Level I Key Pd 1

KINEMATICS

AT KINEMATICS (12)

Directions: Solve the following problems, showing all work and circling answers. Each problem is worth 5 points.

1) A good runner can run the 400 m dash in a time of about 51 seconds. Assuming a mile to be 1600m, determine the speed of the runner in mi/hr.

$$\left(\frac{400m}{51s}\right)\left(\frac{1mi}{1600m}\right)\left(\frac{3600s}{1hr}\right) = 17.6\ mi/hr$$

2) James and Tina, who live in the same neighborhood, both need to get to the Giant Food Store on the other side of town. There are two routes to get there; James takes the bypass around town and Tina takes Main Street through town. James gets on the highway practically immediately after leaving his house and travels the 12 miles at 60 miles per hour after accelerating up to speed from rest. Upon arriving at Giant, he slows at the same rate until stopping in the parking lot. Tina travels at a top speed of 30 miles per hour driving through town, which is only a distance of 3.5 miles. Tina also catches two lights red, which causes her to have to accelerate to a stop and accelerate back up to speed. Tina also must remain at rest for 1 minute at each red light. If Tina and James both leave at the same time, who gets to Giant first and what is the difference in their time of arrival. Both cars accelerate at the same rate of 2.2m/s^2 (5 mi/hr/s) both speeding up and slowing down.

James 12 miles, 60 mi/hr, $a = 2.2\,m/s^2$

Tina $v_{max} = 30\frac{mi}{hr} = 13.3\,m/s$

James

$(60\,mi/hr)\left(\frac{1\,hr}{3600\,s}\right)\left(\frac{1600\,m}{1\,mi}\right) = 26.7\,m/s$

12 mi — Acceleration (at each end)

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

$v^2 = 2ax$

$\frac{v^2}{2a} = x = \frac{(26.7\,m/s)^2}{(2)(2.2\,m/s^2)}$

$x = 161.6\,m$ ⇒ Acceleration Zones

161.6m | 18880m | 161.6m

12 mi = 19200m

$\frac{18880\,m}{26.7\,m/s} = 706\,s$ Time At Const. Speed

$v = v_0 + at$; $\frac{26.7\,m/s}{2.2\,m/s^2} = 12\,s$ Speed Up & Slow Down

James Total Time

$706\,s + 12\,s + 12\,s = 730\,s$

Home (Tina) 40m — 40m 40m Red Light — 40m 40m Red Light — 40m Giant

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

$\frac{v^2}{2a} = x = \frac{(13.3\,m/s)^2}{(2)(2.2\,m/s^2)} = 40\,m$

Total Distance Accelerating

$(40\,m)6 = 240\,m$

$(3.5\,miles)(1600\,m/mi) = 5600\,m$ Total Traveled

Distance At Const. Speed

$5600\,m - 240\,m = 5360\,m$

Constant Speed Travel Time

$\frac{5360\,m}{13.3\,m/s} = 403\,s$

Time To Accelerate

$v = v_0 + at$

$\frac{v}{a} = t = \frac{13.3\,m/s}{2.2\,m/s^2} = 6\,s$

There Are 6 Instances of Acceleration

$(6\,s)6 \Rightarrow 36\,s$ Spent Accelerating

Tina Total Time

$403\,s + 36\,s + 120\,min$ For The Lights

~~439s~~

559s

$730\,s - $ ~~439s~~ 559s

Tina Wins by ~~291~~ second 171s ~~4.8~~ min 2.85 min

3) Two cars are at sitting at a stop light; one is a Nissan and the other a Toyota. The Nissan is driven by Level I and the Toyota is driven by Ethel. When the light turns green, the Toyota accelerates at 2.2 m/s^2 and you accelerate in the Nissan at 0.8 m/s^2. The Toyota stops accelerating once it hits 45 miles per hour (20 m/s), but the you continue to accelerate until the Toyota is caught. Determine how fast you are going in the Nissan when the Toyota is caught.

Nissan (v_0 = Zero)
$a = .8\,m/s^2$
$v = ?$

Toyota
$a = 2.2\,m/s^2$
$v = 20\,m/s$

Distance Toyota Travels To 20 m/s

$$\frac{v^2}{2a} = \frac{(20\,m/s)^2}{(2)(2.2\,m/s^2)} = 91\,m$$

$v = v_0 + at$

$$\frac{v}{a} = t = \frac{20\,m/s}{2.2\,m/s^2} = 9.1\,s$$

Nissan

$v = v_0 + at$

$v = (.8\,m/s^2)(9.1\,s)$

$v = 7.2\,m/s$

$$\frac{v^2}{2a} = \frac{(7.2\,m/s)^2}{(2)(.8\,m/s^2)} = 33\,m$$

Distance Between the Two

$91\,m - 33\,m = 57.9\,m$

~~Acceleration times~~
~~Nissan = t~~

Nissan * $v = 7.2\,m/s$ — 57.9 m — Toyo * $v = 20\,m/s$, a = Zero — * meeting point

