2-25-13 4A

Sp'13 Test 1 Review

CW 3 continued

return ICQ3 in labs

cast call ICQ4.

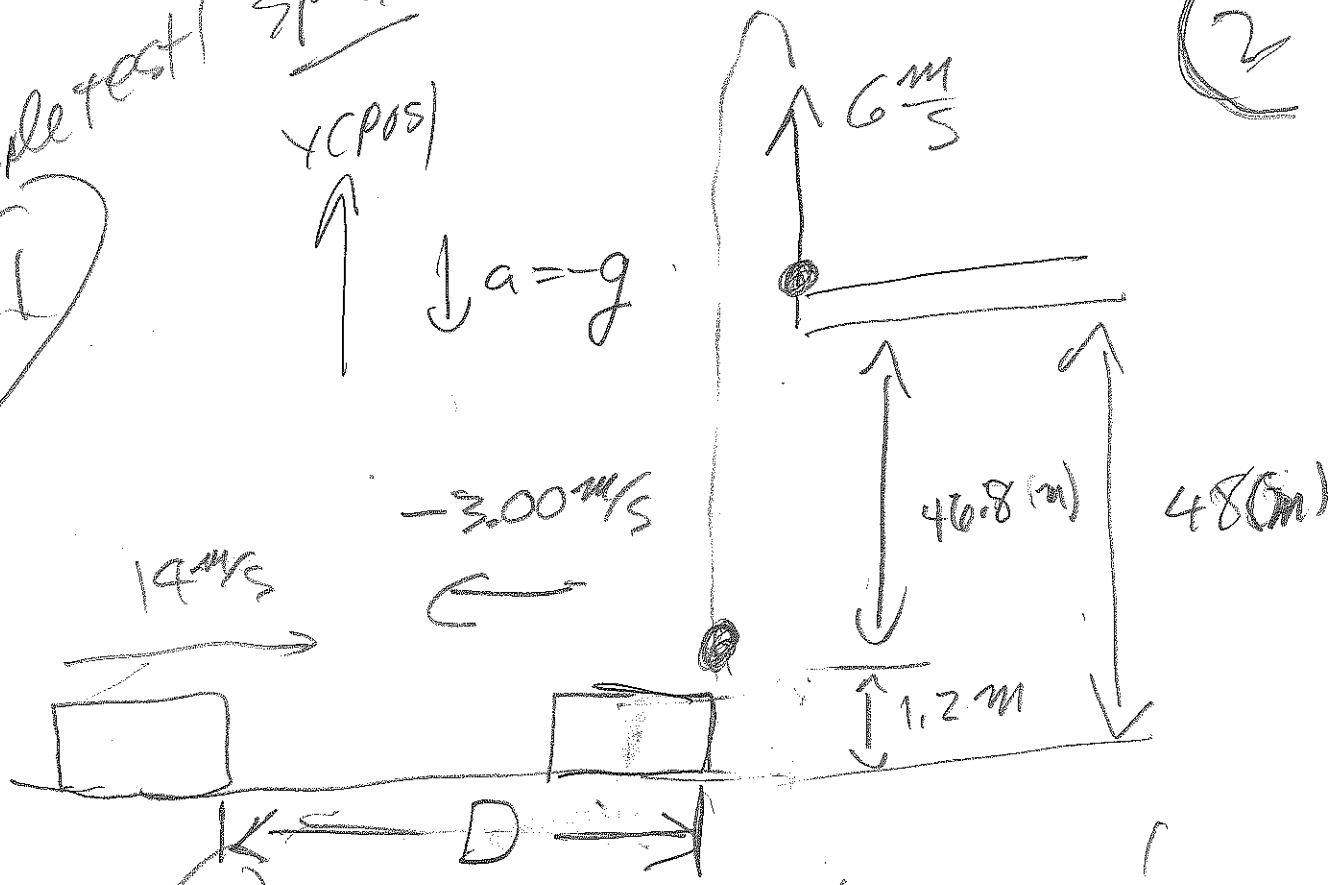
Caps: "easy" projectile motion (covered in labs) on Quiz 4, for practice.

