Kinematics

AT Kinematics(15).doc

Directions: Solve the following problems showing all work and circling your intended final answer. Write in a neat and organized manner such that your work and solutions are readable in much the manner as an essay response, only the language is "Math." Each problem is worth 5points.

1) While driving on an interstate highway, you are in need of a rest stop. You see a sign that says the next rest stop in is 13 miles. If you are driving at 77 mi/hr, how long will it take to get to the rest stop?

$x = 13\,mi$

$v = 77\,\frac{mi}{hr}$

$t = ?$

$a = 0$

$x = v_0 t + \frac{1}{2} a t^2$

$a = Zero$

$x = v_0 t$

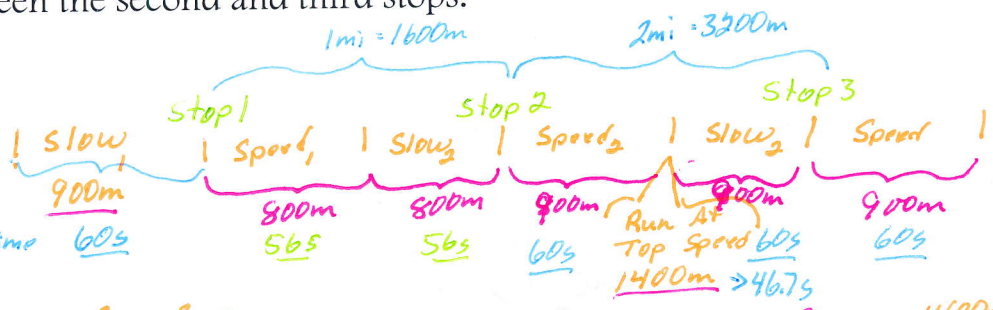
$\frac{x}{v_0} = t$

$\frac{13\,mi}{77\,\frac{mi}{hr}} = .1688\,hr = 10.1\,min$

2) When traveling by rail, there is an option to take an express train or the local train. Both trains stop at the station where you will be boarding, and both trains stop at the station where you will be getting off. Both trains have a top speed of 67mi/hr (30 m/s, actually a little slow for a train, but the 30 m/s is convenient) and both trains accelerate at 0.5m/s^2 when speeding up and slowing down. Determine the time that is saved by taking the express train if the local train makes three stops between your boarding station and your disembarking station. There is 1 mile (1600m) between the first and second stops and 2 miles (3200m) between the second and third stops.

Express

Local



3200m − 900m − 900m = 1400m

Slow$_1$

$v_0 = 30\ m/s$

v = Zero

$a = -.5\ m/s$

$x =$

$v^2 = v_0^2 + 2ax$

$\frac{v^2 - v_0^2}{2a} = x$

$\frac{0 - (30\ m/s)^2}{(2)(-.5\ m/s^2)} = x$

$900m = x$

Speed Up & Slowing Down Is "Symetrical," the Distance To Slow To A Stop Is 900m, So the Distance To Speed Up To max Speed Is Also 900m. Speeding Up ~~And~~ Slowing To A Stop Will Take 900m + 900m = 1800m, There Isn't Room Between Stop 1 & 2 To Come Back Up To Full Speed, So ~~Full~~ Top Speed Between Those Two points Will Be At 800m.

time To Speed Up/Slow Down From Full Speed To Stop

$t = ?$

$v = 30\ m/s$

$v_0 = $ Zero

$a = .5\ m/s^2$

$v = v_0 + at$

$\frac{30\ m/s}{.5\ m/s^2} = t = 60s$

time For Train To Speed Up/Slow For 800m

$x = 800m$

$v_0 = $ Zero

$a = .5\ m/s^2$

$t = ?$

$x = v_0 t + \frac{1}{2} a t^2$

$\sqrt{\frac{2x}{a}} = t = \sqrt{\frac{(2)(800m)}{.5\ m/s^2}} = 56s$

Local

time For Train At Full Speed For 1400m

$\frac{1400m}{30\ m/s} = 46.7s$

(This space should be used as additional space to respond to #2)

Total Time For Local Train To Slow, Speed Up, And Travel Distance Between Stations:

$60s + 56s + 56s + 60s + 46.7s + 60s + 60s = 398.7s$

Total Distance Traveled by Local To Slow, Speed, And Distance Between stops

$900m + 1600m + 3200m + 900m = 6600m$ (4.125mi)

