

1. Kinematics and Dynamics - Numbered list

1. The SI units include meter, kilogram, second, ampère, mole, kelvin, and candela.
2. **Vectors** are physical quantities that have both magnitude and direction. Vector quantities include displacement, velocity, acceleration, and force, among others.
3. **Scalars** are quantities without direction. Scalar quantities may be the magnitude of vectors, like speed, or may be dimensionless, like coefficients of friction.
4. Vector addition may be accomplished using the tip-to-tail method or by breaking a vector into its components and using the Pythagorean theorem.
5. Vector subtraction is accomplished by changing the direction of the subtracted vector and then following the procedures for vector addition.
6. Multiplying a vector by a scalar changes the magnitude and may reverse the direction.
7. Multiplying two vectors using the **dot product** results in a scalar quantity. The dot product is the product of the vectors' magnitudes and the cosine of the angle between them.
8. Multiplying two vectors using the **cross product** results in a vector quantity. The cross product is the product of the vectors' magnitudes and the sine of the angle between them. The right-hand rule is used to determine the resultant vector's direction.
9. **Displacement** is the vector representation of a change in position. It is path independent and is equivalent to the straight line distance between the start and end locations.
10. **Distance** is a scalar quantity that reflects the path traveled.
11. **Velocity** is the vector representation of the change in displacement with respect to time.
12. **Average velocity** is the total displacement divided by the total time.

13. **Average speed** is the total distance traveled divided by the total time.
14. **Instantaneous velocity** is the limit of the change in displacement over time as the change in time approaches zero.
15. **Instantaneous speed** is the magnitude of the instantaneous velocity vector.
16. A **force** is any push or pull that has the potential to result in an acceleration.
17. **Gravity** is the attractive force between two objects as a result of their masses.
18. **Friction** is a force that opposes motion as a function of electrostatic interactions at the surfaces of two objects.
19. **Static friction** exists between two objects that are not in motion relative to each other.
20. **Kinetic friction** exists between two objects that are in motion relative to each other.
21. Whereas static friction can take on many values depending on the magnitude of an applied force, kinetic friction is a constant value.
22. The **coefficient of friction** depends on the two materials in contact. The coefficient of static friction is always higher than the coefficient of kinetic friction.
23. Mass and weight are not synonymous.
24. **Mass** is a measure of the inertia of an object-its amount of material.
25. **Weight** is the force experienced by a given mass due to its gravitational attraction to the Earth.
26. **Acceleration** is the vector representation of the change in velocity over time. Average or instantaneous acceleration may both be considered, similar to velocity.
27. **Newton's first law**, or the **law of inertia**, states that an object will remain at rest or move with a constant velocity if there is no net force on the object.
28. **Newton's second law** states that any acceleration is the result of the sum of the forces acting on the object and its mass.
29. **Newton's third law** states that any two objects interacting with one another experience equal and opposite forces as a result of their interaction.

- 30. **Linear motion** includes free fall and motion in which the velocity and acceleration vectors are parallel or antiparallel.
- 31. **Projectile motion** contains both an x- and y-component. Assuming negligible air resistance, the only force acting on the object is gravity.
- 32. **Inclined planes** are another example of two-dimensional movement. It is often easiest to consider the dimensions as being parallel and perpendicular to the surface of the plane.
- 33. **Circular motion** is best thought of as having radial and tangential dimensions. In **uniform circular motion**, the only force is the centripetal force, pointing radially inward. The instantaneous velocity vector always points tangentially.
- 34. **Free body diagrams** are representations of the forces acting on an object. They are useful for equilibrium and dynamics problems.
- 35. **Translational equilibrium** occurs in the absence of any net forces acting on an object. An object in translational equilibrium has a constant velocity, and may or may not also be in rotational equilibrium.
- 36. **Rotational equilibrium** occurs in the absence of any net **torques** acting on an object. Rotational motion may consider any pivot point, but the center of mass is most common. An object in rotational equilibrium has a constant angular velocity; on the MCAT, the angular velocity is usually zero.