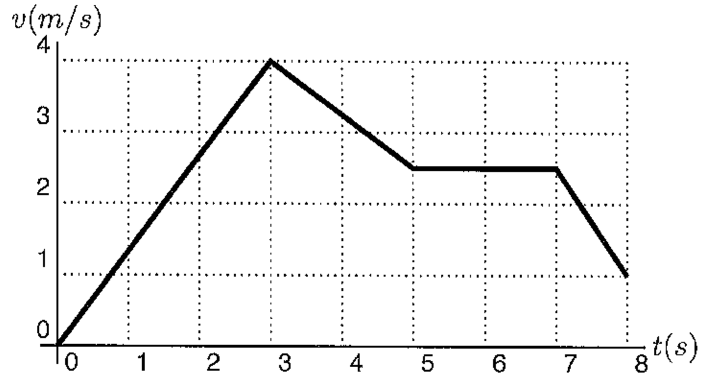
Blue

1. From the intersection of Yale and Central, your instructor's 1973, orange-colored Gremlin starts from rest and has the velocity versus time graph shown below. What was the car's average acceleration for the time interval from $t = 3\,s$ to $t = 8\,s$?



(a) $-0.60\,m/s^2$	(b) $1.3\,m/s^2$	(c) $0.125\,m/s^2$	(d) $-4.7\,m/s^2$

$a_{av} = \frac{V_2 - V_1}{t_2 - t_1}$

$t_2 = 8s,\ V_2 = 1$

$t_1 = 3s,\ V_1 = 4$

$\Rightarrow a_{AV} = \frac{1-4\,m/s}{8-3s} = -3/5\,m/s^2$

$= -.6\,m/s^2$

2. Your physics instructor starts at Regener Hall and runs to the Physics department with average speed $3.0\,m/s$. He then turns around (and being hungry) runs to the Pita Pit for lunch. Due to the hill on Yale, his average speed on his return trip is $2.0\,m/s$. If we assume, for simplicity, that the physics department is $1.5\,km$ due North of Regener Hall and the Pita Pit is $0.50\,km$ due South of Regener Hall, what is the magnitude of the average *velocity* for the entire trip?

(a) $2.3\,m/s$	(b) $0.33\,m/s$	(c) $2.5\,m/s$	(d) $3.3 \times 10^{-4}\,m/s$

P.D. 3m/s 1.5km RH 2m/s .5km P.P.

X: 1.5, 0, -.5km

Velocity $\Rightarrow V_{AV} = \frac{\Delta X}{\Delta t}$

$X_2 = -.5km,\ X_1 = 0$

$\Rightarrow \Delta X = -.5km$

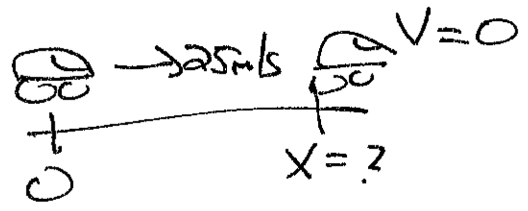
MAGNITUDE $\Rightarrow +.5km = 500m$

$\Delta t = \Delta t_1 + \Delta t_2 \quad \Delta t_1 = \frac{1.5km}{3m/s} = \frac{1500m}{3m/s} = 500s$

Speed = distance / time $\Rightarrow \Delta t_2 = \frac{1.5km + .5km}{2m/s} = \frac{2km}{2m/s} = \frac{2000m}{2m/s}$

$\therefore \Delta t = 500s + 1000s = 1500s$

$V_{AV} = \frac{500m}{1500s} = .33\,m/s$



$V_0 = 25 m/s,\ V = 0,\ a = -5 m/s^2$

$V^2 = V_0^2 + 2a(X - X_0) \Rightarrow 0 = (25 m/s)^2 + 2(-5 m/s^2)(X)$

$\Rightarrow X = 625 m$

3. A car is traveling at 25.0 m/s when the driver hits the brakes causing a constant deceleration of 5 m/s^2. How far does the car go while stopping?

(a) 62.5 m	(b) 5.0 m	(c) 245 m	(d) 125 m

4. A turtle and a rabbit are having a race. The rabbit runs the race with an average speed of 12 km/h while the turtle's average speed is 3.5 km/h. If the turtle finishes the race 36 min after the rabbit, what distance was the race?

