemical compounds are the beginning of systematic learning of elemental compounds in senior high school, and have a vital influence on senior high school chemistry learning. This paper is about the teaching design of the first class --the properties of sodium. Based on the five core qualities of chemistry, it adopts the method of situational teaching, gives prominence to the connection and transition among knowledge points, and sets up multiple experiments and group discussions to guide students to construct and form their thinking pattern in chemistry and scientific thinking methods.

**Keywords:** Teaching Design; Core Literacy of Chemistry; Sodium.

## 1. Teaching Analysis

### 1.1 Analysis on Teaching Material

This class is the first class of "Sodium and its Compounds" in the first section of the second chapter of the first required volume of chemistry in PEP edition high school textbooks. In the textbook, it explains the atomic structure of sodium, and guides students to learn the physical and chemical properties of sodium through experiments and inquiry activities, and expounds the application of its properties.

This section is about the first typical metal element to be learnt in high school, and the first step of systematic learning of inorganic element compounds. It has a vital impact on students' construction of methods and ideas for studying metals and also nonmetals and their compounds, and lays a foundation for later study of other element compounds, material structure and periodic law of elements. In addition, in the first chapter, students have already learned some basic and general knowledge, such as simple experimental operation, classification of substances, mutual transformation among substances containing the same elements, writing of electrolyte ionization and ion reaction equations, redox reaction and so on. In this lesson, the knowledge is made clear and application examples are provided, which is helpful for students to understand and consolidate relevant knowledge.

### 1.2 Analysis of Students' Learning Situation

#### (1) Knowledge level.

Students have already learned related knowledge of metals in junior high school, including the physical properties of some metals, the sequence table of metal activeness, and the reaction of some metals with oxygen, acid and salt, knowledge of atomic structure and simple experimental operation skills. All of the above are the basis for further systematic study of metals and their compounds in high school.

Students have already learned the classification of substances, ion reaction, redox reaction principle and other knowledge in senior high school. They should make use of the above knowledge to understand the properties and reactions of sodium in this class, and consolidate as well as deepen their understanding of related knowledge.

#### (2) Cognitive level.

At present, students' thinking mode is at the transition of changing from perceptual thinking pattern in junior high school to rational logical thinking needed in senior high school, and they already have a certain degree of chemical discipline ability. Through the study of the first chapter, students have

preliminarily established a perspective of understanding the two substances and their changes, namely, substance categories and element valence states, which are very important for the later study of elemental compounds. However, students have not fully grasped the idea of understanding the properties of matter from the perspective of atomic structure and material composition and exploring through experiments, and may still use the perceptual thinking mode and existing experience to learn the related knowledge of sodium [1].

### (3) Learning style.

Senior high school students are more interested in situational classroom, and most of them possess the visual learning style, and there are a few tactile and visual students too [2]. Therefore, using situational teaching strategy and multimedia teaching can introduce knowledge from perceptual experience in life, help students to observe photos and objects carefully, conduct experimental inquiry and sum up the information discovered by students themselves. Then teachers can explain the key knowledge points. This can make students with different learning styles all feel comfort in class while paying more attention to class content, and effectively improve classroom efficiency and students' listening quality [3].

## 2. Teaching Objectives

1). Understand the properties of sodium by learning its atomic structure, cultivate students to gain the concept of "structure determines properties, and properties determine application", and let students form the core literacy of macroscopic identification and microscopic analysis, as well as the awareness of model cognition [4-7].

2). Learn the chemical reactions and products of metallic sodium and oxygen under different conditions through experiments, gain profound understanding of the influences of various conditions on the process, phenomena and generated substances of chemical reactions, and form the core literacy of chemistry of the idea of changing and the thinking pattern of balancing.

3). Learn the reaction between sodium and water through experiments, predict and explore the reaction phenomena and products, and form the core literacy of evidential reasoning and model cognition.

4). Learn to take advantage of experiments to verify conjectures, understand the important steps and thinking mode of scientific research, and form the core literacy of scientific research and innovation consciousness.

