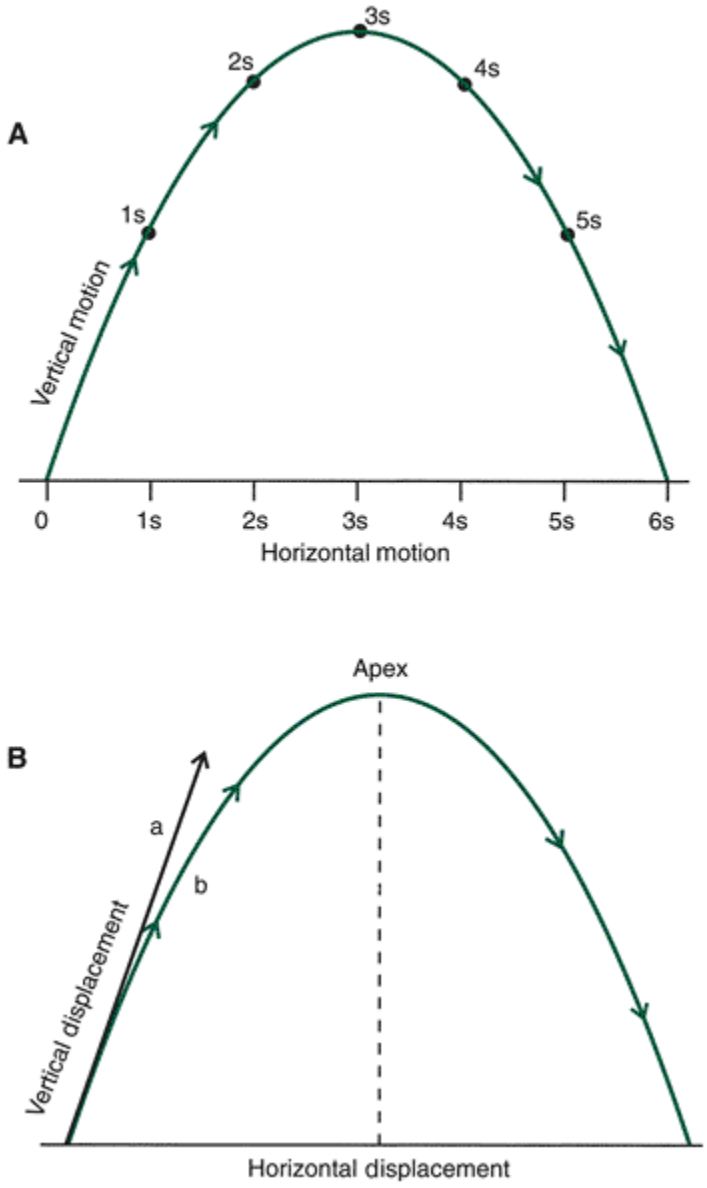
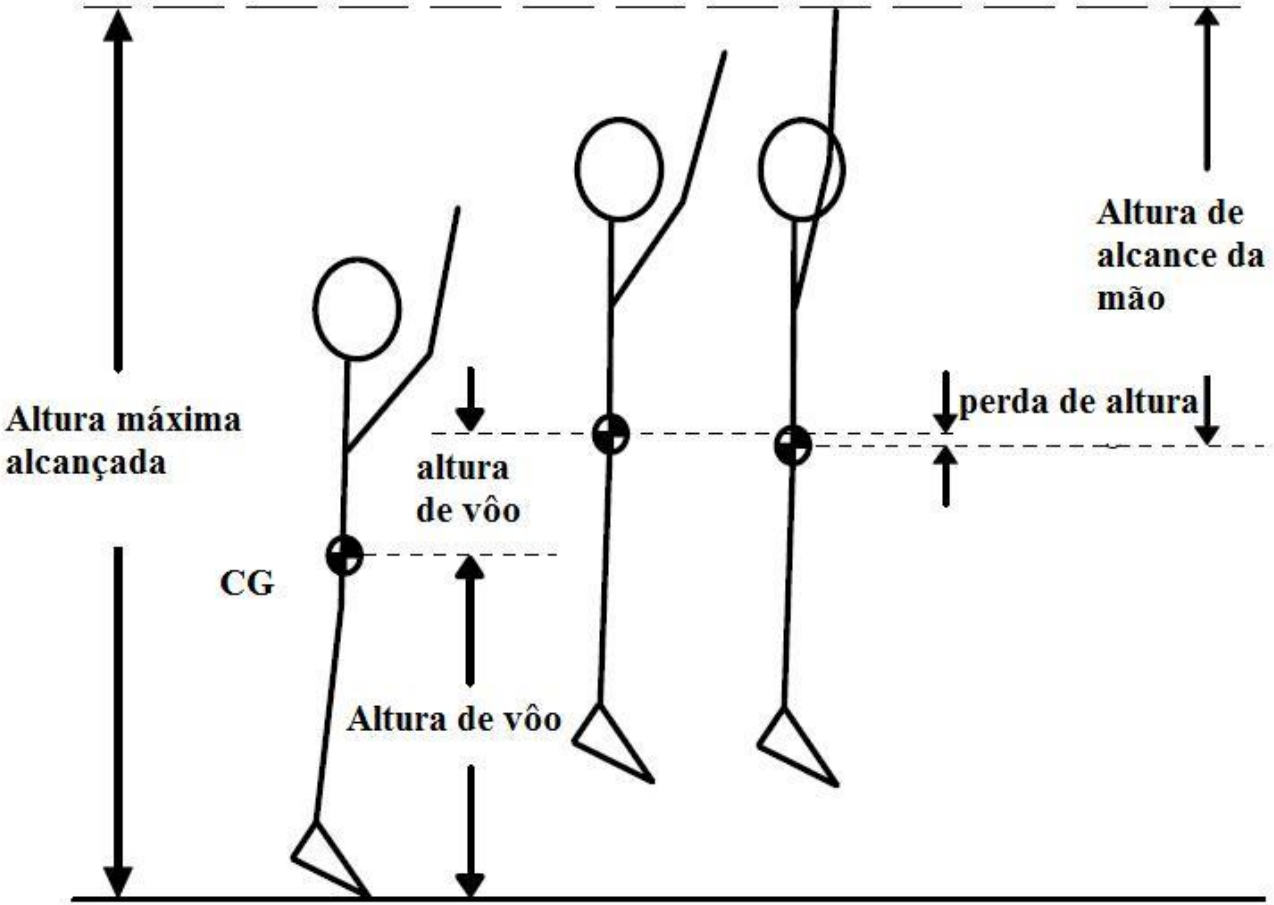
# Biomecânica de corpos lançados no ar - Projétil


