Dave Shoemaker Pd 1

Kinematics Test

AT kinematics (18)

Directions: Solve the following problem. Show all work. Be neat. Your solution should mathematically read like an essay. Each problem is worth 5 points.

1) Your car is able to accelerate at $3 m/s^2$. Determine how far you will travel while accelerating from rest to 22 m/s (50 mi/hr)

$v_0 = 0$

$v = 22 m/s$

$a = 3 m/s^2$

$x = ?$

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

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

$$\frac{(22 m/s)^2}{(2)(3 m/s^2)} = 80.7m$$

2) Two trains travel between the fictitious towns of Newberry and Midland. The towns are 30 miles apart. The train "Comet" is an express train that travels non-stop between Newberry and Midland. The train "Lion" is a local train, meaning that it makes two equidistant stops between Newberry and Midland. The Lion is stopped at each station for 5 minutes. Both trains are operated with the same power unit, so both trains have a top speed of 32 m/s and both accelerate at 0.5 m/s² to speed up and slow down. Determine how much time is saved by taking the "Comet."

Lion

Newberry   midland
    *   *   *   *
          10mi   20mi   30mi
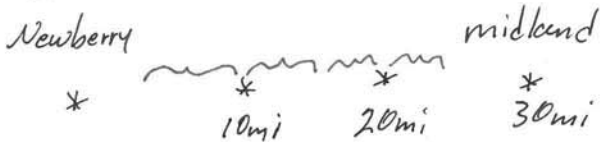
Distance To accelerate

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

$\dfrac{v^2}{2a} = x$; Speeding Up & Slowing Down

$\dfrac{(32^m/_s)^2}{(2)(.5\frac{m}{s^2})} = 1024m$

Time To accelerate

$v = v_0 + at$

$\dfrac{v}{a} = t = \dfrac{32^m/_s}{.5^m/_{s^2}} = 64s$

"Lion" Needs To accelerate 4 Times more than "Comet"

"Lion" Total Distance Accelerating:
    $(1024m)(4) = 4096m$
    Total Time accelerating
            $= 256s$

Time For "Comet" To Travel 4096m

$\dfrac{4096m}{32\frac{m}{s}} = 128s$

Time Saved (Travel)

$256s - 128s = \boxed{128s}$

2 Stops 5min Each
    300s Each
    600s Total

$\boxed{728s \ Diff}$

3) While speeding on the road at 60mi/hr (27m/s), a parked police officer is passed. Assume the police car pulls out just as you pass them, determine how far you travel until the police officer catches you knowing the police car will accelerate at 5 m/s². Assume you continue to travel at a constant speed. Assume the Police car continues to accelerate until they catch you.

Police
$v_0 = Zero$
$x = ?$
$t = ? = t$
$a = 5 \, m/s^2$

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

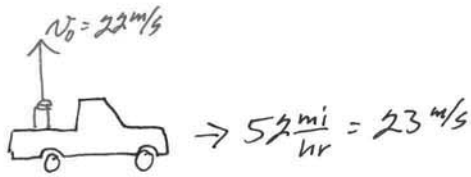$x = \frac{1}{2} a t^2$

$x = \frac{1}{2} a \left[\frac{x}{v_0} \right]^2$

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

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

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

$\frac{(2)(27 \, m/s)^2}{5 \, m/s^2} = \boxed{291.6 \, m}$

You
$v_0 = 27 \, m/s$
$t = ? = t$
$x = ?$

$x = v_0 t$

$\left(\frac{x}{v_0} \right) = t$

4) A "small cannon" is placed in the back of an open pick-up truck. The cannon will fire a small ball straight up with a speed of 22 m/s (small cannon as in not very powerful). The truck is traveling at a constant 52 mi/hr when the cannon is fired. The cannon is pointed straight up. Determine how far the truck will travel while the ball is in the air.

$v_0 = 22$ m/s

$\rightarrow 52 \dfrac{mi}{hr} = 23$ m/s

Time Ball Is In the Air

$v_0 = 22$ m/s

$y = x = $ Zero

$t = ?$

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

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

$0 = \left(22 \tfrac{m}{s}\right) t + \left(\tfrac{1}{2}\right)\left(-9.8 \tfrac{m}{s^2}\right) t^2$

$\left(4.9 \tfrac{m}{s^2}\right) t^2 = \left(22 \tfrac{m}{s}\right) t$

$\dfrac{4.9 \frac{m}{s^2}}{22 \frac{m}{s}} = t$

$.22 s = t$

math error on my part

$t = \dfrac{22 \, m/s}{4.9 \, m/s^2} = 4.4 s$

Distance Truck Travels In .22s

$x = v_0 t$

$x = \left(23 \tfrac{m}{s}\right)\left(.22 s\right)$

$x = 5.12 m$

$\left(23 \tfrac{m}{s}\right)\left(4.4 s\right)$

$103 m$

5) A ball is dropped from a height of 12m. How long does it take for the ball to hit the ground?

$$y = 12m$$
$$a = -9.8\frac{m}{s^2}$$
$$t = ?$$
$$v_0 = 2\text{ero}$$

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

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

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

$$\sqrt{\frac{-(2)(12m)}{-9.8\,m/s^2}} = \boxed{1.56s}$$

6) A ball is thrown downward at 15 m/s from a height of 12m. How long does it take for the ball to hit the ground?

$$y = 12m$$
$$v_0 = -15 m/s$$
$$t = ?$$
$$a = -9.8 m/s^2$$

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

$$0 = -y + v_0 t + \tfrac{1}{2} a t^2$$

$$0 = \overset{C}{(12m)} + \overset{B}{\left(-15 m/s\right)} t - \overset{A}{\left(4.9 \tfrac{m}{s^2}\right)} t^2$$

Quadratic Formula...

$$\boxed{t = .66s}$$