T1 cross-index MP:

All problems are related;
BUT I try to make obvious connections.

sample test 1 spr 11

#1



(a) speed of student

outline: find Δt and use

$$v = 14\frac{m}{s^2} - \left(3.00\frac{m}{s^2}\right)\Delta t$$

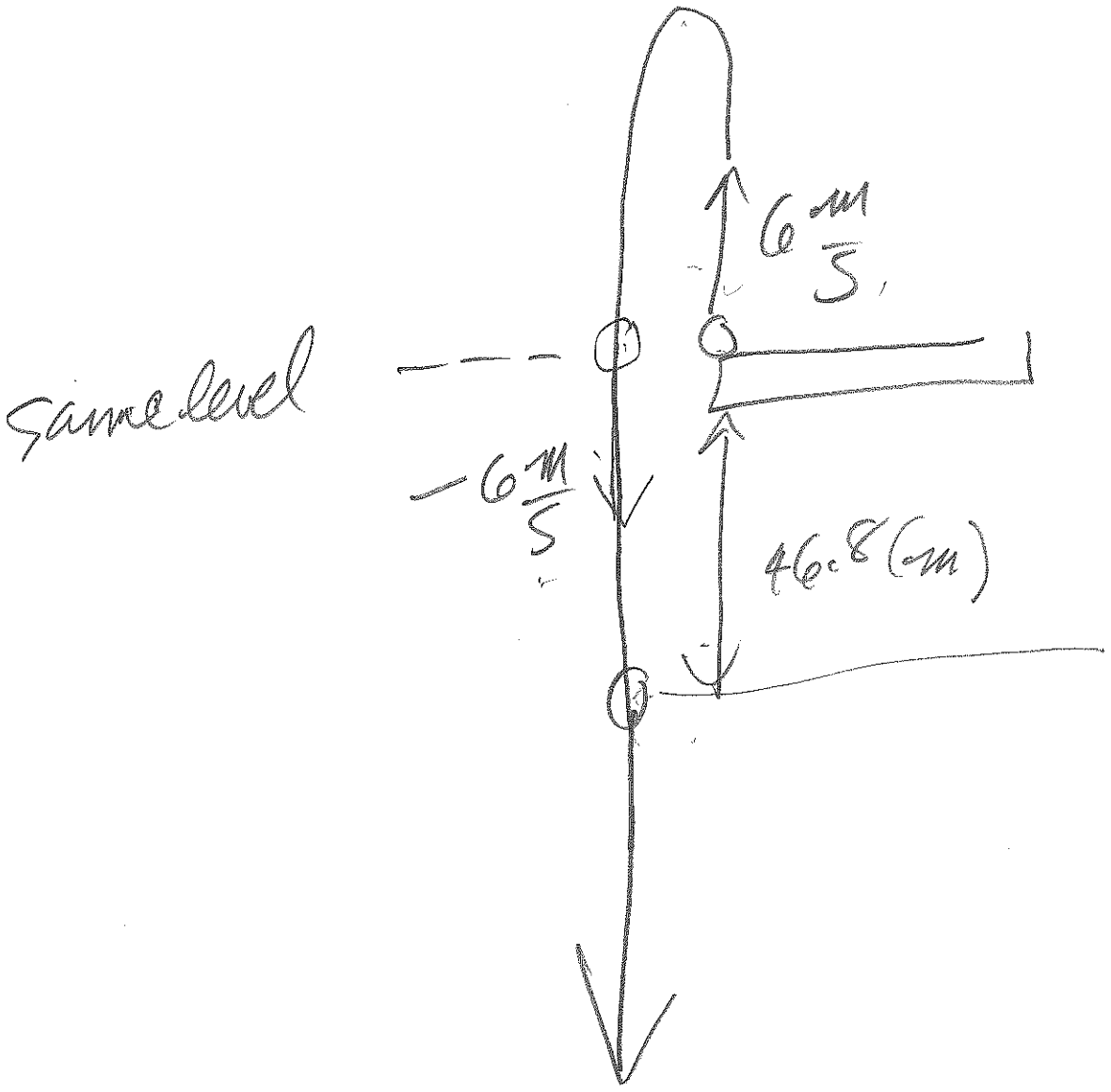
(b) speed egg: find Δt and use

$$v = \left(6\frac{m}{s}\right) - \left(9.8\frac{m}{s^2}\right)\Delta t$$

(c) also $v^2 = \left(6\frac{m}{s}\right)^2 - 2\left(9.8\frac{m}{s^2}\right)\cdot(-46.8\,m)$