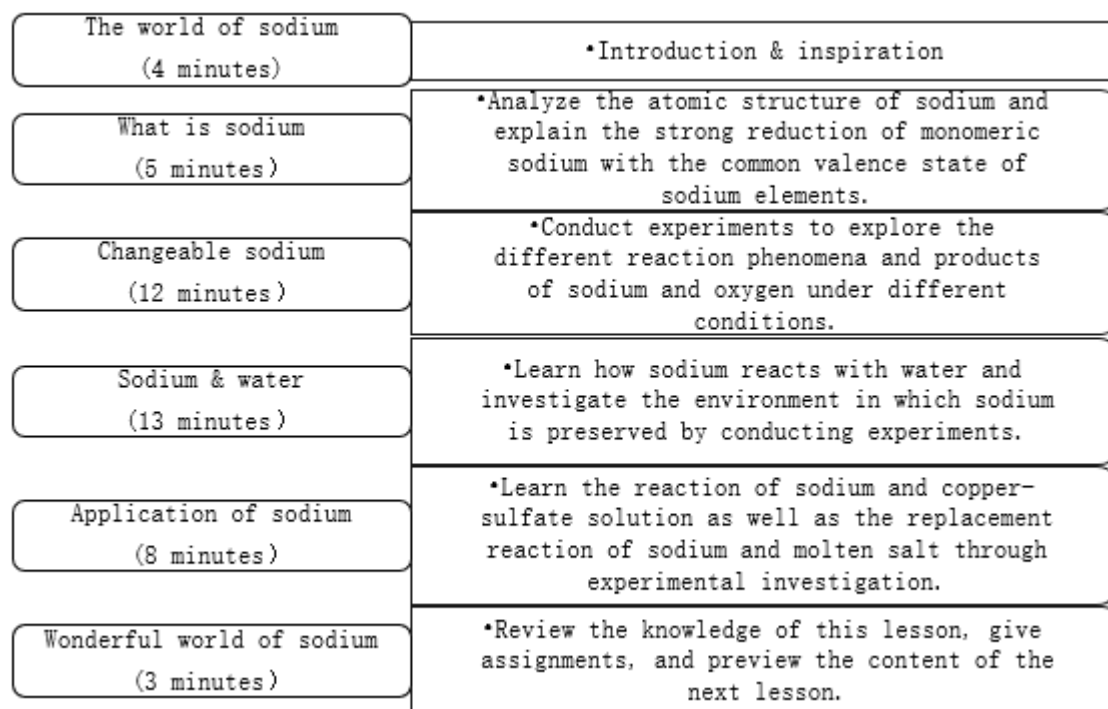
5). By studying the properties of metallic sodium and understanding the application and preservation methods of sodium, form the core literacy of scientific attitude and social responsibility.

## 3. Key and Difficult Points in Teaching

Key points in teaching: (1) Understand the reaction of sodium and water as well as sodium and oxygen through experiments; (2) Analyze the essence of those reactions; (3) Construction of research ideas and methods of sodium.

Difficult points in teaching: (1) Exploratory experiment of reaction between sodium and water; (2) Influence of different reaction conditions on reaction phenomena and products of sodium and oxygen.

#### 4. Teaching Process



**Fig 1.** Schematic diagram of teaching process

(This class is 45 minutes in total)

**Table 1.** Class time distribution

Class sessions	Teacher activities	Student activities	Design intention
<b>Session 1: The world of sodium (4 minutes).</b>			
Situational introduction	[Use multimedia device to show a video of report on sodium ion battery] Sodium ion battery is a hot research field at present. If it can be applied in large scale in the future, the battery field will enter a new stage. Sodium is an element that we are familiar with. In junior high school, we learned about sodium chloride and sodium carbonate. In our daily life, we can also see many substances containing sodium, such as salt, the sodium chloride; and baking soda, the sodium bicarbonate. [Use PPT to show photos of the above examples]	Watch videos and photos, learn about sodium ion batteries, recall and think about the compounds of sodium learned in junior high school and the application of sodium in life.	Introduce scientific research achievements related to this lesson, and expand students' vision of chemistry. Guide students to recall the knowledge they have learned and their daily life experiences, so as to introduce this class's contents.
Questioning	We can find that both sodium ion batteries and other examples are the application of sodium compounds. We are familiar with sodium and its compounds, but we are not so familiar with metallic sodium in the form of	Compare the application of metallic sodium with other metals, and think about the reason why metallic sodium is not common in life.	The properties of sodium are naturally introduced by reflecting on life experience. By comparing it with other metals, students are guided to think about