(a) 15 km	(b) 3.0 km	(c) 7.2 km	(d) 430 km

$Sp = \frac{d}{\Delta t}$

$\Rightarrow 12 km/h = \frac{d}{\Delta t_r} \Rightarrow d = 12 km/h\, \Delta t_r$

$3.5 km/h = \frac{d}{\Delta t_t} \Rightarrow d = 3.5 km/h\, \Delta t_t$

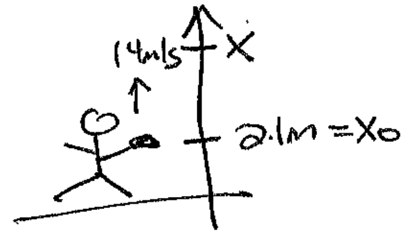
$\Delta t_t = \Delta t_r + 36 MIN$ → but km/h ⇒ hours only $\therefore \Delta t_t = \Delta t_r + \frac{36}{600} h$

$12 km/h\, \Delta t_r = 3.5 km/h(\Delta t_r + \frac{36}{600} h) \Rightarrow 8.5 km/h\, \Delta t_r = 2.1 km$

$\Rightarrow \Delta t_r = .247 h,\quad d = 12 km/h(.247 h) = 2.9647 km \approx 3 km$

5. Your physics instructor finds himself on the moon! where the acceleration due to gravity is roughly one-third of that on earth. If he throws a ball upwards at 14 m/s and the ball is released 2.1 m above the ground, what is the maximum height above the ground of the ball?

(a) 32.1 m	(b) 30.0 m	(c) 89 m	(d) 12.1 m



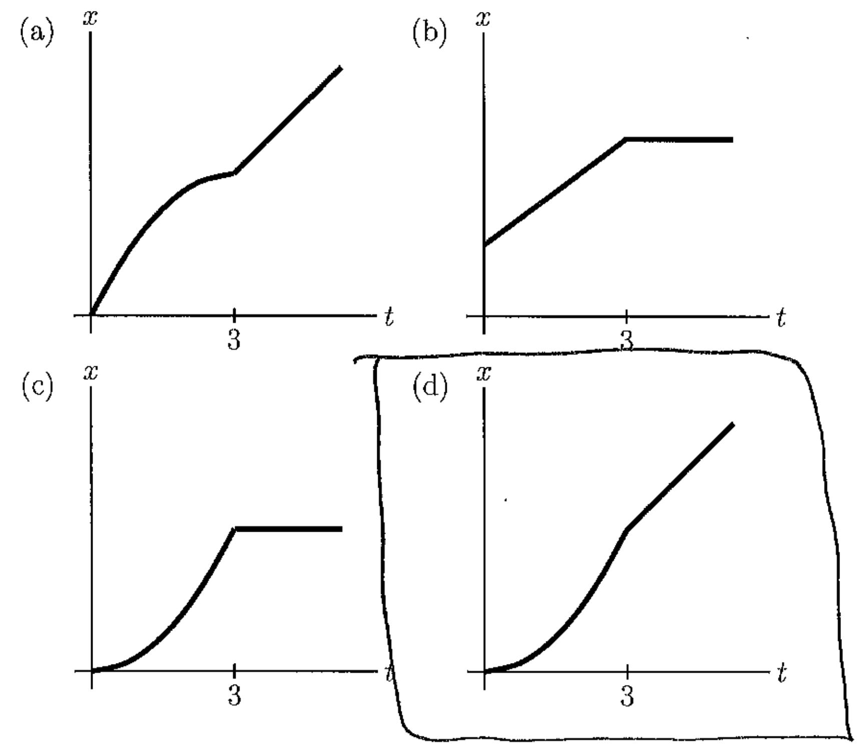
$a = -\frac{1}{3} g = -\frac{1}{3}(9.8 m/s^2) = -3.266... m/s^2$

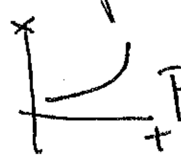
$X_{MAX} = ? \Rightarrow V = 0$

$V^2 = V_0^2 + 2a(X - X_0) \Rightarrow 0 = (14 m/s)^2 + 2(-3.266 m/s^2)(X - 2.1 m)$

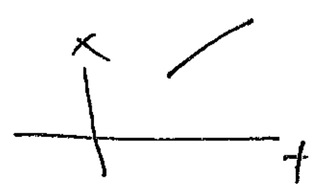
$\Rightarrow X = 2.1 m + 30 m = 32.1 m$

6. Your physics instructor is driving his 1973, orange-colored Gremlin on Lomas Boulevard when he notices that there is an upcoming yellow stoplight . Hitting the gas, he has a constant acceleration for 3 s. At that point, he travels through the intersection, so he eases of the gas and from there maintains a constant velocity. Which of the following plots, correctly corresponds to his position versus time graph?



