HSC Physics Practice Exam (Sample)

Study Guide

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Questions

1. What component is typically found in a generator that allows current to be transferred outside of the device?

A. Slip rings or split ring commutator

B. Transformers

C. Inductors

D. Diodes

2. What physical property do X-rays and light waves share?

A. Both are longitudinal waves

B. Both can travel in a vacuum

C. Both are forms of matter

D. Both require a medium to propagate

3. What is the purpose of a shield wire in transmission lines?

A. To enhance signal strength

B. To protect against lightning strikes

C. To stabilize voltage

D. To increase current flow

4. What phenomenon occurs when a wave spreads into the geometric shadow of an object?

A. Refraction.

B. Interference.

C. Diffraction.

D. Reflection.

5. Which type of orbit allows a satellite to appear stationary above the same point on Earth?

A. Geostationary orbits

B. Polar orbits

C. Elliptical orbits

D. Inclined orbits

6. What phenomenon describes the apparent contraction of an object's length in the direction of motion as observed by a stationary observer?

A. Mass dilation

B. Length contraction

C. Time dilation

D. Relative motion

7. What is defined as the distance that light travels in a vacuum in 1/299792458 of a second?

A. Light-year

B. Metre

C. Kilometre

D. Second

8. How does sympathetic vibration occur within a system?

A. At equal frequencies to the natural frequency

B. At varying frequencies below natural frequency

C. At fixed amplitudes regardless of frequency

D. At multiple harmonics of the natural frequency

9. What is the term for the various techniques used to create internal images of the human body?

A. Scanning

B. Imaging

C. Diagnosis

D. Inspection

10. What equation relates energy and frequency for a photon?

A. $E=mc^2$

B. $E=hf$

C. $E=mg$

D. $E=kT$

Answers

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

Explanations

1. What component is typically found in a generator that allows current to be transferred outside of the device?

A. Slip rings or split ring commutator

B. Transformers

C. Inductors

D. Diodes

The component found in a generator that allows current to be transferred outside of the device is slip rings or a split ring commutator. These components are crucial because they facilitate the continuous transfer of electrical power from the rotating part of the generator, often referred to as the rotor, to an external circuit without physical contact being lost. Slip rings are used in AC generators to enable a smooth and constant transfer of alternating current. They allow the electrical connection to remain stable as the rotor spins. The design of slip rings ensures that the brushes maintain contact with the rings, allowing the induced current to flow to the output. On the other hand, if a generator uses a split ring commutator, it converts the alternating current generated within the coils into direct current suitable for use in many applications. This component periodically reverses the connection, ensuring that the current flows in one direction to the external circuit. The other components listed, such as transformers, inductors, and diodes, serve different functions in electrical systems. Transformers are used to change voltage levels, inductors store energy in a magnetic field, and diodes allow current to flow in only one direction, but they do not facilitate the direct transfer of current from the generator. Thus, the slip rings or split

2. What physical property do X-rays and light waves share?

A. Both are longitudinal waves

B. Both can travel in a vacuum

C. Both are forms of matter

D. Both require a medium to propagate

X-rays and light waves both belong to the electromagnetic spectrum, which encompasses a range of electromagnetic radiation, and one key characteristic they share is that they can travel through a vacuum. This ability is due to their nature as transverse waves and the fact that they do not rely on a medium for propagation, differentiating them from mechanical waves such as sound. This property enables both X-rays and light to travel through the emptiness of space, which is crucial for applications such as astronomical observations and medical imaging. In contrast, the other options incorrectly describe the nature of X-rays and light waves. They are not longitudinal waves; rather, they are transverse waves. They are also not forms of matter, as they are forms of energy. Additionally, they do not require a medium to propagate, which makes them unique compared to mechanical waves that need a material substance to transmit energy.