	<p>simple substance, because there is no free sodium in nature. Metals like iron, gold and silver can be directly contacted in our lives. Why? Why don't people use sodium to make tableware or ornaments?</p> <p>[Use PPT to show photos of iron tableware and gold and silver jewelries]</p>		<p>the phenomena in life and ask questions, students' scientific attitude towards things are cultivated, their awareness of actively exploring problems are enhanced, and students can be concentrated on the content of this lesson.</p>
Preliminary perception	<p>We can use the chemistry knowledge learnt to answer questions found in our lives. Please pay attention to the rank of sodium, iron, silver and gold in the metal activeness sequence table, and answer the questions raised.</p>	<p>[Student's answer] The rank of sodium is quite high, and it is active, so it is difficult to exist as a simple substance in life.</p>	<p>Make students possess preliminary understanding of the activity of sodium.</p>
<b>Session 2: What is sodium (5 minutes).</b>			
Student activities	<p>The properties of substances are determined by structure and can be analyzed from the structure. Use the knowledge learned in junior high school, draw a schematic diagram of the structure of sodium atom and answer the following questions. [Use PPT to show questions]</p>	<p>Draw the atomic structure and answer the questions shown on PPT:</p> <p>There are ____ electrons in the outermost layer of sodium, and it is easy to ____ (lose/get) electrons. The simple substance of sodium has ____ (strong reducibility/strong oxidizability), and the valence state of sodium element is ____.</p>	<p>Through the atomic structure, we can learn the strong reducibility of sodium and the common valence state of sodium. This can guide students to analyze properties from structure, and cultivate their chemistry concept that the structure determines properties. This provides a knowledge base for later learning of the reactions between sodium and various substances.</p>
Transition	<p>The atomic structure of sodium can explain the relatively high activeness of sodium, which is consistent with our conclusion from the metal activeness sequence table. How active is sodium? We can intuitively feel the strong reducibility of sodium through experiments.</p>		
<b>Session 3: Changeable sodium (12 minutes).</b>			
Exploration by activity	<p>Let's first take a look at what happens to metallic sodium in the air. [Use PPT to show steps and precautions of the experiment]</p>	<p>(1) Take a small piece of sodium with tweezers, sip up liquid on its surface with filter paper, and observe the surface of sodium; (2) Cut sodium with a knife by one side on glass sheet, feel the degree of hardness of sodium, and observe the color and luster of the cut surface; (3) Pay attention to the changes in the cut surface; (4) All the remaining sodium is put back into the original bottle. [Group discussion on the above phenomena]</p>	<p>Cultivate students' experimental observation ability and basic operation ability.</p>

Teacher-student induction	(1) The sodium taken out is gray-white in surface; (2) Sodium is very soft and can be cut with a knife, and the cut surface has silvery metallic luster; (3) The cut surface changes from bright to dark quickly.														
Reasoning	Now we know that sodium is silvery white in color and has metallic luster, and it is obvious that sodium reacts quickly after contacting with air. According to our past experience on such reactions, what is the most likely substance in the air to react with sodium?	[Student's answer] Oxygen.	Guide students to think and discover the causes of observed phenomena.												
Transition	In normal temperature settings, sodium reacts with oxygen rapidly, and gray-white metal oxides are formed on the surface of sodium. If you recall the reactions of iron, copper and other metals with oxygen learnt in junior high school, they are all carried out under the conditions of ignition or heating. By comparison, it can be proved that sodium is active. What will happen if sodium reacts with oxygen under the condition of heating?														
Demonstrative experiment	[Play the video of sodium burning in the air and explain the operation steps at the same time]. Heat the dry crucible with an alcohol lamp, cut a piece of mung bean-sized metallic sodium, and quickly put it into the hot crucible. After the sodium melts, get the alcohol lamp away. Prompt students to observe the phenomenon carefully, then put the alcohol lamp back to continue heating. Take the alcohol lamp away and extinguish it immediately after the sodium starts burning.	Watch the video of the experiment, and discuss the observed phenomena and the causes of the phenomena in groups.	The sodium burning experiment is dangerous and not suitable for students to operate. Moreover, teacher's demonstration cannot be clearly seen in every angle, students cannot observe it clearly. Therefore, the video is played to facilitate students' observation and teachers' explanation.												
Teacher-student induction	<table border="1"> <thead> <tr> <th>Phenomena</th> <th>Analysis and conclusion</th> </tr> </thead> <tbody> <tr> <td>Sodium melts rapidly into small balls</td> <td>Sodium has a low melting point and can be melted by heating an alcohol lamp</td> </tr> <tr> <td>It burns intensely, and emits yellow flames</td> <td>Sodium reacts violently with oxygen under heated conditions and there is flame reaction [Note: content for the next lesson]</td> </tr> <tr> <td>A small amount of yellow smoke</td> <td>Product: small solid particles</td> </tr> <tr> <td>Produces small amount of light-yellow solid</td> <td>When sodium reacts with oxygen under heated conditions, light-yellow substance is produced [Note: different from the products at normal temperature]</td> </tr> <tr> <td>Produces small amount of black solid</td> <td>By-products [Note: ask students to explore the causes independently after class]</td> </tr> </tbody> </table>			Phenomena	Analysis and conclusion	Sodium melts rapidly into small balls	Sodium has a low melting point and can be melted by heating an alcohol lamp	It burns intensely, and emits yellow flames	Sodium reacts violently with oxygen under heated conditions and there is flame reaction [Note: content for the next lesson]	A small amount of yellow smoke	Product: small solid particles	Produces small amount of light-yellow solid	When sodium reacts with oxygen under heated conditions, light-yellow substance is produced [Note: different from the products at normal temperature]	Produces small amount of black solid	By-products [Note: ask students to explore the causes independently after class]
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Determine products	Now we know through experiments that although sodium and oxygen are the same reactants, they have different reaction phenomena and different products under different reaction conditions. What are the two products? We can find the answer by looking for data and comparing them.	After reading the data of two kinds of oxides and comparing with the reactants obtained from experiments, it can be concluded that when sodium reacts with oxygen at normal temperature, it can produce grey-white solid, sodium oxide; and when it burns under heating condition it can produce light-yellow solid, sodium peroxide.	Emphasize the influence of conditions on reaction, and prompt students to pay attention to reaction conditions. Make students pay attention to the differences between the two products.												

