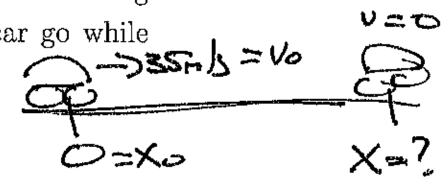
green

1. A car is traveling at $35.0\,m/s$ when the driver hits the brakes causing a constant deceleration of $2.50\,m/s^2$. How far does the car go while stopping?

(a) $14\,m$	(b) $5.6\,m$	(c) $245\,m$	(d) $490\,m$



$a = -2.5\,m/s^2$

$v^2 = v_0^2 + 2a(x - x_0) \Rightarrow$

$0 = (35\,m/s)^2 + 2(-2.5\,m/s^2)x$

$\Rightarrow x = 245\,m$

2. Your physics instructor starts at Regener Hall and runs to the Physics department with average speed $4.0\,m/s$. 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 $2.5\,m/s$. If we assume, for simplicity, that the physics department is $1.2\,km$ due North of Regener Hall and the Pita Pit is $0.75\,km$ due South of Regener Hall, what is the magnitude of the average *velocity* for the entire trip?

P.D.
$1.2\,km = 1200\,m$
R.H.
$.75\,km = 750\,m$
P.P.

(a) $0.69\,m/s$	(b) $1.3\,m/s$	(c) $2.9\,m/s$	(d) $6.9 \times 10^{-4}\,m/s$

$V_{AV} = \frac{\Delta x}{\Delta t} = \frac{-750\,m - 0}{\Delta t} = \frac{-750\,m}{\Delta t}$

distance

$\Delta t = \Delta t_1 + \Delta t_2 = \frac{1200\,m}{4\,m/s} + \frac{(1200 + 750\,m)}{2.5\,m/s}$

$= 300\,s + 780\,s = 1080\,s$

$\Rightarrow V_{AV} = \frac{-750\,m}{1080\,s}$

$= -.694\ldots\,m/s$

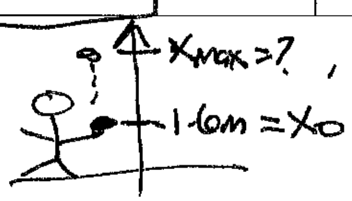
3. Your physics instructor finds himself on the moon! where the acceleration due to gravity is roughly one-third of that on earth. If he throws a ball upwards at $10\,m/s$ and the ball is released $1.6\,m$ above the ground, what is the maximum height above the ground of the ball?

(a) $15.3\,m$	(b) $16.9\,m$	(c) $25.1\,m$	(d) $6.7\,m$

$V_0 = 10\,m/s$

$a_y = -\frac{1}{3}g$

$= -3.267\,m/s^2$

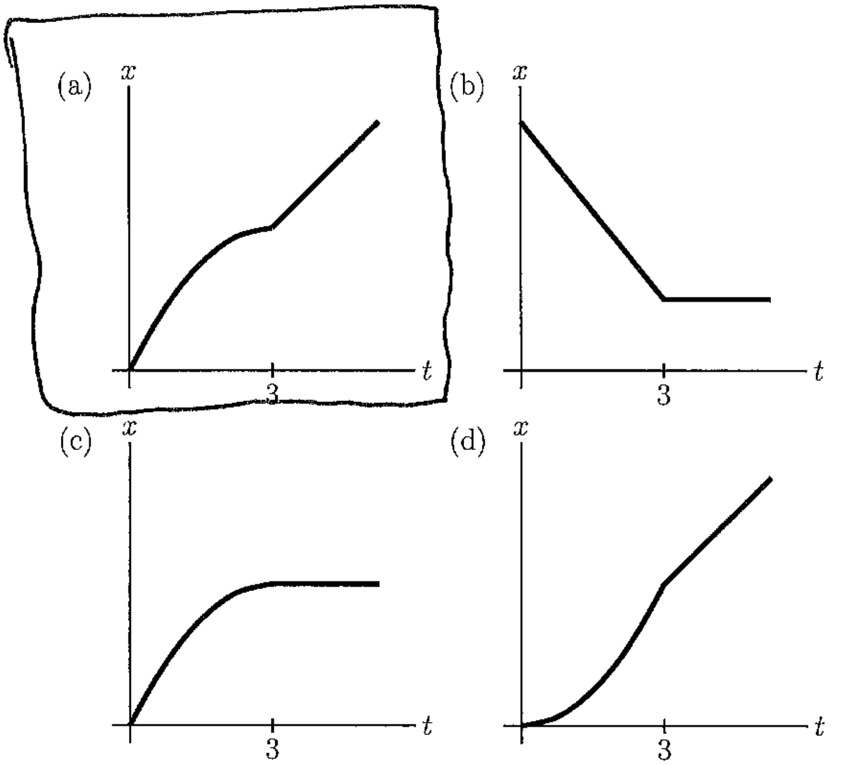


at MAX, $V = 0$

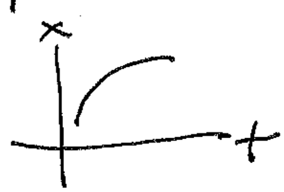
$v^2 = v_0^2 + 2a(x - x_0) \Rightarrow 0 = (10\,m/s)^2 + 2(-3.267\,m/s^2)(x - 1.6\,m)$

