GENERAL PHYSICS I: PHYS 1020

Schedule - Fall 2007
(lecture schedule is approximate)

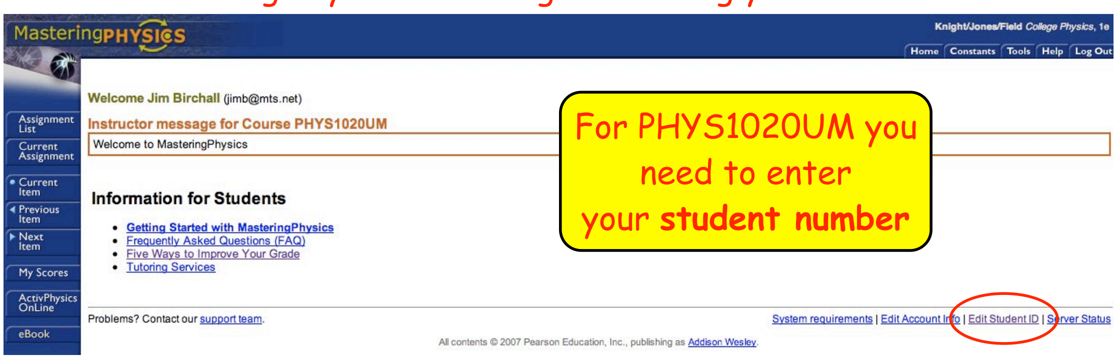
Week	Date		Lecture	Cutnell & Johnson	Topic	Labs/Tests (Tuesdays, Wednesdays, Thursdays)
1	F	Sept 7	1	Chapter 1	Introduction	No lab or tutorial
2	M	10	2			No lab or tutorial
	W	12	3	Chapter 2	Kinematics in one dimension	
	F	14	4			
3	M	17	5			Errors Lecture
	W	19	6			
	F	21	7	Chapter 3	Kinematics in two dimensions	
4	M	24	8			Experiment 1: Measurement of Length and Mass
	W	26	9			
	F	28	10	Chapter 4	Forces and Newton's laws	

The first lab period is this week

It is the errors lecture (in the lab)

You should attend so you know how to combine errors of measurement

Mastering Physics: Entering/correcting your student ID



Mastering Physics

The first Mastering Physics assignment should be available today, after 5 pm – check PHYS1020 website, or Mastering Physics

It has a number of practice problems and problems for credit

It should be completed by Monday, September 24 at 5 pm

Register for Mastering Physics if you haven't done so already! (5% of final grade is from Mastering Physics assignments)

The famous four formulae

$$v = v_0 + at \quad (1)$$

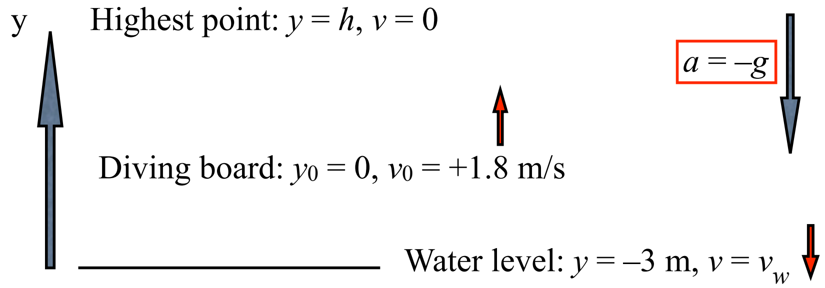
$$x - x_0 = v_0 t + \frac{1}{2}at^2 \quad (2)$$

$$x - x_0 = \frac{1}{2}(v + v_0)t \quad (3)$$

$$v^2 - v_0^2 = 2a(x - x_0) \quad (4)$$

You will definitely need to know these!

Example: A diver springs upward with an initial speed of 1.8 m/s from a 3 m diving board. Find the speed with which he strikes the water and the highest point he reaches.