	[Show photos and data of sodium oxide and sodium peroxide] Sodium oxide, Na <sub>2</sub> O: grey-white solid Sodium peroxide, Na <sub>2</sub> O <sub>2</sub> : light-yellow solid		Cultivate students' ability to actively collect and analyze evidence and find answers in scientific exploration.
Learn about sodium peroxide	We are unfamiliar with sodium peroxide, because the valence state of oxygen is not the familiar -2 valence, but we have learned a similar peroxide-hydrogen peroxide in junior high school when oxygen is -1 valence, hydrogen peroxide. [Write the followings on the blackboard] Na <sub>2</sub> O <sub>2</sub> , H <sub>2</sub> O <sub>2</sub> , and give the valence state of oxygen.	Recall hydrogen peroxide, understand peroxides by recalling it, and compare it with sodium peroxide.	Explain sodium peroxide by analogy with hydrogen peroxide, which is familiar to students. This is helpful for students to understand and remember sodium peroxide.
Chemical equation	We have determined the reaction conditions and products. Please write the chemical equations of the two reactions.	Write down the chemical equations of two reactions: $4\text{Na} + \text{O}_2 \longrightarrow 2\text{Na}_2\text{O}$ , $2\text{Na} + \text{O}_2 \xrightarrow{\Delta} \text{Na}_2\text{O}_2$	Exercise students' ability of writing chemical equations and balancing.
Summary	When there is redox reaction between sodium and oxygen, with sodium as reducing agent and oxygen as oxidant: (1) at normal temperature, sodium can easily react with oxygen $4\text{Na} + \text{O}_2 \longrightarrow 2\text{Na}_2\text{O}$ (white solid). (2) when heated, sodium reacts violently with oxygen $2\text{Na} + \text{O}_2 \xrightarrow{\Delta} \text{Na}_2\text{O}_2$ (light- yellow solid).		
Supplement	Sodium is a metallic simple substance, which can react with non-metallic simple substances such as oxygen. We learned about the reaction between sodium and chlorine in the oxidation-reduction reaction in Section 3 of Chapter 1. Please write down the reaction equation, and write down the chemical equation of the reaction between sodium and sulfur by analogy.	Write down the equations: $2\text{Na} + \text{Cl}_2 \xrightarrow{\Delta} 2\text{NaCl}$ $2\text{Na} + \text{S} \xrightarrow{\Delta} \text{Na}_2\text{S}$	Supplement necessary knowledge points and review previously learnt knowledge. From the reaction of sodium and oxygen to the reaction of metal and nonmetal, it lays a foundation for the learning of other metals.
<b>Session 4: Sodium &amp; water (13 minutes).</b>			
Transition	Through the previous two experiments, we can learn that sodium is very active, and metallic sodium is very easy to react with oxygen in the air. Therefore, how to preserve sodium is an important issue. During the first experiment, students will find that sodium is not directly placed in reagent bottle, but stored in liquid to isolate the air. So what is the liquid in the bottle?		
Questioning	In junior high school, we have also learned a substance that can't be directly exposed to the air -- white phosphorus, which is stored in water. Can sodium metal be stored in water like white phosphorus to isolate the air?		
Exploration by activity	Let's take a look at what happens to sodium in water through experiments, and pay attention to the position, state, movement, size change and sound of sodium in water. [Use PPT to show steps and precautions of the experiment]	Add one-third volume of water into the beaker, take out a piece of sodium, absorb kerosene attached to its surface with filter paper, cut a piece of mung-bean size sodium, carefully put it into the water, immediately cover the beaker mouth with glass sheet, and put the remaining sodium back into the original bottle. During the operation, carefully observe the phenomena,	Cultivate students' experimental operation skills and POE strategies. Guide students to obtain evidence and analyze it through experiments, so as to provide solutions to problems.

