# SQA Higher Physics Practice Exam Sample Study Guide

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# Questions

1. **According to Newton's second law, which equation expresses the relationship between force, mass, and acceleration?**

   A. F = ma

   B. F = mv

   C. F = m/a

   D. $F = m^2a$

2. **In which type of collision is kinetic energy lost?**

   A. Elastic collision

   B. Perfectly inelastic collision

   C. Inelastic collision

   D. Superelastic collision

3. **In which scenario does redshift primarily occur?**

   A. When an object is approaching the observer

   B. When an object is stationary

   C. When an object is moving away from the observer

   D. When an object is moving at constant velocity

4. **How is wave speed defined?**

   A. As the change in frequency over time.

   B. As the distance a wave travels per unit time.

   C. As the amount of energy carried by a wave.

   D. As the amplitude of the wave times the frequency.

5. **In a semiconductor, what is the significance of the conduction band being partially filled?**

   A. It prevents electrical flow

   B. It allows for conduction under certain conditions

   C. It provides insulation

   D. It contains trapped holes

**6. Which law states that the total momentum before a collision equals the total momentum after a collision in the absence of external forces?**

- **A. Newton's First Law**
- **B. Law of Conservation of Momentum**
- **C. Newton's Second Law**
- **D. Impulse-Momentum Theorem**

**7. Under what condition does total internal reflection occur?**

- **A. When the wave passes from a denser medium to a less dense medium at any angle.**
- **B. When a wave hits a boundary at an angle equal to the critical angle.**
- **C. When a wave strikes a boundary at an angle greater than the critical angle.**
- **D. When light waves travel through a vacuum.**

**8. What is thermal equilibrium?**

- **A. A condition where no heat transfers occur between bodies**
- **B. A state of different temperatures in thermal contact**
- **C. A state where one body is cooler than the other**
- **D. A condition where bodies reach different heat capacities**

**9. In the context of particle physics, what do leptons NOT include?**

- **A. Electrons**
- **B. Neutrinos**
- **C. Quarks**
- **D. Muons**

**10. Which elementary particles combine to form protons and neutrons?**

- **A. Electrons**
- **B. Neutrinos**
- **C. Quarks**
- **D. Photons**

# Answers

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

# Explanations

**1. According to Newton's second law, which equation expresses the relationship between force, mass, and acceleration?**

**A. F = ma**

**B. F = mv**

**C. F = m/a**

**D. F = $m^2$a**

**Newton's second law states that the force acting on an object is equal to the mass of that object multiplied by its acceleration. This fundamental principle can be mathematically represented by the equation F = ma, where F denotes force, m denotes mass, and a denotes acceleration. This equation emphasizes the direct proportionality between force and acceleration for a given mass, illustrating that increased force results in increased acceleration, while a constant force will produce a smaller acceleration for larger masses. This relationship is crucial for understanding how objects move and interact under various forces in both classical and applied physics scenarios.**

**2. In which type of collision is kinetic energy lost?**

**A. Elastic collision**

**B. Perfectly inelastic collision**

**C. Inelastic collision**

**D. Superelastic collision**

**In an inelastic collision, some portion of the kinetic energy of the system is transformed into other forms of energy, such as heat, sound, or internal energy, during the collision process. This is a defining characteristic of inelastic collisions, where the objects involved may stick together or deform, indicating that kinetic energy is not conserved. While momentum is conserved in both elastic and inelastic collisions, kinetic energy conservation occurs only in elastic collisions. In the case of perfect inelastic collisions, the two colliding objects stick together after impact, resulting in a significant loss of kinetic energy. However, since "inelastic collision" encompasses both cases where energy is lost and situations where the objects may still separate (but are still not conserving kinetic energy), it is appropriately answered as inelastic collision since it broadly indicates situations where kinetic energy is lost. The terms in the other options refer to scenarios where kinetic energy is conserved or altered in predictable ways that do not fit the definition of kinetic energy loss. Therefore, the classification of inelastic collisions captures the essence of kinetic energy loss correctly.**

