NCEA Level 3 Physics – Mechanics Practice Exam (Sample)

Study Guide

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Questions

1. When an object moves in a circle at constant speed, what type of acceleration does it experience?

A. Centripetal acceleration

B. Linear acceleration

C. Angular acceleration

D. Rotational acceleration

2. What is the term for the maximum displacement of an oscillating object from its rest position?

A. Amplitude

B. Frequency

C. Wavelength

D. Period

3. What is the relationship between work and movement?

A. Work requires force without movement

B. Work occurs during any movement

C. Work is done when force causes movement

D. No work is done if there is no force

4. How are mass and weight related?

A. Weight is independent of mass

B. Weight is the force of gravity on an object, W = mg

C. Mass and weight are the same quantity

D. Weight is always constant regardless of location

5. What does non-uniform velocity indicate about an object's motion?

A. The object maintains a constant speed in a straight line.

B. The object covers equal distances in equal intervals of time.

C. The object changes speed or direction in equal intervals of time.

D. The object moves at a fluctuating speed.

6. What effect does increasing the distance of mass from the axis of an object's rotation have?

A. It decreases the moment of inertia

B. It has no effect on moment of inertia

C. It increases the moment of inertia

D. It creates angular acceleration

7. What distinguishes scalar quantities from vector quantities?

A. Scalars have only direction

B. Vectors have only magnitude

C. Scalars have only magnitude

D. Vectors have no magnitude

8. The distance covered by an object in one unit of time is referred to as its:

A. Velocity

B. Speed

C. Acceleration

D. Displacement

9. Which scenario represents circular motion?

A. A car accelerating in a straight line

B. A satellite orbiting the Earth

C. A ball rolling down a hill

D. A person walking on a flat surface

10. What property describes an object's resistance to changes in its state of motion?

A. Mass

B. Inertia

C. Momentum

D. Velocity

Answers

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

Explanations

1. When an object moves in a circle at constant speed, what type of acceleration does it experience?

A. Centripetal acceleration

B. Linear acceleration

C. Angular acceleration

D. Rotational acceleration

When an object moves in a circle at a constant speed, it experiences centripetal acceleration. This type of acceleration occurs due to the continuous change in the direction of the velocity vector of the object as it travels along the circular path. Centripetal acceleration is directed towards the center of the circle at all times, ensuring that the object remains in circular motion. Although the speed of the object remains constant, its velocity changes because velocity is a vector quantity that depends on both the speed and direction of the object's motion. In contrast, linear acceleration refers to a change in the speed or direction of motion in a linear path, which does not apply when an object is moving uniformly in a circle. Angular acceleration relates to the rate of change of angular velocity in rotational motion, relevant for objects changing their rotational speed. Rotational acceleration is a broader term that generally encompasses angular acceleration but is not specific to circular motion at constant speed. Thus, centripetal acceleration is the most accurate description of the object's situation.

2. What is the term for the maximum displacement of an oscillating object from its rest position?

A. Amplitude

B. Frequency

C. Wavelength

D. Period

The term for the maximum displacement of an oscillating object from its rest position is "amplitude." Amplitude describes how far the object moves from its equilibrium position during oscillation, whether it is a swinging pendulum, a vibrating string, or any other oscillating system. It is an important characteristic of oscillatory motion as it relates to the energy of the system—larger amplitudes usually indicate greater energy. Frequency refers to how many complete cycles of oscillation occur in a unit of time, and wavelength pertains to the distance between successive crests or troughs in a wave. The period is the time it takes to complete one full cycle of oscillation. While frequency, wavelength, and period are all important parameters in oscillatory and wave phenomena, they do not directly define displacement from the equilibrium position, which is specifically what amplitude represents.

3. What is the relationship between work and movement?

A. Work requires force without movement

B. Work occurs during any movement

C. Work is done when force causes movement

D. No work is done if there is no force

The concept of work in physics is defined as the amount of energy transferred by a force acting through a distance. Specifically, work is done when a force causes an object to move in the direction of that force. This means that both components – the application of force and the movement of the object – must be present for work to occur. In the context of the correct answer, when a force is applied to an object and it moves as a result, work is done on that object. For example, if you push a box across the floor, you are applying a force, and the movement of the box in the direction of that force means that you have done work on the box. Understanding this relationship helps clarify why other ideas, such as work occurring during any movement or work being defined by force alone without movement, do not hold true. Work specifically requires the interaction of force resulting in displacement. Therefore, whenever force and movement are in play, work is indeed being done, reinforcing the validity of the correct answer.

4. How are mass and weight related?

A. Weight is independent of mass

B. Weight is the force of gravity on an object, W = mg

C. Mass and weight are the same quantity

D. Weight is always constant regardless of location

Weight is fundamentally defined as the force of gravity acting on an object's mass. The relationship is encapsulated in the equation $W = mg$, where W represents weight, m stands for mass, and g is the acceleration due to gravity. This equation shows that weight is directly proportional to mass—meaning that if you increase the mass of an object, its weight will also increase accordingly, assuming the gravitational field strength remains constant. In the context of different locations, while mass remains constant regardless of where you are in the universe, weight can vary depending on the strength of the gravitational field at that location. For instance, an object weighs less on the Moon than on Earth due to the Moon's weaker gravitational pull. Understanding this relationship is crucial in mechanics, as it helps to distinguish between mass, a measure of the amount of matter in an object, and weight, which is the gravitational force acting upon that mass. This distinction is essential in various applications in physics, including problems involving free fall, orbits, and other gravitational interactions.

