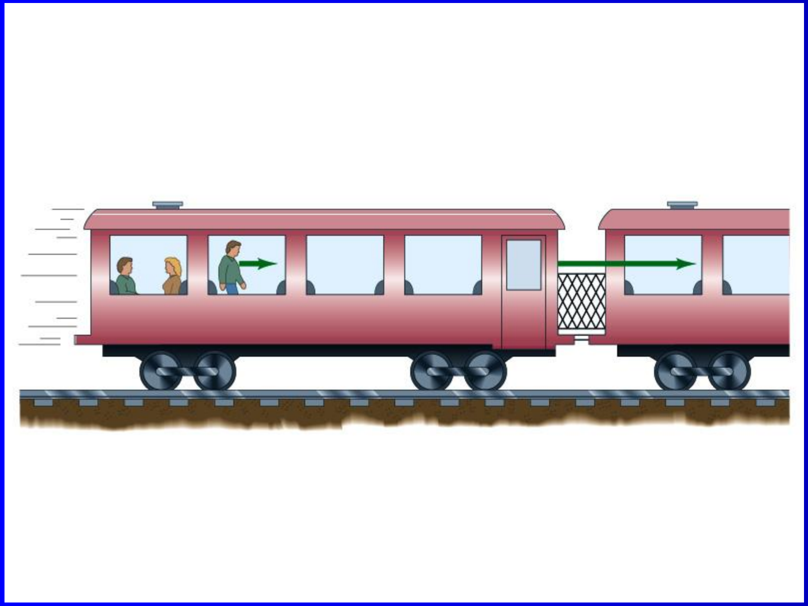
"QUARKS. NEUTRINOS. MESONS. ALL THOSE DAMN PARTICLES YOU CAN'T SEE. THAT'S WHAT DROVE ME TO DRINK. BUT NOW I CAN SEE THEM!"

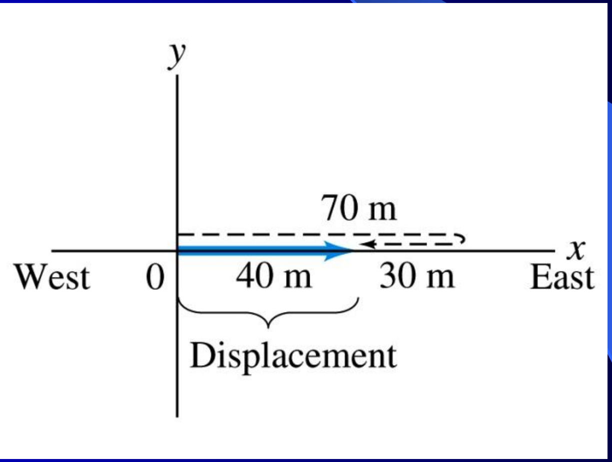
Motion in One Dimension

- Reference Frame



- v_{Train}=85km/h, v_{Person}=5km/h
- v_{Total}=90km/h

- Displacement-Distance



- Distance an object traveled
- Displacement: Change in Object Position
- Scalar – Vector in 1-d and 2-d

