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How to Apply STEAM Teaching Concept to Middle School Physics Teaching Design

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Abstract

STEAM education is an interdisciplinary teaching concept, which applies science, technology, engineering, arts and mathematics to practical teaching activities. This paper mainly takes Ohm's law in Chapter 17 of the textbook for junior high school grade 9 (full volume) of the people's education edition as an example, and uses the STEAM teaching concept to carry out the teaching design of Ohm's Law (Class 2), aiming at trying to explore how to use the STEAM teaching concept to carry out the teaching design in middle school physics and hoping to provide relevant reference for middle school teachers to use STEAM for teaching design.

Keywords

STEAM; Middle school physics; The teaching design.

1. Research Background

STEAM is developed on the basis of STEM. STEM stands for science, technology, engineering and mathematics. STEM education is an interdisciplinary teaching concept, which combines rigorous academic concepts with practical curriculum teaching.

In 2006, Professor Georgette Ackman, a well-known American education scholar, brought art and design into STEM and put forward the STEAM teaching concept. Among them, "A" is the abbreviation of arts, including music, dance, image, literary works, etc. Its research framework includes STEAM teacher practice community, constructivism and reflective theory.

Nowadays, the United States has relatively mastered the STEAM teaching theory and formulated relevant policies, and is still continuing to study the STEAM teaching theory, and has made certain achievements. However, there are few teaching cases that combine the STEAM teaching concept with the middle school physics curriculum. This paper aims to explore this aspect.

2. Teaching Topic:Ohm's Law (Class 2)

Textbook analysis: the content of this course belongs to the second section of Chapter 17 Ohm's law in the ninth grade junior high school textbook (full volume) of the people's education edition. This section is the key content of this chapter. It not only inherits the previous section: the relationship between current, voltage and resistance, and extends the relevant content of the previous section, but also lays a foundation for the following two sections: resistance measurement and application of Ohm's law in series and parallel circuits.

Analysis of learning situation: in terms of knowledge, students have mastered the concepts of voltage, current and resistance, and have been exposed to semiconductors such as gas sensitive resistance and photosensitive resistance in the exercises. In the last lesson, under the leadership of the teacher, the students have studied the relationship between current, voltage and resistance and obtained Ohm's law. In terms of ability, through the study of chapter 15 and chapter 16 and the subsequent exercises, students have basically acquired the ability to analyze circuits and independently design simple circuits. Ohm's law in this chapter is the key content

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of electricity, and it is a little difficult for junior high school students, which requires the patient guidance of teachers.

3. Teaching Objectinves

3.1. Knowledge and Skills

(a)Know the basic principle and structure of the alcohol concentration detector.

(b)Explore the design principle of other instruments similar to the alcohol concentration detector.

(c)Understand the application of Ohm's law in life.

3.2. Process and Method

(a)Understand the meaning of Ohm's law through the cooperative discussion on the related inventions of alcohol concentration detector.

(b)Learn to draw inferences from one instance through discussion of relevant issues and cultivate students' divergent thinking.

3.3. Emotion, Attitude and Values

(a)In the process of discussion and speech, cultivate students' abilities to connect physics with life, cooperate and communicate.Make students realize that physics comes from life, and physics benefits life.Let students fall in love with physics and science.

(b)Make students understand the importance of communication and cooperation through speeches and discussions.

4. Teaching Important Point

The application of Ohm's law.

5. Teaching Difficult Point

Skillfully use Ohm's law and be able to solve practical problems.concentration

6. Teaching Methods

The lecture method and discussion method are combined to fully implement the concept and thought of STAEAM.

Contents which embody STEAM:

S (Science): Understand the connotation of Ohm's law, understand the structure and principle of alcohol concentration detector, and deepen the understanding of Ohm's law through discussion of other inventions in life and related exercises.

T (Technology): Understand the use and principle of circuit components, understand the function of gas sensitive resistor, photosensitive resistor and other components, and think about how to design the circuits of other relevant detection instruments.

E (Engineering): Analyze the principle of alcohol concentration detector through videos and materials, and guide students to conduct more in-depth research on fire alarm and other instruments after class.

A (Arts): Understand that physics comes from life and can benefit life, and strengthen students' safety awareness.

M (Mathematics): Use Ohm's law to calculate relevant exercises.