$$\overline{v_y} = \frac{\left(6\frac{m}{s}\right) + v_f}{2} = \frac{\Delta y}{\Delta t}$$

(d) $$D = \left(14\frac{m}{s}\right)\Delta t - \frac{1}{2}\left(3.00\frac{m}{s^2}\right)\Delta t^2$$



BRUTE FORCE: $\Delta y = y_2 - y_1$

$$y_2 - y_1 = v_1 \Delta t - \frac{1}{2} g \Delta t^2$$

$$-46.8 = 6\Delta t - 4.9\Delta t^2$$

Quadratic equation

Check: FIND $v_{bottom} = v_2$; then $-g = \frac{v_2 - 6\frac{m}{s}}{t_2 - t_1} = \frac{v_2 - v_1}{\Delta t}$

$v_1 = 6\frac{m}{s}$ → FIND Δt.

$$v_2^2 = v_1^2 - 2g(-46.8\,m)$$

v_2: speed of egg

$$v_2^2 = \left(6\tfrac{m}{s}\right)^2 - \left(19.6\tfrac{m}{s^2}\right)(-46.8\,m)$$

$$v_2^2 = 36\tfrac{m^2}{s^2} + 917.28$$

$$v_2^2 = 953.28\tfrac{m^2}{s^2}$$

$$v_2 = \pm\sqrt{953.28}\ \tfrac{m}{s}$$

$v_2 = -30.875\ \frac{m}{s}$

choose + sign

$$\Delta t = \frac{v_2 - v_1}{-g} \iff g = \frac{\Delta v}{\Delta t}$$

$$= \frac{-30.875 - 6\ \frac{m}{s}}{-9.8} = 3.76\,(s)$$

(a) $v_2 = 14\tfrac{m}{s} - \left(3.00\tfrac{m}{s^2}\right)(3.76) = \boxed{2.72\tfrac{m}{s}} > 0$ yeah!

(b.) $v_2 = 6\frac{m}{s} - \left(9.8\frac{m}{s^2}\right)(3.76\,s)$

$\approx -30.875\frac{m}{s}$ confirms earlier computation.

(c)

Prediction:

