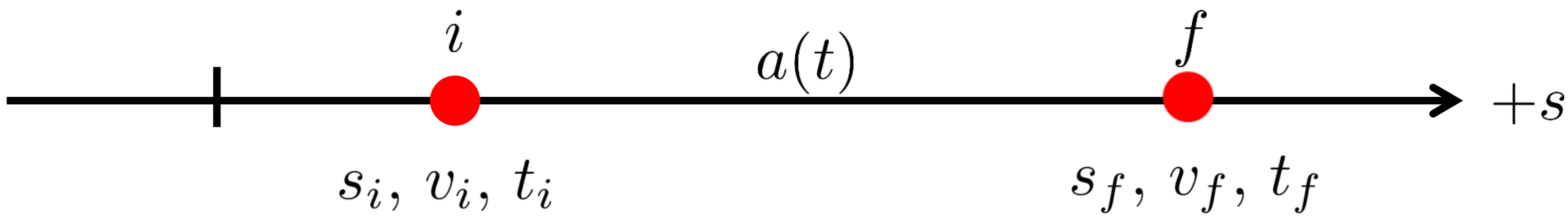
Review of General 1D Kinematics From Our Last Class



The instantaneous velocity and acceleration are:

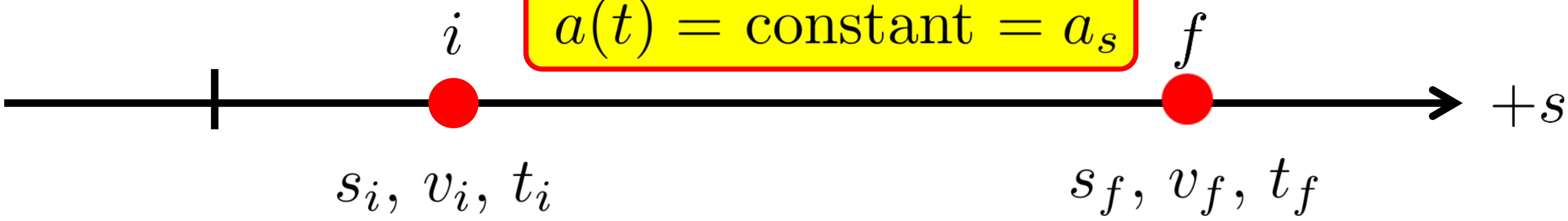
$$v_s = \frac{ds}{dt} \qquad a_s = \frac{dv_s}{dt}$$

If we know the position and velocity at the initial point *i*, we can find the position and velocity at point *f* by:

$$s_f = s_i + \int_{t_i}^{t_f} v_s dt \qquad v_f = v_i + \int_{t_i}^{t_f} a_s dt$$

Constant Acceleration 1D Kinematics

$$a(t) = \text{constant} = a_s$$



In many problems that we'll do, the acceleration will be constant . . . ***Why?***

Many problems in physics involve constant forces which give constant acceleration.

For this special case, your author has integrated the kinematic equations to relate the conditions at point i to the conditions at point f:

(you *can do this integration graphically or analytically*)

$$s_f = s_i + v_{s_i}\Delta t + \frac{1}{2}a_s(\Delta t)^2$$

$$v_{s_f} = v_{s_i} + a_s\Delta t$$

$$v_{s_f}^2 = v_{s_i}^2 + 2a_s\Delta s$$

$$\text{where: } \Delta t = t_f - t_i \quad \text{and} \quad \Delta s = s_f - s_i$$

Note: if the acceleration is NOT constant, you can't use these equations.

$\underline{\text{Note: for } v_s = \text{constant} \Rightarrow a_s = 0}$; so $s_f = s_i + v_s\Delta t$

Whiteboard Problem: 2-6

A speed skater moving left to right across frictionless ice at 8.0 m/s hits a 5.0 m wide patch of rough ice. She slows steadily, then continues on at 6.0 m/s.

a) **Draw the Problem on your Whiteboard.**

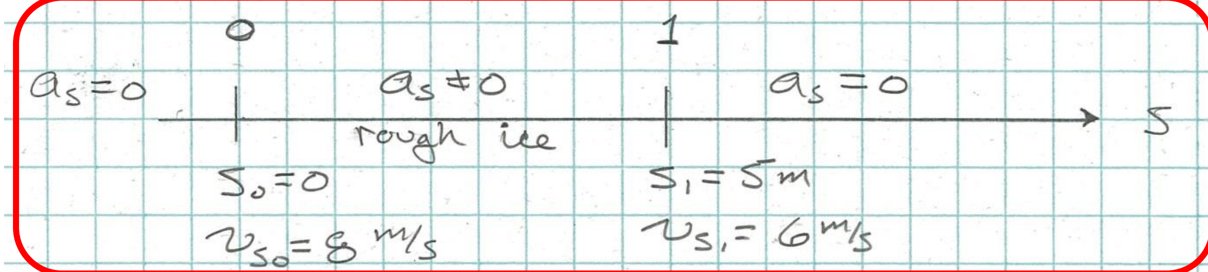
   (i.e. make a sketch showing the problem and important info)

b) **Assuming it is constant, what is the skater's acceleration on the rough ice? (LC)** (take right to be positive)

I'm going to show you my solution for this problem because it has **Some important elements of Problem Solving Strategies**:

Whiteboard Problem: 2-5 Solution

A sketch showing problem and important quantities (“if you can’t draw it, you don’t understand it!”)