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Table 1. Teaching activities and the STEAM teaching concept embodied in them

Teaching activities and the STEAM teaching concept embodied in them					
	S (Science)	T (Technology)	E (Engineering)	A (Arts)	M (Mathematics)
Teaching review	Contents of Ohm's law		Analysis of principle		Mathematical expression of Ohm's law
Lead in new lesson	Understand the structure and principle of alcohol concentration detector		Application of principle	Understand physics in life Understand that physics comes from life and can benefit life	
Group discussion			Application of principle		
Communication and sharing	Discussion on other inventions in life	Understand the function of gas sensitive resistance, photosensitive resistance and other components	Extension of principle		The change in voltage and current caused by the change in resistance in a circuit
Summary and inspiration	Understand the structure and principle of alcohol concentration detector and related inventions	Design the circuit of alcohol concentration detector	Analysis and reflection on the whole process	Consciously abide by traffic regulations and stop drunk driving Train students' awareness of fire prevention	
Explanation of exercises	Application of physical knowledge				Calculation of exercises

7. Teaching Process

7.1. Review the Conclusions of the Last Lesson(about 5 min)

The teacher reviews the "relationship between current, voltage and resistance" (The current through the conductor is proportional to the voltage at both ends of the conductor and inversely proportional to the resistance of the conductor.)and Ohm's law(The current in a conductor is proportional to the voltage across the conductor and inversely proportional to the resistance of the conductor. If U represents the voltage at both ends of the conductor, R represents the resistance of the conductor, and I represents the current in the conductor, then its mathematical expression is: I=U/ R, or it can be transformed into: U=IR R=U/ I.) together with the students based on the contents learned in the previous lesson.

7.2. Introduce the Application of Ohm's Law and Lead in New Lesson(about 5 min)

The teacher leads out the alcohol concentration detector through the characteristics of the gas sensitive resistor(The resistance value of the gas sensitive resistor changes with the change of the gas concentration.), and introduces the principle of the alcohol concentration detector(The resistance value of the sensitive resistor of the alcohol concentration detector changes with the change of the alcohol concentration, thereby changing the current and voltage in the circuit. When the concentration of alcohol gas exhaled by the driver is higher, the resistance of the gas sensitive resistor changes and the indication of the voltmeter in the detector becomes larger. The police can judge whether the driver is driving after drinking according to the value displayed by the alcohol concentration detector) through relevant videos and materials. In the

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process, the teacher can permeate the students with traffic safety knowledge related to alcohol driving and improve their safety awareness.

7.3. Group Discussion(about 10 min)

Then, the teacher uses the alcohol concentration detector to stimulate the divergent thinking of the students. The students are divided into four groups to discuss and think about other inventions that use similar principles in life.

Students discuss with each other in groups.

7.4. Communicate and Sharing(about 10 min)

Each group shares their own discussion results, and the teacher gives an expansion based on the relevant contents. The following are three cases.

Group one:

Student:The fire alarm is similar to the alcohol concentration detector. When the smoke concentration in the gas reaches a certain value, the alarm will be sounded.

Teacher:The fire alarm is equipped with a gas sensor. The change of the gas concentration will change its resistance, thus causing the change of the voltage and current in the circuit and sounding the alarm. Students should also take precautions against fire in your lives. If a fire is found, you should report to the police in time.

Group two:

Student:The principle of the electronic scale and the alcohol concentration detector is similar. When the pressure changes, the resistance value in the circuit will change, so that the voltage in the circuit will change.

Teacher:Pressure will cause the resistance strain gauge in the electronic scale to deform, and the resistance of the strain type pressure sensor will change accordingly, so that the voltage in the circuit will change. We can judge the weight of the object by the change of the voltage in the circuit.

Group three:

Student:Photosensitive resistors are used in today's light controlled switches and gas sensitive resistors are used in alcohol concentration detectors. The principles of them are similar.

Teacher:Very well, the resistance value of the gas sensitive resistor changes with the change of the gas concentration, and the resistance value of the photosensitive resistor also changes with the change of the light intensity, thus causing the change of the current and voltage.

7.5. Reflection and Conclusion(about 5 min)

Through the process of mutual discussion, the teacher helps the students to further understand Ohm's law and expands from the alcohol concentration detector to other instruments such as fire alarm, electronic scale and light control switch.

In the process of summing up, teachers should properly emphasize the use of physics for life and stimulate students' love for physics.

The teacher asks the students to refer to the alcohol concentration detector after class to consider whether they can design the circuits of fire alarm, electronic scale, light control switch and other related inventions and conduct in-depth research.