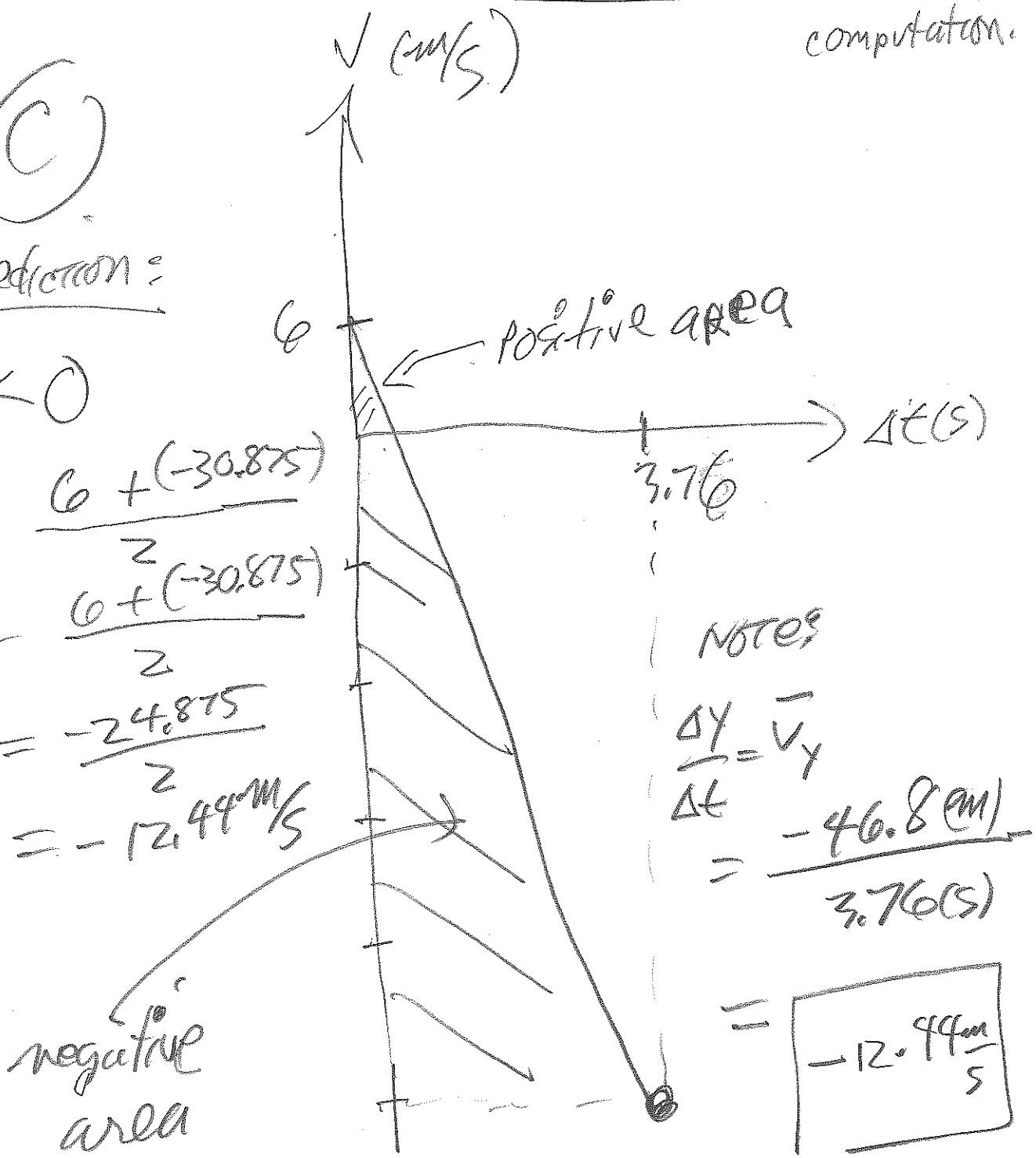
$\bar{v}_y < 0$

$\bar{v} = \bar{v}_y = \frac{6 + (-30.875)}{2}$

$\bar{v} = \frac{6 + (-30.875)}{2}$

$= \frac{-24.875}{2}$

$= -12.44\,m/s$



Note:

$\frac{\Delta y}{\Delta t} = \bar{v}_y$

$= \frac{-46.8\,(m)}{3.76\,(s)}$

$= \boxed{-12.44\frac{m}{s}}$

Sample test #1, SPH

(2.)

$10\ m/s$ →

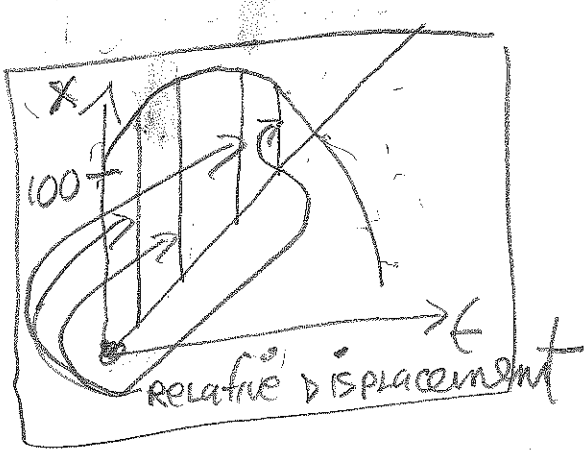
← $25\ m/s$ ← $1\ m/s^2 = a$

[A] maintenance [B] Freight

← 100 m →

(a.) $V_B = ?$

(b.) $\bar{V}_B = ?$



(c.) when $V_A = V_B$?