		communicate and summarize the observed phenomena in groups, and analyze the causes of the phenomena.	
Teacher-student induction	(1) phenomena and analysis:		
	phenomena	Analysis and conclusion	
	Sodium floats on water	Sodium is less dense than water	
	Sodium melts into shiny little balls, water does not boil	Sodium reacts with water and releases heat, the melting point of sodium is below 100°C	
	The balls move rapidly on water surface	The gas generated by the reaction pushes the balls to move	
	Spray appears around the sodium balls	Sodium reacts with water to release heat, water evaporates into water vapor, and turns into spray when cooled	
	A "hissing" sound	Sodium reacts violently with water, and the gas produced makes a sound when making frictions with water	
	The sodium balls gradually become smaller and finally disappear	Reaction of sodium and water	
	(2) Answer:		
	Sodium can't be stored in water, because it reacts chemically with water, and because the density of sodium is less than that of water, it floats on the water surface.		
Predicted product	<p>What product does water and sodium react form? Please use the principle of redox reaction and the law of conservation of mass and elements to predict the products of the reaction and write down the reaction equation.</p> <p>[Teacher's guidance]</p> <p>(1) This reaction is a replacement reaction in which gas is generated; (2) According to the metal activity sequence table, sodium can replace hydrogen; (3) Due to the conservation of electrons (change of valence), the generated gas cannot be oxygen; (4) Due to the conservation of elements, the generated gas can only be hydrogen.</p>	<p>Prediction:</p> <p>Sodium reacts with water to generate sodium hydroxide and water, and the reaction equation is:</p> $2\text{Na} + 2\text{H}_2\text{O} \longrightarrow 2\text{NaOH} + \text{H}_2 \uparrow$	<p>Guide students to analyze and speculate products through observed experimental phenomena and learned knowledge.</p>
Verifying products	<p>Now let's verify whether our prediction is correct. Sodium hydroxide is a strong base. What is the most common method for detecting alkaline substances?</p> <p>Please drop phenolphthalein solution into the water that just added sodium, and carefully observe the color change.</p> <p>For the verification of hydrogen, please look for information after</p>	<p>[Student's answer] Drop phenolphthalein indicator and observe whether it changes color.</p> <p>Phenolphthalein was added, and it is observed that the solution turned red.</p>	<p>Students are guided to use phenolphthalein after predicting the products, which can cultivate students' ability to think and apply their knowledge better than when teachers directly asking students to add phenolphthalein before the experiment. In this way, the experimental ideas are clearer, the experimental</p>