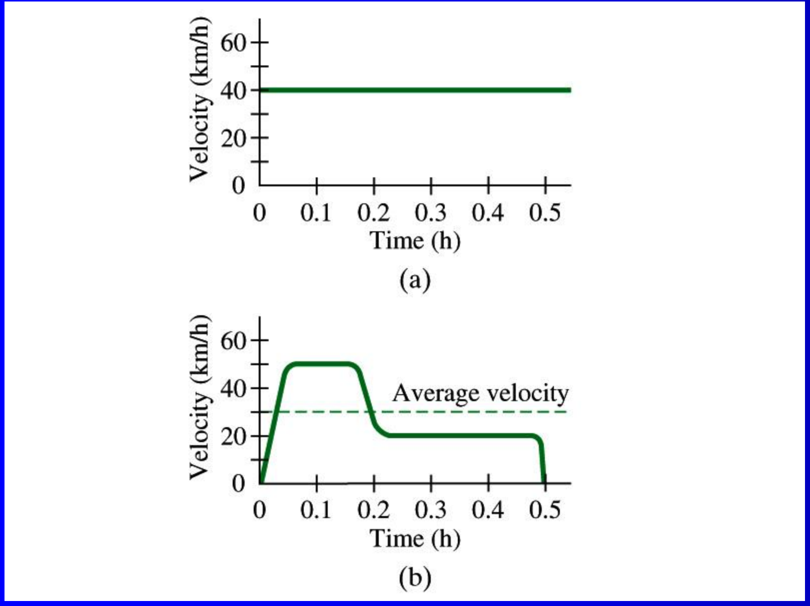
Velocity - Speed

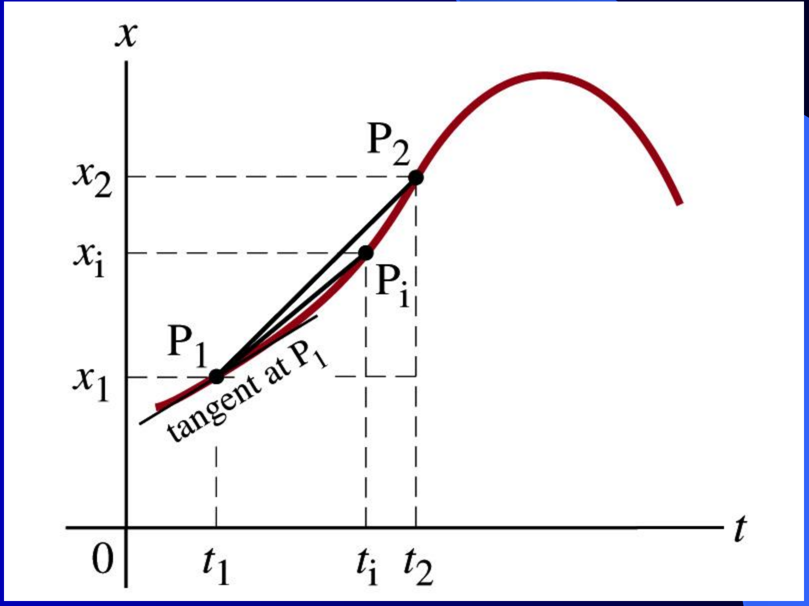
- Average Velocity = displacement / elapsed time
  Average Speed = distance / elapsed time
- Note: displacement-vector, time-scalar $\Rightarrow$ velocity-vector
- Always:
  - vector $\times$ or / scalar = vector
  - scalar $\times$ or / scalar = scalar

- Though this is sloppy: $v = x/t$
- Introductory examples

Instantaneous Velocity

- $v = \lim_{\Delta t \to 0} \Delta x / \Delta t$ (= dx/dt)
- $\Delta t \neq 0$, because if $\Delta t = 0$, then $\Delta x = 0 \Rightarrow 0/0 = ?$





Average Acceleration

- Average acceleration = change of v/elapsed time

0 to 75km/h in 5s

Avg. accel.=?

