

Physics 2311 – Physics I, Week 2

Dr. J. Pinkney

Outline for W2, Day “2”

Finish measurements and errors (Ch. 1)

Motion in 1-dimension

Position, distance, path length, displacement

Average speed & velocity

Homework:

Ch. 1 Read sections 3-5,7 (skim 1 & 2)

Ch. 1 MisConcQs: 2-8,10; Probs:1-8,14,15,17,18,
23,24,54-56 (due today by 2:30 pm)

Ch. 2 Read sections 1-7,(8); Probs. 2,3,5-7,14,
23-27,35-38,53-56 (Due next Wed)

Notes: Lab is “Measurements in Physics”

Quiz 1 next Monday on Ch 1 and some Ch 2.

Try practice quiz online.

I tried to fix Canvas for Sec 2.

Tutoring confirmed Wed and Thur 7-9 pm, Het 201.

Physics 2311 – Physics I, Week 2

Dr. J. Pinkney

Outline for W2, Day “3” (Fri)

Motion in 1-dimension

Position, distance, path length, displacement

Average speed & velocity

Acceleration

Homework:

Ch. 2 Read sections 1-7,(8); Probs. 2,3,5-7,14,
23-27,35-38,53-56 (Due next Wed)

Notes:

Ch. 1 hwk key is under “NEW STUFF”

Mon and Tues Labs do Exp 1, others do Exp 2.

Quiz 1 on Monday on Ch 1 and some Ch 2.

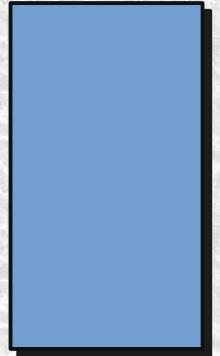
Try THREE practice quizzes online.

I tried to fix Canvas for Sec 2 (9am).

Tutoring confirmed Wed and Thur 7-9 pm, Het 201.

Error propagation example

- 1) Find the Area of a rectangular plate with $L=21.3 \pm 0.2$ cm, $W=9.8 \pm 0.1$ cm, using the “adding the fractional errors” method to determine the errors.



Final answer: $A = 209 \pm 4 \text{ cm}^2$

- 2) Find the same area using the correct “add fractional errors in quadrature” approach to determine the errors.

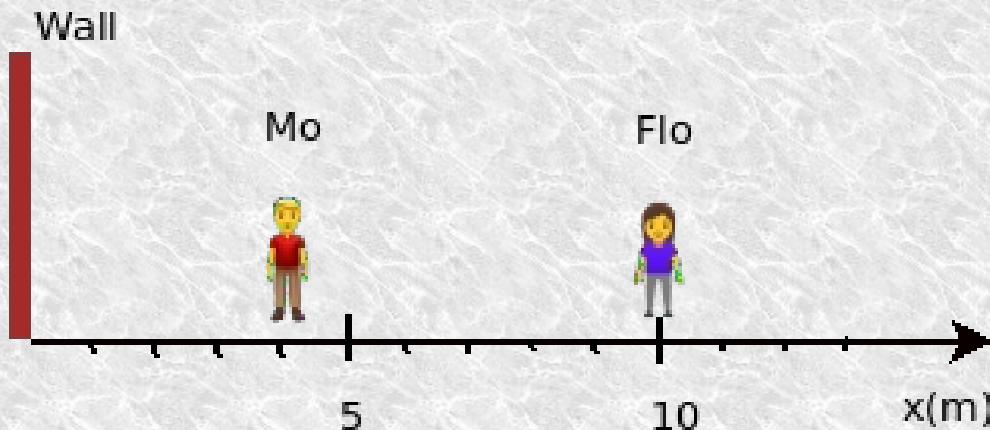
Final answer: $A = 209 \pm 3 \text{ cm}^2$

- 3) Find the same area supposing you were NOT given the errors, only $L=21.3$ cm, $W=9.8$ cm.