PAIR

(d.) Before collision

MAXIMUM distance

between (A.) and (B.)

(a.) $100 + 25t - \frac{1}{2}(1)t^2 = 10t$

Freight B = maintenance A

$$100 = -25t + 10t + \frac{1}{2}(1)t^2$$

$$\frac{t^2}{2} + 10t - 25t - 100 = 0$$

$$\frac{t^2}{2} - 15t - 100 = 0$$

$$t = \frac{15 \pm \sqrt{15^2 + 4\cdot\left(\frac{1}{2}\right)(100)}}{1}$$

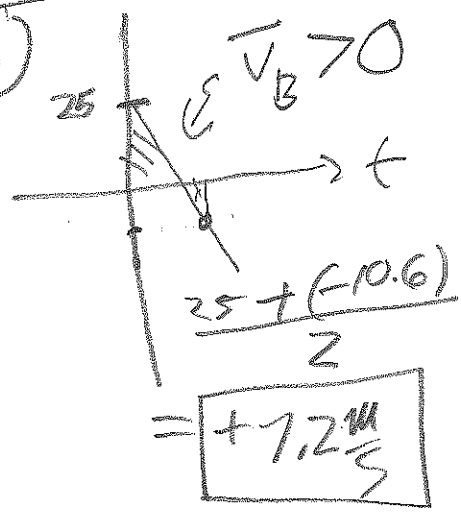
$$= 15 \pm \sqrt{225 + 200}$$

$$= 15 \pm \sqrt{425} = \boxed{35.6\ (s)}$$

(a) $v_B = 25\frac{m}{s} - \left(1\frac{m}{s^2}\right)(35.6)$

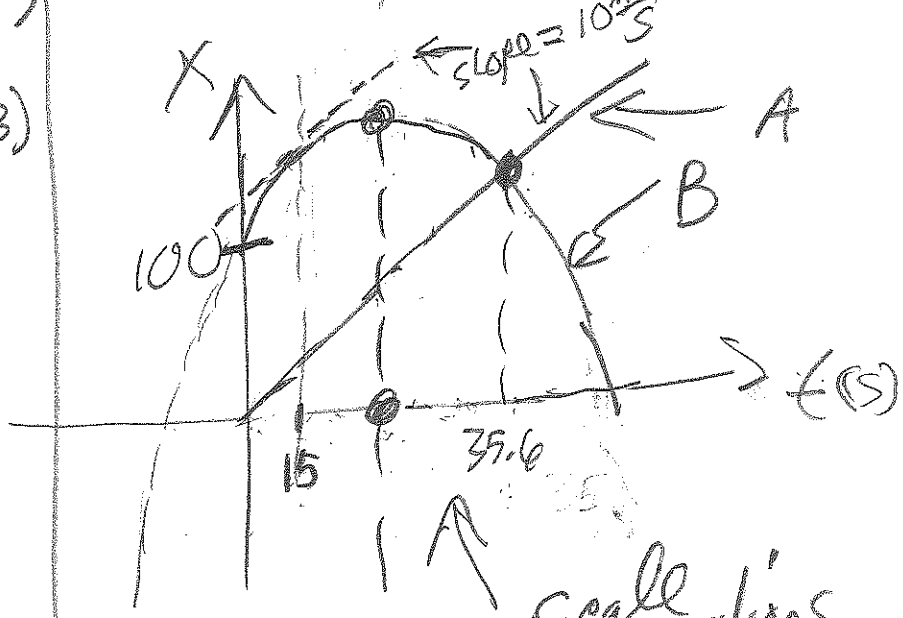
$= -10.6\frac{m}{s}\ (B)$

(b)



$$\frac{25 + (-10.6)}{2}$$

$$= \boxed{+7.2\frac{m}{s}}$$



(c)

$$V_A = V_B$$

$$10 = 25 - t$$

$$t = 15\,(s)$$

(d) 2 ways (Quiz 4 - relative motion)