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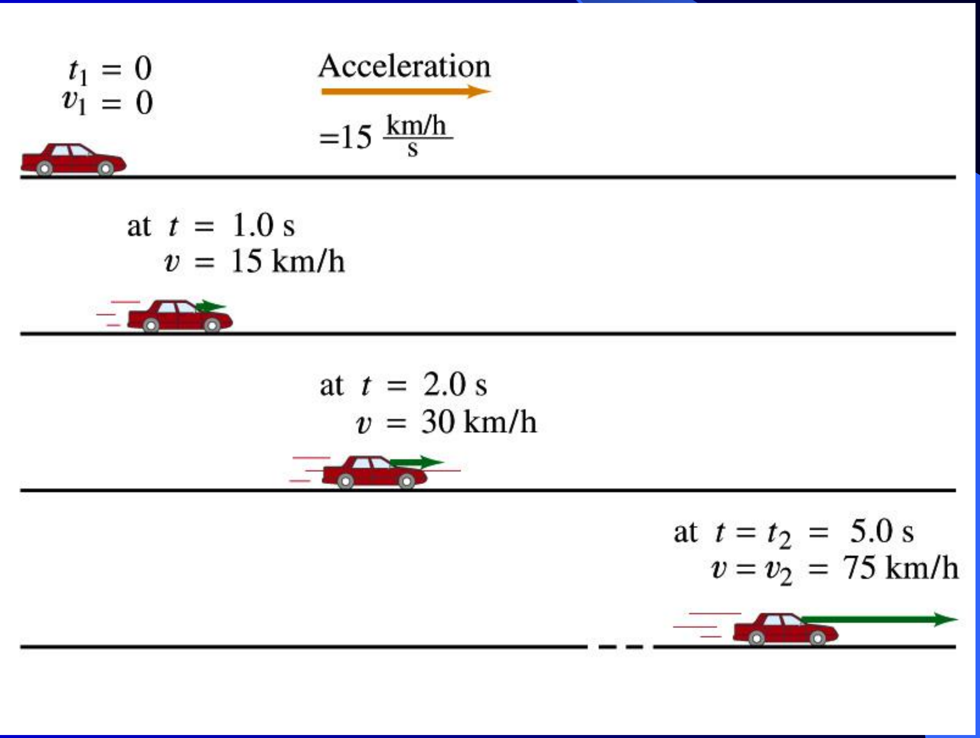