Final answer: $A = 210 \text{ cm}^2$

Motion in 1-Dimension

Mo and Flo are standing conveniently on a number line, which has its origin, $x=0$, where the floor meets a wall.

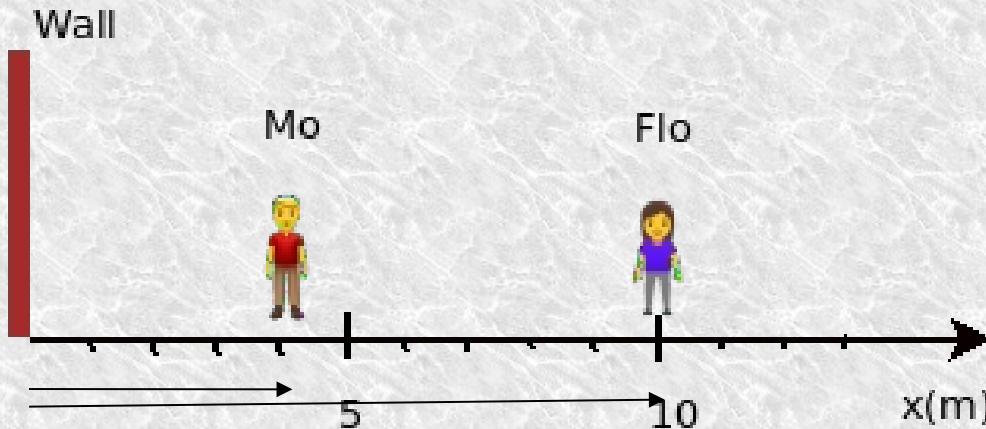


Relative to this origin, we can quantify Mo and Flo's ...

Position: the distance away from a reference point.

- Symbols for position: x , y , z
- Positions for Mo and Flo: $x_{mo} = 4 \text{ m}$ and $x_{flo} = 10 \text{ m}$.

Motion in 1-Dimension (cont.)



Position vector: a vector pointing from a reference point to an object of interest.

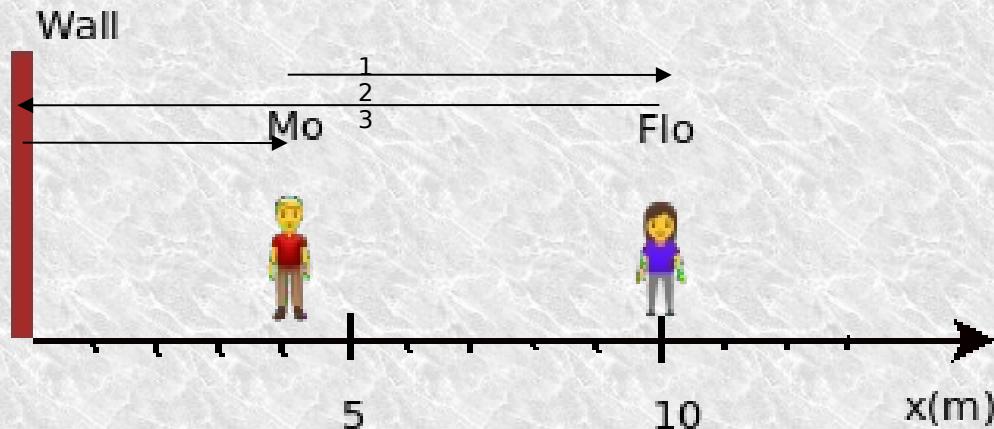
- Symbols for position vector: \mathbf{x} , \mathbf{r} , \vec{x}
- For Mo and Flo we have $\mathbf{x}_{\text{mo}} = 4 \hat{\imath} \text{ m}$ and $\mathbf{x}_{\text{flo}} = 10 \hat{\imath} \text{ m}$.
- The position vectors for Mo and Flo are shown under the numberline.

