Biomechanics

Kinematics: Study of the description of motion.

E.g. Forms of *motion*

- Linear: straight or curved line

- Pure Linear Motion: All parts of body move the same distance, direction in the same time
  → Rectilinear: straight line
  → Curvilinear: curved line

- Angular: Body move in circular path → Axis of rotation

- General Motion: Combination of linear & angular motion

Kinetics: Study of the action of forces

Anthropometry: Measurement of dimensions & weights of body segments

Kinesiology: Study of human movement from the perspective of art & science

Basic Physics

Inertia: Tendency of an object to resist change in its motion
→ Inertia if directly proportional to mass

Force: Push/ Pull → F=ma

Weight Force- force due to gravity → w=m x 9.8 (on earth)

Pressure: Force per unit area → P=F/A

P = pressure in N.m-2
A = area in m2
F = force in N

Volume: Space occupied by an object → Litres (L) or Millilitres (mL)

Density: Mass per unit volume → P= m/v

P = density in kg.l-1 or g.ml-1
m = mass
v = volume

Torque: Turning effect of a force → T= F x d Units: Nm

Impulse: Force x time Units: Ns

Scalar: Magnitude (size) e.g. mass, volume, time, speed

Vector: Magnitude & direction e.g. displacement, velocity, force

→ Arrows have both magnitude & direction.

Head: direction *Tail*: Magnitude

Linear Kinematics

- Linear Kinematics involves study of shape, form, pattern (no ref to force)
- Linear motion: Straight line
- Translational motion: occurs in a straight line when all points on a body or an object moves the same distance over the same time

Distance & Displacement

- Distance (l): length between start & finish point (along a pathway from A → B)
- Scalar, Symbol = l (alternative symbol d), Units =m

- Displacement (d): straight line distance between a start and finish point with its direction indicated (straight from A → B)
- Vector, Symbol = d (alternative symbol is s), Units m (+ direction)

Speed & Linear Velocity

- Speed: rate at which a body moves from one location to another
- S= distance (l) / time (t)
- Scalar Units = m/s, ms-1, m.s-1

- Velocity: rate at which a body moves from one location to another in a given direction
- V= displacement (d) / time (t)
- Vector Symbol = v Units = m/s, ms-1, m.s-1 (+ direction)

Slope measured from tangent
slope = rise / run
= 5 m/ 3 s
= 0.1666 m.s-1

- The slope of a displacement – time curve is the derivative and represents the velocity

- If slope is steep means velocity is high b/w position changes
- If slope is flat means velocity is low b/w position changes

- If no change in position (no rise) then slope & velocity will = 0

- Usually a +ve or –ve value indicates the direction of travel

BUT actual interpretation depends on directional information

Problems

A soccer ball is kicked at a 35° angle with an initial speed at 12 ms-1. How high & how far does the ball go?

• A: What do we know:
– Release q = 35°
– Release speed (v) = 12 m s-1
– Release height = 0
– Acceleration = -9.81 ms-2

• B: What do we want to know:
1) How high does the ball go?
vertical height (s)
• Resolve release velocity into horizontal (x) and vertical (y) components

Vx = 12 x cos 35
= 12 x 0.819
= 9.83 ms-1

Vy = 12 x sin 35
= 12 x 0.574
= 6.88 ms-1**up**

Note – height is not dependent on the horizontal component (which is not influenced by gravity), but it is the vertical component that determines *max height* & this is influenced by gravity

• C: Find the right formula, re-arrange it and put in the values.
– To calculate vertical displacement (s)

Vf2 = vi2 + 2as
0 = 6.882 + 2 (-9.8) x s
0 = 6.882 -19.6 s
19.6s = 6.882
s = 6.882 / 19.6
= 2.41502 or 2.42 m

→ max height is 2.42 m above release point.

2. How far does the ball go?

- 1st Calculate time of flight
- Because release height is ZERO, time up = time down
→ Time of flight = 2 x time up

• A: What do we know:
Vy = 6.88 ms-1
Vf = 0
a = - 9.8 ms-2

• B: What do we want to know:
time up (tup) x 2
vf = vy + at
0 = 6.88 + (-9.8 x t)
9.8 t = 6.88
t = 6.88 / 9.8
t = 0.70 s

Solving horizontal distance
sx = vx x t
= 9.83 x 1.40 s
= 13.76 m

→ t of flight = 2 x 0.7
= 1.40 s

NOTE - Range is dependent on horizontal component which is not influenced by gravity