On entry into water, $y = -3$ m:

$$\begin{aligned} v_w^2 &= v_0^2 + 2a(y - y_0) \\ &= 1.8^2 + 2(-9.8)(-3) \\ v_w &= 7.88 \text{ m/s} \end{aligned}$$

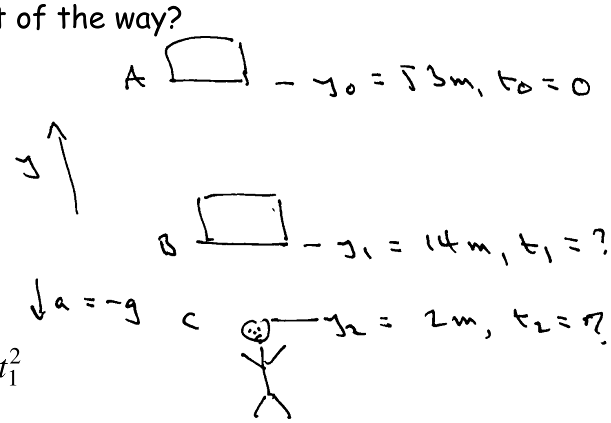
At highest point, $v = 0$:

$$\begin{aligned} v^2 &= v_0^2 + 2a(y - y_0) \\ 0 &= 1.8^2 + 2(-9.8)h \\ h &= 1.8^2/(2 \times 9.8) = 0.17 \text{ m} \end{aligned}$$

As diver is falling, $v_w = -7.88$ m/s

Prob. 2.53/54: A block falls from the top of a building 53 m high. A man 2 m tall notices it when it is 14 m above the ground. How much time does he have to get out of the way?

Use: $x - x_0 = v_0 t + \frac{1}{2}at^2$



At B: $y_1 = y_0 + v_0 t_1 - \frac{1}{2}g t_1^2$

$14 = 53 + 0 - 0.5 \times 9.8 t_1^2$

$\rightarrow t_1 = 2.82$ s

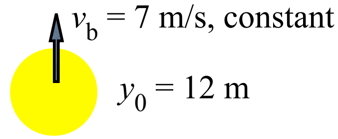
At C: $y_2 = y_0 + v_0 t_2 - \frac{1}{2}g t_2^2$

$2 = 53 + 0 - 0.5 \times 9.8 t_2^2$

$\rightarrow t_2 = 3.23$ s

The time to the crunch is $t_2 - t_1 = 0.41$ s

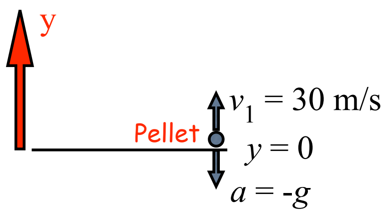
2.78/56: A hot air balloon is ascending straight up at a constant speed of 7.0 m/s. When the balloon is 12.0 m above the ground, a gun fires a pellet straight up from ground level with an initial speed of 30.0 m/s. At what two places are the balloon and pellet at the same height at the same time?



Balloon: $y_b = y_0 + v_b t$

Pellet: $y_p = 0 + v_1 t - \frac{1}{2} g t^2$

Pellet and balloon meet when $y_b = y_p$



$$y_0 + v_b t = v_1 t - \frac{1}{2} g t^2$$

$$\frac{1}{2} g t^2 + (v_b - v_1) t + y_0 = 0$$

$$\text{or, } 4.9t^2 - 23t + 12 = 0$$

$$t = \frac{23 \pm \sqrt{23^2 - 4 \times 4.9 \times 12}}{9.8} = \underline{0.598 \text{ s, or } 4.096 \text{ s}}$$

