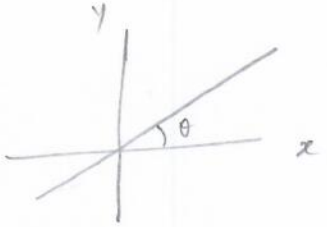
Solutions PHYS-205A (Midterm Exam 01) Spring 2021

Problem 1

No, acceleration is not zero at 3.0 hours. Velocity equal to zero at an instant does not imply acceleration equal to zero at that instant.

Problem 2

$$\frac{y}{x} = \frac{\frac{1}{2} a_y t^2}{\frac{1}{2} a_x t^2} = \frac{a_y}{a_x}$$



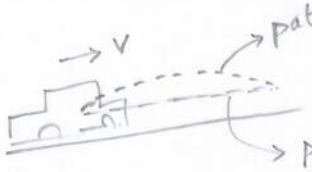
$$\tan\theta = \frac{a_y}{a_x}$$

Thus, $y = \left(\frac{a_y}{a_x}\right) x$,

which is an equation of straight line passing through origin.

Problem 3

Yes, the orange will return to his hands. The orange has the same horizontal velocity as the car.



Problem 4

Stuntman: $x_S = -\frac{1}{2} g t^2$

Ball: $x_B = v_0 t - \frac{1}{2} g t^2$.

Thus, $x_B - x_S = v_0 t$.

That is, the ball moves away from stuntman with uniform velocity.

Problem 5

$$A_{square} = (2R)^2 = 4R^2$$

$$A_{circle} = \pi R^2$$

$$\frac{A_{square}}{A_{circle}} = \frac{4R^2}{\pi R^2} = \frac{4}{\pi}$$

Problem 6

$$[x] = [bt^7] = [ct^8]$$

$$[b] = \frac{[x]}{[t]^7} = LT^{-7}$$

$$[c] = \frac{[x]}{[t]^8} = LT^{-8}$$

$$\left[\frac{b}{c}\right] = \frac{[b]}{[c]} = \frac{LT^{-7}}{LT^{-8}} = T$$

$$\Rightarrow \quad \alpha = 0 \quad \beta = 0 \quad \gamma = 1$$

Problem 7

$\Delta y = -15\,m$ $\quad V_i = -4.0\,\frac{m}{s}$ $\quad a = -9.8\,\frac{m}{s^2}$

$\Delta t = ?$ $\quad V_f =$

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

$$-15 = -4.0\,\Delta t - 4.9\,\Delta t^2$$

$$4.9\,\Delta t^2 + 4.0\,\Delta t - 15 = 0$$

$$\Delta t = \frac{-4.0 \pm \sqrt{4.0^2 - 4(4.9)(-15)}}{2(4.9)}$$

$$= \frac{-4.0 \pm 18}{9.8} = +1.4\,s \text{ (or) } -2.2\,s$$

↘ answer.

Problem 8

$$x(t) = 3\alpha t - \frac{\alpha}{\tau^2} t^3$$

$$v(t) = 3\alpha - \frac{3\alpha}{\tau^2} t^2$$

$$v(t) = 0 \Rightarrow 3\alpha - \frac{3\alpha}{\tau^2} t^2 = 0 \Rightarrow t = \pm\tau.$$

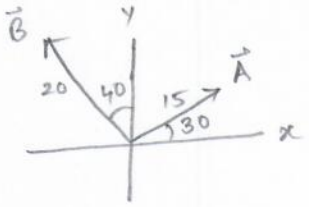
$$a(t) = -\frac{6\alpha}{\tau^2} t$$

$$a(\tau) = -\frac{6\alpha}{\tau^2}(\pm\tau)$$

$$= \mp \frac{6\alpha}{\tau}$$

$$|a(\tau)| = \frac{6\alpha}{\tau}.$$

Problem 9



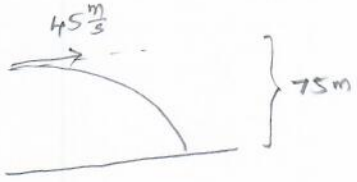
$$\vec{A} = 15\cos 30\,\hat{i} + 15\sin 30\,\hat{j} = 13\,\hat{i} + 7.5\,\hat{j}$$

$$\vec{B} = -20\sin 40\,\hat{i} + 20\cos 40\,\hat{j} = -13\,\hat{i} + 15\,\hat{j}$$

$$\vec{C} = \vec{A} + \vec{B} = 0\,\hat{i} + 23\,\hat{j}$$

$$|\vec{C}| = 23\,m \qquad \text{direction: along } +y.$$

Problem 10



$\Delta x =$

$\Delta t =$

$V_{ix} = 45\ \frac{m}{s}$

$\Delta y = -75\,m$

$\Delta t =$

$a = -9.8\ \frac{m}{s^2}$

$V_{iy} = 0$

$V_{fy} =$

$$\Delta y = V_{iy}\Delta t + \frac{1}{2} a \Delta t^2$$

$$-75 = 0 + \frac{1}{2}(-9.8)\Delta t^2$$

$$\Delta t = \sqrt{\frac{(-75)\,2}{(-9.8)}}$$

$$= 3.9\,s$$

$$V_{fy} = V_{iy} + a\,\Delta t$$

$$= 0 + (-9.8)(3.9) = -38\ \frac{m}{s}$$

$$V_{fx} = V_{ix} = 45\ \frac{m}{s}$$

$$V_f = \sqrt{V_{fx}^2 + V_{fy}^2}$$

$$= \sqrt{45^2 + (-38)^2}$$

$$= 59\ \frac{m}{s}$$