A
3s
2s
4s
1s
5s
Vertical motion
0
1s
2s
3s
4s
5s
6s
Horizontal motion
B
Apex
a
b
Vertical displacement
Horizontal displacement


Altura de alcance da mão
Altura máxima alcançada
perda de altura
altura de vôo
CG
Altura de vôo

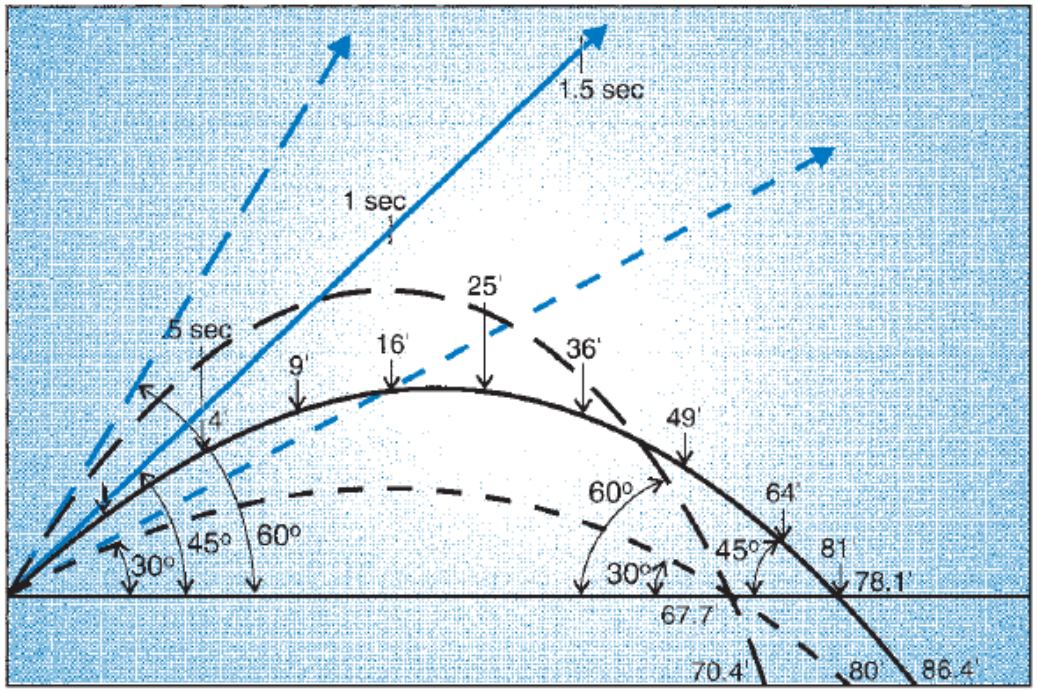
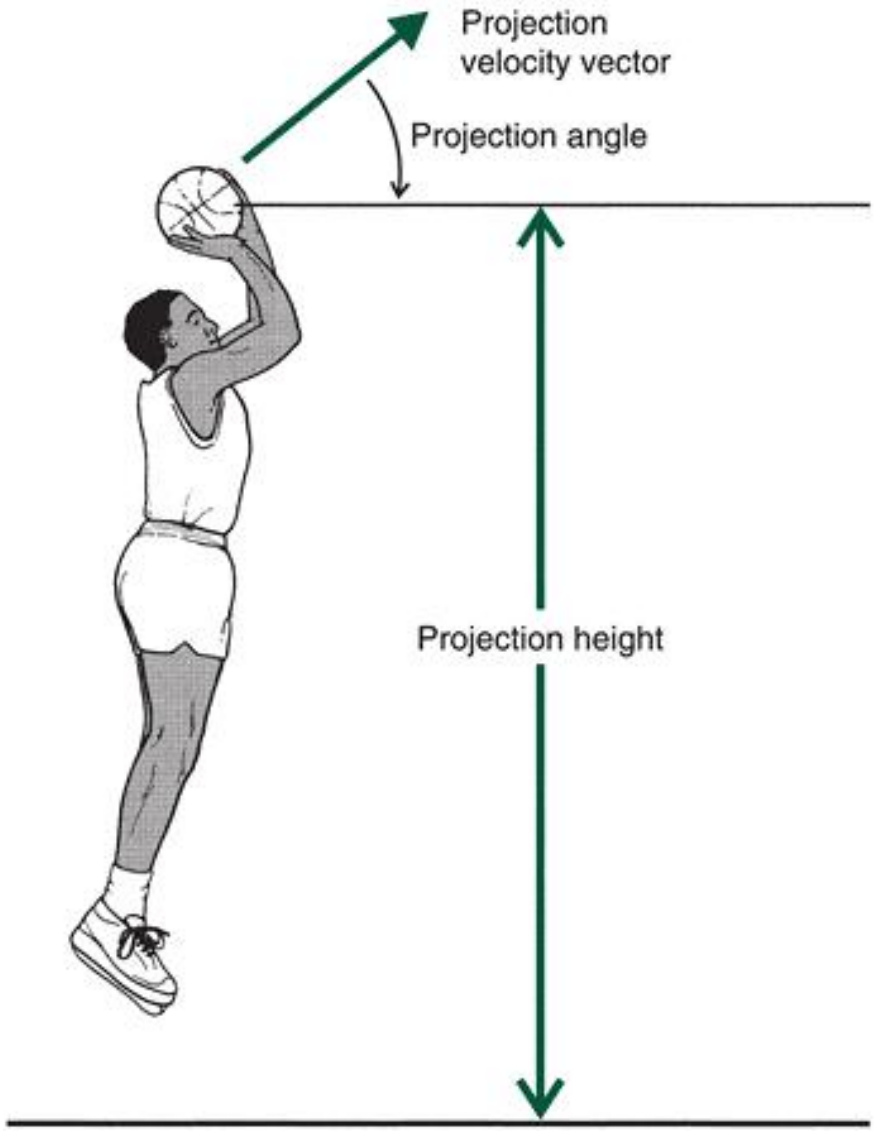