$\Rightarrow x = 16.9\,m$

4. Your physics instructor is driving his 1973, orange-colored Gremlin on Lomas Boulevard when he notices that there is an upcoming red stop-light. Hitting the brakes, he has a constant deceleration for $3\,s$. At that point, the light turns green, so he hits the gas again and from that point onwards maintains a constant velocity. Which of the following plots, correctly corresponds to his position versus time graph?



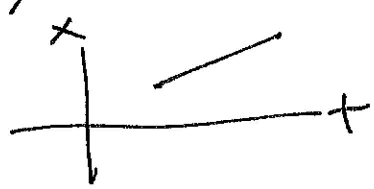
DECELERATING WITH $V_0 \neq 0$ (IN MOTION when PROBLEM BEGINS) ⇒



PARABOLA

CONSTANT velocity ⇒ $a = 0$ ⇒ $X = V_0 t$ ⇒

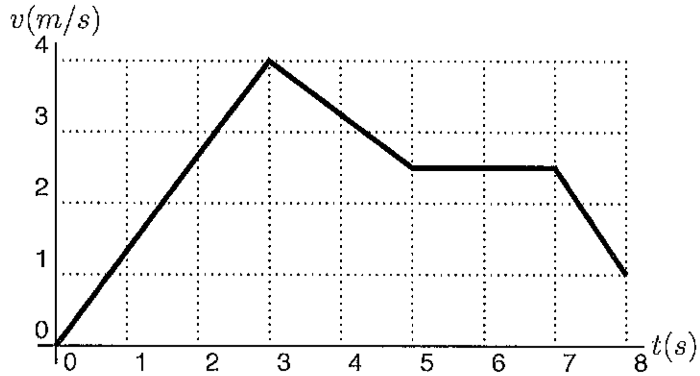
STRAIGHT LINE



5. A turtle and a rabbit are having a race. The rabbit runs the race with an average speed of $15\,km/h$ while the turtle's average speed is $6.5\,km/h$. If the turtle finishes the race $25\,min$ after the rabbit, what distance was the race?

(a) $287\,km$	(b) $6.25\,km$	(c) $4.8\,km$	(d) $3.5\,km$

6. 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 $t = 7\,s$?



(a) $0.36\,m/s^2$	(b) $1.3\,m/s^2$	(c) $-0.375\,m/s^2$	(d) $-0.47\,m/s^2$

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

$V_2 = 2.5m/s,\ t_2 = 7s$

$V_1 = 4m/s,\ t_1 = 3s$

$\Rightarrow a_{AV} = \frac{2.5m/s - 4m/s}{7s - 3s} = \frac{-1.5m/s}{4s} = -.375m/s^2$

RABBIT: $SP_{AV} = \frac{d}{\Delta t_r} \Rightarrow 15km/h = \frac{d}{\Delta t_r} \Rightarrow d = 15km/h\,\Delta t_r$

TURTLE: $SP_{AV} = \frac{d}{\Delta t_t}$ ← SAME! $\Rightarrow 6.5km/h = \frac{d}{\Delta t_t} \Rightarrow d = 6.5km/h\,\Delta t_t$

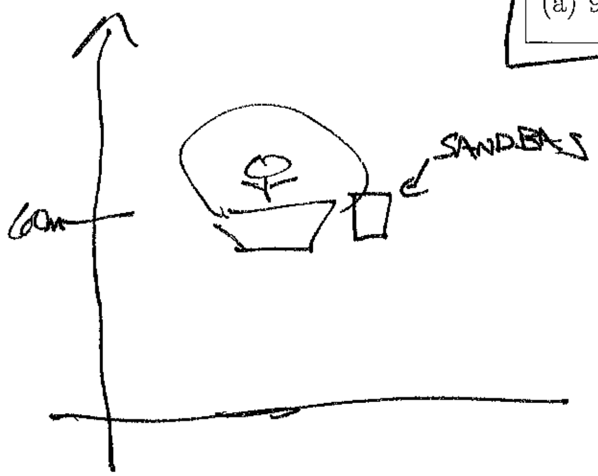
$\Delta t_t = \Delta t_r + 25MIN = \Delta t_r + \frac{25}{60}h$ ← km/h ⇒ hours

$\Rightarrow 15km/h\,\Delta t_r = 6.5km/h(\Delta t_r + \frac{25}{60}h) \Rightarrow 8.5km/h\,\Delta t_r = 2.70831km \Rightarrow \Delta t_r = .318h$

