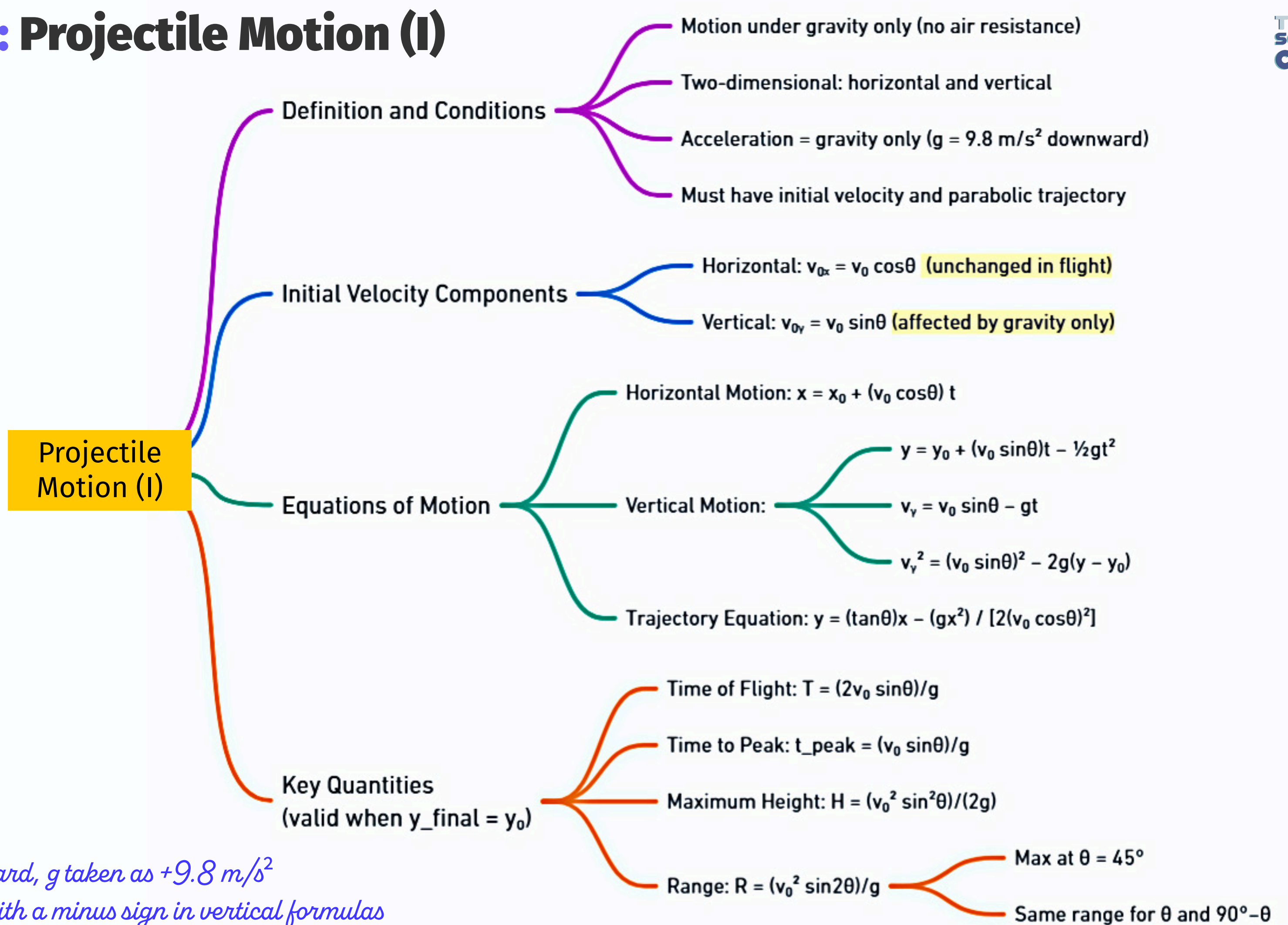


### 3. Mind Map: Projectile Motion (I)



Sign convention: +y upward, g taken as  $+9.8 \text{ m/s}^2$   
downward  $\Rightarrow$  appears with a minus sign in vertical formulas

### 3. Mind Map: Projectile Motion (2)

#### Projectile Motion (II)

##### Velocity at Different Points

Launch:  $|v| = v_0$  at angle  $\theta$  above  $+x$ .

Peak:  $v_y = 0 \Rightarrow v = v_{0x}$  (purely horizontal)

Return to launch height:

$v_x = v_0 \cos\theta$  (unchanged)

$v_y = -v_0 \sin\theta$  (same magnitude, opposite sign)

$|v| = \sqrt{(v_{0x})^2 + (v_y)^2} = v_0$ .

##### Conceptual Insights

Horizontal and vertical motions are independent

Gravity affects vertical motion only

Path is symmetrical if same launch/landing height

Larger  $\theta \rightarrow$  higher peak & longer flight time; range peaks at  $45^\circ$

Complementary launch angles  $\theta$  and  $(90^\circ - \theta)$  give identical range but different flight times

##### Common Mistakes to Avoid

Mixing horizontal and vertical components

Forgetting that  $g$  acts vertically only;  $v_{0x}$  stays constant

Assuming horizontal velocity changes

Overlooking the symmetry of rise and fall when launch & landing heights are equal