SQA National 5 Physics Practice Exam (Sample)

Study Guide

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Questions

1. What do photons depend on for their characteristics?

- **A. Wavelength of radiation**
- **B. Amplitude of radiation**
- **C. Frequency of radiation**
- **D. Velocity of radiation**

2. What is a significant disadvantage of nuclear energy?

- **A. It requires little resource management**
- **B. It produces large amounts of greenhouse gases**
- **C. Disposal of nuclear waste is problematic**
- **D. It has unlimited uranium resources**

3. Which of the following is the formula for electrical power using resistance?

- **A. P = I^2R**
- **B. P = R/I^2**
- **C. P = R^2/I**
- **D. P = IR^2**

4. Which type of radiation is commonly used in radiotherapy?

- **A. Alpha**
- **B. Beta**
- **C. X-ray**
- **D. Gamma**

5. Why do radio and TV waves have less diffraction?

- **A. They have a small wavelength**
- **B. They have a large amplitude**
- **C. They have a high frequency**
- **D. They are not electromagnetic waves**

6. How is heat removed from a nuclear reactor?

- **A. By using liquid nitrogen**
- **B. By pumping coolant past hot fuel elements**
- **C. By letting the reactor vent to the atmosphere**
- **D. By circulating air around the reactor**

7. What does the normal refer to in wave theory?

A. A line at any angle

B. A line at a right angle to the surface

C. A line that represents the direction of waves

D. A line that measures frequency

8. How do gases behave according to the laws of pressure and volume?

A. They expand and contract based on temperature changes

B. They remain unaffected by temperature changes

C. They eliminate the need for thermal energy

D. They have a constant volume regardless of temperature

9. Which element is most commonly associated with nuclear fusion reactions in stars?

A. Uranium

B. Hydrogen

C. Carbon

D. Helium

10. What is a possible result of living tissue being ionised by radiation?

A. Cells may heal better

B. Cells may undergo genetic mutations

C. Cells may become larger

D. Cells may divide at a slower rate

Answers

1. C
2. C
3. A
4. D
5. A
6. B
7. B
8. A
9. B
10. B

Explanations

1. What do photons depend on for their characteristics?

A. Wavelength of radiation

B. Amplitude of radiation

C. Frequency of radiation

D. Velocity of radiation

Photons are elementary particles that exhibit both wave-like and particle-like properties, and their characteristics are fundamentally linked to their frequency. The frequency of a photon determines its energy and color in the context of electromagnetic radiation. According to the equation E = hf, where E is the energy of the photon, h is Planck's constant, and f is the frequency, a higher frequency correlates with higher energy. In the electromagnetic spectrum, different frequencies correspond to different types of radiation. For instance, visible light has frequencies in a specific range, while ultraviolet radiation has higher frequencies and, therefore, higher energy than visible light. Thus, understanding a photon's frequency is crucial, as it directly influences much of its behavior and interaction with matter. While wavelength also describes photons and is related to frequency through the speed of light (c = wavelength × frequency), it is the frequency itself that directly affects the energy and observable characteristics of the photon. Amplitude, on the other hand, relates more to the intensity of the wave rather than the intrinsic properties of the photons themselves. Velocity is generally constant for all photons in a vacuum, being equal to the speed of light, and does not define their characteristics. Therefore, only frequency captures the essence of what defines a photon

2. What is a significant disadvantage of nuclear energy?

A. It requires little resource management

B. It produces large amounts of greenhouse gases

C. Disposal of nuclear waste is problematic

D. It has unlimited uranium resources

Nuclear energy is a powerful source of electricity generation, but one significant disadvantage is related to the disposal of nuclear waste. When nuclear fission occurs in reactors, it produces radioactive waste that can remain hazardous to human health and the environment for thousands of years. The challenge lies in finding a safe and long-term storage solution for this waste. Existing methods largely involve encasing the waste in secure containers and storing it deep underground to prevent contamination. However, developing and maintaining these facilities is costly and technically complex, and public opposition to local disposal sites can pose additional challenges. Furthermore, the potential for leaks or accidents in waste management practices raises serious safety concerns. Other options do not accurately represent the disadvantages of nuclear energy. The assertion that it requires little resource management overlooks the complexities involved in fuel procurement, plant operation, and waste processing. The idea that nuclear energy produces large amounts of greenhouse gases is misleading; nuclear power itself produces minimal greenhouse gas emissions compared to fossil fuels during electricity generation. Finally, claiming that it has unlimited uranium resources is incorrect; while there may be sufficient uranium currently available, it is a finite resource that will eventually be depleted. Hence, the problematic nature of nuclear waste disposal is a critical and well-recognized downside of nuclear energy.