Δv=75km/h-0km/h

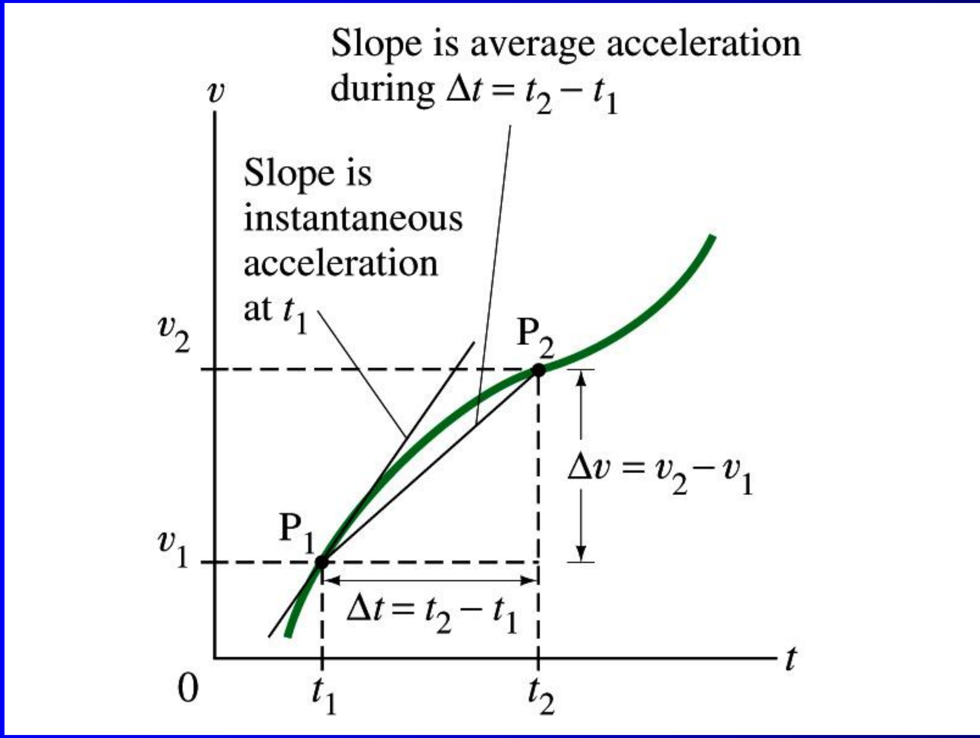
Δt=5s

$\Delta v/\Delta t$=75km/h / 5s

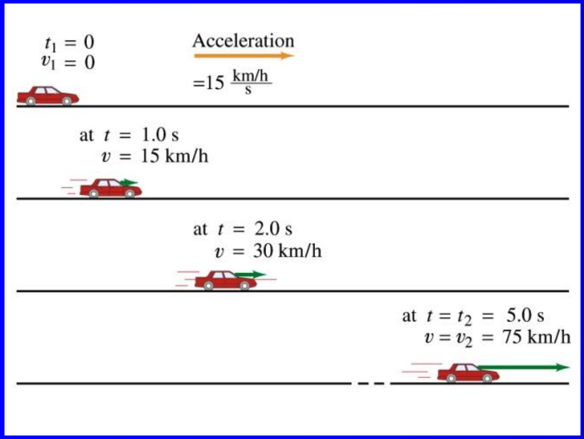
=15km/h/s=4.2m/s^2

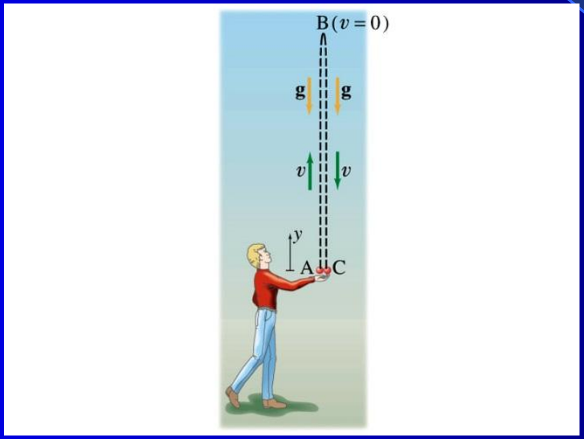
Instantaneous Acceleration

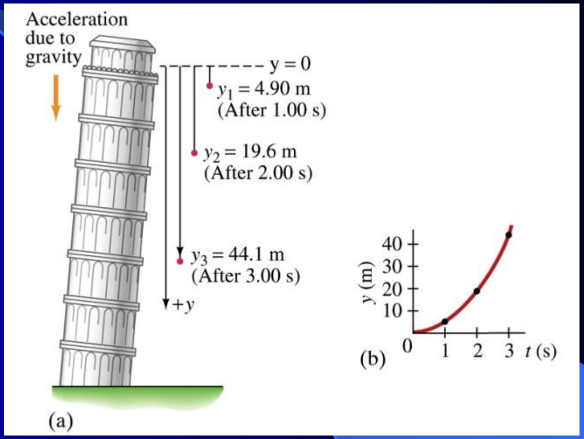
- $a = \lim_{\Delta t \to 0} \Delta v / \Delta t$ ($= dv/dt = d^2x/dt^2$)