The **distance** between two objects can be defined as the magnitude of the difference between their positions.

$$\text{Ex)} \ d_{\text{flo to mo}} = |\mathbf{x}_{\text{mo}} - \mathbf{x}_{\text{flo}}| = |4 - 10| = 6 \text{ m.}$$

Motion in 1-Dimension

Ex) Mo walks to Flo, gets rejected, walks to the wall ($x=0$), and then returns to $x=4$.



Path length (d, ℓ): the sum of all distances making up a path.

Ex) Mo's path length (above) is $\ell = d_1 + d_2 + d_3 = 6 + 10 + 4 = 20\text{m}$

Note: path length is like a cars odometer reading, only increasing.

Displacement ($\Delta \mathbf{x}, \Delta \vec{x}, \Delta \mathbf{r}$): The difference between the final position vector and the initial position vector of a journey.

$$\Delta \mathbf{x} \equiv \mathbf{x}_f - \mathbf{x}_i$$

Ex) Mo's displacement is $\Delta \mathbf{x} = \mathbf{x}_f - \mathbf{x}_i = 4 \hat{i} - 4 \hat{i} = 0 \hat{i} \text{ m.}$

Week 2 (cont.)

Motion in 1-Dimension (cont.)

Average speed (s_{avg} , v , "average speed") = distance or path length per time.

- $s_{\text{avg}} \equiv d / \Delta t = \ell / \Delta t$
- s_{avg} is only positive. s_{avg} is a scalar, not a vector.
- Dimensions are L/T. MKS units are m/s.

Average velocity (\mathbf{v}_{avg} , \vec{v}_{avg} , \bar{v}) = displacement per time.

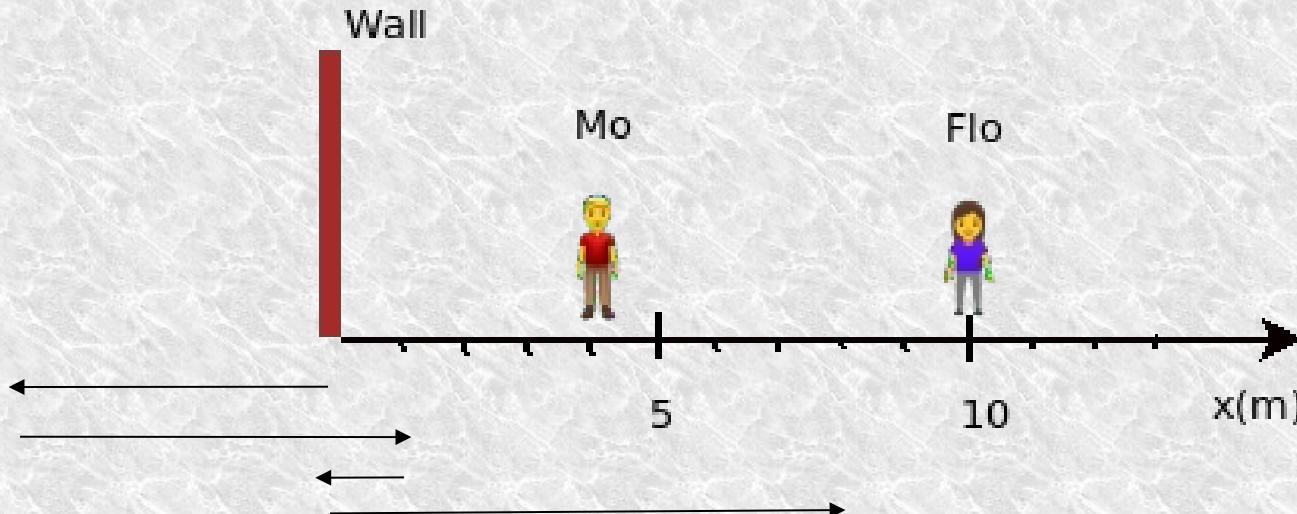
$$\mathbf{v}_{\text{avg}} \equiv \Delta \mathbf{x} / \Delta t$$

\mathbf{v}_{avg} is a vector – it has magnitude and direction.