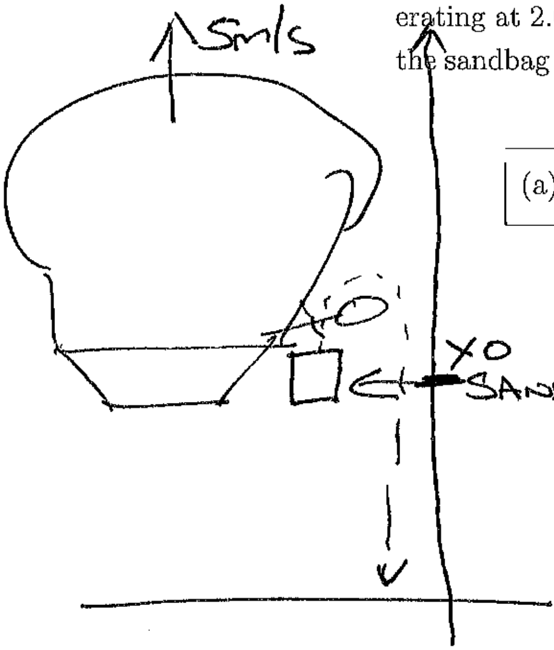
ALREADY MOVING IN POSITIVE DIRECTION,
ACCELERATING ⇒ 

PARABOLA

THEN, CONSTANT VELOCITY ⇒ STRAIGHT LINE 

7. Your physics instructor takes a flight in a hot-air balloon which rises with constant $5.00\,m/s$ speed. $20.0\,s$ after takeoff, a sandbag falls off the balloon. If the missing sandbag causes the balloon to begin accelerating at $2.00\,m/s^2$, how high (above the ground) is the balloon when the sandbag hits the ground? Ignore air resistance in your calculations.

(a) $103\,m$	(b) $151\,m$	(c) $143\,m$	(d) $600\,m$



SANDBAG must have $V_0 = 5m/s$ too

BALLOON has 5m/s constant speed FOR 20s $\Rightarrow X_0 = 5m/s(20s) = 100m$

$a = -9.8m/s^2$

First Find How long it takes For sandbag to hit ground; $X=0$

$X = X_0 + V_0 t + \frac{1}{2} a t^2 \Rightarrow 0 = 100m + 5m/s\,t - 4.9m/s^2\,t^2$

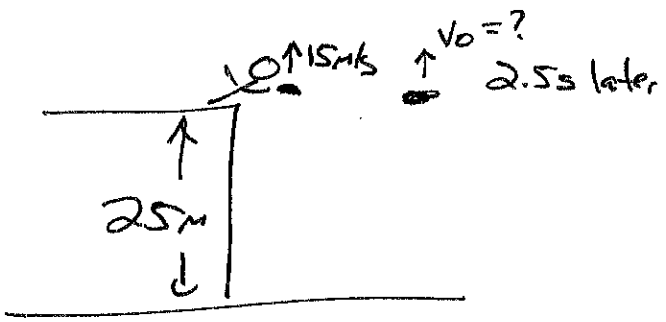
$\Rightarrow 4.9m/s^2\,t^2 - 5m/s\,t - 100m = 0 \Rightarrow t = \frac{5m/s \pm \sqrt{(5m/s)^2 - 4(4.9m/s^2)(-100m)}}{2(4.9m/s^2)}$

$= \frac{5m/s \pm \sqrt{1985\,m^2/s^2}}{9.8m/s^2} = 5.056s$ OR ~~$-4.036s$~~

TO FIND BALLOON's heigHT, RE-start with $X_0 = 100m$, $V_0 = 5m/s$, $a = 2m/s^2$ AND $t = 5.056s$ $\Rightarrow X = X_0 + V_0 t + \frac{1}{2} a t^2 = 100m + 5m/s(5.056s) + \frac{1}{2}(2m/s^2)(5.056s)^2$

$\Rightarrow X = 150.84m = 151m$

8. At the top of a building 25 m high, your instructor throws an egg upwards at 15 m/s. 2.5 s later, he throws another egg. If both eggs hit the ground at exactly the same time, did your instructor throw the second egg upwards or downwards? You must do a numerical calculation to receive full points.



For egg #1: $V_0 = 15m/s$, $X_0 = 25m$, $X = 0$, $a = -9.8m/s^2$

it takes a time $t_1 = ?$ to hit ground.

For egg #2: $V_0 = ?$ ← velocity gives Direction! $X_0 = 25m$

$X = 0$, $a = -9.8m/s^2$. It takes t_2 for it to hit.

2.5s later ⇒ 2.5s less time to hit ground ⇒ $t_2 = t_1 - 2.5s$

$X = X_0 + V_0 t + \frac{1}{2}at^2 \Rightarrow 0 = 25m + 15m/s\, t_1 - 4.9m/s^2\, t_1^2$

$\Rightarrow 4.9m/s^2\, t_1^2 - 15m/s\, t_1 - 25m = 0 \Rightarrow t_1 = \frac{15m/s \pm \sqrt{(15m/s)^2 - 4(4.9m/s^2)(-25m)}}{2(4.9m/s^2)}$

$= \frac{15m/s \pm \sqrt{715 m^2/s^2}}{9.8m/s^2} = 4.26s$ or ~~-1.19s~~

$\therefore t_2 = 1.76s \quad \therefore$ For #2: $0 = 25m + V_0(1.76s) - 4.9m/s^2(1.76s)^2$

DOWN ⟵ $\Rightarrow 9.82176m + V_0(1.76s) = 0 \Rightarrow \boxed{V_0 = -5.58m/s}$