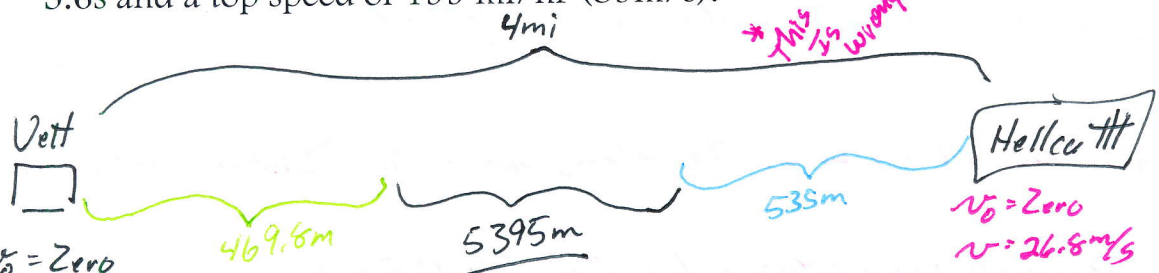
Time For Express To Travel The Slowing And Stopping Distance of Local

$$\frac{6600m}{30\ m/s} = 220s$$

Difference In Time

$398.7s - 220s = \boxed{178s = 2.9 minutes}$

3) A 2016 Corvette Z06 and a 2016 Dodge Challenger SRT Hellcat start 4 miles (6400m) apart, and at rest. Both cars accelerate toward each other at full throttle. How long does it take for them to pass each other? Assume their acceleration is constant (Not true). The Z06 has a 0-60mi/hr (26.8m/s) time of 3s and a top speed of 205 m/hr (91.6m/s). The Hellcat has a 0-60mi/hr time of 3.6s and a top speed of 199 mi/hr (89m/s).



v_0 = Zero
v = 26.8 m/s
a = ?
t = 3s

$v = v_0 + at$

$\frac{v}{t} = a = \frac{26.8\ m/s}{3s} = 8.93\ \frac{m}{s^2}$

Distance To Full Speed

v_0 = Zero
v = 91.6 m/s
x = ?
a = 8.93 m/s^2

$v^2 = v_0^2 + 2ax$

$v^2 = 2ax$

$\frac{v^2}{2a} = x = \frac{(91.6\ m/s)^2}{(2)(8.93\ m/s^2)} = x = 469.8m$

Time To Accel To Full Speed

v_0 = Zero
v = 91.6 m/s
a = 8.9 m/s^2
t = ?

$\frac{v}{a} = t = \frac{91.6\ m/s}{8.9\ m/s^2} = 10.3s$

v_0 = Zero
v = 26.8 m/s
a = ?
t = 3.6s

$v = v_0 + at$

$\frac{v}{t} = a = \frac{26.8\ m/s}{3.6s} = 7.4\ \frac{m}{s^2}$

Distance To Full Speed

v_0 = Zero
v = 89 m/s
x = ?
a = 7.4 m/s^2

$\frac{v^2}{2a} = x = \frac{(89\ m/s)^2}{(2)(7.4\ m/s^2)} = x$

x = 535m

v_0 = Zero
v = 89 m/s
a = 7.4 m/s^2
t = ?