7.6. Explanation of Exercises(about 10 min)

Relevant examples are as follows:

Exercise 1(2022·Xiaogan·adaptation):As shown in the figure is a simplified circuit diagram of the alcohol concentration detector. The power supply voltage remains unchanged, R1 is the constant resistance, R2 is the alcohol gas sensor, and its resistance decreases with the increase

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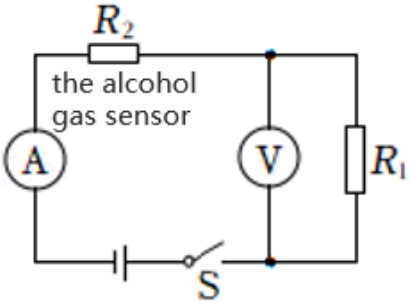
of the alcohol gas concentration. Close the switch S, the drunk driver exhales gas toward R2, and the alcohol gas concentration increases, then( )



A.the total resistance in the circuit increases

B.the indication of ammeter A increases

C.the indication of voltmeter V decreases

D. the indication of ammeter A remains unchanged

【answer】B

【analysis】A.After drinking, the driver exhales gas against R2 and the alcohol concentration increases. The resistance of R2 decreases with the increase of the alcohol concentration, so the total resistance in the circuit decreases. As a result, A does not meet the meaning of the question;

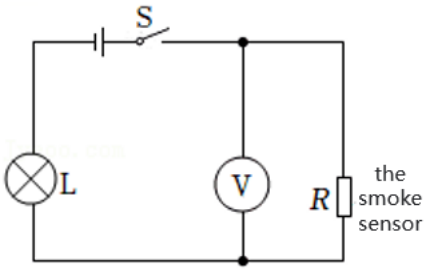
B.The power supply voltage remains unchanged. According to I=U/R, when the total resistance of the circuit decreases, the current in the circuit increases, and the indication of ammeter A increases. Therefore, B meets the meaning of the question;

C.According to U=IR, when the current increases, the voltage at both ends of R1 will increase, and the V indication of the voltmeter will increase, so C does not meet the meaning of the question;

D.According to B, D does not meet the meaning of the question.

Therefore, the answer is B.

Exercise 2(2022·Chenzhou):The circuit diagram of a smoke alarm is shown in the figure. The resistance of the smoke sensor R decreases with the increase of smoke concentration. When the smoke concentration increases, the change of the voltmeter and the change of the bulb brightness in the circuit are( )



A.The indication of the voltmeter increases and the bulb becomes brighter

B.The indication of the voltmeter decreases and the bulb becomes brighter

C.The indication of the voltmeter decreases and the bulb becomes dimmer

D.The indication of the voltmeter increases and the bulb becomes dimmer

【answer】B

【analysis】It can be seen from the circuit diagram that the bulb and the smoke sensor are connected in series, the voltmeter measures the voltage at both ends of the smoke sensor, and the ammeter measures the current in the circuit. When the smoke concentration increases, the resistance of the smoke sensor decreases, so the total resistance in the circuit decreases. According to I=U/R, the current in the circuit increases. According to U=IR, the voltage at both

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ends of the bulb increases, and the bulb becomes brighter. Moreover, because the total voltage in the series circuit is equal to the sum of the voltages of each part, the voltage at both ends of the smoke sensor becomes smaller, that is, the indication of the voltmeter becomes smaller. Therefore, the answer is B.

8. Teaching Summary

Generally, Ohm's law course is divided into two classes. The first class explores the relationship between current, voltage and resistance to obtain Ohm's law. The second class is the application of Ohm's law, mainly for explanation of exercises. However, this case breaks the traditional arrangement in the second class and emphasizes the practical application of Ohm's law in science, technology and engineering. Based on the alcohol concentration detector, it is extended to fire alarm, electronic scale, light controlled switch and other instruments, which cultivates students' innovative ability. At the same time, it also retains the explanation of exercises, which conforms to the current teaching requirements in China and fully reflects the teaching concept of STEAM.

Through the teaching design of this case, it is found that when the STEAM teaching concept is used in middle school physics teaching, the combination and application of engineering (E), technology (T) and mathematics (M) are the key points, and finding suitable materials is the difficult point. On the one hand, teachers are required to improve their own quality and ability, and on the other hand, the society and schools need to fully understand and support teachers. I hope this paper can provide some enlightenment and help to middle school physics teachers.

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