Using kinematic equations

- 3 main kinematic equations for constantly accelerated motion:

$$v_2 = v_1 + a\Delta t$$

$$x_2 = x_1 + v_1(\Delta t) + \frac{1}{2}a(\Delta t)^2$$

$$(v_2)^2 = (v_1)^2 + 2a(x_2 - x_1)$$

- YOU need to know these for the test.

- Remember:
  - x is position (x_1 means position at time 1, etc) – change in position ($x_2 - x_1$) is displacement during time Δt ($t_2 - t_1$)
  - + sign means in the + direction; - sign means in the – direction
  - **** negative acceleration **does not have to mean** slowing down!!!
  - If in free fall, a = -9.8 m/s^2 the whole time, assuming up is positive.

How to tackle complex problems

- Sometimes you'll end up with two objects, multiple equations, and multiple unknowns, or just multi-stage problems that take some thinking. It's good to know how to set up and solve these types of equations.

- This is where **drawing a picture**, **indicating your axes**, and **keeping consistent signs** is critical!

Problem 2.53 from XtraWrk

- A rocket is launched with 50 m/s of initial velocity straight upwards. It continues to accelerate at 2 m/s^2 until it reaches a height of 150 m.
  - What happens after the propulsion cuts out at 150 m height?
  - What is the rocket's maximum height above the ground?
  - How much time does it take to reach that height?
  - What is the total time of flight for the rocket?

Solutions in the XtraWrk problems.

2.50) Sandbag and balloon

- A sandbag is released from a hot-air balloon that is descending at a constant 1.5 m/s. After 2.0 seconds:
  - How fast is the sandbag traveling?
  - How far below the hot-air balloon is the mailbag?
  - How would parts (a) and (b) change if the balloon had been rising at 1.5 m/s?

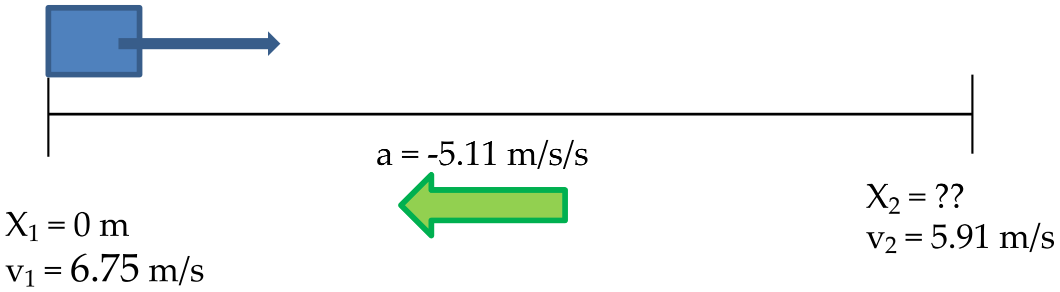
Solutions in the XtraWrk problems.

"quiz" yourself

- Rickey Henderson, baseball's record holder for stolen bases, approaches third base. He dives head-first, hitting the ground at 6.75 m/s and reaching the base at 5.91 m/s, accelerating at -5.11 m/s/s. Determine the distance Rickey slides across the ground before touching the base.

Solutions in the XtraWrk problems.

SOLUTION



Want to find displacement (Δx) but don't know time. Use eqn #3:

$$(v_2)^2 = (v_1)^2 + 2a\Delta x$$

$$(5.91)^2 = (6.75)^2 + 2(-5.11)(\Delta x)$$

$$\mathbf{\Delta x = 1.04\ m}$$

THEN use that time in the displacement equation:

$$\Delta x = v_1(\Delta t) + \frac{1}{2}a(\Delta t)^2$$

$$= (6.75)(0.164...) + \tfrac{1}{2}(-5.11)(0.164...)^2$$

=1.04 m

OR you could solve it this way:

Find the time for the slide using velocity equation:

$$v_2 = v_1 + a\Delta t$$

$$5.91 = 6.75 + (-5.11)t$$

$$t = 0.164\ldots\ \text{sec}$$

Poppers lab (if time)

- Your task: determine the launch velocity and the acceleration required for the party popper to fly as it does.
  - You may use a meter stick but no other equipment (e.g. no timers).
  - Each group needs to turn in a paper that has:
    - A sketch of the situation, including coordinate axes and all known values before data were taken
    - Any measurements that were taken
    - Your analysis (e.g. equations used and work to find the two values above, including blurbs to explain your reasoning)
  - Turn in one sheet per two-student team; this is worth 10 lab points