Motion at Constant Acceleration





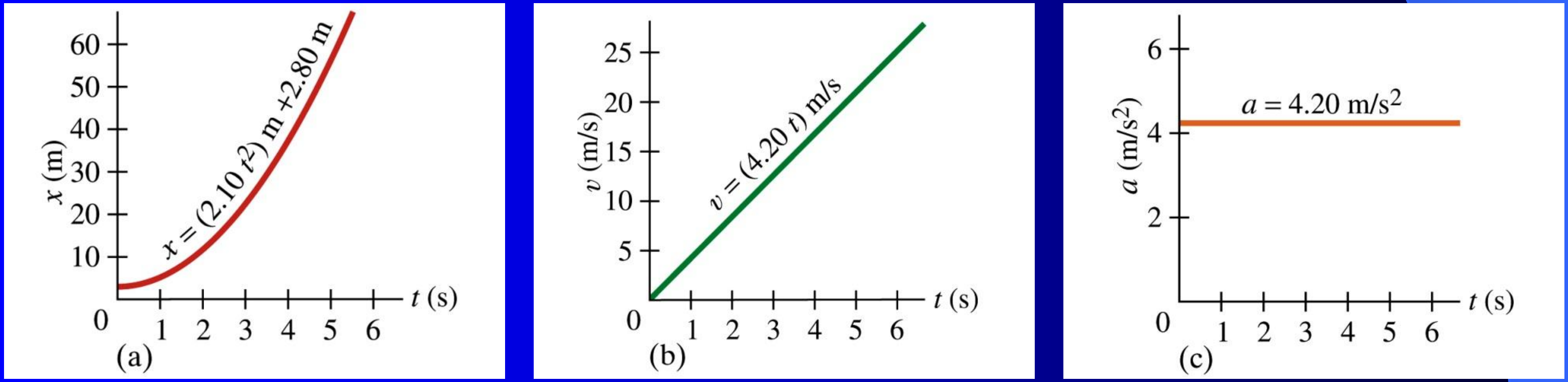


- Let’s talk about the general case

An Example

- $x = (2.10 m/s^2)t^2 + 2.80 m$
- Velocity, Acceleration?
- $v = (4.20 m/s^2)t$
- $a = 4.20 m/s^2$

- $x = x_0 + v_{0x}t + 1/2 a_x t^2$
- Velocity, Acceleration?
- $v = v_{0x} + a_x t$
- $a = a_x$

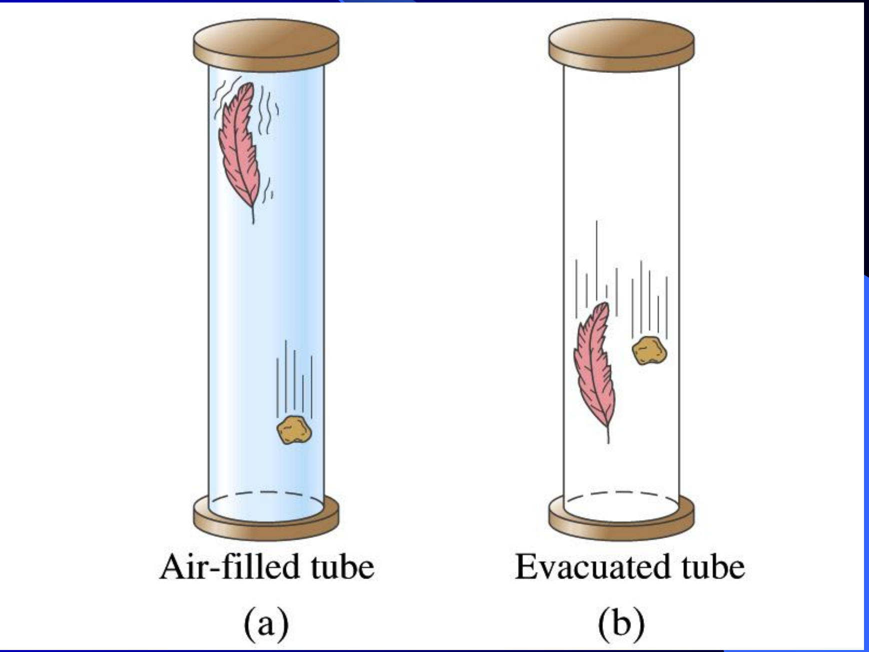


Problem Solving Strategies

- Read the problem carefully – no numbers
- Draw a diagram/picture if necessary
- Extract known quantities
- Consider background, principles
- Apply an equation, that yields additional info
- Calculate result – no mistakes here, please
- Consider units, size of answer, … Does it make sense?