$\Rightarrow d = 15km/h(.318h)$

7. Your physics instructor takes a flight in a hot-air balloon which rises with constant $5.00\,m/s$ speed. $12.0\,s$ 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) $96.6\,m$	(b) $264\,m$	(c) $89.8\,m$	(d) $65.1\,m$



After 12s, BALLOON IS

$X = 5m/s(12s) = 60m$ ABOVE GROUND

$\Rightarrow$ FOR SANDBAG:

$X_0 = 60m,\ V_0 = 5m/s$ ← ON BALLOON

$X = 0,\ a = -9.8m/s^2$

$X = X_0 + V_0 t + \frac{1}{2}at^2 \Rightarrow 0 = 60m + 5m/s\,t - 4.9m/s^2\,t^2$

$\Rightarrow 4.9m/s^2\,t^2 - 5m/s\,t - 60m = 0$

$\Rightarrow t = \dfrac{5m/s \pm \sqrt{(5m/s)^2 - 4(4.9m/s^2)(-60m)}}{2(4.9m/s^2)} = \dfrac{5m/s \pm \sqrt{1201m^2/s^2}}{9.8m/s^2} = 4.046s$ OR ~~-3s~~

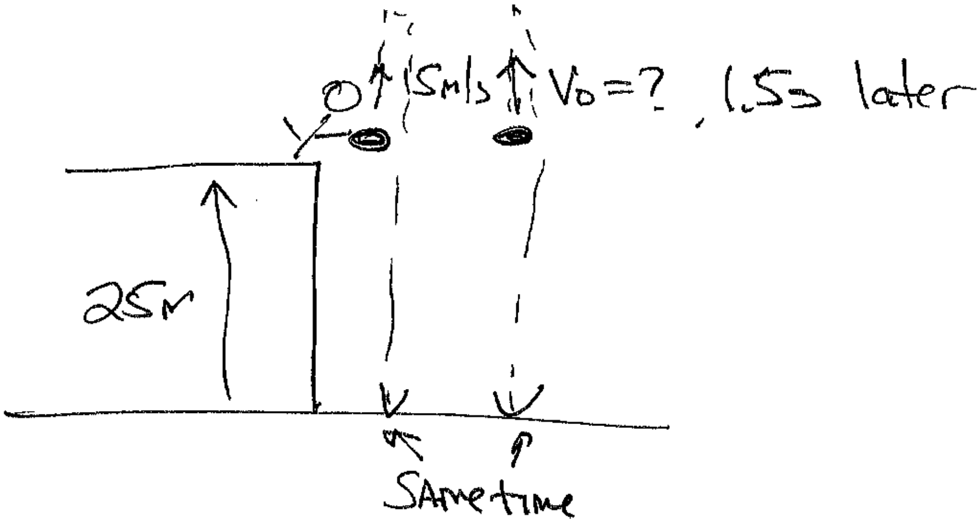
t = How long since SANDBAG DETACHED $\Rightarrow$

Now set $X_0 = 60m,\ V_0 = 5m/s,\ a = 2m/s^2$ FOR BALLOON

$X = ?$

$X = 60m + 5m/s(4.046s) + \frac{1}{2}(2m/s^2)(4.046s)^2 = 96.6m$

8. At the top of a building 25 m high, your instructor throws an egg upwards at 15 m/s. 1.5 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.



but not SAME Elapsed time!

#1: $V_0 = 15\,m/s$, $X_0 = 25\,m$, $X = 0$, $a = -9.8\,m/s^2$, $t_1 = ?$

$X = X_0 + V_0 t + \frac{1}{2}at^2 \Rightarrow 0 = 25m + 15m/s\,t_1 + \frac{1}{2}(-9.8m/s^2)t_1^2$

$\Rightarrow 0 = 25m + 15m/s\,t_1 - 4.9m/s^2\,t_1^2 \Rightarrow 4.9m/s^2\,t_1^2 - 15m/s\,t_1 - 25m = 0$

$\Rightarrow t_1 = \frac{15m/s \pm \sqrt{(15m/s)^2 - 4(4.9m/s^2)(-25m)}}{2(4.9m/s^2)} = \frac{15m/s \pm \sqrt{715m^2/s^2}}{9.8m/s^2} = 4.259s$ OR ~~$-1.197s$~~

#2: $\Rightarrow t_2 = 4.259s - 1.5s = 2.759s$ ← egg #2 gets 1.5s less to REACH GROUND

#2: $V_0 = ?$, $X_0 = 25m$, $X = 0$, $a = -9.8m/s^2$

$\Rightarrow 0 = 25m + V_0(2.759s) - 4.9m/s^2(2.759s)^2 \Rightarrow -12.3m + V_0(2.759s) = 0$

$\Rightarrow$ **$V_0 = +4.46\,m/s$**   **$V_0 > 0 \Rightarrow$ UP**