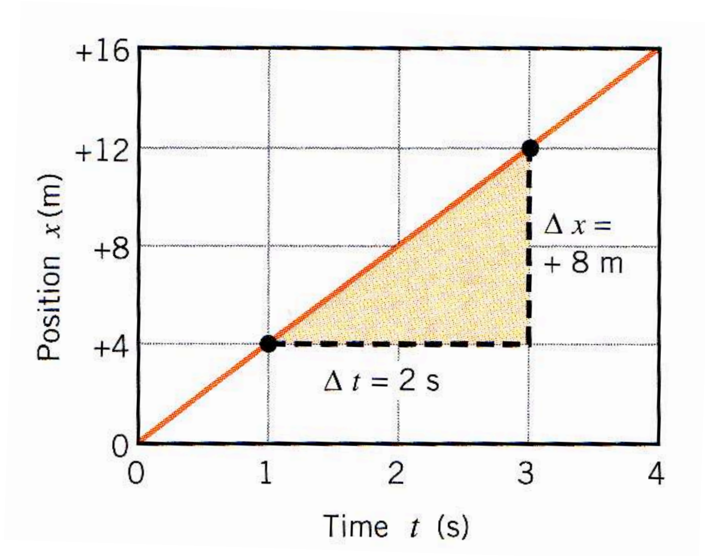
$$\boxed{t = 0.598 \text{ s, or } 4.096 \text{ s}}$$

Balloon: $y_b = y_0 + v_b t \;\; = 12 + 7t$

So, $y_b = 16.19$ m, or 40.67 m

The pellet passes the balloon on the way up at 16.2 m, then passes it again on the way down at 40.7 m.

