2011 USATF Coaching Education Level 2 Biomechanics
Fundamental Concepts Review

Mass –

Center of Mass –

Force –

Torque –

Displacement –

Velocity –

Acceleration –
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**Mass** – the amount of matter in an object

*Units:* Kilogram, ounce, slug

*In Formulas:* \( m \)

**Center of Mass** – an imagined “average” location of the mass in an object

*Shorthand:* CoM

**Force** – something that tends to change the state of motion of an object

*Units:* Newton, pound

*In Formulas:* \( F \)

**Torque** – a rotational force often seen as a linear force applied on a line away from the CoM

*Units:* Newton-Meters, foot-pounds

*In Formulas:* \( \tau \)

**Displacement** – change in position of an object described by the linear distance or angle between its initial and final positions and the direction from the initial position to the final position

*Units:* meters, feet, or radians, degrees

*In Formulas:* \( s \) or \( \theta \)

**Velocity** – the rate of change of displacement \( (\Delta s/\Delta t \text{ or } \Delta \theta/\Delta t) \)

*Units:* meters per second \( (m/s) \), mph, or radians per second, revolutions per minute \( (rpm) \)

*In Formulas:* \( v \) or \( \omega \)

**Acceleration** – the rate of change of velocity \( (\Delta v/\Delta t \text{ or } \Delta \omega/\Delta t) \)

*Units:* meters per second per second \( (m/s^2) \), or radians per second squared, degrees per second per second

*In Formulas:* \( a \) or \( \alpha \)
Newton’s (3) Laws of Motion

Moment of Inertia –

Momentum –

Impulse –
Newton’s (3) Laws of Motion

**Newton’s First Law** – an object will maintain a constant state of motion unless acted upon by an unbalanced external force.

**Newton’s Second Law** – an unbalanced force applied to an object will cause the object to accelerate at a rate directly proportional to the force and inversely proportional to the mass or moment of inertia of the object \((F=ma\ or \ \tau=I\alpha)\)

**Newton’s Third Law** – for every force exerted on an object, the object in turn exerts an equal force simultaneously in the opposite direction

**Moment of Inertia** – an object’s resistance to a change in its state of rotational motion determined by the mass of the object and its distribution relative to the axis of rotation

*In Formulas:  I*

**Momentum** – the product of an object’s mass or Moment of Inertia and velocity \((mv\ or \ I\omega)\)

*In Formulas:  p*

**Impulse** – something that changes an object’s momentum; the product of force or torque and time \((F\Delta t\ or \ \tau\Delta t)\)