3. Which of the following is the formula for electrical power using resistance?

A. P = I^2R

B. P = R/I^2

C. P = R^2/I

D. P = IR^2

The formula for electrical power using resistance is represented as P = I²R. In this equation, P stands for power measured in watts, I represents current in amperes, and R denotes resistance in ohms. This relationship arises from the basic definitions of electrical power and Ohm's Law. Ohm's Law establishes that the voltage (V) across a resistor is equal to the current (I) multiplied by the resistance (R), i.e., V = IR. The power (P) consumed in an electrical circuit can also be calculated using the formula P = VI. By substituting the expression for voltage from Ohm's Law into the power equation, we can derive different forms of the power formula. Using the expression V = IR, we can substitute for V in the power formula, giving us P = I(IR) or P = I²R. This shows how power varies not only with the current running through the circuit but also with the resistance of the components involved. The other formulas provided do not correctly express the relationship between power and resistance in this particular context, as they either alter the relationships established by Ohm's Law or misrepresent the dependence of power on current and resistance. Understanding how to manipulate the basic

4. Which type of radiation is commonly used in radiotherapy?

A. Alpha

B. Beta

C. X-ray

D. Gamma

In radiotherapy, gamma radiation is commonly utilized due to its ability to penetrate deep into the tissues of the body while delivering effective doses of energy to malignant cells. Gamma rays have high energy and a short wavelength, which allows them to target tumors precisely while minimizing damage to surrounding healthy tissues. The penetrating power of gamma radiation is essential in treating cancers that are located deep within the body, as it can traverse several centimeters of tissue, ensuring that the tumor receives sufficient radiation to kill cancer cells. Additionally, gamma rays can be generated from radioactive isotopes or produced in cyclotrons, making them versatile tools in medical treatments. Other forms of radiation, such as alpha and beta particles, have limitations in their applications for radiotherapy. Alpha particles, for instance, have low penetration power and are generally effective only in cases where the source can be placed very close to the tumor. Beta particles can penetrate further than alpha but are still less effective than gamma rays for deeper tumors. X-rays, while also used in medical imaging and treatment, are less potent than gamma rays and are typically used in conjunction with other types of radiation. Therefore, the use of gamma radiation in radiotherapy is attributed to its effectiveness in treating various cancers while managing patient safety effectively.

5. Why do radio and TV waves have less diffraction?

A. They have a small wavelength

B. They have a large amplitude

C. They have a high frequency

D. They are not electromagnetic waves

Radio and TV waves experience less diffraction because they have a small wavelength. Diffraction refers to the bending of waves around obstacles or the spreading of waves when they pass through small openings. The amount of diffraction that occurs is inversely related to the wavelength of the waves compared to the size of the obstacles or openings they encounter. When the wavelength is small relative to the size of an obstacle or opening, the waves will tend to travel in straight lines with less curvature around objects. In the case of radio and TV waves, although they generally have longer wavelengths than visible light, they still exhibit less diffraction when compared to much shorter wavelengths, such as those of X-rays or gamma rays. Therefore, when radio and TV waves encounter buildings or hills, they are less likely to bend sharply and more likely to create shadow zones. The implications of wave characteristics, such as amplitude and frequency, are related to wave energy and perception but do not directly influence the diffraction behavior in the same manner as wavelength does. Thus, the fundamental property that dictates the diffraction of these waves is their wavelength, making the statement about small wavelength accurate in this context.

6. How is heat removed from a nuclear reactor?

A. By using liquid nitrogen

B. By pumping coolant past hot fuel elements

C. By letting the reactor vent to the atmosphere

D. By circulating air around the reactor

Heat is removed from a nuclear reactor primarily by using a coolant that is pumped past the hot fuel elements. The fuel elements produce a significant amount of heat through nuclear fission, and if this heat is not effectively removed, it could lead to overheating and potentially dangerous situations. The coolant absorbs this heat and carries it away from the reactor core, allowing for efficient temperature control. The choice of coolant can vary among different reactor designs, with options including water, liquid metal, or gas. In most reactors, water is commonly used due to its excellent thermal properties and ability to transfer heat effectively. By continuously circulating the coolant through the reactor, heat is efficiently removed, which is critical for safe operation and to maintain the reactor at optimal performance levels. Other options, while they might seem plausible, do not effectively describe the actual processes used in nuclear reactors. For instance, using liquid nitrogen or circulating air would not provide the necessary thermal conductivity and heat transfer capabilities needed for safe reactor operation. Additionally, venting to the atmosphere is not a controlled method for removing heat and could pose serious safety risks.