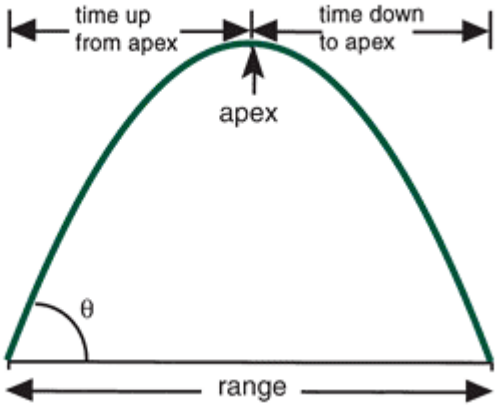

**FIGURE 8-38** Theoretical trajectories of a projectile projected at different angles keeping velocity (15.2 m/s) and height (2.4 m) constant. (Adapted from Broer, M. R., Zernike, R. F. [1979]. *Efficiency of Human Movement*, 4th ed. Philadelphia, PA: WB Saunders.)

# Fatores que influenciam os projéteis

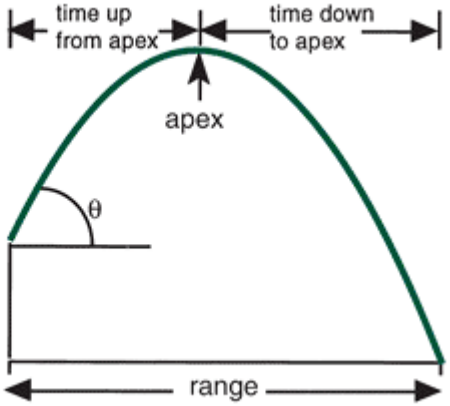



- Ângulo de projeção
- Velocidade de projeção
- Altura da projeção