\mathbf{v}_{avg} can be positive (in the $+x$ direction) or negative (in the $-x$ direction).

Week 2 (cont.)

Motion in 1-Dimension (cont.)



Example) Doing chores, Mo starts at $x=0$, walks 5' left, 6' right, 1' left, and 8' right in 40 seconds. What was Mo's average speed?

$$\text{Ans: } d = 5 + 6 + 1 + 8 = 20', \text{ so } s_{\text{avg}} = 20'/40\text{sec} = 0.5 \text{ ft/sec.}$$

Example) What was Mo's average velocity for this journey?

$$\text{Ans: } \mathbf{v}_{\text{avg}} \equiv \Delta \mathbf{x}/\Delta t = (8\hat{i} - 0\hat{i}) / (40 \text{ sec}) = 8\hat{i}/40 = 0.2 \hat{i} \text{ ft/s}$$

Note: we don't have enough info to say how fast Mo was moving at any point in time during this journey!

Physics 2311 – Physics I, Week 23

Dr. J. Pinkney

Outline for Day W3, D1

Motion in 1-D (cont.)

Instantaneous velocity as a slope of x vs t graph

Acceleration (average and instantaneous)

Graphs of x , v , and a vs t .

Equations of motion

Equations of uniform acceleration

Last 15 min: Quiz 1.

Homework (Due Wednesday)

Ch. 2 Prob. 2,3,5-7,14,23-27,35-38,53-56

Notes: Return Hwk 1. Means=9.2, 9.3

Tutoring on Wed, Thu 7-9 (2nd floor Heterick).

Last day to Drop is Feb 9.

Week 2 (cont.)

Motion in 1-Dimension (cont.)

Instantaneous speed, (s, s_{inst}): the speed at an instant in time.

- Definition: $s \equiv \lim(\Delta t \rightarrow 0) \Delta l / \Delta t$ or $s \equiv \frac{dl}{dt}$
- s is a scalar and so it is always positive
- Dimensions: L/T

Instantaneous velocity, ($\mathbf{v}, \mathbf{v}_{\text{inst}}, \vec{v}, v$): the velocity at an instant in time.

Definition: $\mathbf{v} \equiv \lim(\Delta t \rightarrow 0) \Delta \mathbf{x} / \Delta t$ or $\vec{v} \equiv \frac{d \vec{x}}{dt}$

- \mathbf{v} is a vector, and so it can be positive or negative
- Dimensions: L/T

Ex) A racecar moves obeying $\mathbf{x}(t) = 3 - 6t^2 \text{ m } \hat{\imath}$. What is its instantaneous velocity at $t=3$ seconds?

Ans: $\mathbf{v}(t) = d\mathbf{x}/dt = -12t \hat{\imath}$, so $\mathbf{v}(t=3) = -36 \text{ m/s } \hat{\imath}$.

Week 2 (cont.)

Motion in 1-Dimension (cont.)

Inequalities involving speed and velocity

Possible inequalities: = , ≤ , ≥, ≠, < , >

1) The instantaneous speed is the magnitude of the instantaneous velocity.

$$s = |\vec{v}|$$

Q: Is average speed equal to the magnitude of average velocity? $s_{avg} ? |\vec{v}_{avg}|$

Ans: not necessarily!

2) The average speed is greater than or equal to the magnitude of \mathbf{v}_{avg} .

$$s_{avg} \geq |\vec{v}_{avg}|$$

Q: When is the magnitude of average velocity less than average speed?

(Hint: see previous problem with Mo's 4-leg journey.)

Ans: when there are reversals, or “switchbacks” in the journey.

Q: What is the inequality between path length and magnitude of displacement?

$$d \geq |\Delta \vec{x}_{avg}|$$

Physics 2311 – Physics I, Week 23

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Outline for Day W3, D1

Return Quiz 1

Motion in 1-D (cont.)

Instantaneous velocity as a slope of x vs t graph

Acceleration (average and instantaneous)

Graphs of x, v, and a vs t.