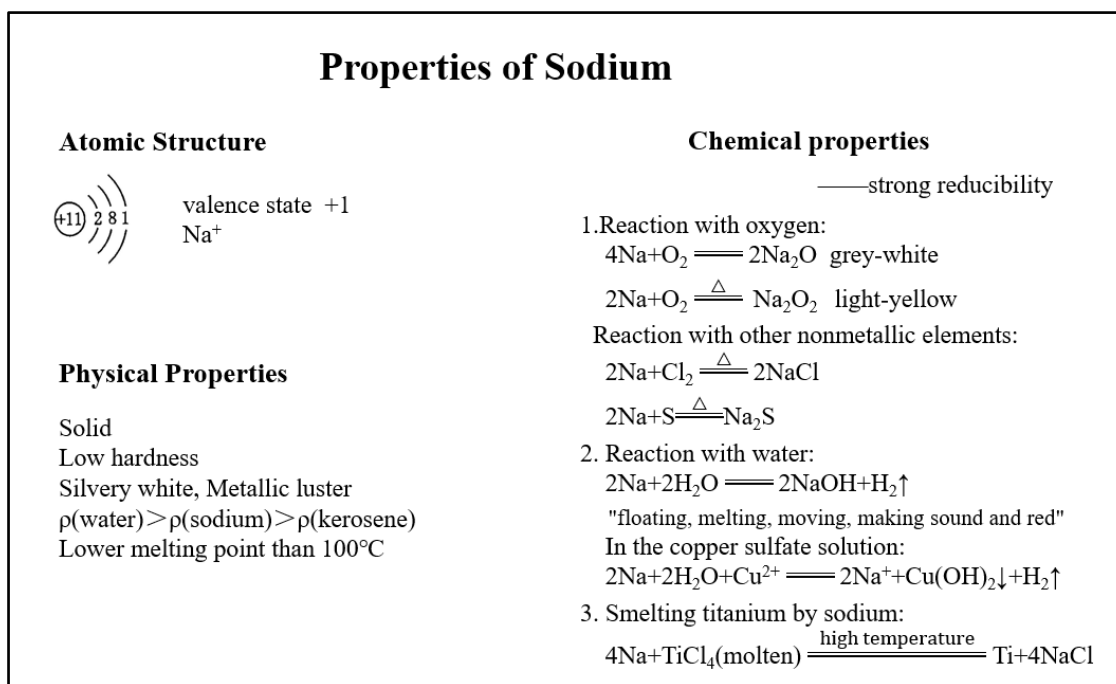
	class, and think about how to improve the experimental device to verify hydrogen, as well as the method of testing hydrogen.		phenomena are more impactful and memorable, and students are more impressed by the reaction products.										
Ionic equation	<p>Combined with the knowledge of ion reaction in Section 2, Chapter 1, write down the ionic equation of reaction between sodium and water.</p> <p>[Teacher's guidance]            (1) Water is a weak electrolyte, and the chemical formula cannot be disassembled; (2) The essence of the reaction is that sodium reduces hydrogen in water, replaces hydrogen, and the remaining hydroxide ions and sodium are oxidized into sodium ions.</p>	<p>Write down the ionic equation for this reaction</p> $2\text{Na} + 2\text{H}_2\text{O} \rightleftharpoons 2\text{Na}^+ + 2\text{OH}^- + \text{H}_2 \uparrow$	<p>Review and consolidate the knowledge of ion reaction, and understand the essence of the reaction between sodium and water in a more profound way, so as to pave the way for understanding the more complicated reactions between sodium and copper sulfate solution.</p>										
Summary	<p>Sodium and water undergo redox reaction to generate hydrogen and sodium hydroxide.            The chemical equation is <math>2\text{Na} + 2\text{H}_2\text{O} \rightleftharpoons 2\text{NaOH} + \text{H}_2 \uparrow</math>            The ionic equation is <math>2\text{Na} + 2\text{H}_2\text{O} \rightleftharpoons 2\text{Na}^+ + 2\text{OH}^- + \text{H}_2 \uparrow</math></p> <p>The experimental phenomena can be memorized and summarized as "floating, melting, moving, making sound and red": sodium floats on the water surface, melts into bright balls, moves quickly on the water surface, makes a popping sound, and the solution which added phenolphthalein test solution turns red.</p>												
Transition	Sodium can't be stored in water. So what is the liquid used to store metallic sodium in reagent bottle?												
Supplementary experiment	<p>[Teacher demonstrates the experiment of sodium reacting with water and kerosene].            Add a proper amount of water into a large test tube, drip three drops of phenolphthalein solution, put a thin plastic partition on the water surface, add a proper amount of kerosene and a piece of mung-bean sized sodium metal on the partition, and gently take out the partition with tweezers after the students make observations.</p>	<p>Observe carefully, discuss in groups, and summarize the observed experimental phenomena.</p>	<p>Learn how to store sodium. By improving the experiment, the students can better observe the contrast of different phenomena of sodium contacting with water and kerosene, and it is easier to observe the reaction between sodium and water by adding phenolphthalein.</p>										
Teacher-student induction	<p>(1) phenomena and analysis:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">phenomena</th> <th style="width: 50%;">analysis and conclusion</th> </tr> </thead> <tbody> <tr> <td>Sodium sinks to the partition at the junction of kerosene and water</td> <td>Sodium is denser than kerosene</td> </tr> <tr> <td>Remove the partition, sodium contacts with water, liquid around sodium turns red</td> <td>Sodium reacts with water and produces sodium hydroxide</td> </tr> <tr> <td>Sodium and water generate bubbles around after contact, and sodium jumps upwards</td> <td>Sodium reacts with water and produces hydrogen, and it pushes sodium upward</td> </tr> <tr> <td>Sodium jumps into the upper kerosene layer and then continues to sink to the junction of kerosene and water</td> <td>Sodium is denser than kerosene, and sodium does not have chemical reactions with kerosene</td> </tr> </tbody> </table> <p>(2) Conclusion:            Sodium can be stored in kerosene: there is no chemical reaction between sodium and kerosene, and sodium is denser than kerosene.</p>			phenomena	analysis and conclusion	Sodium sinks to the partition at the junction of kerosene and water	Sodium is denser than kerosene	Remove the partition, sodium contacts with water, liquid around sodium turns red	Sodium reacts with water and produces sodium hydroxide	Sodium and water generate bubbles around after contact, and sodium jumps upwards	Sodium reacts with water and produces hydrogen, and it pushes sodium upward	Sodium jumps into the upper kerosene layer and then continues to sink to the junction of kerosene and water	Sodium is denser than kerosene, and sodium does not have chemical reactions with kerosene
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Summary	In the laboratory, sodium is usually stored in reagent bottle containing kerosene or paraffin oil to isolate the air so as to prevent sodium from contacting oxygen and water in the air and trigger chemical reaction.		
Knowledge application	<p>By reflecting on what you have just learned, please think about how to put out the fire when sodium catches fire. Can water be used to extinguish the fire? Why?</p> <p>[Teacher's explanation] When sodium is on fire, it can't be extinguished by water or foam extinguisher, because sodium reacts violently with water, and the sodium peroxide produced by burning sodium will release oxygen when it reacts with carbon dioxide and water (this will be learnt in the next class), so it is necessary to put out the fire with dry sand.</p> <p>In addition, by using the reaction of sodium and water, sodium can be used as a strong water remover in industrial production to remove trace water in organic matter.</p>	<p>[Student's answer] We can't put out the fire with water, because the reaction between sodium and water will make the fire bigger.</p>	<p>By asking questions, students are guided to use their knowledge to solve practical problems that may be encountered in production and life, consolidate basic knowledge, cultivate safety awareness and learn to apply chemical knowledge to social practice.</p>
<b>Session 5: Application of sodium (8 minutes).</b>			
Transition	After learning the properties of sodium, let's take a look at the application of sodium.		
Questioning	There is a saying in Chinese ancient books, "add iron into copper sulfate solution, copper will appear", which describes how to get copper through replacement reaction. This reaction has been studied in the first chapter. Iron can react with copper sulfate solution to replace copper, because iron is more reducible than copper. In that case, sodium is more reducible than iron, can copper be replaced too?		
Predicting experimental phenomena	Please think and predict what will happen when sodium metal is put into copper sulfate solution.	<p>Predicting experimental phenomena: (1) Sodium replaces copper: red solid is formed; (2) Sodium reacts with water to generate sodium hydroxide, and sodium hydroxide reacts with copper sulfate to generate copper hydroxide: blue precipitate is generated.</p>	<p>Compare the reactions of copper and copper sulfate solution and iron and copper sulfate solution respectively, students' cognitive conflict may arouse.</p>
Activity inquiry	<p>Now, please verify whether the prediction is correct through experiments. [PPT shows experimental steps and precautions]</p>	<p>Group experiment, add one-third volume of copper sulfate solution into a beaker, cut out a piece of sodium as large as mung bean, absorb kerosene attached to the surface with filter paper, put it into the solution, and immediately cover the beaker mouth with glass sheet.</p> <p>During the operation, observe the experimental phenomena carefully, and discuss and communicate in groups.</p>	<p>Break the mindset of students' perception that replacement reaction only happen according to the metal activity sequence table, and let students gain a clearer and more comprehensive understanding of the activeness of sodium.</p>