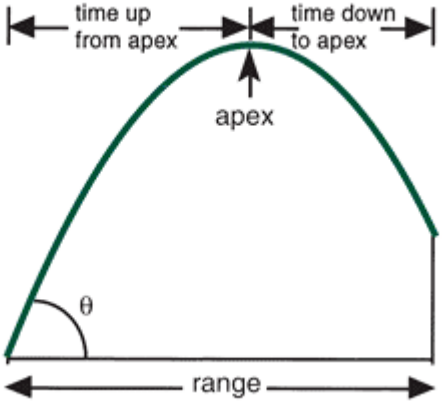
A


time up
from apex
time down
to apex
apex
θ
range

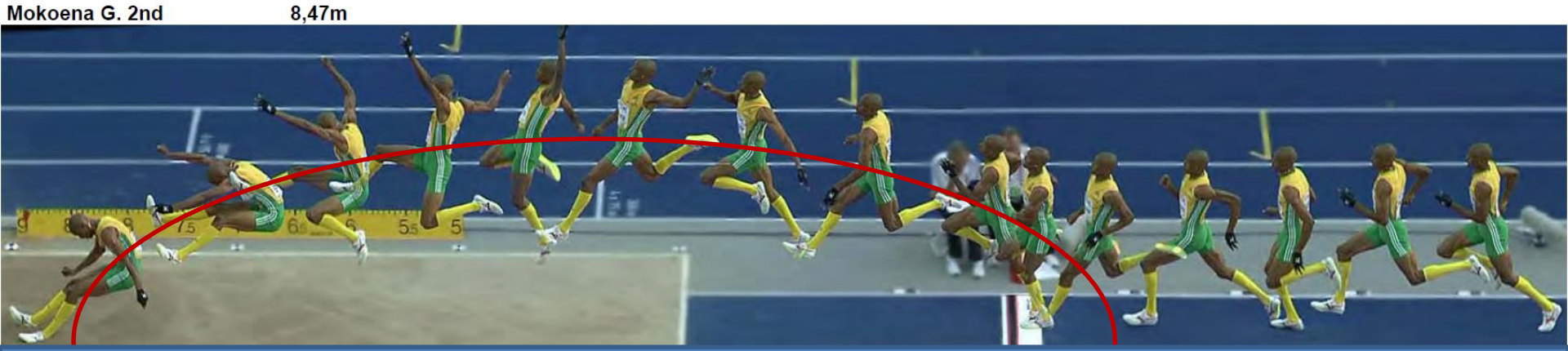
B


time up
from apex
time down
to apex
apex
θ
range

C


time up
from apex
time down
to apex
apex
θ
range

# O CM comporta-se como um projétil em atividades de saltos, queda e etc.



# Equações

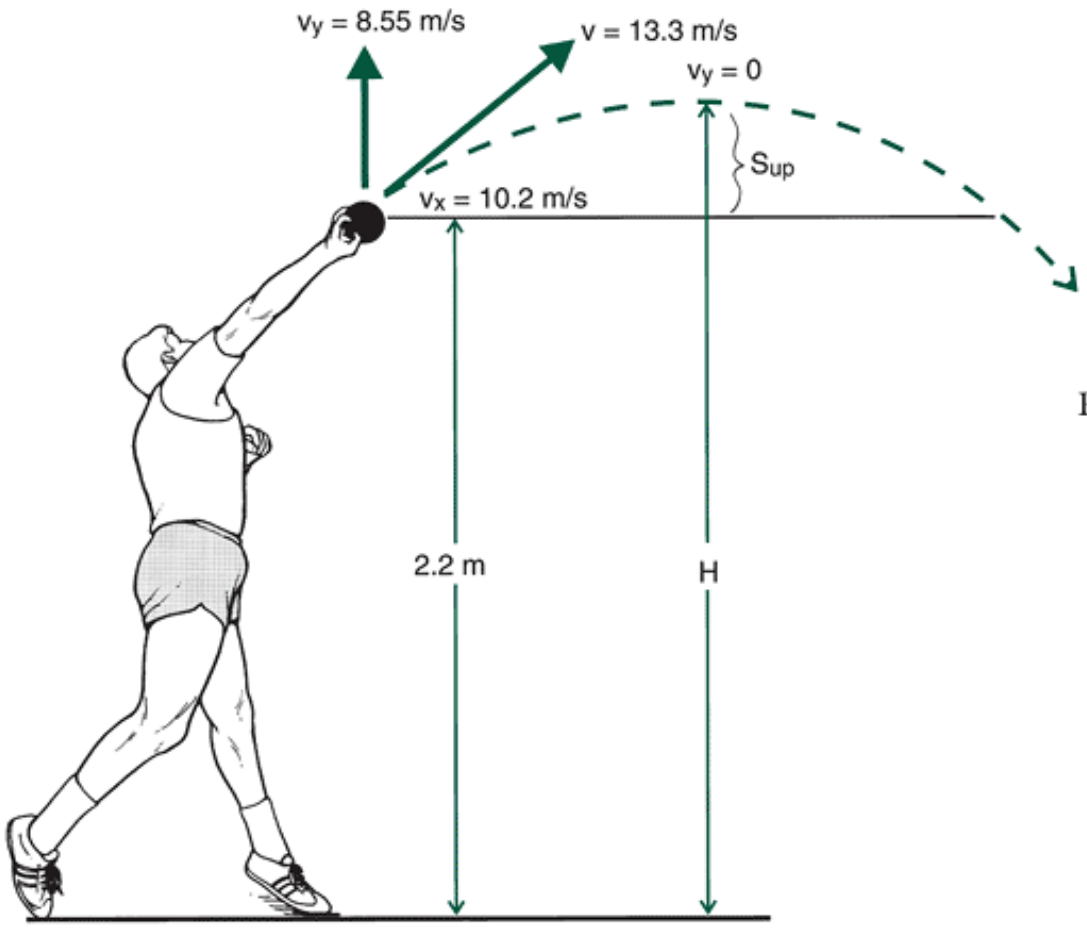
$$v_f = v_i + at \qquad s = v_i t + \frac{1}{2} a t^2 \qquad v_f^2 = v_i^2 + 2as$$