Equations of motion

Equations of uniform acceleration

Homework (Due ~~Wednesday~~ → Friday)

Ch. 2 Prob. 2,3,5-7,14,23-27,35-38,53-56

Notes: Quiz 1 means = 7.4, 6.6 / 10

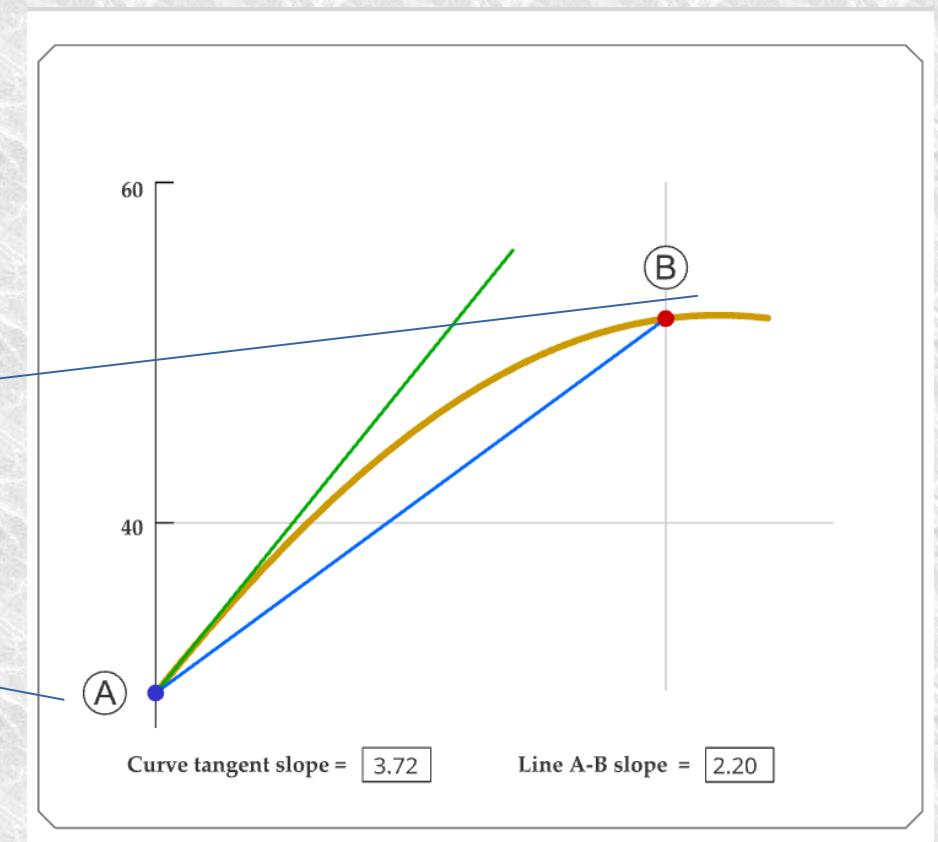
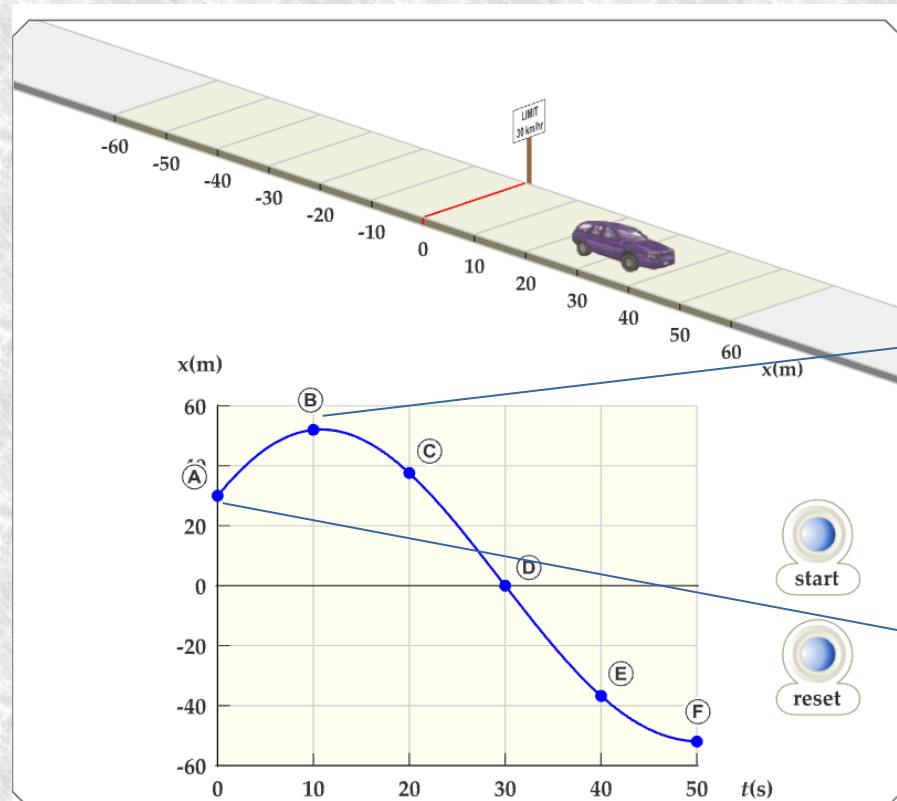
Tutoring 7-9 pm (2nd floor Heterick).