Induction	Sodium floats on the water surface, melts into small bright balls, move rapidly on the water surface, and there is a popping sound, resulting in blue precipitation.		
Chemical equation	Experiments have proved that sodium reacts with water, but copper is not generated, and blue precipitate of copper hydroxide is formed. Please write down the reaction equation of sodium in copper sulfate solution.	Write down chemical equations: $2\text{Na}+2\text{H}_2\text{O}\longrightarrow 2\text{NaOH}+\text{H}_2\uparrow$ $2\text{NaOH}+\text{CuSO}_4\longrightarrow \text{Cu}(\text{OH})_2\downarrow +\text{Na}_2\text{SO}_4$	Practice writing equations.
Ionic equation	Please reflect on the knowledge of ion reaction, and synthesize two chemical equations into one ionic equation. Pay attention to substances that can be split or omitted.  The essence of the reaction can be understood more clearly by learning ionic equation. The reaction between sodium and water generates hydrogen, and the remaining hydroxide ions combine with copper ions in copper sulfate solution to form copper hydroxide precipitate.	$2\text{Na}+2\text{H}_2\text{O}+\text{Cu}^{2+}\longrightarrow 2\text{Na}^++\text{Cu}(\text{OH})_2\downarrow +\text{H}_2\uparrow$	Review the knowledge of ion reaction and give a concrete example to understand the essence of the reaction, so that students can understand the knowledge more thoroughly.
Teacher's explanation	Sodium is different from metallic elements like iron, it is easy to react with water. In alkali and salt solutions, it should be considered that sodium reacts with water to generate sodium hydroxide first, and only in acid with more hydrogen ions does the replacement reaction take place, replacing hydrogen ions with hydrogen.		
Smelting metal by sodium	So is sodium incapable of smelting metals? Actually, it is possible. Please guess, besides the solution, what other conditions are conducive to the reaction?  Titanium in titanium alloy, which is important in aerospace and aviation, is generated by sodium and molten titanium tetrachloride through replacement reaction. Please write down the chemical equation of the reaction according to the description.	[student's answer] molten state.  Write down the reaction equation for smelting titanium by sodium. $4\text{Na}+\text{TiCl}_4(\text{molten})\xrightarrow{\text{high temperature}}\text{Ti}+4\text{NaCl}$	Supplement necessary knowledge points to let students understand the application of sodium.
<b>Session 6: Wonderful world of sodium (3 minutes).</b>			
Teacher-student induction	<p>Finally, let's sort out the content of this class.</p> <p>(1) Physical properties of sodium: silvery white solid with metallic luster, with low hardness, lower density than water, higher density than kerosene or paraffin oil, and lower melting point than 100°C.</p> <p>(2) Chemical properties of sodium: strong reducibility.</p> <p>① Reaction with oxygen: <math>4\text{Na}+\text{O}_2\longrightarrow 2\text{Na}_2\text{O}</math>, <math>2\text{Na}+\text{O}_2\xrightarrow{\Delta}\text{Na}_2\text{O}_2</math></p> <p>② Reaction with other nonmetallic elements: <math>2\text{Na}+\text{Cl}_2\xrightarrow{\Delta}2\text{NaCl}</math>, <math>2\text{Na}+\text{S}\xrightarrow{\Delta}\text{Na}_2\text{S}</math></p> <p>③ Reaction with water: <math>2\text{Na}+2\text{H}_2\text{O}\longrightarrow 2\text{NaOH}+\text{H}_2\uparrow</math></p> <p>④ In the copper sulfate solution: <math>2\text{Na}+2\text{H}_2\text{O}+\text{Cu}^{2+}\longrightarrow 2\text{Na}^++\text{Cu}(\text{OH})_2\downarrow +\text{H}_2\uparrow</math></p> <p>⑤ Smelting titanium by sodium: <math>4\text{Na}+\text{TiCl}_4(\text{molten})\xrightarrow{\text{high temperature}}\text{Ti}+4\text{NaCl}</math></p>		