$v = v_0 + at$

$\frac{v}{a} = t = \frac{89\ m/s}{7.4\ m/s^2} = 12s$

$$\frac{x}{v} = \frac{5239m - x}{v}$$

$$\frac{v}{v}x = 5239m - x$$

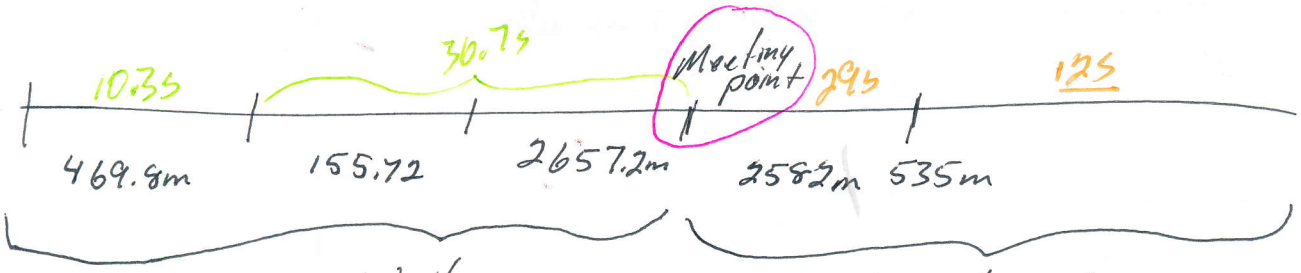
$$\frac{v}{v}x + x = 5239m$$

$$x\left(\frac{v}{v} + 1\right) = 5239m$$

$$x = \frac{5239m}{\left(\frac{v}{v} + 1\right)}$$

$$x = \frac{5239m}{\left(\frac{89\,m/s}{91.6\,m/s} + 1\right)}$$

$$x = 2657.2m$$



Velle

3283m

Hellcat

3117.3m

$$t = \frac{x}{v} = \frac{(155.72m + 2657.2m)}{91.6\,m/s}$$

$$t = 30.7s$$

41.5

$$t = \frac{x}{v} = \frac{2582m}{89\,m/s} = 29s$$

41s

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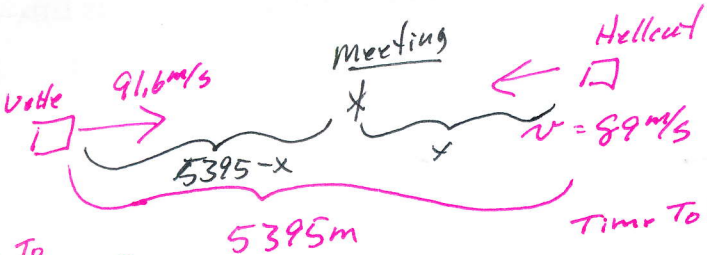
While Traveling At Full Speed



Time To Full Speed = 10.3s

$v = 91.6\ m/s$

$t = t$

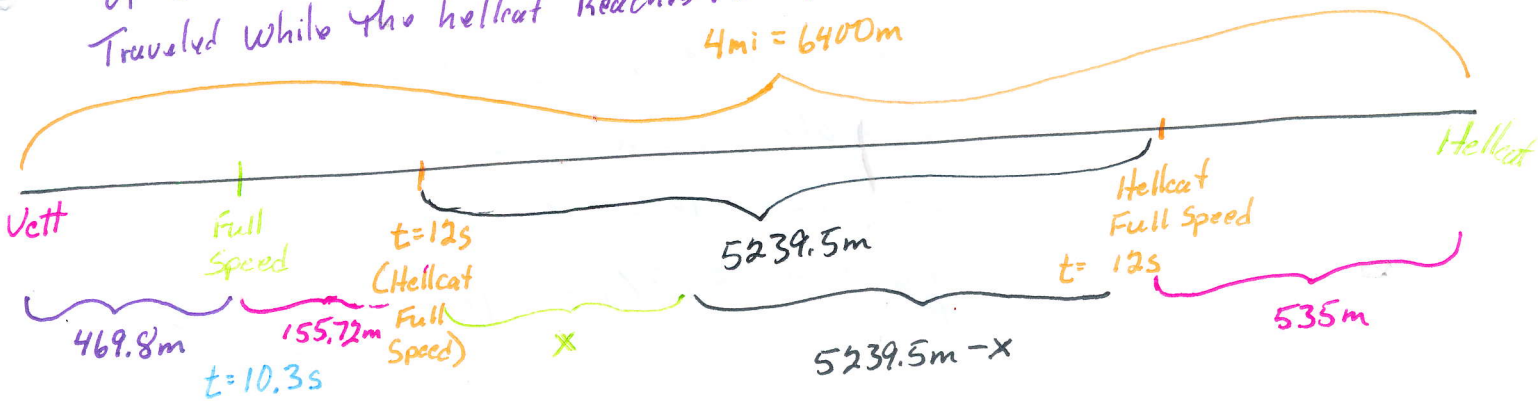
$x = 5395 - x$

$a = zero$

Time To Full Speed 12s

$v = 89\ m/s$

At this Point, there Is An Issue Since Both Cars Do Not Reach Full Speed At the Same Time. So will Look At the Distance Traveled of Each Car While the Vett Reaches Full Speed, Then the Distance Each Traveled While the hellcat Reaches Full Speed, the For Each To Meet.



$t = 12s - 10.3s = 1.7s$

$vt = x$

$\left(91.6\frac{m}{s}\right)(1.7s) = 155.72m$

Vett

Distance = x

$v = 91.6\ m/s$

$t = t$

$\frac{x}{v} = t$

Hellcat

Dist. = 5239.5m - x

$v = 89\ m/s$

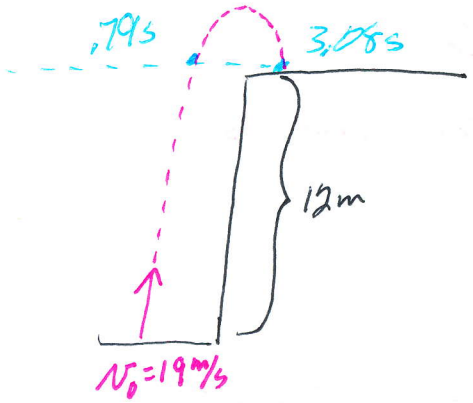
$t = t$

$\frac{5239m - x}{v} = t$

$\frac{x}{v} = \frac{5239m - x}{v}$

Go to *

4) Imagine that you are standing below a 12 m high ledge. You will throw a ball (or small explosive, depending on the degree of your desire to be destructive) up such that it soars over the edge of the ledge and lands on the ledge. Determine how long it will take the ball (or explosive) to land on the ledge if it is thrown upward at 19 m/s.



