Class-7
Force and motion

Force

Definition: Force is a push or pull on an object that can change its state of rest or motion. It is measured in Newtons (N) and has both magnitude and direction, making it a vector quantity.
Types of Forces:
Contact Forces: Require physical contact, e.g., muscular force (pushing a door), frictional force (rubbing hands), normal force (book on table).
Non-Contact Forces: Act without touch, e.g., gravitational force (pulls objects towards Earth), magnetic force (attracts iron), electrostatic force (repels like charges).
Balanced and Unbalanced Forces: Balanced forces result in no change in motion (e.g., tug-of-war tie). Unbalanced forces cause acceleration or deceleration.
Deep Insight: Force is fundamental in Newton's First Law: An object at rest stays at rest, and an object in motion stays in motion at constant speed in a straight line unless acted upon by an unbalanced force (inertia).
Effects of Force
Change in Shape: Forces can deform objects, e.g., squeezing a rubber ball changes its shape due to elastic forces.
Change in Size: Compressing a spring reduces its length.
Change in Direction: A force can alter an object's path, e.g., kicking a football changes its direction.
Change in Speed: Applying force accelerates (speeds up) or decelerates (slows down) an object, e.g., brakes on a bicycle.
Deep Insight: These effects are governed by Newton's Second Law: Force (F) = Mass (m) × Acceleration (a), or F = ma. Acceleration is the rate of change of velocity, and velocity includes both speed and direction.
Motion and Its Types
Definition of Motion: Motion is the change in position of an object with respect to time. It can be described using distance, displacement, speed, velocity, and acceleration.
Types of Motion:
Linear Motion: Straight-line movement, e.g., a car on a highway.
Circular Motion: Movement in a circle, e.g., a spinning top or Earth orbiting the Sun.
Oscillatory Motion: Back-and-forth movement, e.g., a pendulum swing.
Random Motion: Irregular path, e.g., Brownian motion of particles in a liquid.
Deep Insight: Motion is relative; an object appears stationary if observed from a moving frame, like passengers in a train.

Speed, Velocity, and Acceleration
Speed: Distance traveled per unit time (scalar quantity), formula: Speed = Distance/Time. Units: m/s, km/h.
Velocity: Displacement per unit time (vector quantity), includes direction. Formula: Velocity = Displacement/Time.
Acceleration: Rate of change of velocity, formula: Acceleration = (Final Velocity - Initial Velocity)/Time. Units: m/s^2.
Deep Insight: Uniform motion has constant speed; non-uniform motion has changing speed. Acceleration can be positive (speeding up) or negative (slowing down, deceleration).
Friction and Gravity
Friction: Force opposing motion between surfaces in contact. Types: Static (prevents starting motion), Kinetic (opposes moving objects), Rolling (e.g., wheels on road).
Advantages and Disadvantages: Helps in walking, writing; disadvantages include wear and tear, energy loss.
Reducing Friction: Using lubricants, ball bearings, streamlining shapes.
Gravity: Force pulling objects towards Earth's center. Free fall: Objects fall at 9.8 m/s^2 acceleration (g) in vacuum.
Deep Insight: Friction converts kinetic energy to heat. Gravity is a non-contact force; weight = mass × gravity (W = mg).
Newton's Laws of Motion
First Law (Law of Inertia): Objects resist changes in motion. Inertia depends on mass; heavier objects have more inertia.
Second Law: F = ma; greater force or less mass increases acceleration.
Third Law: For every action, there's an equal and opposite reaction, e.g., rocket propulsion.
Deep Insight: These laws explain everyday phenomena like seatbelts preventing injury during sudden stops (inertia) and recoil of a gun.
Simple Machines and Force
Definition: Devices that make work easier by changing force direction, magnitude, or distance.
Examples: Lever (e.g., seesaw), pulley (e.g., flag hoist), inclined plane (ramp), wheel and axle (bicycle), screw, wedge.
Principle: Work input = Work output (ignoring friction); mechanical advantage = Load/Effort.
Deep Insight: Levers have fulcrum, effort, and load; types: Class 1 (seesaw), Class 2 (wheelbarrow), Class 3 (tweezers).
Applications and Importance
Forces and motion explain vehicles, sports, machinery, and natural phenomena like tides (gravitational pull of Moon).
Conservation of energy in motion: Kinetic energy ($KE = 1/2\ mv^2$) and potential energy ($PE = mgh$).
Deep Insight**: Momentum ($p = mv$) is conserved in collisions; impulse = change in momentum.
Key Formulas and Units
Force: $F = ma$ (N)
Speed: $v = d/t$ (m/s)
Velocity: $v = s/t$ (m/s)
Acceleration: $a = (v-u)/t$ (m/s^2)

Weight: W = mg (N)
KE: 1/2 mv² (J)
PE: mgh (J)
Momentum: p = mv (kg m/s)
Important Diagrams and Concepts
Force diagrams: Arrows showing magnitude and direction.
Distance-time graphs: Straight line for uniform speed, curved for acceleration.
Velocity-time graphs: Slope gives acceleration; area under curve gives displacement.
Deep Insight**: Vectors in motion: Resultant force determines net effect.
Exam Tips
Focus on definitions, examples, and applications.
Practice drawing diagrams and solving numerical problems.
Understand real-life examples: Why do astronauts float in space? (Microgravity).
Common mistakes: Confusing speed with velocity; forgetting units.
Important Questions for Exams (Class 7 Level)
Very Short Answer Questions (1-2 words or simple phrases)
What is force?
Name two types of contact forces.
What is the SI unit of force?
Define inertia.
What is the acceleration due to gravity on Earth?
Short Answer Questions (1-2 sentences)
Explain the difference between speed and velocity with an example.
State Newton's First Law of Motion.
How does friction help in walking?
Describe one effect of force on an object.
What is a simple machine? Give one example.
Long Answer Questions (Detailed explanations, 4-6 sentences)
Explain the three laws of motion with examples and their importance in daily life.
Describe the types of motion and give real-life examples for each. Also, explain how motion is relative.
Discuss the effects of force on objects. How are these effects related to Newton's Second Law?
What is friction? Explain its types, advantages, disadvantages, and methods to reduce it.
Define acceleration and explain how it differs from velocity. Use a velocity-time graph to illustrate uniform and non-uniform acceleration.