Concluding remarks & assignment	In this class, we started the exploration of elemental compounds, and learned various kinds of interesting properties and applications of metallic sodium. Now we are no longer unfamiliar to sodium the simple substance. In this lesson, we learnt that metallic sodium cannot be stored in the air, so what will happen if sodium is stored in the air for a long time? What substance will it eventually become? Please preview the content of the next section---sodium compounds after class, and reflect on the knowledge learned in this class to find out the key to this problem. For the exploration of sodium, we will continue in the next class.
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## 5. Blackboard Writing Design



**Fig 2.** Properties of sodium

## 6. Teaching Reflection

1). Use sodium ion battery, the current hot research field related to class content, as the introduction of new course, and expand students' scientific vision by using multimedia. Classroom knowledge points (activeness of sodium) are embodied and introduced through life experience (the application of simple sodium has never been seen in life), which enhances students' awareness of applying the learned chemistry knowledge in daily life. By attracting students' attention through the introduction of new course, students can realize the significance and use of the learned knowledge before learning new knowledge, and actively learn new knowledge instead of being forced to accept it, which is conducive to students' understanding and mastery of knowledge, and can help students form the core discipline literacy of scientific attitude and social responsibility.

2). The whole class is carried out basing on the activeness of sodium, and a learning scenario is set, in which the old knowledge learned in junior middle school and daily life experience can help students feel the activeness of sodium, and the atomic structure of sodium is analyzed and recognized. Sodium's activeness is explored and verified by experiments done by classroom grouping. Then, combined with the knowledge learned in this class, students can reflect on the practical application of activeness, and the teaching sequence is in line with the thinking sequence. The teaching of new knowledge is inspired by existing experience and guides students to think, which is in line with the theory of zone of proximal development. It is conducive to the cultivation of students' scientific thinking ability, the subsequent study of other elements and compounds, and the formation of the core literacy of scientific inquiry and innovative consciousness.

3). Several organized experimental operations and observing experiments in class reflect the characteristics of chemistry discipline, and make students more impressed by the reactions they have learned. The setting of cooperative inquiry and group discussion is beneficial to students' formation of the core literacy of chemistry discipline. In the reaction experiment of sodium and water, the order of adding sodium and phenolphthalein was adjusted, and phenolphthalein was added after the reaction, leaving students with some room for thinking. In the reaction experiment of sodium, water and kerosene, the use of improved new experimental instruments is more conducive to the experiment and observation, and reflects the innovation and inquiry consciousness that learning chemistry should have.

4). At the end of the class, thinking assignments are arranged, and the reactions and final products of sodium placed in the air for a long time involve many knowledge points such as the reaction of sodium and oxygen learnt in this class, the reaction of sodium hydroxide and carbon dioxide learnt in junior high school, and the reaction of sodium oxide and water to be learnt in the next class, so that students can not only recall the learnt knowledge in junior high school, review and consolidate the new knowledge in this class, but also preview the contents of the next class, which will be conducive to the smooth and efficient progress of the next class and cultivate students' awareness and ability of autonomous learning.

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