$y = v_0 t + \frac{1}{2} a t^2$

$12m = (19 \frac{m}{s}) t + (\frac{1}{2})(9.8 \frac{m}{s^2}) t^2$

$A = -4.9 t^2$

$B = 19 \frac{m}{s} t$

$C = -12$

Solving Quadratic gives the 2 Roots Shown. The "Thing" Is 12m Above the starting Position @ .79s & Again At 3.08s

5) According to Car and Driver, the 2016 Ford Mustang Shelby GT 350 will do 0-60mph in 3.7 seconds. What is this acceleration in m/s^2?

$60 \frac{mi}{hr} = 26.8 m/s$

$v_0 = \text{zero}$

$v = 26.8 m/s$

$t = 3.7 s$

$a = ?$

$v = v_0 + at$

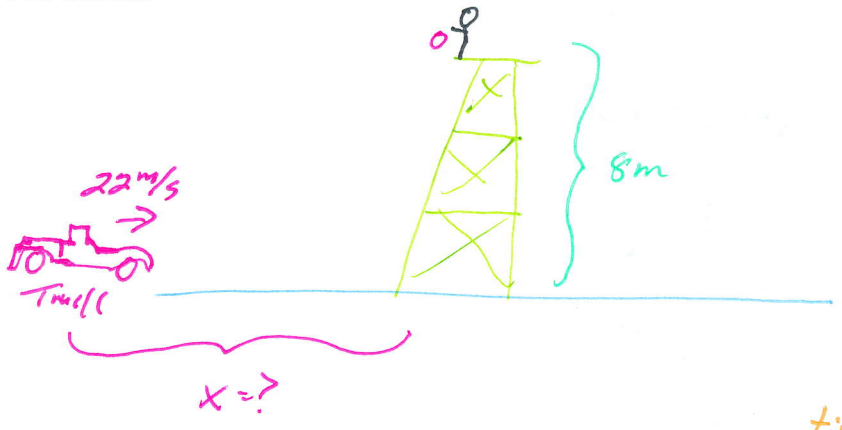
$\frac{v - v_0}{t} = a$

$v_0 = \text{zero}$

$\frac{v}{t} = a$

$\frac{26.8 \frac{m}{s}}{3.7 s} = \boxed{7.2 m/s^2}$

6) A truck is moving toward a tower at 22 m/s. You are standing on the tower, 8 m above the road that the truck is driving on. How far from the base of the tower should the truck be when you release a water balloon if the goal is to hit the truck?



time For Water Balloon To Hit the Ground

$y = -8m$
$a = -9.8 m/s^2$
$t = ?$
$v_0 = zero$
$y = v_0 t + \frac{1}{2} a t^2$

$t = \sqrt{\frac{2y}{g}}$

$t = \sqrt{\frac{2(-8m)}{-9.8 m/s^2}}$

$t = 1.28s$

Truck

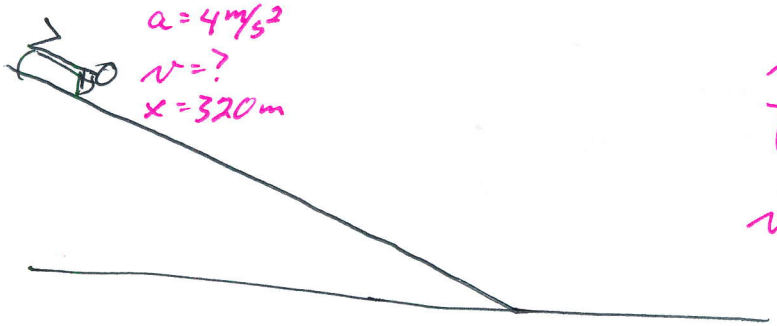
$v_0 = 22 m/s$
$a = zero$
$x = ?$
$t = 1.28s$

$x = v_0 t + \frac{1}{2} a t^2$

$x = v_0 t$

$x = (22 \frac{m}{s})(1.28s) = 28m$

7) When sledding, a 320m long hill will impart a 4 m/s^2 acceleration to a person on a sled. If you run at the top of the hill with a speed of 3 m/s, how fast are you going at the bottom of the hill?



$v_0 = 3\ m/s$
$a = 4\ m/s^2$
$v = ?$
$x = 320\ m$

$v^2 = v_0^2 + 2ax$

$\frac{v^2}{2a} = \frac{v_0^2}{2a} + \frac{2ax}{2a}$

$v = \sqrt{v_0^2 + 2ax}$

$v = \sqrt{(3\frac{m}{s})^2 + (2)(4\frac{m}{s^2})\,320m}$

$v = 50.7\ m/s$