26/2/2014
SSEH2250
Lecture 1 - Linear Motion

What is Biomechanics?

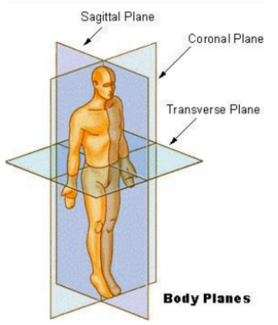
- Biomechanics: study of human movement using mechanics and applied anatomy
- It can be applied in 3 areas:
  - Sport: technique development, optimise performance and injury reduction
  - Clinical: rehabilitation, disease identification and prevention
  - Occupational: ergonomics, kinanthropometry (growth)

Learning Path for Skill

- Tactical
- Technical
- Physical
- Mental

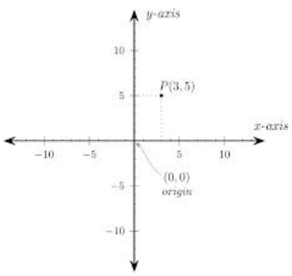
Deciding What Technique to Teach

1. Past experiences as a coach or player: cycling (aerodynamics vs. power)
2. Current world trends: two-hand vs. one-hand backhand
3. Individual flare of the athlete: Sandilands vs. Natanui
4. Mechanics of the movement: tension of tennis strings



Describing Position or Movement

Planes of Motion
- Sagittal: right and left
- Coronal (frontal): front and back
- Transverse: top and bottom



Cartesian Coordinate System (2D or 3D)
- x-axis and y-axis (z-axis if in 3D)

Basic Revision

- Scalars: quantities fully described by a magnitude or numerical value (direction unaware), e.g. 5m, 4000 calories
- Vectors: quantities described by **both** a magnitude and a direction (direction aware), e.g. 30m to the East

Linear Kinematics

- Description of motion along a line (trajectory or path)
  - Rectilinear or Curvilinear
- Factors: Displacement, Velocity and Acceleration

Displacement

$$\vec{\mathbf{d}} = s_2 - s_1 = \Delta s$$

where
Δ = change
s = position
d = displacement

- Displacement: the overall change in position (how far out of place)

Linear Velocity

- Time rate of change over displacement (m/s =m.s $^{-1}$)
- Speed: how fast an object is moving
- Velocity: the rate at which an object changes position

$$\vec{\mathbf{V}} = \frac{\Delta s}{t} = \frac{s_2 - s_1}{t} = \frac{\vec{\mathbf{d}}}{t}$$

Where
Δ s = change in position
t = time interval
d = displacement

Linear Acceleration

- Rate of change in velocity over time (m/s/s = m.s $^{-2}$)

$$\vec{\mathbf{a}} = \frac{\Delta\vec{\mathbf{v}}}{t} = \frac{\vec{\mathbf{V}}_2 - \vec{\mathbf{V}}_1}{t}$$

Where
Δ v = change in velocity
t = time interval
V_1= initial velocity
V_2= final velocity

Vertical Motion

- Constant acceleration acting against direction of travel (gravity)
- We neglect air resistance

$$\vec{\mathbf{a}}_y = -9.81$$

$$\vec{\mathbf{v}}_{2y} = \vec{\mathbf{a}}\Delta t + v_o; (\vec{\mathbf{v}}_{2y})^2 = 2\vec{\mathbf{a}}S + (v_o)^2$$

$$\vec{\mathbf{d}}_y = \frac{1}{2}\vec{\mathbf{a}}(\Delta t)^2 + \vec{\mathbf{v}}_o(\Delta t) + d_o$$

Where
V = Velocity; V_o = initial velocity
d = displacement; d_o= initial position
S = Position
Δt = change in time

Bringing it All Together

Horizontal (X)

$$\vec{\mathbf{d}}_x = S_2 - S_1$$

$$\vec{\mathbf{v}}_x = \frac{(S_2 - S_1)}{t}$$

$$\vec{\mathbf{a}}_x = \frac{(\vec{\mathbf{V}}_2 - \vec{\mathbf{V}}_1)}{t}$$

Vertical (Y)

$$\vec{\mathbf{a}}_y = -9.81$$

$$\vec{\mathbf{v}}_{2y} = \vec{\mathbf{a}}\Delta t + v_o$$

$$\vec{\mathbf{d}}_y = \frac{1}{2}\vec{\mathbf{a}}(\Delta t)^2 + \vec{\mathbf{v}}_o(\Delta t) + d_o$$

$$(\vec{\mathbf{v}}_{2y})^2 = 2\vec{\mathbf{a}}S + (v_o)^2$$

Equations of motion must be resolved to horizontal and vertical components

Trigonometry

$\sin\theta = \dfrac{Opp}{Hyp}$ $\cos\theta = \dfrac{Adj}{Hyp}$ $\tan\theta = \dfrac{Opp}{Adj}$