WAY 1

$$\frac{d(X_A - X_B)}{dt} = 0$$

Math! critical point

$$\frac{dX_A}{dt} = \frac{dX_B}{dt}$$

$$V_A = V_B$$

way 2

way 2 use PART (c)

$$X_B = X_A = X_{MAX}$$

at 15 (s)

$$\left(100 + 25(15) - \frac{15^2}{2}\right) - (10 \cdot 15) = X_{MAX}$$

$$(100 + 375 - 112.5) - 150 = \boxed{212.5}\ (cm)$$

Sample Exam I, Fall '12, #1

Cop acceleration $3.2\ m/s^2$

car speed = $30\ m/s$

Sample Exam I, Fall '12

(1.) (C.) only: How far cop when $V_{cop} = \frac{V_{car}}{2}$

(C.) only: V_{Rel} (relative speed) when cop catches up with car.

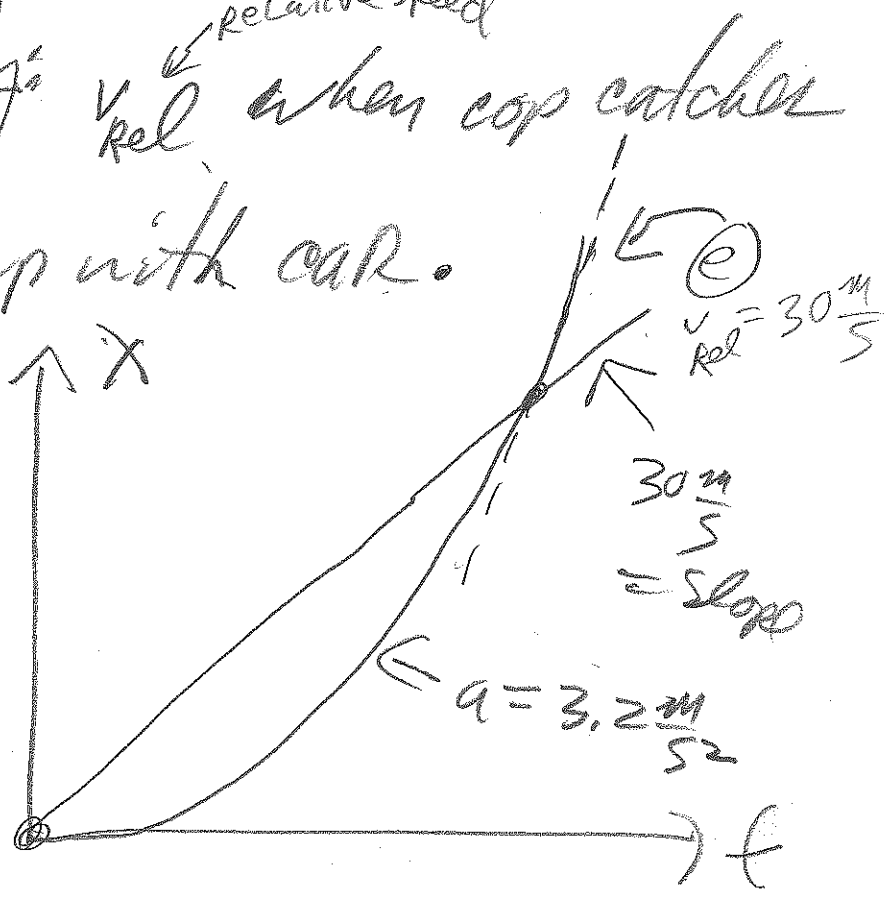
required on test!