5. What does non-uniform velocity indicate about an object's motion?

A. The object maintains a constant speed in a straight line.

B. The object covers equal distances in equal intervals of time.

C. The object changes speed or direction in equal intervals of time.

D. The object moves at a fluctuating speed.

Non-uniform velocity indicates that an object is experiencing changes in either its speed or direction, or both, as it moves. This means that over equal intervals of time, the object does not maintain a constant speed or trajectory. Instead, it may be accelerating or decelerating, or it could be changing its direction while maintaining a particular speed. In the context of the choices provided, non-uniform velocity encapsulates scenarios in which the object's motion is not uniform, which means that the motion is variable. The correct understanding of this concept is crucial for analyzing situations in mechanics where forces and motion are involved, especially when studying concepts like acceleration and resultant forces. In comparison to the other options: - The notion of maintaining a constant speed in a straight line refers to uniform velocity. - Covering equal distances in equal time intervals also describes uniform motion, which contradicts the idea of non-uniformity. - Fluctuating speed would suggest variability, but it does not explicitly incorporate changes in direction, which is a key element of non-uniform velocity. Thus, the most comprehensive definition is that non-uniform velocity involves changes in speed or direction over equal intervals of time.

6. What effect does increasing the distance of mass from the axis of an object's rotation have?

A. It decreases the moment of inertia

B. It has no effect on moment of inertia

C. It increases the moment of inertia

D. It creates angular acceleration

Increasing the distance of mass from the axis of an object's rotation leads to an increase in the moment of inertia. The moment of inertia is a measure of an object's resistance to changes in its rotational motion and depends on both the mass of the object and the distribution of that mass relative to the axis of rotation. Specifically, the moment of inertia (I) is calculated using the formula $I = \sum m_i r_i^2$, where m_i is the mass of each point in the object and r_i is the distance of that mass from the axis of rotation. As the distance (r) increases, the value of r^2 increases, which results in a higher moment of inertia. This means that as mass is moved further from the axis, the object becomes more difficult to rotate. Therefore, it fundamentally increases the moment of inertia. This concept is crucial in understanding how objects behave when subjected to rotational forces and is vital in fields such as engineering and physics. The other options do not accurately represent the relationship between distance from the axis and moment of inertia, as increasing the distance cannot decrease the moment of inertia or have no effect on it, nor does it directly create angular acceleration, which

7. What distinguishes scalar quantities from vector quantities?

A. Scalars have only direction

B. Vectors have only magnitude

C. Scalars have only magnitude

D. Vectors have no magnitude

Scalar quantities are characterized by having only magnitude, meaning they can be fully described by a numerical value and a unit, without any consideration of direction. Examples of scalar quantities include temperature, mass, and speed. For instance, a speed of 60 kilometers per hour tells us how fast an object is moving, but not the direction of motion. In contrast, vector quantities include both magnitude and direction. For example, velocity is a vector because it specifies both the speed of an object and the direction in which it is moving. Therefore, distinguishing scalar quantities as having only magnitude is crucial for understanding the foundational principles of physics, especially when analyzing forces, motion, and other physical phenomena where direction plays a significant role. This understanding lays the groundwork for more advanced topics such as vector addition and resolution.

8. The distance covered by an object in one unit of time is referred to as its:

A. Velocity

B. Speed

C. Acceleration

D. Displacement

The distance covered by an object in one unit of time is referred to as its speed. Speed is defined as the rate at which an object moves and signifies how much distance is traveled per unit of time, typically measured in meters per second (m/s). It is a scalar quantity, meaning it only has magnitude and no direction. When considering the other terms: velocity differs from speed in that it includes a direction component, making it a vector quantity. Acceleration refers to the rate of change of velocity over time, indicating how quickly an object is speeding up or slowing down. Displacement measures the shortest distance from the initial position to the final position and also accounts for direction. In summary, speed is specifically concerned with the distance traveled in a given timeframe, solidifying its role as the correct answer.

9. Which scenario represents circular motion?

A. A car accelerating in a straight line

B. A satellite orbiting the Earth

C. A ball rolling down a hill

D. A person walking on a flat surface

The scenario that represents circular motion is one where an object moves along a curved path that can be defined as a circle or part of a circle. A satellite orbiting the Earth is a perfect example of this. It travels in a path that continuously changes direction due to the gravitational pull from the Earth, which keeps it in a stable orbit. This constant change in direction while maintaining a constant distance from the center of the Earth is characteristic of circular motion. In this case, there are forces at play, primarily gravitational force, which ensures that the satellite does not move off into space or fall towards the Earth. The satellite is in a state of uniform circular motion if it travels at a constant speed around the Earth. The other scenarios describe linear or non-circular motion: the car accelerating in a straight line moves in a linear path; the ball rolling down a hill follows a curved path due to gravity but is not constricted to a circular track; and a person walking on a flat surface moves linearly as well. None of these scenarios involves the consistent radius and force dynamics inherent in circular motion like the satellite's orbit does.

10. What property describes an object's resistance to changes in its state of motion?

A. Mass

B. Inertia

C. Momentum

D. Velocity

The property that describes an object's resistance to changes in its state of motion is inertia. Inertia is a fundamental concept in physics, specifically rooted in Newton's first law of motion, which states that an object at rest will remain at rest and an object in motion will continue in motion with the same velocity unless acted upon by a net external force. Inertia is directly related to mass; the greater an object's mass, the greater its inertia. This means heavier objects require more force to change their state of motion compared to lighter ones. While mass itself quantifies how much matter is present in an object, inertia specifically refers to the effect of mass in resisting changes to motion. Momentum is the product of an object's mass and its velocity, and while it is related to motion, it does not directly measure resistance to changes in motion. Velocity describes the speed and direction of an object's movement but does not address how that object responds to applied forces. Therefore, inertia is the best term to encapsulate the idea of resistance to changes in an object's motion.