## 3. In which scenario does redshift primarily occur?

- A. When an object is approaching the observer
- B. When an object is stationary
- C. When an object is moving away from the observer
- D. When an object is moving at constant velocity

Redshift primarily occurs when an object is moving away from the observer. This phenomenon is a consequence of the Doppler effect, which describes how the frequency of waves changes in relation to an observer who is moving relative to the source of the waves. As an object moves away, the wavelengths of light emitted by that object are stretched, resulting in a shift towards the red end of the electromagnetic spectrum. This effect is particularly evident in astronomy, where light from distant galaxies is often redshifted, indicating they are receding from us. This observation supports the expansion of the universe, as most galaxies appear to be moving away from our point of view. Thus, the correct answer highlights the relationship between the motion of distant objects and the observed shift in their light spectrum.

## 4. How is wave speed defined?

- A. As the change in frequency over time.
- B. As the distance a wave travels per unit time.
- C. As the amount of energy carried by a wave.
- D. As the amplitude of the wave times the frequency.

Wave speed is defined as the distance a wave travels per unit time. This definition emphasizes the relationship between distance and time, allowing us to quantify how quickly a wave propagates through a medium. The wave speed can be calculated using the formula: Wave speed = Distance / Time This relationship shows that for a given distance, the time taken for the wave to travel that distance is critical in determining the speed. Understanding wave speed is essential in various contexts, including sound waves, light waves, and water waves, as it helps in predicting how waves will move through different environments. The other definitions provided do not accurately capture the essence of wave speed. Change in frequency over time relates to wave phenomena but not directly to how fast the wave travels. The energy carried by a wave pertains to its intensity and amplitude but does not define speed. Meanwhile, the amplitude multiplied by frequency refers to a different characteristic related to wave properties but does not describe the wave's travel speed. Thus, defining wave speed as the distance a wave travels per unit time is both concise and correct, aligning it properly within the framework of wave physics.

**5. In a semiconductor, what is the significance of the conduction band being partially filled?**

**A. It prevents electrical flow**

**B. It allows for conduction under certain conditions**

**C. It provides insulation**

**D. It contains trapped holes**

**The significance of a partially filled conduction band in a semiconductor lies in its ability to facilitate electrical conduction under certain conditions. In a semiconductor, the conduction band represents the energy levels available for electrons to move freely and carry an electric current. When the conduction band is partially filled, there are available energy states for electrons to occupy. This means that some electrons can move to higher energy levels and participate in conduction, especially when energy is provided (for example, through thermal excitation or doping). This characteristic distinguishes semiconductors from insulators, where the conduction band is completely empty, and metals, where it is fully filled. Moreover, the ability for electrons to gain energy and transition to these available states allows for increased conductivity with temperature or through the introduction of impurities (doping), making semiconductors versatile materials for electronic applications.**

**6. Which law states that the total momentum before a collision equals the total momentum after a collision in the absence of external forces?**

**A. Newton's First Law**

**B. Law of Conservation of Momentum**

**C. Newton's Second Law**

**D. Impulse-Momentum Theorem**

**The Law of Conservation of Momentum is a fundamental principle in physics that asserts that the total momentum of a closed system remains constant if no external forces act upon it. This means that when two or more objects collide, the momentum they had before the collision will equal the momentum they have after the collision. This principle is foundational in analyzing collision events in various contexts, whether in one dimension or multiple dimensions. In a practical sense, this law allows us to predict the outcomes of collisions by equating the total momenta of the objects involved before the collision to the total momenta after. For example, if two ice skaters push off each other, the momentum they have before they push off (which is essentially zero if they are initially at rest) will equal the momentum they have after they push apart, maintaining the overall momentum of the system. The other options pertain to different principles. Newton's First Law involves inertia and the motion of objects when no net external force is applied. Newton's Second Law relates force, mass, and acceleration, encapsulated in the formula F=ma. The Impulse-Momentum Theorem connects impulse with the change in momentum of an object, which can be derived from the Law of Conservation of Momentum, but it does not**