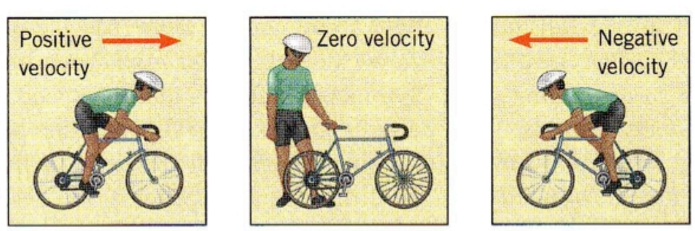
Graphical Analysis

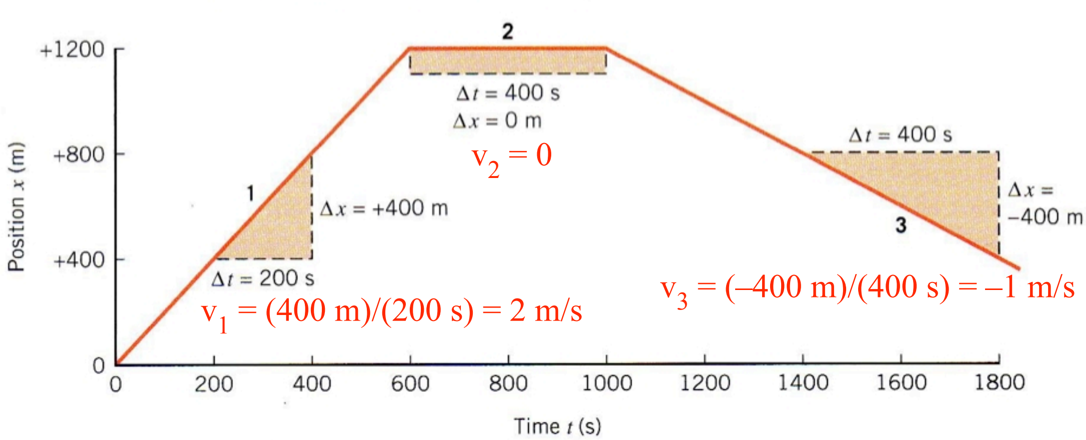


Average speed = $\Delta x/\Delta t$ = (8 m)/(2 s) = 4 m/s

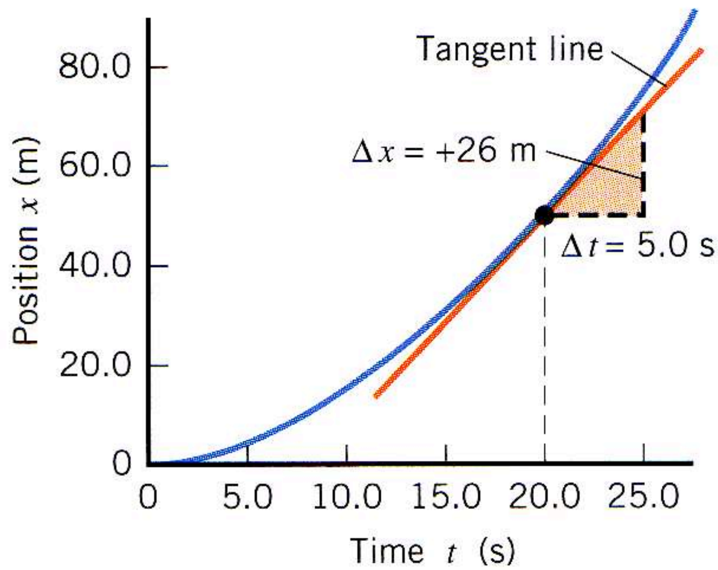
The slope of the curve is constant, so the speed is constant