Thur Lab is Exp. 2. Last day to Drop is Feb 9.

Week 2 (cont.)

Motion in 1-Dimension (cont.)

Position vs Time graphs



The instantaneous velocity (at A) is the slope of the green line tangent to the x vs. t curve.

$$\lim_{\Delta t \rightarrow 0} \frac{\Delta \vec{x}}{\Delta t} = \frac{d \vec{x}}{dt}$$

Week 2 (cont.)

Motion in 1-Dimension (cont.)

Average acceleration (\mathbf{a}_{avg} , $\bar{\mathbf{a}}$): a change of velocity per time.

$$\mathbf{a}_{\text{avg}} \equiv \Delta \mathbf{v} / \Delta t = (\mathbf{v}_f - \mathbf{v}_i) / (t_f - t_i)$$

\mathbf{a}_{avg} (and $\bar{\mathbf{a}}$) are vectors

Negative \mathbf{a}_{avg} means “to the left” (NOT decelerating!)

Slope of a line connecting 2 points on a v vs t graph

Instantaneous acceleration (\mathbf{a} , a_{inst} , a): rate of change of velocity with time at an instant.

$$\mathbf{a} \equiv \lim(\Delta t \rightarrow 0) \Delta \mathbf{v} / \Delta t = d\mathbf{v} / dt$$

\mathbf{a} is a vector. We will NOT have a scalar version of acceleration which is always positive.

Negative \mathbf{a} means “to the left” (NOT decelerating)

Slope of a tangent to a v vs t graph.

Week 2 (cont.)

Example problems involving acceleration definitions

Average acceleration (a , a_{avg}): $a_{avg} \equiv \Delta v / \Delta t = (v_f - v_i) / (t_f - t_i)$

Instantaneous acceleration (a , a_{inst}): $a \equiv \lim(\Delta t \rightarrow 0) \Delta v / \Delta t = dv/dt$

Ex (P. 2.24): A car accelerates at $a=1.8 \text{ m/s}^2$. How long does it take to accelerate from 65 km/hr to 120 km/hr?

Soln: $a_{avg} = \Delta v / \Delta t = 1.8 \text{ m/s}^2$ so solve for $\Delta t = \Delta v / a_{avg}$

Need to convert units of $\Delta v = (120 - 65 \text{ km/hr})$

$$= 55 \text{ km/hr} * (1\text{hr}/3600\text{s}) * (1000\text{m/km}) = 15.28 \text{ m/s}$$

So $\Delta t = 15.28/1.8 = 8.49 \text{ sec} \rightarrow 8.5 \text{ sec.}$

Ex (P. 2.26): If $x(t)=4.8t + 7.3 t^2$, what is the acceleration as a function of time?