7. What does the normal refer to in wave theory?

A. A line at any angle

B. A line at a right angle to the surface

C. A line that represents the direction of waves

D. A line that measures frequency

In wave theory, the normal refers to a line that is drawn at a right angle to the surface at the point of incidence, which is where a wave meets a boundary. This concept is crucial when analyzing how waves behave at interfaces, such as when they reflect or refract. When a wave reaches a boundary between two different media, the angle of incidence is measured from the normal. Understanding the normal helps in applying Snell's Law for refraction, as well as the law of reflection, where the angle of reflection equals the angle of incidence. This alignment allows for clear predictions about the wave's behavior based on its interaction with surfaces. Using the normal is essential for visualizing and calculating wave behaviors, which makes it a foundational concept in understanding wave interactions in various physical contexts.

8. How do gases behave according to the laws of pressure and volume?

A. They expand and contract based on temperature changes

B. They remain unaffected by temperature changes

C. They eliminate the need for thermal energy

D. They have a constant volume regardless of temperature

Gases behave according to the laws of pressure and volume, specifically described by principles such as Boyle's Law and Charles's Law. The correct answer highlights that gases expand and contract based on temperature changes. This behavior is explained by the kinetic molecular theory, which states that as the temperature of a gas increases, the average kinetic energy of the gas molecules increases. This results in more vigorous movement and, consequently, either an increase in volume if the gas is allowed to expand or an increase in pressure if the gas is confined to a constant volume. Moreover, gases do not have a fixed volume; they occupy the volume of their container, which allows them to expand or compress in response to temperature changes. This adaptability is a defining feature of gases and is essential for understanding their behavior under different conditions. Other options suggest alternate behaviors that do not align with the fundamental principles governing gas laws. For instance, suggesting that gases remain unaffected by temperature changes contradicts the observed behavior of gases, as temperature directly influences their kinetic energy and overall dynamics. Similarly, the idea of eliminating the need for thermal energy or having a constant volume regardless of temperature does not accurately reflect how gases interact with temperature changes. Hence, the chosen statement correctly encapsulates the fundamental behavior of gases

9. Which element is most commonly associated with nuclear fusion reactions in stars?

A. Uranium

B. Hydrogen

C. Carbon

D. Helium

Hydrogen is the element most commonly associated with nuclear fusion reactions in stars because it serves as the primary fuel for the processes that power stars, including our sun. In the cores of stars, hydrogen nuclei (protons) collide with enough energy to overcome their electrostatic repulsion and fuse together. This fusion process primarily occurs through the proton-proton chain reaction or the CNO cycle, and it results in the formation of helium nuclei while releasing a tremendous amount of energy in the form of light and heat. This energy production is what creates the radiation that makes stars shine. Other elements, such as helium and carbon, play roles in later stages of stellar evolution or in specific types of stars, but hydrogen is the fundamental building block that initiates the process of fusion. Uranium, while important in nuclear fission reactions, is not typically involved in stellar nucleosynthesis in the same way hydrogen is.

10. What is a possible result of living tissue being ionised by radiation?

A. Cells may heal better

B. Cells may undergo genetic mutations

C. Cells may become larger

D. Cells may divide at a slower rate

Ionisation of living tissue by radiation can result in significant biological effects, one of which is the potential for genetic mutations. When radiation ionises atoms in the cells, it can disrupt molecular structures, particularly DNA. This disruption can lead to changes in the genetic material, resulting in mutations. Mutations can manifest in various ways, such as alterations in the function of genes, which may lead to uncontrolled cell division, cancer, or other genetic disorders. This risk of mutations is a considerable concern in fields like radiation therapy, where controlled radiation exposure is used to target cancer cells, as it also has the potential to damage healthy cells and DNA. In contrast, the other choices do not accurately describe common outcomes of ionisation by radiation. Cells healing better, becoming larger, or dividing at a slower rate are not direct consequences of radiation-induced ionisation and do not reflect the dangers associated with cellular damage at the molecular level.