Changing speed



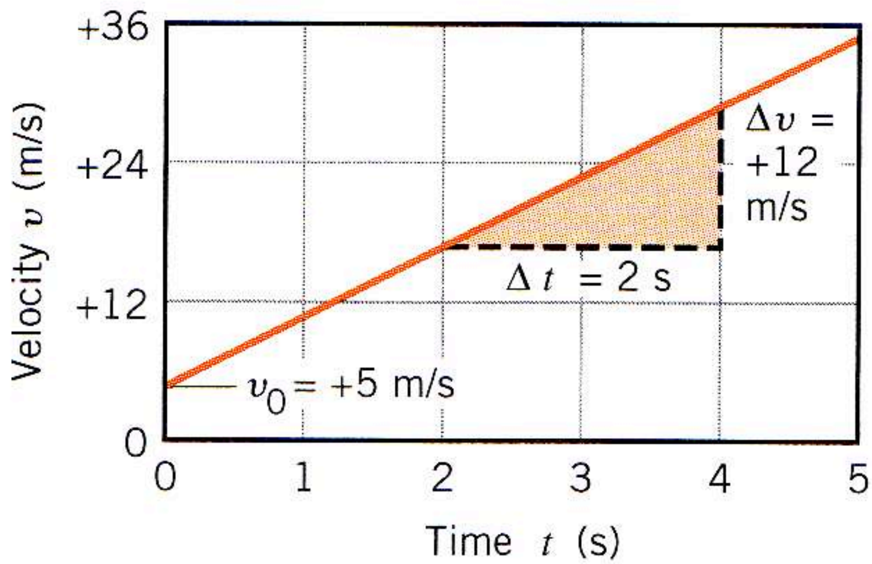


Speed not constant



Instantaneous speed at t = 20 s is (26 m)/(5 s) = 5.2 m/s

Acceleration

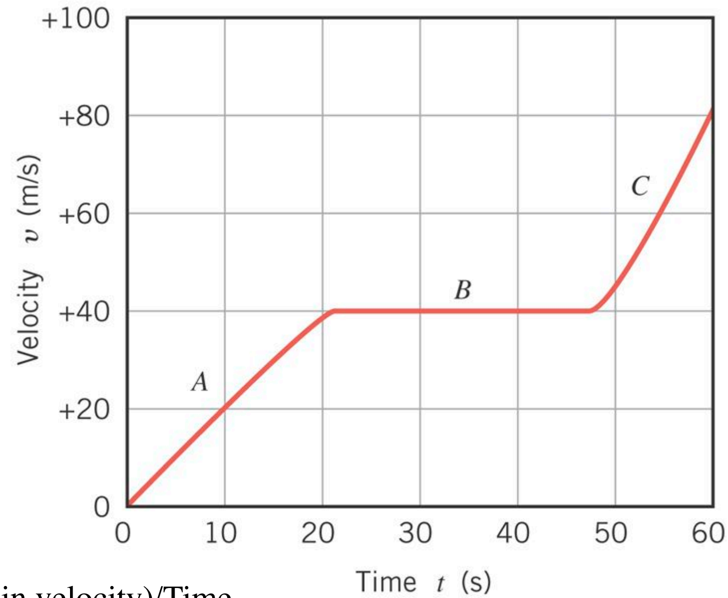


Acceleration = (12 m/s)/(2 s) = 6 m/s^2

The slope of the curve is constant, so the acceleration is constant

2.57/-: A snowmobile moves according to the velocity-time graph shown.

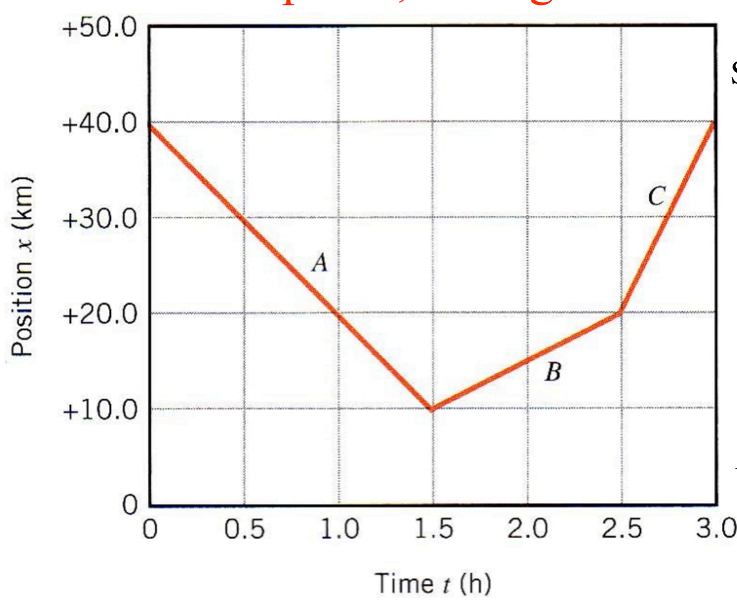
What is its average acceleration during each of the segments, *A*, *B* and *C*?



Acceleration = (change in velocity)/Time

A: $a = 40/20 = 2$ m/s^2
B: $a = 0$ m/s^2
C: $a = (80 - 40)/12 = 3.3$ m/s^2

What are speeds, average acceleration? 2.60/58



$$\text{Speed} = \frac{x_{final} - x_{initial}}{\text{Time}}$$

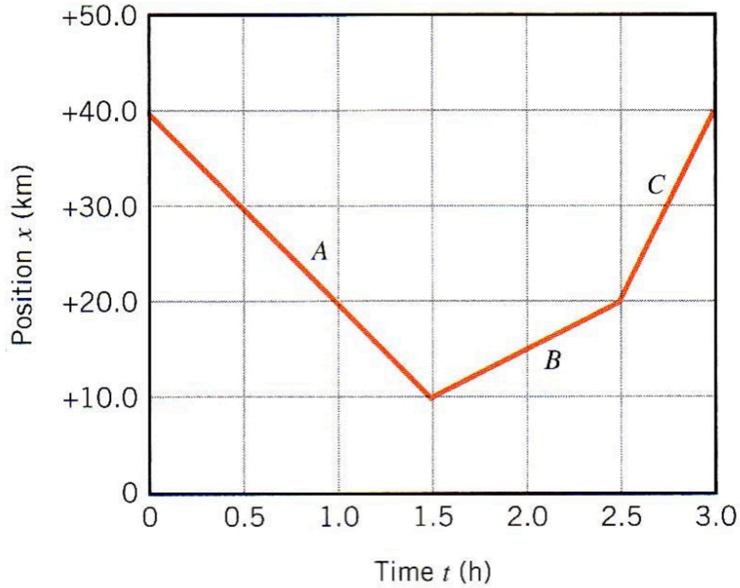
$$v_A = \frac{10 - 40}{1.5} = -20 \text{ km/h}$$