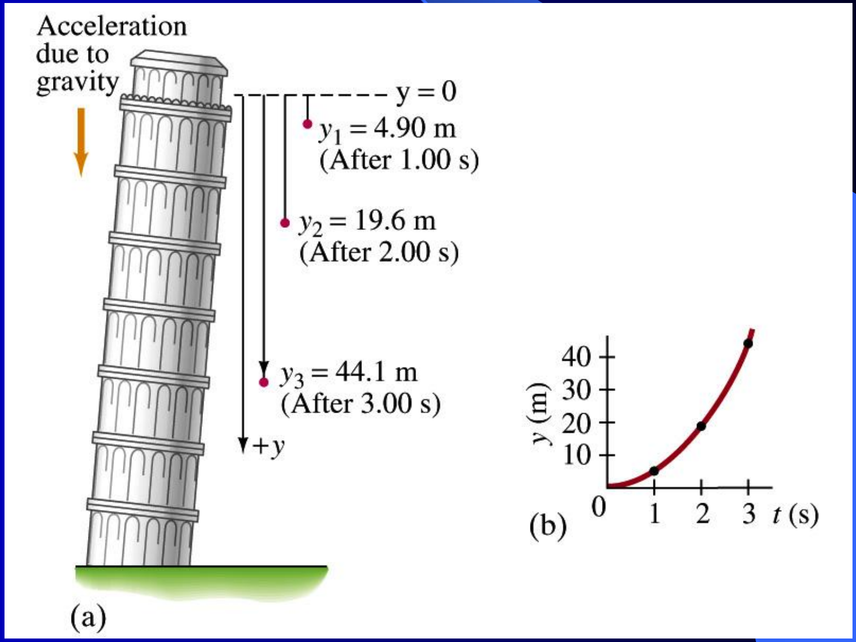
Falling Objects

- Is a~m?
- People first thought so
- Galileo answered that question

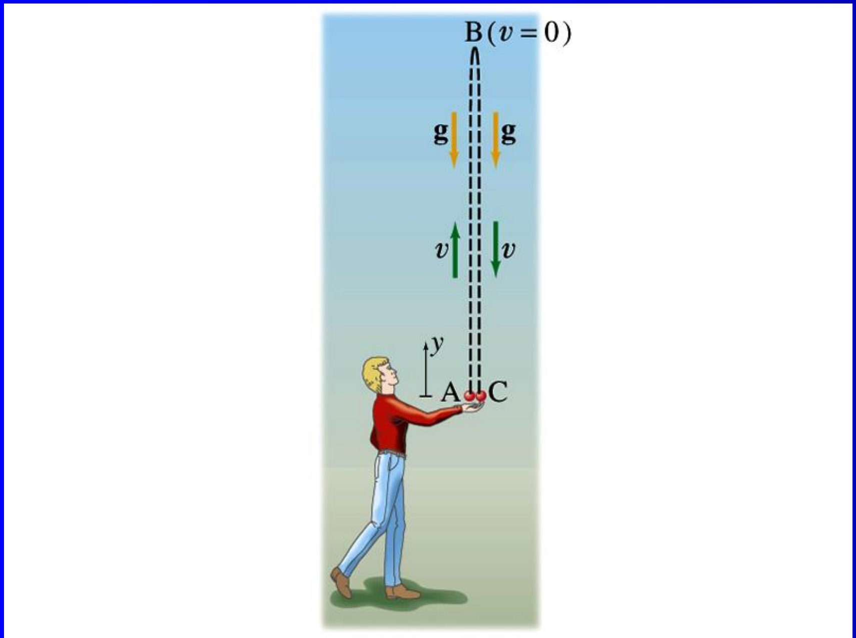


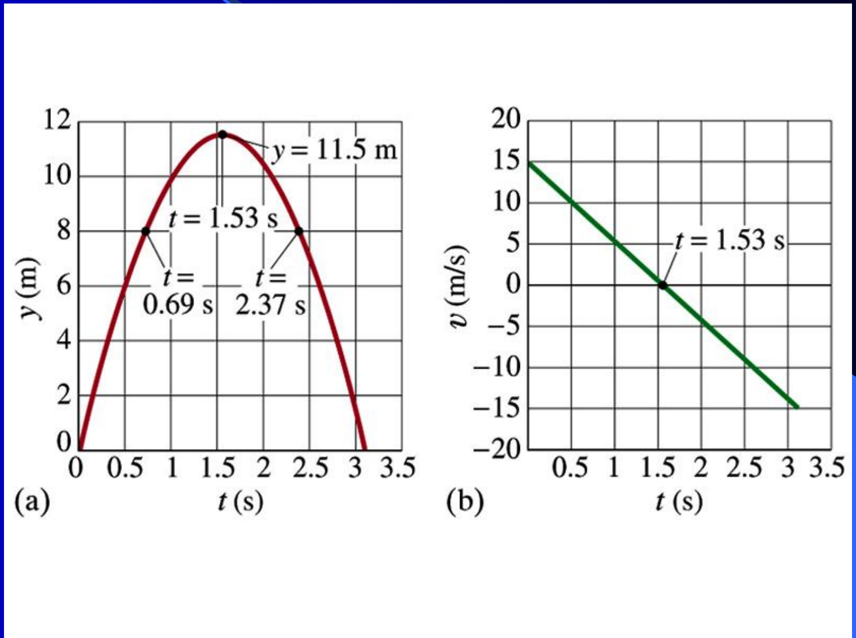
The Tower in Pisa

- Acceleration due to gravity: $g=9.80 m/s^2$
- On the moon: ~$1.6 m/s^2$
- Falling objects: like constant acceleration