## 7. Under what condition does total internal reflection occur?

A. When the wave passes from a denser medium to a less dense medium at any angle.

B. When a wave hits a boundary at an angle equal to the critical angle.

C. When a wave strikes a boundary at an angle greater than the critical angle.

D. When light waves travel through a vacuum.

**Total internal reflection occurs when a wave, particularly light, travels from a medium with a higher refractive index (denser) to a medium with a lower refractive index (less dense) and strikes the boundary at an angle greater than the critical angle. At this angle, the wave cannot transmit into the less dense medium and instead reflects completely back into the denser medium. This phenomenon is crucial in applications such as optical fibers and prisms, where it facilitates the efficient transmission of light. The critical angle is the specific angle of incidence at which the refracted light would emerge along the boundary between the two media. If the angle of incidence exceeds this critical angle, total internal reflection takes place, preserving the energy of the wave within the denser medium. In contrast, when the wave passes from a denser medium to a less dense medium at any angle, it may partially reflect and partially refract without achieving total internal reflection. Similarly, hitting a boundary at the critical angle will result in some light refracting along the boundary rather than being entirely reflected. Lastly, waves traveling through a vacuum do not involve a boundary between two different media, so the concept of total internal reflection does not apply in that context.**

## 8. What is thermal equilibrium?

A. A condition where no heat transfers occur between bodies

B. A state of different temperatures in thermal contact

C. A state where one body is cooler than the other

D. A condition where bodies reach different heat capacities

**Thermal equilibrium refers to the condition in which two or more bodies in thermal contact cease to exchange heat, meaning that there is no net flow of thermal energy between them. This occurs when the temperatures of the interacting bodies equalize, resulting in a uniform temperature throughout the system. At this point, while the bodies are still in contact, they have reached a state where the energy transfer has balanced out, leading to no heat transfer. The other choices describe scenarios that do not align with the definition of thermal equilibrium. When bodies are at different temperatures and in thermal contact, heat will naturally flow from the warmer body to the cooler one until equilibrium is achieved. Moreover, the mention of different heat capacities is irrelevant to the condition of thermal equilibrium; it refers instead to the amount of heat energy required to change the temperature of those bodies, which does not affect whether they are in equilibrium or not.**

## 9. In the context of particle physics, what do leptons NOT include?

A. Electrons

B. Neutrinos

C. Quarks

D. Muons

**Leptons are a specific category of fundamental particles in particle physics that include electrons, muons, and neutrinos. They are characterized by not participating in strong interactions, which is a key feature that distinguishes them from other particles such as quarks. Quarks, on the other hand, do participate in strong interactions and are the building blocks of protons and neutrons. Therefore, in the context of particle physics, quarks are not classified as leptons. This differentiation is crucial to understanding the classification of particles in the Standard Model of particle physics, where each particle's interaction properties define its category.**

## 10. Which elementary particles combine to form protons and neutrons?

A. Electrons

B. Neutrinos

C. Quarks

D. Photons

**Protons and neutrons, which are collectively known as nucleons, are composed of fundamental particles called quarks. Quarks come in different types or "flavors," which are up, down, charm, strange, top, and bottom. A proton is made up of three quarks: two up quarks and one down quark, while a neutron consists of one up quark and two down quarks. The interactions between quarks are governed by the strong force, which is mediated by particles known as gluons. This combination of quarks is essential for the formation of protons and neutrons, making quarks the correct choice in the context of this question. Other particles like electrons, neutrinos, and photons do not combine to form protons and neutrons. Instead, electrons are elementary particles that are part of atoms but do not contribute to the mass of nucleons. Neutrinos are very light particles that interact very weakly with matter and do not contribute to the structure of protons and neutrons either. Photons are particles of light and are responsible for electromagnetic interactions but are not involved in the composition of protons or neutrons. This context helps clarify why quarks are the elemental building blocks in question.**