~~$v_N^2 = v_0^2 + 2ax_N$~~

$x_T = v_0 t + \frac{1}{2}at^2$

$x_T = v_0 t$

~~$x_N = x_T + 57.9\,m$~~

~~$(x_N - 57.9) = v_0 t$~~

~~$x_N = v_{0T} t$~~

$x_N = (v_{0N})t + \frac{1}{2}a_N t^2$

$(x_T + 57.9\,m) = v_{0N} t + \frac{1}{2}a_N t^2$

$v_T t + 57.9\,m = v_{0N} t + \frac{1}{2}a_N t^2$

$(20\,m/s)t + 57.9\,m = (7.2\,m/s)t + (\frac{1}{2})(.8\,m/s^2)t^2$

$0 = (.4\,m/s^2)t^2 - (12.8\,m/s)t - 57.9\,m$

$t = 36\,s$

Nissan

$v = v_0 + at$

$v = (7.2\,m/s) + (.8\,m/s^2)(36\,s)$

$v = 36\,m/s$

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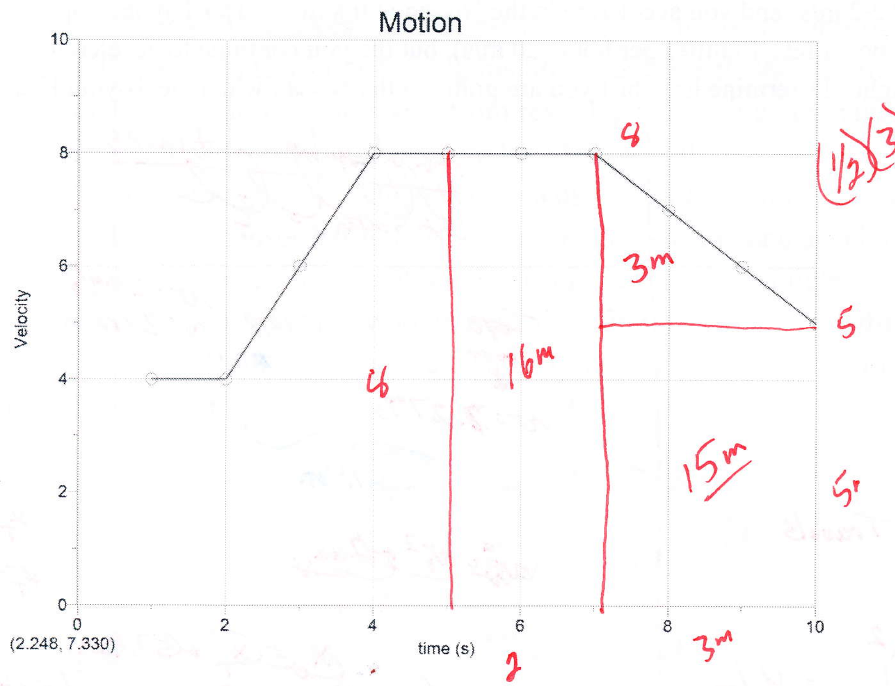
4) From the graph below, determine how far you traveled between the 5 second and 10 second time intervals.



16m + 15m + 4.5m = ~~34m~~ 35.5m

5) While standing on a balcony that is 8 m above a hotel lobby floor, a water balloon is thrown upward with a speed of 8 m/s. Where will the balloon be 2.4 seconds after its release? Will it be going up or down? How do you know?

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

$x = (8\,m/s)(2.4s) + \frac{1}{2}(-9.8\,m/s^2)(2.4s)^2$

-9m

On Ground

6) While driving along at a constant 35 miles per hour (15.6 m/s), a deer jumps out in front of you. Typical reaction time is 0.25 s. If we assume that your reaction is "Clear" and you go for the brakes immediately after seeing the deer, determine the stopping distance if the acceleration of the braking is 3.5 m/s^2. A "clear" reaction time indicates that the driver did not panic and just scream at the sight of the pending collision.

$v = v_0 + at$

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

$x = (15.6\,m/s)\,2.5\,s + 0$

$x = 39\,m$ - Before Braking

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

$\text{Zero} = (15.6\,\frac{m}{s})^2 + (2)(-3.5\,\frac{m}{s^2})x$

$\frac{-(15.6)^2}{-(2)(3.5\,m/s^2)} = 34.8\,m$

$34.8\,m + 3.9\,m = 38.7\,m$

7) Same situation as before in #6, only this time, you are driving at 45 mi/hr (20 m/s). Determine the stopping distance. Consider that if a collision is avoided by a mere 1.4 meters at one speed, it may be ugly at even just slightly faster speeds. Something to consider when driving.

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

$x = (20\,\frac{m}{s})(.25\,s)$

$x = 5\,m$ – Distance During Reaction Time

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

$\frac{(20\,m/s)^2}{(2)(3.5\,m/s^2)} = 57\,m$

Total Stop

$57\,m + 5\,m = 62\,m$

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8) Determine the acceleration of car that changes its speed by 25 mi/hr in a time of 12 seconds.

$a = \frac{25 mi/hr}{12 s} = 2.1 \ mi/hr/s = ~~.0006~~ \ m/s^2$

$.94 \ m/s^2$