**Altura máxima** $$H = \frac{v_0^2 \cdot sen^2\theta}{2 \cdot g}$$

**Alcance horizontal** $$A = \frac{v_0^2 \cdot sen2\theta}{g}$$

**Tempo de subida da fase aérea** $$t = \frac{v_0}{g}$$

$$\text{Range} = \frac{v^2 * \sin\theta * \cos\theta + v_x * \sqrt{(v_y)^2 + 2gh}}{g}$$




$$\text{Range} = \frac{13.3\ \text{m/s}^2 * \sin 40 * \cos 40 + 10.19\ \text{m/s} * \sqrt{8.55\ \text{m/s}^2 + 2(9.81\ \text{m/s}^2)(2.2\ \text{m})}}{9.81\ \text{m/s}^2}$$

$$= \frac{176.89 * 0.6428 * 0.766 + 10.19 * \sqrt{73.10 + 43.16}}{9.81}$$

$$= \frac{87.09 + 10.19 * 10.78}{9.81}$$

$$= \frac{87.09 + 109.84}{9.81}$$

$$= 20.07\ \text{m}$$

## Equation Review for Linear Kinematics

| Purpose | Given | Formula |
|---|---|---|
| Vector composition, magnitude | Horizontal and vertical components | $r^2 = x^2 + y^2$ |
| Vector composition, angle | Horizontal and vertical components | $\tan \theta = y/x$ |
| Vector resolution, vertical | Magnitude and direction of vector | $y = r \sin \theta$ |
| Vector resolution, horizontal | Magnitude and direction of vector | $x = r \cos \theta$ |
| Time between video frames | Camera frame, sampling rate | Time (s) = 1/frame rate |
| Calculate position | Starting position relative to origin, constant velocity (zero acceleration), time | $s = s_i + v_i t$ |
| Calculate position | Starting position at origin, constant velocity (zero acceleration), time | $s = v_i t$ |
| Calculate position | Initial velocity, time, constant acceleration | $s = v_i t + \frac{1}{2} a t^2$ |
| Calculate position | Initial velocity zero, time, constant acceleration | $s = \frac{1}{2} a t^2$ |
| Calculate average velocity | Displacement and time | $v = (x_2 - x_1)/(t_2 - t_1)$ |
| Calculate average velocity | Initial and final velocity | $v = (v_i + v_f)/2$ |
| Calculate final velocity | Initial velocity, constant acceleration, and time | $v_f = v_i + at$ |
| Calculate final velocity | Starting velocity zero, constant acceleration, time | $v = at$ |
| Calculate final velocity | Velocity at time = zero, constant acceleration, initial position relative to origin, final position | $v_f = \sqrt{(v_i^2 + 2a(x_f - x_i))}$ |
| Calculate final velocity | Initial velocity zero, constant acceleration, initial and final position | $v_f^2 = 2as$ |
| | | $v = \sqrt{(2a(x_f - x_i))}$ |
| Calculate acceleration | Final velocity and displacement | $a = v_f^2/2d$ |
| Calculate average acceleration | Velocity and time | $a = (v_2 - v_1)/(t_2 - t_1)$ |
| Calculate time | Displacement, constant acceleration | $t = \sqrt{(2d/a)}$ |
| Calculate time in air for projectile beginning and landing at same height | Vertical velocity, constant acceleration | $t = 2v_y/a$ |
| Calculate distance of projectile | Resultant velocity, initial angle of release, constant acceleration | $s = r^2 \sin 2\theta/a$ |