$$v_B = \frac{20 - 10}{2.5 - 1.5} = +10 \text{ km/h}$$

$$v_C = \frac{40 - 20}{3.0 - 2.5} = +40 \text{ km/h}$$

$$\text{Average acceleration} = \frac{v_C - v_A}{T} = \frac{40 - (-20)}{3} = 20 \text{ km/h}^2$$

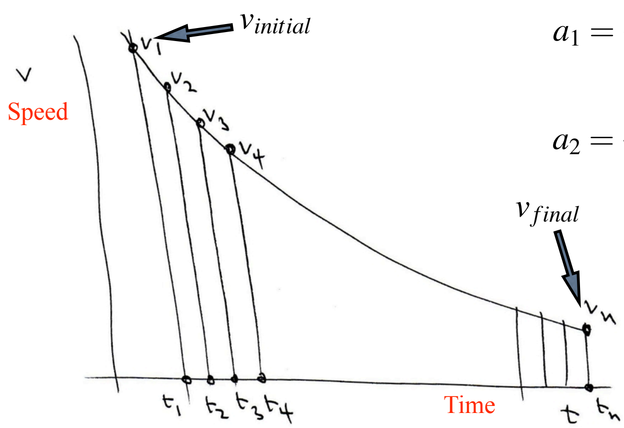
Question about average acceleration



Average acceleration $= \dfrac{v_C - v_A}{T}$ What about v_B?

Question about average acceleration

Average acceleration is $\bar{a} = \dfrac{v_{final} - v_{initial}}{T}$



$$a_1 = \frac{v_2 - v_1}{t_2 - t_1} = \frac{v_2 - v_1}{\Delta t},$$

$$a_2 = \frac{v_3 - v_2}{t_3 - t_2} = \frac{v_3 - v_2}{\Delta t}, \text{ etc}$$

Work out the acceleration at each point, make all the time intervals equal:

Question about average acceleration

$$a_1 = \frac{v_2 - v_1}{\Delta t}$$

$$a_2 = \frac{v_3 - v_2}{\Delta t}$$

$$a_3 = \frac{v_4 - v_3}{\Delta t} \text{ etc}$$

Calculate the average acceleration:

$$\bar{a} = [a_1 + a_2 + \ldots + a_n] \times \frac{1}{n}$$

$$= \frac{(\cancel{v_2} - v_1) + (v_3 - \cancel{v_2}) + \ldots}{\Delta t} \times \frac{1}{n}$$

All of the speeds cancel apart from v_1 and v_n, the first and last values

The total elapsed time is $T = n\Delta t$

So, the average acceleration is $\bar{a} = \dfrac{v_{final} - v_{initial}}{T}$

Speed, Velocity and Acceleration

$$\text{Average speed } = \frac{\text{Distance}}{\text{Elapsed time}} = \frac{x - x_0}{t - t_0}$$

$$\text{Average velocity } = \frac{\text{Displacement}}{\text{Elapsed time}} = \frac{\Delta\vec{x}}{t - t_0}$$

$$\text{Instantaneous velocity } \vec{v} = \lim_{\Delta t \to 0} \frac{\Delta\vec{x}}{\Delta t}$$

$$\text{Average acceleration} = \frac{\text{change in velocity}}{\text{elapsed time}} = \frac{\vec{v} - \vec{v}_0}{t - t_0}$$

$$\text{Instantaneous acceleration} = \lim_{\Delta t \to 0} \frac{\Delta\vec{v}}{\Delta t}$$