(C.) $a \cdot t = 30\ m/s \,/\, 2$

$t = \frac{(30\ m/s)}{6.4\ m/s^2} = (4.69\ s)$

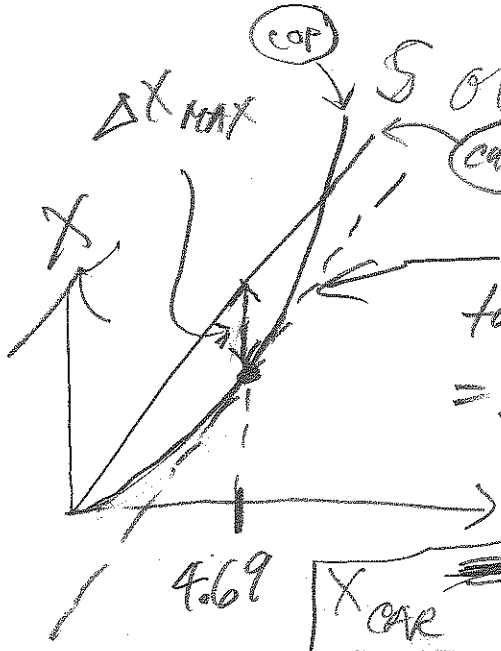
$\Delta X_{cop} = \frac{1}{2}\left(3.2\ \frac{m}{s^2}\right)(4.69\ s)^2$

$= \boxed{35.2\ (m)}$



Possible exam problem:

(c) What is the maximum distance between cop and car?



