Class 9 Science Chapter 8: Force and Laws of Motion (Detailed Notes with Practice Questions and Numericals)

1. Introduction to Force

- **Force**: A push or pull on an object that changes or tends to change its state of rest or uniform motion.
  - **Examples**: Pushing a door to open it, pulling a rope in a tug-of-war.
- Effects of Force:
  - Force can change the speed of an object.
  - Force can change the direction of an object's motion.
  - Force can change the shape or size of an object.

Practice Questions:

1. Define force with examples.
2. What are the effects of force on an object?
3. How is force responsible for changes in the state of motion?

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2. Balanced and Unbalanced Forces

- **Balanced Forces**: When forces acting on an object are equal in magnitude and opposite in direction, and they cancel each other out.
  - **Example**: A book resting on a table experiences balanced forces of gravity and the normal force.

- **Unbalanced Forces**: When forces acting on an object are unequal, causing a change in its motion.
    - **Example**: Kicking a stationary football applies an unbalanced force, making the ball move.

Practice Questions:

1. Explain the difference between balanced and unbalanced forces with examples.
2. What happens to an object when balanced forces act on it?
3. What happens when unbalanced forces act on an object?

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3. Newton's First Law of Motion (Law of Inertia)

- **Law of Inertia**: An object remains at rest or in uniform motion unless acted upon by an unbalanced external force.
    - **Example**: A car moving at a constant speed will continue moving unless friction or another force slows it down.
- **Inertia**: The tendency of an object to resist any change in its state of motion or rest.
    - **Greater mass = Greater inertia.**

Practice Questions:

1. State Newton's First Law of Motion.
2. Why is Newton's First Law also called the "Law of Inertia"?
3. Explain with examples: How does mass affect the inertia of an object?

Numerical Problems:

1. A car at rest is pushed by a constant force and accelerates. After 5 seconds, its velocity is 10 m/s. Calculate the acceleration.

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4. Newton's Second Law of Motion

- **Second Law of Motion**: The acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass.
  Formula:

$$F = ma$$

  Where:

  - F = Force (in Newtons),
  - m = Mass (in kg),
  - a = Acceleration (in m/s²).

Practice Questions:

1. Write the mathematical form of Newton's Second Law.
2. How does the force applied to an object affect its acceleration?
3. A force of 20 N is applied to a 5 kg object. What is the acceleration produced?

Numerical Problems:

1. A 10 kg object is pushed with a force of 50 N. Calculate the acceleration.
2. If a car of mass 1000 kg accelerates at 2 m/s², what is the force applied to it?

5. Newton's Third Law of Motion

- **Third Law of Motion**: For every action, there is an equal and opposite reaction.
    - **Example**: When you jump, your legs push the ground backward (action), and the ground pushes you forward (reaction).

Practice Questions:

1. State Newton's Third Law of Motion.
2. Give two examples from daily life that demonstrate Newton's Third Law.
3. Explain how a rocket launches using Newton's Third Law.

Numerical Problems:

1. A gun fires a bullet of mass 0.05 kg with a velocity of 400 m/s. Calculate the recoil velocity of the gun, assuming its mass is 5 kg.

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6. Law of Conservation of Momentum

- **Momentum**: The product of an object's mass and velocity.
  Formula:

$$p = mv$$

  Where:

    - p = momentum (in kg·m/s),
    - m = mass (in kg),
    - v = velocity (in m/s).

- **Law of Conservation of Momentum**: The total momentum of a system of objects remains constant if no external forces act on it.
    - **Example**: In a collision between two objects, the total momentum before and after the collision is the same.

Practice Questions:

1. Define momentum. How is it calculated?
2. State the Law of Conservation of Momentum with an example.
3. How does the mass and velocity of an object affect its momentum?

Numerical Problems:

1. A 1.5 kg object moves with a velocity of 10 m/s. Find its momentum.
2. Two cars of masses 800 kg and 1200 kg move towards each other at velocities of 10 m/s and 5 m/s, respectively. Calculate the total momentum before the collision.

Important Formulas

1. Force:

$$F = ma$$

2. Momentum:

$$p = mv$$

3. Newton's Second Law:

$$F = ma$$

4. Law of Conservation of Momentum:

$$\text{Total Momentum Before} = \text{Total Momentum After}$$

Revision Notes

1. Force is a push or pull that can change the motion or shape of an object.
2. Newton's First Law explains the concept of inertia and how objects resist changes in their state of motion.
3. Newton's Second Law shows the relationship between force, mass, and acceleration.
4. Newton's Third Law states that every action has an equal and opposite reaction.
5. The Law of Conservation of Momentum explains that the total momentum in an isolated system remains constant during collisions.