3. What is the purpose of a shield wire in transmission lines?

A. To enhance signal strength

B. To protect against lightning strikes

C. To stabilize voltage

D. To increase current flow

The purpose of a shield wire in transmission lines is primarily to protect against lightning strikes. In high-voltage transmission systems, shield wires are typically placed above the main conductors. Their role is to intercept and safely conduct lightning strikes to the ground, thereby preventing damage to the conductors and the equipment connected to the transmission line. By providing a direct path for lightning currents to follow, the shield wire helps to minimize the chances of flashover and equipment failure, which could result from a direct lightning strike to the transmission line. In this context, the other options do not align with the primary purpose of the shield wire. While enhancing signal strength, stabilizing voltage, or increasing current flow are all important factors in electrical transmission, they are not functions served by shield wires. Instead, the shield wire's protective role is crucial in ensuring the safety and reliability of the transmission system.

4. What phenomenon occurs when a wave spreads into the geometric shadow of an object?

A. Refraction.

B. Interference.

C. Diffraction.

D. Reflection.

The phenomenon that occurs when a wave spreads into the geometric shadow of an object is known as diffraction. This behavior is characteristic of waves, including sound waves, light waves, and water waves, allowing them to bend around obstacles and fill areas that are not in direct line with the wave source. When waves encounter an obstacle, if the size of the obstacle is comparable to the wavelength of the wave, the waves will not simply travel in straight lines but will instead bend around the edges of the obstacle and continue into the shadowed region. This results in a spreading pattern that can be observed, demonstrating the wave nature of the phenomenon. The other options relate to different wave interactions: refraction involves the bending of waves as they pass from one medium to another with different densities, interference refers to the effect that occurs when two or more waves overlap and combine, and reflection occurs when waves bounce off a surface. None of these processes specifically describe the spreading of waves into a shadowed area, which is uniquely defined by diffraction.

5. Which type of orbit allows a satellite to appear stationary above the same point on Earth?

A. Geostationary orbits

B. Polar orbits

C. Elliptical orbits

D. Inclined orbits

A geostationary orbit allows a satellite to appear stationary above the same point on Earth because it matches the Earth's rotation period. This orbit is situated at an altitude of approximately 35,786 kilometers above the equator, allowing the satellite to move in sync with the Earth's rotation, completing one orbit in exactly 24 hours. As a result, observers on the ground see the satellite continually in the same position in the sky, making it ideal for communication satellites. Polar, elliptical, and inclined orbits do not provide this stationary effect. A polar orbit passes over the poles, allowing the satellite to cover the entire Earth over time, while elliptical orbits have varying distances from the Earth, leading to changing positions in the sky relative to the surface. Inclined orbits are tilted relative to the equator and do not maintain a fixed position over a point on the Earth. Thus, the unique properties of geostationary orbits enable the satellite's stationary appearance relative to the Earth's surface.

6. What phenomenon describes the apparent contraction of an object's length in the direction of motion as observed by a stationary observer?

A. Mass dilation

B. Length contraction

C. Time dilation

D. Relative motion

The phenomenon that describes the apparent contraction of an object's length in the direction of motion, as perceived by a stationary observer, is indeed length contraction. This effect is a fundamental aspect of Einstein's theory of special relativity. According to this theory, as an object moves closer to the speed of light, it appears to shorten in length along the direction of its motion from the perspective of an observer who is not moving with the object. Length contraction occurs because the laws of physics are the same for all observers regardless of their relative speeds. When an object approaches relativistic speeds (close to the speed of light), time appears to pass slower for that object from the perspective of the stationary observer, which factors into how distance is perceived. This results in a measurable contraction of length along the direction of motion. The other concepts, such as mass dilation and time dilation, relate to different effects observed in relativistic physics, but do not describe the contraction of length. Mass dilation refers to how an object's mass appears to increase with speed, while time dilation involves the differing passage of time as observed from different reference frames. Relative motion is a broader term that encompasses the movement of objects concerning one another, rather than a specific effect like length contraction.