Ball thrown upward

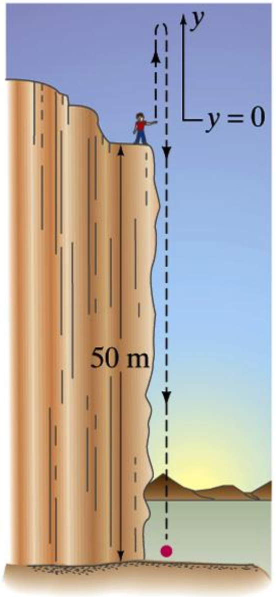


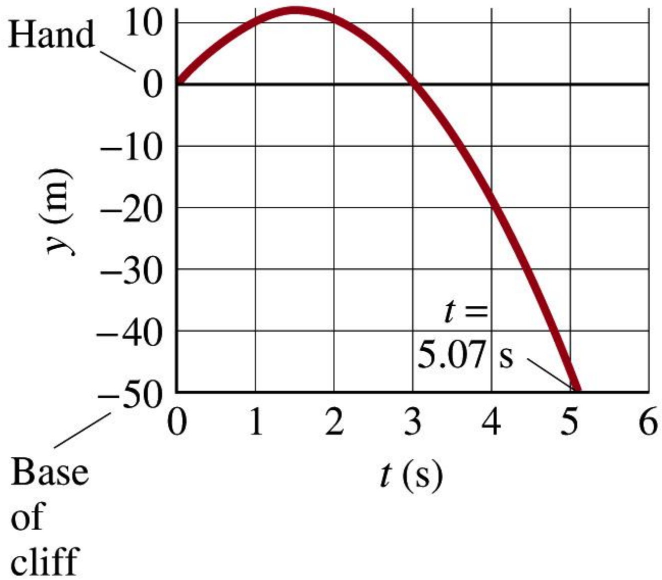


Trick 1: look for symmetry, reverse time

Trick 2: chop complicated problem into smaller ones

Ball thrown upward at cliff





Trick: look for symmetry, even if not so clear

e.g. calculate v at base