Soln: $a = dv/dt = d^2x/dt^2$ so find $dx/dt = 4.8 + 14.6 t$

And then $d^2x/dt^2 = 14.6 \text{ m/s}^2$

Week 2 (cont.)

Motion in 1-Dimension (cont.)

More on graphing

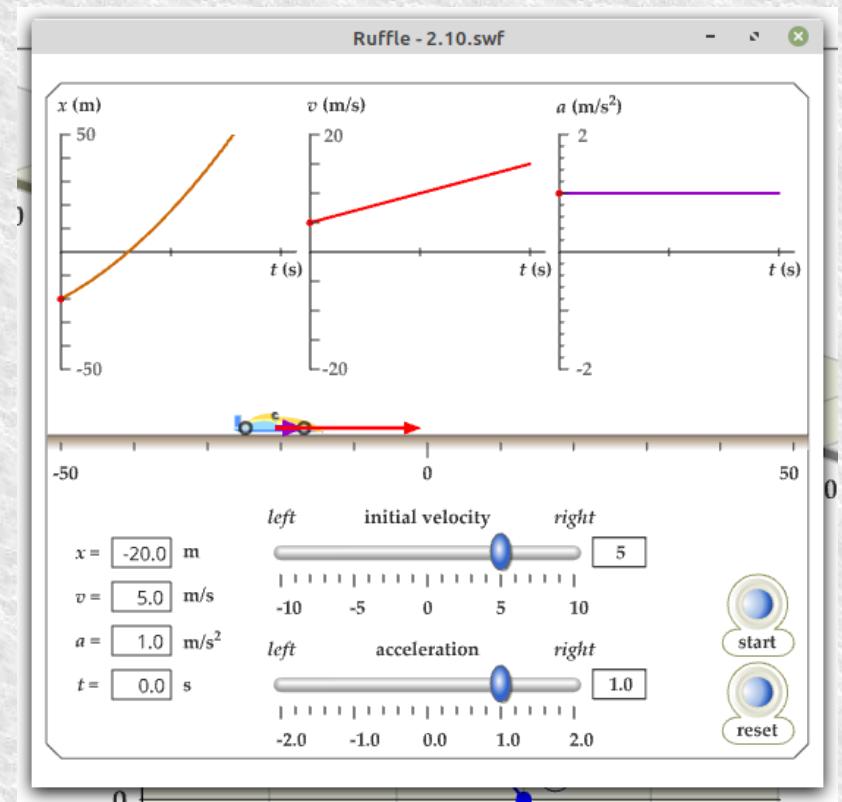
x vs t : v_{inst} is slope of x vs t (but area under x vs t is nothing!)

v vs t : a_{inst} is slope of v vs t

v vs t : Δx is area under v vs t

a vs t : Δv is area under a vs t

See 2.10.swf:



Week 2 (cont.)

Motion in 1-Dimension (cont.)

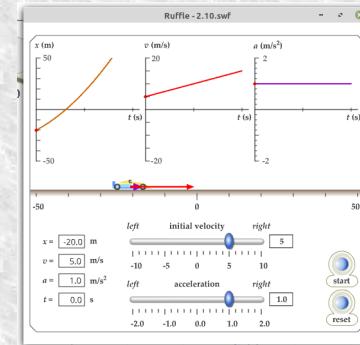
Equations of motion: equations which show x as a function of time.

$x=x_0$ Object is stationary!

$x=x_0+v_0t$ Object moves with a constant speed/velocity.
 x_0 is position at $t=0$, v_0 is velocity at $t=0$.

$x=x_0+v_0t+\frac{1}{2}at^2$ Object has uniform acceleration.

Show graphs on board and with swf:



Week 2 (cont.)

Motion in 1-Dimension (cont.)

Next: Equations of uniform acceleration.