7. What is defined as the distance that light travels in a vacuum in 1/299792458 of a second?

A. Light-year

B. Metre

C. Kilometre

D. Second

The definition provided in the question refers specifically to the metre. In the International System of Units (SI), the metre is defined as the distance light travels in a vacuum in precisely 1/299792458 of a second. This definition integrates the speed of light into the measurement of distance, thereby establishing the metre as a fundamental unit based on a universal constant. Understanding this definition is essential because it illustrates how the concept of distance is closely tied to the speed of light, which is a critical constant in physics. While a light-year is also a measure of distance that is based on the speed of light, it corresponds to the distance light travels in one year, not in a fraction of a second. The kilometre, being a larger unit of distance, is defined as 1,000 metres, and a second is a unit of time, not distance. Thus, this context reinforces why the metre is the correct answer.

8. How does sympathetic vibration occur within a system?

A. At equal frequencies to the natural frequency

B. At varying frequencies below natural frequency

C. At fixed amplitudes regardless of frequency

D. At multiple harmonics of the natural frequency

Sympathetic vibration occurs when an external force or vibration frequency matches the natural frequency of a system. When this happens, the system is able to absorb energy efficiently, resulting in an increase in amplitude of the oscillating system. This phenomenon is often observed in musical instruments, where one vibrating string can cause another string with the same natural frequency to vibrate as well, even if it is not directly struck. The concept of natural frequency is critical because it represents the frequency at which a system naturally oscillates. When the frequencies align, the system reaches resonance, leading to significant energy transfer and enhanced vibration. This is why the choice highlighting equal frequencies to the natural frequency is correct; it precisely describes the condition under which sympathetic vibration occurs. On the other hand, varying frequencies below the natural frequency, fixed amplitudes regardless of frequency, and multiple harmonics do not align with the conditions necessary for sympathetic vibration. Those factors might influence other types of resonance or wave behaviors, but they do not create the specific effect of sympathetic vibration.

9. What is the term for the various techniques used to create internal images of the human body?

A. Scanning

B. Imaging

C. Diagnosis

D. Inspection

The term that best represents the various techniques used to create internal images of the human body is imaging. These techniques encompass a wide range of technologies such as X-rays, MRI (Magnetic Resonance Imaging), CT (Computed Tomography) scans, and ultrasound. Each of these methods allows healthcare professionals to visualize internal structures, assess conditions, and plan treatments by providing detailed images of organs, tissues, and other components of the body. While scanning could refer to specific methods of capturing these images, imaging is the more encompassing term that includes the entire suite of techniques and technologies used in this field. Diagnosis pertains to the process of determining diseases or conditions based on the images obtained but does not describe the imaging techniques themselves. Inspection is a more general term that may refer to visual examination and does not specifically relate to the advanced technologies used to generate internal body images.

10. What equation relates energy and frequency for a photon?

A. $E=mc^2$

B. $E=hf$

C. $E=mg$

D. $E=kT$

The relationship between energy and frequency for a photon is described by the equation $E = hf$, where E represents the energy of the photon, h is Planck's constant (a fundamental constant in quantum mechanics approximately equal to $6.626 \times 10^{-34} \, \text{Js}$), and f is the frequency of the photon. This equation shows that the energy of a photon is directly proportional to its frequency, meaning that as the frequency increases, the energy of the photon also increases. This principle is a cornerstone of quantum mechanics and helps explain phenomena such as the photoelectric effect, which demonstrated that light can impart energy to electrons depending on its frequency. The other choices do not pertain to the relationship between energy and frequency in the context of photons. For example, $E = mc^2$ expresses the equivalence of mass and energy, while $E = mg$ relates energy to mass under the influence of gravity. $E = kT$ describes the relationship between energy and temperature in thermodynamics but is not relevant to photons. These equations are important in their respective areas of physics but do not describe the specific energy-frequency relationship critical to understanding photon behavior.