What are we solving for?

find: a_s on the rough ice.
assume a_s = constant.

from 1D Kinematics $0 \to 1$:

Start with a general equation (from the equation sheet)

$$v_{s_1}^2 = v_{s_0}^2 + 2 a_s \Delta s \qquad \Delta s = s_1 - s_0$$

$$= v_{s_0}^2 + 2 a_s (s_1 - \cancel{s_0})$$

Do the algebra Symbolically! Then Calculate.

so

$$a_s = \frac{(v_{s_1}^2 - v_{s_0}^2)}{2 s_1} = -2.8\ m/s^2$$

The negative sign indicates that the acceleration is to the left.

Whiteboard Problem 2-7

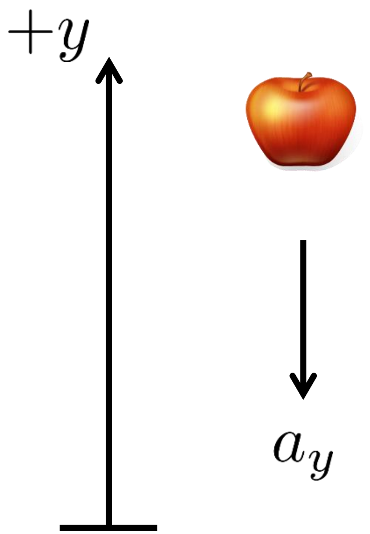
A jet plane is cruising at 300 m/s when suddenly the pilot turns on the afterburners to full throttle. After traveling 4.0 km, the jet is moving with a speed of 400 m/s.

a) **Draw the Problem on your Whiteboard.**

b) **What is the jet's acceleration, assuming it to be constant acceleration? (LC)**

Applications of Constant Acceleration Kinematics

Free Fall: **constant downward acceleration produced by gravity near the surface of the Earth.**



Just use above three equations (i.e. 1D constant acceleration kinematics) with:

$$s \Leftrightarrow y$$

$$a_s \Leftrightarrow a_y = -g$$

(If you choose +y as up)

$$g = 9.8\ \frac{m}{s^2}$$

(reasonably valid near the Earth's surface)

Where should you stick g?
If you have a TI calculator, store it under the letter G!

Note: g is NOT -9.8 m/s²;
if we choose up as +y, then
$a_y = -g = -9.8\ m/s^2$

Whiteboard Problem 2-8

Tiny 6-year old Brenna jumps from a 10 meter diving platform into the water below. ***Man, is she brave or what? Let's Watch.***
We want to know the duration of her fall and the speed with which she hits the water.

a) **Draw the Problem on your Whiteboard.**
b) **How long does Brenna's fall last? (LC)**

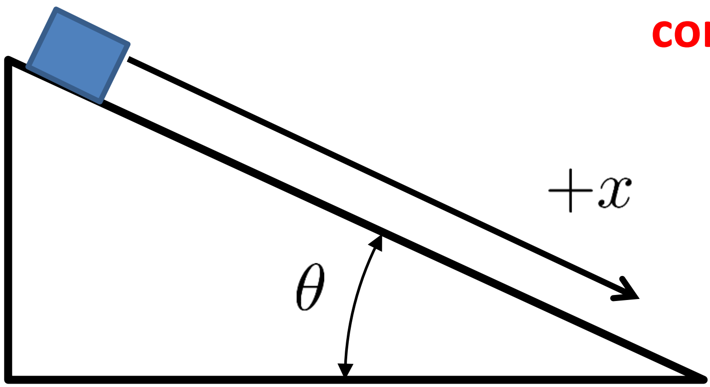
(We'll loop the video; try to time her fall with the stop watch on your phone and see how close your answer is.)

c) **What is Brenna's speed when she hits the water? (LC)**

Applications of Constant Acceleration Kinematics

Inclined Plane: **constant downward acceleration produced by gravity on a frictionless incline plane near the surface of the Earth.**

Just use above three equations (i.e. 1D constant acceleration kinematics) with:



$$s \Leftrightarrow x$$

$$a_s \Leftrightarrow a_x = g \sin \theta$$

(If you choose +x as down the incline)

(In Chapters 5 & 6, we'll learn how to determine what the acceleration is, with or without friction.)

Whiteboard Problem 2-9

A skier is gliding along at 3.0 m/s on horizontal, frictionless snow. He suddenly starts down a 10^{o} incline. His speed at the bottom is 15 m/s.

a) **Draw the Problem on your Whiteboard.**
b) **What is the length of the incline? (LC)**
c) **How long does it take him to reach the bottom? (LC)**

Whiteboard Problem: 2-10 *(a challenging problem)*

A rubber ball is shot straight up from the ground with speed v_0. Simultaneously, a second rubber ball at height *h* directly above the first ball is dropped from rest. At a later time, the balls collide.

a) **Draw the Problem on your Whiteboard.**

b) **At what height above the ground do the balls collide?**

Your answer will be an algebraic expression in terms of *h*, v_0, and *g*. **(LC, a 2-point shot) (in LC, to enter v_0^2 , use $(v_0)^2$)**

Suggested sketch