Solution: set $v_{cop} = v_{car}$

tangent $= 30 \frac{m}{s}$

$3.2 \frac{m}{s^2} \cdot t = 30 \frac{m}{s}$

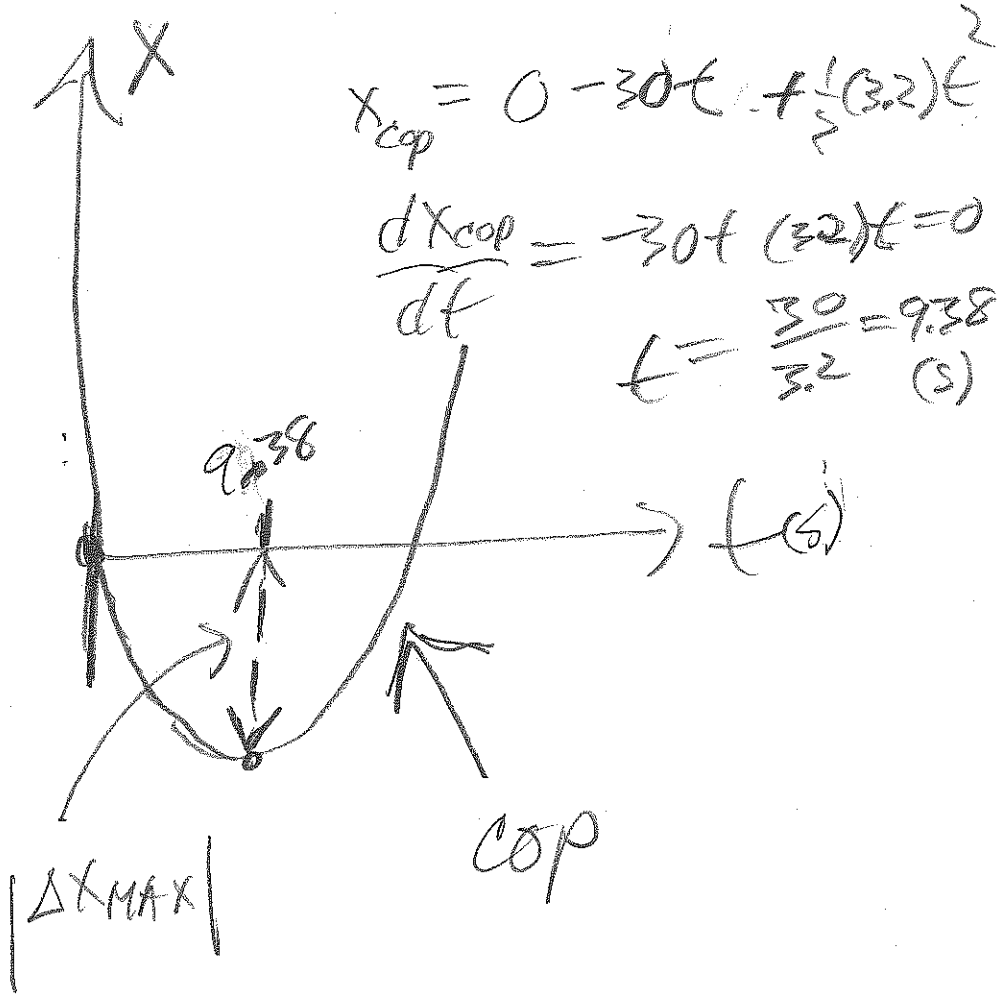
$t = 9.375\ (s)$

$x_{car} = x_{cop} = \Delta x_{max}$

$\Delta x_{MAX} = \left(30 \frac{m}{s}\right)(9.375) - \frac{1}{2}(3.2)(9.375)^2 = 190.6\ (m)$

equivalent to being at rest and cop drives by at $-30\ m/s$ with acceleration $+3.2\ m/s^2$:

reference frame of car: car at rest relative to car.



c.

At catchup:

$|v_{cop} - v_{CAR}| = \underline{\text{relative speed}}$

$|at - 30\frac{m}{s}| = \underline{\text{relative speed}}$

$|(3.2)(18.76) - 30| = \text{rel. speed}$

$|60 - 30| \approx 30\frac{m}{s}$

Find time cop catches up:

$x_{cop} = x_{CAR}$

$\frac{1}{2}(3.2)t^2 = 30t$

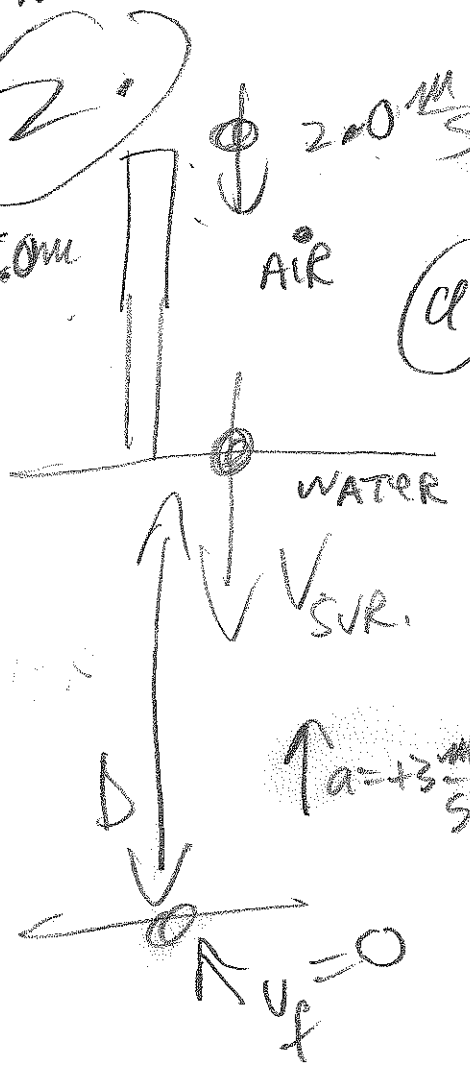
$1.6t^2 = 30t$

$t \cdot (1.6t - 30)$

$t = 0$ or $t = \frac{30}{1.6} = \boxed{18.76\,(s)}$

Sample test 1, #2

2.



$+y$ (pos)

$-g\downarrow = a$

(a.) $|v_{SUR}|^2 = (2)^2 - 2(-9.8)(5)$

$|v_{SUR}|^2 \approx 4 + 100$

$|v_{SUR}| = \sqrt{104} = 10 \frac{m}{s}$

$v_{SUR} \cong -10 \frac{m}{s}$

$v_f^2 = 0^2 = (-10)^2 + 2 \cdot (3) \cdot (-D)$

$a = +3.0 \frac{m}{s^2}$ $\quad \Delta y = -D$

$D = \frac{-100}{-6} = \frac{50}{3} \cong 17 (m)$